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Editors

The Handbook of the Arctic

A Broad and Comprehensive Overview

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With 117 Figures and 100 Tables

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Preface

As of today, the Arctic represents a research conundrum to break. Being a relatively untapped region with ample mineral resources, it has already become an arena for global political, economic, connectivity, ecological, social, and security multilayered discourse. Recent geo-political and geo-economic turbulence, the region's unsettled international status and induced evolving governance, as well as greater influence of ecological agenda on global economy and world order at large do represent key challenging points to conceptualizing the Arctic per se. Simultaneously, raising energy, transport, and military presence of Russia (a member of the Arctic Council [AC] though) and China (a non-Arctic state) in the region do hamper a weighted and depoliticized analysis.

Thus, *The Handbook of the Arctic: A Broad and Comprehensive Overview* undertakes a decisive endeavor to neatly bridge various dimensions of Arctic exploration with revealed interests of actors to the region. Scholars from the USA, Norway, the UK, France, China, Switzerland, Lithuania, Slovakia, and Hungary on board will add greater balance and inclusiveness to the research of contributors representing Russian academia, research bodies, and expert community.

As far as methodology is concerned, it is rooted in the strive for an all-embracing and multidimensional, *albeit* critical, approach from the perspective of global political economy. It is centered around the fusion of qualitative and quantitative tools to make the research findings sound credible and strong.

The volume is broken down to the following logically intertwined parts of chapters shedding light on the institutional, political, economic, digital, transport, ecological, social, and educational dimensions of Arctic exploration. It also contains a part fully devoted to the Russian part of the Arctic.

First, and more fundamentally, the Arctic and its *governance* have undergone a thorough conceptual revision. This part – Part I, Institutional Framework and Governance – consists of six chapters.

The chapter, "Conceptualizing the Arctic," by Alexander A. Sergunin, Valery N. Konyshev, and Maria L. Lagutina is of conceptual origin and strives to position the Arctic in the existing literature on International Relations (IR) broken down to the following four approaches: value-based approach, interest-based approach, securitization approach, and de-securitized (technocratic/instrumentalist) approach. To put it differently, the region has been carefully viewed from the position of normativists, pragmatics, alarmists (security-oriented thinkers), and non-alarmists (proponents of the de-securitized approach). The authors confess that since neo-realists and geopoliticians do not stand for a cooperative agenda in the Arctic, most of the suggestions on how to exploit the region come from the neoliberal and globalist schools.

The chapter, "The Arctic as a Special Object of Modern International Relations," by Vasily I. Deren and Yulia V. Gnezdova confirms the importance of the region to the existing IR discourse, as its geo-political and geo-economic role has drastically increased. Thus, the region is alluring various actors, including those that are not members of the Arctic Council. Special attention has been given to the related role and interests of Russia.

The chapter, "International Cooperation in the Artic: The Arctic Council," by Alexander A. Sergunin scrutinizes the history and current agenda of the Arctic Council as the main internationally recognized region's governing body. It has been stressed that the Council has generally proved its exclusive status of intergovernmental discussion forum on regional agenda. Yet, the Ukrainian crisis stopped its members from embedding a security problematique of its functioning. The author pictures Russia's chairing the AC in 2021–2023 as a consistent successor of Finnish and Icelandic agendas and focus on sustainable development of the region based on the use of environmentally friendly technologies.

"Revisiting the Arctic Strategy of Russia up to 2035" by Maria A. Maksakova investigates the essence and main directions of national policy to the region given Russia's chairing the Arctic Council in 2021–2023. The author states that given the ongoing internationalization of the region and shift to a new geopolitical reality, Russia has the chance to coin an inclusive and consistent approach to the region keeping in mind its national interests.

In "European Arctic Policy: Interests of Non-Arctic States and the EU," Natalia V. Eremina, Maria L. Lagutina, and Sébastien Gadal critically review the interests of eight non-Arctic European states, that is, UK, Germany, the Netherlands, France, Italy, Spain, Poland, and Switzerland, in exploring the Arctic. Being members of the EU, most of them stand for the idea of its greater involvement in the region's governance, supporting the idea of giving the block an observer status. When going into detail, for instance, it has been found out that the UK, Germany, the Netherlands, and France deviate from traditional areas of cooperation in the region such as scientific research, climate change, and environmental safety and push forward the military agenda under the NATO umbrella. In their turn, Spain, Poland, and Switzerland promote a more balanced approach in their Arctic policy still focusing on the development of scientific research in the region.

In their chapter titled "Interests of Non-Arctic Asian States in the Region," Yana V. Leksyutina and Jian Zhang capture the growing interest and, simultaneously, concern of five Asian states (i.e., Japan, South Korea, China, Singapore, and India) to the Arctic's commercial development. Environmental agenda could be generally viewed as a main concern for all the parties. However, it has been revealed that the interests of these states may differ when broken to the exploration of the region's hydrocarbons and its main waterway – the Northern Sea Route (NSR).

Second, the *economic* part of the book – Part II, Economy of the Arctic: Introduction – has studied the region from trade (including related multilateral regulation), financial, energy, agriculture and fishery, digital, as well as transport and logistics dimensions. Such a complex approach has allowed the authors to capture recent economic trends of the region and then critically trace them. Apart from national strategies, specific attention has been paid to corporate ones reflecting the resource potential of the Arctic.

"Geo-economic Aspects of Arctic Exploration" by Natalia Yu. Konina and Elena V. Sapir opens up the discussion and looks into the geo-economic specifics of the region. As such, the Arctic's geo-economic status generally stems from its energy reserves and formation of two blocks of economic power – USA and its allies vs. Russia and China. The authors conclude that geo-economic rivalry in the region also implies control over innovations and technologies with China inevitably increasing its influence over the region.

In their chapter titled "Arctic Economy: Internal Structure, Types, and National Models," Alexander N. Pilyasov, Andrey A. Petrov, and Nadezhda Yu. Zamyatina introduce the phenomenon of the Arctic economy pointing at its specific features. Specifically, the region's economy is broken down to insular and quasi-continental types with a range of transport connectivities. The authors also differentiate and thoroughly analyze four national models – Russian, Canadian, American, and European.

"Including Arctic in Multilateral Trading System Agenda" by Tatiana M. Isachenko, Elena Kašťáková, and Darya M. Soldatenko points to the fact that existing agreements to the Arctic contain little trade, investment, and intellectual property regulation when viewed from the multilateral perspective. Thus, multilateral trade format, for instance, a wide-scope free trade agreement under the WTO rules, might be a good springboard for the region to become a place for truly international cooperation.

Financial and *investment* dynamics in the region have been displayed under the umbrella of the sustainable development concept in the following two chapters presented in Part III, Finance and Foreign Direct Investment.

"Financial Resources for Arctic Exploration" by Irina N. Platonova studies the world's best practices of green bonds as a promising source of funding the development of the Arctic Zone of Russian Federation (AZRF) based on environmental, social, and corporate governance principles. The author concludes that, as of today, Russian business has modest experience in expertise in placing green bonds as a source for commercial development of the Arctic.

The chapter by Alexei V. Kuznetsov, Ilan Kelman, and Elena N. Nikitina titled "Foreign Direct Investment in Svalbard: Special Legal Status and Comparison with FDI in Yamal Peninsula" provides a fresh view on the Svalbard Treaty regime and its implications on foreign direct investment flows into the archipelago. The evolving investment climate of Svalbard is studied on socio-economic, political, and environmental grounds. In this context, the contributors snapshot a historical turn from mining to tourism, transport, service infrastructure, and scientific research as new targets for foreign investors.

Given the ascendancies of climate change, motion toward renewable energy, and existing Western sanctions against Russia, *energy* specifics of Arctic exploration – Part IV, Energy – have been neatly studied in the following seven chapters.

The chapter, "Global Energy Standoff: The Arctic Dimension," by Alexander G. Simonov touches the region's role and place in global energy transition, as global warming is on the way and world energy prices are volatile enough. The author ends up identifying the related influence the evolving energy sector may bring on the development of the economy of the region.

In their chapter "Arctic Energy Sector Under Low-Carbon Transition," Angelina A. Kolomeytseva and Andrey K. Krivorotov take a regional perspective and neatly address the energy profiles of each Arctic state from both policy and practical points of view. Admitting the importance of global climate agenda, the states take different paths when applying it to their energy complexes at large and renewable sector in particular. However, the renewable segment is still lagging behind fossil fuels. It has been stressed that future oil and gas extraction is likely to occur in Russia and Norway, whereas other Arctic states tend to transit toward renewables, yet, with national specifics.

Yulia V. Zvorykina, Alina V. Filippova, and Olga A. Pavlova in their chapter, "Hydrogen Production Prospects in the Conditions of Climate Change in the Arctic," refer to hydrogen as one of the most promising renewables for the region given the recent global greening tendencies. Having critically classified the existing methods of hydrogen production, the scholars focus on the hydrogen strategies of both Arctic and non-Arctic actors, that is, Canada, Norway, Russia, Japan, and EU. When broken down to Russia, it is transport, energy, and manufacturing that turn out to be the most proponent industries with Novatek, Gazprom, and Rosatom to pioneer the hydrogen revolution.

"Energy Security in the Arctic Zone" by Nikolai N. Shvets, Alina V. Filippova, and Evgeny V. Basov carried out a comparative analysis of regional specifics in the Arctic region (on the example of Russia, the USA, Canada, Norway, Denmark, Finland, Iceland, Sweden) when ensuring energy security. It has been revealed that countries adhere to different options for sustaining energy supply of their Arctic territories such as low-power nuclear plants, high-voltage direct current power transmission, and renewables.

The chapter, "Strengthening Multilateral Energy Cooperation for Indigenous Resilience in the Arctic," by Valery A. Akimov and Olga A. Derendyaeva draws parallels between the energy trends in the region, that is, renewables, and their implications on its inhabitants.

The chapter by Lydia S. Leontieva and Ekaterina B. Makarova titled "Arctic Projects in the Russian Oil and Gas Industry: Implementation Features Under the Current Economic Environment" assesses the economic parameters of development of Zapadno-Messoyakhskoye oil and gas field operated by Lukoil and located in the Yamalo-Nenets Autonomous District of Russia. It has been empirically proved that the project is cost-effective enough.

In their chapter titled "Russia's Arctic Oil Transportation Export Strategy: The Geographical Aspect," Tatyana I. Pototskaya and Yulia V. Gnezdova focus on the specifics of Russia's Arctic transportation strategy compared to that of the Baltic Sea, Black Sea, and Pacific. More fundamentally unlike others the Arctic case is grounded in the nearby mineral base and is exclusively centered around maritime transport, yet, hampered by unstable conjuncture and Western sanctions.

Agricultural and fishery dimensions of the region's economic exploration – Part V, Agriculture and Fishery – have been investigated in the following three chapters.

The chapter, "Food Systems in the Arctic: Inclusiveness and Traditionalism," by Lilia S. Revenko and Olga I. Soldatenkova comparatively reviews the food systems of Denmark, Canada, Norway, Russia, and the USA that vary in terms of level of development, preferences, and state regulation. Overall, it stresses that the Arctic as a region is uneven when speaking about traditional approaches to food supply of indigenous people as well as full- and part-time employees working there. Thus, given the UN strategies toward inclusiveness, the authors doubt whether the region's food systems can soon be incorporated into the global systems.

The chapter, "Vertical Greenhouses in the Arctic," by Natalia G. Sidorova, Anastasiia R. Druzhinina, Maksim A. Nedostup, and Vladimir S. Osipov comes up with an IoT-rooted smart greenhouse project as a solution to the low farming self-sufficiency of the region suffering from higher prices on vegetables and fruit as well as disbalanced nutrition of its inhabitants. The authors have empirically proved its efficiency and have estimated its potential impact on the regions of the Arctic Zone of Russia.

The chapter, "Fishery Cooperation of the Arctic States: Current Aspects," by Lilia S. Revenko, Nikolai S. Revenko, and Elena S. Martynova captures key transformations of fishery cooperation between the Arctic states that are shaping the existing format. For instance, fishery in the region is influenced by climate change, revision of national regulation, unsettled disputes of shelf, and a 200 nautical mile's delimitation, as well as the rising presence of non-Arctic actors. It concludes that the revision of the existing fishery governance in the region should follow an inclusive and multilayered approach.

Digitalization track of the region has been touched upon in the following two chapters – Part VI, Digitalization Agenda – at both national and corporate levels of analysis.

Research under the title "Digitalization of the Arctic" conducted by Oleg B. Pichkov, Alexander A. Ulanov, and Kseniia A. Patrunina comparatively tracks the digitization paths of the Arctic Council members from institutional and practical perspectives with Iceland being at the front. Special attention has been paid to the related digitalization policy of Russia with long-distance and scattered facilities as major hurdles. It unveils that involvement of private companies and capital is complicated by regulatory constraints and the need for large-scale capital investments with a long return on investment. Such mechanisms as experimental legal regimes and public-private partnerships can help to attract private capital in the Russia's Arctic Zone digital projects.

In chapter "Digital Technologies of Oil and Gas Companies in the Development of the Arctic Shelf," Anastasia V. Sheveleva names digital technologies as a tool for Russian energy companies to overcome technological restrictions imposed on them after 2014. Based on the best practices of foreign energy companies the author suggests that introduction of digital technologies, in particular digital twins, robots, and big data, into the production and economic activities of oil and gas companies might raise their efficiency and, simultaneously, add sustainability to their operations.

Regional *connectivity* issues have been scrutinized through the lens of the Northern Sea Route (NSR) in Part VII, Northern Sea Route as the Basis of the Arctic Transport Infrastructure. This corridor is practically twice shorter in distance than that via the Indian Ocean and Africa (usually referred to as the Sothern Sea Route), and with Russia's icebreaker fleet set to increase and modernization, it has all the chances to sustain greater cargo volumes in the East-West trade direction. Yet, these prospects are generally challenged by other states questioning the status of the route as an exclusively Russia's waterway. In fact, such status quo is generally accepted by the international shipping society.

Besides, the research has been enriched by the technical side of shipping via the Northern Sea Route by pointing at ideals and realities of shipbuilding, that is, ice-breakers, tankers, and other fleets, for the needs of the Arctic. However, the existing infrastructure of the Russian Arctic ports and their fairly poor specialization in handling containers have been named as major constraints to the development of the route. In their turn, higher freight rates, unstable weather conditions, and bathymetry constraints also hamper making the NSR commercially viable.

A promising connectivity prospect for the region has been drawn from the Chinese Belt and Road Initiative (BRI), whereas a potential one (subject to normalization of political dialogue between the EU and Russia) from the European transport network (TEN-T).

In their chapter "Logistics and Its Role in the Exploration and Development of the Arctic," Frank Detlef Wende, Darya V. Shvandar, and Marina A. Ponomareva provide a general overview of the existing transport and logistics policies of the Arctic Council members. Specifically, the authors highlight the potential of maritime ports via the NSR to service the rising volumes under the related policy of Russia.

Martin Grešš and Mariia I. Ermilova in their chapter, "Northern Sea Route and Its Geoeconomic Importance," capture the increased interest toward the waterway among scholars and practitioners worldwide. However, the route is still far from being commercially attractive. Such phenomenon has been tested on the examples of energy shipments from ports on its way: Sabetta and Novy Port.

Being in the same vein, Natalia G. Shchegoleva, Olga I. Terenteva, and Vladimir I. Khabarov in chapter "Global Competitiveness of the Northern Sea Route" convey a SWOT analysis of the NSR to assess its global competitiveness. They conclude that plans for increasing the transit cargo traffic via the NSR up to 2024 are nearly zero with the route predominantly associated with the security of the Russian Federation.

Joint research done by Egor V. Pak and Isabell Burmester titled "Northern Sea Route from the Russian and the EU Perspectives: Ideals and Realities" confirms the status of the route as an international transport corridor (ITC), yet holding a number of distinctive features. After 2014 it has experienced a rise in transit cargo volumes (both cabotage and international transit) as well as a number of permissions released by the Administration of the NSR, for instance, to foreign-flagged vessels with China and Germany at the front. Thus, there is little evidence of deliberate Russia's increasing protectionism over the NSR. The authors believe that linking the NSR with the European transport network might bring economic benefits for the Northern member states and raise intercontinental connectivity.

"Northern Sea Route as Driver of Economic Growth: Impact on the Arctic Economy's Future" by Katarína Brocková, L'udmila Lipková, and Vladimir S. Osipov discusses the role of the NSR in the economic development of the Arctic Zone of the Russian Federation. The melting of the Arctic ice sheet is making mineral resources more accessible and, consequently, might attract oil and gas companies (both national and foreign) to their exploration. Besides, ice melting might facilitate fishery activities in the coastal part of Russia. Thus, these prospects require induced transport and logistics steps.

The chapter, "Northern Sea Route: Geopolitical Importance," by Ján Koper, Branislav Kováčik, and Rudolf Kucharčík links the geopolitical ascendancies of the NSR with the overall geopolitical importance of the Arctic. The authors argue that given rising geopolitical tensions with the West, the USA in particular, Russia and China are severely interested in developing the route as an alternative trade corridor.

The chapter, "China's Role in the Northern Sea Route," by Attila Fábián and Juraj Ondriaš follows the same path and points at the potential of Sino-Russian cooperation in the Arctic in connectivity terms. The authors stress that such cooperation is mutually beneficial disregarding any tactical rivalry in the exploitation of the region.

"Chinese Polar Silk Road in the Russian Arctic" by Mariia I. Ermilova and Juraj Ondriaš delves into Sino-Russian relations from the perspective of exploiting the Northeast passage: NSR in Russian context and Polar Silk Road under Chinese BRI. It stresses the status of China as an independent player in the region with Russia opting for investments into its northern transport and logistics infrastructure. However, Moscow and Beijing have to meet halfway. With the NSR still ice-covered, China has to recognize Russia's status quo in the region. In its turn, Russia has to take into consideration China's strive for greater and less stringent regulation of transit flows via the route.

The chapter, "Landline Rail Connectivity of Russia in the Artic Zone: Development Under the Belt and Road Initiative," by Kobilzhon Kh. Zoidov, Alexei A. Medkov, and Zarina A. Dadabayeva focuses on investigating the potential of bridging the NSR with a reliable inland rail system. The authors suggest that the conjunction of the NSR with Cold Silk Road (another term for the Polar Silk Road under the BRI) through a rail landline might inclusively exploit the transit potential of Russia as a part of the Eurasian Economic Union (EAEU). Overall, such a vision coincides with the concept of *transit economy* and its implications for the EAEU.

The technical side of shipping via the NSR has been thoroughly investigated by scholars from Saint Petersburg State Marine Technical University (SMTU) in the following three chapters.

In chapter “Gas Turbine Units as Development Drivers for the Northern Sea Route,” Leyla E. Mamedova, Maria E. Gogolukhina, and Taras M. Grigorev justify the necessity of greater use of gas turbine generators in shipbuilding for the needs of the NSR. The authors quantitatively proved the economic feasibility of using gas turbine elements, that is, blades, that now could be repaired using additive technologies instead of simple replacement.

The chapter by Maria E. Gogolukhina, Leyla E. Mamedova, and Taras M. Grigorev, “Northern Sea Route Infrastructure and Shipbuilding Development: Ecological Norms,” is devoted to distinguishing the impact of the existing types of fuel on environment when shipping via the NSR. In this essence, ammonia turns out to be the most eco-friendly and optimal type of fuel for the needs of the NSR.

“Northern Sea Route Development: Sustainability Issues” by Julia N. Solovjova and Maria E. Gogolukhina applies the triple bottom line approach to measuring the sustainability potential of the NSR. There has been an attempt to assess the contribution the NSR may make to the sustainable development of the region and list the related limitations and risks.

Apart from discussing the potential of the NSR as an ITC, it is worth looking at its unique, Russian-tailored historical function – effecting the delivery of all the essentials to the northern territories by sea and river under the framework of Northern delivery – presented in the following two chapters.

The chapter by Mariya V. Voropayeva and Leyla E. Mamedova, “Optimization of Northern Delivery Economic Mechanisms,” focuses on the specifics of Northern delivery with the Republic of Sakha (Yakutia) as a case study. Quantitative tools applied have made it possible to assert that river-sea class vessels of “Kaliningrad” type are the most appropriate for the delivery of cargo in terms of speed both loaded and empty-run.

Finally, Tautginas Sankauskas and Andrey M. Golubchik in their chapter, “Revisiting the Logistics of the Arctic: Case of Chayanda Field,” question the potential of inland waterway transport of Siberia (i.e., the Lena River) in servicing the material flows for the needs of Siberian oil and gas fields with the Chayanda field operated by PJSC Gazprom as a case study. The authors admit that river infrastructure is severely outdated and cannot sustain the rising volumes despite the fact that there is great demand for freight capacities. Thus, it is the state that can finance these innovations taking after positive Soviet expertise in organizational patterns of running river shipping companies on the Siberian rivers.

Third, the ongoing shift of global economy toward greening represent an interesting puzzle for the Arctic Zone to look into. On the one hand, exploring region’s profound energy resources may contribute to global and regional economic growth, and on the other, states and businesses (mainly extracting companies) are being forced to carefully consider *global ecological agenda*. Thus, the following three chapters address such agenda under the framework of Part VIII, Ecology.

“Environmental Aspects of Arctic Development” by Natalia S. Zagrebelnaya admits and classifies the looming environmental problems over the region. It has been argued that ecological clusters implying international organizations, national authorities, businesses (including oil and gas companies), waste processing plants, and experts might be an inclusive tool for losing the environmental burden.

The chapter by Bulat Z. Akhmetzyanov, Vladimir S. Osipov, and Ramilya G. Novikova titled "Wicked Problem of Waste Management in the Arctic Region" goes into detail of the problem of microplastic accumulation in the Arctic. However, it turns out to be a sine qua non of flows within the world ocean. In this essence, Russia with its longest coastal line of the Arctic seas is vulnerable enough. The authors come up with the idea of modeling movements and places of accumulation of microplastic in the Arctic Zone of Russia.

"Global Arctic Issues in Bilateral Cooperation for Environmental Management Protection: Russian-Chinese Case" by Nadezhda K. Kharlampieva, Marina A. Ermolina, and Anna S. Matveevskaya traces global ecological problems from Sino-Russian perspective with both parties displaying concern. Education, scientific and technical cooperation, and eco-tourism have been named as the most promising areas of bilateral interactions in tackling global environmental agenda.

Fourth, given the ascendancies of *sustainable development* concept, the volume provides comparative analysis of state policy on sustainability with cases of Russian Arctic Zone and Alaska, and corporate one – of companies operating in the AZRF – in the following five chapters building up Part IX, Sustainable Development.

The chapter by Inna V. Andronova and Andrei G. Sakharov, "Sustainable Development in the Arctic: Case of Alaska," touches upon the USA formulating its own sustainable strategy for development of its Arctic region, that is, Alaska. Having critically reviewed major socio-economic indicators of Alaska, the authors conclude that they do not look sustainable enough. Declining natural population growth coupled with volatility of world energy prices might lead Alaska into a systemic employment crisis undermining its sustainable prospects.

The chapter, "Sustainable Development of the Arctic Zone of the Russian Federation: Opportunities and Challenges," by Mikhail E. Kuznetsov and Natalya A. Samsonova bridges the UN sustainable development goals applicable to the Arctic at large and national priorities of Russia applicable to the AZRF. The research embarks on measuring the socio-economic effect of projects in fossil extraction and processing in the Russian part of the Arctic at the platform of information and analytical system "ArcticLabs."

The chapter, "Sustainable Development and Corporate Social Responsibility in the Arctic Zone," by Elena B. Zavyalova and Anastasia I. Kuzmenkova initiates the discussion by first diverging two terms – sustainable development and corporate social responsibility. The comparative analysis has been carried out on the examples of oil and gas companies of Russian, Norwegian, and US origin operating in the Arctic. The authors capture the increasing presence of sustainable development goals in the strategies of studied companies.

The chapter, "Energy Development of the Russian Arctic and Sustainable Development," by Natalia S. Zagrebelnaya, Valery I. Salygin, and Maria I. Riabova lays out a corporate perspective of the world's leading oil and gas companies (i.e., Rosneft, Gazprom Neft, Novatek, TotalEnergies, Shell) on sustainable development and comparatively reviews them in terms of environmental protection, social support, and economic incentives for the local population.

In their chapter titled “Transport Planning and Sustainable Development in the Arctic Region,” Nadezhda A. Filippova, Vladimir M. Vlasov, and Veniamin N. Bogumil look into road transport as a promising mode in making transport system of the Russian North sustainable. The authors have quantitatively justified that road transportation in the AZRF generally decreases costs, increases reliability, and requires fewer servicing personnel.

Fifth, *social issues* stand for an integral part of Arctic-related topics with social security, demography, housing, and product quality being the focus of Part X, Social Issues, containing the following five chapters.

In their chapter titled “Human Security in the Arctic,” Alexander A. Sergunin, Valery N. Konyshev, and Maria L. Lagutina pioneer a nonmilitary approach to security issues by introducing the term social security. This phenomenon is broken to the following segments: economic security, food security, health security, environmental security, personal security, community security, and political security. It has been argued that neoliberal and globalist paradigms within the existing realm of IR are the most appropriate ones for conceptualization of this phenomenon. The contributors conclude that the Arctic states do generally address the human security problematique, yet it is poorly coordinated regionally with major attention given to economic and environmental segments. Overall, there still has been a shift from survival to proactive social strategy.

The chapter, “Demographic Development and High North Communities in Eight Arctic States,” by Alexey I. Andreev, Alexey G. Kazanin, and Marina A. Kazanina scrutinizes the demographical tendencies in the Arctic regions of the Arctic Council members. Despite the fact that life expectancy among the indigenous groups in the Arctic regions of the states in question has risen, this indicator is far from compatible with that of their non-Arctic territories’ inhabitants. Thus, higher energy revenues do not guarantee better living conditions for the local population.

Following this vein, Natalia G. Sidorova, Anastasiia R. Druzhinina, and Maksim A. Nedostup in their chapter titled “Housing Infrastructure Development in the Arctic: ‘Smart House’ Systems” have empirically tested the prospects of construction of smart houses in the Arctic regions of Russia. From the technical side, these buildings are easy to mount enough but meet the criteria of harsh weather conditions. Overall, they turn out to be financially affordable for a target audience – a three-member family – cutting down the energy consumption by roughly half and with payback period of less than 2 years.

An interesting snapshot on weather conditions and their implications on construction dynamics in the region has been presented in chapter “Construction Risk Management in the Northern Climatic Zone” by Vadim O. Evseev. Applying the simulation analysis enabled the author to come up with solutions in construction, such as optimization of management and reduction in related cost and risks. The model empirically proved the possibility of managing construction risks making it possible to minimize deviations from the standard indicators of construction.

"Methods of Product Quality Assessment for the Arctic Population" by Svetlana A. Shchegoleva and Pavel L. Titov has quantitatively revisited a tree-graph model of technological process in manufacturing for the needs of Arctic population. Such an approach has all the chances to improve the quality of products consumed in these territories.

Sixth, the book also touches upon the *research* and *education* dimension of Arctic exploration with several regional patterns, that is, Canadian and Russian, depicted in Part XI, Research and Development.

The chapter by Ekaterina V. Serova and Ivan R. Skripka under the title "China's Soft Power Policy in Finland, Sweden, and Norway: A Cross-Country Analysis" represents a brave, *albeit* critical, attempt to delve into the specifics of China's soft power instruments to the region broken down to four domains: education, research, language, and media. Given the overall geopolitical agenda, the authors capture a relatively politicized perception of China in the three with Swedish discourse being predominantly hostile, whereas Norwich and Finnish more pragmatic but still on alert.

"Research Policy and Cultural Specifics in the Arctic Region: Case of Canada" by Petr I. Kasatkin and Marina D. Krynzhina takes a neat look on the culture-induced specifics of research in bilingual Quebec. It has been noted that prevailing French (not English as elsewhere) as a language of research in Quebec has led the region to its peripheral status, resulting in lower citations and impact factor of scientific journals. As a matter of fact, local French-speaking academic institutions lag behind the English-speaking ones in the number of graduates, that is, scientists and engineers. Thus, the authors refer to Quebec as separate scientific field and capture the French-speaking scientists opt for public service instead of doing research.

The chapter, "Personnel Training for Sustainable Development in the Arctic: Project-Based Approach in Formal, Non-formal, and Informal Russian Education," by Natalya Ye. Ryazanova shows how Russian academic bodies disseminate and shape the national agenda for the development of the national part of the Arctic in formal, non-formal, and informal types of education. For instance, it delves into two Arctic-related cases, which the author has already implemented into the education process.

Finally, the book contains a solid share of chapters devoted to the *Arctic Zone of Russian Federation* presented in Part XII, The Arctic Zone Russian Federation. Russia is the largest Arctic state and logically plays a vital role in its political, economic, and social feasibility. However, there is an existing gap in the Russian multidisciplinary perspective on the region both among national and foreign scholars. So, the research aims at covering it in the following nine chapters.

The chapter by Lenka Fojtíková, Eva Jančíková, and Petra Doleželová titled "Russian Participation in Global Value Chains: Role of the Northern Sea Route" pictures peculiarities of Russia's participation patterns in global value chains. More specifically, the authors point at a relatively increasing role of China in Russia's backward participation pattern. And it is the NSR that might contribute to greater connectivity between Moscow and Beijing given the prospects of bridging the EAEU with BRI.

In their joint research on “Northern Sea Route’s Development Potential and Resource Extraction in the Arctic Region of the Russian Federation,” Irina B. Repina and Valeriya V. Nemtsova undertake a theoretical and juridical approach to the analysis of the existing regulatory and developmental strategies of the AZRF. It has been unveiled that these policies contain embedded stumbling points. Yet, should they succeed, the region might experience greater economic, including extracting, social, and carbon-neutral effects.

“Residents of the Russian Arctic Zone: Economic and Legal Aspects” by Dinara N. Mukhamadieva, Julia A. Khudyakova, and Andrei A. Chirkin unveils a juridical approach to the analysis of entrepreneurial activities in the Russian part of the Arctic. Thus, the authors have thoroughly studied major economic and legal aspects of obtaining a resident status in the Arctic under the existing national regulation, as well as identified promising areas of business.

In the chapter titled “Environmental Protection and Indigenous Peoples in the Russian Arctic: Legal Aspects,” a group of authors comprising Anna V. Kukushkina, Tatyana A. Shishkina, Vladimir N. Shishkin, Valery I. Salygin, and Renat A. Perelet continues the juridical approach to the region and looks into the securitization of the indigenous peoples’ rights on the region’s stable environment and ecosystem at large when implementing the developmental programs in the Russian part of the Arctic.

The chapter by Ksenia Yu. Proskurnova and Vladimir S. Osipov titled “Spatial Development Institutions of the Russian Arctic Zone” captures a greater role of informal institutions in settling regional processes in the Russian part of Arctic rather than that of formal ones of both regional and federal origin. So, it has been stressed that focusing on informal institutions that are already embedded in regional economic and behavioral patterns can lead to a more effective spatial development of the region.

In their joint research under the title “State Policy Implementation in the Arctic: Reputational Potential and Risks of the Russian Government,” Nina N. Rozanova and Yulia V. Gnezdova undertake a reputation-based approach to measuring the efficiency of existing regulation in the territories under the umbrella of the AZRF. The contributors argue that despite the announced strategies and programs devoted to the development of the region, such benevolent goals are outweighed by the aggravating demographic situation, shortage of professional personnel, and poor development of social, transport, and communication infrastructure, including places of traditional residence of indigenous peoples. To some extent is a direct consequence of the complexity of priorities laying the grounds for a revised and inclusive policy for the region.

The chapter, “Virtual Entrepreneurial Networks in the Russian Arctic: Design, Management, and Assessment of Network Entrepreneurial Potential,” by Irina N. Tkachenko and Marina A. Meteleva backed up with related methodology delves into the essence of entrepreneurial capabilities of 450 companies operating in the AZRF. Each company’ capabilities are broken down to three types of network potential: source of venture capital, network capacity for innovation result, and network capacity for innovation activity. The authors conclude that only two of them (North West Phosphorous Company and Achimgaz) – far from being the pillars of the regional economy – possess the entrepreneurial capabilities in question. To be more specific, these two are dynamic subsidiaries of large corporations that prioritize innovation in their organization.

Nadezhda A. Filippova, Vladimir M. Vlasov, and Veniamin N. Bogumil in their chapter "Freight Transport Management in the Arctic Zone of Russia: Natural and Climatic Factors" with Yakutia as a case study estimate the full-fledged potential of large transport projects in fostering the economic development of the AZRF. Harsh climatic conditions and large distances between the points of destination generally presuppose stance to multimodal solutions for the region pointing at transport and logistics centers (TLCs) as one of the instruments. So, the authors provide economic, organizational, and technical rational for setting these TLCs within the transport network of Yakutia.

In her chapter, "Development of the Personnel System of Maritime Transport: Case of the Arctic Zone of Russia," Marina A. Kazanina links further development of maritime transport in the Russian Artic with a related process of personnel training. Shipping usually implies high risk to the health of seafarers which coupled with relatively high deterioration rate of Russian vessels and harsh climatic conditions poses a serious challenge for the policy-makers. With Russia paying heavy attention to the development of its Artic Zone, it is high time to work out a new strategy on related personnel training.

To sum it up, such an international, multilayered, and multidimensional research containing 62 chapters might be of use for a broad audience of academics and policymakers worldwide to satisfy their needs in comparative analysis of various aspects, ideals, and realities of Arctic and non-Arctic states', corporate and non-governmental policies to the region. The book is also advisable for graduate and postgraduate students in economics, politics, management, and technical disciplines taking region-related courses at universities and other research bodies of Arctic and non-Arctic states.

MGIMO University
Moscow, Russia
December 2022

Egor V. Pak

Institutional Framework for the Arctic Exploration

Multilateral

- *Agreement on Cooperation on Marine Oil Pollution Preparedness and Response in the Arctic (MOSPA)* (2013)
- *Baltic Marine Environment Protection Commission, The Helsinki Commission (HELCOM)* (1992)
- *Convention for the Safety of Life at Sea (SOLAS)* (1974)
- *International Convention for the Prevention of Pollution from Ships (MARPOL)* (1973)
- *The Ilulissat Declaration* (2008)
- *The International Code for Ships Operating in Polar Waters* (2014)
- *The Nuuk Declaration* (1993)
- *The Ottawa Declaration* (1996)
- *The Paris Climate Agreement* (2016)
- *The Rovaniemi Declaration on the Protection of the Arctic Environment along with the Arctic Environmental Protection Strategy (AEPS)* (1991)
- *The Svalbard Treaty* (1920)
- *The UN Sustainable Development Goals* (2015)
- *UN Convention on the Law of the Sea (UNCLOS)* (1982)

Denmark

- *Digital Strategy 2016–2020: A Stronger and More Secure Digital Denmark* (2016)
- *Kingdom of Denmark Strategy for the Arctic 2011–2020* (2011)
- *Strategy for Denmark's Digital Growth* (2018)

Canada

- *Arctic and Northern Policy Framework* (2019)
- *The Northern Strategy of Canada* (2013)
- *Canadian Energy Strategy* (2015)

China

- *Belt and Road Initiative* (2013)
- *China's White Paper "China's Arctic Policy"* (2018)
- *National Security Law of the People's Republic of China* (2015)

Finland

- *Digital Infrastructure Strategy 2025* (2018)
- *Finland's Strategy for Arctic Policy* (2021)
- *National Hydrogen Roadmap for Finland* (2020)
- *Towards the Internet of Things Broadband Implementation Plan* (2016)

Iceland

- *A Parliamentary Resolution on Iceland's Arctic Policy* (2011)

Norway

- *The Norwegian Government's Arctic Policy* (2021)
- *Meld. St. 36 (2020–2021) Energi til arbeid – langsiktig verdiskaping fra norske energiressurser [Report to the Storting (white paper) "Energy to Work – Long-Term Value Creation from Norwegian Energy Resources"]* (2021)
- *Meld. St. 9 (2020–2021) Mennesker, muligheter og norske interesser i nord [Report to the Storting (white paper) "People, Opportunities and Norwegian Interests in the North"]* (2021)
- *Regjeringens hydrogenstrategi – på vei mot lavutslippssamfunnet [The Government's Hydrogen Strategy – "Towards the Low-Emission Society"]* (2020)
- *The Norwegian Development Programme to Combat Marine Litter and Microplastics* (2018)

South Korea

- *The 9-BRIDGE Strategy* (2017)

Sweden

- *Sweden's Strategy for the Arctic Region* (2020)

USA

- *National Security Presidential Directive 66* (2009)
- *The Implementation Plan for National Strategy for Arctic Region* (2014)
- *The National Strategy for the Arctic Region* (2013)

Russia

- *Comprehensive Plan for the Modernization and Expansion of the Main Infrastructure within the Period up to 2024* (2018)
- *Decree of the Government of the Russian Federation No. 2423-r on "Fundamentals of State Policy in the Field of Environmental Development of the Russian Federation for the Period up to 2030"* (2012)
- *Decree of the Government of the Russian Federation No. 358 of March 15th, 2013 "On the Establishment of the Federal State Institution 'The Northern Sea Route Administration'"* (2013)
- *Decree of the Government of the Russian Federation No. 47 "On the Promotion of Renewable Energy Sources in Retail Electricity Markets"* (2015)
- *Energy Strategy of the Russian Federation through 2035* (2020)

- *Federal Law "On State Support for Entrepreneurship in the Arctic Zone of the Russian Federation"* (2020)
- *Federal Law "On the Territories of Traditional Nature Management of the Indigenous Peoples of the North, Siberia and the Far East of the Russian Federation"* (2018)
- *Federal Law of the Russian Federation "About Subsoil"* (1992)
- *Federal Law of the Russian Federation "On Environmental Expertise"* (1995)
- *Federal Law of the Russian Federation "On Guarantees of the Rights of the Indigenous Peoples of the Russian Federation"* (1999)
- *Federal Law of the Russian Federation "On the Basics of Russia's State Policy in the Arctic for the Period up to 2035"* (2020)
- *Federal Law of the Russian Federation "On the Territories of Traditional Nature Management of the Indigenous Peoples of the North, Siberia and the Far East of the Russian Federation"* (2001)
- *Federal Law of the Russian Federation No. 155 of 2013 "On Internal Waters, Territorial Sea and Contiguous Zone"* (2013)
- *Federal Law of the Russian Federation No. 193 "On State Support of the Entrepreneurial Activity in the Arctic Zone of the Russian Federation"* (2020)
- *Federal Law of the Russian Federation No. 258 "About Experimental Legal Regimes in the Field of Digital Innovations in the Russian Federation"* (2020)
- *Presidential Decree "On the Land Territories of the Arctic Zone of the Russian Federation"* (2014)
- *Presidential Decree of the Russian Federation No. 204 "On National Goals and Strategic Tasks for the Development of the Russian Federation for the Period up to 2024"* (2018)
- *Program for the Development of Shipbuilding and Technology for the Control of Shelf Sites for 2013–2030* (2012)
- *Program on Development of Domestic and Inbound Tourism in the Russian Federation (2019–2025)* (2019)
- *Roadmap for Hydrogen Development until 2024* (2020)
- *Spatial Development Strategy of the Russian Federation until 2025* (2019)
- *State Program "Socio-Economic Development of the Arctic Zone of the Russian Federation"* (2021)
- *State Program for the Development of the Fishery Economic Complex* (2018)
- *Strategy for Activities in Hydrometeorology and Related Fields for the Period up to 2030* (2010)
- *Strategy for the Development of Tourism in the Russian Federation for the Period up to 2035* (2019)
- *Strategy of Development of the Arctic Zone of the Russian Federation and the Provision of National Security for the period up to 2035* (2020)

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List of Abbreviations

AC	Arctic Council
ACAP	Arctic Contaminants Action Program
ACIA	Arctic Climate Impact Assessment
ACRA	Analytical Credit Rating Agency
AD	Autonomous District
ADB	African Development Bank
AEC	Arctic Economic Council
AEPS	Arctic Environmental Protection Strategy
AI	Artificial Intelligence
AIAN	American Indian and Alaska Native
AMAP	Arctic Monitoring and Assessment Programme
APAC	Asia-Pacific
APG	Associated Petroleum Gas
ArCS	Arctic Challenge for Sustainability
ASEAN	Association of Southeast Asian Nations
ASM	Arctic Science Ministerial Meeting
AZRF	Arctic Zone of the Russian Federation
BAM	Baikal-Amur Mainline
BEAC	Barents Euro-Arctic Council
BRC	Barents Regional Council
BRI	Belt and Road Initiative
BRICS	Brazil, Russia, India, China, South Africa
CAFF	Conservation of Arctic Flora and Fauna
CAO	Central Arctic Ocean
CAR	Circum-Arctic Resource Appraisal
CBI	Climate Bond Initiative
CBS	Climate Bonds Standard
CBSS	Council of the Baltic Sea States
CCA	Council of Canadian Academies
CCS	Carbon Capture and Storage
CDB	China Development Bank
CDP	Carbon Disclosure Project
CICERO	Centre for International Climate and Environmental Research

CIS	Commonwealth of Independent States
CLCS	UN Commission on the Limits of the Continental Shelf
CNCEG	China National Chemical Engineering Group
CNG	Compressed Natural Gas
CNPC	China's National Petroleum Company
COSCO	China Ocean Shipping Company
CPC	Caspian Pipeline Consortium
CPG	China Poly Group
CRTA	Committee on Regional Trade Agreements
CSR	Corporate Social Responsibility
CSTP	Federal Comprehensive Scientific and Technical Program
DAC	Dutch Arctic Circle
DC	Direct Current
DSL	Digital Subscriber Line
DSME	Daewoo Shipbuilding & Marine Engineering
DWI	Direct Water Injection
EAEU	Eurasian Economic Union
ECA	Emission Control Areas
ECOI	Electronic Communications Office of Iceland
EDB	Eurasian Development Bank
EEA	European Economic Area
EEAS	European External Action Service
EGR	Exhaust Gas Recirculation
EIB	European Investment Bank
EITI	Extractive Industries Transparency Initiative
EPPR	Emergency Prevention, Preparedness, and Response
ESG	Environmental, Social, and Corporate Governance
ESPO	Eastern Siberia-Pacific Ocean
ETTC	Eurasian Transport and Transit Company
EU	European Union
EurAsEC	Eurasian Economic Community
FAMART	Federal Agency for Maritime and River Transport of Russia
FAO	Food and Agricultural Organization of the United Nations
FDI	Foreign Direct Investment
FESCO	Far Eastern Shipping Company
FMEA	Failure Mode and Effects Analysis
FSS	Fixed-Satellite Service
FTA	Free Trade Agreement
GATS	General Agreement on Trade in Services
GATT	General Agreement on Tariffs and Trade
GBA	Green Bonds Assessment
GBP	Green Bonds Principle
GHG	Greenhouse Gas Emissions
GPFG	Government Pension Fund Global
GTE	Gas Turbine Engine

GTU	Gas Turbine
GVA	Gross Value Added
GVC	Global Value Chain
HELCOM	Baltic Marine Environment Protection Commission (The Helsinki Commission)
HPP	Hydropower Plant
HVDC	High-Voltage Direct Current Power Transmission
IASC	International Arctic Science Committee
ICC	Inuit Circumpolar Council
ICMA	International Capital Market Association
ICP	Interstate-Corporate Partnership
ICT	Information and Communications Technology
IEA	International Energy Agency
IER	International Economic Relations
IFC	International Finance Corporation
IMO	International Maritime Organization
INGSA	International Network for Government Science Advise
IoT	Internet of Things
IP	Intellectual Property
IPBES	Climate Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services
IPCC	Intergovernmental Panel on Climate Change
IR	International Relations
IRENA	International Renewable Energy Agency
IRWG	Impact Reporting Working Group
ISS	International Space Station
ITC	International Transport Corridor
ITER	International Thermonuclear Experimental Reactor
ITU	International Telegraph Union
IUMI	International Union of Maritime Insurers
JOGMEC	Japan Oil, Gas, and Metals National Corporation
KOGAS	Korea Gas Corporation
LED	Light-Emitting Diodes
LNG	Liquefied Natural Gas
LPWAN	Low-Power Wide-Area Network
MARPOL	International Convention for the Prevention of Pollution from Ships
MEAE	Ministry of Europe and Foreign Affairs
MET	Mineral Extraction Tax
MFN	Most-Favored Nation
MOEX	Moscow Exchange
MOL	Mitsui OSK Lines
MOSAiC	Multidisciplinary Drifting Observatory for the Study of Arctic Climate
MSR	Sea-Based Maritime Silk Road
NAFO	Northwest Atlantic Fishery Organization
NAO	Nenets Autonomous Okrug

NCRA	National Credit Ratings Agency
NDEP	Northern Dimension Environmental Partnership
NDPC	Northern Dimension Partnership for Culture
NDPHS	Northern Dimension Partnership for Health and Social Well-Being
NDPTL	Northern Dimension Partnership for Transport and Logistics
NEAFC	Northeast Atlantic Fishery Commission
NFRD	Non-Financial Reporting Directive
NGFS	Network of Central Banks and Supervisors for Greening the Financial System
NGO	Non-Governmental Organization
NIPR	Japanese National Institute for Polar Research
NLP	Northern Latitudinal Passage
NRA	National Rating Agency
NSCOGI	Initiative of the North Sea Countries to Create Marine Networks
NSIDC	US National Snow and Ice Data Center
NSP	Northeast Passage
NSR	Northern Sea Route
NTIA	National Telecommunications and Information Administration
NWP	Northwest Passage
OECD	Organisation for Economic Co-operation and Development
OGCF	Oil and Gas Condensate Field
OPEC	Organization of the Petroleum Exporting Countries
PAME	Protection of the Arctic Marine Environment
PIE	Public Interest Entities
PISM	Polish Institute of International Affairs
POC	Production Optimization Center
PPP	Public-Private Partnership
PRC	People's Republic of China
PRI	Principle for Responsible Investment
PSR	Polar Silk Road
PVC	Polyvinyl Chloride
R&D	Research and Development
RCP	Representative Concentration Pathway
RES	Renewable Energy Sources
RF	Russian Federation
RFBR	Russian Foundation for Basic Research
ROTACS	Russian Optical Transarctic Submarine Cable System
RSZ	Reduced Speed Zone
RTA	Regional Trade Agreement
SAO	Senior Arctic Official
SAON	Sustaining Arctic Observing Networks
SBN	Sustainable Banking Network
SCO	Shanghai Cooperation Organization
SCR	Selective Catalyst Reduction

SDG	Sustainable Development Goal
SDWG	Sustainable Development Working Group
SIF	Forum for Sustainable Insurance
SLC	Single Logistics Centre
SLOC	Sea Lines of Communication
SME	Small and Medium-Sized Enterprise
SOE	State-Owned Enterprise
SPOD	Steady-Predictable-Ordinary-Definite
SREB	Silk Road Economic Belt
SROCC	Special Report on the Ocean and Cryosphere in a Changing Climate
SSA	Space Situational Awareness
SSR	Southern Sea Route
ST	Svalbard Treaty
SWEA	Swedish Wind Energy Association
SWOT	Strengths-Weaknesses-Opportunities-Threats
TBL/3BL	Triple Bottom Line
TCFD	Task Force on Climate-Related Disclosures
TE	Transit Economy
TEG	Group of Technical Experts on Sustainable Finance
TEN-T	Trans-European Transport Network
TES	Total Energy Supply
TEU	Twenty-Foot Equivalent
TFR	Total Fertility Rate
TKR	Trans-Korean Railway
TNC	Transnational Corporation
TOE	Ton of Oil Equivalent
TPR	Trans-Polar Route
TRIPS	Agreement on Trade-Related Aspects of Intellectual Property Rights
TSR	Trans-Siberian Railway
TTS	Transport and Transit System
UAV	Unmanned Aircraft and Vehicle
UNCLOS	United Nations Convention on the Law of the Sea
UNCTAD	United Nations Conference on Trade and Development
UNDP	United Nations Human Development Program
UNEP	United Nations Environment Program
UNIST	Ulsan National Institute of Science and Technology
USCG	United States Coast Guard
USGS	United States Geological Survey
USSR	Union of Soviet Socialist Republics
UV	Ultraviolet
VEB	Vnesheconombank
VUCA	Volatility-Uncertainty-Complexity-Ambiguity
WPC	World Petroleum Council
WTO	World Trade Organization

Part I

Institutional Framework and Governance

Conceptualizing the Arctic

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Contents

Abstract

This chapter pursues the following four aims: First and foremost, to conceptualize the Arctic as a multifaceted region within a changing global context, which is both affected by it and affecting it. Secondly, to examine the present-day world discourse on the Arctic, including neorealist, neoliberal, globalist, and post-positivist approaches. Thirdly, to describe the major drivers of the global Arctic dynamics; namely, climate change, ecological changes, changes in resources extraction practices and corresponding infrastructure development, including urbanization, as well as changes in geopolitical configurations, and changes in Arctic economies, societies and cultures. Finally, to define, analyze, and discuss concrete ways to address these changes in the global Arctic, including mitigation, adaptation, and resilience-building strategies.

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The Arctic · Theoretical approaches · Climate change mitigation and adaptation · Sustainable development · Resilience

Introduction

The Arctic geoeconomic and geopolitical dynamics is a vexed question both in the media and research literature. "Race for the Arctic" and the "New Cold War" are common newspaper headlines when it comes to coverage of Arctic affairs. In popular media, some think tank reports and even official documents, the Arctic is often portrayed as a zone of potential conflict – with unresolved boundary issues, rapidly changing sea ice cover and tempting natural resources forming a potentially explosive political cocktail (Ball et al., 2014; Boulegue, 2019; Brady, 2019; Burke, 2020; Department of the Army, 2021, pp. 15–16; Sputnik, 2017). On the other hand, the region possesses a strong track record of post-Cold War peace and cooperation with a number of institutions that support this cooperative trend. There is a group of experts who believe that the Arctic can avoid the coming of the "New Cold War" and the region will retain its status of low tension, peace and stability (Finger & Heininen, 2019; Heininen, 2016; Konyshev & Sergunin, 2019; Sergunin, 2021; Sergunin & Konyshev, 2016).

Along with the "hot" debate on the Arctic's conflict potential, there is a worldwide discourse on the consequences of the global processes for this region. The Arctic has become exposed to increasing globalization. In fact, the region has long been "global" in the sense that Northern fishing grounds, whaling, fur trading, and mining have connected the Arctic to markets around the world. Today, however, the forces of globalization are boosted by climate change and the Arctic is becoming increasingly integrated into the global economy. As indicated above, there is growing interest in the Arctic sea routes and natural resources that become available as the sea-ice melts.

A significant share of the world's as-yet unexploited oil and gas resources is at the bottom of the Arctic Ocean. As the sea ice melts, coastal states and energy companies view these northern resources with great interest. However, using them would create emissions and accelerate climate change. A debate has started about whether the new Arctic oil and gas reserves should be utilized or left untouched. At the heart of the Arctic discourse lies the question of exploiting new Arctic oil and gas resources at a time when humankind needs to reduce emissions.

Thus, along with the various global issues, new *ethical* questions have emerged that relate to Arctic oil and gas. They concern the "Arctic Paradox": The faster we use fossil fuels, the sooner we get access to new oil and gas resources (Palosaari, 2019). Fossil fuels contribute to climate warming, which makes the Arctic sea-ice melt, making new oil and gas resources available. Using those resources then further accelerates climate warming. This makes Arctic oil and gas development unavoidably an ethical issue. Is it acceptable to explore and exploit new oil and gas in the

Arctic at a time when humankind needs to reduce its carbon emissions? To drill or not to drill, that is the question.

The key questions of the global climate change ethics debate – such as moral responsibility and distribution of burdens and benefits – have lately found their way into Arctic politics. There are conflicting views that range from supporting unlimited oil and gas development to proposing a drilling ban. Some have stressed economic growth and the right of indigenous peoples and other local population to benefit from natural resources, whereas others have highlighted the environmental risks of the mining and fossil energy industry. There are also varying views regarding the extent to which Arctic states, companies, and people have responsibility to mitigate climate change.

In the Arctic case, there are differences in how the actors perceive and promote the oil and gas development. To some it is an ethical problem, to some it is a question of technical standards, and to others it is not a problem at all. The causal interpretations also differ: Some see a connection between Arctic oil and gas extraction and climate change, while others refuse to do so. This is arguably a question of differences in how the issue is *framed*. In the context of global climate ethics, it is interesting to analyze what ethical arguments, if any, are presented in order to build legitimacy for future treatment recommendations regarding Arctic oil and gas.

The Arctic is currently in the midst of an ongoing process of interaction, interpretation, and contextualization due to the political, social, and economic impacts of climate change. The debate is rife with dynamics such as cooperation versus conflict, environment versus extraction, globalization versus periphery, and indigenous peoples' economic growth versus their traditional livelihoods.

This chapter offers a theoretical interpretation of the Arctic as a geographical, geoeconomic, geopolitical, and ethical phenomenon. More specifically, this study aims to discuss different meanings of the concept "Arctic," to examine various theoretical approaches to the region, as well as to explore drivers of change in the High North and discuss concrete ways to address these changes in the global Arctic, including mitigation, adaptation, and resilience-building strategies.

What Is the Arctic? Definition of the Concept

It is well-known from international relations history that naming geographic locations is not only about geography, but also about geopolitics. In the case of the Arctic, this is, for example, shown by the two passages: The Northeast Passage was renamed to the Northern Sea Route in the late 1910s, when navigation and other commercial use of this seaway started. The Canadian Federal Government renamed the Northwest Passage in 2010 to the Canadian Northwest Passage to state that it is a fundamental part of the Canadian internal waters. This is nothing exceptional, since so many names in the world, particularly in peripheries, are so-called *geo-names*. This means that conquers, colonialists, and other outsiders have given their names to geographical places, such as mountains, rivers, lakes, and even continents which they have "discovered." This is the case with the name of the *Arctic* coming from the Greek word *Arctos* (meaning a bear).

There are several geographical, political, and cultural geo-names and terms to describe, and many definitions to define, the northernmost regions of the globe. The mainstream definitions of the Arctic region are either based on geography or physical and natural sciences. The Arctic's common geographical definition is the areas north of the Arctic Circle (66 degrees and 32 min of Northern latitude). Vegetation zones and a tree-line and tundra boundaries are used as physical and environmental definitions. From climatic point of view, there is the 10°C July isotherm defined as the southern border of the Arctic. Concerning Arctic marine areas, there is the extreme border of the multiyear sea ice. Rapidly warming climate has, however, meant that definitions based on climate are not anymore so exact in the Arctic.

Some social scientists and publicists believe that the Arctic is a historical and spiritual concept, and it is closely related to the concept of "Northernness" (Nordicity) and includes all those territories where peoples with a special "northern spirit" live. In Russia, the most prominent representatives of this point of view are the famous philosophers and publicists Alexander Dugin (1993 and 2008) and Alexander Prokhanov (2007), who believe that Russians are the "northern people" and that it is through the development of the Arctic potential that Russia's spiritual and geopolitical revival will take place.

There are also both internal and external images depending on what is your perception. Some of them are competing, even controversial, when some others are more shared and common, for example, by people(s) living in the North, since images are shared among northern people(s) naturally, or by scholars working on Arctic issues, or by those who are enthusiasts of the North. There is also self-perception as an important way to define a region, such as the idea of "the North as a state of mind," and that remapping and renaming of places has started, for example, in the Canadian North.

The Arctic is not always used in Northern languages like, for example, in the Finnish language the Arctic Ocean is *Pohjoinen jäämeri* (The Northern Ice Sea). The same is true for the Russian language, where the Arctic Ocean is called Northern Icy Ocean (*Severnyi Ledovityi Okean*).

The Arctic is, however, a very powerful geo-name and most of the Arctic states use it in their national strategies and state policies: Canada's "Arctic and Northern Policy Framework" (2019); "The Kingdom of Denmark's Strategy for the Arctic 2011-2020" (2011); "Finland's Strategy for the Arctic Region" (2013); "A Parliamentary Resolution on Iceland's Arctic Policy" (2011); "The Norwegian Government's Arctic Policy" (2021); Russia's document "On the Strategy for the Development of the Arctic Zone of the Russian Federation and Ensuring National Security up to 2035" (2020); "Sweden's strategy for the Arctic region" (2020); and the US "National Strategy for the Arctic Region" (2013).

In Russia, this term is of strategic (in different senses, from economy to military affairs) nature since 1926, when the Resolution of the USSR's Central Executive Committee Presidium "On the announcement of the lands and islands located in the Arctic Ocean the USSR's territories" was adopted. Nowadays, the Arctic Zone of the Russian Federation (AZRF), a synonym to "Russian Arctic," is in the spotlight of Russian political and economic agenda. The last time the land territories of the

Russian Arctic were defined according to the Decree of the President of the Russian Federation dated May 2, 2014, no. 296, which was amended in 2017 and 2019 (Putin, 2014, 2017, 2019). As a result, along with the territories located beyond the Arctic Circle, cities and regions belonging to the subarctic zone were included in the AZRF: the Murmansk Region, Nenets, Yamalo-Nenets and Chukchee Autonomous Districts, Russian archipelagos and islands in the Arctic Ocean, as well as some parts of the Arkhangelsk Region, Krasnoyarsk Province, Republics of Karelia, Komi and Yakutiya (Sakha).

There are also two other terms challenging the Arctic: The *Circumpolar North* is much used in North America, particularly in Canada; there is, however, a slight change toward to use the term Arctic, as Canada's recent Arctic strategic documents show.

Correspondingly, the *High North* is recently much used in Norway: The Norwegian 2009 "High North Strategy" claimed that the term of the High North is "really a Norwegian perspective." The term was also used in the "Iceland in the High North" report (2009) but not any more in a "Parliamentary Resolution on Iceland's Arctic Policy" (in 2011). Also, the European Parliament's report on a sustainable EU policy for the High North uses the term, unlike the EU Commission's communication (2008) and its follow-up (in 2012) use the "Arctic."

As a result of definitions and attempts, both from outsiders and northerners, there are also other geographical names and terms for the Arctic region such as *Ultima Thule*, the *Far North* and *Lapland*: The first one is an old term used by the ancient Greeks, and nowadays it is used as a name for exhibition and institute. In Russia, the *Far North* (*Krainiy Sever*) is sometimes used to define the northernmost territories of Russia in a specific Russian legislation to indicate a welfare policy and provide some benefits, such as monthly allowance to the salary, additional leave, to (economically active) population of the regions with severe environment conditions. Finally, *Lapland* is a traditional name for the North Calotte, though nowadays it is mostly used as the name for Finland's northernmost county.

However, when it comes to the Arctic as an international region, it is generally accepted to define it as a geographical area that includes, in addition to the Arctic Ocean, parts of the North Atlantic and the Bering Sea, also those territories of the eight Arctic Council (AC) member-states that are located above the Arctic Circle. This definition has been adopted in the AC and other intergovernmental and nongovernmental organizations, as well as at the expert level. We will also adhere to this definition in our study, but at the same time we will take into account national specifics in defining by each northern country of its Arctic zone.

Theoretical Debate on the Arctic

The world theoretical discourse on the Arctic can be reduced to the fighting between, on the one hand, normativists and pragmatics and, on the other, alarmists (security-oriented thinkers) and nonalarmists (proponents of the desecuritized approach).

The first debate is manifested by the clash between the value- and interest-based approaches to the Arctic:

Value-based approach is mostly shared by the International Relations (IR) paradigms of neo-liberalism and globalism. According to this approach, the Arctic (particularly, its natural resources and sea routes) is a common humankind's heritage/asset that should be exploited together with other countries and in a very careful way (Dodin, 2005; Finger & Heininen, 2019; Heininen, 2016; Kharlampieva & Lagutina, 2011; Zagorsky, 2011). The neoliberals and globalists believe that subregional institutions such as the AC, Barents Euro-Arctic Council (BEAC), Nordic institutions are parts of the global and regional governance systems and should be designed and function accordingly. For them, the AC and BEAC should avoid discussion of security issues; rather, environmental issues and the "human dimension" (indigenous people and other residents of the Arctic regions) should be their main priorities.

Interest-based approach is developed by the neorealist IR paradigm. According to the neo-realist perspective, regional players' principal interest is to turn the Arctic into the main "strategic resource base" and other policy considerations should be subordinated to this over-arching goal. Both Arctic states' domestic policies and international strategies should be oriented to the protection of its national interests in the region (Ball et al., 2014; Boulegue, 2019; Brady, 2019; Burke, 2020; Huebert, 2010; Oreshenkov, 2010; Voronkov, 2012). Against this background, it is especially important to secure Arctic countries' economic interests in the region. A variety of various instruments ranging from diplomacy and international arbitration to a modest military buildup and creation of capabilities to effectively prevent poaching and smuggling are suggested.

In contrast with the neoliberals, the neo-realists are quite pragmatic as regards the international institutions such as the UN, AC, and BEAC. They do not believe that these international fora are the components of the global or regional governance system whose existence is sharply denied by them. They suggest using these bodies first and foremost to protect Arctic countries' national interests in the region rather than promote some abstract universal values.

Another division line emerged from the debate on Arctic security. In this sphere, two approaches can be distinguished as well:

Securitization approach. This approach is developed by the alarmist-type analysts (mainly from the geopolitical and neorealist IR schools) who tend to see every Arctic problem from the national security point of view – be it ecological problems and fisheries or territorial disputes and control over the sea routes.

The radical version of this school views the Arctic as a manifestation of the perennial geoeconomic and geopolitical rivalry between the Arctic states, especially between Russia and the West (Ball et al., 2014; Boulegue, 2019; Brady, 2019; Burke, 2020; Huebert, 2010). In contrast with the past, the West prefers economic rather than military instruments for putting pressure on Russia. The aim of the Western policies is to secure Russia's status of the West's "younger partner" and a source of cheap natural resources and labor force.

Contrary to what has been stated in the Western and Russian official Arctic doctrines, the mutual perceptions of each other as the main threats to the Arctic states security are still alive in large parts of the Russian and Western political, military, and expert establishments. Military and diplomatic activities of the key regional players in the High North are routinely perceived by both sides as being of an "offensive character." For example, the former Director of the US National Intelligence Daniel Coats stated in his testimony to the US Senate Intelligence Committee in May 2017: "As the Arctic becomes more open to shipping and commercial exploitation, we assess that risk of competition over access to sea routes and resources, including fish, will include countries traditionally active in the Arctic as well as other countries that do not border on the region but increasingly look to advance their economic interests there" (Sputnik, 2017).

The 2021 US Army Arctic strategy identifies *four drivers* of great power competition in the Arctic: (1) military developments, (2) energy resources and minerals, (3) transportation, and (4) food security (Department of the Army, 2021, p. 15).

The regional security situation is complicated by the intervention of non-Arctic states into the regional affairs. Some Western countries (particularly, the USA, Canada, Denmark, and Norway) are seriously concerned by the so-called Chinese expansion in the High North. For example, they are wary of the Chinese *Polar Silk Road* doctrine and Beijing's attempts to invest in strategically important sectors of the Russian, Greenlandic, Icelandic, and other northern countries' economies.

They are particularly concerned about the Sino-Russian rapprochement in the Arctic. Western countries are afraid that Sino-Russian cooperation will not be limited only to the economy and will spill over to the military sphere. Recent US strategic documents explicitly state that Russia and China pose a threat to US national interests in the Arctic. For example, the 2021 US Army Arctic strategy notes: "...America's great power competitors – Russia and China – have developed Arctic strategies with geopolitical goals contrary to US interests. Russia seeks to consolidate sovereign claims and control access to the region. China aims to gain access to Arctic resources and sea routes to secure and bolster its military, economic, and scientific rise" (Department of the Army, 2021, pp. 15–16).

The extreme (nationalistic) version of this approach (which is especially popular in the geopolitical school) sees the Arctic above all as a crucial element in shaping the Arctic countries' "Northern identity" and elevating their international statuses in the High North politics.

The first Canadian Arctic doctrine which was pathetically entitled "Canada's Northern Strategy: our North, our Heritage, our Future" stated: "The Government of Canada is firmly asserting its presence in the North, ensuring we have the capability and capacity to protect and patrol the land, sea and sky in our sovereign Arctic territory. We are putting more boots on the Arctic tundra, more ships in the icy water and a better eye-in-the-sky" (Minister of Public Works and Government Services Canada, 2009).

Former Canadian Prime Minister Stephen Harper repeatedly noted that the first rule of Arctic sovereignty is "use it or lose it" and his government "intends to use it, because Canada's Arctic is central to our identity as a northern nation: It is part of our history and it represents the tremendous potential of our future" (cited in Chase, 2014). To this end, Canada started annual summer military exercises entitled "Operation Nunalivut" in its northern territories, which are explicitly designed to project Canadian sovereignty in the High Arctic.

The Russian geopoliticians believe that Moscow's assertive policies in the Far North can help in reviving Russia's great power status and are therefore focused on geopolitical competition with the West, and in particular with the USA. For example, in his book titled *The Arctic Battle: Will the North be Russian?* Artur Indzhiev has announced the onset of a sort of the Third World War in which a weakened Russia will have to prove its heroism in order to safeguard its rights in the Arctic against aggressive Western powers (Indzhiev, 2010). Alexander Dugin, another geopolitical pundit, suggests that nowadays the eternal competition between the sea and land powers has been transformed from the geostrategic rivalry to the geoeconomic one (geopolitics of natural resources) (Dugin, 1991, 1993, 2002).

Other authors put forward a more spiritual view of the role of the High North in the construction of Russian identity and the pursuit of its traditional messianism. For instance, in his *The Mysteries of Eurasia*, Dugin (1991) elaborates a cosmogony of the world in order to make Siberia, the last "empire of paradise" after Thule, the instrument of his geopolitical desire for a domination of the world, justified by Russia's "cosmic destiny." This group of theorists claims that the North is not only Russia's strategic resource base (as stated by the Kremlin) but also its territory of the spirit, of heroism, and of overcoming, a symbolic resource of central importance for the future of the country (Laruelle, 2014, pp. 39–43).

In both cases, the Arctic is presented as Russia's "last chance" and as a possible way to take "revenge on history." The Arctic is presented as rightful compensation for the hegemony lost with the disappearance of the Soviet Union.

De-securitized (technocratic/instrumentalist) approach. The proponents of this approach believe that most of the Arctic problems can be solved beyond the security context, in a "normal way." In case of a conflict, this school suggests using negotiations to realize positions of the opposite party and find a compromise that could satisfy both contending sides. To this group of analysts, the work on the technical/instrumentalist level has a consolatory effect on the conflicting parties and creates an interdependency mechanism that additionally contributes to the problem-solving process (Finger & Heininen, 2019; Heininen, 2016; Kharlampieva & Lagutina, 2011; Zagorsky, 2011).

The proponents of this approach (mainly from the neoliberal and globalist schools) point out that the military significance of the North has dramatically decreased in the post-Cold War period. The region is, in their view, unable to play the role of the great powers' military outpost. The neoliberals and globalists hope that the Arctic will be further opened up for international cooperation to become a "gate-way" region that could help Arctic countries (including Russia) to be better integrated in the world economy and multilateral institutions. They believe that due to its unique geoeconomic location, the Arctic has a chance to be a "pioneer"/pilot region for an enhanced multidimensional international cooperation (Finger &

Heininen, 2019; Heininen, 2016; Kharlampieva & Lagutina, 2011; Vasilyeva & Chen'sin, 2011; Zagorsky, 2011).

It should be noted that there are not only differences between various IR schools, but also some consensus between them exists. For instance, they tend to agree upon the growing significance of the Arctic both for the regional players and the world at large. They also agree that their countries have to have sound Arctic strategies, which should clearly describe these states' national interests and policy priorities in the region, including both opportunities and limits for international cooperation. The IR theorists would like to have flexible Arctic strategies that make a distinction between countries' long-, mid-, and short-term goals in the region and which are able to quickly adapt to change.

To sum up, the world theoretical discourse on the Arctic cannot be reduced to the neorealist and geopolitical paradigms albeit they are still dominant in the Arctic countries' foreign policy thinking. This discourse has gradually grown diverse and creative. Now, in terms of expertise, the Arctic states' political leadership faces diversity rather than uniformity and has the option of choosing among different views and options. And the Arctic countries' choice for soft power instruments in their foreign policies demonstrates that the neoliberal and globalist argumentation has been heard by the decision-makers.

Global Drivers of Change in the Arctic

It became trivial to say that climate change is the main reason and a trigger for the recent significant changes in the Arctic region. Indeed, climate change (first of all, polar ice retreat) can exacerbate existing drivers of instability in the Arctic and may lead to disputes over trade routes, maritime zones, and resources previously inaccessible. This competition may lead to security threats for particular countries of the region and overall international instability. There are a number of areas where rather significant security challenges can be met.

In fisheries, climate change might bring increased productivity in some fish stocks and changes in spatial distributions of others. New areas may become attractive for fishing with increased access due to reduced sea ice coverage. For some of the Arctic high seas waters, there is not yet an international conservation and management regime in place. This might lead to unregulated fisheries and, hence, conflicts because of that.

For example, fisheries have become a bone of contention between the EU and Iceland on the accession negotiations because Reykjavik feels uneasy to provide EU member states with an access to its exclusive economic zone. Besides, Brussels insists on stopping whale hunting in which Iceland is involved (along with Norway and Japan).

The Russian-Norwegian bilateral tensions are one more example of fishery-driven conflict. Particularly, the Russian fishery lobby is discontent with the Russian-Norwegian treaty on maritime zones delimitation of 2010 because it believes that Norway got the maritime zones which are richer in fish than the

Russian ones. For the same reason (the Norwegian "part" of the Barents Sea is getting richer in fish because of the climate change), Oslo insists on the revision of the Paris Treaty on Svalbard of 1920, which establishes an international regime for economic activities on the archipelago while Russia and other treaty signatories are against it. In reality, there are repeated conflicts between Russian trawlers fishing around the Svalbard and the Norwegian coastal guard that tries to arrest them.

In the ***sphere of hydrocarbons extraction***, retreating ice opens up new commercial opportunities for gas and petroleum activities. This may increase competition between the five coastal states for control over continental shelf and maritime zones as well as invite another conflict – between the Arctic-5 (Canada, Denmark, Norway, Russia, and the USA) and noncoastal states (such as Finland, Sweden, UK, China, Japan, South Korea, India, etc.) who would like to participate in exploitation of the Arctic natural resources. The role of international legal regimes (especially UN Convention on the Law of Sea) and bodies (UN Commission on the Limits of the Continental Shelf, CLCS) are particularly important in this regard.

For example, the Lomonosov ridge which is allegedly rich in oil and gas has become an apple of discord between the three coastal states – Canada, Denmark, and Russia. Each country claims that this ridge is a part of their continental shelf. These countries worked hard to prepare their submissions to the UN CLCS to justify their claims on this part of the Arctic. A series of expeditions have been organized to get scientific evidence that the Lomonosov ridge (and the Mendeleev one) is a continuation of either of the Siberian or North American (Canadian or Greenlandic) continental platforms. Denmark, Russia, and Canada filed their submissions to the UN CLCS in 2014, 2015, and 2019, respectively. The CLCS' decision remains to be seen.

In transportation domain, retreating ice opens up new opportunities for shipping as well with a more intensive use of the Northern Sea Route and North-West Passage. This may increase competition between coastal and noncoastal states for the control over these passages and, at the same time, emphasize the need for new legal regimes and transport and search and rescue (SAR) infrastructures. China, Japan, and South Korea (the nations that are most interested in exploitation of these sea routes) insist that the NSR and NWP are the humankind's assets or global commons and should be available for everyone and, hence, internationalized. The USA also believes that the freedom of navigation is the basic principle of the international law order. On the contrary, Russia and Canada believe that they have priority in these areas because of their geographic proximity and historical reasons. Both Moscow and Ottava plan to develop these routes and provide them with more advanced infrastructures and increased safety.

Climate change could expand opportunities for the development of the ***tourism and recreation industry***. On the other hand, it is important that both individual countries and international organizations should continue to support sustainable Arctic tourism, welcoming the efforts made to minimize its environmental footprint. Protection of the environment and benefits to local coastal communities should be primary considerations. The safety of tourist shipping is one more area of concern. To cope with this challenge, the AC started to work on a legally binding document to regulate tourist shipping in the region.

Climate change leads towards significant change in ***population flows***. It caused increased migration of both indigenous population (because of the radical restructuring of its economy and way of life) and work force (which is occupied in the gas/petroleum and mining industries, transport and military sectors). The migration flows are especially intense in the Russian sector of the Arctic because the growing economic activities in this region attract labor migrants not only from other parts of Russia but also from various post-Soviet republics. These developments dictate the need for large-scale socioeconomic programs to adapt both the local population and newcomers (migrants) to such radical changes.

Climate change entails not only socio-economic but also military challenges to the Arctic region, thus might hypothetically lead towards the ***remilitarization of the region***. The increasing competition for trade routes, maritime zones, and natural resources has already led and continues to lead to a military buildup of particular coastal states and intensification of NATO military activities in the region. In contrast with the Cold war era, the current military efforts aim at protection of economic interests of the Arctic states and assertion of their national sovereignty over the maritime zones and trade routes rather than global confrontation between two superpowers or military blocs.

To give some examples of military buildups in the region, for instance, Canada created a 5000-strong ranger unit in its North and builds new ice-class patrol frigates. Ottawa also plans to renovate its Air Force fleet with fifth-generation fighters. The USA and Canada are modernizing the NORAD system. Besides, the USA is strengthening its Alaska Command and deploying the Ballistic Missile Defense systems in the Arctic region (in Alaska and sea-based in the Greenlandic and Norwegian seas). The USA also plans to modernize its strategic submarine fleet.

Norway is engaged in a quite impressive program to modernize its Coast Guard (including five new frigates' acquisition). According to the so-called Stoltenberg Report of 2009, the five Nordic nations (Denmark, Finland, Iceland, Norway, and Sweden) decided to create joint military units as well as air monitoring system and SAR infrastructures, which are specially designed for the Arctic. They also plan to create a space group of three satellites to enhance the above structures' capabilities in communications and navigation.

Russia has resumed its strategic aviation flights over the North Atlantic and Arctic, developed its Northern Fleet (including its nuclear component), and created a special Arctic brigade to increase its military capabilities on the Kola Peninsula.

These developments affect the international security regime in the region in a negative way and increase mistrust between the regional players.

In Lieu of Conclusion: What Should Be Done?

Since neorealists and geopoliticians do not favor a cooperative agenda in the Arctic, most of the suggestions on how to improve the situation in the region come from the neoliberal and globalist schools.

First of all, these schools believe that it is very important to guarantee that the Arctic players should interact with each other on the basis of the following political and legal principles:

- Preserving peace, predictability, and stability in the Arctic region
- Ensuring sustainable management and development of natural resources
- International cooperation to meet common challenges in the Arctic
- Developing national and international legal mechanisms to promote Arctic governance

They think that a priority should be given to the issues that unite rather than disunite regional actors-climate action (including climate change mitigation, adaptation, or geoengineering), trade, cross-border cooperation, transport infrastructure, maritime safety, Arctic shipping (including the Polar Code implementation), environment, health care, Arctic research, indigenous people, people-to-people contacts, and so on. In this respect, they view the Northern Dimension partnerships as well as AC, BEAC, and Nordic institutions' programs as a helpful framework for such cooperation.

It should be noted that all the AC member-states acknowledge the importance of issues related to climate change, discuss them, and prioritize them in their Arctic strategies. The Arctic states fully understand that the main responsibility for solving climate change-related problems lies with them rather than with international institutions.

As far as the multilateral level is concerned, the Arctic states were the key cosponsors of the 2015 Paris UN agreement on global climate change. They support both the UN specialized agencies and regional institutions, such as the AC and BEAC, in their efforts to build an efficient climate change mitigation and adaptation strategies.

However, it is clear that there is still a long way to go to create an efficient multilateral governance system to both adapt the region to the ongoing climate change and prevent climate change-related conflicts between various international actors in the Arctic. Various international actors, which differ by their background, status, and size and range from powerful states to small NGOs, should first harmonize their approaches to the problem of climate change in order to develop common legal regime and institutional mechanisms that could be capable to successfully cope with this fundamental challenge.

Many experts believe that a special arms control regime for the Arctic should be negotiated and it should cover not only land-based forces and weapon systems but also the Arctic seas.

The proposals to develop a system of confidence- and security-building measures in the region are made by the international expert community as well. The regional CSBMs could be based first and foremost on the 1994 OSCE Vienna Document, which proved to be efficient in Europe. In addition, the following measures could be suggested:

- Given the specifics of the region, CSMBs should cover not only land but also naval military activities.
- Along with spatial limitations, temporal limitations on Russian, NATO, and EU military activities in the region could also be established.
- Military-to-military contacts, joint exercises, exchanges, and visits should be further encouraged.
- The countries of the region should intensify exchange information on their military doctrines, defense budgets, as well as on major arms export/import programs.
- Not only regional but also bilateral CSBMs should be further encouraged.
- An idea of establishing a limited nuclear weapon-free zone in the Arctic (say, in Central Arctic) can be discussed. For example, Russia and USA could consider Canada's initiative to ban nuclear weapons in the region. Russia has responded positively to this initiative (Moscow raised a similar idea under Mikhail Gorbachev), but it has questions about the geographical scope of such a zone. Russia supports making the Arctic a nuclear weapon-free zone, provided this would not affect the Kola Peninsula which is a home to two-thirds of the Russian strategic nuclear submarines.

Moscow also considers the field of civil protection as a promising venue for the Arctic regional cooperation. For example, according to the EU-Russia 2005 roadmap to the Common Space on External Security, one of the strategic objectives of Brussels–Moscow cooperation is to strengthen EU–Russia dialogue on promoting common ability to respond to disasters and emergencies, specifically including crisis management situations. The positive experience accumulated in this area could be replicated to the Arctic regional cooperation. The Arctic already has a positive SAR experience under the BEAC and AC auspices (two agreements on SAR and preparedness for fighting oil spills were signed in 2011 and 2013, respectively). The priority areas for civil protection cooperation could be as follows:

- Strengthening coordination of the Arctic states' agencies responsible for civil protection. This requires hard work on implementing the existing arrangements between the Operations Centre of Russia's EMERCOM (Ministry for Emergency Situations) and its foreign counterparts. More specifically this means exchanging contact details for keeping in touch on a 24-h basis; exchanging templates for early warnings and requests/offers for assistance; exchanging information during an emergency, where appropriate; conducting communications exercises on an agreed basis; and enabling operation staff to spend some time in the operational center of the other partner's service in order to gain practical experience.
- Exchanging information on lessons learnt from terrorist attacks.
- Inviting experts, on a case-by-case basis, to specific technical workshops and symposia on civil protection issues.
- Inviting observers, on a case-by-case basis, to specific exercises organized by the partner countries.

- Facilitating mutual assistance in search and rescue operations for submarines, ships, and aircraft in emergency situations.
- Cooperation between the coast guards in the framework of the Arctic Coast Guard Forum.

With the beginning of a new round of the Ukrainian crisis in 2022, doubts arose about the possibility of implementing these proposals in the field of CSBMs and civil protection in the foreseeable future. However, after the normalization of the situation around Ukraine, the Arctic players will somehow have to return to a cooperative agenda in the region.

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The Arctic as a Special Object of Modern International Relations

Vasily I. Deren and Yulia V. Gnezdova

Contents

Abstract

The Arctic is a significant part (about a sixth) of the Earth. It is located between the North Pole and the extreme northern parts of three continents – Europe, Asia, and North America – and includes almost the entire Arctic Ocean (the smallest on Earth, accounting for only 4% of the World Ocean area) with its islands (except for the coastal Norwegian islands) and many adjacent areas of the Atlantic and Pacific Oceans. Taking into account the spatial criterion, the Arctic includes three interrelated parts: continental, coastal, and oceanic. All these parts are rich in mineral resources and, simultaneously, imply regional and global struggle. Thus, the chapter critically positions this region in the existing realm of International Relations.

Introduction

The exact area of the world Arctic has not been calculated yet due to its irregular shape (lack of clear rounded outlines) and is estimated differently. The following three different techniques are most often used: (1) along the southern border of the tundra (when using this technique, the area of the Arctic is close to 27 million kilometers squared, which is approximately 5.3% of the total surface of the Earth), (2) taking into account the isotherm +10° of the warmest month (in this case, the

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Arctic area is approximately 25 million kilometers squared or 4.9% of the total Earth's surface), and (3) the Arctic ends in the south at the Arctic Circle (in this case, the Arctic area is approximately 21 million kilometers squared or more than 4.1% of the total Earth's surface). By the way, in accordance with the international legal doctrine, the Arctic is recognized as a part of the Earth, the center of which is located at the Northern Geographical Pole and the marginal border – the Arctic Circle (66°33′ north latitude).

The total land area of the world Arctic, on which, according to some data, people have been living for about 40 thousand years, exceeds 13 million km^2. Today, 5.4 million people live there (Smirnov, 2020). In comparison with the Arctic countries, the population of the world Arctic is more mobile, has a higher degree of urbanization, and is represented mainly by young men.

The processes of exploring the Arctic (determining its borders, the borders of continents, establishing all the islands, and measuring the depths of its water resources, etc.) have just begun.

Despite the fact that the Arctic is still one of the most unexplored territories of the world, the latest research already indicates that it is one of the richest regions in the world. Besides significant forestry, fishing, fur, water resources, its minerals have been formed throughout Earth's history, keep about 22% of the world's hydrocarbon resources, including 13% of oil reserves and 30% of gas as well as coal, iron ore, nonferrous, precious, rare-earth metals, diamonds, phosphates, etc. For example, the share of global palladium production in the Arctic regions was 40%, diamonds – 21.1%, platinum – 14%, nickel – 10%, cobalt – 6.6%, zinc – 4.5%, titanium – 4.4%, silver – 3.4%, gold – 2.7%, and copper – 1.8% in 2017 (Volkov, 2019). Significant reserves of pure freshwater are stored here in solid form and in several million lakes.

All this is supposed to be located approximately equally in different regions of the Arctic, but it requires exorbitant costs and efforts for its extraction and processing.

Arctic in the Existing Realm of IR

International relations that are formed to solve various problems related to the Arctic and its economy include all components of social relations, first of all, economic, political, military-political, legal, social, class, national, ethnic, ethical, religious, national, and other aspects of human relations (Torkunov, 2019).

The most noticeable objects that cause and complicate relations between different global subjects when it comes to the Arctic are its natural resources, including land plots (islands), water, underwater spaces, any other riches of the regions of the Far North of the planet Earth and the Arctic Ocean.

The subjects of international relations regarding the Arctic and its riches are both individual countries of the world economy and groups of states, as well as individuals, the largest mono-national and multinational corporations with interests in this region.

As for the states, the main subjects here should include Russia, Norway, Denmark (which possesses Greenland and the Faroe Islands), Canada, and the United States, which have a great advantage in the development of the Arctic, since their territories overlook the coast of the Arctic Ocean. They are followed by Iceland, Sweden, and Finland, which do not have direct access to the Arctic Ocean, but are in close proximity to the Arctic circle or have territories within it. The subjects of these relations are also any other (non-Arctic) states with interests in the Arctic region, among which socialist China, Japan, South Korea, individual NATO countries, the EU (especially the United Kingdom, Germany, Italy), etc., have recently been particularly active. The main interstate (intergovernmental) entities that enter into international relations to solve the problem of the Arctic region were formed in 1996. They include Arctic Council (Arctic Council, 1995), NATO, the EU, the UN, etc.

The Arctic Council (AC) includes the following subjects of Arctic relations: 8 of the above-mentioned Arctic states, 6 organizations representing the indigenous peoples of the Arctic, 38 observers, including international organizations, non-governmental organizations, 13 non-Arctic states (Great Britain, Germany, China, etc.), as well as observers with limited rights (EU and Turkey).

Many nongovernmental organizations are special actors – participants in international relations when it comes to the Arctic region. We can name 11 of them that are members of the AC: the Advisory Committee for the Protection of the Seas, the Arctic Institute of North America, the Association of Reindeer Herders of the World, the Union for the Conservation of the Circumpolar Region, the International Arctic Scientific Committee, the International Arctic Association of Social Sciences, the International Union of Health in the Circumpolar Region, the International Working Group on Indigenous Peoples, the Northern Forum, the University of the Arctic, and the World Wide Fund for Nature. The main activities of these organizations include lobbying for their joint interests, promoting all types and results of their activities in the Arctic region, collecting and exchanging various information, and providing other services to any entities related to this region and the world economy as a whole.

International Arctic relations can manifest themselves in the form of cooperation between the relevant actors as well as the rivalry between them, up to prewar conflicts. Cooperation was most noticeable in the first periods of Arctic exploration, especially during search and rescue operations. Today, the statements about cooperation in the development of the Arctic can be found in almost all official interstate documents, but rivalry still prevails.

At the same time, an example of such cooperation can be recognized as the cooperation of the United States with Norway or Canada during military exercises near the Russian border in the Arctic. An example of rivalry is the refusal of the members of the Arctic Council from the proposal of the NATO leadership to take over the provision of search and rescue in the Arctic (NATO, 2009), which, as the Council members rightly believed, would undermine other regional institutions in the Far North.

Besides, almost all forms of relations are antagonistic in nature due to the predominance of the capitalist (albeit mixed) system of social management in the modern world. Perhaps, the maximum surge of antagonistic international relations over the Arctic began during the Second World War (1914–1918), that is, when the world already divided between the capitalist powers was redistributed, when there was no more free land left, they had to divide and colonize the lands of the Arctic. It was during this period that the general relative indifference to the issues of political rights to the polar spaces began to be replaced by fierce disputes and struggles. The confrontation between the UK and the United States sharply intensified in connection with the intentions of the United States to declare the North Pole to them (1924). The UK and the United States tried to seize the islands of the Siberian part of the Arctic Ocean (1923–1924); there were conflicts between the United States and Canada and between Canada and Denmark over the rights to land and islands in the adjacent polar waters. There was also a conflict between Denmark, which occupied the east coast of Greenland, and Norway over the rights to no-man's Greenland, symptomatic rumors appeared about the fact that US President G. Truman offered Denmark to sell Greenland to the United States for $100 million. In response to this, England undertook a number of maneuvers aimed at separating Iceland from Denmark. In other words, the "Danish inheritance" was the object of a struggle between the largest imperialist powers – England and the United States (Pryanishnikov, 2021).

Perhaps the main problem that complicated international relations is the ambiguous assignment of a significant part of the Arctic territories to its official owners. For example, in accordance with international law, the width of the exclusive economic zone should not exceed 200 nautical miles (370.4 km) measured from the baselines, and if a State proves that a certain part of the seafloor is a continuation of its continental platform, it can claim to expand its exclusive economic zone. This gives the largest capitalist states the right to dictate their conditions of behavior in the Arctic to other countries, including the Arctic ones.

Despite the fact that the United States, as a migrant colony, appeared in the world economic system less than 300 years ago and, of course, did not play a significant role in discoveries and research in the Arctic, in modern conditions it has become, perhaps, the only state aimed at taking on a decisive role in the system of international Arctic relations, as well as in the global economic system.

It is important to recall that the United States turned into an Arctic state only in 1867, thanks to the sale of this country by the Government of the Russian Empire for $7.2 million. Alaska, whose area exceeds 1.7 million kilometers squared, which is 10% of the total area of the territory of modern Russia and about 18% of the total area of the territory of the modern United States. Meanwhile, according to its former governor (2009–2014), Sean Parnell, "Alaska is a kind of storehouse of natural resources, where traditional and renewable energy sources are represented in staggering volumes, which can significantly reduce the volume of oil and gas imports from abroad. Gold, zinc, coal, natural gas and oil-together these minerals are of vital importance for the energy security of the United States" (Strategic Importance of the Arctic, 2009). But if we take the Arctic zone, that is, north of the Arctic Circle, not all of Alaska is located there, as is commonly believed, but only 27% of it (Terebov, 2019) and, consequently, the share of the US Arctic Zone from the total area of the Arctic land does not exceed 4%.

The Arctic is not of such strategic importance for the United States as, for example, for Russia or Canada, which have Arctic zones many times larger, so the

US leaders considered the Arctic mainly as one of the possible theatres of military operations during the Cold War and, unlike other countries, did not show much priority interest in the Arctic for a long time. They were passionate about creating a "new American people," which required a significant expansion of the state's territory by seizing foreign lands, pushing back, expelling and destroying the indigenous peoples of North America. This interest was also restrained by the economic crises of overproduction, especially the Great Depression, the First and, especially, the Second World War, thanks to which the United States dramatically increased its wealth, as never before in its history, the forced competition of the United States with the USSR and the socialist system as a whole, which required paying more attention to socio-economic, scientific, and technological development. The US interest began to fade completely to the Arctic region after the collapse of the USSR and most of the socialist system when the new Russia practically gave up competing for the Arctic. At that time, they were very busy introducing their democracy in the former Yugoslavia, Iraq, Libya, Syria, Afghanistan, Georgia, Ukraine, and other postsocialist countries.

However, the United States began to increase its attention to the Arctic and international relations defining the use of its advantages and riches in the 2000s. First, each of the presidents (J. Bush, B. Obama, D. Trump) one after another proposed their "directives" concerning the Arctic and national security, and since 2013, different versions of strategies for the Arctic region have been published in the United States. The US Army, Navy and Marine Corps, Coast Guard, and other military units published their strategies.

On January 19, 2021, an updated version of the 2019 strategy appeared under the title "Regaining Arctic dominance, 2021." It was signed by the Chief of Staff of the US Army, General Jameson K. McConville, and Secretary of the Army Ryan D. McCarthy. This document, as all previous ones, set the same goals and objectives: strengthening its global dominance in the Arctic region (domination); strengthening the US military contingent in Alaska; modernization and accumulation of the icebreaking fleet, unmanned aircraft, ground and underwater systems, space systems, sensors and other systems to achieve and maintain awareness in the maritime field, build relations with Russia and China as opponents of the United States, promote US interests in the Arctic Council, and seek free action – free movement of aircraft, floating vehicles, as well as commercial and scientific expeditions in all regions of the Arctic; and accession to the 1982 Law of the Sea Convention.

By the way, the United States constantly declares its accession to this Convention but does not join it, since, according to some analysts, "the United States occupies the most convenient position, without binding itself to any obligations arising from it, but enjoys the advantages provided by it. Such positioning is potentially destabilizing, in particular, leaving the United States the opportunity to openly ignore any decisions of the bodies established in accordance with the Convention" (Terebov, 2019). This gives them the opportunity to expand the Arctic shelf as much as possible relying on national legislation. According to other scientists, the United States is likely to join this Convention, but only after it is fully confident in its dominance both in the oceans and in the world as a whole.

The US directives, strategies, and other official documents constantly emphasize the desire of their hosts to participate in international relations regarding the Arctic within the framework of international law and to improve the international cooperation and international institutions on cooperation between the Arctic and non-Arctic states. However, practice shows that US relations with all countries regarding the Arctic are implemented exclusively on the principle of "USA first," most often as dictatorial and antagonistic.

Suffice it to say about their problems with Canada, which, by the way, is the closest state not only in terms of territory but also in terms of spirit: Since 1958, the United States and Canada have had an agreement on the creation of a joint North American Aerospace Defense Command (NORAD) and Canada is a member of NATO, the "Big Seven," the North American Free Trade Agreement (NAFTA) between the United States, Canada, and Mexico. Canada dutifully participates in joint military exercises with the United States in the Arctic on its own territory. Canada always supports the United States and follows it. According to the US President, J. Biden, "the United States has no closer friend than Canada" (Biden, 2021). At the same time, the relations between Canada and the United States cannot be called rational and mutually beneficial.

For example, these countries have been continuing difficult disputes over the shortest natural route of the Northwest Passage (NWP) which passes through the Canadian Arctic Archipelago and includes a number of water routes connecting the Pacific and Atlantic Oceans for more than 50 years. At the same time, Canada recognizes its territories of the Arctic from its coastal border to the North Pole as this is an objectively established, accomplished, and recognized by the Arctic states historical fact. This is what gives it the right to resolve possible territorial Arctic disputes with neighboring countries through bilateral regional agreements without the participation of non-Arctic states and international organizations. Due to the fact that all the routes of the NWP pass through the Canadian Arctic Archipelago, the Canadian administration, but especially its public, considers it the "Canadian Northwest Passage," and therefore, there can be no disputes on this issue.

The fact that NWP was officially transferred to Canada in 1880 is another important argument for this. The UK has the right to the Canadian Arctic Archipelago, where British expeditions made many discoveries for more than three centuries. For example, they proved the presence of the NWF (Robert McClure, 1853) and conducted research within it. Besides, Inuit people have been living and farming in the Arctic region of Canada for many millennia. They are one of the three groups of indigenous peoples recognized by the Canadian Constitution. This is also recognized as an important argument in Canada's recognition of its NWF (Byers, 2011), as well as its entire territory in the Arctic.

Canada does not prevent the movement of floating funds belonging to other countries through the NWF but is subject to obtaining a special permit from the Canadian authorities for this, and being within the framework of the NWF, they are in the Canadian jurisdiction.

However, according to the US authorities, the NWF meets the legal criteria of an international strait, since it connects two parts of the open sea (the Arctic and

Atlantic Oceans) and is intended for international navigation. In this regard, the waterway is considered a Canadian territory, but any foreign vessels have the right of free passage through it (Byers, 2011). The United States does not only aggressively hold its ground in this dispute, but also, in fact, provokes it by conducting its submerged and underwater vessels through the NWF without any permission.

The Prime Minister of Canada J. Trudeau and the US President J. Biden held their first meeting on February 23, 2021, where they agreed not to resolve disputes between themselves, but to launch an expanded dialogue on the Arctic, on the modernization of NORAD/NORAD, on a joint struggle for democratic values around the world and confrontation with hostile powers (Biden, 2021). It is easy to assume that the desire to jointly implement these tasks should strengthen the long-established relations between the US and Canadian masters aimed at confrontation with hostile powers, increasing militarization in the Arctic region, and weakening or even Canada's giving up its positions in disputes over the NWF. Under these conditions, US-Canadian relations are becoming an instrument of the United States to increase its presence in the Arctic region. J. Trudeau is probably right when he claims that "(the world) has been very lacking the US leadership" (Biden, 2021).

The United States has been developing special relations with Denmark over its administrative unit located in the Arctic. Greenland is the largest island in the world with an area of 2,131,000 kilometers squared (for comparison, the area of Denmark is 42,394 kilometers squared). The island strongly attracts the owners of the United States not only by its location that can be used for military-strategic purposes (the largest US military facilities have been located in Greenland in the Thule Air Base since the 1950s), but also for its rich reserves of freshwater, oil, uranium, and rare earth metals. Therefore, in 1946, following president T. Jefferson, who bought Louisiana from France for $15 million, A. Johnson, who bought Alaska, President Truman offered Denmark $100 million for Greenland. President D. Trump must have been guided by the same thoughts, so he tried to purchase Greenland in 2018. And when the deal failed this time, and the aspirations to implement it were called "absurd" by potential sellers, the US pressure on the Danes took a new form: It turned out that Denmark had been paying only half of NATO membership fees since 1949.

Russia's international policy regarding the Arctic and its riches is extremely important for the socio-economic, military-strategic, humanitarian, and other areas of the country's development, and, according to Vladimir Putin, not for decades, but for centuries to come (Transcript, 2021). Economic history shows for certain that these relations began to take shape since 1648 when Russian navigators led by F. Popov and S. Dezhnev laid the first route along the entire coast of the Chukchi Peninsula and went to the Pacific Ocean on a sailing and rowing vessel.

It should be particularly noted that throughout history, the international relations of tsarist Russia, the Soviet Union, and now the new Russia with other Arctic, as well as with non-Arctic, countries have developed in different and ambiguous ways. In our opinion, in pre-Soviet times, they manifested themselves in the form of classical relations peculiar to the capitalist form of management and, accordingly, to capitalist countries, where the main goal is to extract profit at any cost, by any means, no matter what; in the Soviet (1917–1990) years, especially since the 1950s, when the world system became bipolar (with the dominance of the socialist countries led by the USSR and the capitalist world led by the USA), they were largely competitive, which became an important factor in activating global economic growth and development; in 1990, with the collapse of the USSR and the main part of the socialist countries, when the world at once became unipolar (under the auspices of the United States), and the leadership of the new Russia for unknown reasons began to play "giveaway," with Western states, Russia's international relations became largely flawed; since the 2000s, when the new leadership of Russia began to resist the excessive interference of individual states in the internal affairs of other countries, especially the CIS countries, international relations returned to the classic capitalist channel, but began to be predominantly more aggressive.

It should be particularly noted that when dealing with the Arctic, international relations were formed mainly between economic entities and private individuals for quite a long time. The passivity of the Russian state in the Arctic region is indicated by the statement of the Swedish-Norwegian Kingdom in 1871 that it was intended to annex Svalbard. Russian international policy regarding the Arctic began to manifest itself more and more noticeably only during the Soviet era. In 2019, the USSR unilaterally demarcated the borders of the Soviet part of the Arctic within the following framework: from the Norwegian Svalbard in the west to the Bering Sea in the east and from the North Pole to the southern coast of the Barents and Kara Seas, the Laptev Sea, the East Siberian and Chukchi Seas in order to ensure and strengthen its presence in the world Arctic and protect national interests. In the early 1920s, the government of Soviet Russia organized northern expeditions at the expense of the state, large-scale research and transport and fishing development of the Arctic regions began, and work was intensified to create objects of strategic importance: the Northern Navy, its coastal infrastructure, and large-scale and systematic development of the Northern Sea Route, which then transported up to 7 million tons of cargo per year and turned out to be the safest route for cargo transportation during the Great Patriotic War.

In the 1920s and 1930s, such port cities as Murmansk, Norilsk, Naryan-Mar, Igarka, Dixon, Tiksi, Ust-Port, New Port on the Ob, Port of Providence Bay, etc., were created and began active work on cargo transportation as part of the Northern Sea Route. Today, 135 out of 415 settlements on the territory of the World Arctic with a population of more than a thousand people are Russian (Fauser & Smirnov, 2018). And the largest city in the Arctic by population (352.1 thousand people) is the Russian Arkhangelsk. And this is even though since the 1990s, when the revolutionary transformations took place in the country, the number of people in this Russian region has sharply decreased. For example, if we take the Chukotka Autonomous Okrug, an array the size of three Great Britains, according to official data, the population decreased from 180,000 people in 1990 to 48,500 people in 2021.

In 1935–1936, successful high-latitude voyages were carried out on the icebreakers "Sadko," "Sedov," "Malygin," and "Krasin."

In the 1970s, the implementation of a large-scale state project for the development of rich natural resources in sparsely populated regions of the North, Siberia, and the Far East began. It involved the construction of the Trans-Siberian and Baikal-Amur highways to connect the center of Russia with these regions as well as the construction of more than a dozen large territorial-industrial complexes, including industrial enterprises, research centers, power plants, social infrastructure. Some things have already been created, but due to the lack of interest in this project and the Arctic region as a whole among the new managers of the new Russia, the implementation of this project was interrupted; only the ghost towns and other ghost objects in the Minusinsk basin of Siberia are evidence of this.

There have been many stages in Russia's relations with the United States, as well as with other Arctic states, when discussing the Arctic. The most notable of them, in our opinion, were associated with the following historical events:

1. Russia sold Alaska to the USA in 1867.
2. A special diplomatic note (Note, 1916) sent by the Ministry of Foreign Affairs of the Russian Empire on September 20, 1916, to foreign states, including the United States, which listed the vast lands and islands included in the territorial composition of Russia, located near the European coast of the country, as well as along the northern coast of Siberia, which were discovered by the Russian B.A. Velkitsky in 1913–1915.
3. The memorandum of the Government of the USSR to the Government of the United States, which stated that in accordance with the Agreement concluded between Russia and the United States regarding the cession of Russia's possessions in North America dated March 30, 1867, all the named islands and lands are located in the waters that wash the Northern coast of Siberia, and are located to the west of the line defining the border, to the west of which the United States pledged not to make any demands (Memorandum, 1924) (by the way, neither the diplomatic note nor the Memorandum was disputed by the world community).
4. The Arctic Council created in 1996.
5. The Russian flag was planted at the bottom of the Arctic Ocean near the North Pole in 2007 during the expedition "Arctic-2007" under the leadership of A.N. Chilingarov.

The last event was perhaps the most noticeable one for the USA and their wards in NATO, which increased the tension in international relations over traditional problems and paved the way for new disputes and conflict situations related not only to the Arctic. Responding to this event, Cohen Ariel, the head of the Center for Energy, Natural Resources and Geopolitics of the Institute for Global Security Analysis of the United States, qualified Russia's actions as an "attempt at territorial seizure" and called on the US government to "react decisively" (Cohen, 2010). After that, the US State Department said that the flag hoisted by Russian polar researchers did not add any legal weight to Russia's application for the territory of the sea shelf.

We are talking about one of the main disputes that unfolded primarily between Russia, Denmark, and Canada (with the active participation of the United States) around the Lomonosov underwater ridge, discovered by Soviet high-latitude expeditions in 1948, with a length of 1.8 thousand km and an average width of 200 km. The ridge runs in the Arctic Ocean from Russia to Canada and is a continuation of the Russian continental shelf. Russia has submitted a repeated application to the UN Commission on the Limits of the Shelf, including a deeper scientific justification that the Lomonosov Ridge is a continuation of its continental shelf in terms of its geological structure. Similar applications that have been submitted by Denmark, Canada, and other countries can also do the same. The Commission's recognition of the Russian materials as justified will allow Russia to get the right to expand its exclusive economic zone by 1.2 million km^2.

Another unresolved problem for Russia in the Arctic is, perhaps, the tensions with the United States and some other Arctic countries about the Northern Sea Route (NSR, North-Eastern Passage, Sevmorput) – one of the most important and promising objects in the Arctic for Russia and for the world economy as a whole.

The NSR runs along the northern coasts of Russia along the seas (Barents, Kara, Laptev, East Siberian, and Chukchi) of the Arctic Ocean and part (Bering Sea) of the Pacific Ocean. It forms a single transport system of Russia, connecting more than 50 of its European and Far Eastern ports, as well as the mouths of many navigable Siberian rivers, which today are the only means of communication between the NSR and the Trans-Siberian Railway. Currently, the entire NSR is conditionally divided into two sectors – the western one, located between Murmansk and the port of Dudinka (Dubinsky seaport on the Yenisei is the northernmost international port of Russia and the largest in Siberia), and the eastern one, located between the port of Dudinka and Chukotka. The total length of the NSR, taking into account its modern official borders, from the Kara Gate Strait (connecting the Barents and Kara Seas) to Providence Bay (Chukchi Peninsula), is 5600 km.

Despite the fact that in modern conditions, the navigation period of the ice-bound NSR without the use of icebreakers does not exceed four months, we can safely talk about its significant economic and strategic advantages compared to the one widely used Suez Canal, which today provides about 7% of the world's sea cargo turnover. For example, the length of the route from St. Petersburg to Vladivostok via the NSR is shorter by more than 60%, while the one between European and Chinese, Japanese, and South Korean ports is shorter by about 30–40%. Hence, the cargo is moved faster, the cost is reduced, and the time, effort, and money are saved. Besides, when moving through the NSR, there are no risks associated with piracy, which are characteristic of transit through the Suez Canal. It is also important that the NSR is the only transport highway that provides access to the natural resources of the North, Siberia, and the Far East, whose reserves, according to experts' estimates, will become almost the main raw material base of the planet in the twenty-first century.

Cargo transportation on the NSR, which began in 1935 (moving two timber carriers from Leningrad to Vladivostok have been increasing sharply in recent years: in 1986 they amounted to 6.4 million tons, in 2019 it was 30.5 million tons, and in 2035 it is planned to transfer 90 million tons (Presidential Decree, 2020).

Meanwhile, the United States, more precisely, the US Armed Forces, referring to some provisions of the UN Convention on the Law of the Sea taken out of context, believe that the NSR is an international transport corridor, within which not national, but international legislation should operate (we recall that in accordance with the US Constitution, their priority belongs not to the international, but to the domestic law).

Therefore, in their opinion, any surface, underwater and lethal, including military, means should move freely along the NSR. In other words, they, in fact, recognize the NSR as a "no-man's territory" and are strenuously striving to consolidate this status in international law.

However, the established historical practice shows that the NSR is located in the areas that fall under the Russian sovereignty or jurisdiction, since it does not have a single and fixed route and in cases of increased ice conditions moves for significant distances in the latitudinal direction. In 1999, the Code of Merchant Shipping of the Russian Federation (Article 5.1) (Code, 1999) gave the following definition of the water area of the NSR of Russia: This is "the water space adjacent to the northern coast of the Russian Federation and covering the internal sea waters, the territorial sea, the adjacent and exclusive economic zone of the Russian Federation and bounded on the east by the maritime boundary line with the United States, on the west by the meridian of Cape Desire, the eastern coastline of the Novaya Zemlya archipelago and the western borders of the Matochkin Shar, Kara Gate, Yugorsky Shar Straits."

Besides, the Russian legislation defines the NSR as "a historically established national transport communication line of the Russian Federation," navigation in the waters of which is carried out in accordance with generally recognized norms of international law, international treaties of Russia, and the provisions of its national legislation (Federal Law, 2012). This law must apply to both commercial and military vessels of foreign countries. This norm, on the one hand, is based on historical legal grounds, since Russia has always considered the Straits of Vilkitsky, Shokalsky, Dmitry Laptev, Sannikov, and the Kara Gate, which are currently part of the NSR, to its internal waters. It is enough to recall that the Moscow state confirmed its rights to the Arctic seas and other Arctic objects in 1616 and 1620 (about 200 years before the United States and 400 years before Canada, Norway, and Finland-appeared), and there were the orders of the emperors and decrees of the Senate in the eighteenth and nineteenth centuries, the Imperial Instructions of 1893, the Resolution of the CEC of the USSR of April 15, 1926, and Resolutions of the Council of Ministers of the USSR of 1984 and 1985 "On the declaration of lands and islands in the Arctic Ocean the territories of the USSR." Moreover, all these legal grounds have never been challenged by anyone.

On the other hand, this norm fully complies with the provisions of the UN Convention on the Law of the Sea of 1982, which states that ". . .special rights are granted to the circumpolar states in terms of managing various types of maritime use, including navigation within their economic zone in the areas covered with ice for most of the year" (Convention, Article 234, 1982).

Simply put, the NSR, like the North-Western Passage, was a historical fact that had been established, accomplished, and recognized by the Arctic states but much earlier.

The Russian Government developed rules providing for a mandatory procedure for the passage of swimming vehicles through the NSR (Government Decree) after the naval activities of NATO countries in the Arctic region sharply intensified in recent years, to ensure the safety of navigation and prevent, reduce, and keep marine pollution under control.

In particular, the organization of navigation of ships on the NSR is entrusted to the state corporation Rosatom, which forms the headquarters of maritime operations, which provides icebreaking wiring of ships and their wiring along the appropriate routes in the waters of the NSR, develops navigation routes, and arranges icebreaker ships taking into account the hydrometeorological, ice, and navigation conditions.

A permissive navigation procedure is introduced for ships, a list of documents submitted is provided by the owner or captain of the vessel for obtaining a permit, and specific start and end dates of the permit are determined. The annexes of this resolution contain the criteria for the admission of vessels to the NSR water area, the layout of the areas of the NSR water area, their description, etc.

Russia and Norway have argued on the Arctic region since 1814, that is, since the Norwegian statehood was resorted. They lack full agreement on the maritime borders in the Barents Sea and have been developing the Svalbard archipelago. There were no designated borders between Russia and Norway until 1826, and in 1871, due to the passivity of the Russian state in the Arctic, the Swedish-Norwegian Kingdom announced its intention to annex Svalbard.

This archipelago, which includes more than a thousand islands, was named “Svalbard” by the Dutch navigator V. Barents in 1596. It was considered a no-man’s land (terra nullius) until 1920, although England, then Denmark, Norway, and other countries announced their rights to it. But Norway’s right to Svalbard was recognized in 1920, at the Paris Conference, and all the parties who signed the treaty were allowed to continue using the natural resources of the archipelago and there were no contradictions about this.

Russia and Norway have always conducted their economic activities on an equal footing in Svalbard, where a kind of dual power was preserved even in Soviet times: One part of the archipelago (Longyearbyen) functioned according to the laws of Norway, while the other (in Western Svalbard) according to the laws of the USSR, but the contradictions on the shelf persisted until 2010.

However, in 2010, despite the sharp objections of many Russian scientists, politicians, military, and diplomats, D. A. Medvedev (former Russian President) and former Norwegian Prime Minister J. Stoltenberg (current NATO Secretary General) signed an agreement on the delimitation of maritime spaces in the Barents Sea and the Arctic Ocean between Russia and Norway. As a result, Norway received about half (175 thousand kilometers squared) of the disputed territories (four times the total area of the Moscow region), as well as full control over the 200-mile zone around Svalbard, including the territorial sea and the continental shelf, the world’s richest sources of land, and fish resources.

These circumstances, NATO exercises on the territory of Norway (in 2018, the largest of them took place in all the postwar years), as well as the extension of internal Norwegian rules to the behavior of Russian entrepreneurs in the Barents Sea and the Arctic Ocean cannot but affect their relations with modern Russia. Therefore, Russian fishermen who work in the waters of the Arctic have to cover the units of the Russian Navy from the Norwegian fish protection forces. According to the Russian Foreign Ministry, Norway is deliberately moving towards the role of a NATO outpost on the Russian border.

In 2021, despite the protests of the Norwegians, the United States and Norway signed an additional agreement on defense cooperation, which should increase the presence of the American Armed Forces on the territory of Norway, and according to the US Secretary of State E. Blinken would strengthen NATO (Norway and the United States, 2021).

As for Russia's Arctic relations with the other Arctic and non-Arctic states, it should be noted that China, India, Japan, South Korea, Finland, Sweden, Iceland, and other countries are currently showing a growing interest in developing bilateral mutually beneficial relations with Russia regarding the cooperation in the Arctic space, including the green agenda (Arctic Policy, 2021; Piskulova & Pak, 2017).

The further development of international Arctic relations (in the form of cooperation) is reflected in the state document "On the Strategy for the development of the Arctic Zone of the Russian Federation and ensuring national security for the period up to 2035." Among the many measures that will contribute to the fulfillment of the main tasks in developing international cooperation, such as the implementation of multi-vector foreign policy activities aimed at preserving the Arctic as a territory of the world; ensuring mutually beneficial bilateral and multilateral cooperation of the Russian Federation with foreign states; international legal registration of the external border of the continental shelf and maintaining interaction with the Arctic states in order to protect national interests; ensuring the Russian presence in the Svalbard archipelago on the terms of equal and mutually beneficial cooperation with Norway and other states parties to the Svalbard Treaty of February 9, 1920, etc. (Presidential Decree, 2020).

Conclusions

In conclusion, we must say that when it comes to implementing Russia's international policy concerning the Arctic, the priority should belong to a rationally acting state, which determines and encourages the participation of any other domestic and foreign rationally acting entities. These relations should be accompanied not only by preserving the corresponding territories in the Arctic, but also by actively developing them in order to prevent their transformation into no-man's land, and the development of Arctic territories should be accompanied by the activation of the socio-economic development of the Russian economy as a whole, as the main factor in the development of Arctic territories, the improvement of international Arctic relations as well as the improvement of public relations in the country.

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International Cooperation in the Arctic

The Arctic Council

Alexander A. Sergunin

Contents

Abstract

This chapter examines historical evolution and the present-day structure and activities of the Arctic Council. First, the author presents the historical development of the AC that stretches from the so-called Rovaniemi Process and formal establishment of the Council in 1996 until the present day. Second, the author presents the current structure and operation of the AC. This has been gradually strengthening over 25 years of its existence. As a result, the Council increasingly resembles an international organization while retaining its formal status as an intergovernmental discussion forum. However, with the start of the Ukrainian crisis, even those member-states, which favored the Council's transformation into a full-fledged international organization and expansion of its agenda by including the security problematique, now suggest retaining its current status and mandate in order to avoid possible complications in the AC functioning. Russia's role in

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the AC has been also examined, including the prospects of Moscow's AC chairmanship in 2021–2023.

Keywords

Arctic Council · International cooperation · Sustainable development · Russian chairmanship

Introduction

Since its founding through the Ottawa Declaration in September 1996, the Arctic Council (AC) has evolved to become the preeminent forum for international cooperation in the Arctic. The eight-member Council is the key intergovernmental body for regional cooperation in addressing environmental and sustainable development challenges in the circumpolar North and plays a vital role in conveying Arctic perspectives to other international and global organizations. Although a high-level "discussional and catalytic" venue rather than a political decision-making body (Koivurova & VanderZwaag, 2007), the Council does excellent technical work and informs and enables states to adopt progressive and environmentally and socially responsible policies. The inclusion on the Council of formal status for six organizations as Permanent Participants representing indigenous peoples – an innovative development in international relations – enables the region's original inhabitants to contribute their political perspectives, policy expertise, and traditional knowledge to debates on circumpolar issues. The institute of the AC observers allows to engage a number of non-Arctic countries with Arctic interests into regional cooperation and pool their resources for studying, exploring, and developing the Far North.

Despite different (sometime conflicting) interests in the High North, all Arctic states repeatedly emphasized the need for multilateral diplomacy and a proper governance system to solve numerous "soft" security problems in the region. This explains why the Arctic countries believe that global (e.g., UN bodies), regional and subregional (AC, Barents Euro-Arctic Council (BEAC), Nordic organizations, etc.), and international institutions are crucial for the success of Arctic cooperation. No doubt, the AC is seen by the Arctic players as both a centerpiece and cornerstone of the regional governance system.

As compared with other regional and subregional organizations and forums (such as the Nordic institutions, BEAC, Northern Forum, etc.), the AC is viewed by the eight Arctic states as a more representative (in terms of its geographic scope), multidimensional (in terms of areas covered by its activities), science-based and efficient international entity. Despite the fact that seven other AC member-states belong to Western institutions that do not include Russia (NATO, EU, Nordic organizations), even Moscow feels itself comfortable in the Council because it functions there on the equal footing and it is able to partake in the AC decision-making. Russia's current AC chairmanship (2021–2023) further elevates the

Council's role to the highest priority of Moscow's Arctic strategy in the near- and midterm future.

Based on the AC quarter-century history, this chapter aims at examining the Council's role in the past, present, and future Arctic governance system. More specifically, this study addresses for research objectives: first, to trace the AC's historical evolution since its origins to the present, second, to describe the Council's current organizational structure and activities, and third, to discuss which challenges the AC faces at the present moment and may face in the near future? Finally, Russia's ongoing chairmanship, including its major policy priorities, is analyzed.

The Arctic Council's Brief History

The idea of establishing a special institution dealing with regional soft security problems was inspired by the speech given by Soviet Secretary-General Gorbachev on 1 October 1987 in Murmansk, in which he outlined a proposal for transforming the Arctic into a "zone of peace." This concept, which became known as the Murmansk Initiative, comprised arrangements such as a nuclear-free zone in Northern Europe, restraints on naval activity in the Arctic seas, utilization of Arctic resources based on peaceful cooperation, further scientific research on the region, cooperation on environmental protection among the northern nations, and opening the Northern Sea Route (NSR) to icebreaker-escorted shipping, including foreign customers.

Although most of these ideas proved premature, two of them elicited response: promoting international scientific study on the Arctic and cooperation on environmental protection. The former led to the establishment of the International Arctic Science Committee (IASC) in 1990. The latter laid the foundations for intergovernmental cooperation on the Arctic environment and finally resulted in the adoption, in July 1991, of the Arctic Environmental Protection Strategy (AEPS) prepared jointly by the representatives of the Arctic countries and a wide range of observers (both state and nonstate actors, such as international organizations and NGOs) (Arctic Environmental Protection Strategy, 1991).

This document provided for the expansion of cooperation in the field of Arctic research, environmental monitoring, assessment of human impact in the region, and the implementation of measures to control and reduce emissions of major pollutants. AEPS not only set primary directions for cooperation between the countries in the region, but also laid the foundation for the institutionalization of a multilateral cooperation mechanism.

AEPS made provisions for the establishment of multiple mechanisms, such as Arctic Monitoring and Assessment Program (AMAP), Protection of the Arctic Marine Environment (PAME), Conservation of Arctic Flora and Fauna (CAFF), Emergency Prevention, Preparedness and Response Working Group (EPPR), all of which eventually transformed into the AC working groups. In March 1996, the Arctic states decided to transform the Task Force on Sustainable Development and

Utilization into the fifth working group (SDWG), thereby promoting a sustainable development pillar in circumpolar cooperation.

Already in the early 1990s, it became apparent that there was a compelling need for coordination, supervision, and communication between working groups and governments, as well as routine preparation of ministerial meetings. To bridge this management gap, the Arctic states decided to create a group of Senior Arctic Officials (SAOs), which, however, had no formal mandate stemming from the Rovaniemi Declaration or AEPS. The first SAO meeting was held in Copenhagen in April 1992. Since then such meetings became a permanent fixture in the Rovaniemi Process calendar and were held at least once a year or as many times as necessary between ministerial conferences. One major task of the SAOs was to review progress in implementing the objectives of the AEPS Action Plan (Graczyk & Koivurova, 2015).

The AC itself was established in 1996 with the signing of the Ottawa Declaration (Arctic Council, 1996) as a high-level intergovernmental forum to facilitate cooperation, coordinated action, and interaction among eight Arctic states, involving indigenous communities and other inhabitants of the Arctic to address common problems of the region, especially in the field of sustainable development and environmental protection.

Under the Canadian presidency, the initial priority was to establish the Arctic Council as a full-fledged successor to the AEPS. There were three primary objectives: development and adoption of the rules of procedure for the Council, definition of its mandate, and effective transition of the AEPS into the AC.

The last conference under the AEPS auspices took place in June 1997 in Alta, Norway, to conclude the Rovaniemi Process. In the Alta Declaration issued during the meeting, the Arctic states decided that AEPS, its working groups, and its programs would be integrated with and further developed within the AC.

At the Iqaluit meeting in September 1998, which completed a period of Canadian chairmanship, the ministers approved the Arctic Council Rules of Procedure. This document set procedure of the Council and SAO meetings, affirmed the establishment of working groups and task forces, as well as conferred the secretariat functions to the presiding country. According to the procedure approved by the ministers, SAO was to present a report on the activities of the Council during a two-year period to each ministerial meeting. Also, representatives of the Arctic States noted the successful integration of the AEPS structures into the Council (Sakharov, 2015).

At the Iqaluit meeting, the University of the Arctic, an international network of universities and research centers of the northern states, engaged in research of specific regional issues, was established. The aim of the organization is the development of human capital in the region through cooperation in education and science.

During the American presidency, the Arctic Council Action Plan to Eliminate Pollution of the Arctic and the Sustainable Development Framework Document were adopted in October 2000. The AMAP and CAFF working groups prepared a joint project to assess the impact of human activity on the Arctic climate – Arctic Climate Impact Assessment (ACIA). ACIA Steering Committee was established in order to implement this project, which involved monitoring and evaluation of environmental change in the Arctic. The results of the ACIA research were presented at the fourth AC meeting, as well as at the international scientific symposium held in November 2004 in Reykjavik.

During the US presidency, the SDWG launched several projects on health services (telemedicine), cooperation between children and youth of the Arctic states, cultural and ecological tourism, and support to coastal fisheries.

The AC Finnish chairmanship (2000–2002) focused on the following priorities: sustainable development, Arctic residents' capacity-building, as well as the utilization of traditional knowledge of indigenous peoples of the North. Also, for the first time, the issue of gender equality in the Arctic region was raised by the Council. The Finnish presidency also made efforts to establish cooperation with other international institutions such as the BEAC, Conference of Parliamentarians of the Arctic Region, the Nordic Council, Council of Baltic Sea States, as well as with the regional authorities in the Arctic.

The Icelandic chairmanship (2002–2004) focused on issues such as human capital development, including preparing the Arctic Human Development Report (AHDR) initiative progress, expansion of scientific and educational cooperation between the Arctic countries, intensification of cooperation between the AC and EU in the framework of the EU Northern Dimension program, as well as the preparation for the 2007–2008 International Polar Year (IPY).

Finally, under the Icelandic presidency, the Council decided to establish a Project Support Instrument, which further promoted the institutionalization of the forum and strengthened its financial basis (Sakharov, 2015).

The Russian presidency (2004–2006) retained the key priorities of the forum – the fight against pollution, human capital development, climate change, as well as the preparation for the 2007–2008 IPY. In additional to the traditional agenda, the Russian chairmanship initiated a series of discussions on energy cooperation in the Arctic.

The Norwegian presidency of 2007–2009, which started the so-called "Scandinavian cycle" in managing the AC, prioritized the following topics: climate change, biodiversity, human capital development, emergency response, ocean environment research, fight against pollutants, energy cooperation, the implementation of joint monitoring programs, as well as the discussion of the IPY results. It was also decided to set up the task force to develop and complete negotiations by the 2011 Ministerial meeting of an international instrument on cooperation on search and rescue operations in the Arctic, and the Task Force on Short-Lived Climate Forcers (SLCF).

During the Danish Presidency (2009–2011), a draft Agreement on Cooperation on Aeronautical and Maritime Search and Rescue in the Arctic was prepared and signed at the May 2011 ministerial meeting in Nuuk (Greenland, Denmark) and became the first legally binding instrument negotiated under the AC auspices. The SLCF identified an initial priority of its activities in the researching black carbon emissions as an initial priority of its activities due to the significant role played by this type of pollutant in the Arctic region.

The establishment of an expert group on ecosystem management, the creation of a task force for the organization and completion of the negotiations on an international instrument on cooperation on combating oil spills in the Arctic, the decision to establish an AC permanent secretariat in Tromso, and the adoption of a set of criteria for observer countries were among the most prominent accomplishments of the Danish chairmanship.

The Swedish presidency (2011–2013) was able to adopt the Terms of Reference of the Secretariat of the Arctic Council and sign an Agreement on Cooperation on Marine Oil Pollution, Preparedness and Response in the Arctic, which provides for joint measures to combat oil spills in the region, measures aimed at preventing such incidents, as well as appropriate monitoring activities. Another important achievement of the Danish chairmanship was the creation of two task forces: the Scientific Cooperation Task Force (SCTF) and the Task Force to Facilitate the Circumpolar Business Forum (which later led to the establishment of the Arctic Economic Council.

The second Canadian presidency (2013–2015) has partially coincided with the Ukrainian and Syrian crises which have negatively affected the Arctic cooperation in general and AC activities particularly. The USA and EU introduced economic sanctions against Russia, including some offshore energy projects in the Russian Arctic. NATO stopped all military-to-military contacts with Moscow. Search and rescue (SAR) exercises under the auspices of the AC and BEAC were suspended for a while (Konyshev et al., 2017). However, after some time, the work of the Council more or less returned to its former course; Arctic cooperation was restored, and it even began to expand.

Russia rather effectively collaborated with the USA in the Council. For example, the USA sponsored two projects on environmental protection in the Russian Arctic. The USA and Russia cosponsored eight projects. Russia cosponsored four projects with Canada despite Ottawa's most tough position on Moscow in the aftermath of the Ukrainian crisis (Chater, 2016: 49).

The Council's role in regional governance continued to shift as policymaking continued during Canada's leadership. The Council did not create any formal agreements during Canada's turn as chair, seemingly indicating that the institution's policy-making role has diminished or paused. However, institution-building was continued under the Canadian chairmanship. For example, the Task Force on Arctic Marine Oil Pollution Prevention created an informal agreement, with its mandate to identify how best the AC can contribute to marine oil pollution prevention in the Arctic, recommend a concrete plan of action, and, as appropriate, develop cooperative arrangements to implement the Action Plan.

In contrast with gloomy prognoses on the possible failure of the Canadian AC presidency, the 2015 Iqaluit ministerial meeting demonstrated that Ottawa's chairmanship was a rather productive one. For example, a key achievement during the Canadian presidency was the establishment of the Arctic Economic Council, a new independent forum of business representatives to facilitate Arctic business-to-business activities in the region.

Other important achievements included: (1) the publication of a compendium of best practices in promoting the traditional ways of life of Arctic indigenous peoples; (2) recommendations on how to better use traditional and local knowledge in the work of the Council to improve decision-making and research; (3) the publication of a guide on how to respond to oil spills in snow and ice conditions in the Arctic; (4) a collection of work related to short-lived climate pollutants that will lead to local health, economic, and climate benefits; (5) the development of the Arctic Marine Strategic Plan (2015–2025), which aimed to provide a framework to protect Arctic marine and coastal ecosystems and to promote sustainable development in the region; (6) Arctic biodiversity work, including an action plan to implement recommendations from the Arctic Biodiversity Assessment, and a detailed work plan to protect migratory birds along key international flight paths.

As was expected, the ministers agreed to defer decisions on pending observer applications and examine the roles and responsibilities of observers within the AC. There was widespread agreement by the Council that the observer system needed to be seriously revamped before more nations can be let in. In the specific case of the EU, which also wanted its status in the AC upgraded and which was seen as a promising candidate for observer status, the decision was postponed because Canada and some indigenous peoples organizations were displeased with the European ban on seal products that Inuit hunters say was ruinous to local economies. Moscow joined the opposition to the EU observer application because of its dissatisfaction with sanctions imposed by Brussels in 2014–2015.

During the second US presidency (2015–2017), an Arctic Coast Guard Forum was established in October 2015. Now the ACGF operates as an independent, informal, operationally driven organization, not bound by treaty, to foster safe, secure, and environmentally responsible maritime activity in the Arctic. All Arctic countries, Canada, Denmark, Finland, Island, Norway, Russia, Sweden and the USA are members of the forum. Chairmanship duties of the ACGF rotate every two years in concert with the AC Chairmanship.

Notably, the USA and Russia cochaired the Scientific Cooperation Task Force, which in July 2016 agreed a text of a third legally binding agreement negotiated under the auspices of the AC, which was formally signed at the 2017 Fairbanks AC ministerial meeting (Arctic Council, 2017). This development is particularly worth noting considering that the USA cochaired the SCTF along with Russia at the time of a general freeze in relations between the two countries following the start of the Ukrainian crisis. The USA and Russia also initiated the discussion on the need to develop a long-term strategic plan for the Council, the idea which was endorsed by the SAOs at their meeting in October 2016.

As Smieszek and Koivurova note (2017), despite very serious tensions between the former Cold War adversaries in other parts of the world and the sanctions imposed on Russia by all other AC member states, it was the policy of the USA during its AC chairmanship to diligently and consistently maintain the Council as a platform of dialogue, collaboration, and engagement with Russia.

The Finnish presidency (2017–2019) prioritized the preservation of the Arctic's biodiversity, its unique and extremely vulnerable ecosystems, as well as prevention of sea and ground pollution and improvement of practical cooperation among the Arctic states as regards joint response measures, for example, further expansion of coast guard cooperation within the ACGF framework. For example, the Arctic states' Coast Guards took an active part in the multilateral Polaris exercise staged in the Gulf of Bothnia in late March and early April 2019. Finland also launched initiatives in areas, such as enhancing the region's resistance to global climate change, minimizing man-made environmental impacts, preserving biodiversity, developing the telecommunications infrastructure, and expanding the cooperation with the Arctic Economic Council, which was seen as a promising venue for attracting investment and promoting business and innovation.

Helsinki tried to make AC observers' activities more efficient and better integrated into the Council's activities. Under the Finnish presidency, the International Maritime Organization became a new AC observer. The Finnish chairmanship also organized a separate session with observers as part of the 2018 Senior Officials Committee plenary meeting, where they presented measures undertaken to fight pollution in the Arctic and maintain its biodiversity. However, Helsinki was unable to push an AC long-term strategic plan onto the Council's agenda because of the Trump administration's resistance.

The program of the Icelandic chairmanship (2019–2021) included the promotion of marine bio-economics and green shipping, mitigating marine refuse, including microplastics, as well as ocean acidification. To the surprise of many, the Icelandic presidency was able to push through the adoption of the AC Strategic Plan, which, apparently, is explained by the coming to power of the Biden administration, which took a more constructive position with regard to the Council.

To sum up the above historical analysis, in a quarter of a century of its existence, the AC has gone from a rather amorphous entity with an uncertain mandate and areas of activity to a leading regional institution, whose opinion is listened to by all Arctic players. It is important to note that the AC member-states managed to "bracket out" Arctic cooperation from Moscow's tensions with the West caused by the Ukrainian crisis. Tables 1 and 2 demonstrate various forms of AC member-states' activities from the first Canadian presidency to the second American one.

The Arctic Council's Present-Day Structure and Activities

Established by a declaration instead of a binding treaty, the AC is not a formal international organization in the traditional understanding of the term in international law: It is a high-level intergovernmental forum for cooperation on a wide range of circumpolar issues. Despite its rather informal character, the Council has certain features, such as negotiated rules of procedure and permanent secretariat, which allow it to be perceived as a coherent and organized entity.

The Arctic states have avoided demonstrating a deep commitment to cooperation on certain issues within the AC. The forum has remained a body that, through its working groups, produces technical recommendations, guidelines, and influential scientific assessments. It has not become a regulatory body, although its recent scientific assessments have been accompanied by policy recommendations, advocating the development of legally binding agreements under the auspices of the Council. In fact, the Council has started to serve as a platform for negotiating Arctic-wide treaties such as the Agreement on Cooperation on Aeronautical, and

Table 1 The number of delegates from the member states to attend the Council's meetings

Year	Country, number of delegates							
	Russia	Norway	USA	Canada	Finland	Denmark	Sweden	Iceland
1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*
1998	6	10	7	16	9	9	5	4
1999	3	6	43	19	3	7	2	2
2000	5	7	33	23	6	8	2	1
2001	5	9	12	15	17	8	4	4
2002	3	6	19	16	14	6	3	3
2003	2	8	13	18	6	4	3	5
2004	5	11	13	17	3	5	3	4
2005	–	6	7	9	5	2	3	1
2006	–	24	17	11	14	12	12	5
2007	8	21	14	16	5	8	5	1
2008	7	15	10	8	2	4	4	1
2009	5	5	5	3	1	10	6	1
2010	6	18	9	10	3	10	3	2
March 2011	10	24	12	13	5	11	9	3
Nov. 2011	5	9	6	11	5	5	16	2
2012	6	9	10	10	5	8	9	2
2013	3	3	4	8	3	6	4	3
2014	1	5	4	12	3	5	3	2
2015	1	4	10	7	2	4	3	2
March 2016	1	5	10	8	3	8	7	3
Oct. 2016	1	7	7	9	7	6	6	3
March 2017	1	5	9	8	4	7	4	4
May 2017	12	12	12	10	12	12	10	7
March 2018	2	6	6	5	7	4	3	4
Nov. 2018	2	5	6	7	7	4	4	4

Source: compiled by the author based on Voronchikhina, D. (2019). The Arctic Council as an international forum of the state cooperation: the participation of Russia. *Ars Administrandi* 11(2), 306–329. https://doi.org/10.17072/2218-9173-2019-2-306-329 (in Russian)

Maritime Search and Rescue in the Arctic, the Agreement on Cooperation on Marine Oil Pollution Preparedness and Response in the Arctic, and Agreement on Enhancing International Arctic Scientific Cooperation.

Nonetheless, the primary function of the Council has been to conduct major scientific programs to produce knowledge about a wide range of issues pertaining to Arctic ecosystems, natural processes, human activities, and, in particular, the impacts of climate change and its consequences.

The AC members are the eight Arctic States: Canada, Denmark, Finland, Iceland, Norway, Russia, Sweden, and the USA.

There are the six Indigenous Permanent Participant organizations: Aleut International Association, Arctic Athabaskan Council, Gwich'in Council International, Inuit Circumpolar Council, Russian Association of Indigenous Peoples of the

Table 2 The number of projects funded by the Council member countries

Year	Country, number of projects							
	Russia	Norway	USA	Canada	Finland	Denmark	Sweden	Iceland
1996–1998	2	3	3	2	4	2	2	5
1998–2000	4	10	7	7	5	5	4	4
2000–2002	7	2	2	2	2	4	1	1
2002–2004	11	12	12	13	8	6	4	3
2004–2006	23	13	12	13	9	7	3	3
2006–2009	13	16	18	18	4	3	2	6
2009–2011	6	3	3	3	2	2	3	2
2011–2013	6	5	6	4	4	2	8	1
2013–2015	21	29	32	29	8	11	5	3
2015–2017	6	4	3	4	3	3	4	3
2018–2019	No data							
Total	25	24	21	25	24	20	21	23

Sources: compiled by the author based on Voronchikhina, D. (2019). The Arctic Council as an international forum of the state cooperation: the participation of Russia. *Ars Administrandi* 11(2), 306–329. https://doi.org/10.17072/2218-9173-2019-2-306-329 (in Russian); Chater, A. (2016). Explaining Russia's relationship with the Arctic Council. *International Organizations Research Journal,* 11(4), 41–54.

North, and Saami Council. The Indigenous Peoples' Secretariat supports the Permanent Participants. The Permanent Participants have full consultation rights in connection with the Council's negotiations and decisions. The Permanent Participants represent a unique feature of the Arctic Council, and they make valuable contributions to its activities in all areas.

The Council has more than 35 observers. They include three types of entities: non-Arctic states, intergovernmental and interparliamentary organizations, and non-governmental organizations.

There are six Working Groups within the Council, each of which focuses on a particular set of issues for the AC:

- Arctic Contaminants Action Program
- Arctic Monitoring and Assessment Programme
- Conservation of Arctic Flora and Fauna
- Emergency Prevention, Preparedness, and Response
- Protection of the Arctic Marine Environment
- Sustainable Development Working Group

In addition to the working groups there are currently two AC expert groups:

- Black Carbon and Methane Expert Group
- Ecosystem-Based Management Expert Group

AC Ministerial meetings can appoint to work on specific issues for a limited amount of time, remaining active until they have produced the desired results. Experts from the Working Groups and representatives from the Arctic States take part in the Task Forces.

There are no currently active Task Forces. These Task Forces have completed their work and are no longer operational. Three of these Task Forces provided the venue for negotiating the Arctic Council's three binding agreements:

- Task Force on Search and Rescue
- Task Force on Arctic Marine Oil Pollution Prevention
- Task Force for Enhancing Scientific Cooperation in the Arctic

Other Task Forces included:

- Task Force on Arctic Marine Cooperation
- Task Force on Improved Connectivity in the Arctic
- Task Force on Telecommunications Infrastructure in the Arctic
- Task Force on Black Carbon and Methane
- Task Force to Facilitate the Creation of a Circumpolar Business Forum
- Task Force for Institutional Issues
- Task Force on Arctic Marine Oil Pollution Preparedness and Response
- Task Force on Short-Lived Climate Forcers

The Council is run by the Chairmanship which rotates every two years among the Arctic States. All Council's decisions and statements require consensus of the eight Arctic States.

Each Arctic State appoints a Senior Arctic Official (SAO) to manage its interests in the Council. Each SAO is thus a government representative, usually from an Arctic State's Ministry of Foreign Affairs. The SAOs guide and monitor the AC activities in accordance with the decisions and instructions of the Foreign Ministers of the Arctic States. That guidance is usually provided in the form of Ministerial Declarations, which are produced roughly every two years when the Chairmanship of the Arctic Council rotates.

SAOs and Permanent Participants meet at least twice a year, while all partners meet at Ministerial Meetings held every two years. These meetings are typically held in the Arctic State that holds the Chairmanship at the time of the meeting. Working Groups and Task Forces hold additional meetings in other locations and at other times.

The AC has a Secretariat, which is an administrative office that works under the direction of the SAOs and the AC Chairmanship.

International Discussions on the Arctic Council's Reform

The fact that the AC faced a series of challenges of both endogenous and exogenous character became obvious even before the Council's 20th anniversary in 2016. The internal challenges stemmed from the evolving and constantly growing workload of the Council, which led to problems with overlapping and prioritizing work across AC working groups and task forces, funding the ongoing projects and new initiatives, and regarding the effective implementation of the AC recommendations by the member states (Supreme Audit Institutions of Denmark, Norway, The Russian Federation, 2015).

Many experts (Exner-Pirot, 2015; Graczyk & Koivurova, 2015; Klimenko, 2015; Sakharov, 2015; ´Smieszek & Koivurova, 2017; Voronkov & Smirnova, 2017) believed that a remedy for internal AC problems could be a comprehensive vision of Arctic cooperation to guide the work of the Council and bring to it more continuity between rotating chairmanships. Moreover, such a vision – as well as establishing more stable financing mechanisms – could make the Council more secure in view of shifting political priorities and radical changes on Arctic states' domestic political scenes.

The 2013 AC "Vision for the Arctic" pledged to "pursue opportunities to expand the Arctic Council's roles from policy-shaping into policy-making" (Arctic Council, 2013). The statement missed, however, any further details and the debates for the prospects for the development of the AC's long-term strategic plan continued for several years.

International experts pointed out that a new vision should better define position and role of the AC within the regional governance system. It appeared that the Council was not a principal venue for solving many important Arctic problems in areas such as shipping, fisheries, climate change, or biodiversity (Exner-Pirot, 2015; Graczyk & Koivurova, 2015; Klimenko, 2015; Sakharov, 2015; ´Smieszek & Koivurova, 2017; Voronkov & Smirnova, 2017). For example, negotiations launched within the UN bodies in 2018 to develop an implementing agreement under the UNCLOS on conservation and the sustainable use of marine biodiversity of areas beyond national jurisdiction, if successfully completed, would be of major relevance to the Arctic Ocean. However, the AC and its relevant working groups did not participate in these negotiations. Another example is the 2018 agreement on the commercial fishery ban in the Central Arctic Ocean, where discussions were held within the extended Arctic Five including China, Iceland, the EU, Japan, and South-Korea, but not in the AC framework (Sergunin, 2019).

It should be noted that very important changes happened in the Arctic states' academic and official thinking about the future of the AC, its functions, and the role in the regional governance system. Prior to the Ukrainian crisis and the rise of tensions between Russia and the West, some AC member states' official position and academic discourse favored transformation of the AC from the intergovernmental discussion forum to a full-fledged international organization (with formal charter, institutional structure, and power to conclude binding agreements). For example, in his 2013 article, the then Russian ambassador for Arctic Affairs and SAO Anton Vasiliev noted: "In my view, we embarked on the path of turning the Arctic Council from a 'forum' into a full-fledged international organization, although we will move in this direction gradually, in stages, with full respect for the positions of all member states - after all, all decisions in the Council are taken by consensus" (Vasiliev, 2013). At the 2013 Kiruna AC Ministerial Meeting, Russian Foreign Minister Sergey Lavrov noted that the Council is on the way to becoming a full-fledged international organization, referring to the fact that two binding agreements were concluded under its auspices (Lavrov, 2013). Many experts on Arctic geopolitics, law, environment, economy, and humanitarian issues also believed (and still believe) that the lack of formal status and proper legal powers is a serious hindrance to further development of the Council as a key structural element of the regional governance system (Exner-Pirot, 2015; Graczyk & Koivurova, 2015; Konyshev et al., 2017). In their view, the Council should be gradually, step by step, further institutionalized and finally transformed to a "normal" international organization with a proper legal status.

However, with the outbreak of a "new Cold War" in the East-West relations, both the decision-makers and expert communities serving their governments realized that any plans to make the AC an intergovernmental international organization seem unrealistic. All Council member states introduced economic sanctions against Russia. Five Arctic countries, being NATO member states, cancelled military-to-military contacts with Russia, initiated military build-up in the North, and increased their military activities, including land and sea military exercises, air and sea patrolling in the Arctic region, and so on. Generally, mutual trust between Russia and the rest of the AC member states was significantly undermined. The Russian activities in the Council's framework decreased in the aftermath of the Ukrainian crisis. It took some time to identify some areas where cooperation between Moscow and other Arctic countries was still possible and delineate them from the conflictual issues. For the above reasons, Arctic diplomats and politicians stopped to speak about providing the AC with new legal powers and its transformation from a "discussion forum" to a full-fledged international organization.

There can be at least two explanations why Arctic leaders and experts changed their mind about the Council's status. First, in the current – conflictual – situation, it is unrealistic to expect that non-Russian AC member states (especially the USA) would agree to create a new full-fledged regional intergovernmental organization where Russia would have an equal standing with Western states. Second, as some experts (Voronkov, 2014; Voronkov & Smirnova, 2017) believe, under the current circumstances, the AC, being an informal and flexible institution, can be more efficient and preferable cooperative platform that a formalized organization with rigid structure, rules, and procedures. For example, as "classical" international organizations (e.g., UN and OSCE) demonstrate, if there are antagonisms between member states in the turbulent times, the whole work of these institutions can be blocked. In contrast with these "traditional" institutions, the AC not only "survived" the crisis in the Russian-Western relations but also made some progress in developing Arctic cooperation. Some experts even called the AC a "new-type multilateral organization," which is more powerful than just an intergovernmental forum but less institutionalized and formalized than "classical" international organization (Voronkov, 2014; Voronkov & Smirnova, 2017).

One more important change in Arctic politicians' and experts' perceptions of the Council's future prospects relates to its role as a regional security provider. In the pre-Ukrainian era, both policy-making and expert communities believed that with time the AC should include the military security problematique to its mandate and become a sort of an Arctic OSCE (Konyshev et al., 2017; Wilson, 2016). However, for the same reasons as in the case of plans to turn the Council into an international organization, AC member-states had to abandon the idea of including military security issues on the agenda of this forum.

According to the present-day assessments, the Council should retain its role as an international body dealing only with the "soft" security issues, such as socio-economic problems, environment, conservation of biodiversity, climate change mitigation, maritime safety, search and rescue operations, local communities, connectivity and social cohesiveness of Arctic regions, Arctic research, etc. (Sergunin, 2021; Voronchikhina, 2019; Voronkov, 2014; Voronkov & Smirnova, 2017). At the same time, Moscow believes that discussion of soft and hard security issues between the Arctic states can be resumed in other formats, such as the Arctic Coast Guard Forum, Arctic Chiefs of Defense Staff Conferences, and Arctic Security Forces Roundtable, which slowed down or froze their activities in the aftermath of the Ukrainian and other international crises (Arctic Council, 2021).

Rather lively discussions take place in the international expert communities regarding the possible AC institutional reform. The moderate versions of these speculations suggest certain changes, including:

- Improvement of coordination of the Council's structural elements and implementation process.
- Better coordination of the AC activities with other regional and subregional institutions (Arctic Economic Council, ACGF, BEAC, Nordic institutions, Northern Forum, etc.).
- Streamlining the secretariat system. For example, David Balton (former U.S. SAO and Senior Fellow at the Woodrow Wilson Center's Polar Institute) proposed an idea of subordinating working groups' and task forces' secretariats to the Council's permanent secretariat (Balton, 2019). This plan, however, can provoke resistance not only from AC working groups and task forces but also from some SAOs who dislike the idea of making the Council's secretarial system more centralized because it could make the AC too bureaucratic (such accusations have been already made by some permanent participants, observers, and international NGOs).
- Further AC budget's centralization, streamlining, and increasing transparency are possible as well.

Some experts suggest a more radical version of the Council's institutional reform. For example, an international team of WWF (Dubois et al., 2016) proposed to distinguish between three types of the AC bodies:

- Knowledge-related bodies: working groups, task forces, expert groups, and SAOs. This group would be responsible for conducting all assessments, coordinating early warning work (identifying new and emerging issues), producing technical reports, coordinating science and research agendas, and ensuring use of traditional knowledge for coproduction of new knowledge coming through the AC.
- Policy-related bodies: SAO and ministerial meetings. This group would develop and recommend policy options and actions based on the scientific assessments/reports and scientific recommendations submitted by the knowledge bodies.
- A newly created implementation body would consider decisions and recommendations as provided by ministers and operationalize them through developing general implementation plans. These plans would guide joint implementation through the Council and include clear timelines and measures to guide and support Arctic states in developing national implementation plans. The standards for implementation established by this body would constitute the benchmarks against which the effectiveness of national or other actions regarding implementation would be measured and reported on.

These experts believe that possible structural changes could strengthen the AC role in asserting regional stewardship by responding to the challenges of a rapidly changing Arctic and the increasingly more integrated policy frameworks from local to global scales. The problem is, however, whether the current Russian presidency and future ones would have enough political will, authority, and resources to implement such a radical institutional reform of the Council.

The Russian Chairmanship (2021–2023)

Moscow started preparations for its AC chairmanship well ahead. As for Russia's AC presidential agenda, President Vladimir Putin was the first who tried to identify its main priorities as early as in 2019. At the 5th International Arctic Forum "The Arctic – a Territory of Dialogue" in St. Petersburg (April 9, 2019), he noted: "Priorities for our chairmanship include vitally important themes for the Arctic development: the development of environmentally safe technologies in the spheres, such as industry, transport and energy" (International Arctic Forum, 2019).

One month later, at the 11th AC Ministerial Meeting (Rovaniemi, May 7, 2019), Russian Foreign Minister Sergey Lavrov, on the one hand, emphasized Moscow's intention to ensure continuity between the Icelandic and Russian chairmanships: "We will ensure the continuity of the general Arctic agenda when the council chairmanship is transferred to Russia in 2021. We will pursue the implementation of all the initiatives originated under Reykjavik's chairmanship" (Lavrov, 2019).

On the other hand, Lavrov explained what specific priorities are planned for the Russian presidency agenda for 2021–2023: (1) sustainable socioeconomic development of the Arctic region on the basis of environmentally clean technologies, (2) development of renewable sources of energy, (3) promoting a circular economy, (4) environment protection, (4) climate change mitigation, (5) social cohesiveness and connectivity in the region, (6) improving the well-being of the people living in the Arctic, especially the indigenous peoples, preserving their languages, cultures, and traditions, (7) science diplomacy, and (8) joint educational projects, including further support for the University of the Arctic (Lavrov, 2019).

In the course of Moscow's preparatory work, Russian top-ranking officials' clarified Moscow's *specific priorities* for the Russian AC chairmanship: (1) further development of Arctic shipping, including the NSR, (2) development of telecommunications in the region, (3) conservation of biodiversity, (4) increasing bio-security (anti-epidemic measures), (5) nuclear waste treatment, (6) organization of the Arctic indigenous peoples' summit, (7) Arctic cruise and coastal tourism, (8) establishment of an international Arctic Hydrogen Energy Applications and Demonstrations station "Snowflake" (in the polar Ural), and (9) creation of an International Arctic Development Fund (Ministry of Foreign Affairs, 2020).

According to the presidential advisor Anton Kobyakov, during the Russian chairmanship, 38 various events will be organized under the Council's auspices. In addition, 50 other events are scheduled in Russia itself. Seventeen federal agencies, 11 members of the Russian Federation, and 12 universities and NGOs will take part in organization of these events (The Government of the Russian Federation, 2021).

At the May 2021 AC ministerial meeting, Russian Foreign Minister Lavrov delivered a program of the Russian AC chairmanship. He told that cross-cutting priority of the Russian AC Chairmanship will be "Responsible Governance for Sustainable Arctic" through promoting collective approaches to the sustainable development of the Arctic, environmentally, socially, and economically balanced, enhancing synergy and cooperation and coordination with other regional structures, as well as implementation of the Council's Strategic Plan, while respecting the rule of law (Arctic Council, 2021).

The Russian program includes the following priority areas:

1. *People of the Arctic, including Indigenous Peoples*. The sustainable development of the Arctic is largely determined by the quality of human capital. The Russian Chairmanship's main focus will be given to enhancing sustainability, resilience, and viability of the Arctic communities, climate change adaptation measures, improving the well-being, health, education, quality of life of the Arctic inhabitants, as well as ensuring sustainable socio-economic development in the region. Promotion of scientific, educational, and cultural exchanges, tourism, and contacts between peoples and regions will also be high on its agenda. Special attention will be given to the preservation of linguistic and cultural heritage of Indigenous peoples of the Arctic, to the youth cooperation across the borders.
2. *Environment protection, including Climate Change*. Taking into account the rapid climate change in the Arctic, most notably accompanied by degradation of permafrost and the icy gas hydrides emissions, the Russian Chairmanship will continue supporting efforts to mitigate the negative effects of climate change, increase adaptation of life activities and ensuring resilience to its consequences, preservation, and restoration of the environment, sustainable use of natural resources, maintaining the health of the Arctic ecosystems, including marine environment, preserving biodiversity, in particular, the Arctic migratory birds. In the context of further development of the region, it is important to take into account not only the vulnerability of the Arctic to climate change, but also its long-term contribution – due to its natural, energy, and transport resources and solutions – in facilitating the transition to a low-emission economy and, accordingly, to the implementation of the goals of the Paris Agreement. Equally topical task is to promote the introduction of advanced sustainable innovative technologies into the transport sector, industry, infrastructure, and energy, including the use of renewable energy sources to improve the standards of living of the Arctic inhabitants.
3. *Socio-economic Development*. A key condition for the well-being and prosperity of the Arctic is its sustainable economic development. The Russian Chairmanship will be further promoting constructive economic cooperation in the region, developing of reliable energy infrastructure, sustainable transport routes, including shipping, telecommunication systems, food production sector, improving the conditions for sustainable investment flows, encouraging innovations and entrepreneurship, business financing.
4. *Strengthening of the Arctic Council*. The Russian Chairmanship plans to continue supporting the establishment of the AC as the leading format for international Arctic cooperation, improving its work, increasing the effectiveness of its Working and Expert groups, the Secretariat, as well as developing mechanisms for financing the Council's activities, including its projects and programs, implementing decisions and recommendations, as well as encouraging the dialogue and interaction with the Observers to provide their meaningful and balanced engagement in the Council's activities. It intends to further intensify collaboration of the Arctic Council with the Arctic Economic Council, the Arctic Coast Guard Forum, the University of the Arctic. Among the priorities of the

Russian Chairmanship – promoting international scientific cooperation, in particular, exploring the possibility to conduct an Arctic Council scientific expedition to the Arctic Ocean (Arctic Council, 2021). With the start of Russia's special military operation in Ukraine in February 2022, seven Western AC member-states decided to suspend cooperation with the Russian chairmanship. Moscow reacted to this move by saying that it is determined to implement those parts of its presidential program which lie in the sphere of its responsibility.

Conclusions

The AC has undoubtedly come a long and complex way in achieving its current status and level of development. Three functions seem crucial for shaping the roles played by the Council in the regional governance system.

First, regular meetings at relatively high levels have favored building continuity of cooperation and have fostered good interstate relations in an organized manner, contributing to better understanding of the positions and views of the member-states. Moreover, cooperative efforts have served to ensure mutual confidence-building that might result in expanding the cooperation into other issue-areas.

Second, knowledge production and information sharing within the working groups and joint scientific projects have further strengthened the foundations for regional stability. Being able to operate with the same data as the basis for domestic and transboundary actions has significantly reduced the risk of misunderstandings.

Third, clearer spatial definition of the problems and acting within a specific grouping of states have contributed to building an "Arctic identity" and thus to discussion of the Arctic as a region in political terms.

The Council is clearly expanding its activities. The ambitious programs set up by recent chairmanships aim at further elevation of the Council's position in circumpolar cooperation. The 2021 Strategic Plan conveys a clear message that the forum plays a central role in the Arctic international system, to be enhanced further.

The Arctic Council has become a hub for a wide range of forms of circumpolar cooperation, including issues such as sustainable development, energy security, environment protection, climate change mitigation and adaptation, conservation of biodiversity, maritime safety, search and rescue operations, connectivity of Arctic regions, telecommunications, sustainable fisheries, well-being of local communities, including indigenous peoples, gender equality, scientific cooperation, etc. The Council plays an unquestioned role in managing these activities and ensuring that they develop in the spirit of peaceful cooperation.

However, the AC must now face several questions about its own identity, such as its legal status or proper budget, before proceeding toward the next stage in its evolution.

It should be noted that there were serious changes in Arctic states' thinking about the AC in the post-Ukrainian era. They do not want any more to transform the Council into a full-fledged international organization preferring to keep the AC as an informal and flexible intergovernmental mechanism, which is better designed for difficult times than "classical" international organizations. The AC member-states have also abandoned their previous plans to bring hard (military) security problematique onto the Council's agenda, and currently they favor retaining the AC's competencies only in the soft security sphere.

As regards Russia's AC presidency for 2021–2023, on the one hand, it ensures continuity of the Finnish and Icelandic chairmanship agendas and, on the other hand, it focuses on sustainable development of the Arctic region based on the use of environmentally safe technologies.

Moscow tries to implement the newly born Council's Strategic Plan and streamline the AC's organizational structure. At the same time, it is unlikely that the Russian chairmanship will initiate any radical institutional reforms.

In general, Russia uses its AC presidency both to promote its national interests in the High North and increase the Council's role in an emerging regional governance system. Unfortunately, seven Western AC member-states suspended their cooperation with the Russian chairmanship with the start of the Ukrainian crisis' new phase in 2022. However, there is reason to hope that with the resolution of this crisis, or at least with a decrease in its severity, the AC activities will resume on the previous scale.

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Revisiting the Arctic Strategy of Russia up to 2035

Maria A. Maksakova

Contents

Abstract

The chapter highlights the main issues and problems of Russian political and economic presence in the region through the prism of international processes. Various actors have declared their interests in the Arctic, and even non-Arctic countries have become more active recently; this is due to the fact that the institutional and legal structure of the Arctic region has not yet been finally formed, and the international legal status of the Arctic has not been determined. In attempts to solve this problem, countries use different approaches (sectoral, conventional, and international). In the near future, the region could become a platform for rather tough competition, or a place for more active and effective dialogue within the framework of such organizations as the Arctic Council, BEAC, not to mention informal ones, for example, the Arctic Five. In addition, the Russian view on the Arctic development agenda as a member of the Arctic Council will be neatly studied in this chapter. The chairmanship of Russia in the

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Arctic Council in 2021–2023 will be based on the comprehensive program that includes the following priority areas: the population of the Arctic; environmental protection; socioeconomic development; and strengthening the Arctic Council. Particular attention in the chapter is also paid to the critical analysis of key points and feasibility of the goals stated in the Russian Arctic Strategy until 2035 given the sanctions policy of the West and deepening cooperation with the Eastern countries.

Keywords

Arctic Council · International cooperation · Non-Arctic states · Russian Arctic policy · UNCLOS

Introduction

The Arctic region is of particular importance for Russia from the geostrategic, geopolitical, geo-economic, historical, and cultural positions. Russia has been exploring the Arctic for many centuries: It has lain polar routes, made geographical discoveries, and historically has always been present in the region.

Recently, lots of studies considering different aspects of the Arctic development have appeared. Many of them pay special attention to Russia and its Arctic policy as one of the main objects of interest. From historical and political points of view, the Russian presence in the Arctic attracts attention of national and foreign scholars (Aleksandrov, 2017; Brosnan et al., 2011; Collins, 2017; Stokke, 2013).

They research different stages of the Russian Arctic policy, showing that Russia was historically interconnected with the region and assessing the interaction of various factors, objectives, and motivations that shape the Russian policy in the North. For many centuries, the northern seas were the main Russian trade gates to the countries both near and further abroad. Until the times of Peter the Great, the "northern borders" accounted for about 60% of the country's foreign trade. The most active period of the Arctic development was in the sixteenth to eighteenth centuries, when mainly individuals (Russian merchants and industrialists), not the state, actively explored the North (Aleksandrov, 2013).

However, the Arctic only became an object of state policy in the twentieth century, when it began to be considered as one of the key regions. By establishing control over the Arctic territories, countries gain a significant advantage from a geostrategic point of view. Attention to the Arctic issues is further fueled by the publication of data on the resource potential of this region. The Arctic possesses significant reserves of various natural resources, including unique ones, but of the greatest interest are significant reserves of energy resources on a global scale. The economic and energy aspects of the Arctic development are also among the relevant topics for research both among Russian and foreign specialists (Istomin et al., 2008; Krutikov et al., 2020; Gautier et al., 2009).

According to Russian experts, more than 60% of the forecasted oil and gas resources are located in the territories that Russia already owns or claims. So far, only a small part of them has been explored (Istomin et al., 2008). The region also has significant reserves of agrochemical ores, copper-nickel ores, tin, cobalt, rare and rare earth metals, and large reserves of diamonds, gold, silver, ferrous metals, and various minerals that are of strategic importance. Moreover, most of these deposits are located in the mainland of the Arctic.

Such assessments and forecasts aroused increased attention and unprecedented interest in the Arctic on the part of many states, including non-Arctic ones, as well as the largest oil- and gas-producing transnational companies, considering the Arctic as a territory with enormous economic opportunities and potential. In this context, some scientists also analyze the unfolding struggle of various countries for the control over the Arctic (Konyshev & Sergunin, 2010), security aspects (Zagorskiy, 2011, 2019), and the main problems of Russian foreign policy in the region (Konyshev & Sergunin, 2011a, 2011b; Kudryashova et al., 2019; Myers, 2016; Smith & Giles, 2007): the ambiguity of the Arctic's international law status, delimitation problems, economic cooperation with foreign countries, the tendency to militarization of the region, etc.

Actually, the ecological aspects and transport possibilities of the Arctic play an important role and become the object of many studies (Berkman & Young, 2009; Brubaker & Østreng, 1999; Ebinger & Zambetakis, 2009; Istomin & Leus, 2009; Laulajainen, 2009; Lebedev, 2012; Nikolaeva, 2011; Nong, 2012; Stokke, 2010). Global climate changes open up new areas of possible location of natural resources; in addition, new shipping routes are opening up. The Arctic has transport routes of global importance: the Northern Sea Route, and the Northwest Passage that connects the Pacific Ocean with the Atlantic Ocean.

The institutional and legal structure of the region is currently under development: There is no international treaty defining the legal status of the Arctic. For this reason, attempts to internationalize Arctic issues are becoming more frequent. Oil and gas reserves, biological resources, or promising transport prospects arouse interest in the region and sharpen the perception of the legal status of its territories (Kovalev, 2009; Kukushkina & Shishkin, 2011). In particular, quite influential states located far from the Arctic Circle are increasingly showing a desire to redistribute the Arctic space. The issue of declaring it as a common heritage of mankind and introducing global governance to this part of the planet is gradually being included in the Arctic agenda of negotiations, naturally opposed by the Arctic states.

Still, interests of different actors overlap in the region and also become objects of careful research by specialists (Bloom, 1999; Exner-Pirot, 2016; Kuersten, 2016), Arctic and non-Arctic states, global (UN) and regional organizations and forums (EU, NATO, and Arctic Council), subregional associations (Barents Euro-Arctic Council, Council of Ministers of the Nordic countries), transnational companies, associations of Indigenous peoples of the Far North, and other participants.

Over the past 20 years, the Arctic has turned from a peripheral region, "frozen" along the line of confrontation between the East and the West, into the region of intersection of interests, tough competition of many actors, and, at the same time, a region of cooperation and intergovernmental dialogue in the context of creating a new platform for multilateral and regional interaction.

International Legal Status and Institutional Structure of the Arctic: A View from Russia

At the moment, the following key issues remain a stumbling block in the Arctic region: its international legal status, long-term territorial disputes, and multilateral dialogue with the participation of all Arctic states.

The Arctic legal status at the international level is still not regulated. Currently, there are at least three approaches on the problem of the delimitation of Arctic spaces: sectoral (based on the priority right of the Arctic states in all activities in the region including natural and biological resources production and transport opportunities), conventional (based on the 1982 UN Convention on the Law of the Sea, UNCLOS), and international (based on the idea of multilateral governance and management of the Arctic, i.e., its internationalization).

Initially, two main approaches regarding the Arctic prevailed – sectoral and conventional. The sectoral approach means that each Arctic state can allocate its own sector of the Arctic Ocean, including islands, and its borders run along the meridians from the coast to the North Pole. The countries supporting the sectoral approach insisted that the Arctic should be viewed as an ice continent that could be divided into sectors between the five Arctic states. This position in the historical retrospective was adhered to by the USSR/Russia and Canada.

Several circumstances testify in favor of this approach. First, it historically preceded the emergence of the UN Convention on the Law of the Sea in 1982, and thus the legal regime of the Arctic was for many years formed on the basis of international law, i.e., the recognition of historical rights and the practice of delimitation of the Arctic space in accordance with the national legislation of the Arctic states. Second, the sectoral principle is more in line with Russian interests, since it enables Russia to keep its Arctic sector entirely. Third, this approach is supported by the experts who doubt the applicability of the norms of the 1982 UN Convention on the Law of the Sea to the Arctic and the Arctic Ocean due to their natural and climatic features and peculiarities. However, a serious blow to the sectoral approach was caused by two factors: the melting of Arctic ice and the position of the Arctic countries, including Russia itself, that almost unanimously decided to take the 1982 UN Convention on the Law of the Sea as a basis for settling the division of the Arctic.

In contrast to the sectoral approach and in accordance with the conventional approach, the Arctic states should limit their area so that the rest of the territory is considered free for any companies and enterprises. In this case, the Convention on the Law of the Sea allows the Arctic to be the object of the claims of many states.

The conventional approach is also referred to as the "median linear method," when division along the median line means that the ocean area is divided in proportion to the length of the coastline at an equal distance from the coast of the specified countries. The division of the water area of the Arctic seas is carried out on the basis of the enforcement of the 1982 UN Convention on the Law of the Sea, which divides the sea areas into zones: internal waters; territorial waters (12 nautical miles); adjacent waters (24 miles); exclusive economic zone (200 miles); and the continental shelf (up to 350 miles). The Ilulissat Declaration (2008) reaffirmed the intention of the five Arctic countries to act in the spirit of UN norms, procedures, and international law and contributed to the creation of the Arctic Five mechanism.

However, the conventional approach also has some weaknesses. In particular, the provisions of the Convention on the "area of the common heritage of mankind" give non-Arctic states a reason to claim part of the Arctic shelf, i.e., to create the basis for the regional conflicts. In addition, the Convention to some extent breaks the established order of delimitation in the Arctic and creates an element of tension. Finally, the USA is guided by the principles of the Convention but has not yet ratified it, which also adds to the uncertainty in the Arctic. The USA, Norway, and Denmark are staunch supporters of the conventional approach among the Arctic countries.

The international approach proceeds from the need to adopt a new universal legislative act that will help to recognize the wealth of the Arctic as a "world heritage" and open access to a wide range of countries to develop Arctic resources and use Arctic routes. This approach is mainly adhered to by non-Arctic states, while such a position fundamentally contradicts the interests of the Arctic countries. In particular, there is a proposal to transfer the legal regime of Antarctica (1959) to the Arctic within the framework of a single legislative act, to internationalize it with general accessibility to all. Meanwhile, the clash of interests of the parties will not contribute to the emergence in the near future of universal and binding "rules of the game" in the Arctic. The need to adopt a single legal act is disputed by many experts and is being questioned by the Arctic states themselves.

There is also an option of identifying the UN circumpolar zone around the North Pole. Finally, it is proposed to combine, when dividing the Arctic, the approaches of the 1982 UN Convention, interregional and regional legal acts, and historical traditions, as well as a combination of the principle of equal distance, the sectoral principle, and the criterion of proportionality.

In this regard, the problem of the Arctic continental shelf delimitation is of particular relevance now. The UN Commission on the Limits of the Continental Shelf satisfied Norway's application in 2009 and Russia's application for the Sea of Okhotsk in 2014, and now it is considering a large Russian application with a claim for 1.2 million square kilometers. However, there is an overlap with the claims of Canada and Denmark and problems of delimitation of maritime boundaries in some disputed areas of the Arctic (Bering Sea, Spitsbergen). There are also discrepancies regarding the legal regime of the Northwest Passage and the Northern Sea Route.

All these Arctic problems can be overcome through interaction mechanisms within the organizations. In the 1990s, several multilateral organizations related to the Arctic were created: The main one of these is the Arctic Council, established in 1996 in Ottawa (Canada). The Arctic Council was formed on the basis of the so-called Rovaniemi process, which leads to the dominance of the environmental cooperation issues in the Council's activities. In the Arctic Council, decisions are taken by consensus or unanimous agreement of all eight countries. Given the military, economic, and geographic disparity of power between these countries, a consensus model is seen as a key to building confidence in the Council and ensuring that "the Council will not be used to impose certain policies" on any particular state (Bloom, 1999).

It is noteworthy that the Council does not have the legal status, so it does not rely on the Treaty and its decisions are not legally binding. In 2013, a permanent Secretariat of the Arctic Council was established in Norway to build an institutional framework and coordinate meetings of ministers of the Arctic countries every 6 months (Collins, 2017). In 2016, the Secretariat of Indigenous Peoples (formerly located in Copenhagen), created to support the activities of the Permanent Participants in the Arctic Council, became part of the Secretariat of the Arctic Council.

Members and observers believe that the Council is successfully setting norms to maintain peace and stability in the region and strengthen cooperation. This is one of a few international organizations composed of representatives of the Indigenous peoples of the North (Exner-Pirot, 2016). Moreover, although the Council itself is not a treaty-based organization, its research and expertise has become a mechanism for the elaboration of three agreements: the Agreement on Cooperation in Aviation and Maritime Search and Rescue in the Arctic (2011), the Agreement on Cooperation in the Field of Preparedness and Response to Marine Oil Pollution in the Arctic (2013), and the Agreement on Deepening International Arctic Scientific Cooperation (2017). It can be concluded that these agreements correspond to two of the Council's tasks, which are closely related: environmental protection and sustainable development.

There are also six working groups in the Arctic Council: on the implementation of the Arctic monitoring and assessment program; on prevention, preparedness, and response to emergencies; on the conservation of the Arctic flora and fauna; on the implementation of the program for the protection of the Arctic Marine Environment; on sustainable development; and on the Action Program for the Elimination of Pollution in the Arctic. On a temporary basis, so-called task forces and expert groups of the Arctic Council are being created. Under the auspices of the Arctic Council, about 80 projects are being implemented in the field of protection of the interests of the Indigenous peoples of the North, prevention of emergencies, climate change, ecology, economics, culture, and healthcare.

In 2014, the Arctic Council Project Support Instrument (a joint fund for financing environmental projects – mainly in Russia) began the financing of projects. Simultaneously the Arctic Economic Council was established as an independent organization of the business circles to strengthen business relations for the purpose of economic development. In 2015, the Arctic Coast Guard Forum was established. Chairmanship varies on a rotational basis every 2 years and is synchronized with the Chairmanship of the Arctic Council.

The Arctic Council also attracted the attention of non-Arctic states such as China and India, which are among the 13 other Council members today with observer status; (Members of the Arctic Council with observer status: France, Germany, Italy, Japan, the Netherlands, China, Poland, India, Republic of Korea, Singapore, Spain, Switzerland, and UK.) many of them even have appointed their own representatives for the Arctic, thereby demonstrating their interest in this region (Pickford & Collins, 2016).

In spite of the tensions in other parts of the world, all the Arctic states maintain positive relationships with each other, thanks to the constant engagement in the work of different institutions and commitment to the Arctic region in the management structure and order based on rules. The success of organizations such as the Arctic Council, with its consensus-based decisions, as well as the undeniable fact that severe weather conditions and common challenges necessitate cooperation, have probably contributed significantly to keeping any such strategic situation from getting out of control (Myers, 2016).

In May 2021, a ministerial session of the Arctic Council was held in Reykjavik, where the post of chairman of the Council for 2021–2023 passed to Russia. Among the main priorities of the Russian chairmanship are the following: Arctic population, including Indigenous peoples; environmental interaction; socioeconomic development; and strengthening the Arctic Council. At this meeting, the Russian Foreign Minister Sergei Lavrov spoke out, in particular, in favor of holding a summit of the Arctic states, for the spread of positive relations between the members of the Arctic Council on the military sphere through the resumption of multilateral dialogue of the Arctic states through the general staffs of the armed forces. He drew attention to the project put forward by Russia and approved by all members for the digitalization of the linguistic and cultural heritage of Indigenous peoples, and advocated the development of further interaction with the Arctic Economic Council. The members of the Arctic Council supported the program of activities proposed by Russia, containing over a 100 different events.

The ministerial meeting endorsed the Council's first-ever Strategic Plan, which will guide its work over the next decade, reflecting common values and aspirations of the Arctic states and six permanent Indigenous participants. It is important to emphasize that the participants of the ministerial meeting in Reykjavik, despite the participation in the sanctions against Russia, signed a joint declaration confirming the commitment of the Arctic Council to maintaining peace, stability, and constructive cooperation in the region.

Although the Council has made great success over the past 20 years, it has also come under fire for its limited mandate (according to some experts). Meanwhile, it is considered that the Council has a monopoly in the conduct of policy in the Arctic, which excludes the creation of other forums or new organizations for this purpose (Exner-Pirot, 2016).

However, the institutional structure of the Arctic is complemented by some smaller but equally important subregional organizations, although these organizations have relatively few members and do not have the same weight in the international arena as the Arctic Council. One of these organizations is not even official – it is the Arctic Five, which includes Canada, Russia, the USA, Denmark, and Norway.

The five countries met in 1973 and concluded an Agreement on the Conservation of Polar Bears. However, only in the past 15 years has this informal association developed a lot of activity, largely due to the influence of climate change, increased economic interest of non-Arctic states in this region, and tensions over boundary claims in the mid-2000s. The Arctic Five are conducting “spontaneous negotiations,” but on at least three occasions over the past decade they have come together: in Ilulissat (Greenland, 2008); in Chelsea (Canada, 2010), and in Oslo (Norway, 2015) (Kuersten, 2016). Meetings in Greenland and Norway resulted in the adoption of nonbinding declarations. In one of them, five countries made it clear that they saw no need for a legal regime in the north like the one in Antarctica (favored by China), and that the 1982 UN Convention on the Law of the Sea – which the USA has not ratified, but tacitly abides by in practice – is sufficient for dealing with disputes. The five countries emphasized their belief in regional cooperation and in the “orderly settlement of any possible conflicting claims” (The Ilulissat Declaration, 2008). Notably, many see an advantage in the Arctic Five informal structure in terms of developing binding agreements with non-Arctic countries and dealing “concretely with issues of state interests” (Kuersten, 2016), primarily in the field of security (Zagorskiy, 2019).

In addition to the Arctic Five, there is also the Barents Euro-Arctic Council (BEAC). BEAC was established in 1993. Now the organization brings together Denmark, Finland, Iceland, Norway, and Russia. BEAC aims to ensure that close cooperation secures long-term political stability and reduces potential tensions in relations. Simultaneously with the BEAC, the Barents Regional Council (BRC) was formed. BRS unites 14 districts located in the Far North of Finland, Norway, Sweden, and north-west Russia. With the inclusion of Indigenous representatives, the BRC seeks to support and promote cooperation and development in the Barents Region.

Subregional Indigenous groups have also emerged: the Inuit Circumpolar Council (ICC) was formed in 1977, representing more than 160,000 Inuit located in Alaska, Canada, Greenland, and Chukotka (Russia). One of the main goals of this Council is to promote Inuit rights internationally, to unite the Arctic Inuit population, and to strive for a full and active partnership in the political and socio-socioeconomic development of the circumpolar regions.

As the practice of international relations in the Arctic region shows, it is necessary to use additional political and diplomatic mechanisms. Moreover, the struggle for the Arctic and its resources is no longer carried out only by international legal instruments. Competition of technologies, the efficiency of socioeconomic systems, and the ability to protect sovereignty by force are coming to the fore.

Russian Arctic Interests and Policy

The value of the northern territories for Russia is of high significance. The Arctic development is associated with solving long-term tasks Russia has and increasing its competitiveness. The Arctic region can become the main strategic resource base for Russia. In addition to hydrocarbons, the biological resources (unique animal and fish species of the North Seas) are of great importance for the economy. Benefits from the northern transport routes, environmental protection, and sustainable use of natural resources are no less important for the interests of Russia.

Compared to other countries, the role of the region in the development of Russia is incomparably higher. The region accounts for about 10% of Russian GDP and 20% of its total exports. Nevertheless, the opportunities for the region development are limited by barriers of economic, technological, environmental, and social natures.

The Arctic is indeed becoming more accessible. However, the global energy transition and growing environmental risks are increasing the requirements for expensive Arctic projects, the implementation of which is less profitable in the context of low energy prices. Russia is ready for cooperation and open to joint projects in the Arctic. The Arctic development will require Russia to attract large-scale investments, including foreign ones. Currently, 150 priority projects for the development of the Russian Arctic have been identified with a deadline for implementation up to the 2030s, with a total cost of almost ₽5 trillion, with most of the funds (about ₽4 trillion) coming not from budget sources.

The Arctic policy of modern Russia has gone through several stages in its evolution. The 1990s can be considered as a failure for Russian Arctic policy, since, during this period, almost all the achievements of the Arctic policy of the Soviet period were lost. Some researchers note a number of factors aggravating the state of affairs during that period, particularly including incompetence, corruption, growing scientific and technological backwardness, and de-industrialization (Aleksandrov, 2017). Actually, Russian actions in the Arctic in the 1990s and the first half of the 2000s were fragmented and contradictory, lacking a systematic approach, while decisions were sometimes made spontaneously and ill-considered, under the influence of the current political conjuncture and without a long-term perspective.

In 1997, Russia ratified the 1982 UN Convention on the Law of the Sea, on the basis of which it submitted an application to the UN in 2001 to expand its Arctic shelf. This event is considered to be a kind of starting point in the Arctic policy of modern Russia. The Russian "Arctic comeback" started in the second half of 2000s, when the Arctic officially became one of the priority areas of Russian foreign policy. In 2007, Russia announced its ambitions by organizing an expedition in which about a 100 experts, scientists, representatives of the authorities, and journalists took part; the atomic icebreaker "Russia," the vessel "Akademik Fedorov," helicopters, and deep-sea bathyscaphes "Mir-1" and "Mir-2" took samples of the Arctic soil at the bottom of the North Pole and put the Russian flag. This expedition began as one of the steps to define the subjects of the Russian Arctic policy.

The successful conduct of the Arctic expedition testified to the emergence of a subject of Arctic policy, including representatives of state authorities and large oil and gas companies – Gazprom, Rosneft, Rosshelf, and Zarubezhneft. In order to make the Russian Arctic more investment attractive for domestic companies, the state agreed to provide them with tax holidays and also allowed them to attract foreign investors at their own choice.

In recent decades, the Arctic is undergoing significant transformation, especially related to climate change. This gives rise to a change in the tactics and development strategy of both the Arctic states and countries geographically located outside the region. Analyzing ongoing processes and determining the prospects for the development of the region form the choice of state policy instruments in the Arctic (Schach & Madlener, 2018).

In 2008, with the approval of the Fundamentals of State Policy of the Russian Federation in the Arctic for the period up to 2020 and beyond, the Russian Arctic again found itself in the focus of public administration after the reforms of the 1990s. In fact, this was the next step in the formation and governance of the Russian Arctic zone. From this moment, Russia began to take steps toward strengthening its presence in the region on a permanent basis. The goals, objectives, priorities, and mechanisms for the implementation of state policy were determined, the State Commission for the Development of the Arctic was created, and the Arctic zone was allocated as a separate object of statistical observation; this significantly contributed to improving the quality of monitoring the achievements and increasing the quality of life in the region (Krutikov et al., 2020).

In 2014, the State Program of Socio-Economic Development was adopted as a tool for implementing the Strategy. The development and approval of these documents were timely, because by the beginning of 2011, all the Arctic states with access to the Arctic Ocean had approved documents aimed at the development of their Arctic territories and defining their Arctic priorities (Brosnan et al., 2011).

The activities of various state programs did not cover the entire range of tasks defined by the Strategy and did not become a tool for the implementation of strategic planning documents for the development of the region. In this region, the provision of socioeconomic development and national security are maximally interconnected. Foremostly, this concerns the development of infrastructure, the development of Arctic technologies, and the intensification of scientific research, which together will allow Russia to build up not only technological, but also intellectual presence in the region (Kudryashova et al., 2019).

On March 5, 2020, the President of the Russian Federation approved a new edition of the Fundamentals of State Policy in the Arctic for the period up to 2035 (2020). The main instrument for implementing state policy in this region should be a new Strategy for the Development of the Arctic Zone of Russia and Ensuring National Security until 2035 (2020), approved on October 26, 2020.

Many of the Strategy priorities are already being implemented, and a regulatory framework is being created for others. This new Strategy defines the main directions, tasks, and measures for the Arctic zone development, as well as mechanisms, stages, and expected results of their implementation. In accordance with the document, the Arctic is defined as a strategic region of great importance for the country and its security.

The main problems, challenges, and threats include an intense warming of the climate, a decrease in the population, a lag in the values of life quality indicators from national average ones, and a low level of availability of high-quality social services and comfortable housing in remote settlements, including places of Indigenous peoples' traditional residence and economic activity. At the same time, a high level of occupational risk is recorded, due to the impact of harmful industrial and cooling meteorological factors of working conditions, an increased level of occupational morbidity compared to other country regions, the absence of a state support system for the delivery of fuel, food, and other vital goods to the Arctic zone at affordable prices, the low level of development and a high cost of creating transport infrastructure, and the lack of competitiveness of business entities due to higher costs, the delay in the development of the infrastructure of the Northern Sea Route, and a number of other negative aspects.

The new document is fundamentally different from the previous version of the Strategy and the previously valid strategic planning documents in two key provisions: First, the main emphasis is placed on improving the quality of life of people living there, and accordingly, a number of tasks are formulated that are aimed at social regional development; second, a special regional section has appeared in the Strategy that determines the priority areas of socioeconomic development of each territory within the Arctic zone.

The Strategy defines a set of measures to achieve the main tasks of the Arctic social development. Some of these are aimed at the development of primary health care, including the provision of equipment, provision of medical organizations with auto and air transport, the improvement of public financing mechanisms of medical assistance, etc. A number of other measures are designed to improve the quality of the education system in the Arctic, including improving legal regulation and creating conditions for the education of Indigenous peoples; the development of a network of professional educational organizations together with large- and medium-sized enterprises; and support for development programs of the Federal University and other educational institutions of higher education, their integration with scientific organizations and enterprises of the real sector of the economy. The set of activities also includes measures to support Indigenous people, to develop creative fields and sports for the population from remote settlements, and, in particular, to improve the mechanisms for subsidizing air travel, state support for housing construction, and other such areas.

The implementation of the Strategy is designed in three stages: the first stage (2020–2024), the second stage (2025–2030), and the third stage (2031–2035). The provisions of the document will be ensured by amending the state program "Socio-economic development of the Arctic zone of the Russian Federation," regional state programs, and the implementation of measures for the development of the Northern Sea Route infrastructure.

In comparison to the Strategy of 2013, the main tasks have not fundamentally changed: comprehensive socioeconomic development, intensification of scientific research, development of advanced Arctic technologies, formation of various infrastructure (from energy, transport, to information and telecommunications), ensuring environmental security, and preserving the Arctic as a zone of peace through the development of international cooperation.

However, the focus has shifted over the years. If in the early 2010s the task was to create a lot anew, then in the early 2020s the task is to develop and improve what has been achieved. In 2019, the President of the Russian Federation noted that the new strategy for the development of the Russian Arctic until 2035 should combine the activities of Russian national projects and government programs, investment plans of infrastructure companies, and programs for the development of the Arctic regions and cities.

At the same time, the development of the Arctic spaces is impossible without the population permanently residing in the region. All Arctic states "rely" in their strategies on the permanent population, and Russia is no exception. In this regard, ensuring the quality of life at a level not lower than the national average, as well as achieving the average Russian values of key socioeconomic indicators, should be one of the priority goals of the Strategy until 2035. In addition, development issues should take into account the specifics of the Indigenous peoples' lives.

One of the goals for the period up to 2024, determined by the President, is to ensure the transportation of goods along the Northern Sea Route in the amount of 80 million tons. Achieving such an ambitious goal implies the comprehensive development of the transport sector. This involves not only the construction of icebreaking vessels, but also vessels for the transportation of goods, as well as vessels supporting the appropriate ice class; it also entails the development of port infrastructure along the entire length of the route, the development of inland waterways, navigation facilities, meteorological support, and much more.

It also requires the development of other infrastructure, primarily energy. Infrastructure projects can serve as the basis for attracting additional investments and implementing large business projects. Thus, the adoption of the new Strategy, as well as the adjustment of the State Program "Social and Economic Development of the Arctic Zone of the Russian Federation," will contribute to a more systematic implementation of Russian policy toward the Arctic region.

Among the main tasks in the international cooperation development, the Strategy highlights a measure to ensure the effective work of the Arctic Council under the chairmanship of Russia in 2021–2023, including the promotion of joint projects. The priority of Russian chairmanship in the Arctic Council has been identified as Responsible Governance for Sustainable Arctic. It promotes collective approaches to ensuring sustainable development within the Arctic region, maintaining balance in its social, economic, and environmental dimensions, increasing synergy, constructive cooperation, and the coordination of the Arctic Council with other regional structures, and the implementation of the Strategic Plan of the Arctic Council.

Russia intends to give priority attention to improving the well-being, health, and quality of the Arctic inhabitants' lives, including Indigenous peoples, and to ensuring progressive social growth, on the basis of sustainable economic development of the region. The growing positive potential of the Arctic should be used to ensure prosperity and progress in the interests of the entire Arctic population, as well as to promote scientific, educational, and cultural exchanges, tourism, and people-to-people contacts.

The comprehensive program of the Russian chairmanship assumes the promotion of multilateral cooperation in the following priority areas:

1. *Population of the Arctic, Including Indigenous Peoples*

   The sustainable development of the Arctic is largely determined by the quality of human capital. The Russian Chairmanship's main focus will be given to maintaining the stability and vitality of the Arctic inhabitants, promoting climate change adaptation measures, improving the welfare, health, education, and quality of life, and ensuring progressive socioeconomic development throughout the region.

Promotion of scientific, educational, and cultural exchanges, tourism, and contacts between people and regions will also be high on its agenda. Particular attention will be paid to the preservation of the linguistic and cultural heritage of the Indigenous peoples of Arctic, and the promotion of cross-border youth exchanges.

2. *Environmental Protection, Including Climate Change Issues*

Given the rapid change of climate in the Arctic, most notably accompanied by degradation of permafrost and gas hydrides emissions, among the priorities will be the tasks of mitigating the negative effects of climate change, increasing the adaptation of life activities, ensuring resilience to its consequences, preserving and restoring the environment, rationally using natural resources, and maintaining the health of the Arctic ecosystems, including marine environment, conservation of biodiversity, and in particular migratory bird species.

In the context of the further development of the region, it is important to take into account not only the vulnerability of the Arctic to climate change, but also its promising contribution – due to its natural, energy, and transport resources – in facilitating the transition to a low-emission economy and, accordingly, to the fulfillment of the goals and objectives of the 2015 Paris Agreement on Climate. An equally topical task is to promote the introduction of advanced innovative technologies in the region into the transport sector, industry, infrastructure, and energy, including the use of renewable energy sources in order to improve the living standards of the Arctic population.

3. *Socioeconomic Development*

A key condition for the well-being and prosperity of the Arctic is its sustainable economic development. The Russian chairmanship will focus on further promoting economic cooperation in the region; on developing a reliable energy infrastructure, as well as sustainable transport routes, including maritime shipping, telecommunications systems, and the food production sector; and on improving conditions for investment inflows, promoting innovation, entrepreneurship, and business financing.

4. *Strengthening of the Arctic Council*

The Russian chairmanship will continue to promote the consolidation of the Arctic Council as a key format for international Arctic cooperation, improve its work, increase the efficiency of the Working and Expert Groups and the Secretariat, develop mechanisms for financing the Council's activities (including its projects and programs), implement decisions and recommendations, and encourage the dialogue and interaction with the Observers in order to ensure their meaningful and balanced involvement in the Council's activities. It intends to further intensify collaboration between the Arctic Council and other Arctic structures. Among the priorities of the Russian Chairmanship is the promotion of international scientific cooperation, in particular exploring the possibility to conduct the Arctic Council scientific expedition to the Arctic Ocean.

Within the framework, as well as under the auspices of the Russian chairmanship, it is planned to hold more than 100 international Arctic events, divided into 11 thematic clusters:

1. Human capital development in the Arctic
2. Indigenous peoples of the Arctic
3. Arctic youth
4. Climate change and ecology of the Arctic
5. Prevention of emergencies
6. Economic cooperation
7. Development of infrastructure and sustainable shipping
8. Arctic tourism
9. The cultural program
10. International Arctic cooperation
11. International scientific cooperation

The priority for Russia is to preserve the territory of the Arctic for peace, stability, and constructive cooperation. Russian policy in the Arctic should be systematic, consistent, and based on a historical foundation. New Russian Arctic policy should proceed from new conditions: due to geography, Russia needs the Arctic incomparably more than the rest of the world. International community interest in the region is growing, but it is hardly possible to count on the fact that it can become the main driver of its development. Russia needs a strong state policy, aimed at creating a competitive resource economy of an innovative type at the institutional level, taking into account both internal and external impediments and obstacles.

The Russian Arctic development is traditionally understood through the discovery of new fields and the implementation of new infrastructure and energy projects. However, the further development of the region by extensive methods is fraught with the aggravation of three groups of risks:

1) Capital-intensive Arctic projects, designed over decades and requiring significant costs, risk not paying off in the future.
2) Increasing the production and export of primary energy resources is fraught with the aggravation of the technological dependence of the Russian economy.
3) The expansion of economic activity in the Arctic can lead to negative environmental consequences or even man-made disasters, especially in the context of accelerated climatic changes.

Modern state policy in the Arctic is mostly limited to providing large-scale economic benefits to companies that are potentially ready to implement resource projects, including on the Arctic shelf. This approach was extremely relevant when the situation in the world markets was favorable and there were still opportunities to strengthen cooperation with Western companies with competencies in the North. Now this approach looks risky; the proposed measures, most likely, will not be enough for a noticeable increase in the investment attractiveness of the Russian

Arctic. As a rule, such benefits are largely aimed at supporting large companies that already occupy a monopoly position, if not at the industry level, then at least at the level of some Arctic regions. But in the absence of competition and one-sided dependence on companies in the Russian regions, environmental risks from economic activities in the Arctic will increase many times over, simultaneously causing serious internal and external political reputational damage.

Russian Arctic international goals can be divided into two main groups: the provision of military and environmental security in the region, and the development of the region through Arctic projects. Each of these goals includes a number of tasks, all of which require both international and domestic Russian measures to solve. The first block of international tasks is associated mainly with the relief of common threats faced by the Arctic countries and involves both intensive interaction at the site of the Arctic Council and parallel international tracks within the framework of bilateral and multilateral formats (Likhacheva et al., 2021).

A prerequisite for the successful solution of these problems is increased support for science and the introduction of advanced environmental standards and practices. The block of international tasks associated with the development of the Russian Arctic predominantly presupposes bilateral cooperation or appeal to international development institutions with Russian participation. Finally, the internal development objectives imply the transformation of the Arctic development model from an extensively operational model to an innovative resource based on the principles of environmental development of the Arctic together with other regions of Russia.

The issues of regulating the sea passage and economic activity in the open part of the Arctic Ocean are also on the agenda but should be considered separately. In the open part of the Arctic Ocean, Russia's risk is not losing its positions, but not realizing the economic and geostrategic potential that is created by the greater physical accessibility of the open part of the Arctic Ocean.

Russian chairmanship should be used to run the discussion on the proposed international regime "enhanced climate responsibility," as well as revitalization and reanimation of the institution as a whole by promoting climate and environmental issues, the issues of disaster prevention, mitigation, etc. It is crucial to overcome the institutional crisis – a return to the practice of adopting joint declarations, the implementation of previously assumed obligations, an audit of the Arctic Council activities, and a precise definition of the climate agenda by the Arctic countries.

This approach is more in line with Russian interests than self-limitation by the agenda of reducing greenhouse gas emissions prevailing in the global climate movement: The accumulated scale of climate change makes adaptation in the Arctic a priority for decades to come, even with the comprehensive fulfillment of obligations to reduce emissions in the world – the Arctic is already too hot.

Moreover, Russia should not take a passive ecological position. The significance of the region for Russia allows us to come up with ambitious programs of changes in the Arctic. The new development of the region, being so rich in natural resources, can be a powerful catalyst for other regions in terms of research and development work (R&D), mechanical engineering, sources of increasing prosperity, reducing depopulation, and complicating production.

The Arctic should become a platform for innovative resource development for the entire country. In part, this vision of a "self-sufficient" region is enshrined in the new Strategy until 2035. All goals formulated in it are strictly "Arctic," not taking into account the effects for other regions. The stated goals, of course, need to be realized. However, an expanded and potentially more effective understanding of the Arctic development tasks requires a different balance of international and domestic Arctic policy instruments.

International cooperation in the Arctic is more varied across countries and instruments. It should address the issues of reducing technological dependence, providing sales markets for Arctic exports and attracting investment in the Arctic projects. At the same time, the Arctic specifics mainly concerns international cooperation in the field of technology transfer to Russia – increasing exports and foreign investment in the Arctic.

However, the role of the domestic Russian strategy is much more important in this region: the involvement of Russian suppliers of technological equipment in the resource projects, the financing of relevant R&D in scientific centers, the creation of an infrastructure for the physical interface between the Arctic and Siberia, and the development of the Northern Sea Route.

Russia and International Cooperation in the Arctic

International cooperation in the Arctic can be considered as a development tool, including of the Russian North. The main task of it is access to the technologies of Arctic work. So far, Russia imports in 70% of cases, including crucial technologies. The import of foreign technologies should form the basis of a more comprehensive industrial and technological policy. The priority of the technological and spatial development of Russia should become the main policy of "managed cooperation" with foreign countries. The main goal of this policy is to reduce foreign policy risks and strengthen cooperative relationships with foreign companies at all stages of high-tech production, but with their localization within Russia.

First of all, it is important to ensure the localization of high-tech resource-intensive industries and the formation of a pool of domestic service companies and industrial production focused on the needs of the Arctic projects. The nonspecific tasks of the Arctic development, universal for any export-oriented region of Russia, are attracting investments and providing sales markets. In both cases, a combination of international efforts and domestic Russian decisions is required. The issue of dual-use infrastructure is extremely important for foreign investment attraction, because almost all infrastructure in the region has historically been exactly like this. From the investment side, it is advisable to concentrate international cooperation on the following areas:

- Cooperation within the framework of international development institutions with Russian participation (e.g., Asian Infrastructure Investment Bank, BRICS New

Development Bank, and Eurasian Development Bank), including through targeted projects for sustainable development of the Arctic.
- Cooperation with non-Arctic countries without empowering them to manage the region – the main focus herein is on China and other Asian countries (Japan, India, Korea, and ASEAN countries) – and also Middle Eastern countries interested in diversifying assets.
- Integrated development of the Northern Sea Route as a way to attract investment not only in the resource sector, but also in the infrastructure and logistics complex of the region, the development of tourism, and Arctic cities.
- Use of "green" financing instruments for the region, or "Arctic" bonds issue for the large-scale projects.
- The application of mechanisms of public-private partnership (PPP) for the implementation of the Arctic projects.

International cooperation in terms of sales markets for the Arctic should take into consideration the entire range of efforts: regulatory, logistic, insurance, and informational – inside and outside.

Cooperation with Asian Countries

Under current conditions, the possibility of a robust international cooperation is opening up in the East. Now the enhancement of cooperation with China, Japan, Republic of Korea, a number of ASEAN countries, and India is largely constrained by the closure of the Russian Arctic policy and the lack of a coherent interaction strategy with them. One of the main tasks of cooperation on the eastern part is to attract funds of non-Western development institutions, created with the participation of Russia.

Among Asian countries today, Russia's main partner in economic development projects in the Arctic is China. Despite differences in the strategic vision of the Arctic future and its management, the tactical potential of Russian-Chinese cooperation in the region is significant: First of all, this is important in the field of resource development, transport, and logistics infrastructure, more active use of the Northern Sea Route and Arctic tourism development; in addition to this, significant potential for cooperation lies in such areas as the Arctic rural economy, electric power industry, and Arctic settlements development in the region.

The policy of cooperation with China in the Arctic should be accompanied by a set of measures that strengthen confidence that the implementation of joint projects is carried out in accordance with the principles of sustainable development. Environmental control over joint projects should be strengthened by measures of additional environmental expertise, as well as a general increase in its effectiveness, including stricter requirements for the completeness and transparency of the information provided.

Cooperation with China should be complemented by strengthening partnerships on the Arctic issues with Japan, Republic of Korea, India, and those ASEAN countries that also show interest in this region. Intensification of cooperation with Korean and Singaporean companies can be useful in terms of exchange of experience and knowledge in the field of shipbuilding, port infrastructure management, and tourism development. The dialogue with India and Japan is promising in terms of LNG projects, joint scientific Arctic research related to the study of the dynamics of processes, and the consequences of climate change.

It is useful to study joint investment projects with the countries of the Middle East. In context of the geographic diversification policy, they may be interested in a wide portfolio of Arctic projects in Russia.

Cooperation with Western Countries

Despite the sanctions, restrictions, and the "green protectionism" of the EU, there are still a number of promising niches in technological and economic cooperation with traditional Arctic partners. It is undoubtedly important to preserve and support existing projects in border areas, encourage entrepreneurship and cross-border trade, and implement joint projects by small- and medium-sized businesses.

During the presanction period, Russian energy companies actively interacted with European and American transnational companies on the Arctic joint projects. However, the Western sanctions forced companies to curtail their activities, which added some technological problems to Russia. The economic security of Russia and its technological independence directly depend on overcoming these problems.

An important priority of Russia's cooperation with the Scandinavian countries, especially Norway, is the Northern Sea Route development. For the promotion of green bonds and loans as a financing tool for the Arctic projects, within the framework of chairmanship, Russia could put forward a proposal to establish an interstate operator for the Arctic projects focused on attracting "clean" funding. Such an initiative may not only bring image advantages, but also become a really demanded financing tool, since the Russian Arctic has a huge potential for cheap reduction of greenhouse gas emissions by increasing the energy efficiency of equipment, switching to "clean" energy, reforestation, etc.

A great potential for cooperation can be realized with the Nordic countries in terms of projects in the field of the renewable energy sources. In the context of critical inefficiency of northern fuel delivery, projects for the renewable energy sources development in isolated territories of the Russian North can become commercially attractive with minimal government support.

In the current conditions, any decisions in the Arctic cannot take into account the criteria of financial efficiency. But, more importantly, they should also include requirements for maximizing positive effects for the environment, the population, improving technologies and spatial development of Russia.

Taking into account the peculiarities of the economy of Arctic projects, requiring large-scale state support, they cannot work only for themselves, and the state has significant leverage over them. The approach to the Arctic development through the implementation of the most profitable projects is obviously insufficient. Arctic domestic policy should proceed from the need to prioritize the promotion of projects that have significant added value for Russia as a whole, that is, stimulating R&D, localization of the high-tech production, and the development of related industries in the other Russian regions. Such projects will most contribute to the tasks of high-tech development and environmental protection in Russia.

Conclusion

The Arctic still remains a territory with an unregulated legal status, actually contributing to the implementation of the "internationalization" concept, supported by all non-Arctic states. The geopolitical, economic, climatic, and other changes in the Arctic directly affect not only the interests of the polar states, but also a wide range of the non-Arctic countries. This state of affairs carries the threat of various kinds of restrictions on the sovereignty of the five Arctic states in the name of "the interests of mankind," under which the interests of the largest transnational corporations may be hidden.

Russia plays one of the main roles in the Arctic. Russia is a member of all Arctic-related organizations, both formal and informal. For the period 2021–2023, the Arctic Council will work under the chairmanship of Russia, within the framework of the integrated comprehensive development program in the Arctic territories, and therefore prioritizes the balanced promotion of the region's sustainable development in the social, economic, and environmental dimensions.

Russian Arctic policy has undergone significant changes in recent years and has moved from a passive stage to an active one. Under the current conditions, Russian Arctic policy is undergoing a serious test of its strength in the new geopolitical and economic realities. Russia needs to rethink the achievements and failures of the entire historical path of development and presence in the Arctic and rely on continuity, consistency, and systemic character in its Arctic policy. In its further Arctic policy, Russia should take into account the problem of the growing internationalization of the region.

The Arctic can claim the role of a pilot region for the formation of a highly innovative resource and nature-saving economy. However, this requires completely different institutional approaches to its development. Without an active technological policy, Arctic projects run the risk of remaining dependent on the import of foreign equipment, which is fraught with an increase in foreign economic and political risks. At the institutional level, there should be conditions created for the deep integration of Arctic projects into high-tech value chains in the country. Otherwise, the development of the Arctic will be carried out to satisfy a limited number of individuals and companies and will not bring Russia closer to solving the problems of modernization and technological development.

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European Arctic Policy

Interests of Non-Arctic States and the EU

Maria L. Lagutina, Natalia V. Eremina, and Sébastien Gadal

Contents

Abstract

The European non-Arctic states – the UK, Germany, France, Italy, Spain, the Netherlands, Poland, and Switzerland – are mostly experienced Arctic explorers. From the very beginning their attention to the Arctic was driven, firstly, by an interest in finding the shortest trade routes from Europe to Asia and, secondly, by scientific research. At the end of the twentieth century, the participation of European non-Arctic countries in Arctic governance began to be institutionalized – this group of countries received the status of observers in the AC. The range of their interests in the region has expanded significantly: from scientific research to security issues. Most of these European countries are the members of the European Union (EU) and

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provide the idea of including the EU to the Arctic governance system. The national roadmaps of the EU Arctic member states and observers are mainly driven by the EU Arctic policy framework. This chapter provides an analysis of strategic documents and a summary of the main common interests of the non-Arctic European states and the EU in the region and their activities in the Arctic.

Keywords

Non-Arctic European states · Arctic Council · Observers · The European Union · The UK · Germany · France · Italy · Spain · Poland · The Netherlands · Switzerland

Introduction

Nowadays, in the modern globalizing environment not only the traditional Arctic countries, but also a range of the non-Arctic nations (e.g., China, Singapore, Germany, France, Italy) and international institutions (e.g., the EU, NATO) are manifesting their interest in the Arctic. First and foremost, the non-Arctic countries are anxious about the climate changes in this region and their impact on the globe in general. Apart from that, they are interested in the development of scientific cooperation on the Arctic issues and an unrestrained access to the Arctic mineral riches and transport arteries, economic cooperation in the region. At present, this group of countries is striving to gain a foothold in the leading Arctic regional structure – the Arctic Council (AC), to influence the decision-making process in Arctic affairs.

Almost all European non-Arctic observer countries at the AC – the UK, Germany, France, Italy, Spain, the Netherlands, Poland, and Switzerland – have some historical experience of working in the Arctic. Among the non-Arctic European observer countries, only Spain has no tradition of Arctic exploring, Spain's attention was paid to the Antarctic mainly. Thus, Spanish interest in the Arctic is dictated by current events and challenges. The European countries (e.g., the UK, the Netherlands, Italy) equipped expeditions to the Arctic region to explore new sea routes, new lands, and open new opportunities for trade. If the development of the Arctic territories before the nineteenth century was mainly associated with the development of fishery and trade, then after the nineteenth century, the importance of the region from a military point of view increased significantly, and a steady scientific interest in it was indicated. This land was perceived by European travelers as Terra Incognita, which had its secrets. And the laurels of the pioneers have always attracted ambitious travelers. In addition, in the nineteenth century, technical capabilities based on developed shipbuilding appeared, which contributed to the scientific research of the region. At the same time, the role of the North in general and the Arctic in particular as a region associated with ensuring the security of many states increased first during the First and then the Second World War. All these events have best confirmed that the Arctic should remain a territory of dialogue. It should be noted that the historical experience of participation in the development of the Arctic and contribution to Arctic scientific research played an important role in obtaining observer status in the Arctic Council by European non-Arctic countries.

Today, among the European non-Arctic states are six EU member states (France, Germany, Poland, the Netherlands, Spain, and Italy) and two non-EU members (the UK and Switzerland). The European nations obtained observer status in several stages: Germany, the Netherlands, Poland, and the UK joined the AC in Iqaluit Ministerial meeting, 1998; France obtained observer status in Barrow Ministerial meeting, 2000; Spain got the observer status in Salekhard Ministerial meeting, 2006; Italy joined as an observer to the AC in Kiruna Ministerial meeting, 2013; and, finally, Switzerland became an observer to the AC in Fairbanks Ministerial meeting, 2017. On the one hand, it is an acknowledgment of the achievements of these countries in exploring the Arctic, and, on the other hand, it is their new responsibility, envisaging the ever-increasing activity in the region.

The observer application of the European Union to the Arctic Council was rejected several times. Meanwhile, in 2013 at the ministerial meeting of the AC in Kiruna an agreement was reached, which allows the EU to work within the AC on conditions similar to the observers (Mann, 2021). Besides that, the EU, with three Arctic states, and six non-Arctic state's observers is de facto a player with the standards and regulations in addition to the Science's Polar budget of 76,1 million euros (European Polar Board, 2021), and the other EU research and national states budgets. Science is one of the main drivers of the EU polar policy and the European states with the sustainable exploitation of the natural resources: fishery, mines, tourism, oil, and gas.

Interests of European Non-Arctic States in the Arctic

Even though many European non-Arctic observer countries have been present in the Arctic for a long time (For example, British historians have proven their country's presence in the Arctic since the sixteenth century; Dutch fishermen and sailors began to enter the Arctic expanses in the sixteenth century as well; France began scientific research in the Arctic already in the eighteenth century in the field of terrestrial and marine ecosystems, anthropology, and ethnography; the Italians began their advance into the Arctic only at the end of the nineteenth century; it was in the second half of the nineteenth century that Germany began its active advance into the Arctic; Poland established its formal connection to the Arctic in 1931 by ratification of the Svalbard Treaty; the first Swiss expeditions to the Arctic were organized in Greenland 1909 and 1912–1913. Besides, all these countries are the parties of the Svalbard Treaty: the Netherlands (1920), the UK (1923), France and Italy (1924), Germany, Spain, and Switzerland (1925), and, finally, Poland (1931).), they began to publish their strategies only in 2013. Among European countries, which gained observer status to the AC, by now only Switzerland and Poland have not issued an Arctic strategy document with national priorities for the Arctic region. For the first time, the UK has clearly stated its position on the Arctic in 2013 in "Adapting to Change: UK policy towards the Arctic" and in 2018, the UK published an updated version of its Arctic strategy "Beyond the Ice: UK Policy towards the Arctic." The interests of Germany in the Arctic are reflected in the document "Guidelines of the Germany Arctic policy," which was developed in 2013 and 2019. In 2015, the Ministry of Foreign Affairs of the Italian Republic published on its website the document "Towards an Italian Strategy for the Arctic. National priorities." In 2016, France adopted its *National Arctic Exploration Programme*, which sets out the country's basic interests in the region and delineates the principal trends and priorities of its Arctic policies in the coming years. In the case of Spain and the Netherlands, these countries have their Polar strategies, which lays out their interests in both polar regions – the Arctic and the Antarctic: in 2016, Spain published "Guidelines for a Spanish Polar Strategy" and the Netherlands issued "Nederlandse Polaire Strategie 2016-2020," which was republished in 2020 as "The Netherlands' Polar Strategy 2021-2025. Prepared for Change." Let us look in detail their Arctic strategies.

The United Kingdom. In 2013 the British government presented its multilateral Arctic strategy – "Adapting to change. UK policy towards the Arctic." Since that time the United Kingdom has begun to show its interest in the North in four areas: security, politics, economy, and environment. This document pointed out that the UK considers NATO as the central link in building relations with the Five Arctic countries and that it is very important for the UK to maintain contacts with its allies in the region in the military-political context.

The Arctic is of interest to Great Britain in terms of resources, logistics in the event of the opening of the Northern Sea Route, and scientific research. The UK's ability to confidently advance in these areas in the Arctic is based on the gigantic experience of military geographic research and powerful schools in the field of oceanology and polar geography. The unique experience of shipbuilding is also a UK asset. The accumulated knowledge creates a technological breakthrough opportunity. The London location of the headquarters of many maritime organizations and Lloyd's Register also works to support the UK's Arctic positions. In addition, the UK is a Nordic country, and its geographic location also indicates the need for an Arctic policy. From the point of view of public opinion, the reason for the proximity to the Arctic is that the northern border of the economic (two hundred miles) economic zone of the Shetland Islands is located relatively close to the Arctic Circle. In general, the geographic location of Great Britain is beneficial from the point of view of developing its cooperation with members of the Arctic Council, primarily Norway, Denmark, and Iceland.

Moreover, it is this that allows the UK to become a possible part of the Northern Sea Route, as well as to talk about common tasks in preserving the environment in order to maintain its own fishing industry and climate, since marine ecosystems are interconnected. For the same reason, the country's scientific presence in the Arctic should be highly appreciated.

The formation of the British Arctic agenda took place consistently and quickly. Thus, the first document of a framework nature "Adapting to Change," dedicated to the Arctic, appeared in Britain in 2013. Then the country outlined some specific plans in the Arctic, primarily in terms of security, economics, politics, and the environment (Adapting to Change. UK politics towards Arctic 2013). In this document, the Arctic is indicated as a platform, the geopolitical potential of which will grow, and the British will be able to show their diplomatic, military, and scientific potential there. A clearer positioning in the Arctic was also dictated by the international agenda, in which the region has already become the most important negotiating platform, whose role is constantly growing in many respects. In addition, the Arctic for Britain appears to be a zone that ensures the country's security, which was also noted in another document – the "Security Ordinance" of 2015. In 2015, the House of Lords published the first report on the Arctic, and exclusively in the context of security (Select Committee of the Arctic 2014–2015). And before that, in the 2014 National Maritime Security Strategy, the British indicated that the Arctic Sea routes are unsafe because of Russia, for which it is proposed to jointly patrol the region with other countries (National Security Strategy and Strategic Defense and Security Review, 2015). This approach was reaffirmed in 2017 when a new British foreign policy strategy related to Brexit was presented. This circumstance forced the country's authorities to think over an independent strengthening of positions in Arctic without the EU within the framework of the Global Britain strategy.

In 2018, the UK justified its positions on the Arctic even more clearly and more specifically in the framework of the strategy report "Beyond the Ice. United Kingdom Arctic Policy" (Beyond the Ice. UK policy towards the Arctic 2018). This strategy should reaffirm Britain's leadership in Artik after Brexit. It states that since ecology is an international matter, the Arctic also requires cooperation not only of the Arctic, but also of non-Arctic states. In strategy, Britain calls itself a "Middle Arctic state" and a world leader in the Arctic. The mechanisms for strengthening the British presence in the Arctic are called intergovernmental meetings designed to ensure the appropriate representation of Britain in the Arctic Council and other Arctic organizations: "Although the UK is not an Arctic state, we are its nearest neighbor, with Lerwick in the Shetland Islands closer to the Arctic Circle than it is to London. We have always been a world leader in Polar affairs where British views have long held sway in the fields of polar science, exploration, diplomacy, business and environmental protection" (Beyond the Ice. UK policy towards the Arctic 2018: 14).

The 2018 UK Arctic Policy Framework also presented science diplomacy as a tool for Britain to collaborate with other Arctic actors through the dedicated Scientific Council for Environmental Research (Natural Environmental Research Council, NERC) (Eremina, 2021).

The UK is considered one of the leaders in Arctic research among non-Arctic states. About 9 percent of all scientific publications on Arctic issues belong to the British, primarily in the field of biological diversity, climate change processes in the Arctic, as well as changes in the state of ice. The country continues to focus on joint research on the Arctic climate with the Arctic states. For one, in the current period (from 2018 to 2022), the Changing Arctic Ocean program is being developed, with funding of £16 million. The country has a wide research network related to scientific research in both the Arctic and Antarctic NERC – the Natural Environment Research Council. Today it represents the UK's largest environmental science, education, and innovation institution (the Natural Environment Research Council 2021; Eremina, 2019: 30–39).

At the same time the Arctic as an important region for security and defense was indicated for the UK. In 2018 a new "Defence Arctic Strategy" was announced. It considers British positions in the Arctic in the contest of different increasing opportunities and threats that demand close cooperation with NATO and Euro Atlantic allies to solve security threats in the region. So, it is not hard to see strengthening the security element in the country's approaches to the Arctic (Defence Secretary announces new Defence Arctic Strategy 2018).

The British government has special structures dealing with Arctic issues. For example, the Polar Regions Department functions under the Foreign and Commonwealth Office. Also in White Hall, the so-called Arctic Network has been created, which organizes negotiations with the departments of climate, energy, business, transport, and defense. In addition, the Arctic and Antarctic Partnership is actively working, which is designed to develop strategies for Britain in these regions.

These documents and institutions allow the United Kingdom to develop full and varied ties not only with the Arctic countries but also with non-Arctic players. It is obvious that here the British are relying on the experience of interaction with many participants received in the EU. The UK was an active participant in European projects, among which EU-PolarNet stood out. Financing of such projects (before Britain left the EU) partially or completely came from the EU budget. However, after Brexit, the British are even more actively developing bilateral ties, relying on scientific diplomacy and defense cooperation (Eremina & Mezhevich, 2020).

The UK has always had its own, independent of the EU, relations with the states of the Arctic zone, based on bilateral and multilateral partnerships in the field of science and defense. In the context of Brexit, the United Kingdom is deprived of some resources for entering the Arctic, the main of which is financial and political interaction with the EU and its support. Therefore, Brexit will affect Britain's capabilities. For example, this concerns difficult negotiations on fishing opportunities in the Arctic Ocean. Brexit will also partly affect UK scientific cooperation with the Arctic states.

Thus, the United Kingdom is a leader in Arctic research, the most important partner of the Arctic states in matters of security. The Security Agenda is becoming the most important for Britain after Brexit to maintain and deepen cooperation with the European Arctic states. Therefore, the interaction of the northern countries thanks to the NATO platform is important for the British in the development of cooperation in the Arctic. At the same time, Britain also relies on the diplomatic dimension and scientific partnership with all states, not only members of the Arctic Council, interested in the development of the Arctic.

Germany. Germany is one of the most active non-Arctic observer countries in the Arctic, which has a range of different interests in the region: from environmental protection and scientific research to the access of German companies to Arctic resources.

In 2011, the German government began to develop the main directions of the state Arctic policy. As a result, in 2013 the Federal Government adopted the document

"Guidelines of the Germany Arctic policy," where for the first time the main goals and objectives of the Arctic policy of Germany were defined. It is important to note that the main provisions of this document have been coordinated with the relevant EU's provisions (Germany's Arctic Policy Guidelines, 2019). The key principles of the German Arctic policy were fixed in the document: freedom of scientific research; freedom of navigation; compliance with environmental standards; and responsibility for any environmental damage ("the polluter pays" principle).

Germany, as an observer state, formally supports the international principles of cooperation in the Arctic, but at the same time consistently advocates a shift from the narrowly national approach of the Arctic states to Arctic cooperation and promotes the idea of expanding the international development of the region.

Today several departments are involved in the implementation of the German Arctic policy: Federal Foreign Office, Federal Ministry for Economic Affairs and Energy, Federal Ministry for the Environment, Nature Conservation and Nuclear Safety, Federal Ministry of Education and Research, etc. Each ministry is responsible for the respective components of Germany's Arctic policy.

In 2019 the Cabinet adopted the new Arctic policy guidelines (Germany's Arctic Policy Guidelines, 2019) that is the first at interministerial level, and "bring together the Arctic policies of the different ministries and set out the German Government's strategic goals in the Arctic" (Germany's Arctic Policy Guidelines, 2019). According to the document Germany's current Arctic policy has six priorities: climate and environmental protection, international cooperation, security policy, science and research, sustainable development, and the involvement of the local and indigenous population in the Arctic. The main aims of the German Arctic policy are:

(a) Germany wants to work toward worldwide climate and environmental protection in line with the Paris Climate Agreement.
(b) The German Government is calling for the deployment of environmentally-friendly technology as well as the application of the highest environmental standards and the designation of protected areas to preserve biodiversity in the Arctic.
(c) The interests of the indigenous population as well as the safeguarding of their rights to freedom, good health, and self-determination in their habitat should be strengthened.
(d) Germany is committed to free and responsible research in order to learn more about the Arctic.
(e) For the future of the Arctic, close and rules-based cooperation with other countries within a strengthened international legal framework is necessary. Germany is therefore working in the Arctic Council as well as within the EU and NATO to protect the Arctic as a largely conflict-free region (Germany is taking on more responsibility for the Arctic, 2019).

Like several other non-Arctic European states (e.g., France and Italy), Germany fully supports the active role of the EU in Arctic cooperation and acts as a kind of link between the EU and the Arctic countries. So, in 2008, Germany was among those countries that supported the EU in its desire to apply for an application for observer status in the Arctic Council.

The Federal Government supports multilateral cooperation, particularly in the Arctic Council, where Germany is represented by its experts in all working groups. In addition, it is important to note the participation of Germany in the work of Barents Euro-Arctic Council (BEAC), EU Arctic Forum, International Maritime Organization (IMO), etc.

The basis of the Arctic policy of Germany should rightfully be considered its polar scientific research. So, during 2000–2019 there was an increase in funding for Arctic research in Germany: for example, funding for the activities of the leading German research institute – the Institute for Polar and Marine Scientific Research named after Alfred Wagner (AWI) in the specified period increased from 60 million euros to 140 million euros (Kotov, 2021: 50). This institute has a rich material and technical base, including the research vessel *Polarstern* and two Arctic stations (jointly with the French on Svalbard and with the Russians on Samoilovsky Island). In addition, it is important to mention the Federal Office for Geological Sciences and Natural Resources (BGR) and its affiliated German Raw Materials Agency (DERA). Germany is very active in international scientific cooperation in the Arctic and develops partnerships both with the Arctic (mostly with Russia, Norway, and Canada) and non-Arctic countries (e.g., China, France, and Great Britain).

Regarding energy cooperation in the Arctic, Germany has a very modest potential. So, in Germany, there is only one large oil and gas company operating on an international scale – Wintershall (Vyatkin, 2015), which focused on the development of offshore fields in Norway.

However, Germany has the world's largest container fleet and the third largest merchant fleet (Auswärtiges Amt, 2013) that determines its interest in participating in the development of the Arctic transport corridors.

It is interesting to note the position of Germany regarding the militarization of the region, which has a controversial character: formally Germany proclaims the demilitarization of the region (Germany's Arctic Policy Guidelines, 2019), but in practice it actively participates in the implementation of various Arctic projects of NATO and officially supports NATO's participation in Arctic affairs.

Thus, the primary objective of Germany's current policy in the Arctic is focused on solving the problems of the consequences of climate change in the Arctic and protecting the environment of the region and its sustainable development. At the same time, it is obvious that the resources for the growth of Germany's influence in Arctic affairs are limited: scientific research and new technologies. The economic position of Germany in the region is very modest at this stage, but in the perspective of climatic changes in the Arctic, new opportunities for Germany may open to participate in the commercial development of the region's natural resources and its transport routes. One should also consider the high degree of German influence on the European Union and its Arctic policy.

Italy. After receiving the observer status in the AC, the Italian Ministry of Foreign Affairs (*Farnesina*) was actively involved in the Arctic affairs. At the end of 2015, the Ministry of Foreign Affairs of the Italian Republic published a first version of Italy's Strategy for the Arctic "Towards an Italian strategy for the Arctic – National Guidelines" (Verso una strategia italiana per l'Artico, 2015). The text contains historical background and purpose of the modern Italy's presence in the Arctic. According to the document, the Italian activities in the Arctic are in the so-called "five dimensions": political, environmental, social-humanitarian (human), research, and economic. This document can be considered an attempt to formulate the strategic interests of the Republic in the Arctic in the future. According to this document modern Italian activities in the Arctic are realized at several levels: international, national, and informal.

At this stage Italy aims at strengthening its position in the Arctic Council. Italy participates in the work of the Arctic Council at all levels: from the Task forces to Working groups, where it has an opportunity to make its significant contribution to the development of various areas of cooperation.

In the document mentioned above special attention is paid to the key role of the European Union in the field of protection of the Arctic environment and sustainable development. Italy sees itself as the "conductor" of European interests in the region (Caruso, 2014). Italy has been granted the observer status of the AC while the European Union was denied it. But like other European countries-observers – EU members (e.g., France, Germany), Italy has consistently advocated the importance of the EU involvement in solving urgent problems of the Arctic region and supports the idea of giving the observer status to the EU.

Italy, as a member of the AC, is ready to develop bilateral cooperation with the Arctic states in various fields: from scientific cooperation to economic cooperation. Italy's key partners in the region are Norway and Russia. Besides Italy has established informal relations with the Saami Council. Italy holds regular informal consultations with other non-Arctic countries (e.g., China) on topical issues of development of the region.

At the national level, according to the document, the government of Italy intends to continue to support Italian research centers working on Arctic projects. In 2018, the Arctic Research Program for the three-year period 2018–2020 was approved, the financing of which was for the first time provided for by the state budget of the Republic. Italy's leading centers for Arctic scientific research are National Research Council of Italy (*Consiglio Nazionale delle Ricerche (CNR),* the National Institute of geophysics and volcano studies *(Istituto Nazionale di Geologia e Vulcanologia (INGV)*), the National Institute of oceanography and marine geophysics (*Istituto Nazionale di Oceanografiaed I Geofisica Sperimentale (OGS)*), the National meteorological institute (*Istitutonazionale di Ricerca Metrologica (INRIM)*), the National Institute of astrophysics (*Istituto Nazionale di Astrofisica (INAF)*), and Italy's Universities (e.g., *l'Università di Roma La Sapienza*) (Novello, 2014).

Italy pays particular attention to involvement in the Arctic Economic Council, established in 2013. For Italy it is a good opportunity to deepen business contacts with other Arctic players. In this context it is interesting to mention such Italian initiative as the "Arctic table" ("*Tavolo Artico*"), which at the national level represents a number of informal events to exchange views with representatives of Italian business and civil society. As an Italian expert M. Tornetta remarks, “ENI has become the first foreign stakeholder in the Norwegian part of the Arctic, this company develops there Italy’s first offshore project ‘Goliat’, which is set to enter the operational stage soon” (Tornetto, 2014: 16). Nowadays ENI is implementing projects in the three Arctic regions – in Norway (the Barents Sea), Russia (Yamal), and in Alaska. ENI features one of the largest Italian companies to valiantly carry out projects in environment protection and education (The Climate Challenge in the Arctic, 2013). Many Italian companies following suit of ENI, the biggest Italian energy company, are ever more manifesting their interest in the Arctic: for instance, BECROMAL, Magma Energy Italia, Valvitalia, Telespazio, and others. Most of the mentioned companies develop oil and gas fields, and high technologies.

After all, Italy is one of the crucial maritime powers, by virtue whereof it has formidable experience both in navigation and shipbuilding. It is interesting to underline that the Italian Navy has been actively involved in major research projects since 2017 (e.g., the “High North” program).

To conclude, at this stage, the primary objective of Italy’s policy in the Arctic boils down to gain a foothold in the Arctic Council and region in general through the active engagement of Italy in multilateral and bilateral Arctic cooperation. Italy considers the EU must have an increasingly important role in the Arctic cooperation. Undoubtedly, Italy takes a holistic approach to its Arctic diplomacy, successfully combining the rich history and available modern scientific and technological potentials.

France. Following the example of the other European Union and European member states of the Arctic Council, French policy follows the main lines defined in the framework of the EEAS (EU Arctic Policy, 2021).

In June 2016, France adopted its National Roadmap for the Arctic (Le grand défi de l’arctique, 2016)*, which sets out the country’s basic interests in the region and delineates the principal trends and priorities of its Arctic policies in the coming years.* The Roadmap defines France as a polar state and a leading Arctic actor. The idea has been supported by politicians over the last few years, most of all by the academic community. The Roadmap for France’s action in the Arctic is based on a threefold geographical, cultural, environmental, and economic logic. The Arctic regions are located between 2500 and 5000 km from the French coast, “which, for a maritime power like France, which has the second-largest maritime domain in the world, remains relatively close. The Arctic Ocean thus appears as the natural extension of the North Atlantic, which bathes the western coastline” (Le grand défi de l’arctique, 2016). Thus, France’s geographical distance from the Arctic is not considered a serious obstacle to its participation in Arctic affairs (Gadal, 2015). Moreover, for France, the Arctic is an “environmentally sensitive area” where “national interests should be determined while taking common interests and a sustainable development policy into account” (Le grand défi de l’arctique, 2016).

The National Roadmap comprises seven sections that consistently describe the principal tenets of France’s long-term Arctic strategy (academic research and cooperation; economic opportunities and cooperation; defense and security issues; protecting Arctic marine life; the French presence at international Arctic forums; the EU and the Arctic; national and common interests in the Arctic) and practical recommendations on implementing the strategy. The National Roadmap states that France has a broad range of interests in the Arctic, which cover various areas from research and economy to politics and defense, and France intends to support them.

However, it should be noted several important points in the French "road map": promoting the interests of the European Union in the region; like other European non-Arctic states, France cares greatly about its status as an Arctic actor, which is legitimized by its participation in the Arctic Council; and the most interesting point is that France, unlike most European non-Arctic states, pays particular attention in its strategy to the issues of defense and security and intends to participate actively in this area of Arctic cooperation; finally, France calls for active Arctic participation by countries outside the polar zone: China, Poland, South Korea, Singapore, and other possible consumers of Arctic resources. Thus, Paris views the Arctic as an area of both national and global interests (Lagutina, 2016).

France's Arctic policy is based on priorities in order of importance:

(a) The research and scientific cooperation. This involves both national and bilateral research programs between states, as well as those of the European Union.
(b) The economic cooperation with energy, mining and fishing resources, tourism, infrastructure, and perhaps in the future, Europe-Asia maritime exchanges (North sea roads) if the questions of economic profitability and free circulation in the Arctic Ocean (open ocean on the model of the Mediterranean for example) are resolved.
(c) The defense through its commitments within NATO and the EU, and the protection of its national interests.
(d) The contribution to the protection of the environment and biodiversity.
(e) The European Union and the Arctic policy support.

French Total is the leading foreign company in Norway, a country that will provide 36 percent of France's gas consumption in 2019, ahead of Russia with 20 percent. France is the second-largest importer of Norwegian salmon behind Poland, with the Carrefour group controlling a significant portion of exports. In Russia, the Yamal Peninsula will account for 25 percent of the Federation's GDP in 2020 with the exploitation of gas; gas extraction could not be done without the technical and technological assistance of Total which it is dependent on.

Unlike in Great Britain or the Russian Federation, French diplomacy and economy are dissociated. The economic interests of French industrial groups do not merge with those of diplomacy and the state.

The scientific and academic cooperation is particularly intense with Canada, Scandinavian countries, and Finland, through bilateral cooperation and the European Union with common scientific bases, especially in Norway, Sweden (joint space reception bases of CNES – *the Centre national des études spatiales* – for example), and Canada, weak with the Russian Federation. The Institute Paul-Emile Victor (IPEV) ensures the scientific coordination of French scientific and academic activities with the Ministry of Europe and Foreign Affairs (MEAE). It remains that the coordination of scientific and academic activity, beyond the common scientific infrastructure shared with Canada, the USA, Germany, the European Union, and the Scandinavian countries, paradoxically often remains unclear in terms of the scientific "task force" by a large number of academics and researchers involved in Arctic studies. It is, as for Germany, imposing and surpassing that of the Scandinavian countries. This partial lack of visibility is partly due to the policy of autonomy implemented at the end of the 2000s by the universities and research units, which depend for the most part on the CNRS (*Centre national de la recherche scientifique*). The state and the MEAE no longer have direct control over these units.

In addition, academics and researchers have developed their networks and programs of academic and scientific cooperation, which do not necessarily go through the IPEV, the CNRS, or the MEAE services which must ensure their follow-up. Although very significant, the French academic and scientific presence sometimes appears fragmented, atomized, especially in the Russian Federation where it is in any case still insignificant, even more so than in Germany. Driven by funding and research programs, it is part of the definition of the objectives of the Arctic policy of the European Union and ensures the presence of France in the Arctic.

To conclude, France positions itself as a global player aiming to promote the general interest of the Arctic, and those of the Arctic territories of the European Union countries. As such, it participates in the various international instances dealing with the Arctic and supports the entry of the European Union as a permanent member of the Arctic Council: the EU is de facto a key preeminent territorial, economic, scientific, political, and diplomatic actor, with three Arctic countries as permanent members of the Arctic Council, and six observer non-Arctic countries in addition to Great Britain and Switzerland, which have similar Arctic policies that overlap with those of the EU.

Spain. Despite the fact that Spain has also received an observer status in the AC, its policy in the Arctic is not active. However, there is obvious interest to the region due to the fact that Spain has historically been the largest maritime power. In addition, today Spain is the owner of the largest fishing fleet in the EU.

The concern about the effects of climate change and the need for energy resources have contributed to Spain's interest in participating in the Arctic cooperation. Spain annually sends its expeditions to the Arctic in order to study the effects of the impact of climate change (Almazova-Ilyina et al., 2020: 2). In 2016, Spain published "Guidelines for a Spanish Polar Strategy," where the strategic significance of Spain's presence is substantiated not only in the Antarctic but also in the Arctic. As for the Arctic, first of all, the document notes the importance of Spain's wide participation in Arctic international cooperation in various fields (e.g., scientific research, environmental protection, natural reserves, energy, industry, resources, polar technologies, bioprospecting, tourism, transport, fishery, and support for the lifestyles and cultures of the indigenous Arctic populations) and international organizations: first of all, in the AC, as well as in the International Arctic Science Committee (IASC), of which Spain became a member in 2009, also Spain is an observer at the CBSS (Council of the Baltic Shore States). In 2011 the Spanish government appointed the Ambassador in charge of Arctic Affairs (Grinyaev et al., 2014: 24–25).

Besides that, among the priorities of Spain's policy in the Arctic are: "foster peacekeeping, environmental protection and security in the polar regions, as well as the development of scientific and technical polar research in the framework of international cooperation" (Guidelines for a Spanish Polar Strategy, 2016). A lot of attention in the document is paid to the development of polar scientific research in order to find solutions in the fight against the consequences of global climate change. For Arctic exploration, Spain has the "Hesperides" under the Spanish navy and the "Las Palmas" (Antyushina, 2016: 81). Research results are stored at National Polar Data Centers.

Special attention is paid to the important role of the EU in Arctic affairs and Spain's intention to actively participate in the implementation of the common European Arctic policy.

As for as the institutionalization of Spain's Arctic policy is concerned, the Spanish Polar Committee should be mentioned here. Polar research in Spain, in general, and in the Arctic, in particular, is based on the research platforms of Spanish universities, including the Polytechnic University of Madrid, University of Barcelona, etc., and they are funded in part or in full by the EU.

At the level of bilateral relations, Spain actively cooperates with such Arctic countries as Canada, the USA, Norway, and Iceland; there is also an interest in cooperation with Russia in the field of securing safe energy supply. In the meantime, the main area of bilateral cooperation is joint research. Spain's interests in energy cooperation and tourism development at this stage are poorly realized in practice.

Thus, today Spain is difficult to define as an active player in Arctic cooperation, with the exception of Spain's participation in scientific cooperation. Nevertheless, the goals and objectives stated in the Arctic strategy published in 2016 suggest that in the future, the degree of Spain's participation in Arctic cooperation will increase in environmental security, energy, fishery, and tourism.

The Netherlands. As in the case of Spain, the Netherlands assumes that the country is the largest maritime power: "About 10 per cent of all Dutch maritime activities are related to the Arctic" (Factsheet, 2016).

The first document defining the polar strategy of the Netherlands was *Dutch Polar Strategy*, published in 2016. The post of Arctic Ambassador was created according to the Polar Strategy 2016–2020. In 2020, a new document was adopted – "The Netherlands' Polar Strategy 2021–2025. Prepared for Change." The Netherlands also views the Arctic as part of its polar strategy, along with Antarctica, so the document addresses the country's priorities in the two polar regions. The text of the Strategy emphasizes that the Netherlands views both poles "as global public goods (also known as global commons)" due to the importance of the changes taking place in these regions. The Netherlands' polar policy, according to the texts of the Strategies 2016 and 2020, is based on "three key concepts: sustainability, international cooperation and scientific research." Based on this, the priority areas of the Dutch polar policy included "protect the ecosystems and environment of the polar regions, strengthen international cooperation and ensure that economic activity is sustainable" (The Netherlands' Polar Strategy 2021–2025).

The main motive for the Netherlands' participation in Arctic cooperation, as in the case of most non-Arctic countries, is climate change and its consequences for the entire planet, as well as new economic opportunities that are opening up as a result of melting ice and the current geopolitical situation in the region. Moreover, the text of Strategy 2020 notes that the situation with climate change has deteriorated significantly since the publication of the first Strategy of the Netherlands in 2016. In the Arctic, the main focus of the Danish authorities is on “the protection of human interests, the environment, and international security and stability” (The Netherlands’ Polar Strategy 2021–2025).

Along with the importance of ensuring environmental security in the region, the Netherlands’ Strategy pays special attention to military security issues. The Netherlands is concerned about a possible increase in tensions in the Arctic, caused by the global geopolitical situation. However, at the same time, they note the importance of establishing a direct dialogue between Russia and NATO on these issues in order to raise awareness of the intentions and actions of each other. At the same time, the activity of China in the Arctic causes some concern in the Netherlands.

The Netherlands tries to actively participate in Arctic cooperation both at the multilateral level, supporting the central role of the AC in Arctic affairs, and in the field of security in the region – supporting NATO, and bilaterally. As part of the development of bilateral relations, the Netherlands gives priority to cooperation with the European Arctic countries and the EU, which is regarded as an important player in the Arctic region. Then it is noted that “the EU is a *de facto* participant in all activities in which official observers like the Netherlands participate” and “The Netherlands is in favour of giving the EU official observer status at the Arctic Council.”

The Netherlands is represented in the Arctic at the level of business companies as well (e.g., Van Oord, Tideway), whose interest is aimed at such areas as fishing, tourism, and resource extraction in the Arctic (the Netherlands has accumulated rich experience in deep-sea drilling and experience in dismantling old oil and gas platforms), prospects for using the NSR, the Northwest Passage and the Transpolar Sea Route. Knowledge institutions and NGOs are also involved in the implementation of the polar policy, together with representatives of a number of ministries (the Ministry of Foreign Affairs which is the coordinator of the activity of other ministeries, such as the Ministry of Economic Affairs and Climate Policy, the Ministry of Infrastructure and Water Management, the Ministry of Agriculture, Nature and Food Quality, the Ministry of Defense and the Ministry of Education, Culture and Science) “have formed the Dutch Arctic Circle (DAC), which informally shares knowledge regarding Arctic activities.” This network approach is seen as very promising for the Netherlands’ participation in Arctic cooperation.

Summing up, it can be noted that the Netherlands has recently been very actively interested in the Arctic, and not only in such traditional areas as scientific research and ensuring the environmental security of the region, its sustainable development and governance, but also in the field of military security. The threat of increased tension in the region, a possible geopolitical conflict between Western countries and Russia, as well as China’s activity in the region, cause serious concerns in the Netherlands. This is mainly due to the fact that the Netherlands views the Arctic as a region whose development has global implications.

Poland. Poland presents one more case of a non-Arctic country that received observer status in the AC largely due to its active participation in scientific research in the Arctic. The basis of current Polish policy in the Arctic is mainly based on the country's active scientific activities. Poland is represented in the Scientific Committee on Antarctic Research, International Arctic Science Committee (IASC), the sustaining Arctic Observing Networks (SAON), the European Polar Board, and the Svalbard Science Forum (Głowacki, 2021). The main priorities of Poland's polar scientific research in the Arctic and Antarctic are reflected in "Strategy for Polish Polar Research 2017–2027."

Since 2008, Poland has consistently formulated its position on the Arctic, outlining its main priorities in the region in 2008 and 2010 in the framework of the AC Deputy Ministers Meeting:

- Recognition of the key role of the AC in Arctic affairs and an active participation of Polish experts in the working groups of the AC.
- Recognition of the international principles enshrined in the 1982 UN Convention on the Law of the Sea.
- Supporting the principle of freedom of scientific research in the Arctic.
- Support for the policy of protecting the natural environment of the region and minimizing the negative consequences of climate change.
- Support for harmonious cooperation between AC member states and observer states (Łuszczuk, 2012).

In 2011, Poland announced four pillars of its Arctic policy:

1. Compliance with applicable legal and regulatory obligations and developing an international framework of various agreements relating to the cooperation in the Arctic in science and another fields
2. Active participation in the development of European policy toward the Arctic
3. Co-operation with the Arctic Council
4. Development of public diplomacy relating to the polar issues (Łuszczuk, 2012)

As we mentioned before, Poland has not issued an Arctic strategy document with national priorities for the Arctic region. However, the article "Poland's Policy towards the Arctic: Key Areas and Priority Actions" was published by the Polish Institute of International Affairs (PISM) in 2015, and in this paper, Poland's key interests in the region are outlined, but this article does not have the status of an official strategy. Thus, according to the document "from the polish standpoint, the key issue is active participation in regional cooperation institutions, the most significant of which is the Arctic Council" (Poland's Policy towards the Arctic, 2015). One of the interesting initiatives of Poland in this regard is the organization of the so-called the Warsaw Format Meetings – meetings of non-Arctic observer countries of the AC and the country presiding in the AC, which are held twice a year. Thus, Poland manifests itself as an active participant in the organization of Arctic cooperation. In addition to the AC, Poland is an observer in the Barents Euro-Arctic Council since 1993.

As far as the priority areas of Polish interests in Arctic cooperation is concerned, along with international scientific cooperation and scientific diplomacy, one should mention the protection of the Arctic environment and the fight against the consequences of climate change, the socioeconomic development of the region (formulation and implementation of the Go Arctic initiative), and participation in the extraction of Arctic resources (including energy), Poland is showing its interest in the development of the northern sea routes and fishing. In this regard, it is interesting to note that Poland defines itself as "a leading builder of ships suited to the difficult Arctic conditions" and "a major Baltic transshipment and destination port from the point of view of sea transit between Europe and Asia" (Poland's Policy towards the Arctic, 2015). Polish experts note that Poland's participation in Arctic affairs "should be seen through the prism of the Baltic Sea region <. . .> that is interconnected" (Graczyk, 2012: 143) with the arctic region. In other words, we have seen a clear expansion of Poland's Arctic agenda in recent years, which indicates the country's ambitions in the region.

It should be noted that Poland sees its Arctic policy in close connection with the EU's interests and policies in the region: "Cooperation with the EU on Arctic matters could become an important aspect of Polish Arctic policy" (Poland's Policy towards the Arctic, 2015). Thus, Poland, like other non-Arctic European observer countries, intends to promote the interests of the EU as a whole through its Arctic policy and strongly supports the idea of EU integration into the Arctic Governance system (Graczyk, 2012: 144, 147). Poland's priority is also the development of cooperation with all European Observers in the AC, exchange of experience and good practices. As for as the Arctic countries are concerned, special attention is paid to countries such as Norway and Iceland.

One more important initiative of Poland is "to establish an inter-ministerial coordination framework cooperating with representatives from academic, business and non-governmental sectors with an Arctic agenda." Although at this stage the economic activity of Poland is very limited, nevertheless, Polish companies are showing interest in participating in exploration works in the Barents Sea and Greenland. Mostly Polish companies (e.g., Emag, Fasing, Komag) are focused on equipment suppliers. In addition, Polish companies act as sub-contractors, for example, in the Norwegian project the Melkoya LNG plant.

As for the institutionalization of Polish policy in the Arctic, the following should be noted here: in 2006, a special position of Ambassador for Polar Affairs was set up (Graczyk, 2012: 144), and in 2012, a working group on polar issues was created under the Ministry of Foreign Affairs of Poland – Polar Task Force (*Grupa Robocza do spraw Polarnych przy Ministerstwie Spraw Zagranicznych*) (Arkticheskiye strategii: energetika, bezopasnost', ekologiya i klimat 2020), which plays a coordinating role between all interested parties (representatives of official authorities, scientists, and public figures).

Thus, the Arctic policy of Poland is mainly determined by its scientific interests and the desire to develop its scientific diplomacy. In the submitted documents, Poland did not indicate its interests in such sensitive areas from the point of view of the Arctic countries as the sphere of military security or the economic activity in the region, thereby not creating grounds for concern on the part of the Arctic countries. At the same time, the Polish approach to Arctic cooperation can be characterized as practice-oriented, based on a realistic assessment of its potential in the region.

Finally, **Switzerland** is a very new actor in the Arctic, which, like many other non-Arctic countries, justifies its interest in the region with its scientific activities aimed at studying the impact of climate change, the consequences of ice melting, and the impact of these processes on the situation in the Swiss Alps. Drawing parallels between the Arctic and the Alps, the Swiss define their country as a “vertical Arctic” (Estermann, 2019). The main research center is the Swiss Polar Institute, established in 2016, which acts as a coordinator between government agencies and 15 research institutions involved in polar research (Todorov, 2018: 13).

As an observer country in the AC, Swiss researchers actively joined the work of three working groups – the Arctic Monitoring and Assessment Programme (AMAP), the Protection of the Arctic Marine Environment (PAME), and the Sustainable Development Working Group (SDWG), and also began to take an active part in the Warsaw Format meetings.

In 2019, the Swiss Head of the Sectoral Foreign Policies Division, Ambassador Stefan Estermann, during his plenary session at the Arctic Circle Assembly session, presented the first pillars of a Swiss Polar Policy:

1. Support Swiss Arctic research and education institutions
2. Promote international scientific cooperation
3. Leverage foundations and private sector capabilities
4. Engage in the international dialogue on the Arctic
5. Promote actions tackling environmental challenges
6. Show solidarity with indigenous peoples and inhabitants (Estermann, 2019)

Switzerland views the Arctic as a region of cooperation, free from any kind of confrontation, a region of multilateral cooperation and sustainable development.

EU in the Arctic: The International Dimension

Almost all European observer countries in the AC consistently support the EU in its aspiration to actively participate in Arctic affairs and try to actively participate in European Arctic initiatives. It is the observer countries that are today a kind of conductors of the EU’s interests in the Arctic.

However, the EU is a newcomer to the Arctic region, therefore it acts cautiously, through the so-called “soft” power, which is based on the ideology of sustainable development and innovation. The concept of “Arctic region,” presented in various EU documents, for example, in the *Communiqué of the European Commission 2008*, refers to the territories around the North Pole. These are the territories of the Arctic Ocean and eight countries – Canada, Denmark, Finland, Iceland, Norway, Russia, Sweden, and the USA (EU Arctic Policy, 2021: 6–15; European Parliament resolution of 12 March 2014 on the EU strategy for the Arctic, 2014; European Parliament resolution of 16 March 2017 on an integrated European Union policy for the Arctic 2017: 156–169).

The very notion of "EU Arctic policy" raises questions, since the EU talks about its Arctic status solely thanks to the EU member Denmark, although the Arctic territory of Denmark – Greenland – is not part of the EU following the 1982 referendum. The EU also proves its involvement in the Arctic through Finland and Sweden, which are members of the Arctic Council. At the same time, other European members of the Arctic Council with whom the EU actively cooperates in the region – Iceland and Norway – are not EU members. Based on these provisions, the organizational (institutional) activities of the EU in relation to the Arctic seem to be somewhat contradictory.

First of all, the EU does not have legal instruments for the implementation of full-scale initiatives, since it is not a member of the Arctic Council. Moreover, the EU's interest in the Arctic was not received positively by other states adjoining the region, but rather caused some concern in the countries with Arctic status. Obviously, for the countries of the Arctic Council, the EU is an incomprehensible player with an unclear strategy.

However, the EU is a member of a number of organizations important for the development of the Arctic. Thus, the EU signed the UN Convention on the Law of the Sea and the UN Framework Convention on Climate Change. All EU member states have become members of the International Maritime Organization at the UN, and the European Commission has observer status there. In addition, the EU participates in other international organizations that periodically raise issues about the Arctic, for example, the International Civil Aviation Organization (Integrated Arctic Policy, 2016). The EU is also an ad hoc observer to the Arctic Council. Therefore, the issue of the Union's participation in the Arctic agenda is nevertheless resolved through three EU members, members of the Arctic Council (Denmark, Finland, and Sweden), as well as other EU countries that act as permanent observers with it (France, Germany, the Netherlands, Italy, Spain, and Poland).

It is obvious that the EU does not make large-scale claims to be involved in the Arctic agenda and relies on complicity in financing research, environmental programs, and projects in the field of sustainable development. Within the framework of the Arctic Council, the EU participates in six groups on environmental pollution, environmental monitoring, conservation of flora and fauna, protection of the marine environment, prevention of emergencies, and sustainable development. Also, EU representatives are actively working in the framework of task groups of the Arctic Council, formed on specific issues for a certain period of time.

Thus, EU officials are part of the teams on Arctic maritime cooperation, telecommunications infrastructure, and scientific cooperation (Joint communication to the European Parliament and the Council. An integrated European Union policy for the Arctic Brussels 2016).

In the person of the European Commission, the EU also participates in the working groups of the Barents / Euro-Arctic Council, primarily in the Transport Committee, since this region is included in the EU transport zone. Within the framework of the

Barents / Euro-Arctic Council, the EU is present at meetings of foreign ministers, as well as in working groups on economic cooperation, environment, transport, forestry, tourism, education, and support for indigenous peoples. Also, EU representatives participate in the meetings of the Barents Regional Council, primarily in the groups on logistics, environment, and investments. Thus, the EU seeks to establish multilateral, regional, and sub-regional cooperation with many and different participants in the Arctic dialogue. At the same time, the EU is trying to interact not only with states but also with Arctic societies through programs on climate, sustainable development, research, etc. (International Cooperation on Arctic Matters, 2017).

Interaction with partners in the framework of the Arctic Dialogue on behalf of the EU is carried out by the External Action Service, as well as by a number of Directorates General of the EU Commission related to maritime, fishery, energy, and climate issues. The European Parliament has created a committee dealing with Arctic issues, which participates in the work of the International Standing Committee of parliamentarians of the Arctic region. In addition, the EU has created its own programs to address issues on the Arctic agenda.

For example, the Northern Dimension is precisely the EU policy, which touches upon Arctic issues and the interests of many states with Arctic status – Russia, Norway, and Iceland. Within the framework of the Northern Dimension, issues related to the environment, transport, cultural development, intensification of economic development, and competitiveness of the Nordic countries are being addressed (1st panel session: High-Level Arctic event "A sustainable Arctic – innovative approaches", 2018: 11–21). The Northern Dimension Program has played a positive role in cooperation between the EU and other Nordic states. However, this direction has not become a key one in the development of the Arctic and the EU's Arctic policy. However, thanks to the joint programs of Russia and Finland, the EU continues to cooperate with Russia on many issues related to the Arctic region. For example, the EU and Russia are the main donors of the Northern Dimension Environmental Partnership Fund (Lipponen, 2015: 8–18; Perez & Yaneva, 2016: 441–449).

Another program affecting the EU's Arctic direction is the Integrated Maritime Development Policy program. One of its goals is to develop clear EU interests in the Arctic (EU Arctic Policy, 2021). Its adoption coincided with the intensification of Russia's activity, promoting its Arctic agenda. All this convinced the EU that it needed an Arctic policy. However, the EU remains mainly focused on environmental protection and sustainable development.

The Interreg program is an additional important tool for developing the Arctic agenda for the EU. For example, "the Gulf of Bothnia-Atlantic project," funded within its framework, is aimed at cooperation between Sweden, Finland, and Norway in the development of the Northern Sea Route, environmental protection, and the cultural heritage of the Arctic. Another Interreg project, "Sweden-Norway," aims to strengthen the economic position of the northern territories. The project "Baltic Sea Region," which promotes the idea of integrated development of the territory, the Baltic is seen by the EU as a gateway to the Arctic. Here we also mention the project "Northern Periphery and the Arctic," which operated in the period 2014–2020 and contributed to the creation of sustainable growth in the northern and Arctic regions. One more project, "InterregNord," is aimed at the integrated development of the northern regions. In addition, EU structural and investment funds, primarily the European Regional Development Fund, are involved in financing the Arctic and northern territories. To coordinate various EU programs in Northern Europe in 2017 the post of Ambassador-at-Large was established in relation to the Arctic. Undoubtedly, the gradual growth of EU projects in the northern, subarctic, and arctic territories demonstrates the steady evolution of both EU policy and its interests in this region.

EU Versus the EU States: An Integrative Arctic Policy

The European Union's Arctic policy is based on two axes: its policy that applies to the whole of the European Union and its specific policy linked to the Arctic. Carried by the common ideals (social democracy, economic liberalism, freedom, and environment) shared by the member countries, the policy carried out by the EU refrain from encroaching on the very sovereign rights of the EU Arctic states while providing answers and operational support to the human, economic, and territorial Arctic development problems of the latter at the local and regional levels.

The EU policy in the European Arctic regions is merged with the general policy conducted in the Union. However, it is subject to regional adjustments in response to human and development issues in the Arctic regions of Finland, Sweden, and Denmark, at the request of these three states. It is common to all EU member countries in economic, regulatory, developmental, social, human, political, ecological, etc. terms. For example, it has imposed on Finland and Sweden (but also on Norway, which did not vote to join the EU), the recognition of indigenous peoples such as the Sámi, with the implementation of ad hoc policies in terms of sustainable development at the regional and local levels, a certain degree of political self-government (diluted in Norway and Sweden by the membership of the Arctic peoples in the national political parties), and strict environmental standards for mining.

It is also expressed through active politics at the regional level. In addition to active support for regional development policies in the Arctic (or not), these are reinforced by actions aimed at regional integration through intra-European (Finland-Sweden) and inter-European (with the Russian Federation – which has been excluded since 2014 – and Norway) cross-border cooperation, in particular through operational tools such as the Interreg programs. It is one of the common action levers of the policy conducted by the European Union to strengthen cooperation and regional integration between the Arctic territories of the EU and their close neighbors.

Specificity of the General EU Arctic Policy

The third lever of the European Arctic policy is the one for which the European External Action Service (EEAS) is mandated. As such, it is in many respects merged with the Arctic policies of the member states, whether they are permanent members or observers of the Arctic Council, for example – and vice versa: the Arctic policies of the member states involved in polar and sub-Arctic issues are merged with those of the EU and its diplomatic arm, the EEAS. The convergence of the actions carried out by the EU and the EU states (but also by the UK and Switzerland) can be broken down into two scientific and socio-territorial themes that respond to the primary concerns of the Arctic Council by promoting interregional and international cooperation. The scientific and science-diplomacy instruments play a central role. In this respect, science (diplomacy) as an instrument for understanding the dynamics underway, societal and environmental issues, as well as in decision-making and cooperation, plays a key role. It relies on substantial European research budgets of several tens of millions of euros. The two priority research areas are common to all the issues addressed by the international scientific community and the EU member states involved in Arctic research:

(a) Climate change and sustainable development issues in the Arctic regions are at the heart of the EU's scientific, academic, economic, and diplomatic policy. It aims to better understand the processes and climate dynamics underway to guide European policies and legislation in terms of environmental policies as a whole, and more specifically in terms of economic, territorial, and societal development of the Arctic regions. It responds to the commitments made by the EU to the United Nations in the framework of the 2030 Agenda for Sustainable Development (The 2030 Agenda for Sustainable Development, 2021): "The Climate Change and the Arctic Environment to protect the Arctic and global biodiversity as well the livelihoods of Arctic inhabitants. [. . .] The importance of the relationship between climate change and the Arctic has become very prominent in recent decades. Understanding climate dynamics in the context of the fragile Arctic environment, helping to develop specific strategies to mitigate and adapt to climate change in the Arctic, and safeguarding the Arctic environment are part of the EU's wider efforts to the Arctic. These efforts are directed at activities at lower latitudes and in the Arctic. Science, research and innovation will play a key role in deepening our knowledge base and informing EU policy about the complex relationship between climate change and the Arctic" (EU Arctic Policy, 2021).
(b) Sustainable Development in the Arctic. "While the Arctic region is rich in resources both on land and in the seas, the Arctic faces several challenges due among other things to its sparse population, limited logistical networks, and fragile environmental conditions. The inhabitants of the Arctic are familiar with these conditions – however harsh they may seem to people living in lower latitudes – and have socio-economic aspirations for sustainable development under Arctic conditions. The indigenous peoples who have lived in various parts of this vast region for millennia have specific traditional knowledge and across the Arctic region, several forms of traditional livelihoods have developed over the centuries, not least reindeer herding, fishing, and hunting. As modern life has increasingly taken hold in Arctic regions, other forms of economic activity and technologies have been added. These include public administration and

> education, more intensive fishing, maritime and shipping operations, resource extraction, research activities, tourism, telecommunications etc." (EU Arctic Policy, 2021).

If the emphasis is placed on preserving the way of life of the autochthonous populations, which are characterized by important socioeconomic evolution dynamics, nothing or almost nothing is said about the central question of the exploitation of natural resources. They are at the center of the economic policies of the EU member states as much as the preservation of the environment, the sustainable development of local populations, and the issues related to climate change.

If we talk about financing EU projects related to the Arctic, we will not be able to give an exact figure, since not all of the projects are completely aimed exclusively at the Arctic region. For example, the projects of the Northern Dimension concern not only the Arctic territories but the whole European North. Arctic programs are implemented within the framework of the EU Northern Dimension. Some research programs of the EU, as well as projects related to the life of the indigenous backgammon in the Arctic, are of a purely Arctic character.

If we talk about specific figures, we note that in the completed seven-year budget cycle from 2014 to 2020, it was for research work in the region that more than 1 billion euros were allocated from the EU structural and investment funds. Basically, these funds were implemented within the framework of the Northern Dimension. It is interesting that for the program period 2014–2020. The EU has allocated 15.4 billion euros for various projects of the Northern Dimension in general, not only of a scientific nature (Northern Periphery and Arctic Programme 2014–2020). During 2007–2013 the EU has also funded projects to support the indigenous peoples of the Arctic. For example, it allocated more than 1 billion euros for this task during the specified period, and taking into account co-financing from the states participating in the project (states participating in the Northern Dimension), the amount increased to 2 billion euros. However, after 2020, the financial capacity associated with the Arctic has been revised. Currently, the "close neighborhood" programs in Eastern Europe and North Africa are identified as priority funding. At present, the exact amount of funding for Arctic projects for the period from 2021 to 2027 has not yet been indicated (Brocza & Brocza, 2018).

Conclusions

To conclude, today all eight non-Arctic European countries have a wide set of interests in the Arctic cooperation (from scientific research and environmental safety to economic development, resource exploration, and security issues) and have taken an active role, although to a different degree, in Arctic affairs. This different degree of involvement of European observer countries is largely due to their historical experience of participation in the development of the Arctic, as well as their current potential (financial resources and technologies). Thus, among the most active participants in Arctic cooperation are the UK, Germany, the Netherlands, and France – a group of states which is interested not only in such traditional for non-Arctic states areas as scientific research, climate change, and environmental safety of the Arctic but also in the field of economic development of the region and military security that are more traditional spheres of the Arctic countries interests. These countries support the NATO's participation in Arctic cooperation and consider NATO as the central link in building relations with the Five Arctic countries in the military-political context. This approach undoubtedly raises certain concerns in some Arctic countries. The second group of non-Arctic European states (Spain, Poland, Switzerland) promotes a "softer approach in their Arctic policy, preferring to continue to pay more attention to the development of scientific research in the region.

At the same time, it should be noted such a new format of cooperation as the so-called the Warsaw Format Meetings – meetings of non-Arctic observer countries of the AC and the country presiding in the AC. In the framework of these meetings the common positions of non-Arctic countries in relation to the Arctic are being agreed upon. It seems that non-Arctic countries try to form a community of non-Arctic countries within the system of Arctic governance. Here it is pertinent to note that non-Arctic European countries mainly view the Arctic as an area of both national and global interests and call for active Arctic participation by countries outside the polar zone and different non-state actors. The number one candidate for most non-Arctic European observers is the European Union.

Except for Great Britain and Switzerland, the strategies of all non-Arctic European observers note the leading role of the EU in Arctic affairs, they consistently advocate the importance of the EU involvement in solving urgent problems of the Arctic region and support the idea of giving the observer status to the EU. Although the EU is a newcomer to the Arctic region, therefore it acts cautiously, through the so-called "soft" power and the concept of "Arctic region" is presented in various EU documents since 2008. Despite the fact that the EU is not formally an observer in the Arctic Council, the EU, with three Arctic states, and six non-Arctic state's observers, is de facto an Arctic player today.

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Interests of Non-Arctic Asian States in the Region

Yana V. Leksyutina and Jian Zhang

Contents

Abstract

Since the 1990s, a number of Asian countries – primarily Japan, South Korea, China, Singapore, and India – have expanded their scientific research activities in the Arctic and revealed their desire to participate in Arctic governance. Global warming has brought about new opportunities for the development of Arctic hydrocarbon and mineral resources and trans-Arctic commercial shipping, which have led to a substantial increase in some Asian countries' economic interests in the region. This chapter elaborates on interests that are both specific to and shared by all five Asian countries, as well as concerns relating to Arctic commercial development. It demonstrates how Asian countries' perception of their interests, concerns, and challenges, their companies' readiness to take commercial risks, and scope of their financial and technological power all influence the depth and intensity of their cooperation with Arctic states in Arctic commercial development. It characterizes the current scope of these five Asian countries' involvement in the commercial development of the Arctic: in the exploration, extraction, and

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production of Arctic hydrocarbons and minerals, and in commercial shipping along the Northern Sea Route.

Keywords

Arctic · China · Japan · South Korea · Singapore · India · Russia

Introduction

Over the past two decades, the Arctic region as a place of international cooperation has experienced many changes, largely triggered by global climate change. On the one hand, global warming has pushed many countries to intensify their scientific research into ongoing changes in the Arctic, given that such changes impact weather patterns all around the globe; in the 2000s, even countries that had never been engaged in Arctic research activities started their first Arctic research programs, launched their first scientific expeditions, or opened their first research bases in the Arctic. On the other hand, the warming temperatures have accelerated the melting of Arctic ice and snow cover, which has opened broad opportunities for the development of Arctic hydrocarbon and mineral resources and trans-Arctic commercial shipping. As a result, many non-Arctic countries started considering the benefits and drawbacks of joining Arctic commercial development, while Arctic states began to look for financial and technological partners among non-Arctic states to develop the area.

A strong interest in the Arctic has been demonstrated by various Asian countries, including in the Northeast, Southeast, and South of the continent. Although they do not have direct access to the Arctic Ocean and are not located in close proximity to the Arctic Circle, they want to be regarded as important stakeholders in the Arctic, to contribute to Arctic scientific research and international efforts of strengthening Arctic environmental protection, and to join the commercial development of the Arctic. Among Asian countries, the most active and assertive in expanding their participation in the Arctic affairs and the development of the Arctic have been China, South Korea, Japan, Singapore, and India. In order to expand their footprint in the Arctic, these five Asian countries one after another submitted requests to the Arctic Council to be considered for Observer status: China submitted its application in 2007, South Korea in 2008, Japan in 2009, Singapore in 2011, and India in 2012. Their admission to the Arctic Council as Observers in 2013, among other things, signaled a "green light" from the Arctic states' side for cooperation in the commercial development of the Arctic.

General Outline of Asian Countries' Interests and Concerns in the Arctic

By the time Asian countries applied for Observer status in the Arctic Council, they had very different polar and Arctic backgrounds and a record of scientific or exploratory engagement in the Arctic. Northeast Asian countries had a comparatively strong track record of polar and Arctic research, being parties of the Svalbard Treaty (The 1920 Svalbard Treaty recognized the sovereignty of Norway over the Arctic Archipelago of Svalbard, but provided for certain rights in commercial activities on and around the islands for the other signatories.) (South Korea, however, was very late to sign the Svalbard Treaty, only doing so in 2012). In contrast, India was a new actor in the Arctic region: It only revealed its interest in the Arctic in 2007 by initiating its Arctic research program and launching its first scientific expedition to the Arctic Ocean. Singapore was not a signatory to the Svalbard Treaty and lacked polar scientific experience.

Having different polar and Arctic backgrounds, these five countries were greatly striving to attain their Observer place in the Arctic Council, which coordinates Arctic scientific research, strengthens Arctic environmental protection, and promotes Arctic economic and social development cooperation. Asian countries wanted to be able to participate in Arctic governance and contribute to the work of the Council by providing scientific expertise, project proposals within working group, etc.

One of the major concerns for five Asian countries was climate change in the Arctic, which is a climate-forming region, with climate changes there affecting weather patterns across the globe. Even for Asian countries, situated far away from the Arctic, concerns over environmental changes in the Arctic are high on the national agenda. Arctic weather affects the Indian monsoon that is highly important for the Indian economy, being predominantly agrarian. Melting ice in the Arctic presents an existential threat to Singapore due to rising sea levels. According to China's 2018 White Paper "China's Arctic Policy," the natural conditions and changes in the Arctic have a direct impact on China's climate system and ecological environment, and, hence, on China's economic interests in agriculture, forestry, fisheries, marine industry, and other fields (State Council of the PRC, 2018). Chinese experts accentuate correlation between the changes in China's environment and climate change in the Arctic. They claim, for example, that the thinning of the Arctic's ice has contributed to the climate shift in China due to alternations in atmospheric circulation at high altitudes, and that the severe snowstorms that hit central and southern China in 2007–2008 are connected with the warming of the Arctic, or that the extreme pollution in the East China plains in 2013 resulted from poor ventilation conditions caused by the loss of Arctic ice in the preceding Autumn and boreal snowfall in the earlier Winter (Kong Soon Lim, 2018: 4). Japan is concerned that change in the Arctic environment could increase the frequency of extreme weather events in Japan (Headquarters for Ocean Policy, 2015: 5). Korean researchers also point out that "during negative phases of the Arctic Oscillation, East Asia experiences an enhanced winter monsoon and frequent cold surges" (Kim, Lee, 2020: 3). Each Asian country pays attention and undertakes efforts to contribute to such dimensions of the Arctic agenda as climate change, Arctic scientific research, and environment protection.

The Arctic is appealing to Asian countries as it has abundant hydrocarbons and minerals, including rare earth metals. In the Arctic, more than 30 different minerals are extracted: copper, gold, nickel, zinc, etc. Asian countries are among the world's largest hydrocarbon and mineral consumers. An important driver behind Asian countries' Arctic activities might be their hunger for hydrocarbons and the need to diversify their imports of hydrocarbons and minerals to ensure energy and resource security. The only exception is Singapore which, according to Simon Wong Wie Kuen, formerly Singapore's senior Arctic official, has neither the interest nor capabilities to engage in natural resources exploration and development in the Arctic (Wong, 2014: 20). Singapore's natural resource needs are modest in comparison to the other four Asian countries and are fully met by the global market. Saying that, we should stress that the exploitation of Arctic resources may be of interest to Singaporean physical commodity trading groups (like Trafigura's recent investment in Russia's Vostok Oil project in the Arctic) and companies producing cutting-edge maritime (shipping and offshore) technologies for Arctic development. Singapore operates the most technologically advanced rig-building, conversion, ship repair, and specialized shipbuilding facilities in Southeast Asia (Wong, 2014: 21). Singapore's offshore engineering industry holds nearly 70% of the world's market for self-elevating mobile drilling platforms and floating production, storage, and off-loading units used in the production and processing of hydrocarbons (Storey, 2016: 68). A Singapore corporation, Keppel Offshore and Marine, has been also collaborating on the world's first Arctic-grade, environmentally friendly "green" rig, taking into consideration the importance of protecting the Arctic environment (Wong, 2014: 21).

The development of the Arctic energy resources and transporting hydrocarbons along the NSR has also promised large commercial opportunities to South Korean shipbuilders, which have the expertise to build advanced ice-class ships for Arctic navigation, offshore oil and gas rig platforms for Arctic use (Yoon, 2016: 55), and antipollution equipment. Arctic states' efforts to develop the Arctic are seen by many Asian countries as opening vast business opportunities to industries and companies with relevant spheres of expertise.

All five Asian countries are established maritime powers with extralarge ports, for which the creation of new sea lines of communications (SLOCs) through the Arctic Ocean will undoubtedly have direct implications. If trans-Arctic routes as commercially viable and beneficiary SLOCs become a reality, it would benefit China, South Korea, and Japan, and, on the contrary, challenge and disadvantage India, Singapore, and other Southeast Asian countries. There are two viable trans-Arctic routes: the Northern Sea Route (NSR), which stretchers along Russia's northern border and would be applicable for trade between Northeast Asia (i.e., Japan, South Korea, and China) and Northwest Europe; and the Northwest Passage, which runs through the Canadian Arctic Islands and is potentially applicable for trade between Northeast Asia and the Northeast of North America, but is less commercially viable than the NSR (O'Rourket et al., 2021: 54). Russia, which strongly promotes the NSR, expects that by 2035 the NSR will become a globally competitive national maritime transport corridor that will compete with the southern route via the Suez Canal.

For China, South Korea, and Japan – as export-oriented and resource-hungry economies – the NSR presents a potentially shorter, time-saving, and safer route from/to Europe with expectedly lower shipping costs (in comparison to traditional shipping routes via the Suez Canal). The high trading demand between Europe and

Asia accentuates the need to explore alternative or supplementary maritime passageways. In terms of reducing the sailing distance between the Atlantic and Pacific, of all Asian countries, Japan has the biggest potential to benefit from the use of the NSR due to its northerly location (Moe & Stokke, 2019: 29). In China, the major beneficiaries are expected to become ports in the northeastern part of the country. In South Korea, theoretically, all ports would make gains; as the NSR promises opportunities for South Korean local ports to become the transportation hubs of the new trans-Arctic routes, there seemed a competition among South Korean ports (like, Busan, Ulsan, and Kangwon), which have asked the Korean central government to invest in the development and modernization of their ports, arguing that their ports best fit for the Arctic era (Park, 2014: 64).

The NSR is also important for Northeast Asian countries, as it provides an opportunity to diversify strategically critical transportation routes. Currently all three countries are highly dependent on a single SLOC passing through the busy and narrow Malacca Strait in Southeast Asia, vulnerable to piracy. For China, the NSR has strategic significance, because it would solve the so-called "Malacca Dilemma" – China's dependence on the Malacca Strait, which could potentially be blocked by a rival nation (for instance, the USA) in the event of conflict (Lagutina & Leksyutina, 2019: 51). The search for alternative SLOCs has become a pressing issue for China due to its dramatically worsening of relations with the USA since 2018.

Adversely, if shipping companies decide to use the NSR as the alternative route for transporting cargoes from/to Europe and Asia, the shipping activities along the traditional SLOC via the Malacca Strait will be affected (Rahman et al. 2014). The transformation of the NSR into a global SLOC may result in the diversion of some traffic from the Singapore port, at present profiting from its status as the world's major transshipment hub (Leksyutina, 2021: 142). The development of hydrocarbon resources in the Arctic and their transportation to destination markets in the energy-thirsty Northeast Asian economies may lead to a shift in hydrocarbon import patterns, thus diminishing the role of the Singapore port as transshipment hub. Some experts, however, argue that the NSR would have a marginal effect on global shipping movements, and that the development of new northern port infrastructure along the trans-Arctic routes opens opportunities for Singapore due to its competence and broad expertise in the management of complex port facilities (Watters & Tonami, 2012: 107–108).

It can also result in the redirection of sea traffic from Indian ports to other countries, although, according to Indian researcher Sinha, it will have limited impact on Indian harbors, since India is not a transshipment hub (Sinha, 2019: 122). Delhi is much more concerned by the fact that the development of the NSR would have implications for Indian military strategy. Contemporary military strategy is based on the assumption that Delhi could put pressure on China – which is seen as presenting a threat or a rival nation for regional leadership – by blocking off the Malacca Straits and cutting Chinese oil supplies if needed (Husanjot, 2016). These kinds of considerations explain Singapore's and India's reservations over developing the NSR.

These five Asian countries are very different in geographical location and features, economic priorities and challenges, their niche in the world economy, and their financial resources; these differences define the countries' varying policies and approaches in the Arctic. Roughly, there are two groups of countries: Northeast Asian countries, which pursue both research, environmental, and commercial interests in the Arctic; and Singapore and India, which focus on the research and environmental dimension of Arctic affairs. Northeast Asian countries' Arctic policies and activities are driven by their interests in the commercial development of the Arctic, while Singapore's and India's are driven primarily by the concerns and challenges that the development of the Arctic, its resource base, and its trans-Arctic shipping routes might present: environmental challenges, challenges to Singapore's transshipment hub status, challenges to India's maritime strategy, etc.

Arctic Agenda in the Policies and Diplomatic Activities of Asian Countries

Over time, the Arctic agenda has expanded in the policies and diplomatic activities of Asian countries. By now, out of five Asian countries, only Singapore and India have not issued an Arctic strategy document with national priorities for the Arctic and how to pursue them. South Korea was the first to issue its official Arctic policy in 2013; 2 years later, Japan published its Arctic Policy; China unveiled its White Paper "China's Arctic Policy" in 2018; and then finally India publicized a draft Arctic policy in January 2021.

A very active approach to the formulation of Arctic policy and expanding diplomatic activities related to Arctic affairs was taken by South Korea. In 2013, it announced its first Arctic policy document – the Arctic Policy Master Plan, providing directions for national activities in the Arctic from 2013 through 2017. In 2015, it appointed its first Ambassador for Arctic Affairs. The next year, Seoul initiated the establishment of the Trilateral High-Level Dialogue on the Arctic with China and Japan, as well as the Arctic Partnership Week, a forum on the Arctic annually held in Korea's Busan. In 2017, the Presidential Committee on Northern Economic Cooperation was established ***to take charge of northern economic cooperation under the direction of the President.*** In 2018, South Korea declared 2050 Polar Vision and issued an updated Arctic policy document – the Policy Framework for the Promotion of Arctic Activities of the Republic of Korea (2018–2022).

Successive South Korean Presidents have paid much attention to the Arctic. Lee Myung-Bak, South Korean President from 2008 to 2013, was a strong advocate of Arctic engagement. In 2009 and 2012, he visited Russia, Greenland, and Norway to discuss Arctic cooperation. The Arctic has been assigned an important role in Park Geun-hye's Eurasian Initiative and Moon Jae-in's New Northern Policy. In September 2017, at the 3rd Eastern Economic Forum, held in Russia's Vladivostok, President Moon delivered a keynote speech, where he introduced the New Northern Policy and outlined the 9-BRIDGE strategy for cooperation with Russia in nine areas. The goal of New Northern Policy is to develop the relations between South Korea and northern countries, create a good atmosphere to improve the relations on the peninsula, and finally to realize its own development in the process of promoting the common economic development of East Asia (Guo & Song, 2020). The 9-BRIDGE strategy aims to promote cooperation with Russia in nine areas: energy (LNG and PNG cooperation, power grid), ports and navigation (the NSR, port modernization), investment (joint investment fund establishment, financial support expansion), railway and infrastructure (railway technology, TKR-TSR connection, and industrial complex), healthcare, innovation platform, shipbuilding (shipbuilding cooperation, shipbuilding technology, and expert exchange program), agriculture and fisheries, and culture and tourism (Presidential Committee on Northern Economic Cooperation, 2021). The Arctic development is an important dimension of the New Northern Policy and the 9-BRIDGE strategy.

In its Arctic cooperation with Arctic states, Seoul prioritizes building up economic Arctic cooperation with Russia, since it is the largest Arctic nation with abundant Arctic natural resources and control over the NSR. However, it also pursues multivector Arctic diplomacy, developing cooperation with other Arctic states and non-Arctic countries. In 2019, for example, President Moon visited Finland, Norway, and Sweden to discuss Arctic cooperation.

The South Korean Arctic agenda has evolved over the past decade. Seoul's activity in the Arctic now goes far beyond the scientific research to rather focus on international economic cooperation in the Arctic. In the Policy Framework for the Promotion of Arctic Activities of the Republic of Korea, adopted in 2018, the primary policy goal is to "promote participation in Arctic economies," followed by the goal to "increase participation in the Arctic governance" and to "contribute to the international community and build capacity for addressing challenges in the Arctic" (Korea Polar Portal Service, 2018). In the first South Korean Arctic policy document, issued in 2013, the goals' subsequence was different: the formation of Arctic partnerships, the strengthening of scientific research, and the creation of new Arctic industries. The economic dimension in South Korea's Arctic policies currently overshadows the other dimensions considerably.

Of all Asian countries, Japan has the longest history of Arctic research and engagement. In 1991, Japan became the first non-Arctic country to establish an observation station in the Arctic (initially in collaboration with the Norwegians). In 1992, it was the first non-Arctic country to join the International Arctic Science Committee, which was established in 1990. In 1993–1999, Japan participated in an international research program to study the feasibility of the Northern Sea Route from the Russian Arctic to Bering Strait (Holroyd, 2020: 320). Having extensive experience in the Arctic research, Japan has accelerated its Arctic diplomatic activities and efforts aimed at articulating its Arctic priorities and policies since the late 2000s. In 2013, the Japanese Cabinet adopted the Basic Plan on Ocean Policy, which, for the first time, outlined focus areas to be pursued in Japan's Arctic policy: observation of and research into the Arctic from a global perspective; international cooperation on the Arctic; and an examination of the feasibility of the Arctic Sea Route (Headquarters for Ocean Policy, 2015). In 2013, Japan appointed its first ambassador for Arctic affairs, which indicated the Japanese government's attention to Arctic affairs and the high priority placed on Arctic issues in Japan's diplomatic agenda (Sun Kai, 2019). In 2015, Japan published its first Arctic policy, where it defined seven Arctic issues to be addressed: global environmental issues, Indigenous peoples of the Arctic, science and technology, rule of law and international cooperation, Arctic sea routes, natural resources development, and national security (Headquarters for Ocean Policy, 2015).

Japan has been actively participating in the work of major international organizations involved in Arctic affairs; it regularly hosts various events dedicated to the Arctic; and it develops cooperation with Arctic and non-Arctic countries in the region. According to some experts' estimates, Japan assumes that the commercial potential of the Arctic is limited, yet nonetheless remains important enough to be monitoring and considering (Holroyd, 2020: 328).

In the past two decades, China has pursued very active Arctic diplomacy. It has accumulated memberships in all Arctic-related regional associations and become an active participant in all international organizations with responsibilities covering the Arctic Ocean (Brady, 2014: 8). The first official document, which mentioned the Polar Regions, was the National Security Law of the People's Republic of China (2015), which considered China's possible participation in rescue and military operations outside the country. There was a whole paragraph on the Arctic in the 2017 "Vision for Maritime Cooperation under the Belt and Road Initiative" – a document which was meant to synchronize development plans and promote joint actions among countries along the twenty-first Century Maritime Silk Road (a pillar of Belt and Road Initiative). In its first Arctic Policy (2018), China calls itself a "near-Arctic state" and an "important stakeholder in Arctic affairs" and also refers to trans-Arctic shipping routes as the Polar Silk Road – a third major corridor for China's flagship Belt and Road Initiative in addition to the Silk Road Economic Belt and the twenty-first-Century Maritime Silk Road. The Polar Regions – the Arctic and Antarctic – are included in China's 14th Five-Year Plan for the period 2021–2025 (State Council of the PRC, 2017).

China has been engaging in proactive diplomacy to all Arctic actors: Russia, Canada, the USA, Norway, Denmark, Iceland, Greenland, and Sweden. Those actors which control trans-Arctic shipping routes and whose territories contain hydrocarbons and minerals are of primary interest to Beijing. The economic dimension in Chinese Arctic activities prevails.

In contrast to Northeast Asian countries, India is in the process of developing its Arctic policies. Although India – being a part of the British colonial empire – was among the parties that signed the 1920 Svalbard Treaty, it revealed its interest in the Arctic only in the late 2000s: In 2007, it launched its first scientific expedition to the Arctic, and in 2008, it established its first research base in the Arctic (Himadri base in Svalbard, Norway). Nevertheless, over several decades, through its activities in the Antarctic (India's polar research experience started in 1981, when it initiated the first scientific expedition to Antarctica.), India has developed expertise in polar scientific research. The Indian government's 2021 draft Arctic policy defines India's engagement in the Arctic region with respect to five pillars: science and research, economic and human development cooperation, transportation and connectivity, governance and international cooperation, and national capacity building. So far, India's Arctic activities lie predominantly in scientific research, climate change, and environment protection. Major challenges and impediments to India's Arctic policies and activities are a lack of technical expertise to explore and exploit the mineral resources in the Arctic, and a lack of financial resources to invest in the Arctic projects and to develop favorable partnerships with Arctic states (Agarwala, 2021: 6–7).

Despite the fact that Singapore has been acting as Observer in the Arctic Council for almost a decade, its Arctic policy is still in its early stages of development. So far, there is no officially articulated Singaporean Arctic policy or even a draft, like in the case of India. However, some policy statements made by Singaporean high-level officials or materials on Singaporean government Internet sites give some insights into its Arctic priorities. For instances, outlining its relations with Europe, the Singaporean Ministry of Foreign Affairs underlines its interests in the Arctic: "the protection of the Arctic environment; the development of a safe Arctic region; the economic advancement of the Arctic; the development of human capital in the Arctic; and climate change" (Ministry of Foreign Affairs of Singapore, 2021). Singapore does attach attention to the Arctic affairs. In January 2012, the Singaporean Ministry of Foreign Affairs appointed a Special Envoy for Arctic Affairs. Since its admission to the Arctic Council in the capacity of Observer in 2013, Singapore has sought to deepen cooperation with Arctic states. For example, in 2016 there was a meeting between Special Representative of the Russian President on International Cooperation in the Arctic and Antarctic and the Singaporean Minister of State in the Prime Minister's Office and in the Ministry of Manpower, Sam Tan Chin Siong. The two sides discussed the issues of the Russian-Singaporean Arctic partnership. In 2016, then-Singaporean President Tony Tan Keng Yam made a visit to Norway, which also included a stop in the Arctic city of Tromsø.

Development of the Arctic's Hydrocarbons and Minerals: Asian Countries' Interests Versus Investment

Despite the fact that, due to climate change, natural resources in the Arctic region are gradually becoming accessible, foreign investors are very cautious in taking part in natural resource development in the Arctic and do not rush to extract Arctic resources. The extraction of Arctic natural resources is an area where both vast commercial opportunities and various challenges and risks coexist. The Arctic is among the most challenging places for commercial development in the world: There are obvious technical difficulties in the development of Arctic natural resources (conditioned by low temperatures, harsh weather conditions, etc.); logistical challenges present themselves (lack of transport infrastructure, special ice-class vessels are required, etc.); the operational costs of their exploration, extraction, and transportation are relatively high; required investment is massive; resource development in the Arctic are highly dependent on global commodity prices (for example, a fall in global hydrocarbon prices in 2014–2015 and again in 2020 did impact investor's decisions); and there are environmental risks.

The recent rise of environmental concerns around the world has already resulted in the suspension of some natural resource development in the Arctic. In December 2016, the Canadian government halted offshore oil and gas exploration in Canadian Arctic waters, subject to 5-year reviews based on environmental assessments. In June 2021, the Biden administration suspended oil and gas leases in Alaska's Arctic National Wildlife Refuge. In July 2021, taking into consideration the impact on climate and environment, the Greenland government decided to cease issuing new licenses for oil and gas exploration in Greenland (Government of Greenland, 2021). The government statement made no mention of any impact to four existing hydrocarbon exploration and production licenses, which were awarded in 2013 to a consortium of energy companies, which is a part in Japanese company. Since 1989, the Japan Oil, Gas, and Metals National Corporation (JOGMEC) has been a member of the so-called KANUMAS project – a regional program, including preliminary studies for hydrocarbon potential offshore Greenland. No commercial exploration activities have taken place in the Greenland Sea, but there were expectations that large hydrocarbon deposits can be present in the area. Each participant of the KANUMAS project was granted a special preferential consideration for exploration and exploitation licenses of the area (Japan Oil, Gas, and Metals National Corporation, 2012). Japan expected this project would reinforce Japan's energy security when successful. In 2013, JOGMEC secured a 50% investment in Greenland Oil Development Co. and was successfully awarded two exploration licenses in partnership with Chevron and Shell.

Falling commodity prices also may impact Arctic exploration. In 2011, the Korea Gas Corporation (KOGAS) bought a 20% share of the Umiak gas field in Canada's Mackenzie Valley in the Northwest Territories. It was South Korea's first Arctic resource development project, which, however, was suspended due to falling LNG prices.

Such uncertainties, inconsistencies in Arctic states' Governments' policies, and general risks in Arctic resource development are impacting Asian investors' choices. Saying that Asian countries are interested in the Arctic hydrocarbons and minerals does not mean that Asian energy companies and investors are rushing to take on commercial risks and join Arctic resource development.

Some researchers argue that while Asian countries are keen to access much needed resources, their investments remain strategic and economically based, Asian countries have much more resource interests in non-Arctic regions (like Middle East, Africa, Central Asia, and Latin America), and the Asian share of all investments in the Arctic region is miniscule (Holroyd, 2020: 326; Coates & Holroyd, 2017: 218; Stensdal, 2015: 163). So far, Asian mineral investment in the Arctic concentrates in a number of Projects, like China National Bluestart bought a quartzite mine in Finnmark. Since 2009, Japan's Sumitomo Metal Mining Company and Sumitomo Corp have been operating the Pogo gold mine in Alaska. Korea's Daewoo owns 1.7% of the Kiggavik uranium mine in Nunavut. In 2015, China's General Nice purchased the Isua iron ore mine in northern Greenland (Holroyd, 2020: 326).

As for Arctic hydrocarbon development, something that has been very appealing to Asian non-Arctic countries has been Russia's LNG Arctic projects. Russia has very ambitious plans aiming to increase its LNG output fivefold – with development of its

Arctic reserves – to more than 120 million tons by 2035. In 2020, Asia remained the leading importing region with a 71.4% share of global LNG imports. Japan, China, South Korea, and India are the world's largest LNG importers, with global shares of 20.9%, 19.3%, 11.5%, and 7.5%, respectively (Henriquez et al., 2021: 30).

Currently, the two largest LNG projects in the Russian Arctic – the Yamal and Arctic LNG 2 projects – are both exercised by the Russian privately owned gas company Novatek. The largest foreign investor in these two projects is China. In 2013, the Chinese CNPC acquired a 20% stake in the Yamal LNG project, and in 2015, the Chinese Silk Road Fund bought another 9.9% in the same project. China also acquired 20% stake in the Arctic LNG 2 project. However, Chinese investment in Russian Arctic hydrocarbon development mainly concentrates only on these two projects. Previously, Chinese companies ignored Russian Rosneft's invitations to buy a share of the Vankor deposit in the Russian Arctic. Instead, a consortium of Indian companies acquired large stakes in Vankorneft project in 2016. Beside general concerns over difficulties in Arctic resource development (mentioned above), major barriers to Chinese investment in the Russian Arctic projects are cost concerns, poor infrastructure, distrust between Chinese and Russian businessmen over the Arctic, and Russian bureaucracy (Stronski & Ng, 2018).

Japan is the 2nd largest Asian investor in Russian Arctic energy projects. Since 2011–2012, two factors have arisen contributing to Russia-Japan Arctic energy cooperation. The 2011 Fukushima accident and the subsequent nationwide shutdown of nuclear power plants have resulted in a rise of Japan's demand for gas, with Russia seen as a promising source of gas imports. Since 2012, when Prime Minister Shinzo Abe came to power, the Japanese government started to promote Japanese companies' economic engagement with Russia so as to create a favorable environment for resolution of the long-standing territorial dispute and the conclusion of a peace treaty with Russia (Leksyutina, 2021: 148). However, the 2014 Ukrainian crises and the Western sanctions against Russia influenced Japanese companies' investment cooperation with Russia. Being concerned with the anti-Russian sanctions and its impact on Russian energy sector, Japanese companies, which initially planned to make large investment in Yamal LNG project, decided not to get connected with the project as shareholders. However, Japan Bank for International Cooperation opened a credit line facility with Yamal LNG, and Japanese companies remained to provide their services for the project: the joint venture of JGC and Chiyoda was an engineering, procurement, and construction contractor for the project (Taisuke, 2019). Japanese Yokogawa Electric Corporation also has received a contract to supply integrated control and safety systems (Yokogawa, 2014).

In 2019, even with anti-Russian sanctions in place, the Japanese consortium of Mitsui & Co and Japan Oil, Gas and Metals National Corporation opted to invest $3 billion in the Arctic LNG 2 project for a 10% stake with 2 million tons of annual LNG supply to Japan (around one-tenth of the facility's capacity). The change in Japan's position on investment in Russia's Arctic LNG projects maybe was conditioned by the high commercial value and expected benefits of the Arctic LNG project, Japan's high demand for LNG alongside competition with other LNG importers in the international market, and concerns over China's taking a lead in Arctic energy cooperation with Russia.

There has been some minor Indian investment in Russian Arctic energy projects. Russia-India cooperation in the Arctic hydrocarbons is potential rather than currently happening. On several occasions, Indian companies were considering investing in Russian projects but eventually backed off. For instance, Indian consortium of OVLPetronet LNG and IOC was in talks with Novatek to buy a stake in the Yamal LNG project, India's GAIL – to buy a minority stake in Arctic LNG 2. However, the negotiations stumbled, as Indian investors feared difficulties of developing Arctic LNG (Indian companies lack expertise in the development of shelf deposits under severe climate conditions.), like the projects' high costs, long investment payback periods, environmental risks, and low energy prices (Fedorovsky et al., 2016: 15).

Indian companies have been more active in joining Russian Arctic oil projects. In 2016, Indian company ONGC Videsh (The ONGC Videsh is participating in the development of oil and gas fields in the Russian Far East under the Sakhalin 1 project, where it owns 20% stake.) purchased 26% shares and a consortium of Indian companies (Oil India Limited, Indian Oil Corporation, and Bharat Petroresources) seized a 23.9% stake in the Vankorneft oil project, exercised by Russian Rosneft. In 2020, India reportedly made a principal decision to participate in Russia's new Arctic giant project in Taymyr – the Vostok Oil (Rosneft, 2020).

Unlike the others of the world's largest LNG importers, such as Japan and China, South Korea has refrained from investing in Russia's largest LNG projects in the Arctic – Yamal LNG and Arctic LNG 2. Although Korea's KOGAS was considering the Arctic LNG 2 project, it did not appear on the final list of investors. Moreover, in the global context, currently there is not a single ongoing Arctic hydrocarbon project with the participation of South Korean investors. South Korean investors are extremely cautious toward Arctic energy projects. They fear technical difficulties in the development of Arctic hydrocarbons, the relatively high cost of their production, unstable global energy market, etc. South Korean companies prefer to participate in such projects that completely exclude financial, commercial, and political risks. Recently, South Korea has demonstrated its intent to cooperate with Russia in creating a green system of independent energy supply in the Arctic. In 2020, the government of the Republic of Korea unveiled its decision to form a special fund for cooperation with Russia in the field of hydrogen energy. The first project is expected to be the construction of the Arctic station "Snowflake" (in the Yamal-Nenets Autonomous Okrug) on the basis of renewable energy sources and hydrogen energy (without diesel fuel).

Participation of Asian Countries in the Development of the Northern Sea Route: Shipping and Shipbuilding

The diminishing ice cover in the Arctic Ocean and Russia's activities in the Arctic have created vast opportunities for foreign shipping and shipbuilding companies. Although there are still doubts in the prospects of the NSR to become the global SLOC, over past several years there has been a surge in shipments along the

Northern Sea Route. From 2014 through 2020, cargo traffic on the NSR jumped from 4 million tons to 32.97 million tons, including 1.28 in transit cargo. The most shipping activities on the NSR are domestic and destination shipping, and the number of international transits remains insignificant both in the number of transit voyages and their cargo volumes. In 2016, there were 8 transit voyages via the NSR, in 2017 there were 12, in 2018 17, and in 2019 14. All transits except two – shipments of coal from Vancouver, Canada, to Finland in 2016 – have been between Northeast Asian ports (in China, Japan, and South Korea) and ports in Northwest Europe (in the five Nordic countries, Germany, UK, the Netherlands, and France) (Gunnarsson, 2021: 6). Asian shipping companies are in the leading role, with the Chinese COSCO totaling 23 voyages or 45% of all transits during the 4 years, followed by German companies with 25% (Gunnarsson, 2021: 6). According to Bjorn Gunnarsson, currently all international transit voyages along the NSR are largely exploratory in nature or demonstrations of intentions, aiming at evaluating the commercial viability of the NSR as a possible trade route (Gunnarsson, 2021: 7).

An increase in overall shipments along the NSR during the last several years has resulted from domestic and destination shipping. From 2016 to 2019, 76–92% of all voyages on the NSR were domestic shipping. Also, out of 1232 destination voyages on the NSR, there were 1108 voyages between the NSR and European ports, and 124 voyages between the NSR and Asian ports (Gunnarsson, 2021: 5). Major drivers for domestic and destination shipping have been Russian natural resource projects, which involved transportation of machinery, constructional materials, and various supplies for the construction of the Yamal LNG Plant and supportive infrastructure. Once the Yamal LNG Plant became operational, regular LNG and gas condensate shipments from Russia's Sabetta port (Sabetta being located on the eastern side of the Yamal Peninsula) started (from December 2017). Asian shipping companies have been involved in these shipments as operators. In 2014, Japanese Mitsui OSK Lines (MOL) and Chinese COSCO established a joint venture to provide transport services for Yamal LNG project by signing contracts with South Korean Daewoo Shipbuilding & Marine Engineering (DSME) to build three Arc7 LNG carriers. Since March 2018, COSCO and MOL have been engaged in transporting LNG using these vessels for the Yamal LNG project. In November 2020, Japanese MOL announced that it had signed agreement for the long-term chartering of three more Arc7 LNG carriers with Arctic LNG 2 project. Beside MOL, subsidiaries of China's COSCO Shipping also made joint ventures for financing the construction of Arc7 LNG carriers to provide services for Russian Arctic LNG projects with Greece's Dynagas and the UK's Teekay Shipping LNG (Gunnarsson & Moe, 2021: 18).

While China and Japan have been actively engaged in shipping along the NSR, providing shipping services for Russia's LNG projects and beyond, other Asian countries still lag behind. They are in the process of exploring opportunities and evaluating the viability of navigation along the NSR. Since 2013, South Korea has participated several times in pilot projects for the use of the Arctic route, designed to assess the features of navigation and the commercial value of the NSR. In 2013, the Stena Polaris, a Swedish-owned vessel, was chartered by Korea's Hyundai Glovis, a shipper, to ship cargo from Europe to South Korea along the NSR, but it was not until 2017 that a South Korean vessel did so (McGwin, 2017); this was South Korea's first commercial voyage, delivering cargo from Europe to Asia along the Arctic route along the NSR.

Russia's Arctic resource development efforts also triggered the need for special ice-hardened vessels, capable of transporting oil, LNG, and gas condensate along the NSR. Asian leading shipbuilding companies, including those from Singapore, South Korea, Japan, and China, have seen vast business opportunities, because Russia could not meet these rising demands in civil ice-class vessels.

South Korean and Singaporean shipyards were first to break into this market. In 2001, Gazprom Neft received two storage tankers from Hyundai Heavy Industries and Hitachi Zosen, to be placed in the Kola Bay. From 2008 to 2017, a fleet of six Arc7 shuttle tankers was built by Samsung Heavy Industries to the order of Gazprom Neft to deliver crude oil from Novoportovskoye oil field on the Yamal Peninsula (Leksyutina, 2021: 150). In 2008–2009, Samsung Heavy Industries also constructed three Arc6 ice-class vessels for the needs of the Varandey Terminal (Lukoil) in the Pechora Sea (Agarcov et al. 2020: 3–5). In 2008, Singapore's Keppel constructed three ice-capable vessels for Russia's Lukoil.

Japanese, Singaporean, and Chinese shipyards made bids to build carriers for the Yamal LNG project but lost out to Korean competitors (Moe & Stokke, 2019: 29). In 2014, South Korean DSME won this contract for the construction of 15 Arc7 ice-class LNG carriers. In 2020, DSME received contracts for the construction of another six Arc7 carriers worth $1.7 billion for the Arctic LNG 2 project. In June 2020, DSME also received an order from Novatek for two floating storage facilities LNG worth $748 million. In July 2021, Russia's state-owned nuclear authority Rosatom and Japan's AEON Corporation agreed on joint ventures to build Arc5 class vessels to transport coal from the Syradasayskoye coal fields in the Taimyr Peninsula (Rosatom, 2021).

Conclusion

The Arctic activities of these five Asian countries are driven by both interests and concerns. For each Asian state, climate change and environmental issues have been of major concern on the Arctic agenda; that was a primary motivation for all of them to join the Arctic Council as an Observer and to conduct Arctic scientific research on a regular basis. For some Asian countries, joining the "Arctic club" was also a matter of status: For China, India, and Japan, it represented a great power status, while for South Korea, it was a middle power status. The commercial development of the Arctic is an area where Asian countries can be roughly split into two categories. Northeast Asian countries' Arctic policies and activities are driven by their *interests* in the commercial development of the Arctic, while Singapore and India's are rather driven by the *concerns and challenges* that the development of the Arctic, its resource base, and trans-Arctic shipping routes might present: environmental challenges, challenges to Singapore's transshipment hub status, challenges to India's maritime strategy, etc.

Asian countries' perception of their interests, concerns, and challenges, their companies' readiness to take commercial risks, and the scope of their financial and technological power influence the depth and intensity of their cooperation with Arctic states in the Arctic commercial development. The exploration and extraction of Arctic hydrocarbons and minerals and commercial shipping along the NSR are areas where large investment and readiness to take risks are needed. Currently, China and Japan are largely engaged in Arctic resource development and commercial shipping along the NSR. A highly beneficial area with almost zero-risk but with strong competition is the construction of special ice-hardened vessels for Arctic navigation and equipment used in the production and processing of hydrocarbons and minerals under severe Arctic conditions (like drilling platforms and floating production, onshore and offshore oil and gas rig platforms, onshore and offshore modules, storage and off-loading units, etc.). So far, among Asian shipbuilders, the principal beneficiaries from Arctic resource development have been South Korean shipyards, which managed to receive multiple large contracts. Japanese, Singaporean, and Chinese yards and engineering companies have also been awarded various contracts for the construction of ice-class vessels and equipment for the development of Arctic resources.

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Part II

Economy of the Arctic: Introduction

Geoeconomic Aspects of Arctic Exploration

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Abstract

The aim of this study is to testify the hypothesis on the transitive nature of the current geo-economic confrontation in the Arctic and to identify the specific features of geo-economic rivalry in the Arctic. The research methods are: a combination of historical and logical approaches, analysis and synthesis, a systems approach, comparative analysis, and a geo-economic approach. The case of the Arctic presented in the chapter identifies that the geo-economics of the twenty-first century, along with the control of resources and space as before, is strongly seeking the control of innovation, technology, entrepreneurship, and innovative skills. The current geo-economic situation shows that the significance of the Arctic Region and the severity of competition between its main geo-economic actors for world trade waterway priority and natural resource extraction increases dramatically. The authors argue the fact that two powerful geo-economic blocs are being formed in the Arctic: the United States and its western allies on the one hand, and Russia and China on the other. The research leads to the conclusion that the permanent growth of geo-economic influence of China inevitably takes place in the Arctic zone. Among geo-economic participants of the second level, the energy and mineral Russian multinationals are emphasized, whose active participation in Arctic waterways and resources exploration enhance the growing scale of Russian geo-economic operations and its overall impact in the region.

Keywords

The Arctic · Climate change · Geo-economics · National interests · Northern Sea Route · Geo-economic balance

Introduction

The modern world economy is characterized by an increasingly complex system of interconnected forces and drivers that form a single geo-economic space with a new overall set of crossing strategic interests from different global actors. One of the key macroregions where the dramatic geo-economic competition of the strongest nation states is presently unfolding is the Arctic.

Currently, geo-economic processes in the Arctic are influenced by a number of factors. At the core of the big interest of geo-economic actors in the Arctic is the growing scarcity of many resources, especially fuel and energy. The second reason is that the Arctic is of great military and strategic importance. The third reason stems from the activation of the Russian Federation's efforts to accelerate the development and governance of the Arctic zone of the Russian Federation (Russian Arctic) in an integrated manner.

The relevance of the research topic is determined by the following. Arctic ice melting and fast warming are creating a new geo-economic situation, characterized by an increase of volatility in the Arctic region alongside contradictions between the major centers of power, due to its significant resource potential (primarily oil and gas) and transport value. The frozen state of many conflicting claims to Arctic sovereignty represents regional governance failures, indicating a lack of consensus on the region's international status, leaving open opportunities for non-Arctic states.

Rapidly increasing Arctic temperatures are leading to the melting of the ice cover and easier access to previously hidden natural resource and sea routes; this arouses great interest of not only from the neighboring arctic states such as Russia, Norway, Denmark (Greenland), Canada, and the United States, but also of other international geo-economic actors far beyond. According to various estimates, more than 20 countries currently intend to participate in exploration of the Arctic shelf wealth. A high interest in Arctic issues, in addition to the states located within the Arctic Circle, is demonstrated by China, Japan, South Korea, and the countries of the European Union as well.

Theoretical Foundations of the Study

In the last decades, the traditional military and strategic rivalry between states has become much less important than their economic competition; thus, the significance of the military power is comparatively falling and serving more for achievement of long-term geo-economic goals.

Since the 1990s, issues of geo-economics were developed in the works of American scientists E. Luttwak, E. Leishon, W. Nester, and P. Dicken. In Europe, the concept of geo-economics was developed towards the end of the twentieth century by researchers K. Jean, J. Attali, D. Garten, P. Savona, B. Kase, F. B. Rocci, S. Fiore, and M.-A. Vila. A cohort of geo-economics researchers have appeared in China and India in recent years: worth mentioning in this regard are prominent Indian geoeconomists M. N. Kuareshi and A. A. Maturu, as well as Chinese researchers Wu Xinbo and Pan Wei, who are behind a number of publications.

Modern Russian geo-economics took shape in the 1990s. Among the Russian scholars who have made a significant contribution to the area one should mention E. G. Kochetov, A. D. Bogaturov, N. K. Vafina, E. P. Grigoriev, N. Y. Konina, A. I. Neklessa, L. V. Novokshonova, V. I. Pantin, M. A. Pivovarova, V. Y. Rogov, E. V. Sapir, V. V. Sokolov, M. I. Gelvanovsky, S. Y. Glaziev, and B. N. Kuzyk, among others.

The works of many foreign and domestic scientists are devoted to the issues of globalization and regional development, among whom noteworthy figures include M. Baidakov, U. Beck, Z. Brzezinski, F. Braudel, I. Wallerstein, A. Weber, V. Geitz, F. Jameson, P. Jacques, M. Zgurovsky, R. Kardla, L. Klein, P. Krugman, R. Robertson, B. Seltsovsky, J. Soros, N. Stolyarov, A. Filipenko, and T. Fridman.

Political, legal, social, and environmental aspects of the current dynamics of processes in the Arctic region were thoroughly researched by A. Alekseyev, F. Baker, S. Borgerson, T. Borisov, J. Krout, A. Colley, H. Conley, N. Didenko,

V. Konyshev, I. Lundestad, A. Oreshenkov, N. Petersen, I. Prokofiev, V. Pronichev, V. Selin, A. Sergunin, A. Tarasov, J. H. Ford, M. Cel, V. Zuckerman, etc.

At the same time, issues related to the state and dynamics of geoeconomic processes in the Arctic region remain poorly studied, which determines the relevance of the research topic.

Statement of the Research Problem

Global warming and related climate change have an increasing impact on the world economy, which, against the background of the technological and digital revolution, create a new geo-economic reality (Konina, 2021).

The case of the Arctic presented in this chapter clearly shows that geo-economics of the twenty-first century, along with the control of resources and space as before, is seeking strongly for the control of innovation, technology, entrepreneurship, and innovative skills (Brutschin & Schubert, 2016).

When analyzing the geopolitical situation in the Arctic, most authors point out the following: firstly, a shift in the balance of power towards China, both at the global and regional (Arctic) levels; secondly, the growing rivalry between the United States, China, and Russia; and thirdly, the growing strategic convergence between Russia and China (Conde & Sanchez, 2017).

Research Goals and Objectives

The aim of this study is (1) to test – both analytically and empirically – the hypothesis on the transitive nature of the current geo-economic confrontation in the Arctic and (2) to identify the specific features of geo-economic rivalry in the Arctic.

The main question is whether one can continue talking about the continuation of the period of Arctic exclusivity, which can be characterized by the absence of competition between great powers in the region and the supposed position beyond the reach of the traditional realistic perspective. However, the rise of China, its claims for the Arctic, its status of nearby Arctic state, the militarization of Arctic waters at large, strengthening the convergence between Russia and China while geopolitical tensions enhancing between Russia and the United States, and the global rivalry between the United States and China are drawing the Arctic into a new phase of confrontation between the great powers.

The wellbeing and prosperity of all Arctic countries is intertwined with the development of global security. At the core of the tensions between the USA and Russia lays a view that is widespread among of the part of the American elite that Russia is no longer a global power and cannot seriously challenge US dominance. A low level of trust and confrontation has since 2014 become typical to the US-Russia relations, although even before this (since 2008) Russia faced a very annoying lack of respect from behalf of the USA to its national interests even on the territory of the former Soviet Union.

The last decade has given clear evidence of a lot of disrespectful cases on the side of the United States towards certain red lines connected with the key national interests of Russia, including its national security issues. This, along with the dynamic development of China, is a prerequisite for a strategic convergence of Russia and China. The longer the current confrontation between Russia and the West persists, the more likely the space of cooperation in the Arctic would begin shrinking rather than further growing. There already are visible signs that the situation can aggravate in the not-so-distant prospective. A sense of increasing political uncertainty spreads among the Arctic countries. This pertains specifically to prospects of a cooperative management of overlapping claims over the continental shelf in the central Arctic Ocean.

Researchers wonder if a stable state of the Arctic consensus is possible, or if all the main geo-economic actors are only now clarifying their positions for the upcoming battle for the Arctic. Great power rivalries are not determined by cooperation, but by the dynamics of the security dilemma.

The Arctic badly needs cooperation, which can be based on such issues as environmental protection, climate change, and sustainable development, with great powers setting up camp in the region.

Arctic states have their own interests and would like to get certain advantages from the current tensions between Russia and the United States, though strong competition creates a threat to Arctic stability and cooperation. Despite its unique geographic location, the Arctic does not exist in isolation from the broader international context or away from current situation of lack of trust, misunderstandings, and tension between Russia and the West. Political compatibility of the new Russia and the West does not mean the absence of conflict of geo-economic and geopolitical interests between the parties in the Arctic (as well in other parts of the world).

The research methods are a combination of historical and logical approaches, analysis, and synthesis, a systems approach, a combination of induction and deduction, comparisons, and a geo-economic approach (Konina, 2018b).

Major Geo-economic Participants

The Arctic countries have already gone a long way seeking for understanding and building trust in the Arctic region.

In the situation of Arctic ice rapidly melting and global warming happening around twice or thrice as fast as elsewhere in the planet, the Arctic region is gaining a much more important strategic position due to multifaceted factors associated with political, military, and infrastructural aspects of economic activity. In the Arctic, the main geo-economic actors are both the Arctic countries and non-Arctic states and international organizations, as well as transnational corporations (TNCs).

Arctic states – Russia, the USA, Canada, Denmark, Iceland, Sweden, Finland, and Norway – are interested in active participation in the affairs of the region. In addition to the main Arctic players, nonregional players – including China, Japan, South Korea, and India – are also showing interest in the Arctic region.

Several other non-Arctic states besides China have developed robust Arctic policies and regularly engage in political discussions, including with the Arctic Eight, on the regional issues. This list includes Japan, Singapore, and South Korea, as well as France, Germany, United Kingdom, Italy, and Poland, who are eager to participate in distribution of Arctic resources and using of cheaper and more convenient sea transport routes.

The Role of International Organizations and Other Geo-economic Actors

The Arctic Council has occupied a leading position in the international political arena since its formation by eight Arctic states in 1996 based on a proposal by Canada. The main goal of the Arctic Council was declared to be the promotion of cooperation and coordination of interaction between the participating states, primarily in the areas of environmental protection and promoting sustainable development.

The Arctic Council is the most important international organization on Arctic affairs. Arctic rules and regulations have evolved at a faster pace, and the United States has been at the center of many successful regional agreements, including the Polar Code governing civilian vessel traffic in and around Antarctica, a moratorium on fishing in the Central Arctic Ocean, and cooperation between the Arctic Coast Guard. Thus, either ending US engagement in the Council or widening disagreements between Washington and the other seven members could seriously damage the organization at a time when group cooperation is so much desired and needed.

There are various international polar organizations created as alternatives or narrowly focused political or scientific discussion platforms, such as a forum of the Arctic “five” or The Barents Euro-Arctic Council (BEAC), but generally their geo-economic importance is close to zero.

Organizations such as the EU and NATO are paying particular attention to the region. The EU proclaims a policy of active participation in the affairs of the Arctic region, and from year to year, it tries to strengthen, in one way or another, its presence in the Arctic; nevertheless, the EU’s geo-economic influence remains minimal for now, in spite of certain political steps.

NATO is also making active attempts to “infiltrate” the region. Large-scale maneuvers have been implemented, plans are being discussed to revive NATO’s Arctic and Atlantic command, and military activity around Norway is growing. NATO’s geo-economic influence is very negative because this military bloc creates the tensions between Russia and the West and is a military enforcement of US interests in the Arctic.

TNCs have established their own plans for the Arctic resources development (Konina, 2018a). However, all these plans, which are especially deployed by the major oil and gas multinationals concerning the extraction of hydrocarbons in the Arctic zone, have been seriously adjusted at the turn of the 2010s due to the reassessment of trends in the development of global energy markets and the growth of renewable energy sources.

Russia in the Arctic

The Russian Federation has also put forward a new policy as the country became the chairman of the Arctic Council in May 2021. Through its Development Strategy of the Russian Arctic and National Security until 2035, the Russian Federation revised the Arctic strategies for the nearest 15 and more years, with a focus on the energy and resources extraction, development of the Northern Sea Route (NSR), and improvement of the standard of living for the Arctic peoples of the country. Russia's policy in the Arctic is mainly determined by the Fundamentals of the State Policy of the Russian Federation in the Arctic for the period until 2035 and the Maritime Doctrine of the Russian Federation for the period until 2020.

The Fundamentals lays out the country's strategy in the region and points to Russia's role as the "leading Arctic power." National interests are based on two key elements – natural resources and maritime transport. According to the Fundamentals, the ultimate goal of Russia is to transform the Arctic into a "leading strategic natural resource base" by 2020. Consequently, one of the main goals of the Russian Arctic policy is to increase the extraction of natural resources in the region and the development of the infrastructure of the NSR (Lukin, 2010). Of particular importance are the protection of the wealth of the exclusive economic zone and the continental shelf, ensuring free access of the Russian fleet to the Atlantic, the decisive role of the Northern Fleet for defense, and the increasing importance of the NSR for the sustainable development of the Russian Federation.

Russia has the world's largest icebreaker fleet with over 40 units; three more nuclear icebreakers are under construction and a dozen more are planned for the next decade.

The Arctic has always been of vital interest to Russia. As Arctic forums and frameworks developed, Russia quickly claimed control over its stake in the region. Along with four other Arctic coastal states (the USA, Canada, Denmark, and Norway), Russia signed the Ilulissat Declaration in 2008, asserting a regional state presence in Arctic affairs. In March 2021, Russia declared its rights to new sections of the continental shelf in the Arctic Ocean in two fresh submissions to the UN Commission. According to the materials submitted on March 31, 2021, Russia claimed to increase the external boundaries of its continental shelf, including the Gakkel Ridge, Lomonosov Ridge, and the Canadian Basin.

At that stage, Russia showed a preference for cooperation in the field of energy development in the Arctic with Western energy companies over China and other countries (Aalto, 2016; Selin, 2011). Even before the imposition of sanctions in 2014, tensions between Russia and the West changed Russian calculations. Given the disagreement over the settlement of international complicated situations, Russia considers it important to diversify its energy partnership and to have a client bases not dependent on Europe and the West; moreover, in the nearest decades, the growing demand for energy resources will be in Asia. Diversification reduces the vulnerability of the state to the actions of one actor and also reduces the ability of one actor to influence Arctic affairs through local investment (Sapir & Karachev, 2020).

The introduction and strengthening of sanctions against Russia affects the geo-economic position of Russia in the Arctic.

Compared to smaller countries, Russia has traditionally been less susceptible to foreign influences. However, the sanctions cause significant damage and severely restrict potential partners from the Arctic, leaving Russia with several difficulties. When it comes to its needs and negotiations with China on the Arctic, Russia is gradually in an even weaker position than those of Iceland and Denmark: in need of capital and funding, but severely limited in the choice of partners.

Russia's Arctic offshore energy efforts are in an unwelcome hiatus, and the flight of Western companies in the face of sanctions imposed by their home countries has left the future of these efforts up in the air.

Development strategies for the Arctic zone of Russia are closely connected with oil and gas development in the Yamalo-Nenets Autonomous Okrug (Chanysheva & Ilinov, 2021). This was stated in the corresponding decree of the President of the Russian Federation, Vladimir Putin.

The main directions were identified: expansion of liquefied natural gas (LNG) production on the Yamal Peninsula, as well as on the Gydan Peninsula; development of deposits in the Gulf of Ob with the development of a pipeline system for gas transportation; development of oil and gas chemical production in Sabetta, Yamburg, and Novy Urengoy; construction and development of the Obskaya–Salekhard–Nadym–Pangody–Novy Urengoy–Korotchaevo and Obskaya–Bovanenkovo–Sabetta railways; maintenance and development of oil and gas pipeline networks, development of oil and gas mineral resource centers connected to pipelines in the Nadym-Pursk and Pur-Taz oil and gas regions, including with the use of new technologies for the production and development of underlying layers, as well as hard-to-recover oil reserves.

The directions for the implementation of the Arctic Development Strategy in the Yamalo-Nenets Autonomous Okrug also include: development of the Novoportovskoye oil and gas condensate and Bovanenkovskoye gas condensate mineral resource centers; development of the Tambey group of fields and preparation for the development of shelf fields; formation of a diversified industrial and technological complex for gas processing and petrochemistry; development of technologies for involving low-pressure natural gas into industrial circulation, including gas compression technologies; expansion of the centralized power supply zone by connecting settlements to a unified power system; development of oil and gas services through the creation of industrial zones in support settlements; organization of production of building materials in order to meet the needs of the fuel and energy complex and housing construction; creation of an emergency rescue unit and an Arctic crisis management center in Sabetta and the formation of a tourist cluster based on the agglomeration, including Salekhard, Labytnangi, and the village of Kharp.

The growing geo-economic importance of the Arctic for Russia is connected with the dynamic development of NSR. In 2020, the volume of cargo transportation along the NSR amounted to 32.97 million tons, which is 4.7% more compared to 2019. According to the May 2021 decree of the President of the Russian Federation, by 2024 the freight traffic along the NSR should grow to 80 million tons/year. The Arctic development strategy until 2035 provides for a further increase in the volume of traffic along the NSR – up to 120 million tons/year by 2030 and up to 160 million tons/year by 2035.

Taking into account the increasing role that the Arctic will play in the coming years, one can suggest China's growing presence in the region. The wealth and capital of China, China's desire to participate in the development of the Arctic, and the current confrontation between Russia and the West create the preconditions for Russian-Chinese cooperation in the Arctic (Lukin, 2021). Russia, as well as Nordic countries such as Finland and Iceland, has been comparatively more favorable to China's economic participation in the Arctic. Also trying to diversify its economic ties in the Arctic, Russia has made certain steps towards a partnership with India in the exploration of the Arctic oil and gas resources.

The Russian Federation launched a new policy at the end of 2020, as the country prepared to take over as chair of the Arctic Council early next year. The Russian government also provided additional information on the policies it will pursue in its presidency of the Council in 2021–2023, including climate change and sustainable development issues, as well as on the application of a more "comprehensive inclusive approach" to regional governance. It was also confirmed last month that Yuri Trutnev, deputy prime minister and presidential plenipotentiary in the Far Eastern Federal District, will take on the council's Moscow policy plans.

USA

The United States is often described as an Arctic power, whose potential to become an Arctic superpower remains largely unrealized. At the same time, Alaska's economy has been hit hard by falling global energy prices and lost tourism revenues due to COVID-19. There are problems with the backwardness of the American Arctic.

Internationally, the United States has been a member of the Arctic Council since its inception in 1996. The US held the chairmanship of the Arctic Council from 2015 to 2017, after which it established the US Special Representative for Arctic Affairs for Ocean and Polar Affairs in the US Department of State. As Obama traveled north to become the first incumbent American president to visit the Arctic, announcing new climate and diplomatic pledges, he was surrounded by an atmosphere of anticipation – the expectation that the United States was finally on the cusp of realizing its polar potential. This hope for an American Arctic country became a sign of US regional engagement, but failed further.

While the Obama administration poured resources and priority into the Arctic in Alaska and the region as a whole through development of finance, political action, and scientific efforts during the Arctic Council presidency, little was done during the Trump administration.

No other issue has weakened the US position on Arctic more than the Trump administration's approach to climate change. Despite growing evidence of this overall dangerous natural phenomenon (existing in the Arctic as well), the administration has repeatedly insisted that the threat does not exist. 2020 was the warmest summer in the Arctic, where the level of the sea ice in the region fell to the second lowest level (2012 still holds the record). In August 2020, the last intact ice shelf in the Canadian Arctic on the island of Ellesmere split due to local weather conditions, and current modeling has led to predictions that the Central Arctic Ocean (CAO) could be ice-free in the summer months by 2035. This has had a profound impact on the global environment, including in Alaska, as well as on Arctic and indigenous communities.

In addition to abandoning the Paris Climate Agreement, the United States also stood against ratifying the United Nations Convention on the Law of the Sea (UNCLOS), which seriously thwarted Washington's attempts to establish rules over the emerging Arctic seas routes. In the meantime, seven other Arctic nation states have ratified UNCLOS, leaving the United States in diplomatic isolation.

The US has contradictions with Russia over the NSR as well. First of all, this concerns the determination of the status of the latter. Russia's position is that the NSR is under national jurisdiction as a historically established transport route. The United States, however, considers the principle of freedom of navigation as the basic component of its maritime strategy, which it intends to apply in the Arctic at large (Konyshev & Sergunin, 2018).

The United States is also extremely unprepared for the possible opening of the CAO for shipping, since the waterway will very soon (after 2035–2040) become more and more ice-free. Unlike 40 Russian icebreakers which are regularly replenished, the US Navy could boast of only two existing vessels, out of which one icebreaker is under renovation.

After several years of disputes, the USCG's Arctic capabilities were to be strengthened with confirmation that the long-delayed construction of a new icebreaker would start soon to complement the existing US cohort. In April 2020, it was announced that VT Halter Marine, an American firm owned by Singapore Technologies Engineering, would receive a $1.9 billion contract to build new icebreakers.

The United States pays great attention to the study and creation of conditions for the economic development of its Arctic territory (Alaska) and the adjacent shelf. However, there are differences in the ruling class of the United States on the economic and environmental development of the country's Arctic sector. The Democratic Party is in favor of the conservation of natural resources in the High North. Republicans insist that work on the gradual development of hydrocarbons in the Arctic should be started now, so as not to lag behind other polar powers.

The US oil and gas companies consider energy cooperation with Russia in the Arctic as a promising profitable business. In April 2012, ExxonMobil and Rosneft signed an agreement on cooperation in exploration and development of oil and gas deposits in the Kara Sea. It was beneficial for Russia to attract the missing financial resources and modern technologies for exploration and drilling in the northern latitudes. Another large Rosneft-ConocoPhillips joint project was to be launched in the Nenets Autonomous District, where the Ardalinskoye field was developed, and significant investments were expected from the American side. After imposed sanctions following the events of 2014, under strong political pressure, US companies had to leave Russia and lose significant money.

The United States consider China also the main developing strategic competitor in the Arctic region. China's entry into the Arctic Council in 2013 as an observer, broad statements that the country is a "near-Arctic state," the launch of a second conventional icebreaker, and strong interest in the construction of a nuclear-powered icebreaker – and especially the inclusion of the Arctic in China's Belt and Road Initiative (BRI) – clearly show deep Chinese involvement in the future of Arctic.

Greenland, Iceland, and Finland are in the focus of geo-economic contest between the United States and China too. America's concerns about China's investment in Greenland's mineral resources, geothermal energy facilities in Iceland, and the silk road project with Finland are evident in its policy documents and diplomatic behavior.

Greenland also presents a pattern of conflicts of interests between the United States and China in the region. China's attempts to buy a nonexistent naval base and the intention to build a new airport in Nuuk (the capital of Greenland) were very negatively received in Washington, due to the fear that Chinese investment could give courage, give new incentives to the island economy, and can help Greenland in its quest for independence from Denmark.

Canada

Canada has a vast territory yet only a minority of the population in the Arctic: about 107,000 inhabitants (albeit with a tendency towards growth), including representatives of indigenous peoples. The Canadian Arctic covers more than 40% of the land in Canada and 25% of the area of the Arctic.

In 2019, prior to parliamentary elections, Prime Minister Justin Trudeau's government released a long-awaited – and long-overdue – updated set of policies for the Canadian North. The main element of the policy – the Arctic and Northern Policy Framework – was intended to update the regional policy, highlighting the need to better protection for the country's sovereignty in the Arctic, to empower the peoples of the Canadian Arctic, and to focus on meeting critical infrastructure needs. The goals of the new Canada plan, identified as priorities for the Canadian Arctic, will be achieved by 2030. The ten basic principles embrace the need to be included in various policy decisions affecting the Arctic, as well as the requirement that indigenous peoples and northern communities be specifically involved.

The goals in question are to ensure the health and well-being of Arctic indigenous people, develop infrastructure to close the income gap with the rest of Canada, increase the strength of Arctic communities, improve understanding of the Canadian North, protect the Arctic ecosystem, maintain a "rules-based international order" in the Arctic in the face of various challenges, protect the Arctic and its peoples, and support the ongoing process of reconciliation between Aboriginal and non-Aboriginal people. To achieve these goals, specific calls have been made to tackle regional poverty and health risks, to develop sectors such as fisheries and tourism, for economic growth, and to improve northern education. These goals need around $520 billion for financing.

One of the keen issues is the dispute with the USA regarding the status of the Northwest Passage (NWP), which Ottawa considers internal waters of Canada. The United States have an alternative view of the NWP as international waters, and there is also a dispute between the two countries over the wedge-shaped region of the Beaufort Sea near the border between Alaska and Yukon. Canada also has a land dispute with Denmark/Greenland over the sovereignty of Hans Island, which lies between Greenland and Baffin Island in Nunavut, and the border between Canada and Greenland in the Lincoln Sea.

An attempt to modernize the Internet infrastructure in the northern areas of Canada happened be a problem. Telecommunications in northern Canada were widely considered fragile and prone to accidental outages, with Yukon particularly suffering from Internet disruptions in recent times. However, Huawei as potential external partner to improve the Internet experience in the Canadian Arctic was considered controversial at best. In July 2020, under strong US pressure, the Canadian division of Huawei was denied a license to deploy high speed 5G mobile networks in the Arctic part of Canada.

One important geo-economic task for Canada is to get approval of submitted to UN Commission claim on its right to the shelf of the Lomonosov Ridge.

Denmark

The Danish government, the Faroe Islands, and Greenland are currently working on a new Arctic strategy for the period 2021–2030, which is expected to be presented shortly.

Denmark can celebrate centuries-old ties with the Arctic. Climate change and advanced technologies have increased the availability of its enormous economic potential. Nevertheless, Denmark has territorial claims in areas outside the Danish kingdom, such as its exclusive economic zone in areas north of Greenland, covering parts of the North Pole that Russia also claims. Despite the fact that Denmark is among the largest Arctic territories, the population of the Arctic is the particularly small. In 2018, the Danish population of the Arctic numbered around 109,000.

For Denmark, the issue of Greenland's independence is extremely sensitive from geo-economic point of view, as the only thing permitting Denmark to lay claim to the Arctic resources is Greenland's current status quo. The Trump administration's attempt to acquire Greenland reflects the tense geo-economic situation around the island. At one time, ex-President of the United States Harry Truman was going to buy Greenland for $100 million; more recently, ex-President Donald Trump, as it turned out, was ready to pay $600 million a year for the island, even though its real resources are worth about $1 trillion. However, the Danish authorities rejected this proposal.

Denmark, being one of the ten largest shipping countries, presents new options for navigation through the north-west and north-east sea lanes open in a case of Arctic Sea ice reduction. Greenland is seen by the Danish Government as a potential bottleneck, because of Denmark's concerns about Chinese investment, as well as earlier attempts by Chinese investors to build a tracking station and research base in Greenland (both projects are currently on hold), investing plans in airport renovation (the Chinese company's application was canceled after the Danish government agreed to provide financial support for the project by the end of 2018), and mining investment projects in prospect (none of which are currently operational).

Norway

The Arctic population of Norway is about 471,000. The Arctic plays a very important role for Norwegian wellbeing, because the high profitability of the state-owned oil and gas industry located in Arctic allowed Norway to accumulate unused assets in the sovereign fund (Government Pension Fund - Global, GPFG), established in 1990, also known as the Oil Fund, whose volume of the fund in October 2017 exceeded $1 trillion, being one of the biggest sovereign funds in the world.

The United States is developing especially close ties with Norway, which not only creates infrastructure facilities, but also builds up its military presence in the Arctic, trying in every possible way to involve NATO as a counterweight to Russia. The position of Norway in relation to the Russian Federation cannot be called friendly. Relations between the two countries became significantly complicated in the post-Crimean period.

A new Norwegian White Paper on the Arctic – the first of its kind in the last 9 years – was published at the end of 2020, which is important in view of the political divide between the central government and the Norwegian North, such as the controversial merger TROMS Governor of Finnmark, created from the two northernmost districts of the country, as well as some opposition with plans to allow US nuclear submarines to dock in the northern Norwegian port of Tønsnes, near Tromsø, which has been criticized by the Tromsø municipal government (Kravchuk, 2020).

As expected, the White Paper, being concentrated on human development policies, including innovation and business, is strongly focused on the Norwegian Arctic. The Norwegian North is facing shrinking population, questions around the protection, promotion, and development of Saami self-government and culture safekeeping, and the growing popularity in the northern regions of the Center Party (Senterpartiet), which has agrarian roots but has also developed a platform to promote greater decentralization of government, reflecting the real-life division between north and south in much of current Norwegian politics.

Finland and Sweden

The geo-economic positions of Sweden and Finland are determined by geo-economic ties and realities of these states. Finland is an Arctic nation itself, about a third of its territory is within the Arctic Circle, and the Finnish population in the Arctic is about 184,000.

The first version of the Finnish strategy for the Arctic was issued in 2010, with corrections being made in 2013. Being from the beginning an active member of the Arctic Council, Finland held the chairmanship of the Arctic Council in 2017–2018, with an increased focus on Arctic politics calling to strengthen the Arctic Council through more efficient burden sharing and joint budgeting, the creation of a permanent secretariat, the expansion of the Council's normative role, and increased interaction with nonprofit organizations, finally making the Arctic Council a stronger treaty-making organization. Finland has also been a member of the Barents Euro-Arctic Council since its inception in 1993. In 2020 Finland adopted a new strategy for the Arctic, with environmental and climate issues as the most important subjects. If earlier, in 2013, the Finnish strategy mentioned the fact that there are huge fossil reserves in the Arctic with possibility to use them, and the new strategy of Finland stipulates that usage of new fossil resources in the Arctic contradicts the goals of the Paris Climate Agreement.

Along with Sweden and Denmark, Finland is a member of the EU, which gives it an increased role in EU Arctic policy and, similarly, gives the EU a significant role in Finland's Arctic strategy. Finland supports accession to the EU as a permanent observer in the Arctic Council, paying particular attention to environmental problems.

The Arctic population of Sweden is about 250,000 people. Sweden's Arctic policy comes from the Swedish national interests in prior issues promotion ("människorna, Freden oche klimatet" ("the people, the world and the climate")) in the Arctic, involvement in cooperation with other regional entities and the European Union and under the auspices of international law.

Finland and Sweden, which both declare a relatively neutral status, have not yet rejected the possibility of participating in the so-called Mini-NATO.

Iceland

As a member of NATO, Iceland is playing an important role in security subjects. Having a population of 321,000, Iceland obtains limited political, economic, and military opportunities to influence the geo-economic balance of great powers and yet is claiming its rights to the significant part of the Arctic shelf. In the last years after the devastating financial crisis of 2008–2009, the economy of Iceland needed stronger cooperation and investment of the bigger states, which Iceland found from China. China has a very large Embassy in Iceland, based the expectations that Iceland will become an important transit hub. The China Polar Institute, in collaboration with Icelandic institutions, has opened the Sino-Icelandic Arctic Science Observatory in northern Iceland.

China in the Arctic

The three pillars of China's Arctic policy are respect, cooperation, and sustainability (Guangmiao, 2016).

Cooperation for win-win results is a key element of China's Arctic policy. The BRI has significant potential for its implementation.

In January 2018, China adopted the new Arctic policy. It paints a picture of how China views the economic opportunities the region offers. China's growing activity in the Arctic is primarily driven by scientific and climatic considerations, commercial interest in the oil and gas, shipping and mineral sectors, and diplomatic and legal concerns. China shows respect to the sovereignty and sovereign rights of Arctic states, while insisting that non-Arctic states should also exercise the right of scientific research and navigation. To develop a partnership of cooperation, Arctic and non-Arctic states should recognize and respect each other's rights under the international law. China endorses UNCLOS to be the main legal instrument of the Arctic Governance and considers the Arctic Council as the most influential international forum promoting the development of Arctic Governance and cooperation.

The Chinese White Paper on the Arctic separates *specifically territorial* rights, which the document states do not belong to non-Arctic states, from common rights to carry out *scientific and economic activities* in the area, which Beijing believes non-Arctic states do have in accordance with international law, such as the UN Convention on the Law of the Sea (UNCLOS), due to climate change (Zagorskii, 2019).

China's research interests go far in the region, including its icebreaking program and research stations in Norway (New-Ålesund on Svalbard) and Iceland (Carhall), with further long-term goals for the Arctic Ocean.

China currently has two icebreakers. The first of them – the research vessel Snow Dragon 1 – was built in the Ukraine and suffers from a lack of sufficiently comfortable premises, as well as relatively poor maritime qualities with extremely strong rocking and limited icebreaking capabilities. A new icebreaker – Snow Dragon 2, the first diesel-powered icebreaker engineered in China – was built at the famous Jiangnan shipyard in Shanghai in 2019. This ship is seen as a major upgrade to the Ukraine-built Snow Dragon 1. China is planning to build one more nuclear-powered icebreaker, called Beijing. It will be 152 m long and 30 m wide, with a displacement of 30,000 tons. The vessel, which will cost China about RMB1 billion, will be equipped with two 25 MW high-pressure reactors. Thus, it will be quite comparable to Russian giant nuclear icebreakers of the Arctic class (Hsiung, 2016).

Taking into account that environmental issues are of key importance for the Arctic states, the Chinese government states its responsibility for monitoring its foreign investment, with a particular emphasis on the protection of biodiversity and the environment protection. As the country committed to support of the UN SDG, China highlights "sustainability" as one of its key strategic objectives in the Arctic (Kuang & Ou, 2019).

The BRI could provide the tools to achieve Arctic policy goals in China. Meanwhile, the Arctic states need to consider the best way to involve China so that they can benefit from this huge investment while avoiding potential environmental problems.

Climate change opens the way for access to new resources and new transportation routes, and China is positioning itself and getting a "foot in the door" to access and extract resources and take advantage of the strategic, economic, military, and scientific opportunities in the Arctic region. Only savings from NSR-wide shipping developing can amount $60–100 billion annually. Chinese interests in the Arctic are determined by investment, trade development, and new geopolitical opportunities for economic expansion.

Arctic policy correlates with the main postulates of China's "peaceful rise" strategy. China's Arctic targets can complement BRI. Geographically, the Indian Ocean and the Arctic Ocean are the southern and northern flanks of the Eurasian landmass. Investment in shipping and infrastructure along the NSR and the Maritime Silk Road could strengthen China's Silk Road economic belt strategy.

In addition, China remains a huge coastal state. Consequently, China can add three ocean frontiers to Mackinder's Eurasian "heart" and overcome some of the problems associated with past control of the center. This could provide China with a favorable geopolitical position and the ability to operate in Asia, Europe, and Africa in the twenty-first century. However, it remains to be seen whether China could implement the BRI strategy successfully and bring its investments in the Arctic in favor of it.

Russia provides the main link between the belt and road and the Arctic. This is maintained particularly through Yamal LNG, a major natural gas liquefaction project. Located in the Arctic Circle of the Yamal Peninsula in Russia, the Yamal project is an integrated project encompassing oil and gas exploration and development, natural gas processing, liquefaction, marketing, and shipping. Yamal LNG shareholders are: The Silk Road Fund (established by China on 29 December 2014) (9.9%), China National Petroleum Company (20%), Russia-backed NOVATEK (the second largest natural gas producer in the world) (50.1%), and the French oil giant Total (20%). Yamal LNG is worth $19 billion. The project can provide three million tons of liquefied natural gas to China every year. Promoting industrial development, Chinese enterprises have participated in project construction in an all-round way, from financing to design to construction. The construction of the Yamal project has directly promoted the technological innovation and restructuring of Chinese industrial sectors including steel, equipment, materials, construction, and shipbuilding. During the construction of the project, Chinese enterprises undertook 85% of the workload for the construction of all modules and exported products more than $10 billion. Yamal LNG project is a good example of mutually beneficial geo-economic project.

The USA and China in the Arctic play different roles and increasingly seek to demonstrate their influence; they both have common interests such as freedom of the seas, resource extraction, and infrastructure development in the region. So far, there are no practical signs indicating that the Arctic will become the object of potential rivalry or confrontation in the broader USA–China relationship. Other areas are more important to their respective international priorities and their interactions.

China's policy in the Arctic and in relation to some Arctic governments has a number of problems. While China's cooperation with Russia in the Arctic is likely to fully resume after the global health crisis dies down, Beijing found that building the Polar Silk Road in other parts of the High North was much more difficult. Sino-Canadian relations remain devastating, and a planned Chinese investment deal in the

Nunavut gold mine could be collateral damage. China's relations with Sweden have also deteriorated due to human rights and investment concerns, and the previously strong relationship between Helsinki and Beijing may also be on the brink of problems in light of the decision taken by the Finnish government to terminate the mining deal with Hong Kong in view of the city's new national security laws.

Oil and Gas as Geo-economic Treasures of the Arctic

In 2008, according to data of the US Geological Survey, Arctic resources are estimated to account for 1% of the world's undiscovered oil, 30% of its undiscovered natural gas, and 20% of its undiscovered natural gas fluids. These percentages, respectively, equal approximately 90 billion barrels of oil, 1.670 trillion cubic feet of natural gas, and 44 billion barrels of natural gas.

A big part of these resources is at the disposal of the Russian Arctic. The total recoverable resources of the Russian Arctic are estimated at 106 billion tons of oil equivalent, while gas reserves are estimated at 69.5 trillion cubic meters. Almost 60 large hydrocarbon deposits are located beyond the Arctic Circle, of which 43 are in the Russian sector.

In 2020, the production of oil and gas condensate in Russia was less than in 2019, due to the decrease in demand for hydrocarbons around the world in the context of the COVID-19, pandemic amounting to 512.8 million tons. Production of natural and associated petroleum gas (APG) amounted to 692.9 billion cubic meters.

The energy strategy until 2035, approved by the Russian government, provides for an increase in oil and gas condensate production in Russia under the upper scenario to 560 million tons in 2024 and to 555 million tons by 2035. Under the lower scenario, production will grow to 556 million tons in 2024 and decrease to 490 million tons in 2035 as a result of the energy transition in the global energy sector. Gas production may grow to 820 billion cubic meters in 2024 and 1000.7 billion cubic meters in 2035 under the upper scenario, or 795.1 and 859.7 billion cubic meters, respectively, under the lower scenario. Russia's oil reserves will be enough for 58 years, of which only 19 years will be profitable. According to the estimates of the Ministry of Energy of the Russian Federation, oil production on the Arctic shelf will increase by 2035 up to the level of 31–35 million tons. LNG exports should reach level of 100–120 million tons by 2030 (Kozmenko et al., 2018).

The strategic convergence between Russia and China is driven by the perceived need to equal the United States. The quest for balance is fueled by Russia's need for infrastructure modernization and foreign investment inflows, as well as China's need for natural resources. Imposed by the USA and EU, sanctions affected Russia's hydrocarbon export-oriented economy and China's energy security. China is the largest global oil consumer and Russia is a major oil producer and thus does not compete directly. On the contrary, Sino-Russian energy cooperation is the strongest in the Arctic. China's National Petroleum Company (CNPC) is seeking for experience in international project management and strives to develop high technology skills as well as Russian companies need investments and industrial equipment.

In the flight back of the biggest Western energy companies, such as ExxonMobil, ENI, or ConocoPhillips, who were strongly told by western governments to stay far away from cooperation with Russia since 2014, there is a limited number of funding locations and technology needed for Arctic resource ventures.

On the other hand, the Russia-Chinese Arctic collaboration got a new impetus when Washington blacklisted COSCO Shipping in September 2019 (COSCO Shipping's tanker fleet is an important component of Yamal LNG exports). Chinese firms participate in exploration areas in the Pechora and Barents Seas in the Arctic as well Kara Sea. Russia has started to receive drilling rigs from the South China Sea into the Arctic Ocean to replace western rigs.

Geo-economic Positions of the Leading Asian States in the Arctic

Asia, the epicenter of most of the twenty-first-century's maritime activities, has a rich maritime history and is the center of the shipping industry. Asian economies generate seven of the ten largest maritime exporters and six of the ten largest importers. In particular, Chinese seaports are among the ten busiest ports in the world. The region has complex, multitiered claims to geopolitical maritime interests that require careful management.

Leading Asian countries' need for energy resources is increasing, and following China, such countries as India, the Republic of Korea, Japan, and Singapore are keeping a close eye on the situation in the Arctic region and its wealth.

India

Indian researchers often compare the significance of the Arctic with Himalaya, which supplies drinking water to the entire region.

At the same time, India has come up with the idea of initiating the process of demilitarization and denuclearization of the Arctic region, considering that refocusing of the United States on the Arctic region leads to a redistribution of economic opportunities in favor of China and reduces its dependence on coastal transport routes (Sharma, 2020).

Interested in strengthening of cooperation with Russia, including the energy sector, India calls Russia "India's ticket to the energy riches of the Arctic" and, in a similarly friendly manner, has at least declares, if not promised, deep interest in the exploration of energy resources in partnership with the leading Russian companies.

Rosneft CEO Igor Sechin held talks in New Delhi in February 2020 with Indian Oil and Gas Minister Dharmendru Pradhana. After the completion of the negotiations, Pradhan said that a fundamental decision had been made on the participation of Indian companies in the Vostok Oil project. To implement the project, huge funds are required – according to various estimates, from $70 to $100 billion, since deposits will have to be developed in remote regions of the Far North, where there is no infrastructure at all. To make the project more attractive to foreign investors, the Russian government has provided Vostok Oil with substantial tax breaks. The management of Rosneft viewed Indian companies as strategic partners to whom they planned to transfer up to 49% of Vostok Oil shares. A consortium of Indian companies is a partner of Rosneft in a project to develop fields in the Vankor cluster. However, Indian companies refrained from participating in Vostok Oil, citing economic difficulties during the coronavirus pandemic. The Russian company had to start implementing the project, having enlisted the support of only the international commodity trader Trafigura, who became the owner of 10% of Vostok Oil shares.

The lack of participation from Indian companies in the development of oil and gas resources in the Arctic under the Vostok Oil project is due to the active confrontation and pressure from the United States on all geo-economic actors in order to worsen the competitive position of Russian oil and gas companies. The United States is opposed to cooperation between Russia and India in the Arctic. After Sechin, US President Donald Trump arrived in India on an official visit. During a meeting with Indian Prime Minister Narendra Modi, the American president warned that large-scale investments in Russian Arctic projects could seriously damage the development of relations between Washington and New Delhi. A number of experts are confident that pressure from the United States was the main reason for the refusal of Indian companies to become partners of Rosneft in the Vostok Oil project. However, the inability of the United States to meet the growing demand for energy resources, competition from China, and the threat of economic stagnation due to lack of resources forced India to change its attitude towards projects in the Russian Arctic.

On its part, Russia is also interested in developing cooperation with India in the development of natural resources in the context of Western sanctions.

The Republic of Korea

Seeking to strengthen its role in the Arctic, Korea is guided, first of all, by the demand for energy resources and the diversification of sources of hydrocarbons and minerals. It is planned to implement a long-term strategy in the Arctic of a comprehensive scientific and practical nature, providing for the involvement of a wide range of management, research, and business structures in projects. Icelandic President O. Grimson called the Arctic policy of the Republic of Korea a model for countries with observer status in the Arctic Council. Korea has the world's largest shipbuilding complex, which is actively involved in the implementation of Russian projects with LNG ships (Seo et al., 2021).

It is likely that it will use the large-scale capabilities of the NSR to transport its cargo or participate in individual projects for the development of mineral and energy resources of the polar zone, environmental monitoring, and measures to protect the climate and Arctic nature.

Japan

Having no access to the Arctic of its own, Japan is showing great interest in this region. Japan, which currently receives 80% of oil from the Middle East via the unsafe southern route, is also interested in energy security issues. Therefore, the country's economic interests lie of the Arctic basin – hydrocarbons and biological resources of the sea (Zhuravel, 2016). Traditionally, Japan, which at one time initiated the Kyoto Protocol, the first global agreement on environmental protection, attaches great importance to global warming, climate change and the challenges associated with these processes. Experts in Japan generally believe that the Arctic is not yet ready for safe and reliable navigation. They have claims to the transit tariffs established by the Russian side, the state of meteorological services and ports, and other infrastructure facilities on the NSR, as well as to the compliance of norms and rules with international standards.

Singapore

The Arctic interests of this state, which has the second largest seaport in the world, are connected with factors vital for the economy, such as trade, investments, and maritime transportation, and are not of a political nature.

Conclusions

This chapter addresses the question: what is the current geo-economic specification of the Arctic zone and is there a chance of maintaining cooperation in the Arctic between the main geo-economic actors? There is not a simple or a linear answer. If warming continues at such a pace, then after 2035 importance of the Arctic and competition severity of its main geo-economic actors for world trade (waterway) priority and natural resource extraction will increase dramatically.

From the point of view of geo-economics, the Arctic is a unique region for two reasons: Firstly, although the key feature of modern geo-economics is the control over technologies and ways of development rather than the space and resources, the Arctic gives a pattern of their organic combination because of the need to control both spaces and technologies due to active global warming. Secondly, unlike many regions where confrontation is the main form of relations, the Arctic has been a zone of cooperation and interaction for the last 30 years.

Another vantage point is recognition of the fact that two powerful geo-economic blocs are being formed in the Arctic for now: the United States and its western allies on the one hand and Russia and China on the other. All the rest are intermediate.

A comparative analysis of the actual performance and the dynamics of development of situation in the Arctic make it possible to conclude that permanent growth of geo-economic influence of China is taking place in the Arctic zone.

A final point worth highlighting is the geo-economic role played by Russia to promote sustainable and innovative development trajectory in the Arctic. Russian steps for the complex development of the Arctic zone of the Russian Federation are of fundamental importance and stem from endeavor to meet crucial issues in geo-economic Arctic agenda: oil and gas exploration that is of vital significance with the softening effects of climate change, protection of biodiversity, and regulation of shipping and Polar navigation. Among geo-economic actors of the second level, the growing influence of Russian energy and mineral multinationals should be mentioned, which actively exploit Arctic resources while their western counterparts remain passive and follow in the footsteps of their national government policies.

The study did not address a number of certain important features of modern geo-economics, such as the correlation between the digital revolution and development of the Arctic as well as possible scenarios for future Arctic balance of powers within 10–15 years. The aforementioned and other key issues of modern Arctic studies will receive reasoned and reliable answers in the further research within the framework of geo-economic analysis. Together, all the provisions outlined in the chapter contribute to the new research outcomes in modern Arctic development knowledge, as shaped by both natural-climatic and economic-technological features of geo-economic transformations and impacts.

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Arctic Economy

Internal Structure, Types, and National Models

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Contents

Abstract

The authors introduce the concept of the Arctic economy as an absolutely special phenomenon that differs from both the neighboring northern and the usual regional economy and characterizes its basic features, which consist primarily in a relatively simple internal structure, a significant essential load (economic, social, and value-cultural) of each sector – traditional, corporate (market), and transfer (state) and their multifunctional (complex) nature, the presence of diverse integration links between sectors. Within the Arctic economy, there is an "island" type, absolutely isolated by transport, and a "quasi-mainland" type, which is characterized by stable year-round relations with economic entities in the non-Arctic part of the country. At the level of the global Arctic, the authors

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identify and characterize four national models of the Arctic economy, each of which has significant features: Federal-Russian, Canadian, and American; unitary European in the island and mainland versions.

Keywords

Arctic economy · Three-sector model · Traditional · Corporate (market) · Transfer (state) sectors · Island and quasi-mainland type · National models of the Arctic economy

Introduction

Dozens of northern and regional studies have been devoted to the economic features of the existence and development of circumpolar territories in the past (Slavin, 1961; Agranat, 1984; Armstrong et al., 1978; Macdonald, 1966). It was discovered and postulated that despite the peculiarities of the state structure of various polar countries, the dominant form of ownership (model) of the national economy, the northern and Arctic territories of the world have a significant commonality of natural extremity, reliance on land, and resources as the foundation of their sustainable development "on top of this." Today, if we take the aspect of interest in institutions, innovations, and creative factors of economic development, we are more interested not in the statement of specific features of the Arctic economy itself, but in how they form an environment of uncertainty and risk, and therefore challenges to the development of new ways to regulate, mitigate, and compensate for them. (Douglass North, the winner of the Nobel Prize in Economics in 2010, called for understanding the process of economic change as an attempt to build a new, better man-made system of coping with natural and social risks.)

The development of the economy in the Arctic, extremely closely, like few other places, is constantly associated with natural rhythms and resource cycles. The convergence of natural and social systems manifests itself only during periods of force majeure, catastrophic natural phenomena – floods, earthquakes, hurricanes, and tornadoes – in the temperate climatic zone transformed by urbanized spots of metropolitan areas. On the other hand, this coupling is constantly manifested in the extreme climatic conditions of the Arctic zone. Here, the natural "challenge" and "response" of human communities constantly coexist. In other words, the Arctic economy should be considered in the context of socio-ecological systems.

If in the temperate zone the close connection of the economy with landscape, natural, and climatic conditions is preserved only for some relatively isolated and constantly declining in their economic role, activities, for example, agriculture, forestry, which in their industrial, mass forms are already breaking away from nature, then in the Arctic zone almost all types of human activity, and above all the most basic, retain a close connection with the landscape, with natural conditions. In the Arctic zone, the interweaving of natural and social processes, their rhythms, is exceptionally multidimensional, the coupling is deep, and it is carried out at a certain primary level.

As in other areas of the Earth, the natural environment provides economic centers with several resources (from clean air and water to minerals and esthetic resources) or, in a broader approach, with ecosystem services; in turn, it is influenced by the urban economy (emissions, pollution, etc.). However, there are many specific impacts in the Arctic, for example, thermal and mechanical effects on permafrost rocks, which can lead, in turn, to the thawing of permafrost, and further to the deformation of buildings and structures.

The buildings and structures built on it can simply collapse due to the melting of the permafrost – as happened in Norilsk, where the building of the dining room instantly collapsed in 1976 (Stryuchkov, 2019); people died. To prevent damage, constant ***monitoring is necessary. We have to assess not only the condition of the foundations but also the temperature of the soil around buildings and structures*** (monitoring the permafrost itself prevents deformation of the foundations; there are different ways to cool the soil). However, today this system does not work properly. Monitoring, as well as measures to improve the stability of buildings, requires considerable budget expenditures – and until appropriate standards are introduced, systematic, comprehensive control of dangerous permafrost thawing cannot be performed. Meanwhile, completely disappointing assessments of the seriousness of the problem have appeared in the scientific literature. For example, one of the works (the authors are recognized experts in their field) explicitly states that the projected (according to the main scenario) climate changes by 2050 should affect 20% of structures and 19% of infrastructure facilities in Russia, currently located in the permafrost distribution zone (as it is more correct to call permafrost); the elimination of the consequences of these changes will require \$16.7 billion and \$67.7 billion, respectively. As for residential real estate, 54% of the housing fund currently located in the permafrost zone should also significantly suffer from permafrost degradation by the middle of the twenty-first century (Streletskiy et al., 2019). Similar calculations for road infrastructure show that "under the inertial (conservative) scenario of road infrastructure development in 2020–2050, the capital costs for maintaining its stability and reducing the risks of destruction under the influence of thawing and degradation of permafrost will amount to an average of at least ₽14 billion per year, under moderate and modernization scenarios – will exceed ₽21 and ₽28 billion, respectively" (Porfir'yev et al., 2019).

A very powerful influence of nature on man, characteristic of the Arctic, lies in the phenomenon of seasonality, manifested here to the maximum extent. Many industries that have been operating steadily in southern regions throughout the year – and even in those with a moderate climate in winter – are switching to a pulse operation mode in the Arctic.

Perhaps the most bizarre connection of natural rhythms is with the one of public procurement carried out by budgetary institutions, especially in the areas with a limited goods delivery period. For example, these are settlements located in a zone of complete off-road, and it is cheaper to take cargo to them by water transport – and in some cases, there is high water for just 2–3 weeks. The navigation period on large rivers is about 3–4 months, for example, from June to September. It is difficult, or even impossible to carry out all the necessary tender procedures during this period.

In this regard, the issue of changing the norms of federal legislation has been repeatedly raised. In addition to the terms of procurement, there are many complaints about the requirement to ensure competition, laid down in Federal Law No. 44 "On the contract System . . .," which regulates procurement by state and municipal institutions. "The specifics of the polar regions sometimes do not leave hopes for the competing offers even in a seemingly demonopolized market. . . Sometimes only one supplier decides to provide certain products to such a remote area" (Zhandarova, 2016) – this opinion has been expressed more than once in the media and the State Duma. Moving through the winter road is such a nontrivial task that, as a rule, we are not talking about competition. It is no accident that scientists talk about the naturalness of monopoly in the most difficult, roadless areas of the Arctic (Pilyasov, 2020).

There are also some other "little things," for example, the need for additional insulation of the lower floors of tall buildings in the North to avoid the effect of "pumping" cold air; the calculation of advertising structures, windows, and roofs for increased wind loads (in the Arctic, even in the city, the wind under 20 meters per second is not a natural disaster, but almost an ordinary phenomenon), etc.

The unprecedented degree of natural and economic integration means that the best social institutions in the fight against Arctic uncertainty are those that "learn" from nature, from the traditional way of life of the Indigenous small-numbered peoples of the North, who have been coexisting here with extreme nature for centuries.

Natural and economic extremes cement the structural elements of the Arctic economy into a single life-supporting complex, which is observed less often in other landscape zones, where the economy is significantly more divided into separate industry "apartments." The relative simplicity of this complex is combined with a very multipurpose and multifunctional (loaded) use of each of its structural elements, each sector, each asset, and each institution. Intensive intraregional and intersectoral mutual transitions, maneuvers, and flows of financial, material, and natural resources have been established here. They are the ones who work as insurance institutions because there is always a very high natural uncertainty and risk. The land and resources of the Arctic (for example, funds of future generations) are usually the support and foundation of the best "insurance" institutions in terms of complexity.

The small size of Arctic communities and Arctic markets create objective prerequisites for the emergence of price and intellectual monopolism as development blocks. And only the flow and mobility of northern populations of people serves as insurance against stagnation and conservation of institutions for decades (which was typical, for example, for Iceland). Here, it plays a relatively greater role in organizing the flow of knowledge from the mainland to the Arctic "islands" than in the cities of the temperate zone. The constant induction of new human resources, technologies, financial resources, and institutions from the outside has always been characteristic of the development of the Arctic territories, but in recent decades, due to the increase in their availability as a result of the active use of not only the traditional sea, but also air transport, the role of these factors has significantly increased and become even more significant in the fight against Arctic uncertainty and risks. The influx of qualified personnel from the metropolitan centers, southern regions, and countries has given a new dynamic and improved the quality of human resources in the polar regions.

The paradox is that the more insular the economy of the Arctic territories is, the more significant external relations are for its development and the settlement of uncertainty. This is demonstrated by the small Arctic countries, which in recent decades have found a new driver for their development in international economic and political cooperation in the Arctic.

The fundamental feature of the Arctic economy is its spatial organization. If in the temperate zone the central-peripheral model dominates in the spread of innovations, which is "corrected" in specific areas of space, taking into account the river, road, and railway network, then in the polar and circumpolar zones the "base-routes" model of the organization of space and the diffusion of innovations dominates. This is the fundamental difference between the ways of extinguishing uncertainty in space – along the lines of routes, the penetration of the mastered into the undeveloped.

The specifics of the territorial organization of the Arctic economy, which determines the specific mechanisms of innovations in this territory, are characterized by three main features.

First, it is the ***specifics of the local territorial division of labor in the areas of new development*** – the formation of a two-part local economic system consisting of a settlement (development base) and distributed, as a rule, over a vast area of primary extraction of natural resources. Although the main volume of industrial products is produced outside the locality (and often with the involvement of shift labor), the locality is an integral part of this system, providing transport, logistics, and services, reproducing personnel, providing medical care, etc. However, the work in the field of information and innovation support for mining activities are of particular importance. Services of this kind provided by enterprises and organizations of the locality (geological work, oilfield services, etc.) are a key factor in extending the operability of the entire system over time since they ensure the renewal of resource reserves "in breadth" (new deposits) or "in depth" (ensuring the development of hard-to-recover reserves).

The second feature is the *specific role of the settlements of the North in the interregional division of labor in the system "The North and the settlement zone."* Here, settlements serve as the main "conductor" of development – logistics centers of a transregional scale, as well as the basis for adapting equipment and technologies developed in key economic centers of the country and the world for specific conditions of the North and the Arctic.

The third feature is the *network organization of the settlement system and economy*, which is characteristic of the Arctic as a special (network) region. In fact, the system of settlement and economy in the Arctic is a network of relatively poorly connected local centers, whereas monocentric regions prevail in the main zone of settlement (especially in Russia). They have dominant centers, with which, in turn, all the settlements of the region are connected by year-round transport highways. Such a structure – and then adjusted for the worst transport connectivity – in the Arctic is represented only in the Murmansk and Arkhangelsk regions; the

Arctic regions of the Republic of Karelia are part of such a system with the center in Petrozavodsk, in North America – in the southern part of Alaska (Anchorage), partly in the north of Norway (Tromso).

The network organization of settlement and economy is characterized by the specialization of individual nodes of the system with the exchange of goods and services not according to the scheme “regional centre – serviced periphery,” but according to a more complex scheme. In particular, in the Russian Arctic, a kind of “division of labour” often develops between administrative centers, transport hubs, and the main service bases of mineral extraction areas (YaNAO, CHAO, the Arctic part of the Krasnoyarsk Territory and the Republic of Sakha (Yakutia)); in some cases, research and innovation centers (Apatity) are also included.

There are too many obstacles to implementing the center-peripheral model in the conditions of transport disorder and lack of development. The system of cities-input bases (rear, outpost, and focal) is the main source of supply of new knowledge, new technological solutions, and business processes for the Arctic economy. It is the Arctic and near-Arctic base cities that are the main information and knowledge intersections of the Arctic economy, a means of combating natural uncertainty.

There is a deep (genetic) relationship between civil and military-economic activities, close intertwining in all the Arctic economies of the world. Mechanisms for ensuring military (national) and civil (collective and individual) security in the extreme conditions of the Arctic also closely coexist. This dense coexistence of civil and military institutions, the injection of new technological and technical solutions from the military sector into the civilian sector, is a specific way for the Arctic economy to cope with high natural and resource risks.

The main result of all the described features of the Arctic economy is its probabilistic nature and very strong (to a much greater extent than in the economy of the temperate zone) pressure of the uncertainty factor. It permeates to such an extent all facets, all sectors, and all types of activities of the economy of the Arctic territories, which inevitably affects both the thinking and the economic behavior of the main large and small economic entities. Therefore, there are a lot of differences between the nature of the modern global market, which is focused on relative predictability, unconditional regularity and accuracy of deliveries in the laws of just in time, and the nature of the Arctic economy, which depends on a huge number of complexes interacting and unstable natural and economic factors.

That is why new knowledge and information play, first of all, the role of effective ways to reduce its natural uncertainty and mitigate risks in the Arctic economy, to such an extent that generating new knowledge is the very guarantee of the long-term sustainable existence of the Arctic economy itself. And this is a huge difference with the territories of the temperate zone. There, new knowledge is a source of competitiveness, stability of development, and here, in the Arctic – the very fact of preserving the economy, continuing its existence in a stationary form in the long term.

Specific “expert” knowledge about the Arctic natural system, due to the temporary residence of the main part of the population, is an extremely limited resource and is confined to Indigenous peoples, veterans, and old-timers of the territory. Its role in the fight against the Arctic natural uncertainty is not obvious at first glance, but it is extremely great. The best solutions and institutions found by the polar countries and local communities in this area have always absorbed the elements and best practices of the aboriginal peoples – the first settlers in this territory. For example, the idea of twelve “sister” national land corporations of the state of Alaska located in a single network of mutual assistance with each other incorporated the principles of dividing the prey of sea hunters among the entire Eskimo community.

The Arctic economy, like few other economies in the world, few other “zonal” economies (for example, temperate, steppe zones), is experiencing constant challenges of natural uncertainty and risks. Its entire internal structural organization can be understood as a desire to reduce and muffle these challenges. This is the goal of the most important institutions of the Arctic economy, institutional experiments within the Arctic economic islands, and cooperative (and not competitive) strategies of its main economic entities. However, the Arctic frontier is always a venture of uncertainty, a territory of new discoveries. Therefore, one cannot completely eliminate the risks of uncertainty.

The Model of a Three-Sector Arctic Economy

We use the ideas of the prominent Alaskan economist Lee Huskey about the three-sector nature of the Arctic economy (Huskey, 1992), which, in turn, is based on the previously expressed idea of a dual economy by Arthur Lewis: In developing countries, there is a modern sector (enclave European industrial islands, platforms) and a traditional sector of aboriginal residents. The modern sector is connected with urban life, modern industry, and the use of advanced technologies. The traditional sector is associated with rural life, agriculture, inherited institutions, and technologies, for example, in the form of communal land ownership. In 1979, Arthur Lewis received the Nobel Prize for these works in the field of economic development (Lewis, 1954).

The model of the three-sector economy of the Arctic includes an enclave economy, in which the market sector of the Europeanized industry is powerfully connected with the external market; the traditional economy of historically existing types of activities focused on self-sufficiency and the internal market; and the transfer (state) economy, closely connected with budget transfers, with subsidies, which lives from state-organized redistributive mechanisms, and not from markets. Each of these economies relies on its specific forms of integration of economic entities. The market economy relies on the market exchange; the traditional one on the principles of reciprocity (reciprocity, donation, and giving); and the transfer economy on the principles of permanent redistribution. All three sectors of the Arctic economy in the Arctic spaces can exist separately, but often coexist with each other, and interact at the level of an individual household, a national village, or a region. The institutions of one sector are affected, are permeable to the institutions of other sectors, and are often subjected to mastication.

All three sectors do not interact with each other calmly: They sometimes have conflicts, generate overloads, and overstrain in local communities during periods of sharp expansion of one of the sectors. First of all, this applies to the contradictory interaction of the market and public sectors. The traditional sector of the Indigenous peoples of the North in the last century in the Arctic has been influenced by both partner sectors and absorbs their institutions and hybridizes them to a greater extent than it itself carries out expansions to neighboring sectors.

The integration of all sectors takes place here on the foundation of land and resources as a basic feature of the Arctic economy: The traditional sector lives from the territories and resources of the places of traditional residence of Indigenous peoples; the corporate sector lives from rents formed due to the unique properties of natural assets of the Arctic land and shelf; and the transfer sector from vertical and horizontal redistribution of resource rents (budget revenues) between levels and links of the budget system.

Each sector represents a dynamic and very unstable natural-economic, spatial-*temporal* unity; it develops its institutions, its social structures, and its values to cope with the common "curse" of the entire Arctic economy – the strongest uncertainty and risks. Each sector has its spatial structure in the form of its settlement system and its rhythm of economic activity – its chronostructure.

The traditional, corporate, and transfer subsystems of the Arctic economy have their dichotomy (dialectic) of stationarity and mobility/nomadism. For example, nomadic reindeer herding, semistationary fur, hunting, fishing, and marine crafts exist within the traditional sector. The case of stationary and shift single-profile settlements is isolated in the corporate sector. If we take the transfer sector, the forms of inpatient and mobile provision of social and budgetary services are separated (for example, along with outpatient forms, confined to cities and towns, there are also mobile medical teams for deployment in the tundra).

The spatial and temporal structure of each sector, the dialectic of nomadism, and stationarity determine the peculiarity of the flows and dissemination of new knowledge and information, and through them, the ways of "extinguishing" risks within the Arctic territories.

Initially, there is only a *traditional* Indigenous sector within the Arctic economy, which has very irregular interactions with state and market structures located outside the Arctic. The basic values of the Arctic economy in the form of land, labor, and capital are not subject to purchase and sale in the traditional sector. The purpose of the traditional sector is to make the products to meet the needs of Indigenous families (including traditional food and clothing), not only purely material needs, but also the preservation of traditional culture, language, values, and skills. In the case of state-stimulated expansion of the traditional sector, its products may acquire commodity value.

The main institution of the traditional economy changes plastically to meet the requirements of the dominant economic structure and in different epochs and in different countries acts as a national (tribal community) – collective farm-state farm) – corporation/district association of communities. The use of biological resources and the properties of the "feeding" landscape, the indissoluble connection with the land of historical residence, always remains common. Communal, collective ownership of the land and resources of the traditional residence of the entire local community is a fundamental institution that has been preserved for centuries, despite all external transformations and various country models of the Arctic economy. The main time rhythm of the traditional economy is the seasonal annual cycle, to which the main types of activities – reindeer herding and fishing – are timed.

The fundamental feature of the traditional sector is its colossal plasticity, the ability to absorb the institutions of the other two sectors and remain even with external reshaping, with the expansion of the public sector under the waves of collectivization or the market sector under the waves of privatization. For example, in the state model, institutions of state farms are based on the traditional economy, while in a market model, institutions of national village and district corporations (the state of Alaska) arise. The stationary form of placement of the traditional sector is the national village, and the mobile form is the nomadic camp of reindeer herders.

In many Arctic communities, subsistence activities and incomes from the public or corporate economies are combined in a form of a "mixed economy." Mixed economies incorporate components of both market and subsistence activities. The emergence of a mixed economy has contributed to strengthening the viability of local economies. A mix of income sources is often required to support flexibility in household incomes and helps to alleviate the economic constraints, such as the small size of the local market economy, limited access to full-time and well-paying jobs, the high costs of doing business, and limited accessibility to markets in the Arctic. The local mix of human, social, physical, and natural capital determines the outcomes of global change impacts.

The built-in internal contradiction of the development of the traditional sector is a conflict, a struggle between traditions and modernization, archaism and innovations. Despite its name, here we should not talk about the preservation of archaic, but about the creative perception of new technologies and communication opportunities in the name of careful preservation and delicate transformation of the centuries-old way of life of Indigenous peoples.

The traditional sector is an important source of implicit knowledge about the properties of landscapes, climate and relief for the entire Arctic economy. This knowledge of Indigenous peoples is always used constructively in the activities of economic structures in the market and public sectors. At the stage of pioneer economic development, the role of this knowledge in reducing uncertainty and risk for migrants is simply unprecedented. Numerous examples have already become paradigmatic: the help of reindeer herders with sledge deer and dogs in the delivery of goods in the first geological expeditions, about the role of Indigenous kayurs in determining routes during surveys and searches in the Arctic.

The traditional sector can exist for centuries as the only one. In this case, its size is relatively constant in the long term, which is determined exclusively by the natural rhythms and productivity of Arctic ecosystems.

In Russia, under the influence of radical economic reform and a sharp reduction in state support for the traditional sector in many areas of the Arctic and the North has significantly shrunk in the last 30 years. In addition to the crisis phenomena, this can be seen as a rational return after decades of expansion in the Soviet era in the name of achieving marketability – to the size justified from the point of view of the natural bearing capacity of landscapes. There was no significant reduction in the size of the traditional sector, and even growth was indicated in the areas of strong corporate structures that assumed the former functions of state support (Yamalo-Nenets and Khanty-Mansi Autonomous Okrugs).

The most important task of the traditional sector of the Arctic islands of the Nenets and Chukotka Autonomous Okrugs is to ensure the security (primarily food) of local aboriginal communities in national villages and nomadic camps – in the conditions of strong external economic uncertainty, always inherent in the modern Arctic. For the sustainable development of the traditional economy (and the justified modernization of the technical means that are used in it), a source of monetary income is necessary, which is often impossible to get from it. That is why the integration of the traditional, often nonmonetary, and monetary corporate and transfer sectors is a necessary factor. On the one hand, the monetary income is used for purchasing the equipment necessary for traditional crafts and reindeer husbandry. On the other hand, traditional life support can play a compensatory role in periods of insufficient monetary income and difficulties with the delivery of food.

The development of the corporate sector of the Nenets Autonomous Okrug for the reasons of the recent establishment of pioneer oil and gas industrial development, compactness of Nenets tundra compared to the Chukchi spaces, and commercial character of large herd Nenets reindeer herding define *most* of their relative ease of integrating the traditional with the corporate sector and transfer at the County level (through the transfer of redistribution from "strong" sectors to "weak") compared to the Chukotka. On the other hand, there are few areas of commercial reindeer herding in the Chukotka Autonomous Okrug, there are mining corporate structures, and therefore it is more appropriate to integrate the traditional and monetary economy not at the district level, but at the level of the national village and an individual household – as a combination of monetary and traditional employment in one family by family members, by time (seasons) of work, and according to the calendar schedule. Or it can be in the form of an opportunity within the Arctic microeconomics of a separate national village to establish the sale (exchange) of products of traditional crafts and reindeer husbandry for equipment and snowmobiles of a reindeer breeder and a tradesman.

Under the influence of a favorable external environment on the resources of the Arctic, a *corporate* (market/resource/departmental) export-oriented sector with narrow specialization in the extraction of one or two resources in demand by the outside world, linking the Arctic economy with the global one, is emerging. Its activities allow the mining territory to receive an influx of new human, financial, and material resources when pioneering economic development of a new resource. The size of the traditional sector is growing, which is gaining marketability and becoming a participant in commodity-money relations with the new economy of immigrants. But this growth also contains the dangers of a subsequent collapse, when the volume of marketable products of the traditional economy exceeds the natural limitations of the productive capacity of the Arctic ecosystems.

The corporate (market) sector of the Arctic economy generates its main income through the extraction of the most profitable (globally attractive) types of local natural resources of the land and water area. It is through the corporate sector that the previously small and parochial Arctic economy becomes connected to the national and global economy. And it is the corporate (resource) sector that defines the nature of the Arctic as a territory of permanent pioneer development, as a frontier territory.

If we take the market model of development, the global resource market begins to determine the economic dynamics of the Arctic economy through the corporate sector: The fact is that all other markets, labor, capital, and land, as a rule, do not have global geographical coverage and are significantly weaker because they face numerous barriers in their development in the form of small size, high transport costs, lack of entrepreneurial spirit of the local population, etc. If we take the state model, there is a conflict between the interests of the sectoral departments that have come to work out the resources and the interests of Indigenous and permanent residents of the Arctic.

The key feature of the corporate sector is that it is designed as a large economic structure of global or national significance (a state superorganization or a private transnational corporation), which, due to its size, is able to overcome the pressure of high Arctic costs (primarily transport costs) and extract a resource of global interest and significance – oil, gas, gold, diamonds, etc. Even when the mining structures operating in the Arctic are not superlarge in size, there is always a superstructure behind them (for example, a Soviet department or a Russian global corporation) that finances them, equips them with personnel and resources. The economic history of the Arctic knows examples of development with the efforts of small structures. However, as a rule, then, in the case of the global attractiveness of open resources, they were quickly replaced by large corporate structures – mining corporations of a national and global scale of activity.

The "integral combine" was replaced by superorganizations based on the labor of prisoners, then departmental heads and trusts, and then branches of global resource corporations. In all cases, the large size of economic entities coming to the Arctic for finding attractive natural assets remained common. And only in cases of severe depletion of subsurface resources, the transformation of the Arctic territory into an old industrial area, and very pointwise, there were prerequisites for the transfer of resource deposits for use to independent-, small-, and medium-sized resource companies, as a rule, one way or another, still affiliated with large corporations. Resource assets depleted after decades of development by large companies were either partially and pointwise transferred to small- and medium-sized businesses (or this could happen during their fragmentation in the process of privatization), or they were completely abandoned for decades until the turn of a new economic development when technological and technical innovations turned these old assets attractive again.

Another characteristic feature of the corporate sector is the close connection of its activities with the transport development of the Arctic. We are talking, in fact, about a single complex process of resource and transport arrangement of the area in the form of industrial nodes if we speak in the old way, or local clusters if in a modern way.

If we take the temperate zone, the sphere of production and the sphere of transport are never connected at the stage of arranging a new economic object to such an extent as in the Arctic since there is already sufficient transport development initially. In the Arctic, however, open deposits can be considered an economic resource only potentially, as there is no transport scheme for the delivery of industrial goods and the export of extracted products. It is only the laying of development routes to the locations of the resource which transfers its reserves to the "active phase." Since private or state-owned companies rarely take the costs of transport equipment entirely upon themselves, there is a need and prerequisites for public-private partnership in the market model of Arctic development or for departmental-state partnership in the state model of Arctic development.

The forms of spatial placement of the corporate sector are either single-resource settlements (stationary type) or shift settlements (mobile type). As a rule, the state-based model of Arctic development is more inclined to create a network of stationary single-profile resource settlements, and the market model more often relies on a network of shift settlements in order to save costs for social development. But in both cases, due to the integrated resource and transport nature of the corporate sector, local, outpost, input bases of development are needed, from which knowledge and information in the form of qualified personnel, labor resources, and financial and material resources are supplied to the territory of resource activity along the sea and land routes of development. These internal outpost bases are connected to external rear bases, many of which are located on the Trans-Siberian Railway or are sea gates to Arctic (Murmansk and Arkhangelsk).

The main internal contradiction in the development of the corporate sector lies between the imperatives of globalism and locality, i.e., the aspiration to global markets and, on the other hand, the need for local rootedness, obligations to the territory of deployment, and local economic entities – the government, small businesses, and public structures. The forms of resolving this contradiction are mobile in time and depend on the specific model of Arctic development. The institutions of corporate social responsibility of big business in the Arctic are aimed at mitigating these conflicts and finding a temporary compromise for their solution.

The rhythm of development of the corporate sector is set by the life cycle of the main natural asset being worked out. It is the resource-dependent nature that makes the activity of the corporate sector "ragged," feverish, and nervous when huge rises in production volumes are followed by collapses of resource crises and catastrophes. On the one hand, the successful development of the corporate sector can give the Arctic economy financial resources for development; on the other hand, its hard landing can plunge the Arctic economy into depression for many years.

It is the long existence of the corporate (resource) sector that determines the differentiation of the Arctic territories into old-industrial ones (for example, the Murmansk Region, the Chukotka Autonomous Okrug, in which large-scale development has been going on since the 1930s and 1950s) and the territories of new economic development (for example, the Nenets Autonomous Okrug, in which large-scale development began since the late 1980s). The beginning of a new large-scale economic development on new promising areas or on new types of natural assets can "rejuvenate" the old industrial territory.

The activities of the corporate sector play a huge role in increasing knowledge about the natural resources of the territory. At the pioneer stage, due to the integral, complex nature of the activities of resource companies, which have to perform various functions of geological exploration, transport, and social development, there is an active increment of new knowledge in all areas of socioeconomic development of the Arctic. Subsequently, the information activity of the corporate sector structures becomes more pragmatically focused exclusively on mining production, and the tasks of increasing comprehensive knowledge about natural conditions and socioeconomic factors of the territory's development are transferred to the state.

The corporate sector has largely survived in most of the Arctic territories in the last 30 years of the radical transition of the national economy from a directive-planned to a socio-market model. This is the essential difference between the Arctic and the North: Large economic structures are more characteristic of the Arctic than of the North, and therefore, all other things being equal, they have been preserved in the Arctic, while in the North they have often been fragmented or eliminated.

Simultaneously with the corporate (large-structural), or even ahead of it – if the territory is geopolitically significant, important in military-strategic terms, there is a *public sector*, which is always represented in the form of a "civil-military" dichotomy in the Arctic. If we take all the Arctic territories of the world, defense activities closely coexist with the civil ones due to the coastal fringe of the Arctic zone, for example, in the Russian Arctic, in the Murmansk Region, urban settlements are located next to ordinary cities; in Chukotka, military units and border guards are located near national villages and district centers.

The main goal of the transfer sector of the Arctic economy is a protective role, the one of ensuring residents in the conditions of the strongest Arctic uncertainty and constant natural risks. No sector performs security functions here to such a powerful and comprehensive extent as the transfer sector.

We are talking about ensuring national security through the presence of defense structures; the security of Arctic communities through the import of critical food, coal, oil, and petroleum products to the Arctic "islands" with limited delivery time; and the security of individual households through the development of a single social complex of educational, medical, cultural services, support for the provision of daily catering services, household services, and other personal services. The transfer sector is represented by a very wide range of structures and institutions of state and municipal property, small and medium-sized Arctic businesses that feed on budget resources in services, and "import-substituting" and export-oriented activities that are closely related to budget support. The range of activities tied to budget support and redistributive procedures in the Arctic economy is exceptionally large and far from being connected not only with budget institutions themselves, but also with numerous nonprofit organizations, civil society structures of an ethnic, gender, fraternal, confessional, and other nature, and small and medium-sized businesses, which are not profitable but socially oriented.

Many types of activities of budgetary (social) institutions in the Arctic are also protective in terms of ensuring the sustainability of the existence of cities, urban and rural settlements. What in other areas is a matter of choice for the authorities, to whom, to which commercial structures to give the rights to supply villages and settlements with food, in the conditions of the Arctic sparse settlement network, is a matter of the authorities' uncontested obligation to ensure the food and energy security of local communities – either by authorized commercial structures and in case they refuse or are absent – by their own.

Therefore, the development of the transfer sector in the Arctic objectively has limitations of the natural resource potential (there are no profitable resource riches everywhere in the Arctic zone; they are located locally and extremely unevenly – where it is dense and where it is empty – which means the need to establish extensive redistributive procedures); objective weakness of market mechanisms and market institutions here due to high-cost barriers, the periphery, and small size of local markets; and the inability of the traditional economy to ensure the security of residence and guarantee the economic development of local (including even national) communities.

It is not surprising that the Arctic is a world champion in redistributive procedures, cross-subsidization, and vertical and horizontal budget flows for transfer support to national households, municipalities, and regions. But these multidimensional and multigenre transfer procedures do not only perform the function of social protection in the narrow sense of supporting the population of the Arctic in conditions of frequent security threats. They also work to diversify the Arctic economy (no other sector of the Arctic economy is so focused and is not concerned about the imperatives of diversification and greater relative stability through it) by partially replacing the import of goods and services with the local production by local, small-, and medium-sized businesses and budget institutions – always in very modest and limited volumes, as far as the high-cost stranglehold, periodically pushed by innovative breakthroughs in the field of heat and energy supply and transport arrangement of the Arctic regions, new production, and consumption technologies, allows. For example, even in Greenland, under the influence of global warming and large-scale state support, conditions are emerging for the development of local potato growing, dairy farming, in other polar regions, and egg poultry farming, relying entirely on expensive imported feed, haylage, silage, etc.

In recent decades, transfer state support to small businesses in many polar countries has also allowed diversifying the local economy through new nonresource exports, for example, the export of tourism services for travelers "from outside."

The resources for the transfer sector to perform protective functions within the Arctic economy are the rental income of the corporate sector – in the case of globally attractive natural assets and a rental development model, or cash flows of the higher budget system in the form of budget transfers, for example, from the federal level to the regional, from the regional level to the municipal one.

The key structures of the transfer sector are the bodies of federal, regional, and municipal authorities, whose structures and institutions in the Arctic economy are extremely numerous if compared with its analogues in terms of the size and volume of the gross regional product in the temperate zone. For example, federal (central) infrastructure, monitoring, and research facilities of defense and civilian significance are located in the Canadian, American, and the Russian Arctic. The federal (central) budget sector is involved in investigating the Arctic and its resources. The regional budget sector fulfills the mission of humanizing the Arctic development through implementing numerous social protection programs, creating jobs and generating an income stream in the most remote Arctic villages. If we take the unitary polar countries, the public sector simultaneously performs both functions – resource, research, and social protection.

The internal "eternal" contradiction in the development of the transfer sector is the dichotomy "temporarily or permanently, to develop or settle, here or in the south." This choice permeates all decisions made within the framework of transfer procedures and related public policy. There is no final decision, and it always depends on the specific conditions for the development of this Arctic territory, its infrastructure equipment, the degree of profitability of the main natural asset, the country's budget capabilities, etc.

The main rhythm of development of the transfer sector is set by the investment cycle, which partly depends on the volume of rental income, but more on budget investment resources since the main program for the construction of social facilities is formed at the expense of budget funds, not the resources of corporations.

The most important mission of the transfer sector in the Arctic economy is to cut off the fevers of instability, and establish powerful redistributive procedures in time (for example, through insurance funds, funds of future generations) and in space as a result of cross-subsidization and transfer support. In this sense, the activity of the transfer sector has an anesthetic character. But in addition, it actively generates new knowledge about the territory to an increasing extent at the expense of local scientific and educational structures (universities and colleges, centers, and institutes) located in cities-outpost bases of development. The role of the public sector in dampening the uncertainty and risk that are always inherent in the Arctic economy is simply unprecedented and is not comparable to any other sector. Numerous research expeditions, stationary research centers, and local federal universities that have been created throughout the Arctic over the past two decades mark a new trend of shifting the emphasis in the accumulation of knowledge about the territory to local public sector structures located here.

In Soviet times, the transfer sector of the Arctic economy was everywhere excessive in size due to generous state subsidies, guarantees, and compensations. This fact confirms the widely recognized phenomenon of overpopulation of the Soviet Arctic and the North. Then the assets were privatized, there has been a rapid "deflation" of it in the last 30 years, with a huge outflow of population, many service and single-industry settlements were eliminated, and large and medium-sized Arctic cities were compressed.

Although the Arctic economy is still in many ways defined by the three "pillars," there is a growing role of the Arctic's "other" economies largely instigated by the shift to postindustrial economy. When compared to the resource sector, especially mining, some of the emerging industries that include many knowledge-driven sectors have been growing faster and demonstrated higher productivity. These industries are prevalent in the Arctic urban centers. “Other” economies include a broad range of economic activities, outside of the tree dominant sectors, although they may be connected to them. They tend to have stronger internal linkages and multipliers and generate more local development. These economies are not solely local and often are closely linked to the global economy. Examples of “other economies” include knowledge-based industries, professional services, information technology, arts and crafts, custom manufacturing, and tourism/recreation. Local investment in human capital is an element in stimulating “other” economic activities and diversifying local economies. These postindustrial sectors are considered to be more advantageous for building a more sustainable economy in the Arctic.

For example, *knowledge economy* is based on advanced skills in technology, culture, leadership, or entrepreneurship. Some Arctic urban communities serve as clusters of competence in engineering and applied sciences. *Innovation* activity is another indicator of strengthening new economies. While large concentrations of innovation activity remain in the Arctic gateway cities, many smaller areas show innovation activity, although many of them were highly specialized. Finally, c*ultural economy* is an important emerging sector in the Arctic. Elements of traditional knowledge, such as arts and crafts, are important components of Indigenous culture and can become commodities to turn economic profit. Although such commodification must be driven by the local and Indigenous communities themselves (not outside corporate interests), they can be a substernal source of employment and income. In addition, cultural economic activities are highly complementary with traditional.

There are a few general economic trends that shed light on the future of the Arctic economies. First, the pattern of development continues to be determined by natural resources destined for international markets. Second, structural and persistent factors such as remoteness, lack of accessibility, long distance to markets and long supply lines, and harsh climate and an often-inhospitable environment mean that production costs remain high in the Arctic and are unlikely to fall relative to costs outside the region. Third, natural resource production continues to be a driving force of the Arctic economy, although other sectors are expected to grow in importance. Fourth, institutional arrangements that define the relationship between resource development and local communities will continue evolving with an increasing share of economic benefits from resource development remaining locally. Finally, the share of nonresource-related economic activity will continue to increase, including tourism, arts and crafts, electronics, and other trades, thereby providing the foundation for more of the economic value created to remain locally.

Types of the Arctic Economy

The territories of the “mainland” Arctic and the “island” Arctic are separated within the Arctic zone. The former have regular land connections with the southern territories, the Arctic sea coast, and the Arctic Ocean. The latter are formal or actual islands due to their absolute economic remoteness and peripherality. All Arctic extremes on the territory of the "islands" manifest themselves extremely sharply and clearly in comparison with the northern and Arctic mainland territories, in which they manifest themselves more faintly. Here, the instability of the weather dynamics of long-term statistical indicators is significantly higher, mortality and morbidity from accidents, injuries, and poisoning are increased, and the institutions of national self-government, traditional life support (reindeer husbandry and fisheries), participation in economic activities, and environmental management of Indigenous small-numbered peoples are more pronounced.

The Nenets and Chukotka Autonomous Okrugs have been implementing the island model of the Arctic economy for many recent decades. Both regions stand out sharply from the rest of the Russian Arctic regions and have many similarities with each other, on the one hand, and with the North American Arctic, on the other. For example, the Nenets and Chukotka okrugs (especially the Nenets) even have a settlement system closer to the North American Arctic than to the Russian Arctic: There are no large cities (there is not a single city there with a population of more than 25,000 people – as in Arctic Canada; there are no such regions in the Russian Arctic!). In terms of size, population density, and raw materials specialization, Nenets Autonomous Okrug could be safely called a piece of the Canadian Arctic in Russia – unlike most areas of the Russian Arctic, the local combination of national villages, shift settlements of raw materials corporations, and a very modest-sized capital city are very specific (Table 1).

The Indigenous people of the Nenets Autonomous Okrug are the Nenets, whose share, according to the 2010 census, is 17.8%; in Chukotka, the share of Indigenous peoples is 33.4%. According to this indicator, the closest values are observed in the Canadian Yukon (24.2%), Norwegian Finnmark (24%), and American Alaska (14.8%).

However, despite many similarities, we are actually talking about two different models of the Arctic island economy.

The first endogenous rental type is with all the bright signs of the territory of pioneer economic development, in which the corporate structure of the economy is

Table 1 Similarity of the Nenets Autonomous Okrug (as of January 1, 2017, current accounting) with the northern resource territories of Canada (2016, census data), the features of the settlement system

Territory	NAO	Yukon	Northwest territories	Nunavut
Name and population of the administrative center, people	Naryan-Mar, 24,654	Whitehorse, 28,225	Yellowknife, 19,569	Iqaluit, 7740
The population of the entire territory, people	43,937	35,874	41,786	35,944
Area, square kilometers	1,767,000 square kilometers	474.7	1143.8	1877.8

Source: Rosstat and Canadian Census Data. Retrieved from: www.rosstat.org, https://www12.statcan.gc.ca monopolized by the large oil and gas company Lukoil; the territory is young from the economic point of view and has the dynamics of natural growth, which has largely preserved the features of the traditional nomadic way of life and therefore characterized by the dominance of internal migration, weak indicators of the development of ordinary communication.

The second exogenous transfer type (Table 2) is very close in its qualitative characteristics to the territories of the foreign Arctic (for example, the north of Canada, Greenland, with their characteristic mining resource profile of the economy). One can see a pronounced predominance of external "long-distance"

Table 2 Comparison of two types of Arctic economy

	Nenets Autonomous Okrug (closed island)	Chukotka Autonomous Okrug (open island)
The most developed sector within the Arctic economy	Corporate	State (transfer)
Stage of economic development	Pioneering, exponential growth	Maturity, a drop in many production volumes or stabilization
The key type of resource and its features	Hydrocarbons, a corporate structure from oil and gas companies	Gold, dispersed organizational structure from large, medium, and small firms
Problems of interaction between the traditional and the market (resource) sector	The distribution of rents from oil and gas development for the traditional and public sectors at the regional level	The distribution of rent from mining development at the local community level
Problems of interaction between the state and market sectors	Social alienation of corporations from the mining territory – weak social rootedness of resource companies	The uniqueness of positive examples of corporate social responsibility in the behavior of companies
Problems of interaction between the state and traditional sectors	Development of reindeer husbandry, overgrazing of pastures	Extreme nationalization, the collapse of reindeer husbandry in the Soviet era
Mechanisms of integration of the three sectors, the specifics of each case, the integration platform, and problems for management purposes	Two tundras – two integration models, relative landscape homogeneity There are no administrative districts	Significant microlandscape diversity of integration conditions, four landscape zones There are eight administrative districts
Problems of island management, the need for institutional innovations and their areas	The desire to do without zoning, the potential for standardization and unification	The challenges of underestimating local specifics that are not grasped even at the district level, the need for administrative-territorial, natural-landscape and other zoning to reduce managerial entropy

Source: Compiled by the authors

migration from the "mainland," the dominance of male "industrial" employment in the economy, a corporate structure of large, medium, and small enterprises, non-monopolized by a single global company, a high degree of nationalization, and state support for development.

The most important integral result of the fundamental differences between the Nenets and Chukchi islands, all sectors of their Arctic economy, is the formation of a model of a closed island in the first case and an open island in the second. The closed island model means that pioneer development has very little impact on the settled and nomadic community that has been living here for centuries, which, as can be judged by the main indicators of communication penetration, the frequency of using mobile communications, remains very conservative and stationary.

On the other hand, if we take the open model, almost all local populations are "flowing" and have the best indicators of mobile penetration. All communication innovations are actively used by all segments of the local population – both aboriginals and immigrants.

Four National Models of the Arctic Economy

Humanity has been actively exploring the Arctic spaces for more than 70 years. During this period, four significantly different models of the Arctic economy have developed. They are American, Canadian, Russian, and European. The first three were born in federal states and therefore imply the joint involvement of the federal and regional levels of government in many key economic issues. The latter, the European model, is implemented in unitary states – in the Arctic territories of Finland, Sweden, Norway, Denmark (Greenland), and Iceland, and on several large Arctic islands (Faroe Islands, Svalbard, etc.). The responsibility for the development of the Arctic regions lies with the central government here.

The Arctic economy of the federal states has the largest size and the maximum spatial coverage. Therefore, the differences in the level of economic development between the Arctic regions within each model reach significant values. On the other hand, the economic model of the unitary state is more modest in terms of the main economic indicators, spatial coverage. Its internal differences are related to the national characteristics of the economic development of the polar Atlantic countries.

The greater the latitudinal extent of the Arctic territories of a country, the more centralized and nationalized this federation is (the regions have fewer rights to key assets). For example, the Russian Arctic has a maximum stretch from west to east. Russian Federation is the most centralized among all three. The preservation of control over these vast spaces throughout the entire period of active development was ensured by the regime of strictly forced centralization, directive state management. The rapid pioneer development of these territories in the 1930s was provided by the Soviet superorganizations "Pechlag," "Norillag," "Dalstroy," and others, which actively used the forced labor of millions of GULAG prisoners. In the late Soviet period, the development of these territories was provided by state departments – a system of powerful industry associations controlled from the center. But even today, in the second decade of radical economic reform, there is still strong state management of key processes. For example, the joint federal-regional form of ownership of land and mineral resources is combined with the federal management of key natural resources, almost exclusively the federal appropriation of the state part of the economic rent.

The Canadian Arctic has a smaller stretch from west to east than the Russian one. The Canadian Federation, of course, is centralized, but not to the same extent as the Russian and even more so the Soviet Federation. The large-scale development of the Arctic in this model began during the British colonial administration of the Hudson Bay superorganization, then it was continued by royal corporations, and now it is partly carried out by state-owned and private resource corporations and state-owned economic development corporations. Unlike all other models, the pioneering infrastructure development of the Canadian Arctic was provided by the efforts of the civilian sector, because there has never been a strong and decisive military presence here. Compared to the Russian model, regional authorities have more rights in controlling natural resources here. The resources are owned by the provinces, but their use is managed on the principles of cooperative federalism by the joint efforts of the center and the regions. If we take the Northwest Territories, the Yukon, and the Territory of Nunavut, the ownership and management of resources belong to the federal center. (The difference in status and differences in the scope of rights to natural resources of provinces and territories are a characteristic feature of the Canadian federation.)

The American Arctic (Alaska) has the minimum latitudinal stretch among all three federations. At the same time, the American federation is also the most decentralized, the least nationalized by the nature of the Arctic economy created here. The pioneering development of Alaska in the late 1800 and early 1900 continued the traditions of frontier penetration into the Wild West (although, unlike the Wild West, the Homestead Act did not apply here), i.e., it was based on the energy of free enterprise of gold miners and cowboys and not state coercion. Here, regional authorities have maximum powers in the ownership and management of the most valuable natural resources, although the federal center, local administrations, and Indigenous peoples retain control over significant lands. When organizing the state of Alaska, it received a federal land grant the size of California, with the right to freely cut it on the territory. The most valuable land and mineral resources were owned by the region (Hull & Leask, 2000), which provided Alaska with the rights to a third of the economic rent generated during the operation of the Prudhoe Bay oil and gas field. Total 25% of this rent goes to a specially created Permanent Trust Fund under the Constitution of the state of Alaska. Its investment policy is aimed at increasing the financial assets of the state, which act as regional insurance in the face of a steady decline in oil production. Nonrenewable oil resources have been partially transformed into renewable, self-growing financial assets for more than 25 years (Pretes & Robinson, 1989).

The centralized nature of the federation has affected the configuration of the territorial structure of the development of the North and the Arctic. For example, in the Russian and Canadian North and the Arctic, it is a linear-nodal, hierarchical ("colonial") system of southern bases and meridian routes to the northern and Arctic resources. On the other hand, in the state of Alaska, it is a network-decentralized structure, a grid of several meridian and latitudinal routes.

Under the federal system, the rights of Indigenous peoples are protected through the institutions of agreements and contracts of various types and formats, which include issues of aboriginal rights to traditional lands, compensation for the past use of these territories, the formation of special structures of native corporations/communities with land ownership rights, and priorities of traditional life support for Indigenous peoples. At the same time, of course, the internal differences of each specific model are also preserved.

For example, in the American version, agreements were concluded with all Indigenous peoples living in the state of Alaska at the same time, according to federal law; native corporations were created not according to the ethnic, but to the areal principle – the entire state was "cut" into 12 parts, in which 12 district corporations were created, as well as 220 local (village) corporations, whose shares were distributed among the Indigenous residents. On the other hand, in the Canadian version, the agreements were not concluded at one time. There was a long process of settling claims and disputed, conflict issues with each ethnic group. The document was signed between the federal, regional authorities and the ethnic group. The regional corporation of Indigenous peoples was formed based on an ethnic community, not according to the areal principle. In the Russian case, we are not talking about large-format agreements yet. Tribal communities sign separate local agreements with oil and gas companies on private, very narrowly defined issues.

The European unitary model of the Arctic economy has long been influenced by the military confrontation of the superpowers in the North Atlantic. Therefore, it was characterized by extreme closeness, the dominant influence of expenditures of naval bases, and the military sector as a whole. In the last decade, the nature of development here has changed radically. The international military organizations have been replaced by the central authorities of these unitary states, which now play a decisive role in managing the development of these territories. (It is curious that in taking into account the social benefits of the regions in the development of oil and gas resources of the shelf, the unitary model is now ready to go even further than the federal one, in which all these issues are entirely and solely within the competence of the federal center.) The interests of Indigenous peoples in the unitary model are ensured by the creation of legislative and administrative authorities of the aborigines (the Sami parliaments of the Scandinavian countries, the statutory board in Greenland) and the provision of significant state subsidies for reindeer husbandry and traditional crafts.

Each national model of the Arctic economy has its own "Oedipus complex," born from the past, often shameful history and prevailing intellectual ideas. For example, in the American model, this is the fear of repeating the Indian "history" when dealing with the Indigenous population of the Arctic, the inevitability, due to the extreme conditions of most of Alaska, of the deviations from the postulates of a liberal economy (the market is primary, the state is secondary). In the Canadian model, this is the fear of returning to the colonial past (frightening analogies of the Arctic and developing countries are popular), the fear of any conflicts that threaten the integrity of the federation. In the Russian model, this is the fear of losing the Arctic spaces in a "hostile" environment and the fear of repeating the "GULAG" scenario of the development of the North and the Arctic. Finally, in the European model, there are fears of preserving the traditions of colonial dependence on the mother country and the fear of international isolationism. Due to the extreme nature of the Arctic economy, this national complex is manifested in it as clearly as possible. Many state decisions in the field of Arctic policy can only be understood in its context. Overcoming some of the entrenched traditional views can greatly catalyze the development of the Arctic economy.

The realities of the last decade included an increase in internal contrasts in each national Arctic economy; the ratio of development rates between national models is becoming more complex and contradictory than before. The global role of the Russian Arctic has significantly decreased during this period under the influence of the all-Russian systemic crisis. At the same time, the pace of development of the Alaskan economy has slowed down. On the other hand, the effect of sudden openness caused an active increase in employment and real income in Iceland, in the Arctic regions of the Scandinavian countries.

Arctic peripherality, isolation, remoteness, small size, and archaic and traditional – this is one face of the Arctic economy. Another face is dynamism, innovation, creativity, and high profitability.

The nature of the Arctic economy in the state of *Alaska*. It is a rent-based decentralized competitive model of the ultimate degree. Nowhere else in the circumpolar region has it been possible to create an economy of such a degree of marketability as here. The main natural asset of the region – the Prudhoe Bay field – is operated by two oil and gas companies (in any other model, of course, it would be one company). A competitive environment has been created and maintained by the state authorities in the basic sector of the economy. A huge amount of intellectual and practical energy has been spent on ensuring that the most important regional labor and real estate markets are as competitive and dynamic as possible. This is achieved to a large extent, due to the maximum transparency of their work and expensive information support for all subjects of these markets (it allows them to be exclusively informed about vacancies, rates, qualification requirements, etc.). Most of the state's governors over the past 30 years have come from the small and medium-sized business sector, which underlines its role in shaping the overall competitive environment of the local economy. The deepest and most thorough differentiation of ownership rights to land and mineral resources (federal, regional, and national corporations) ensured that the state appropriated a huge economic rent in absolute terms and accumulated it in the Permanent Trust Fund of Alaska, and distributed part of it annually among all residents of the state under a special dividend program.

Now this Arctic economy is at a turning point. Adapting the size and structure of the state's economy to the new conditions of falling oil production every year is the modern super task of the regional authorities. How to land painlessly significant expenditures of the regional budget to the realities of decreasing regional revenues? There is a systematic search in many areas for new revenue sources (Goldsmith, 1994): the involvement of new resource facilities located east of Prudhoe Bay

(Arctic National Wildlife Refuge – ANWR), as well as the National Petroleum Reserve in Alaska (National Petroleum Reserve – Alaska – NPR – A); improving the regional trust fund by eliminating the dividend program; using market mechanisms for the intersectoral flow of human resources within the state and departure from Alaska to the "lower" 48 states; lobbying for federal funding and increasing the military and civilian presence of the federal government.

The Canadian state-based and centralized model of the Arctic economy is characterized by cooperativeness and extreme local transferability. The polar zone here includes the Northwest Territories, Yukon, Nunavut, the northern part of the province of Newfoundland, and Labrador, where more than 100 settlements are located. Social criteria and goals are everywhere above the considerations of competition. A huge amount of energy and time is spent in this model to come to a conflict-free solution to the problem of Indigenous land claims. Due to the formal differentiation of ownership rights to the main resources, cooperative procedures of interaction between the federal and regional authorities should be involved for effective management. And in this model, the art of partnership interaction between the authorities of two levels, the state and Indigenous peoples, resource corporations and the state, and resource agencies and Indigenous peoples (Usher, 1993) is brought to the absolute. Unlike the American model, the solution here is not sought in an extremely clear delineation of ownership rights to key assets, but in working out filigree conciliation procedures for the interaction of many participants. In contrast to the American case, it deliberately emphasizes the continuity of modern national policy toward Indigenous peoples, Indian policy in this British colony in the nineteenth century.

The advantage of this model is the painstaking work to find sources of local development in each national village. The local level is the main direction of federal intellectual efforts and financial resources. Perhaps, due to the lack of integrated (cross-cutting) military structures and units in the Arctic, the Ministry of Northern Territories and Indian Affairs has existed here for many years to fulfill a coordinating role. This is unprecedented in world practice. The Russian equivalent of the State Committee of the North of Russia was created in 1991 and existed for 10 years, after which it was closed.

In recent years, the attitude of the public to resource superprojects has been changing in this model under the influence of the effective settlement of the first land claims of Indigenous peoples. Some of them were postponed for a long 20 years, but they can be revived now: Oil and gas resources have been discovered in Canada on the shelf of the Beaufort Sea, within the borders of the Northwest Territories (NWT) and on the territory of the Yukon, which directly borders the territory of the state of Alaska.

During all the years of the USSR's existence (1922–1991), the *Soviet* model of the Arctic economy (including the entire Nenets, Taimyr, Yamalo-Nenets, Chukchi Autonomous Okrugs, part of the Murmansk, Arkhangelsk Regions, the Komi Republic, and the Arctic districts of the Sakha-Yakutia Republic) could be considered extremely nationalized and overcentralized. And in this sense, it was a useful experiment for humanity and an important lesson in terms of the costs and benefits of the central government's maximum participation in the development of the Arctic.

The Soviet large-scale industrial development of the Arctic began 40–50 years earlier than in the other Arctic countries. This was a highly expensive model, in which the geopolitical interests of full state control of giant spaces often dominated over purely economic ones. The high costs of Arctic development were compensated for a long time by the free labor of millions of prisoners, then by extensive redistribution of oil and gas rents, which allowed to maintain subsidies for the entire Arctic life support, subsidize prices, transport, and energy tariffs, and establish generous benefits and guarantees for the northerners, despite the requirements of economic expediency.

Since the beginning of the 1990s, when the radical economic reform was started in Russia, the Arctic economy has been transitioning to new development principles – from administrative-command to social-market ones. This leads to a widespread reduction in the size and structure of the Arctic economy, an increasing isolation of the Arctic zone from the rest of Russia.

The collapse of state funding in the Arctic can be compared in its consequences to a dried-up superlarge field; the difference was that it happened instantly and suddenly, and residents of the state of Alaska, for example, have the luxury to work out scenarios and prepare for a safe landing at a lower level of budget revenues, after the exhaustion of Prudhoe Bay. The state itself has become a generator of a shock cycle, quasi-resource in nature. The high costs of the previous model were revealed, and the state withdrew from their bearing.

As a result of the loss of prestige of work in the North and the Arctic, more than a million people left these areas (over 10% of the total population) during the years of reform. Dozens of industrial settlements were closed. After the collapse of state farms, the Indigenous population had to return to traditional life support, while receiving almost no state assistance for the purchase of equipment, ensuring the sale of reindeer husbandry products and crafts.

There was a difficult problem of transforming old assets. Created for one era, they were not suitable for the new one. For example, nuclear submarines and nuclear icebreakers were created specifically for all-season work on the routes of the Northern Sea Route. Now it is extremely expensive even to dispose of them.

On the other hand, the old tangible assets of the unique Arctic deposits allowed their new private owners to receive a huge economic rent without investing significant investments. If we take the Soviet economy, the entire Arctic rent was involved in an extensive redistributive process held on a national scale. Now only a certain part of it goes to the federal budget, and the rest is appropriated by integrated business groups who own natural assets of the Arctic. They only use it to some extent for implementing old investment programs from the Soviet era and mainly direct it to current consumption.

The former Arctic superprojects inherited from the Soviet era, for example, the development of the Yamal Peninsula, which were owned by the state, can now be implemented only by a Russian or international consortium of oil and gas companies.

The task is to form an Arctic economy that will be capable of self-development, and create new, more market-oriented Arctic institutions to replace the already outdated norms and rules of the Soviet era.

The European version of the Arctic economy (which includes the territories of Greenland, Iceland, Svalbard, the Faroe Islands of Denmark, the northern parts of Norway, Sweden, and Finland-Lapland) (Table 3) is distinguished by less extreme natural conditions due to the influence of the warm Gulf Stream, the pressure of the colonial past, and the former strong militarization in the North Atlantic. Many Arctic island territories have had reliable connections only with their mother country for centuries, and only now are they opening up to the outside world.

The energy of postcolonialism and liberation from the mentality of isolationism give a significant impetus to the modern development of these territories, all the more powerful because it is accepted by very compact and small-in-size entities. The tourism business uses the new opportunities to the maximum extent. The innovative dynamism of the modern development of European development is most clearly demonstrated by the growth rates of mobile coverage unprecedented for the rest of the world. This allows one, given the advantages of compactness, to form integrated markets, which are almost unattainable for the rest of the Arctic regions, as well as fishing and oil and gas clusters.

In this group of countries, collective and individual security, the protection of human life in the Arctic, as can be judged by the average life expectancy and the degree of development of the social insurance system, has a maximum limit.

Over the past two decades, there has been a trend toward convergence of various national models of the Arctic economy in the world. For example, the economy of Alaska, which has always relied exclusively on rental income, is now beginning to use federal transfers to a greater extent. On the other hand, the marginal state-controlled Soviet model of Arctic development has become significantly more market-oriented. The extremely isolated model of the enclave islands of Greenland and Iceland is becoming more integrated into global processes and markets. The extremely social model of the Scandinavian welfare state is gradually becoming somewhat more rigid in the Arctic. The extremely cooperative network model of Canada is gradually beginning to lean toward greater centrality in its Arctic territories of the Yukon, the Northwest Territories, and Nunavut.

Conclusion

The main and fundamental feature of the Arctic and its economy is its significantly more unstable, uncertain nature, and significant risks. These basic specific features of the Arctic economy are the combination of major differences between the Arctic and the North, which permeate all three sectors of the Arctic economy – traditional, corporate, and transfer. If we take the traditional sector, the uncertainty is verified in the changes of yearly dynamics of the number of deer, the volumes of fish, and marine mammals extracted from traditional fisheries. If we take the corporate sector, unfavorable global market conditions and the general depletion of natural resource reserves provide for giving up work at any stage. If we take the transfer sector, uncertainty means frequent mass closures of dozens of single-industry villages and settlements created over decades.

Table 3 Comparing the models of the Arctic economy

	American model	Canadian model	The Russian model	European model island	European model mainland
State structure	Decentralized federation	Centralized multistatus Federation (formerly a colony)	Centralized federation (extreme centralized nationalization)	Unitary (Iceland, Greenland, and Faroe Islands)	Unitary (northern Norway, Sweden, and Finland)
Natural conditions	Relatively harsh – heated by Kuroshio	Harsh	As harsh as possible	Relatively harsh – Gulf Stream	Relatively harsh – Gulf Stream
The shape of the Arctic zone	The enclave is average in the area, latitudinal extent, and diversity of ethnic and natural conditions	A large area, latitudinal extent, and a variety of ethnic and natural conditions. The legal status of the regions of the North and the Arctic (provinces and territories). The proximity of the polar regions of federal and subfederal jurisdiction	The maximum area, latitudinal extent, and diversity of ethnic and natural conditions	Compactness. Island enclave	Small area
North-south dichotomy	No	Yes	Yes	No	Yes
Institutes of pioneering development	Frontier	Colonial expeditions	Imperial expeditions, Cossack migrations	Colonial expeditions and agricultural settlement	Commercial and agricultural settlement
Superorganization of the nonmilitary type	No	Hudson Bay state-owned companies, Royal Development Corporations	Camp-integrated combines free labor and prisoners	No	No
Military presence	Permanent	No	Permanent	Permanent	Permanent
The mechanism of formation of the first	Military efforts (market and competition arose later) – military	State efforts, direct civil infrastructure	Efforts of super organizations of the camp type (free labor of	NATO naval bases, then the market and competition	NATO naval bases

extensive territorial structures (framework)	infrastructure before the civilian one Private sector efforts (the initial infrastructure of the "gold rush")		prisoners) The limit is global in terms of the pace of creating a pioneer layer of industrial development. The large-scale industrial development of the Arctic spaces is 40 years earlier than in other models		
Territorial structure	Networks, grid	Bases and routes	Bases and routes	–	–
The "Oedipus" complex of the Arctic economy	Fear of repeating the Indian scenario. Fear and necessity of deviations from the postulates of the liberal economy (the market is primary, the state is secondary): objective limitations of the Arctic economy	Fear of returning to the colonial past (analogies of the Arctic and developing countries). Fear of the conflicts that threaten the integrity of the federation	Fear of the loss of Arctic spaces in a hostile environment Fear of repeating the Gulag scenario.	Fear of preserving the colonial dependence. Fear of international isolationism	Fear of maintaining colonial dependence on the southern regions
The model of the Arctic economy	Regional rent model of the **limit** type. Regional transfers (The market is primary, the state is secondary)	The local transfer and rental models are marginal in terms of cooperativeness. Federal transfers	Regional transfer and rental models are marginal in terms of nationalization in the USSR. Federal transfers	Rent and transfer national model are marginal by enclave	Rental and transfer regional models are marginal in terms of social orientation
Decentralization	Simultaneously	A long, careful process	A long process	No	No
Ownership of natural and land resources	The maximum depth of differentiation. Diversified land and	Formal differentiation of ownership rights to land and resources in	Joint management of the federal center and the regions under the	National	National

(continued)

Table 3 (continued)

	American model	Canadian model	The Russian model	European model island	European model mainland
	resource management by owners	the cooperative federal-regional resource management and land use planning. Comanagement	federal resource and land management		
Conflicts of owners	Effective judicial resolution procedures	Cooperative, nonjudicial resolution mechanisms	Inefficient judicial resolution procedures	Active role of the state, cooperative mechanisms	Active role of the state, cooperative mechanisms
Economic coordination	The market is primary, the state is secondary Competitive markets in the basic sector; regional labor and real estate markets; national corporate markets; market criteria for the investment policy of the Alaska State Trust Fund	State interdepartmental is primary, market is secondary. Employment is more important than competitiveness, salary income, and social criteria of the investment policy of trust funds (aboriginal settlement is a brake on market coordination)	The ultimate state system in horizontal (integral combines) and vertical (departments) forms in the USSR. Transition from state to state-market coordination	State-market coordination	State is primary, market is secondary
Creative energy	Energy of the market-competitive initiative	Energy of aboriginal self-awareness and self-development from below	Energy of new nonstate owners	Energy of postcolonial openness, overcome defense isolationism	Innovative energy of creativity
Age of tangible assets	Average age	Average age	Oldest	Young	Youngest
Special structure	No	Department of Indian Affairs and Northern Development of Canada	State Committee on Developing the North (Russia) (1992–2000)	National structures	Regional and ethnic representative bodies

Security priority	National and regional level	Local level	National and regional	International and national	National and regional
Maximum effort (time and resources spent) Achieving sustainability mechanisms	The instruments of separation and collection of rent; regional marginal control of rent distribution and the search for ways to stabilize the resource-dependent economy	The process of settling the land claims of Indigenous peoples; the search for prospects for local development; and coordinating the interests of resource companies and local residents	USSR – military camp mobilizations, departmental planning, and the deployment of noneconomic incentives for coercion Russia – adaptation of forms and conditions of the economy The shift method has not been used before Unlimited import substitution in noneconomic planned settlements, the effect of saving on size	Ensuring the openness of the economy and competitiveness in the metropolitan and European markets	
The main Arctic institutions	Spontaneous and planned lawmaking from below. New institutions – the Constitution of Alaska, the federal land grant, the trust fund, national corporations, etc.	The institutions of the center that maintain continuity with the colonial ones. Partial failures with new institutions: Northern cooperatives in national villages of the 1970s	USSR had its own, the reform of state institutions Experiments at the federal level, there are no regional ones. Northern institutes are developed in isolation from resource ones	Metropolitan areas and local, conservative, traditional ones	National, no regional ones
Security guarantees/ sustainability guarantees	At the regional level, there is a trust fund as the ultimate form of collective regional insurance	At the local level, there are federal transfers	At the federal level. The nationwide nature of the generated Arctic rent, and its budgetary	At the metropolitan/ national level	At the national and regional levels

(continued)

Table 3 (continued)

	American model	Canadian model	The Russian model	European model island	European model mainland
			redistribution on a national scale		
Mechanisms of linking to the rest of the country, organizing flows for life support for the North and from the North	By the forces of market competition	Federal programs for food security of Arctic villages, etc. Preferential flights on latitudinal routes	USSR – preferential tariffs and prices for food, energy, northern coefficients, and surcharges. Russia – ties are broken and isolation is increasing	No problem	No problem
R and D	Separation of the social sciences from the natural ones, a strong resource rental direction of local research	Interdisciplinarity, integration of social and natural research	Arctic interdisciplinarity, Northern specificness of the social and natural block	Interdisciplinarity, integration of social and natural research with a high role of resource (marine economy) and social-ethnic blocks	Interdisciplinarity, integration of social and natural research with the role of the resource (extractive industry), and social-ethnic blocks
Indigenous peoples	Rejection of the previous (Indian) tradition. Interethnic mixing is minimal. A one-time unified agreement with the Indigenous peoples on land requirements based on areas of residence. The rights of land and resource ownership are more	Continuity with the previous (Indian) tradition. Interethnic mixing is minimal A 30-year process of concluding a series of individual agreements of different formats and conditions for land claims on an ethnic basis. Ethnic rights are more important than	Return to the traditions of the tsarist time. Interethnic mixing is strong, and national villages are mixed by ethnic structure. Deep assimilation. Now-individual agreements of tribal communities on lands and resources Soviet times – the main level – agricultural	No separate Aboriginal policy No mixing (except Greenland), homogeneous ethnic group Inuit, Icelandic Vikings, Faroese Traditional activities (commodity and noncommodity)	One Sami tradition Interethnic mixing No agreements, issues of its preparation are being discussed The main level is the Sami Parliament at the national level Traditional activities (commodity and noncommodity)

	important than ethnic rights. The main district level of structuring of Indigenous communities (ethnicity is obscured) Local level costs of overcomplication of the diversity of old and new models of national self-government The concept of a nonmarket sector	property rights to land and resources. The main community local level of structuring of Indigenous peoples (ethnicity is emphasized) Traditional activities (commodity and noncommodity)	enterprises and areas where Indigenous peoples live. Villages – the policy of enlargement. The nomadic way of reindeer herders as a separate problem. Transfer to settlement and collectivization for controlling nomads. An ambitious program of marketability of crafts and reindeer husbandry in the USSR, now commodity and noncommodity		
Trends (challenges and opportunities)	The challenge of a depleted field. Sustainability of development through special funds, flanking facilities, federal funding, and development of the service sector	After a series of satisfied land requirements, the attitude toward the development of resource megaprojects has changed from negative to positive		Openness, expansion of external relations as the main factor of economic development Growing number of educational institutions. Rapid development of means of communication and communication, the formation of a fish cluster. The problem of diversification, import substitution. Tourism	Formation of an oil and gas cluster. Innovative development

Source: Compiled by the authors

The Arctic economy is extreme to a much greater extent than the northern one if we understand by this phenomenon not just cold discomfort, but a set of features of transport peripherality, the severity of the weather (cold and wind), the Arctic Ocean freezing for a long time, and frequent heliogeomagnetic disturbances. Extremity puts pressure on all three sectors of the Arctic economy and determines the corridor of opportunities for them in terms of expansion or contraction (we are talking about high costs of production activities and development in the Arctic).

To a much greater extent than in the northern economy, the phenomena of mobility are developed in the Arctic. The mobility of the traditional sector means the nomadic nature of reindeer herders and the seminomadic nature of traditional fisheries for fish, sea animals, and furs. The mobility of the corporate sector implies a significant role of shift workers in the main resource fields. The mobility of the transfer sector implies the migration flow of many local populations of Arctic people in individual villages and towns.

To a much greater extent than the northern economy, the Arctic economy is prone to various manifestations of cooperativeness in the forms of cross-subsidization and mutual assistance of households and networks of local communities, district corporations, etc. Cooperativeness is present in the traditional (division of prey by hunters among the whole community) and transfer sectors (extensive horizontal and vertical redistributive procedures), but if we take the corporate sector, it is also manifested in the form of public-private partnerships, corporate social responsibility, and partnerships of several global companies on the platform of unique Arctic deposits.

Implicit (personal, expert) knowledge plays a significantly greater role in the economic development of the Arctic than in that of the north, and not only in the pioneer but also at all stages of economic development of natural resource deposits. Its role is especially evident not even within each sector, but with intersectoral flows of implicit knowledge from Indigenous peoples to immigrants, from experienced geologists to miners, and from the generation of veterans and pioneers to youth. Knowledge in general and implicit knowledge in particular contribute to the development of rapid improvisational responses to rapidly and unexpectedly emerging changes in external conditions.

The main rhythm of the main tangible assets of the sector also determines its internal cycle. For example, the annual natural (seasonal) cycle is the internal structure-forming rhythm of the traditional sector based on the Indigenous peoples of the North. Favorable external and internal conditions contribute to the growth of the traditional economy's marketability. On the other hand, the general unfavorable background compresses marketability and adapts the life-supporting character for domestic consumption.

If we take the corporate sector, the main rhythm is set by the life cycles of the largest deposits of the province. A specific stage of the life cycle determines the abyss of parameters of the Arctic economy: the volume of production, the amount of budget resources, the tone of the local community and its main expectations, prices on the local housing market, etc.

If we take the transfer sector, the main rhythm is set by investment (construction) cycles. Together with educational efforts, these factors determine the success and scale of the usually implemented strategy of replacing imports with their own production.

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Including Arctic in Multilateral Trading System Agenda

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Contents

Abstract

The development of the Arctic and cooperation among the Arctic states is one of the most pressing problems of a dynamically developing global economy based on advanced technology and knowledge. The Arctic was and remains a region with unique natural resources, primarily energy, located at the intersection of undeveloped – but potentially important – transport routes, an extremely attractive and unexplored region in terms of the implementation of tourist services. In addition, the development of the Arctic requires a substantial intensification of the efforts of all actors, since it has serious environmental impacts, while requiring substantial investments and the development and implementation of new technologies. All these problems require coordination not only at the level of existing regional consultation forums, but also the development of a special regime for trade in goods, services, and investments within the multilateral trading system with the possible formation of a Free Trade Zone in this region.

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Introduction: The State of Play and Main Stakeholders

The development of the Arctic and cooperation among the Arctic states is one of the most pressing problems of a dynamically developing global economy based on advanced technology and knowledge. Thus, the region is attracting constant international attention and is becoming the new center of global geopolitics.

Interest in the polar regions and the opening access to large reserves of mineral resources of the continental shelf due to climatic changes are shown not only by the circumpolar states (Denmark, Norway, Canada, and the USA), but also by the leading powers of Europe and Asia, including Germany, France, Great Britain, Japan, India, China, etc. In total, about 40 countries have announced their interests in the Arctic. The national security interests of the Arctic states include maintaining sea access and protecting natural resources. These directed political intentions are formalized in the form of a variety of political, legal, and economic documents (statements, conventions, charters, strategies, etc.), as well as materials for mass consumption (publications in the media, etc.).

The Arctic was and remains a region with unique natural resources, primarily energy, and is located at the intersection of undeveloped but potentially important transport routes; it is an extremely attractive and unexplored region in terms of the implementation of tourist services. All this cannot be but regulated by the commonly accepted, yet often violated, rules. The most complete and complex set of rules is determined by the World Trade Organization (WTO) and its agreements. The extraction of the resources may not be regulated by WTO rules, since these regulations do not imply the extraction issues. However, at the same time, international exchange and trade of resources produced in the Arctic can and should be regulated by strictly established rules in order to avoid any violation of interests and discrimination. With regard to discrimination, it is important not only to take into consideration the interests and ensure equal access to resources for all Arctic states, but also to ensure the use of extracted resources and the value created for all participants in the global trading system. Some services issues are regulated by the International Maritime Organization (IMO) and multilateral agreements, like the Polar Code, worked out by the IMO, but there is an urgent need for more concrete operational actions, aimed at the solution of the needs and concerns. The lack of regulatory harmonization is a challenge and a significant problem for Arctic development.

In case of transportation services and logistics, basic trade facilitation measures could enable more efficient cooperation, simplifying doing business in the region and thus making it more attractive for private investment.

Besides, the future safe and sustainable development of the Arctic requires a substantial intensification of the efforts of all actors, since it has serious environmental impacts and requires substantial investments and the development and implementation of new technologies. The successful negotiations on intellectual property rights also promote shared investment in infrastructure and ease technology transfers, one of the major issues and in some cases a definite priority.

That means that all these problems require coordination not only at the level of existing regional consultation forums, but also around the development of a special regime for trade in goods, services, and investments within the multilateral trading system, with the possible formation of a free trade zone in this region.

While traditionally the Arctic development was the focus of eight recognized Arctic states (Canada, Denmark, Finland, Iceland, Norway, Russia, Sweden, and the USA), defined by UN Convention on the Law of the Sea (UNCLOS) (Rothwell, 2013) as Arctic coastal states, nowadays more and more countries are declaring their economic interests in the Arctic. The activity in the region is rapidly increasing, for example, by China.

China is undertaking considerable efforts and is very actively involved in scientific research in various fields in respect of the Arctic development. The general policy principles are respect, cooperation, a win-win result, and sustainability (Xinmin, 2019). The main areas of Chinese Arctic science are the issues of climate change and the search for possible ways of resolving the problems arising in this context. This includes measuring key chemical changes in the Arctic Ocean, for example, using buoys to measure ice melt and carbon dioxide. This country is also one of the largest investors and players in the world market of raw materials and technologies, at the same time doing this in the most diverse forms: from the establishment of the Institute for Polar Research in 2009 and the opening of polar stations (on Svalbard and Iceland) before participating in projects for the development of mineral resources (in Canada and Russia – on Yamal) (Kryukov & Kryukov, 2019). Another example is the significant expansion of the Arctic Council participation: except for 8 subarctic countries, a special status is provided for six organizations of the indigenous nations of the Arctic. They have the right to make decisions jointly with the countries participating in the Council. Germany, China, Great Britain, Italy, Poland, Republic of Korea, France, India, Singapore, the Netherlands, and Japan are participating in the Arctic Council as observers.

In the 1990s, the EU as a block began to pay special attention to the Arctic region, justifying this by its extreme concern with the growing competition of states for the resources of the Arctic, territorial disputes, and, as a consequence, control over the northern sea routes. Without being directly involved in the activities of the region, as noted above, in 2006 the EU approved an updated concept of the Northern Dimension, in accordance with which it is working with several regional organizations in the Arctic: the Council of Ministers of the Nordic countries and the Arctic and Barents Euro-Arctic Councils.

In 2007, the European Commission issued an Integrated Maritime Policy Action Plan, which highlighted the problem of the deletion of the Arctic continental shelf, as well as the development and operation of the northern sea passages, was addressed in an Integrated Maritime Policy Action Plan adopted by the European Commission in 2007. In 2008, the European Union and the Arctic Region communiqué defined a strategic vision for the EU's policy in the Arctic. It notes that the European Union is linked with the Arctic by inextricable geographical, historical, economic, and scientific ties. At the same time, the communiqué contains arguments for the participation in Arctic affairs mainly of the countries of the "Arctic Five." The main institution for the formation, coordination, and implementation of EU policy in the Arctic region is the European Commission, which, together with the European External Action Service – the High Representative – develops working programs and recommendations and also puts forward proposals. Taking this into account, the European Commission stated that special attention will be paid to the definition of external borders continental shelf in relation to the interests of a united Europe. At the same time, the EU does not plan to remain a passive observer of the competition of other powers for the right to possess the Arctic resources.

In accordance with the UNCLOS, each state in the Arctic region has a 200-mile exclusive economic zone. At the same time, this boundary of the continental shelf can be moved more than 350 nautical miles from the baseline, provided that the Commission on the Limits of the Continental Shelf can prove that the sea bottom is morphologically, geologically, and genetically related to the continental part. These circumstances allow the Russian Federation to claim to a significant part of the Arctic, even larger than the "polar possessions of the USSR," the conditional boundaries of which were drawn along the medians from Chukotka and the Kola Peninsula and closed at the North Pole. This particular issue is one of the main reasons for geopolitical conflict, mainly between Russian and the USA, that could be mitigated by the joint efforts of other countries should they potentially cooperate in the region once there is a new mutually accepted legal base.

Except for the issue of boundaries, during the last decade, the main players that have long cooperated in the Arctic region, especially Russia and the United States, have clashed on many matters. Geopolitics started to prevail on the economic issues, being stipulated by a set of international, regional, and subregional governance mechanisms. As argued in the RAND Corporation report (Sacks et al., 2018), the conditions in the Arctic are evolving – driven by such factors as climate change, economics, and geopolitics – and, thus, its governance mechanisms must also evolve in order to mitigate new risks before they potentially escalate into conflict. That provides the grounds for the debate on the regional cooperation legal arrangements and governance.

Literature Review

Scientific and practical interest in the development of cooperation in the Arctic region is not yet a reality at the current stage of development. However, the research and scientific debate has traditionally concentrated on three main issues: military issues; updating and providing new opportunities for existing agreements; and the recognition of problems that cannot be solved with the help of existing mechanisms, as well as the search for mechanisms to reduce the impact of already identified risks. Being one of the most important problems of the UN and other international organizations, these problems have received wide coverage in studies conducted by international research centers; among the most fundamental are Arctic Council reports marine and coastal ecosystems (Arctic Shipping Status Report, 2020) and its Annual environmental reports (2016–2019), as well as the World Economic Forum, the Arctic Council, Barents Euro-Arctic Council (BEAC), International Maritime Organization, The United Nations Convention on the Law of the Sea (UNCLOS), and Northern Dimension policy from different years. A lot has been done in respect of social and human development research by Steffanson Arctic Institute.

Among scientific research, the majority of studies are focused on the military and political status of the region and, thus, the state of relations between Russia and USA, with slight attention paid to the positions of other players, trying to keep certain neutrality. The overview of the literature and studies leads to the conclusion that the study of the region is concentrated in the field of international relations, law, and security in the Arctic (Borgerson, 2008; Hubert, 2010; Hough, 2013; Posner, 2007). One of the most provocative is the research by Borgerson (2008), a former Lieutenant Commander in the US Coast Guard, blaming Russia in an oft-quoted article in Foreign Affairs for the actions that require a clear American answer. His main argument is there should be a clear American Arctic strategy (Borgerson, 2013). Even in spite of the fact the title of the article identifies economic implications, his attention is paid primarily to the upgrade of the American icebreaker capabilities in particular, as well as US full scale diplomatic involvement in the region. He advises the US administration to enforce the ratification of the UNCLOS, which, in his view, might strengthen the US position at ongoing negotiations about regulation in the Arctic. According to Borgerson (2008, 2013), the region lacks both in international norms and laws and the concrete national strategy, developed by participants of the existing conflicts.

A similar approach and view are expressed by Conley (2012) from the Center for Strategic and International Studies in Washington D.C. It is not by chance that they have chosen a quote by Vilhjalmur Stefansson, the famous Icelandic American Arctic explorer and ethnologist, stating “There are two kinds of Arctic problems, the imaginary and the real. Of the two, the imaginary are the most real” as an epigraph. In the research paper, they mention that the region is experiencing extraordinary economic and political changes that it was hard to imagine even 10 or 20 years ago. However, subsequent research is again being conducted in terms of the US military budget build-up and new commercial opportunities for US companies as the sea ice retreats.

The politics and the division of influence between main powers have not spared the North Pole. Byers (2009), a Canadian scholar of international law, surveys the emerging lines of conflict, focusing on territorial and sovereignty disputes. He argues that since the Arctic is a sea of frozen ice, no country will “own” its expanse (Byers, 2009), and comes up with the conclusion that governments should not just settle claims of sovereignty but also elaborate a common approach to the problem of an open and peaceful Arctic region. Later, Byers (2017) published research in which he developed his previous analysis and supplemented it with new aspects of confronting Russia and its main Arctic partners after the Ukrainian conflict, which affected all spheres of interaction between Russia and the United States, exacerbating the confrontation in the Arctic region. At the same time, all these studies deal with cooperation, mainly regional, but the attention is focused on military-political and environmental aspects.

It is difficult not to agree with Olesen (2014) dividing all research on Arctic into two groupings. The first one, he points out, are called "the warners," who presage the possible political conflict in the Arctic and advise nations either to avoid it or at least to be ready for such development. The second group, he identifies, is represented by the optimistic "re-assurers," who argue that conflict is unlikely and that the Arctic nations are quite safe and able to focus on strengthening their existing cooperation in the Arctic on the base of existing laws and conventions.

During the last decade, the main players that have long cooperated in the Arctic region, especially Russia and the United States, have clashed on many matters. Geopolitics started to prevail on the economic issues that are stipulated by a set of international, regional, and subregional governance mechanisms. As argued by Sacks et al. (2018), the conditions in the Arctic are evolving and such factors as climate change, economics, and geopolitics demand new legal arrangements and governance mechanisms that must also evolve in order to mitigate new risks before they potentially escalate cooperation. According to this study, the majority of research identifies such categories of potential conflict reasons in the Arctic as: Russia's central role in the access to transportation routes; environmental risks; challenges to the current Arctic governance; the uncertain geopolitical status of Greenland; and, certainly, China's active economic and political involvement in the region. Given the existence of such serious factors and extremely rapid changes in geopolitics and the global economy, it is necessary to intensify and significantly expand the dialogue both through new participants and new areas of cooperation.

With all the diversity of research, the novelty of this article is to analyze the procedure for regulating the Arctic cooperation in terms of applying the norms and rules of the multilateral trading system. The main goal is to identify promising areas of cooperation in the Arctic region, which could be regulated multilaterally and suggest the new governance mechanism.

The short literature review above is the evidence that the regional cooperation is fundamentally studied from the political point of view with increasing interest to the environmental and energy resources issues. At the same time, it is quite obvious that effective cooperation in none of the sectors, even in the military-political sphere, is impossible without settling purely trade issues, since it provides for the exchange of tangible and intangible achievements and assets in order to develop the region and increase its potential. It was this thesis that motivated the study of cooperation in the region from the standpoint of the elements of the multilateral trading system, primarily the WTO agreements and the possibility of deviating from the basic principles in order to effectively use the capabilities of the region while preserving its unique natural potential.

Scientific and Technological Cooperation in the Arctic

One of the areas of cooperation in the region is the scientific research and technological cooperation. This scientific collaboration does not per se require any multilateral framework and is organized in the base of the agreements and institutions responsible for whichever area of study. Some of them are initiated by large-scale nongovernmental organizations (NGOs), taking care of the research on the environment, climate change, and/or ethnic studies. The issue of the multilateralism and regulation norms arises in the moment when the discussion about the dissemination and distribution of the acquired knowledge – especially technologically – begins. However, scientific and technological cooperation in the region is the basis for the development of economic cooperation in general, since the modern problems of the region alongside its development and preservation of its uniqueness are possible only if restrictions are eliminated and access is granted to the most modern achievements. The authors believe that it is scientific and technological cooperation in the region that underlies economic and trade cooperation and creates the basis for the regulation of intellectual property rights and the development of the service sector.

Today the Arctic is an object of research interests not only for the Arctic states, but also for a number of European and Asian countries. However, conducting scientific research is not a top priority for all Arctic states (Łuszczuk et al., 2020). In this context, Asian countries and their shipping companies in particular become quite active participants in Arctic initiatives (Beveridge et al., 2016). Among examples of international cooperation and the interest of non-Arctic states in the study of the Arctic, it is important to mention the financing of the construction of polar research vessels by Japan, China, and South Korea, international expeditions to Spitsbergen, participation of non-Arctic states in working groups of the Arctic Council, etc.

It is worth highlighting that some of the Asian countries interested in development of the Arctic are the world's technological leaders, such as Japan, China, and South Korea, and they are actively involved in scientific Arctic expeditions both at the national level (creation of national research programs, academic institutions) and by organizing joint research international programs. This gives particular importance to the possibility of multilateral regulation of the Arctic to provide equal access to all interested parties.

Japan is an active player with long research history in polar regions (Barr, 2013; Kamikawa & Hamachi, 2016) and makes a great contribution to international research of the Arctic, being at the same time one of the world leaders in technological development, which makes it an important exporter of technologies required for the development of mineral recourses in the Arctic. Hence, the Arctic issue is an important area of the country's policy (Sueyoshi et al., 2021) and its access to the region is mainly subject to multilateral trading system.

The first vivid example of Japan's interest in the Arctic is the GRENE Arctic Climate Change Research Project (2016), initiated by the Japanese National Institute for Polar Research (NIPI). It brought together more than 300 scientists from 35 organizations under its auspices. The GRENE was to grasp the ongoing changes in the

Arctic, to understand the mechanism, to know the global influences, and to contribute to future climate projection (Yamanouchi & Takata, 2020). The main strategic goals of the project were extremely diversified: understanding the mechanism of warming amplification in the Arctic, understanding the Arctic system for global climate and future change, evaluating the impacts of Arctic change on weather and climate in Japan, marine ecosystems, and fisheries, and projecting sea ice distribution and Arctic sea routes (Arctic Climate Change Research Project 2011-2015). The Project sought for and promoted collaboration with other institutions in various nations, which might be essential for Arctic research and international cooperation. The GRENE Arctic was epoch-making as the first all-Japan comprehensive project incorporating multidisciplinary studies and collaboration between observation and modeling (Yamanouchi & Takata, 2020).

The particular importance of the GRENE project in the context of multilateralization is given by the fact that the most significant changes in the regional climate system in the Arctic continue to happen (an increase in water temperature in the ocean, an increase in the average temperature in the Arctic is twice as fast as the world average, melting of permafrost, etc.) although they started a long time ago (Desjardins et al., 2020). All these processes affect the hydrological cycle and ecosystems of the Arctic and inevitably occur in other regions of the planet, which requires the involvement of not only the Arctic G8 in solving emerging problems, but also the states that do not have direct access to the Arctic but could contribute significantly with multilateral access mechanism.

The scientific efforts of both Arctic and non-Arctic nations are directed towards the creation of observation and analytical systems, the formation of research networks in the region, and the deployment of research stations. These goals can be successfully achieved through international cooperation. One example of such a kind of mutually beneficial work is the Arctic region research project, initiated by Japan and called Arctic Challenge for Sustainability (ArCS), which melds natural sciences, social and human sciences, and data management. This project is the result of two shifts in the style of Japan's Arctic research during the last 10–15 years: from small research projects by individual scientists to a large national program and from a purely scientific program to a comprehensive Arctic research program (Sueyoshi et al., 2021). The main goal of the ArCS was to elucidate the changes in the climate and environment, clarify their effects on human society, and provide accurate projections and environmental assessments for internal and external stakeholders so that they can make appropriate decisions on the sustainable development of the Arctic region (Arctic Challenge for Sustainability, 2015–2020). The main research areas were climate, weather, ocean environment changes, the material cycle of short-life air pollution materials, ecosystems, and biodiversity (Arctic Challenge for Sustainability 2015–2020).

Being Japanese in its nature and recognizing such an ambitious goal, the ArCS has become an important source of information not only for national experts of the Arctic, but also for any interested party, whether they were international organizations, governments, independent research communities, or even individual scientists. ArCS served as a foundation for the development of international cooperation, providing capacity building and sending young scientists and experts to the Arctic countries. Generally, the ArCS project allowed international cooperation to deepen in the field of arctic research by sharing valuable data and research results and can be considered as valuable experience and a source of information when establishing the multilateral regulation in the Arctic in the context of scientific and technological cooperation. This becomes of particular importance, taking into consideration the increasing global data traffic between Asia and Europe, and that the Arctic Ocean offers a shortcut that shortens physical cable connections (Tabata et al., 2021).

Along with its global significance, the national interests of many countries are to be acknowledged, and Japan is not an exception. It is certainly seeking to pursue its national objectives, particularly in the development and use of the Northern Sea Route (Ikeshima, 2016). The practical result of Japan's policy concerning the Arctic can also be considered through the initiative to build Japan's new Arctic research vessel, which at the same time will be serving as an international research platform. The start of construction is announced for 2021 and its maiden voyage is planned for 2025. Taking into account that traditionally there are three main Arctic shipping routes involving transiting through the Russian Arctic, the Canadian Arctic, and the North Pole (Smith & Stephenson, 2013; Stephenson et al., 2013; Theocharis et al., 2018), Japan's initiative is of special importance for possible multilateralization of the Arctic as the development of advancing methods in Arctic shipping can lead to more detailed insights into the economic feasibility of Arctic routes under different policy scenarios (Lambert et al., 2021).

On the part of Japan, such initiatives indicate a special interest in the exploration and development of the Arctic on a par with the Arctic countries. Moreover, in order to deepen international and diplomatic cooperation in this field in September 2015, on a trial basis, the first science and technology advisor to the Minister for Foreign Affairs of Japan was appointed. His role was stipulated as to support the Minister's activities, to give advice on utilization of science and technology in diplomatic policies, and, more than that, to strengthen the network with science advisors, scientists, and researchers abroad. In matters of scientific and technological cooperation, the most active interaction is marked between Japan and the United States of America. The main areas are cyber security and governance, new and sustainable energy (the International Thermonuclear Experimental Reactor (ITER), International Thermonuclear Experimental Reactor (ILC), hydrogen etc.), space (The International Space Station (ISS), exploration, observation, Space Situational Awareness (SSA) etc.), health science including big data and gene bank, and rules and regulations. With regard to the Arctic, the countries' cooperation is directed towards research and observation, sustainable development, and governance.

China is another player that is successfully competing in various fields, including research and technology. The attraction of young scientists and the massive dissemination of information about the Arctic are important directions of Chinese policy in the study of the Arctic space as well. However, large-scale action problems, such as climate change, involve a vast range of not locally confined actors, and therefore, the likelihood of cooperation diminishes (Argüello, 2021), which indicates the growing importance of creating a special legal framework for multilateral system in the

Arctic. The Agreement on Enhancing International Arctic Scientific Cooperation (2017) may be considered as one of the basic documents for that purpose. Science cooperation, according to the 2017 Arctic Agreement, may contribute to improving regulatory measures in a number of vital areas (Berkman et al., 2017).

One of the most important directions of Chinese policy is the environmental aspect, namely, the reduction of carbon dioxide emissions. According to the statements of the Chinese government, the country will become carbon neutral by 2060. This implies interaction and cooperation with the world community, including participating in international economic projects in the Arctic. Scientific and technical cooperation between China and the Arctic states is aimed at deepening and expanding existing ties in the research and development of the Arctic. For example, in Fall 2018, a joint Russian-Chinese cruise aimed to evaluate the distribution of atmospheric gaseous elemental mercury from the Sea of Japan to the Arctic was organized (Kalinchuk et al. 2021).

Another vivid example of international cooperation in the Arctic is the Multidisciplinary Drifting Observatory for the Study of Arctic Climate (MOSAiC program), which gathered under its auspices hundreds of scientists and researchers from 20 countries from all over the world (MOSAiC, 2019). The largest international polar expedition in history began in 2019 with the departure of the German research icebreaker Polarstern from Norwegian territorial waters to the Arctic Ocean. Moreover, for the first time in the history of Arctic research, the icebreaker was near the North Pole during the polar winter. The main goal of the expedition was to take the closest look ever at the Arctic as the epicenter of global warming and to gain fundamental insights that are key to better understand of global climate change (MOSAiC, 2019). As a result of the expedition, which took 1 year, the most valuable data were collected, intended to be studied by scientists from all over the world, and designed to bring the issue of global climate change to a new level, taking into account that generally there are two major challenges stand out in the context of arctic research: rapidly advancing environmental change and the international governance of the implications of change (Numminen, 2010). At the moment, the main scientific areas of MOSAiC are the study of the sea ice, ocean, atmosphere, biogeochemistry, and ecosystems of the Arctic, which are in full compliance with the stipulated problems and require new cooperation input.

The study of the Arctic and international exchange of knowledge and technology transfer are key elements of the successful development of the region, both in terms of the global economy and the implementation of the UN Sustainable Development Goals. All this requires deepening international cooperation in the region both in the fields of scientific and technological interaction as well as to prevent a possible "wicked problem" such as a higher risk of mishaps and disasters (Mileski et al., 2018). Certain success has been achieved in these issues: such initiatives concerning the Arctic as the Intergovernmental Panel on Climate Change (IPCC), Special Report on the Ocean and Cryosphere in a Changing Climate (SROCC), the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES), and Global Assessment Report on Biodiversity and Ecosystem Services as well as the United Nations Decade on Ocean Science for Sustainable

Development (2021–2030) and the global Seabed 2030 initiative, which all are of special importance for improving international scientific and technological cooperation in the Arctic. At the same time, new contemporary challenges, such as the escalation of geopolitical conflicts, restrictions on trade caused by the pandemic, or restrictions on technology transfer due to the sanctions policy, all require a new approach to the formation of an unprecedented economic condition in the Arctic.

Knowledge for a Sustainable Arctic has become the main topic for the third Arctic Science Ministerial Meeting (ASM3), the intergovernmental conference coorganized by the governments of Japan and Iceland (3rd Arctic Science Ministerial Meeting, 2021). The Science Advisory Board was brought together under the guiding principles for ASM3: transparency, inclusivity, and implementing a bottom-up approach to science. Notably, delegates from 27 different countries and the European Commission, as well as representatives from Arctic Indigenous Peoples' Organizations, took part in the event, which underlines the particular importance of the Arctic issues at the international level. Under the 3rd Arctic Science Ministerial meeting, the international community paid special attention to implementation of observing networks and data-sharing, enhancing understanding and prediction capability for Arctic environmental and social systems, the global impact of these changes, an evaluation of the vulnerability and resilience, and applying knowledge as well as preparation of next generation through capacity building, education, and networking (3rd Arctic Science Ministerial Meeting, 2021). The result of the 3rd Arctic Science Ministerial Meeting was a joint Statement signed by the 25 Ministers in charge of research, among which were representatives of Japan, Republic of Korea, China, Singapore, and other Asian Pacific countries. Taking into consideration that, in some cases, the Arctic Council as the main intergovernmental forum in the region faces challenges to ensuring effective outcomes from its activities (Barry et al., 2020), meetings like the Arctic Science Ministerial Meeting demonstrate the willingness of the global community to move forward in modernizing and improving the existing mechanisms of the multilateral system.

It is obvious that Arctic research is a complex and challenging area; it is supposed to investigate both natural and anthropogenic processes. Assumptions that, in the Arctic shelf (ecosystems with low productivity), a more intense anthropogenic impact is possible while supposedly causing no significant damage are rather controversial (Solovjova, 2021) and prove the need to elaborate special rules of multilateral system for the Arctic. Since the processes occurring in the Arctic territory affect the lives of the whole world, its study should be the object of multilateral cooperation and the efforts of the international research community. More than that, taking into account that research on climate change is largely based on the study of processes occurring in the Polar regions, the interaction of interested parties should be based on the principles of transparency, openness, environmental friendliness, and compliance with intellectual property rights at the multilateral level; this final matter is, and should be, included in the multilateral negotiations agenda, given that it is expanding its coverage, and scientific cooperation in its turn needs to be facilitated by trade in services, equipment, intellectual property, and even liberalized movement. One of the examples is the transfer of "green technologies," which also requires regulation at the multilateral level, since it plays an important role in solving the problems of climate change.

Areas of Economic Cooperation in the Arctic

The world community needs to find mutually acceptable solutions in order to prevent the escalation of negative trends. Cooperation in the Arctic region, with mutual respect and acknowledging each other's position, is preferable to new rounds of confrontation. Passivity and ineffective steps are fraught with upsetting the global ecological balance and stability. The public demonstration by various states of their interests in the Arctic also emphasizes the relevance of the issue of the legal regime of the Arctic as a whole. As was mentioned at the symposium "Asian Interests and the Path Forward in the New Arctic," organized by the Wilson Center in February 2021, the distance and lack of boundaries has not discouraged Asian countries from looking to the Arctic. The region provides new opportunities in many areas of shipping, research, and environmental or climate initiatives. The participants confirmed the low level of cooperation that the Arctic deserves.

Currently, there is a competition between two legal regimes in relation to the Arctic: the regime established by the UNCLOS, and law, the customary regime, traditionally formed in the Arctic on the basis of a complex of economic, historical, and geographical factors, as well as other factors that are not covered by UNCLOS. At the present stage, some important issues of the use of the Arctic resources and the possibilities of the region are regulated and discussed at the bilateral level, mainly between the Arctic countries. One of main issues is resource exploration and management. Based on the above, several directions of *multilateral cooperation in resource management* of the Arctic states can be distinguished:

- Assessment of the state of water areas, marine and coastal ecosystems of the Arctic seas in connection with global climate change
- Issues of substantiation of the continental shelf and issues of future delimitation of the "extended" shelf
- Transport projects and transport communications
- Exploration work in the Arctic region

Exploratory drilling on the shelf of the Arctic seas is growing quite fast, mainly due to the efforts of Norway, which is actively developing existing oil and gas fields. In accordance with the forecasts, by 2025 the volume of drilling on the continental shelf of the Arctic seas will continue to grow, mainly due to the increase in exploration on the continental shelf of the Russia, Denmark (Greenland), Canada, and the USA. At the same time, if the subarctic states fail to prove that the seamounts of the Arctic Ocean and the sea are a geological continuation of the continental shelf, then large spaces with undetermined status may appear. These spaces will most likely have the status of areas of the Common Heritage of Humanity; consequently, the right for geological exploration work, and subsequently to extract mineral resources, may be claimed by various international companies, including non-Arctic countries (China, India, Japan, etc.). This example inevitably provokes the necessity of extremely close cooperation, but not only between Arctic states, since, in addition to purely economic problems, they have important political and socio-economic significance for all countries.

Given the growing and expanding interest to the region and its resources, the problem of the lack of legal substantiation and, accordingly, the unity of approaches to development and preservation of the Arctic could be considered as a potential issue of the multilateral agenda.

The contemporary multilateral negotiations are very much concentrated on the *environment, sustainable development, and climate change*. All three have direct implications for the Arctic. The increasing melting of the Greenland ice sheet is contributing to a rise in global sea levels. Recent forecast models allow for a full meter rise in global sea level by the end of the century. A rise in sea levels of this magnitude will have far-reaching consequences for the entire planet. Evidence of global warming is more evident in the Arctic than anywhere else. The Arctic has been warming up rapidly over the past four decades. The rate of temperature rise in the Arctic is twice as high as globally. The impacts of changes in the Arctic climate will have serious consequences at the local, regional, and global levels. One of the platforms for negotiating these problems is World Trade Organization (WTO). Even during the Uruguay round of negotiations, and subsequently in the WTO rules and documents, the environmental services were included in the Services Sectoral Classification List (MTN.GNG/W/120). Unfortunately, environmental services, which are commonly understood to be covered by the category "Other" in this list, were not in the central focus of the WTO work. Among them, services such as "nature and landscape protection services," which include protection of ecological systems as well as studies on the inter-relationships between environment and climate, are directly relevant to Arctic problems. The harmonious coexistence between WTO rules and specific trade obligations in various agreements has been mutually acknowledged by all WTO participants and has been negotiated multilaterally during the last decade very intensively.

The existing and future international trade regulations could also deal with the *transportation and logistics services*, since the Northern Sea Route (NSR) makes the Arctic one of the most promising and important transport corridors. According to Kobayashi (2020) from Otaru University of Commerce, governments should undertake immediate efforts along with negotiations under the WTO and the Organization for Economic Cooperation and Development (OECD) to ensure the safe transportation. As an option, he argues that there should be a critical mass agreement to allow special rules for government subsidies for vessels with a superior environmental performance (Kobayashi, 2020).

The future expansion of international trade and global value chains (GVCs) can contribute to the more intensive and extensive exploitation of the Arctic as a transportation route between continents. That provokes more strictly regulated interdependence between trade and environment, as is up to date and included in the WTO agenda; hence, this is more as a recommendation and not a rule.

Although all these issues have been stressed in the Arctic Council Strategic Plan 2021 to 2030, adopted in Rekjavik in 2021, and are relevant to the current multilateral trade rules, as we proved above, the more concrete efforts should be undertaken to avoid the significant risk and danger to this specific region.

Another important and less studied aspect is the *cooperation on the microlevel*, which also needs the support at the international and multilateral level, indicating the microlevel means mainly small and medium-sized enterprises (SMEs). While recently there have been more active processes of mergers and acquisitions of national corporations (the shareholders of which become nonresidents of various countries, and thus, global corporations are extending their exploitation of planetary resources), a lot is to be done to support small business. In 2018, the Arctic and Antarctic Council of the Russian Parliament published a report on the Russian strategy in two Polar regions. Alongside with an analysis of the legal provisions, the report determines the obstacles for Russian companies to start and/or develop business in the region, as well as basic recommendations for international cooperation that may boost it. A summary analysis of the provisions of the report, edited and interpreted by the authors, is presented in Table 1.

In separate states, including Russia, there are also official information resources that national business could use to learn about Arctic projects, as well as new opportunities for business in the Arctic Zone of the Russian Federation and possible support for investors. Besides, there is an Arctic Economic Council (AEC), which is endowed with the opportunity to organize and implement international projects of a strategic nature, including large infrastructure facilities that are significantly changing the face of the Arctic. In this regard, it can be assumed that Arctic states will support the AEC's existence in the system of regional relations of a truly independent association of business circles; however, there is the danger of politicization even of this pure economic institution. In such circumstances, the only way to support the economic activity is to integrate it to the multilateral mechanism.

The Necessity of the New Governance: Reality or Science Fiction?

There is a whole range of international legal and regulatory documents called Arctic law. Unfortunately, not all of them are updated enough to address the current problems so to be used in the current conditions and state of relations between signatories. As mentioned in the RAND study (Sacks et al., 2018), multiple forums and mechanisms create the grounds for cooperative Arctic dialogue and decision-making across a variety of areas and among different stakeholder groups. However, even they do not address the most urgent challenges that the region and the whole world is currently facing.

In a 2010 report by one of the judges of the International Tribunal for the Law of the Sea, it was noted that the region could become a laboratory for a new international legal regime, with the emphasis on the word "new" (RIAC, 2013). The authors of this article propose a new approach to the regulation of economic cooperation in the Arctic region, based on the application of not only traditional treaties and norms of the law of the sea, but, above all, the norms and rules of the multilateral trade

Table 1 The basic recommendation for international business cooperation in the Arctic. (Based on Russian experience)

Problem	Evaluation of the State potential to boost international cooperation	Recommendations for international cooperation
Lack of financial resources from the regional budget	Average	The determination of the priority tasks and coordination of the policy between countries
Changes in the tax regulation	High	Regular business-government dialogue, round tables and consultations with foreign business and international organizations, possible agreement, establishing special tax regime for business entities, operating in the Arctic
Lack of trust from business	High	Openness and information, the creation of the database of successful and potential projects with international participation
Lack of self-confidence among entrepreneurs	High	Educational programs, best business practice exchange, liberalization of trade in educational and advisory services, use in the region
Low competitive level of production	High	Implementation of commonly accepted standards, based on ISO-9000 and in full compliance with the WTO Technical Barriers to Trade Agreement
Low level of medium-term and long-term planning	High	The coordination of policy towards Arctic on the macrolevel and the support of the realization initiative on the company level with a very close and targeted cooperation between business associations and chamber of commerce

Source: compiled and edited by authors on the base of Arctic Resources and Transportation Information System (2009). *The State and Problems of the Legal Provisions for the Russian Strategy in the Russian Zone of Russian Federation for the Period of 2020*. Retrieved from: http://www.arctis-search.com/Russian+Federation+Policy+for+the+Arctic+to+2020

system. One of the important tasks for the multilateral negotiations process is *a common understanding and definition of the term coastal territory*. As noted in the report of the Council on the Arctic and Antarctic under the Federation Council of Russia, the definition of the term "coastal territory" still does not exist in Russian legislation. GATT Article 24 uses the term "frontier trade" as an exception to the MFN. By analogy, it could be proposed to elaborate the regulation of cooperation between coastal territories on the basis of exclusion from the MFN and special rules that apply specifically to these territories. Sharing of best practice across the Arctic region is one of the ways that will boost and facilitate the cooperation and make it more effective.

The second important issue concerns *barriers to business development*, existing or artificially created, mainly for geopolitical reasons. The modern economic situation is characterized by a large number of barriers to the development of businesses interested in the development of material production and services. Despite the practical difficulties associated with doing business in these environments, the polar region (the Arctic in particular) is attractive for business (Chong, 2020). The authors of the current article argue that the business attractiveness of the Arctic region is due to reasons that can be grouped as follows:

- Growth in production, including mining, industry, and manufacturing. Thus, during the construction and operation of hydrocarbon deposits, up to 80% of the total volume of work is made up of enterprises and organizations – suppliers for the oil and gas sector (geological exploration, construction, transportation, metalworking, and other service companies).
- Increasing the investment attractiveness of the region, by means of creating a favorable investment environment, in which not only taxes will be taken into account, but also a general set of factors (infrastructure sites, subsidies, and personnel issues).

To support the attractiveness and avoid serious conflicts, unfair competition, and unjustified protectionism, special *facilitation measures* should be applied in respect of the regional trade. Sethi (2018) from Harvard Kennedy School Belfer Center for Science and International Affairs research brings the vivid example of how inconsistent formalities prevent business in the region. She has also analyzed icebreaker services as an expensive but necessary requirement for many Arctic industries. Even if a Finnish icebreaking company operates in Iceland under similar regulations as Finland, there is an additional income tax on top of the home country's taxes while crossing to Greenland, which, to her fair statement, is a significant tax burden that could demotivate business, especially if involved in the infrastructure development. This also justifies the need for the tax treaty between Finland and Denmark and/or the European Union and its main partners as a trade facilitation initiative.

Another trade limiting measure is classification and strategic goods definition. According to the legislation in several countries, especially the USA and Russia, the aforementioned icebreakers are classified as military industry products and are not opened for the international cooperation, which limits the GVCs in this particular sector.

With regard to the environment and climate change, the ongoing WTO *negotiations on environmental goods and services*, with a strict definition and the legibility of such goods, might facilitate the access to products, services, and technologies and improve energy efficiency, which will have a positive impact on environment and natural resources conservation. If the consensus for multilateralism is preserved, the WTO reform should anticipate actions in respect to climate change in many problematic regions, including the Arctic.

One of the possibilities to include all this improvement into a multilateral negotiations framework is the initiations and use of such popular WTO practice as the creation of the "Friends of the Arctic" group by analogy with similar initiatives existing in the WTO. Such a group could later promote the plurilateral free trade agreement (FTA), which will not only promote trade liberalization, but also fix environmental standards, special trade facilitation measures, a joint approach for small and medium size enterprises, and technological cooperation and intellectual property rights protection. Proposing the FTA Agreement, we proceed from the assumption that modern agreements have an extremely wide scope of coverage and can go far beyond the scope of trade. The proposed agreement could be regional (Arctic states only) or cross-regional (with the participation of a larger number of countries, even China). The new FTA agreement is subject to a procedure by Committee on Regional Trade Agreements (CRTA), which assesses it in terms of compliance with the WTO rules.

One of the problems of the current stage of globalization and, as a consequence, the attention of the main global regulator, the WTO, is the inextricable link between world trade and investment. The importance of *investment issues* in the modern international economy and in the development of cooperation in the Arctic has been discussed at many international forums, albeit more attention should be paid to the inclusion of the issue in the system of global regulation measures. So far, international investment is the prerogative of the World Bank and is of a recommendatory nature; separate transparency issues are contained in the OECD documents.

At the same time, it is worth noting that, in the context of multilateral regulation, investment is not a "new issue." One of the targets of the Charter of the International Trade Organization (ITO), drafted in the late 1940s, was to formulate investment rules along with trade rules. At that time, plans to develop multilateral investment rules were not implemented; hence the urgent need to harmonize rules was clear. In 1996, for a more consistent solution of trade and investment issues in the recently created WTO, a decision was made by the 1st Ministerial Conference of the organization with the simultaneous establishment of the Working Group on the Interaction of Trade and Investment, discussions of which until 2001 focused on the following: identifying the relationship between trade and investment, a review of international practices in terms of trade and investment, and possible initiatives on the WTO platform, including the pros and cons of bilateral, regional, and multilateral investment rules. The Working Group was also mandated to collaborate with other organizations, such as the United Nations Conference on Trade and Development (UNCTAD), in order to make the best use of available resources and ensure the achievement of development goals (Isachenko & Medvedkova, 2020).

Among the initiatives, there are certain ones that prove very important for Arctic measures, such as:

- Transparency of regulation and access to regulations, the ability to track changes in legislation
- General principles for considering projects proposed by foreign investors (stability, predictability, efficiency, etc.)
- A "single window" for investors
- The presence of a coordinator and ombudsman to assist investors on various issues
- Regulation of collection and payment issues

The suggested measures have direct implications for the exploration of Arctic hydrocarbon deposits and mineral resources, the extraction of renewable resources, and the development of the transport potential of the Arctic Ocean. In their turn, these areas stimulate cooperation in global shipbuilding and the implementation of international projects for the development of the Arctic infrastructure. The prospects for the development of Arctic tourism have been identified. The World Economic Forum recently estimated investment potential only in order to support environment and prevent disasters as $1 trillion (Sethi, 2018). Due to increased industry and transport, the risk is constantly increasing. If the investment is regulated on the multilateral level, it might help investors from many countries to contribute to the safe and stable use of Arctic resources in line with the Sustainable Development Goals (SDG) concept. The same goal also could be reached by including environmental regulations in the proposed FTA focused on the investment as it is done in many modern RTAs, since they are going significantly beyond trade, and in a wide range of agreements, investment issues are prevailing.

The development of investment cooperation is driven by the development of Arctic hydrocarbon deposits and mineral resources, the extraction of renewable resources, and the development of the transport potential of the Arctic Ocean. These areas stimulate cooperation in world shipbuilding and the implementation of international projects for the development of the Arctic infrastructure. The prospects for the development of Arctic tourism have been identified. While the extraction is not covered by the multilateral rules, *the transport potential and tourism* are directly linked to the WTO General Agreement on Trade in Services (GATS). Arctic countries consider extra liberalization in the services sector, provided that such agreement, in relation to any other WTO member, especially Asian countries, that as described above, are expressing an interest in the region, do not increase the overall level of barriers to trade in services compared to the level that was applied before such an agreement is concluded.

The maritime transport services are regulated by the special Annex on maritime transport services to GATS agreement. The special rules were needed due to the ongoing multilateral negotiations on this type of service and retain the right of states to derogate from the most-favored-nation treatment in relation to international shipping, ancillary services, and access to port infrastructure pending negotiations. It is understood that such deviations are recorded in the Appendix on exemptions from obligations under Art. II GATS. In some cases, measures applied reflect the existing practice of ad hoc regulation of the issues concerned on the basis of case-by-case decisions and subject to the concrete situation. The acknowledgment of the Arctic transportation routes as a WTO concern and including it in the agenda may contribute to the more effective and safe use of the network, contribute to the efficient distribution of goods, as well as address the needs of environmental protection.

As far as Arctic tourism is concerned, there is an absolutely new and, hence, important common concern for all countries: Either they are Arctic and would be hosting tourists or countries outside the region but considering the possibility of attracting tourists from other regions and continents. Tourism commitments have been undertaken by over 133 WTO members, more than in any other service sector. This indicates the desire of most members to expand their tourism sectors and to increase inward foreign direct investment (FDI) as part of their efforts to promote economic growth (GATS, 1995). In the multilateral trade system, there are no serious precedents of limiting access to tourist services; however, given the specific environmental conditions of the Arctic, the commonly accepted environmental, technical, and information standards are extremely desirable. To elaborate such provisions, the efforts of only eight Arctic states are not enough and the best technological decisions and inventions should be open in order to apply them in very specific pole conditions.

The tourist sector – and its regulation by generally accepted multilateral rules, as well as integration of this issue in the possible FTA format – is closely connected with intellectual property right transfer.

Protection of intellectual property (IP) rights is one of the key elements of economic cooperation in the Arctic and, except for traditional forms of IP objects such as patents, industrial design, or copyright, it can be included in the negotiation agenda in two areas:

- Protection of *traditional knowledge and traditional cultural expressions* as an independent element of IP system
- Protection of *industrial intellectual property* in the context of the use of technologies both during the exploitation of the region's mineral resource base and while conducting scientific research using special arctic vessels

The peculiarities of the Arctic economy lie in the nonstandard conditions of economic activity, high risks and costs of production activities, and the great role of natural conditions in the formation of the economic conjuncture. However, the traditional knowledge and skills of indigenous peoples in many ways make it possible to smooth out or even completely neutralize the constraining conditions for the development of the Arctic economy and allow them to create unique products. Traditional knowledge includes all the accumulated experience, know-how, skills, and practices that become an integral part of the cultural identity of the Arctic nations, and in a broader sense, traditional knowledge even includes distinctive signs and symbols associated with particular indigenous people. An example is the peoples of Inuit (Canada) and Sami (Norway), which are famous for their handicraft, art, and priceless knowledge about natural resources in their respective areas. Thus, traditional knowledge can be applied in a wide range of fields such as agriculture, ecology, pharmaceuticals, scientific activities, etc.

It should be noted that traditionally indigenous peoples of the Arctic are inclined to cooperation, mutual assistance, and mutual support, but unfortunately very often their knowledge is illegally appropriated and misused. As Agranat (1994) notes, the development of these areas has not been able to fit into the stereotypical market framework of the capitalist economy. Thus, there is a clear gravity towards cooperation rather than competition among the local population of the Arctic, which should be taken into account when forming the conditions for access of global participants of the world economy to the Arctic region. Since the protection of traditional knowledge and traditional cultural expressions have both potential benefits and challenges for local economy players, it must be included in the multilateral agenda of the Arctic negotiations as a special kind of IP in order to eliminate gaps in protection in the current IP system. Indigenous peoples should be given not only the opportunity to derive economic benefits from traditional knowledge but get real tools to prevent unauthorized use of their competitive advantages arising from traditional knowledge.

Expert knowledge and personal skills play a significant role in the development of natural resource deposits in the Arctic. Since existing IP systems most commonly do not protect traditional knowledge as it is (often it is fixed only in oral form) – and at the same time the result of its commercial use usually leads to innovation – the second of the proposed areas of the IP negotiation agenda under multilateralizing Arctic (protection of industrial intellectual property) takes on a special importance.

The establishment of the rules for the use and protection of industrial property rights in the Arctic at the multilateral level will allow not only the stimulation of industrial production in the region and technology transfer, but also to attract additional investment in the infrastructure of previously unattractive regions due to legal uncertainty and diverse geopolitical interests. Surely the Arctic has never been isolated from international capital flows, but high competition with more attractive and less risky territories acts as a deterrent factor, the impact of which could be reduced by guaranteeing IP rights.

Another hot-button issue in the use of industrial intellectual property when creating a multilateral trade mechanism in the Arctic may be the possibility of using a patent without the authorization of the right holder (Art.31 Agreement on Trade-Related Aspects of Intellectual Property Rights – TRIPS Agreement). From a practical point of view, this article has received wide applicability in the field of pharmaceuticals in the form of the so-called compulsory licensing mechanism when a government allows someone else to produce a patented product or process without the consent of the patent owner or plans to use the patent-protected invention itself. Taking into account recent genetic-based studies which showed that the diversity of the polar region is much greater than previously predicted (Tripathi et al., 2018), it can be argued that there is a hidden potential of the Arctic's biologically diverse areas such as the marine environment for the pharmaceutical industry of the world economy. In addition, the aforementioned TRIPS article can also be applied to patents for inventions, which carries certain risks of using technologies in the Arctic territories with an uncertain or controversial legal status.

IP rights not only advocate equitable profit sharing with the indigenous peoples (Singh et al., 2020), but also command the sustainable use of the natural resources of the Arctic. Resolving these complex and multifaceted issues can bring the multilateral regulation of economic relations between stakeholders in the Arctic to a fundamentally new level of IP protection. The creation of a unique regional IP system in the Arctic should be a top priority, taking into account its cultural and economic features.

Conclusions

It is obvious that the Arctic could not be approached just from the purely regional point of view, that is, from the interests and need of eight Arctic states. With its rich reserves of mineral resources, its ecology and nature management could be defined as one of the key priorities of the global economy as a whole. At the same time, it is important to understand that this region has a certain specificity both from a natural and climatic point of view and from a socio-economic one.

The existing overwhelming majority of the traditional Arctic agreements provides quite weak or, in a certain respect, no regulation on trade in the region, environmental aspects, intellectual property rights, and investment access. The efficient work and the future development significantly depend on the multilateral efforts and investment – there is no possibility to solve the exiting problems and confront constantly emerging threats with the efforts of only a few countries. The development in the last two decades proved that, as mentioned above, the Arctic has become a global issue and thus needs global approach and regulation, including trade in goods and services mechanism, investment climate, and very special and cautious management of the environmental and socio-ethnic characteristics of the unique territorial enclave. The interests of all interested parties should be taken into account: the Arctic states, non-Arctic states, international organizations, nonprofit organizations, small and medium-sized businesses, transnational business, and of course the local population's needs. The lack of a legal status of a part of the Arctic territory and the theoretical possibility of access to it by any interested party (including a non-Arctic one) gives rise to increasing interest from Asian states, which inevitably entails an rise in competition and political tension in the region.

International scientific cooperation is of great importance in solving all existing and emerging problems of the Arctic region. The analysis made it possible to identify interesting features: The most important and large-scale projects with the maximum volume of investment in solving technological problems and new solutions are offered not by the northern countries participating in all existing conventions, but by Asian partners. Development programs and scientific research carried out in Japan and China can become a good basis for cooperation on a global, regional scale.

International scientific cooperation is the basis for expanding effective economic interaction without damage or in order to reduce the level of danger to the environment and climate. The main areas of cooperation can be identified: the extraction of mineral resources, transport systems, and tourism services. The economic activity in the Arctic affects the global climate change. These issues can only be resolved by intensifying international scientific cooperation and multilateral regulation.

The provided analysis makes it possible to argue that – given the expansion of the system of multilateral regulation that all processes taking place in the Arctic – methods of solving emerging and potential problems, as well as reducing politicization in the region, can be reached by including Arctic issues on the agenda of multilateral negotiations of the WTO. This is the urgent task in the process of the overdue WTO reform.

The transport and logistics component of Arctic development (the three most important marine routes that carry enormous potential for world trade pass through the waters of the Arctic) is also one of the key issues of international cooperation, directly connected to the provision of a wide range of services. Modernization of the existing provisions within the framework of the GATS and their application to the Arctic realities and specifics may create the most favorable and economically rational conditions for access of foreign services providers, while at the same time maintaining a commitment to caring for the Arctic nature and the principles of the WTO. This applies equally to tourism services, the development of which is being discussed at the bilateral and regional level, and to the transfer of intellectual property rights. The latter is inextricably linked with all areas of cooperation, since it allows the introduction and exchange of the most modern technological advances in the interests of preserving the Arctic ecosystem.

Social and environmental aspects should prevail over possible economic benefits when creating an integration unit of any type in the Arctic; the growth of industry and economic activity in the Arctic is important, while the features of the entrepreneurial culture of the indigenous people of the Arctic, their culture, and traditional knowledge are a priceless asset and competitive advantage when opening access to third countries. This would make it possible to achieve an economic result while reducing the environmental burden on the arctic nature and preserving and increasing the intellectual potential of the region. Obviously, multilateralization of the Arctic requires a special approach to the issues of protection and guarantee of intellectual property rights, and it possibly even requires the consolidation of fundamentally new detailed provisions regarding types of intellectual property that are nontraditional for regional trade agreements (traditional knowledge and traditional cultural expressions).

Except for multilateral norms, it may be effective to sign a free trade agreement with a wide scope with the participation of all interested parties and in accordance with WTO rules.

Further difficulties in developing a multilateral approach to solving the geopolitical issue are created due to inconsistencies and the absence of a unified position within individual integration blocs or countries that are traditionally allies in multilateral negotiations. A clear definition of legal status and access conditions to the aforementioned territories at the multilateral level would make it possible to form transparent and fair competition for all interested parties.

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Part III

Finance and Foreign Direct Investment

Financial Resources for Arctic Exploration

Irina N. Platonova

Contents

Abstract

The development of the rich natural resources of the Arctic and the conduct of economic activities based on the environmental, social, and corporate governance (ESG) principles implies an increasing use of green financing. Based on the analysis of the institutional infrastructure of green financing that has developed in the world economy as well as the use of green bonds, this chapter shows the possibilities and directions of the development of green financing for the implementation of projects undertaken by the Russian Federation in the Arctic zone. The identified institutions and structures of the Russian system of green financing allow us to conclude that it is incomplete and there is a weak relationship between the organizations involved in green financing in the Arctic. The necessity of using the State program "Socio-economic development of the Arctic zone of the Russian Federation until 2025," along with budget financing, is justified the capital of private investors with the help of green bonds. The modest experience of Russian companies in placing green bonds showed the need to improve the verification system and the system of disclosure of nonfinancial information of an

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environmental nature of companies implementing projects with an environmental component. More complete information about the green characteristics of the projects and about the purposes of using the funds received from the placement of bonds will become prerequisites for attracting investments from the international capital market to the Arctic. In addition, improving the system of stimulating the placement of green bonds will increase the interest of Russian investors to use this tool more widely to finance green projects in the Arctic.

Keywords

Capital market · Green bonds · Green financing · Environmental projects · The Arctic

Introduction

One of the important and urgent problems of the Arctic development is to attract financial resources to ensure the sustainable and stable development of this polar territory. The importance of the Arctic for the population of the planet Earth is constantly increasing. The richness of its natural resources, as well as the development of a transport highway that provides the shortest sea route from Asia to Europe, has long determined the value of the Arctic territory primarily for the northern states that are beyond the Arctic circle, have sea zones in the Arctic, have legitimate borders on land and at sea, and are members of the Arctic Council.

Global climate change has made significant changes in the processes of international cooperation in the development of the Arctic space. The Arctic is a special, complex ecosystem in which environmental risks are rapidly increasing as a result of climate change: Permafrost is thawing (which creates enormous threats to infrastructure), the risk of man-made disasters increases, coastal erosion occurs, floods become more frequent, threats to life for the indigenous population increase, and much more. Therefore, sustainable development will be ensured throughout the planet depending on how successfully the issues of achieving sustainability in this region are solved. This is what determines the need to work on financial mechanisms for the implementation of development projects in the Arctic, as well as to develop recommendations for the selection of projects that can be classified as green projects. A unified approach to understanding the characteristics of green instruments and green projects can become a condition for international cooperation in the Arctic region.

At the same time, in the conditions of increasing friction between the United States and Russia and China, the Arctic region, which is becoming more and more open, is turning into an area of intense rivalry between the great powers, which complicates international cooperation and the implementation of joint projects for the development of the Arctic region. This situation suggests that financing can be carried out mainly on the basis of public-private partnership, and financing instruments should meet the interests of all participants in the implementation of projects in the Arctic. Therefore, it is so important to use the international experience of financing environmental projects to analyze and identify those forms and instruments of financing, the use of which will allow more effective implementation of Arctic economic and environmental projects. For this purpose, the State Program "Socio-Economic Development of the Arctic Zone of the Russian Federation" has been developed, updated, and extended until 2025 in Russia. This Program is based on the principle of ensuring the sustainable development of the Arctic, based on the provisions formulated in 1987 in The United Nations International Commission on Environment and Development. The international community considers achieving sustainability as "development that meets the needs of the present without threatening the ability of future generations to meet their own needs." The implementation of the concept of sustainable development in the Arctic is impossible without a comprehensive solution to the economic, social, and environmental components of the development process of society, ensuring that the level and quality of people's lives grows. The choice of financing instruments is based on the principle of "responsible investment," which assumes not only the profitability of projects, but foremostly the achievement of sustainable development and positive changes in the environmental situation, ensuring social benefits in the Arctic.

The implementation of the goal of responsible investment is more consistent with green financing; the experience of using it in the interests of implementing projects with an environmental component is already quite well known in world practice. The priority goals of green financing include the use of financial services and instruments for economic activities aimed at improving the state of the environment, smoothing out negative climate changes, and using natural resources to improve the quality of life amongst society. Thus, the hypothesis of the study is to find and offer green financing tools for implementing the principle of "responsible investment" in the Arctic and deepening international financial cooperation in this region.

Literature Review

Green financing, as well as the possibilities of its use in the Arctic based on the principle of responsible investment, has not yet been fully and objectively studied. Moreover, in the theoretical discourse on the form of attracting investment flows to the Arctic in the form of traditional and green financing, opinions do not coincide. A number of researchers note a significant difference in their assessments of the possibilities of using green and traditional finance: The placement of assets in the conventional financial market is carried out as a reaction to changing market conditions, while the placement of green financing assets is aimed at the implementation of a specific environmental object and often on the basis of encouragement "from above" by international institutions and national governments (Zhang et al., 2019). For this reason, the understanding of the essence of green financing in the business community and in practice is constantly deepening; however, with a lack of empirical data for quantitative research, there are gaps in the scientific literature, which are noted by Agliardi and Agliardi (2019).

The formulation of the essence of green financing may differ between international organizations and national financial institutions, but they are united by an indication of the ultimate goal of financing, which is to achieve sustainable development of the world and national economy. Most often, when determining the essence of green financing, one can find a reference to the definition of the G20 Working Group on the Study of Green Financing (2016), which, when determining the essence of green financing, focuses on environmental benefits in the context of an environmentally sustainable development strategy.

In turn, the experts of the World Bank Group point out that when determining the essence of green financing, it should be taken into account that, in comparison with climate financing, more ambitious tasks related to the environment are solved on the basis of green financing. Green finance includes a wide range of financial institutions and asset classes, providing for both public and private financing (Damianova et al., 2018). Both of these approaches, as a key characteristic of green finance, emphasize their focus on using them to preserve and improve the quality of the environment. At the same time, there is an expansive and narrow interpretation of the term green financing in the scientific literature: The first includes only financial products and services, and the second also includes financial institutions and mechanisms for stimulating green financing (Porfir'ev, 2016).

Researchers who analyze the possibilities of using green financing outline the target areas of its application in the Arctic in different ways. Two approaches have been formed to determine the scope of the use of green financing in the Arctic zone. Supporters of the first direction outline a very wide range of projects that can be attributed to green projects in any region: (1) renewable energy; (2) conserving biodiversity; (3) adaptation to climate change; (4) prevention and control of pollution; (5) the construction of environmentally clean buildings that meet the relevant national or international standards or certifications for environmentally sustainable management of living natural resources and land use; (6) energy efficiency of creating environmentally friendly transport; (7) sustainable management of water resources and wastewater; and (8) the use of eco-efficient measures – and/or the adaptation to an economy based on the resumption of resources – for the production and implementation of production technologies (Tolliver et al., 2019). Proponents of the second approach move away from the emotional and expansion characteristics of green projects for any other global region, instead including within the scope of green finance only those projects that are more acceptable to the Arctic. The basis for this is the results of studies of climate processes in the Arctic, which have significant economic consequences emphasized by modern researchers and analysts (Whiteman et al., 2013; Hope & Schaefer, 2015; Yumashev et al., 2019). Researchers highlight those ecological processes that are associated with climate change in the Arctic region, manifested on a planetary scale (Goosse et al., 2018). Such climate changes affect the conditions for the development of resources and transport routes – therefore, when choosing the form of financing for projects implemented in the Arctic, their environmental nature should be the first priority, and therefore, green financing is preferable.

However, although at present green financing is aimed at ensuring environmental safety, at the same time uniform strict criteria characterizing green projects have not yet been developed. Still, to determine the most important industries whose development involves green financing, aspects are taken into account: firstly, the economic and social profitability of the project; secondly, the possibility of its implementation with the lowest administrative and transaction costs; and, thirdly, the maximum increase in the quantitative and qualitative characteristics of the country's GDP. Experts identify those areas of activity in the Arctic where, when implementing projects, it is necessary to take into account the environmental factor and the achievement of sustainable development resulting from the climatic features of the Arctic territory (Vorotnikov, 2018).

As the international experience of the development of the green financing market in the twenty-first century shows, there is a tendency to expand the market of financial instruments, since investors receive certain benefits from the use of green financing. In international documents, green bonds are treated as bonds of any type, the proceeds from the placement of which are directed exclusively to full or partial financing or refinancing of new and/or existing green projects that meet the established requirements.

Nevertheless, it is green bonds that have certain advantages over traditional bonds, which Tolliver et al. (2019) pay attention to: They highlight, first of all, a flexible coupon payment schedule when referring to green bonds; secondly, the possibility of obtaining state preferences in the form of tax benefits and guarantees; and thirdly, risk hedging, combining the diversification of investment in both green instruments and traditional financing. The role of the green bond is critical to achieving sustainable national and global economic development (Barua & Chiesa, 2019).

At the same time, there are factors that hinder the wider use of green financing: firstly, the uncertainty of investors in the project's belonging to the green economy (Holt, 2009); and secondly, preferences of the banking sector in favor of existing technologies and firms that are not related to the environment (Perry, 2012: 178). Green projects are generally perceived as riskier, and therefore, there is a higher cost of environmental projects and a high level of control in this market; this leads to increased costs, a lack of awareness among consumers, high risks and low return on investment (Brown & Kjell, 2007: 24–27), and a lack of clear legal requirements for the issuance of green bonds (Gutbrod et al., 2017).

Nevertheless, in Russia, when developing a mechanism for green financing in the Arctic, the following have been proposed:

1) The establishment of special regimes for nature management and environmental protection in the Arctic zone of the Russian Federation, including monitoring of environmental pollution
2) Reclamation of natural landscapes, disposal of toxic industrial waste, and ensuring chemical safety, primarily in places where the population is densely populated and where work is carried out
3) Improvements to the applied information and telecommunication technologies, including to ensure reliable communications (including from mobile technology), television and radio broadcasting, ship and aviation traffic control, remote

sensing of the Earth, ice cover survey, hydrometeorological and hydrographic support systems, and scientific expeditionary research

4) The creation of a system for the provision of navigation, hydrometeorological, and information services in the high latitudes of the Arctic (including the route of the Northern Sea Route), providing effective control of economic, military, and environmental activities in the Arctic, as well as forecasting and preventing emergencies and reducing damage in case of their occurrence, including through the use of GLONASS and the multipurpose space system (Vorotnikov, 2019)

The use of green finance in Russia is less developed than in countries such as Japan, Canada, Germany, the Republic of Korea, or a number of developing countries such as China or India (French, 2017). Nevertheless, some authors have paid attention to the study of funding support mechanisms in Russia and a number of countries based on regression analysis (Rakov, 2017). The results obtained on the basis of the use of regression analysis showed that in Russia, unlike a number of other countries, there is no relationship between the allocated expenditures of the Russian state for environmental protection and green investments of business, which is largely explained by the initial stage of development of the green investing in Russia.

Among the less studied problems of green financing in the Arctic is determining the form of financing that is more preferable for the implementation of green projects in the Arctic zone of the Russian Federation on the basis of public-private partnerships.

International Focus: Features of Infrastructure and Forms of Green Finance in International Practice

When choosing forms of green financing for the implementation of projects in the Arctic zone of Russia, the rich experience that the international community has accumulated is of great importance. The modern transition from the traditional model of economic growth to a green economy is characterized by “responsible” investment, which corresponds to the solution of economic projects in combination with the achievement of a social result for sustainable development and ensuring an increase in the level and quality of people’s lives. The implementation in the Arctic of such characteristics of the green economy as the use of innovative, waste-free and risk-free technologies for the environment is associated with the determination of the scale of costs and payback periods for environmentally friendly projects in the Arctic territories, which are characterized by a violation of the climatic balance, as well as a long period of the restoration of nature. In order to highlight those forms of green financing, the use of which is preferable for the Arctic territory of Russia where active economic activity is carried out, it is necessary to highlight those international norms regulating green financing, the use of which will make it possible to interest foreign investors and attract their capital to this region.

In international practice, the choice of the form of green financing is carried out on the basis of the UN Principles for Responsible Investment (PRI), containing recommendations for the implementation of the analysis of ESG (The principles of ESG investment are characterized by the priority of preserving the environment, taking into account social factors with qualified management (E – Environmental, S – Social, G – Governance)) factors in the investment activity of sustainable development of the global financial system and the economy as a whole.

In 2006–2020, more than 3200 asset owners, investment managers, and financial service providers, owning and managing assets valued at approximately $83 trillion, have supported the Principles for Responsible Investing. In turn, according to UNEP (2021), the developed Principles of Sustainable Insurance were supported by insurance companies with a total share in the global paid insurance premium of 25%, as well as the Principles of Responsible Banking, which were adopted by 130 banks holding $47 trillion in assets, which is one third of the total global banking sector. In order to develop recommendations for the use of green financing in the Arctic zone of the Russian Federation, it is necessary to consider, firstly, the system of institutions that have developed in the world economy that regulate, monitor, and analyze the state of the green finance system, developing recommendations and technical assistance to states and corporations implementing green projects, and secondly, financial instruments that are used for green financing (Fig. 1).

Currently, the participants in the institutional system of green financing can be conditionally divided into three categories:

1. Global and international financial institutions and banks involved in the development of principles and recommendations, monitoring, and analytical research, as well as consultants, exchanges, rating agencies, certification organizations, and standards developers
2. Investors: institutional investors (pension, insurance, and investment funds), investment banks, and private investors
3. Organizations implementing environmental projects and needing funding

An important role in the formation and development of green finance in Russia is played by those decisions that have been made at the global level, which allow all participants in the implementation of green projects to use the same terminology, criteria, and methodology when assessing and making decisions based on socially responsible financing.

In the institutional structure of green financing, an important place is occupied by the International Capital Market Association (ICMA), (ICMA was founded in 2014 consortium of investment banks Bank of America, Merrill Lynch, Citi-bank, Crédit Agricole Corporate and Investment Bank, JPMorgan Chase, BNP Paribas, Daiwa, Deutsche Bank, Goldman Sachs, HSBC, Mizuho Securities, Morgan Stanley, Rabobank and SEB.) which is the developer of the Green Bonds Principles (GBP), on which most of the emissions in the global green bond market are based. Following the GBPs gives investors' confidence that the issuer is guaranteed to channel funds from the bonds towards environmental projects. The second edition of

Fig. 1 The institutional infrastructure of green financing in the global economy. (Source: Compiled by the author)

GBPs, which came out in 2015 with the support of ICMA, specified four characteristics of green bonds:

1) Use of income (eligibility criteria)
2) The process of evaluating and selecting projects (the procedure for drawing up an objective view of the investment object)
3) Revenue management (distribution procedures)
4) Reporting

In March 2015, a working group was established to develop Harmonized Framework for Impact Reporting, initiated by institutional investors such as Blackrock and Zurich Insurance, a number of international development banks (African development bank group (AfDB), EIB, IFC), and the World Bank. A further step was the creation in 2016 of The Impact Reporting Working Group, (IRWG), within the framework of which the industry coverage was expanded. In addition, at the beginning of 2019, a number of methodological materials were published:

1) Suggested Impact Reporting Metrics for Sustainable Water and Wastewater Projects
2) Suggested Impact Reporting Metrics for Waste Management and Resource Efficiency Projects
3) Suggested Impact Reporting Metrics for Clean Transportation Projects
4) Suggested Impact Reporting Metrics for Green Building Projects
5) Harmonized Framework for Impact Reporting

Taking into account that all activities in the Arctic are influenced by the climatic factor, it is necessary to highlight the role of the Task Force on Climate-Related Financial Disclosures (TCFD), (TCFD was established in 2015 at the initiative of the G20's Financial Stability Board) which has developed guidelines for the disclosure of nonfinancial information, climate information, and information that can be useful for decision-making by lenders, insurers, and investors. In 2019, TCFD published a Report on Disclosure Practices for the 3-year period from 2016 to 2018. The availability of such recommendations enables investors to assess the degree of climatic risks and thus contributes to more responsible strategic planning. Deloitte experts note that TCFD is currently the most authoritative organization, the use of whose recommendations are intended to simplify the management of climate risks for making investment and management decisions by private investors.

To clarify the usefulness of information for climate risk management, in 2019 785 business structures were assessed that have established cooperation with TCFD. Among business structures, there are financial and nonfinancial organizations with a total capitalization exceeding $9.2 trillion, with assets under management of $120 trillion (Deloitte, 2020).

At the regional level, the Action Plan on Financing Sustainable Growth activities developed in 2018 can be singled out. The European Commission has formulated a comprehensive strategy for the use of financial resources for sustainable development. In accordance with this document, the European Commission undertook to revise the nonbinding guidelines (NBGs) from the Non-Financial Reporting Directive (NFRD), that is, information disclosing environmental, social, and governance aspects (ESG). The recommendations indicate that information should be disclosed in accordance with the Financial Stability Board's Task Force on Climate-Related Financial Disclosures (TCFD), as well as indicators characterizing the climate under the new classification system. This directive applies to the so-called Public Interest Entities (PIE), which include public companies, banks, insurance companies, and other legal entities with more than 500 employees (as defined by the EU member states). Recommendations are supported by 785 companies from around the world. In general, about 7.4 thousand companies fall under the NFRD, as some EU countries have lowered the threshold for employees from 500 to 250 people.

In accordance with the implementation of the strategy for the development of the European economy based on the ESG principles, in 2018 the European Commission established a Group of Technical Experts on Sustainable Finance (TEG) to advise on the implementation of the Action Plan for Financing Sustainable Growth. The TEG recommendations can be useful for countries that are not members of the EU, since they cover such aspects as: (1) a unified classification system in the field of sustainable economic activity, (2) the EU standard for green bonds, (3) criteria for low-carbon investment strategies, and (4) guidelines for improving the disclosure of corporate information related to climate change. Activities in the field of green finance are mainly focused on investors. For example, the UNEP Research Group managed to establish cooperation with 20 countries in the form of developing national action programs for greening financial systems, as well as cooperating with the Network of Financial Centers for Sustainable Development (FC4S) and the Forum for Sustainable Insurance (SIF), whose recommendations are used by investors.

A special place in the system of institutions involved in green financing is occupied by the International Finance Corporation (IFC), a member of the World Bank Group, on whose initiative the Sustainable Banking Network (SBN) began operating in 2012 in the interests of financial regulators and banking associations that finance sustainable development.

When developing a mechanism for green financing, the need to technologically comply with international standards while simultaneously acknowledging national interests is taken into account. In their activities, international financial institutions are guided by the principles of ESG and act as a technical consultant and coordinator of SBN participants. In 2018, the SBN Working Group on Green Bonds developed a set of practical recommendations for national governments and financial regulators on the formation of green bond markets in developing economies (IFC, 2018).

An important role is played by intergovernmental and informal organizations that develop green financing of environmental projects. To promote sustainable development and accelerate the transition to a green and low-carbon economy, the OECD established the Center for Green Finance and Investment in 2016, which, based on monitoring and analyzing the information collected, develops practical recommendations for governments; it also holds an annual Forum on Green Finance and Investment.

According to representatives of the association "Stock Exchanges for Sustainable Development" (Sustainable Stock Exchanges Initiative (SSE)) – established in 2009 on the initiative of the UN Secretary-General and with the support of the United Nations Conference on Trade and Development (UNCTAD), UNEP Financial Initiative, UN Global Compact, and the Association for Responsible Investment PRI (Principles for Responsible Investment (PRI)) – exchanges play an important role in the development and strengthening of the financial system to support the SDGs.

The number of participants in the Sustainable Stock Exchanges Initiative is rapidly increasing. At the beginning of the second quarter of 2019, 85 international trading platforms were registered, compared to 77 exchanges in 2018, where securities of 45,000 companies with a total capitalization of more than $81 trillion were represented (National Association of Concessionaires and Long-term Infrastructure Investors, 2020). At the beginning of 2021, 103 exchanges had already become partners of the initiative, on which 54,116 companies with a total capitalization of more than $89 trillion are listed in total (Sustainable Stock Exchanges Initiatives, 2021).

It is difficult to overestimate the role of stock exchanges in the greening of finance, since the development of their methodological guidelines for reporting in the field of ESG allows exchange issuers to accurately invest in green projects. Another important area of their activity is working with financial products. Thus, in 2018, 35 exchanges had at least one index in the field of financial stability and 13 stock exchanges announced the launch of the section of sustainable development bonds, including green bonds (National Association of Concessionaires and Long-term Infrastructure Investors, 2020).

Considering the institutional structure of the green financing system in the global economy, it is necessary to highlight the special role of international development banks, which, in accordance with the official documents of international UN conferences, have for many years been involved in financing projects that promote sustainable development.

The peculiarity of their activities is determined by the fact that they combine the functions of a financial institution with those of an intergovernmental organization; this allows them to all at once be a donor, a creditor, and a guarantor in the implementation of strategic projects aimed at solving global environmental problems that contribute to the achievement of SDG, to create conditions for the use of green bonds, especially at the regional level.

Modern high-tech projects that comply with the principles of ESG investment are characterized by long payback periods and relatively low profitability. Therefore, the role of international development banks increases significantly when implementing projects with an environmental component. Their support often compensates for the inability of developing countries to independently implement green projects, in which short-term planning prevails over long-term strategic thinking, inflation risk insurance is poorly developed, and there are no mechanisms to respond to negative environmental changes.

Another important area of regulation of the activities of ESG investment participants is the provision of nonfinancial information describing the purposes of using investments and income received as a result of investment, which is filled in according to the Reporting Guidelines for Investors. Part of the report is devoted to the problem of climate change, which is singled out as one of the priorities, following the recommendations of the TCFD. This important condition for responsible investment is fulfilled by NGOs, such as the Carbon Disclosure Project (CDP) and TCFD. CDP reporting systems are aimed at disclosing information regarding environmental impacts on three environmental aspects: climate change, water, and forest resources.

To strengthen the role of central banks in the implementation of the Paris Agreement (2015), the Network of Central Banks and Supervisors for Greening the Financial System (NGFS) was created at the Paris One Planet Summit in December 2017 on the initiative of eight central banks and supervisory authorities. Its goal is to exchange experience and develop environmental and climate risk management in the financial sector and to mobilize capital for green and low-carbon investments in the broader context of environmentally sustainable development. As of June 11 2019, the NGFS unites the regulatory financial authorities of 46 countries on 5 continents as members and observers (Anosova & Kabir, 2019).

Currently, NGFS unites the central banks of Germany, Great Britain, Finland, France, Mexico, the Netherlands, China, and Singapore, as well as the Financial Supervisory Authority of Sweden and the Swiss National Bank. The Bank for International Settlements, the European Bank for Reconstruction and Development, the European Investment Bank, the Organization for Economic Cooperation and Development, the Forum on Sustainable Insurance, the World Bank, and the International Finance Corporation joined the NGFS as observers. NGFS has structured its work in three areas: (1) supervision, (2) macrofinance, and (3) updating green finance. In April 2019, NGFS published its first comprehensive report, A Call For Action, which offers important recommendations aimed at strengthening the role of the financial sector in achieving the goals of the Paris Agreement (2015).

Operational management of financing flows is carried out by banks and exchanges, which provide customers with information for making investment decisions, for example in the form of stock indices. Rating agencies contribute to the assessment of up-to-date information on the green financing market.

Thus, two approaches are actively combined in the regulation and development of the global market of green financing. On the one hand, the processes of green financing in national economies are initiated at a high political level with the participation of global and intergovernmental organizations, but on the other hand, the development of specific norms and standards for the use of green instruments at the national level is actively developing with the participation of investors demonstrating leadership in their field.

As international practice shows, each country can choose projects in accordance with its national plans, strategies, and priorities of sustainable development, giving them their green status. At the same time, however, we should not lose sight of climate risks that affect not only the economies of individual countries but also the global economy. From this perspective, the development of a strategy for financing green projects and the choice of green tools for their implementation in the Arctic is very important.

Green Bonds as a Form and Instrument of Green Financing

When choosing the form of financing projects in the Arctic, it is necessary to take into account that the attraction of resources to green projects can be carried out from various sources. This can be the attraction of funds from international organizations, budget financing of environmental projects by the donor state, and the state, which can also create conditions for attracting private sector finance to environmental projects. The forms of financing of such projects are gradually changing: until recently, the provision of state guarantees that reduce the risks of private investors was mainly used; lending or public-private co-financing increases the profitability of the project for a private investor to a competitive level; the state can refuse subsidizing “dirty” projects or sending subsidies to targeted green projects. However, in the last decade, such forms of green financing as green bonds, green loans, green bond indices, or green investment funds have been increasingly introduced. It is these forms of investment in support of the environmental component in the Russian economy that are recommended by the experts of the World Bank (Damianova et al., 2018).

In contrast to international practice, where the main form of financing projects with an environmental component is green bonds, the leading role in the development of green financing markets in Russia is played by the public sector. However, it should be borne in mind that financing projects featuring an environmental component using the Russian budget allows for a guaranteed allocation of funds on the one hand, but on the other hand has insufficient control over the expenditure of budget funds in conditions of long-term uncertainty regarding tariffs and taxes, and causes investors to be unsure of their implementation, given the long-term nature of green projects.

Therefore, based on global practice, for the implementation of projects in the Arctic that contain such characteristics of a green economy as the use of innovative, waste-free, and risk-free technologies for the environment (which are characterized by significant amounts of costs and a long payback period), forms of green financing are preferred, which allow flexible response to climate changes in the Arctic territory and processes associated with the extreme vulnerability of nature and a long period of its recovery.

The main instrument of green financing that meets these requirements is green bonds, since a flexible payment schedule for their coupons can be an economic reaction to changing environmental conditions, and the possibility of obtaining state preferences in the form of tax benefits and guarantees is supplemented by the possibility of participating in the exchange market to attract additional investment resources.

As the analysis of international experience shows, in the practice of green finance, the most widespread are the issues of green bonds – debt instruments that attract funds for the implementation of projects related to renewable energy, energy efficiency, environmentally friendly transport, or a low-carbon economy. It is the green bonds that more fully meet the needs for financing economic activities in the Arctic territory of Russia.

In international practice, green bonds have been used for more than 10 years to attract financial resources to projects with an environmental component. A prerequisite for their implementation is confirmation that the project that is supposed to be financed has a positive environmental effect, and the proceeds from them will be directed to environmentally friendly projects. To do this, they must pass certification under the Climate Bonds Initiative to confirm their compliance with the goals of the Paris Agreement.

In 2011, the first pilot voluntary standard for climate bonds and the corresponding Climate Bonds Standard and Certification Scheme (CBI Certification Scheme) were published. From 2012 to 2015, four more CBI industry standards were developed and approved for projects on solar energy, low-carbon public transport (high-speed bus), and low-carbon buildings. In addition, industry standards have been developed that relate to the issuance of bonds for the implementation of programs and projects in the field of wind energy, tidal energy, and geothermal energy. In the “Version 2.1” of the CBI standards (2017), the range of debt instruments that can be certified for issuing green bonds has been expanded and the possibility of simplified verification is defined for those issuers that issue several certified green bonds per year to finance projects of the same class. The “Version 3.0” of the CBI (Version 3.0 of the “CBI Standards” has established the criteria that must be met by projects in the fields of forestry, bio and hydropower, land management, aquaculture, and fisheries, financed through the issuance of green bonds.) standards is aligned with other regional and international standards, such as the Green Loan Principles, the European Union Green Bond Standards, and the ASEAN Green Bond Standards. On June 6, 2019, information was published that the CBI announced the beginning of discussions with market participants on industry criteria related to the issuance of green bonds for the implementation of projects and programs in the field of waste management, The “Waste Management Criterion.”

Given such a wide range of problems related to the environment and the sustainable development of the national and global economy, the volume of the issuance of green bonds is growing very rapidly. Accordingly, whereas in 2015 about $36 billion of green bonds were issued around the whole world, then in 2020 $250 billion have already been issued and already $236 billion in the first half of 2021. (This figure characterizes the placement of green bonds (green bonds): that is, instruments that follow the principles of Green Bond Principles/Climate Bonds Initiative, etc. In addition to green bonds, there are also social bonds (social bonds), sustainable bonds (sustainability bonds), bonds linked to sustainability indicators (sustainability linked bonds), transitional bonds (transition bonds), etc. Together, all these tools are united by the term “Sustainable Bonds.” If we take all such issues in the first half of 2021, their total volume will be, according to various estimates, from $500 to $680 billion.) Also, according to some expert estimates, in 2021 the amount of the issue of green bonds will reach $1 trillion dollars (Gianfrate & Peri, 2019: 128). The history of the emergence of green bonds is connected with the European Investment Bank (EIB) and the World Bank. (In 2007, the EIB issued structured bonds linked to the stock index in the amount of €600 million ($807.2 million), calling the product “Climate Awareness Bonds.” Proceeds from the placement of bonds were used to finance projects for the development of renewable energy sources and energy efficiency improvement. Also in 2007, the World Bank Group was approached by a group of Swedish pension funds through the bank SCB (Skandinaviska Enskilda Banken) with a request to develop a financial product that would be reliable and almost risk-free, but at the same time would support activities aimed at combating and adapting to climate change. Pension funds sought not only to minimize the climate risks of their portfolio, but also to direct financial flows to projects that would have a positive impact on the environment and the well-being of society. The World Bank Group, in turn, worked to mobilize private financing for climate projects. The result of the coinciding of mutual interests and joint work with Swedish institutional investors was the formation of the concept and implementation in practice of a fundamentally new financial instrument – green bonds with fixed income and a credit rating of AAA, issued for the first time in 2008 in the amount of $2.3 billion with a maturity of 6 years. The first green bonds as securities did not differ from ordinary bonds in terms of credit financial risk. They were released under the same conditions, and they had the same risks.)

In the modern financial market, there is a constant expansion of the types of green bonds, which makes it possible to choose the financing instrument that better meets the conditions for attracting capital to finance green projects. This is very important when it comes to choosing a financial instrument for Arctic projects that are implemented in extremely difficult climatic conditions. Green bonds in modern financial markets, according to the classification presented in the Green Bond Principles, can be of four types: standard, income-linked, project, and securitized. Standard green bonds include debt obligations certified according to the international green standard. Income-linked bonds differ from them in that they do not provide for the right of recourse to the issuer in the terms of their issue, and credit risk is tied to cash receipts on account of income. Asset-backed bonds, or securitized, green securities (mainly bonds), are a relatively new instrument in the green market. Their collateral can be green mortgage assets, clean energy loans with property valuation, car loans, and receivables. The main source of repayment of secured bonds is cash receipts from assets. As an example, there is the issue of bonds secured by leased cars in order to finance the sale of zero-emission cars, which was carried out by the Japanese auto giant Toyota in 2014.

At the international level, green bonds are regulated by the Green Bond Principles (GBP) and the SBN Climate Bond Initiative, which provide a mechanism for ensuring confidence in green securities. Such trust is certified by the presence of a certificate with the stamp of approval "Certified Climate Bonds." In order to receive "Certified Climate Bonds" with the seal of approval, a potential issuer of a Green or Climate Bond must appoint a third-party Verifier who will provide confirmation that the bond meets the Standard of Climate Bonds.

The Climate Bonds Standard (CBS) provides a detailed taxonomy of projects whose financing can be qualified as green. The CBS taxonomy contains eight sectors of green projects: energy, transport, water resources, buildings, land and marine resources use, industry, waste management, and information and communication technologies. The peculiarity of the Principles of Green bonds (Green Bond Principles (GBP)) is the ability of issuers and independent appraisers to independently interpret and determine the degree of environmental friendliness of projects. Nevertheless, the Green Bond Principles formulate four key requirements for the placement and circulation of green bonds: (1) strictly targeted use of borrowed funds, (2) evaluation of funded projects, (3) clear rules for managing the proceeds from the placement, and (4) regular publication of reports on the use of funds and the environmental effect.

Confirmation of compliance of green bond issues with the four key principles is carried out with the help of an independent assessment of experts or organizations with generally recognized experience in the field of environmental sustainability or in other areas related to the issue of green bonds. There are several types of independent external audits – "second opinion," certification, rating – and they, in turn, are regulated in detail by the Guidelines for External Evaluation, also developed by MARK and applicable for external audits of the issue of not only green but also social and sustainable development-related bonds. One of the problems of issuing green bonds is that the criteria for the compliance of projects and instruments with the green status, developed by various international structures and national regulators, may not coincide.

For example, within the framework of the Action Plan on Financing Sustainable Growth, the European Union proposed a regional environmental taxonomy in order to universalize the requirements for member countries, but at the same time this requires other countries to be guided by these requirements and criteria for classifying projects as environmental, thereby not taking into account the requirements of the national legislation of individual countries. An active participant in the Chinese green bond market is constantly updating the Catalog of Projects that can be financed with green Bonds by the Green Finance Committee in the form of bonds. This Catalog includes industries related to the extraction and production of fossil fuels, which does not meet international standards.

The remaining differences in approaches to determining the criteria and requirements for projects that can be considered green constrain the growth of the market of green bonds, also indicating that the conditions for harmonization and the unification of requirements for projects that can be implemented on the basis of green financing have already been formed in the global green finance market.

The Centre for International Climate and Environmental Research (CICERO) (Norway) – a nonprofit organization that studies changes in the field of the environment, climate change, and green finance – contributes to the assessment of the quality of the issue of green bonds. The first significant result of its activity was the expert assessment (second opinion) of the first issue of green bonds of the World Bank in 2008. CICERO offers three different degrees of compliance with the criteria of green bonds. In order to increase professionalism in the work in the second opinion direction, a subsidiary company – CICERO Shades of Green AS – was founded in December 2018 to conduct an independent assessment of green and sustainable bonds and the relevant internal management procedures of the issuer.

According to the CBI report, at the end of 2018, CICERO accounted for 28% of all certificates issued anywhere in the world. The international rating agency Moody's participates in the assessment of the quality of the issue of green bonds, which in 2016 developed a methodology for evaluating green bonds (Green Bonds Assessment (GBA)), based on the principle of targeted use of funds, which allows evaluating the approach of the issuer of green bonds to the management, administration, and distribution of funds raised and received from the issue of bonds, as well as evaluating the quality of disclosed information about the impact of the project on the environment.

According to Moody's methodology, green bonds are evaluated on the basis of five key factors, taking into account their weight (significance):

1) The effectiveness of the management of the company that issued the bond, including the assessment of the organizational structure of the company, the decision-making process, and the quality of reporting. The weight of this factor in the aggregate assessment is 15%.
2) Distribution of the raised funds: assessment of the approved policies in the field of green financing, as well as compliance of the implemented project with one of the international assessment systems (e.g., the Green Bond Principles). The weight of this factor in the aggregate assessment is 40%.
3) Disclosure of information on the distribution of attracted funds, assessment of the quality, and transparency of information disclosure by the issuer. The weight of this factor in the aggregate assessment is 10%.
4) The quality of management of the attracted funds; assessment of internal organizational procedures and methods used by the issuer to manage the attracted funds. The weight of this factor in the aggregate assessment is 15%.
5) Reporting and disclosure of information on ongoing projects of environmental significance: assessment of the quality and transparency of the issuer's reporting, as well as the frequency of published information. The weight of this factor in the aggregate assessment is 15%.

For each of the five factors, an assessment of the additional five factors (subfactors) is given. The final rating of green bonds can vary on a scale from *G1 (excellent)* to *GB5 (bad)*. In April 2019, Moody's Investors Service expanded its activities by acquiring a stake in the capital of the French company *Vigeo Eiris*, specializing in the development of ratings in the field of responsible investment.

Thus, it can be stated that an institutional system of green financing has been formed in the world economy, but there are still differences in the regulation of the use of specific forms of green financing, in particular green bonds, which may be an obstacle to expanding their use.

From these positions, the approach to overcoming obstacles to the development of the green finance market, proposed by researchers who identified five conditions that create the most favorable environment for the issuance of green bonds, deserves great attention:

1) Macroeconomic stability
2) Formation of a transparent institutional structure
3) Participation in intergovernmental organizations such as the OECD
4) The country's participation in the implementation of the Paris Climate Agreement 2015
5) The presence of a developed institutional environment and the growth of macroeconomic characteristics (Tolliver et al., 2019)

Based on a factor analysis of data for 49 countries that in the period from 2007 to 2017, the issue of green bonds was carried out, and the researchers formulated their own Index of the impact of the terms of the Paris Agreement on the issue of green bonds. This index allowed us to confirm the influence of four of the five conditions on the creation of the most favorable environment for the issuance of green bonds. The exception was such a condition as the impact of membership in the OECD on the issue of green bonds, which, according to experts, does not affect the issuance of green bonds. We can agree with this conclusion, since such countries as India and China, which entered the market of green financing in 2015, are most actively using green financing. Chinese and Indian financial institutions have boomed in the market of green financing, which was previously dominated by Scandinavia, the United States, and the United Kingdom.

In 2018, according to Bloomberg, the volume of the global market of environmental and social bonds has exceeded $430 billion in 10 years and continues to grow. A third of all securities are accounted for in 2018 with the placement amount of $114 billion. At the same time, the list of Top-five issuers by the volume of placement in 2018 included:

1) The Chinese industrial bank – Industrial Bank – placed in the amount of $9.6 billion dollars
2) European Investment Bank – for $7 billion
3) Dutch Financial Group ING – for $4.3 billion
4) The World Bank – for $3.8 billion
5) Chinese Industrial and Commercial Bank of China – for $2.3 billion

In 2018, China is the leader in the regional context, accounting for 28% (or $32 billion) of all issued green bonds. Among developing countries, China is the leader in issuing green bonds. The volume of Indian bonds is not so significant and in 2019 amounted to a little more than $1 billion, but it can be assumed that the volume of green instruments will grow rapidly. The reason for the expansion of green financing was the reorientation of the Indian economy to the use of low-carbon technologies. At the same time, in the OECD countries, investments in renewable energy sources amounted to $266 billion; the leaders are Germany, the Netherlands, and the United States.

For the period from 2007 to 2020, out of the ten countries with the largest volume of green debt, the United States is the leader in total volumes of green borrowing, with China taking the second place. Eight countries (France, Germany, the Netherlands, Sweden, Spain, Canada, and Japan) of the ten leading countries participating in the green finance market are developed countries and have high per capita income indicators. However, it is not entirely legitimate to establish a direct relationship between per capita income and the volume of green borrowing. Such an indicator as per capita income depends on many factors and conditions and cannot linearly affect the possibility of using green financing. The examples of India and China show that developing countries can quickly take high positions in the green debt market and their activities do not depend on per capita income. It is likely that their capabilities are currently limited by the insufficient level of development of the financial market and financial institutions. In addition, a possible reason for the less widespread use of green financial instruments by developing countries may be the level of qualification of the local workforce and, as a result, the lack of opportunities for implementing high-tech environmental projects that would require green financing.

Green Bonds in the Russian Federation

The green finance market in Russia has emerged quite recently and is just beginning to gain growth rates. The formation of a mechanism for regulating the market of green instruments takes place in conditions when they are already used; therefore, institutional structures and state bodies are forced to quickly formulate regulatory norms.

Nevertheless, in Russia, some attention was already being paid to solving environmental problems in the 1990s; however, Russia's priorities in the field of climate change mitigation were presented more systematically and comprehensively in 2009 in the Climate Doctrine of the Russian Federation, which not only identifies problems related to climate change that cause damage (primarily as a result of dangerous weather events in the amount of about ₽60 billion), but also identifies priority climate goals for the future. The priorities that are highlighted in the Climate Doctrine almost all relate to projects implemented in the Arctic territory of Russia. Referring to the most significant impact on the greening of the economy, the Climate Concept highlights the need to increase the share of energy from renewable sources, increase energy efficiency in the energy sector, expand the use of energy-efficient and environmentally friendly technologies, and introduce innovative eco-technologies in the field of energy production and district heating.

An important step towards the implementation of Russia's national priorities in the field of environmental protection was the development in 2017 of "Strategies of Environmental and Economic Security for the Period up to 2025." 2017 was named the "Year of Ecology in Russia," which provided a high level of attention to existing environmental problems and attracted a wide range of citizens and interested participants in economic activities. During this period, the attention of Russian corporations and banks was attracted by green bonds that met the ESG principles, although they accounted for only about 5% of the total volume of the bond market in the global green finance market. In 2018, the solution of environmental problems became one of the 12 national programs in accordance with the Decree of the President of the Russian Federation No. 204 dated 07.05.2018 "On national goals and strategic tasks for the development of the Russian Federation for the period up to 2024."

The Government of the Russian Federation has developed national projects (programs) in 12 areas: (1) Demography; (2) Healthcare; (3) Education; (4) Housing and urban environment; (5) Ecology; (6) Safe and high-quality roads; (7) Labor productivity and employment support; (8) Science; (9) Digital economy; (10) Culture; (11) Small and medium-sized entrepreneurship and support for individual entrepreneurial initiative; and (12) International cooperation and export.

The national projects approved in the Russian Federation meet the paradigm of the Sustainable Development Goals and the development strategy of the Russian economy. Implementation of priority tasks in the field of ecology within the framework of the national Ecology project is estimated to attract ₽3.2 trillion from the market.

One of the directions of targeted programs financed from the budgets of various levels of the budget system of the Russian Federation and extra-budgetary sources is the state program "Socio-economic development of the Arctic zone of the Russian Federation," updated and extended until 2025. This program provides for the creation of promising points of economic growth based on the introduction of high-tech production and energy, production and fisheries clusters, and special economic zones. The use of a public-private partnership is envisaged as one of the promising forms of attracting financial resources to the Arctic region.

An essential prerequisite for the formation of the green finance market in Russia was the development, in accordance with the decree of the Government of the Russian Federation No. 2423-r of December 18, 2012, of a plan for the implementation of the "Fundamentals of state policy in the field of environmental development of the Russian Federation for the period up to 2030."

This plan included a number of activities:

1) Preparation of proposals on the development of voluntary environmental responsibility mechanisms for organizations with the participation of the state, and the transition of state corporations to mandatory nonfinancial reporting in the field of environmental protection and environmental safety in accordance with international standards (due date: 2014; responsible executors: the Ministry of Natural Resources of the Russian Federation, interested federal executive authorities,
2) Inclusion (voluntary) of nonfinancial reporting of organizations containing indicators (groups of indicators) in the field of environmental protection in the annual state reports on the state and environmental protection of the Russian Federation, as well as (among other things) its placement on the official website of the Ministry of Natural Resources of the Russian Federation (due date: 2015–2030; responsible performers: the Ministry of Natural Resources of the Russian Federation, interested federal executive authorities)

As international practice has shown, for the development of green financing in Russia, it is necessary to have nonfinancial information that makes it possible to assess the company's contribution to solving environmental and social problems and to get information about its environmental management, strategy, and goals in the field of sustainable development. "Concepts for the development of public nonfinancial reporting and an action plan for its implementation," developed in 2017, further made it possible to determine the content of nonfinancial reporting, which characterizes the results of the organization's activities in terms of social responsibility and sustainable development, as well as preventing corruption. Already in 2017, 164 companies and organizations were included in the National Register of Corporate Non-Financial Reports, which is maintained by the Russian Union of

Industrialists and Entrepreneurs. These companies issued 751 nonfinancial reports for the period from 2000 to 2016. These include: environmental reports (68), social reports (291), reports in the field of sustainable development (247), complex reports (120), and industry reports (25) (The World Bank Group, 2018).

The result of the creation of the Working Group on Responsible Financing (ESG finance) in May 2018, within the framework of the Expert Council on the Long-term Investment Market at the Bank of Russia, was the preparation of a Diagnostic Note "The Diagnostic Overview Green Finance: the Agenda for Russia." Thus, the regulatory and organizational basis for green financing in Russia was created.

There is a gradual transition from mainly state financing of green projects and a wider attraction of private investment. During the period from 2003 to 2015, the share of environmental protection expenditures as a percentage of WFP decreased from 1.3% to 0.7%, which is comparable to developing countries.

In 2016, investments in the fixed capital of green projects began to grow at the expense of the companies' own funds, the share of which amounted to 5.4% of the total volume of green investments in Russia (Fig. 2).

According to the World Bank experts, in order to guide Russia on the path of sustainable development, environmental protection expenditures should not be lower than the level of 2003, that is, 1.3% of GDP. This amount will be approximately comparable to the share of public spending on environmental protection in the systems of national accounts of OECD countries. For example, Germany spends 1.2% for these purposes, Hungary 1.3%, Switzerland 1.7%, Greece 2.5%, Slovenia 2.7%, and Latvia 2.6% (The World Bank Group, 2018).

However, this does not mean a reduction in the role of state green investments, which usually initiate private partnerships in such areas as energy, municipal waste disposal, wastewater treatment, transport infrastructure, and construction in the field of water infrastructure. According to IFC estimates, taking into account climate factors, short-term investments should reach $9.3 billion in renewable energy

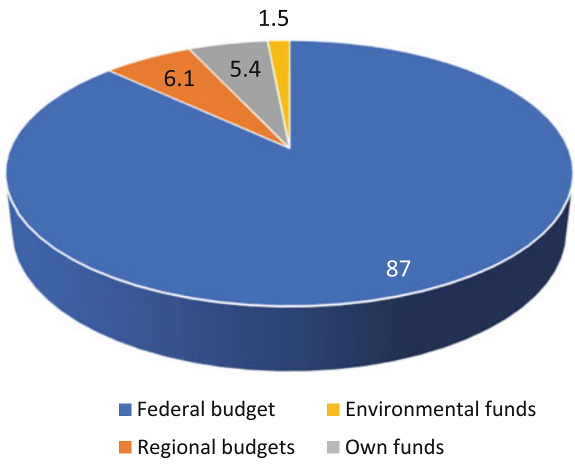

Fig. 2 Investments directed to the fixed capital of projects related to environmental protection in 2016 (% of the total). (Source: Compiled by the author based on The World Bank Group (2018))

sources by 2020 and $47 billion in urban infrastructure, including $6 billion in transport and $22 billion in building modernization (IFC, 2016).

The year 2018 marked the beginning of the formation of the market of green bonds in Russia, when the first placement of green bonds by the company "Resource Saving KhMAO" (engaged in the processing of municipal solid waste in Western Siberia) took place on the Moscow Stock Exchange. This was the first issue of green bonds in Russia based on the Green Bond Principle ICMA, with a volume of ₽1.1 billion. The company received a second opinion from the European rating agency Rating-Agentur Expert RA GmbH. In March 2019, the issue of green bonds of the company "Resource Saving of KhMAO" was included in the international register of green bonds Environmental Finance Bond Database. In addition, Russia was among the countries that issued green bonds, and the RAEX-Europe verifier was included in the list of verifiers of 2018. In May 2019, the issue of green bonds of the RSB KhMAO was included in the ICMA register.

The next important step was the formation in 2019 of the fund of shares of socially responsible companies, which was recognized as The Swedish fund Alfred Berg Ryssland, which is under the advice of the Russian company TKB Investment Partners, and has been investing in Russian shares since 2008.

Among the most significant companies that placed green bonds in 2019 is the company "Russian Railways" (RZD). The volume of the issue of green Eurobonds amounted to €500 million, with a coupon rate of 2.2% and a maturity of 8 years. The placement was organized by JP Morgan, VTB Capital, and UniCredit. The company "Russian Railways" intends to use the funds raised from the issue of green bonds to finance or refinance the costs of buying electric locomotives or passenger trains, in accordance with the categories of ICMA (Eligible Green Project Categories), Green transport (Clean Transportation), including electric, hybrid, railway, etc.

To support environmental projects, MOEX has created a sustainable development sector (Table 1).

As of the 1st quarter of 2020, seven issues of green bonds were placed by five issuers. All issues were approved by external verifiers in accordance with the principles of green ICMA bonds. The issuers of green bonds were: LLC "Transport Concession Company," FPC "Garant-Invest," LLC "SFO RuSol 1," PJSC CB "Center-Invest," and the Government of Moscow (Table 2).

In April 2019, a significant event occurred for the Russian green finance market, when MOEX joined the Sustainable Stock Exchanges Initiative, which will allow implementing projects in accordance with the UN Sustainable Development Goals. Since April 2019, two indices that meet the ESG principles are calculated daily on

Table 1 The amount of green bond issues in 2016–2021

Year	2016	2017	2018	2019	2020	2021
The amount of the placement (billion ₽)	3.2	3.5	3.7	1.8	6.5	70
Growth rate (%)	–	9.4	5.7	−51.4	261	976.9

Source: Compiled by the author based on data from the *Moscow Exchange*. Retrieved from: https://www.moex.com

Table 2 Issues of green bonds by Russian issuers

Issuer	Industry and region	Type of bonds	Output volume	Date and place of placement	External verifier	Foreign registry
LLC "Resurso-sberzhenie KhMAO"	Housing and communal services Khanty-Mansi Autonomous Okrug – Yugra	Project bonds	₽1.1 billion	19.12.2018 MOEX	PAEX-Europa Rating Agency	Environmental Finance Bond Database
"Russian Railways," RZD Capital PLC	Railway Transport Infrastructure Russian Federation	Euro-bonds	€500 million	23.05.2019 Irish Exchange	Sustainalytics	Green Bond Database Climate Bonds Initiative
PJSC CB "Center-Invest"	Renewable energy sources, ecological transport Krasnodar Krai	Corporate bonds	₽250 million	15.11.2019 MOEX	PAEX Rating	Agency-Europe Green Bond; Database Climate Bonds Initiative; Database of Environmental Finance Bonds; ICMA Database, Green, Social and Sustainable Bonds Database
JSC Commercial Realty FPC "Garant-Invest"	Commercial real estate, green technologies Moscow	Corporate bonds	₽500 million	17.12. 2019 MOEX	Rating Agency RA Expert	
LLC "SFO RuSol 1"	Green energy, solar power stations Astrakhan region	Structural bonds	₽4.7 billion ₽900 million ₽100 million	12.02. 2020–14.02.2020 MOEX	PAEX-Europa Rating Agency	

Source: Compiled by the author based on data from the *Moscow Exchange*. Retrieved from: https://www.moex.com

MOEX. These are the “MOEX Index-RSPP Responsibility and openness” and the “MOEX Index-RSPP Vector of sustainable development.” The first index is calculated based on the share prices of 22 issuers that are among the leaders in disclosure of information in the field of sustainable development, and the second index takes into account the share prices of 15 issuers that managed to demonstrate the best dynamics in terms of sustainable development in relation to the previous year.

The infrastructure of the green financing market includes five rating agencies (Expert RA, RAEX Europe, the National Rating Agency (NRA), the National Credit Ratings Agency (NCRA), and the Analytical Credit Rating Agency (ACRA)), which perform the role of verifiers performing external environmental assessment of projects. In June 2019, the rating agency RAEX-Europe published the rating “Leaders of Russian Business in environmental spending” based on the results of an analytical assessment of companies’ expenses on environmental projects.

Among the leaders in 2017 were Norilsk Nickel, Ilim, and Arkhangelsk Pulp and Paper Mill, whose environmental expenditures were estimated at an average of 3.8%, while the average rating of the TOP-20 companies allocated about 1.9% for these purposes; this is also higher than the average level in the European Union, where companies give about 1.5% to the environment (The World Bank Group, 2018). As follows from the rating published in October 2019, Lukoil has the first position. Tatneft takes the second place. Gazprom is in the third position (National Association of Concessionaires and Long-term Infrastructure Investors, 2020).

The rating indicates not only an interest in solving environmental problems, but also a direct participation in their solution by using the best experience in the field of ecology, management, and social responsibility of the company. It also creates conditions for increasing the interest of foreign businesses in participating in Russian green projects.

The successful implementation of a limited number of projects with an environmental component on the basis of green bonds has created favorable conditions for the use of green financing in the Arctic zone of Russia, where active economic activity is conducted. So that such measures in the Arctic as the creation of mineral resource centers for the development of deposits, the development of renewable energy, the processing of garbage and household waste, or the development of national parks, nature reserves, and nature reserves and other areas of environmental activity can be implemented; there are provisions by the State Program “Socio-economic development of the Arctic zone of the Russian Federation” until 2025. For the implementation of this, ₽58 billion have been allocated from the federal budget and the budgets of the territories belonging to the Arctic Zone of Russia for the period 2021–2025.

A system of preferences has been developed to increase the interest of private capital in solving environmental projects in the Arctic. First, those entrepreneurs who show interest in implementing green projects and are ready to invest at least ₽1 million will receive the status of a resident of the Arctic economic zone and will be able to receive preferences and incentives. Thus, in May 2019, the government resolution approved the procedure according to which the budget reimburses the issuer for 70% of coupon payments. If a company purchases Russian industrial equipment as part of its project for which the securities are issued, then 90% of the payments are already reimbursed. This benefit will not affect foreign firms or Russian companies controlled through offshore companies; nor will it affect those who have tax debts. There are other benefits for participants of specific projects: for example, according to the statement of the plenipotentiary representative of the President of the Russian Federation in the Far Eastern Federal District Yuri Trutnev, for projects in the field of LNG production and gas chemistry and projects for the development of new oil fields in the Eastern Arctic, the MET will be provided at 0% for 12 years.

This provides for the reimbursement of 75% of the volume of insurance premiums for new jobs. VAT on sea transportation and icebreaking support is reset for all companies. In addition to tax benefits, there are plans to create a free customs zone, provide land plots without bidding by the decision of the regions, and reduce the time for customs clearance of goods and expertise (Trutnev, 2020).

Taking into account the gradual development of the institutional infrastructure and the development of the State Program for the Socio-Economic Development of the Arctic, the prerequisites for the use of green financing and the issuance of green bonds for the purpose of financing production activities based on the ESG principles have been formed. However, despite the successful experience of green financing of a number of projects discussed above, proposals for issuing green bonds for the Arctic region of Russia are moving very slowly. It is expected in the near future to establish subsidizing of a part of the coupon income on bonds, with the help of which projects on modernization of production facilities in the Arctic will be carried out, as well as subsidizing of the interest rate on bonds issued in circulation in order to attract investment in projects related to environmental modernization.

Thus, the process of using green bonds for the development of environmental projects in the Arctic is at an initial stage.

Conclusions

The analysis of the use of green financing to attract investment resources, based on the ESG principle in the Arctic zone of Russia, has shown that, in general, there are good prospects for its use, along with public-budget financing of private capital through the issue of green bonds.

The institutional system of green financing that has developed in international practice, in which all structures interact (including international structures that regulate, monitor, and analyze the state of the green financing system, as well as that develop recommendations and technical assistance to states and corporations implementing green projects), can become a basic example for the green financing system that is being formed in Russia, the structural elements of which are still operating separately. Therefore, it is necessary to create a single coordinator for the use of green financing in the Arctic based on the ESG principles. This task could be performed by a specially created Environmental Bank of the Arctic, like the Northern European Nordic Investment Bank or the Green Investment Bank in the UK.

The organization of green financing in the Arctic zone of Russia requires a standard for evaluating the practices and results of companies' activities on environmental and social aspects. The lack of clear criteria for classifying investments as green hinders the attraction of foreign capital and the arrival of foreign investors, for whom following the ESG principles is impossible without a guarantee of eliminating environmental risk. For example, when buying bonds of an incineration enterprise that reduces environmental pollution but at the same time increases greenhouse gas emissions into the atmosphere, it is impossible to clearly understand whether such an enterprise belongs to green projects. If such an enterprise is considered green in accordance with the ICMA and Climate Bond Initiative standards, then in the EU standards for green enterprises, the restriction of carbon emissions into the atmosphere and the conservation of natural resources and biodiversity are in the first place.

Investors from developed countries who have a great interest in investment participation in the Arctic are trying to clearly understand whether this project is green, since they attach great importance to social responsibility. Therefore, the creation of a list of green projects in the Arctic is one of the first places for the introduction of green financing. National environmental and social standards have been developed in many countries seeking to use green financing. This applies to the European Union and some European countries; for example, in France, such standards are available in China, but many countries use the international standards of the ICMA and Climate Bond Initiative.

An analysis of the state of the institutional system of green finance in Russia allowed us to conclude that the verification institute is still being formed, so issuers resort to the services of international companies. At the same time, according to the established international practice, international verification companies are quite independent in their expert calculations, so the investor should be able to evaluate their opinion and, if necessary, make their own decision. Therefore, it is important to have national verifiers that take into account the peculiarities of the green project in the Arctic region. In the meantime, rating agencies such as Expert RA, RAEX Europe, the National Rating Agency (NRA), the National Credit Ratings Agency (NCRA), and the Analytical Credit Rating Agency (ACRA) are engaged in this activity in Russia.

The international experience of using green finance shows that in order to attract investment flows to the Arctic, it is necessary to expand benefits for companies that invest in green Arctic projects and strengthen responsibility for violating the ecological balance in this region. Benefits from the financial regulator, the Bank of Russia, could be added to the benefits already put into effect. For example, it is possible to take into account the methods of green management when calculating the rating of banks, to introduce minimum requirements for managing social and environmental risks, and to reduce the mandatory reserve rates for banks participating in the issue of green bonds.

When it comes to financing green projects in the Arctic, it is necessary to take into account the fragility of the eco-environment in this region and the impact on the climate on a planetary scale. Thus, awareness of this fact should initiate the attraction of financial resources from the global capital market. This is also possible with the help of debt securities, such as green bonds, the demand for which is growing very rapidly in all countries. However, entering the world market with Arctic green bonds implies the presence of a well-structured institutional system in Russia of green financing, improving the system of regulating the process of issuing and circulation of green bonds, and expanding incentives for investors participating in green projects based on the ESG principles.

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Foreign Direct Investment in Svalbard

Special Legal Status and Comparison with FDI in Yamal Peninsula

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Abstract

This chapter reviews the changing Arctic context and track record of investment climate, including foreign direct investments (FDI) on the remote Arctic Archipelago of Svalbard under the specifics of its regime combining the "extraterritoriality" status and sovereignty of Norway according to the 1920 Svalbard Treaty. It explores a package of drivers – socio-economic, political, and environmental – which define the specific frameworks for investment climate, including both investment opportunities and constraints. In this context, it discusses a possible vision of investment dynamics for this remote Arctic Archipelago with its northernmost settlements of the world as well as approaches of countries traditionally involved in Svalbard economic development (Norway, Russia) and non-Arctic states (China) inclined to get access to remote polar regions, transportation routes, and economic activities on and around Svalbard. A rebranding of economic activities on Svalbard is underway, away from coal mining as the major item of its previous mono-sector economy – to tourism, transportation, service infrastructure, and scientific research, with its implications and challenges for investment climate. It analyzes major recent innovations in the sustainability paradigm and its possible impacts on investment opportunities, including new trends in green investments and their sustainability. Specifics of investments and economic activities on Svalbard are in their role of a strategic instrument for "maintaining the presence" of the signatories to the Svalbard Treaty. This chapter presents the innovative results of analysis of the major drivers, frameworks, and trends in Svalbard investment opportunities in the context of rapid Arctic transformations. They are coupled with results of inquiry into the specific role of the Svalbard Treaty regime for defining the opportunities and limitations for foreign direct investments.

Keywords

Svalbard · Arctic transformations · Sustainable development · Extraterritoriality · Investment climate · Foreign direct investments · Non-Arctic states

Introduction

In recent years, investors have been looking for new areas of capital application abroad. Despite the crisis in the world economy, foreign direct investment (FDI) stocks continue to grow. Thus, while at the end of 2010 the global FDI stock amounted to $20 trillion, by the end of 2020 it reached $39–41 trillion (in current prices). The indicator increased by $5 trillion, even in 2020 during the COVID-19 pandemic (UNCTAD, 2021). The forms of FDI have become more diverse and the range of investors has expanded. New important recipients of FDI are emerging among industries and regions that were previously almost ignored by international business. Among other things, peripheral regions with a fragile ecological balance are of increased interest. This leads to the inclusion of issues on the agenda of combining the interests of FDI expansion and the goals of ensuring sustainable development, in particular in the Arctic.

Svalbard is a prime example, since the beginning of its economic development was associated with the extraction of resources (coal), and now it is increasingly interesting for FDI in the development of transport and tourism, as well as research and development (R&D) in the Arctic in the conditions of melting ice and other consequences of climate change. An important feature for the analysis of investment opportunities in Svalbard is its special legal status. At the same time, the Svalbard Treaty of 1920 requires an adequate interpretation, so it is with its analysis that our chapter begins. Next, we consider the general conditions for investing in Norway, since Svalbard is an integral part of it. At the same time, the socio-economic specifics of Svalbard are too unique to consider the region only as a part of Norway. Next, we assess the current state of FDI in Svalbard, as well as the prospects (rather limited) for expanding the presence of foreign companies in the region. The latter aspect we consider in comparison with the other Arctic region, namely, the Russian Yamal, which is more successful in attracting FDI.

Svalbard Treaty: Pillars for Investment Regime

About one hundred years ago, the Svalbard archipelago was *terra nullius*, until the 1920 Svalbard Treaty (ST) was signed as a result of the Paris peace conference after World War I, entering into force in 1925 following the Svalbard Act. As of now, 46 states have signed, or acceded to, this international regime. According to ST, Norway was allocated with the absolute sovereignty over the archipelago (in 1925 Norway declared Svalbard as a part of the Kingdom of Norway), and it has been adopting and enforcing since then laws and regulations for Svalbard. Other signatories were granted a set of rights to perform economic activities and research on the archipelago along with a variety of corresponding investment opportunities. At the same time, all economic activities are to strictly adhere to the regulations established by Norway, which had been under constant developments and updates over the last century. The Treaty envisions Svalbard to be a completely demilitarized zone, so Norway ensures that no naval bases or military fortifications are established on the archipelago (Article 9). Norwegian security activity is limited to fisheries surveillance by the Norwegian Coast Guard and to search and rescue operations. The latter is gaining its importance with expanding economic activities in the region and changing weather under rapid climate change (Kelman et al., 2020).

The Svalbard Treaty details the scope of envisioned economic activities of its parties on Svalbard and requires Norway to grant foreign persons and companies from other member states the equal rights to be engaged in economic activities – in hunting, fishing, mining, and industrial and commercial activities in the archipelago and its territorial waters. According to Article 3, all parties have the equal right “to exercise and practice of all maritime, industrial, mining or commercial enterprises both on land and in the territorial waters, and no monopoly shall be established on any account or for any enterprise whatever" in compliance with all local laws and regulations.

Particularly important for an assessment of investment opportunities on Svalbard is that the Treaty contains norms and regulations governing foreign trade and financial flows and promotes that for its signatories' "exports, imports and transit traffic, nationals, their ships and goods shall not be subjected to any charges or restrictions," and "no charges shall be imposed on the exportation of any goods to the territories of the contracting parties" (Treaty, 2020, Article 8). Nationals of the signatories have free access and entry to the waters, fjords, and ports of the territories of the archipelago and may carry without impediment all maritime, industrial, mining, and commercial operations on a footing of absolute equality, provided that all activities are subject to the Norwegian legislation and observance of all national laws and regulations.

As to the taxation system, Svalbard has a lower income tax than mainland Norway, and there is no value added tax. According to the Treaty, mining regulations for the archipelago do not envision imposts, taxes, or charges of any kind and exclude privileges, monopolies, or favors (Article 8) (Treaty, 1920). There is an exception when taxes are applied in case of export of minerals, and the Norwegian government has the right to levy an export duty, which shall not exceed 1% of the maximum value of the minerals exported up to 100 thousand tones; beyond that quantity, the duty will be proportionally diminished. The value shall be fixed at the end of the navigation season by calculating the average free on-board price obtained (Treaty, 1920).

The Treaty specifically limits the rights of Norway to collect taxes only for the purposes of providing services on Svalbard. These taxes are collected only for the purpose of supporting its local authorities. This results in a significantly lower level of taxes than in mainland Norway and in excluding any taxes on Svalbard supporting Norway as such. Also, Svalbard's revenues and expenses are separately budgeted from mainland Norway. Nondiscrimination principles are applied: All citizens and all companies of every Treaty signatory country are allowed to become residents and to have access to Svalbard including the right to fish, hunt, or undertake any kind of maritime, industrial, mining, or trade activity. The residents of Svalbard must follow Norwegian laws, though Norwegian authority cannot discriminate against or favor any residents of any nationality.

Specifics of the regulatory frameworks for Svalbard – combining the rights of the Treaty members to be involved in economic sectors, with the gradual tightening of laws and norms enacted by Norway over the century – define to a high extent the basics and context for investment climate on Svalbard, as well as opportunities for FDI, particularly by foreign investors and business of the signatories. Of special importance is the Treaty's welcome stance towards investments in economic activities, but in application of its provisions in reality, possible limitations for investment opportunities might occur.

Investing on Svalbard: Diversity of Context

The Investment Climate

Besides the provisions of the Svalbard Treaty outlining the basic framework for investment climate on the archipelago, a set of diverse socio-economic, environmental, and political factors affect its implementation and shape both opportunities and constraints for investments in general and FDI in particular.

The context and perspectives for investing on Svalbard depend to a high extent on the national investment strategies of Norway: It has a particularly favorable investment climate. According to World Bank assessments, Norway ranks 9th out of 190 countries in its 2020 Doing Business index (World Bank Group, 2020). Norway has a positive track record and welcomes FDIs. It has a very strong economy and encouraging prospects for development, high-quality infrastructure, high-skilled workforce, and a stable and positive business environment, combined with a healthy and transparent political environment (U.S. Department of State, 2021). FDI in Norway in 2019 accounted for $167 billion (i.e., $31 thousand per capita in contrast to $17 thousand for the EU-28, or $29 thousand per capita for the United States), including $1.2 billion of greenfield investments, which has almost doubled during the last decade; there are about 7300 foreign owned companies present in Norway. There are no free trade zones, although taxes are minimal on Svalbard (Santander, 2021). Sweden (21.3%), the Netherlands (10.2%), and the USA (8.6%) rank as the top three foreign investors in Norway and contribute for over one third of investment inflows (Statistics of Norway, 2021). Mining and quarrying (22%), manufacturing (15%), and financial services (14%) are the main sectors in terms of FDI here. Apart from its oil and gas sector, shipping, shipbuilding, and aquaculture, there are emerging opportunities in professional service industries like finance and ICT, cleantech, medtech, and biotechnology. Strong collaboration between industry and research institutions attracts international R&D activity and funding (Santander, 2021).

In general, Norway is a safe country to do business with, and the investor protection indexes in Norway are quite high as compared to the OECD average level, including *Transaction transparency* (7.0), *Manager's responsibility* (5.0), and *Shareholders' power* (8.0) (World Bank Group, 2020). The government is liberalizing its legislation and norms for FDI to conform more closely to the EU standards of free access and national treatment, and over the last decade, it has cut many bureaucratic regulations to make investments easier. Usually, it controls industries under the government monopoly, including railways, postal services, hydropower, and alcohol retail sales. Experts underline that there is no prohibition on foreign ownership of Norwegian real estate, but foreign companies have to obtain a license to purchase forest, land, mines, titled lands, and waterfalls. According to domestic legislation, the license is issued after the proof that the applicant has sufficient capital for the acquisition, development, and operation of real estate that will be used in mining. The regulation also prescribes a two-year postdecommissioning period for a license so as to mitigate any environmental impacts after the mine is closed (Rosen & Thuringer, 2017).

Along with a generally liberal investment regime and provisions for foreign economic activities, Norway performs tight government controls in this field, and the role of the state is quite high. It is particularly "visible" in the case of Svalbard, with its extremely vulnerable natural, socio-economic, and political environment, and this affects the investment climate of the archipelago. In 2019, the government of Norway introduced a new investment screening regime under the National Security Act; it provided the legal foundations for the Norwegian authorities to assess and block FDI on grounds of national security, national financial stability, and autonomy. This applies both to EU and non-EU investors (keeping in mind that Norway is not in the EU and Svalbard is not in the Schengen area). Regulations for the implementation of the law are being developed, including a comprehensive list of critical infrastructure, entities, and products to be covered by legislation and by investment screening procedures. Most of them are applicable on Svalbard.

It is well known that the government plays a strong role in Norway's economy through its ownership or control over many leading commercial companies. The government is the largest owner in Norway, with ownership stakes in a range of key sectors like energy, mineral resources, transportation, finance, and communication infrastructure. About 70 state owned enterprises are managed directly by the relevant government ministries; successive governments have sustained levels of strong, transparent, and predictable government ownership. The public sector in Norway accounts for about 60% of GDP. In Svalbard, according to the recent domestic statistics, for example, the share of employment in private sector accounts for about 50.4%, while the other half is engaged in the public sector – in the municipal sector, central government works (including social security funds), and in enterprises owned by central and local government (Statistics of Norway, 2020). Today, the level of annual public subsidies in all economic sectors of Svalbard is quite high, accounting for about 21% of their total annual turnover, and they are 1.8 times surpass the level of investments in economic sectors (Table 1). The major part of them goes to public administration support, education, and mining. The strong role of the government spreads over regulatory practices in FDI. Influx of unregulated FDI in Svalbard is somewhat possible.

Norway established a fisheries protected area surrounding Svalbard on June 5, 1977, with strict fisheries regulations extending to 200 nautical miles beyond the territorial waters. Fishing vessels from Norway, Iceland, Russia, the Faeroe Islands, and the European Union are awarded quotas for cod and herring. Until 2010 when the compromise was reached, Norway and Russia (as well as the USSR before 1991) disagreed about the bilateral border in the exclusive economic zone in the Barents Sea. However, regularly minor fisheries conflicts and disagreements over fisheries occur between Russia and Norway in the marine areas around Svalbard, which are among traditionally attractive grounds for Russian shipping vessels.

The important context-specific issue is how and to what extent political factors and superpowers' Arctic politics around Svalbard could affect the FDI dynamics. For example, there is an opinion that due to political reasons, and in order to avoid possible conflicts with the parties of the Treaty, and particularly, with Russia/USSR, Norway

Table 1 Svalbard: Indicators of economic sectors in 2019

Sectors	Investments ($ million)	Turnover ($ million)	Public subsidies ($ million)	Wage costs ($ million)	Number of establishments (units)
Svalbard, *total*	**46.55**	**400.99**	**84.12**	**124.10**	**321**
including Mining and quarrying	0.17	16.77	17.78[a]	10.29	1
Manufacturing; electricity, gas, steam supply, air conditioning, water supply, sewerage, waste management, remediation	0.86	27.41	0.58	6.51	15
Construction	2.20	71.33	0.004	17.94	21
Transportation, storage	7.62	50.32	0.006[a]	13.17	22
Accommodation, food services	5.31	40.84	3.63	12.78	21
Information, communication, finance	11.16	74.55	0.06	6.09	15
Real estate	8.57	10.18	0	0.50	27
Professional, scientific, technical activities	0.97	5.63	8.04	N/A	N/A
Education	1.51	7.07	20.79	12.60	8
Administrative a support service	3.51	36.97	8.44	10.75	64
Public administration, defense, social security	1.64	3.36	36.70	8.88	8
Human health, social work	0.06	1.56	2.49	5.43	9

Source: Compiled by the authors based on Industry Statistics for Svalbard (2021). *Statistics of Norway*. Retrieved from: https://www.ssb.no/en/
[a]Data for 2018

has been tending to discourage any foreign presence on Svalbard, particularly where it could raise tensions, as well as economic activities and investments, even while they were strongly encouraged on the mainland (Tamnes & Offerdal, 2014). In general, during the Cold War, Norwegian politicians intended to avoid placing the archipelago within superpower wrestling (Tamnes, 1992; Ulfstein, 1995; Vylegzhanin, 2010; Dyomkin & Fouche, 2013); trying to avoid any tensions led Norway to disallow practically all foreign and innovative use of the archipelago, thus simultaneously tightening its national regulations. The USSR, basing its view on the Treaty norms

(Article 9), was constantly insisting that the archipelago was a demilitarized zone, and protested against any foreign or new forms of Norway's activities, even if remotely related to military. Not going into details of ongoing scientific discussion on the Svalbard Treaty implementation process, it should be mentioned that experts underline the existing deviations in approaches and legal interpretations of some of its articles by the parties. For example, some note that despite the demilitarized status of Svalbard, Norway supports narrow interpretations and does not consider as violations the entry of military vessels into its ports, as well as military aviation flights over the archipelago; due to recent developments of polar technologies of dual use, some experts pose the question about the eligibility of satellite data collection by the Svalbard stations with its further use for military purposes (Todorov, 2020). The same relates to norms defining legal aspects of marine activities in the areas adjacent to the Svalbard islands (Vylegzhanin et al., 2019). Such variations in approaches to the state of the art might affect, for example, not only fisheries, but future development of port infrastructure and attraction of FDI for these purposes.

Sustainable Development

During the last decade, important trends in sustainable development have been emerging. Innovations relate to consolidating corporate sustainability strategies to meet the global sustainable development goals by the companies operating in the Arctic regions, and on Svalbard in particular. These have impacts on corporate investment strategies and are to be taken into account by companies to enhance their competitiveness (Nikitina, 2018). Of particular importance might be wider application of such mechanisms as: (1) the diversification of instruments of corporate social responsibility and sustainability; (2) integrating the *Triple Bottom Line* principles into corporate management models based on interactions between their ecological, social, and economic priorities; (3) ensuring the sustainability of corporate supply chains and logistics; (4) a transfer to green investments; (5) the development of strategies towards carbon neutrality and reductions of carbon footprint; and (6) the introduction of regular corporate reporting on sustainable development actions.

Responsible investments and sustainable business conduct are very much part of the Norwegian corporate and political consciousness, and significant attention is paid to sustainable business practices. These principles are applied in corporate practices on Svalbard. A series of guidelines and white papers had been issued by the Norwegian government, including Guidelines for responsible conduct in state-owned enterprises, climate policy, and sustainability policy that are parts of the government vision of corporate social responsibility and CSR (Kelman, 2018). Norway adheres to the OECD Guidelines for Multinational Enterprises; transparency and disclosure are key to the development of CSR practices: Large enterprises are required under Section 3-3c of the Norwegian Accounting Act to report on their CSR activities. In the mining sector, Norway encourages adherence to the *OECD Due Diligence Guidelines for Responsible Supply Chains* of Minerals from Conflict-Afflicted and High-Risk Areas and participates in the Extractive Industries Transparency Initiative (EITI) (Rosen & Thuringer, 2017).

Svalbard Environmental Protection Act and Environmental Fund

Specific regulatory framework for sustainable development on Svalbard is represented by the *Svalbard Environmental Protection Act*, adopted in 2001 and taking effect on July 1, 2002 (Ministry of Climate and Environment, 2001), which replaced some previous environmental regulations. It established a set of stringent norms for responsible economic activities to preserve the ecosystems of the archipelago and contained additional limitations for doing business and land-use; it is supplemented by a variety of specific regulations. For example, they include regulations relating to (a) motor traffic, (b) camping activities, (c) environmental impact assessment and the delimitation of the land-use planning areas, (d) an environmental fee for visitors to the archipelago, (e) requirements to keep dogs on a leash on Svalbard, etc.

It addresses the protection of wilderness, flora and fauna, climate, and cultural heritage. Although according to section 1 it allows environmentally sound settlements, research, and commercial activities, it imposes bans on the use of transport in certain territories (particularly motorized vehicles in off-road areas), but allows the locals to operate snowmobiles in wider areas than tourists. Restrictions on motor transport in river systems and at sea are in effect. It introduces detailed provisions for land-use planning and permits for economic activities. Two thirds of Svalbard's area is protected through national parks and nature reserves. In some cases, it raises concerns of foreign entities acting on Svalbard, as a system of extremely strict rules regulating access to and passage through the natural environment (including restrictions and prohibition) is established. This Act is applied to the entire land territory of Svalbard and marine areas of the territorial sea. It is strictly enforced, with its implementation controlled and verified by designated authorities, that is, the Ministry of Climate and Environment, as well as the governor of Svalbard; enforcement regulations, penalties, and sanctions are in effect (ØKOKRIM, 2002). According to its section 98, a special *Svalbard Environmental Protection Fund* was established: It is formed from environmental tax which equals NOK 150 (about \$17–\$18) collected since 2007 from everyone coming to Svalbard; residents also pay this tax, but may get a refund. The proceeds of this fund can be used exclusively for protecting environment of Svalbard, including monitoring, mapping, research and training, restoration, and ecological impact assessments.

Svalbard's Socio-economic Track Record

Profile

By 2019, the annual turnover of main economic sectors on Svalbard accounted for NOK 3,645,405,000 (i.e., about \$400 million). According to recent statistical regional accounts from Norway, in 2018 the value added of Svalbard at basic prices accounted for NOK 1m361,000,000 (about \$150 million). Investments increased almost by 1.5-fold during 2009–2019, up to NOK 423,213,000 (about \$46.5

million) (Statistics of Norway, 2020). In the structure of investment and in annual turnover across economic sectors, the top leaders on Svalbard are (1) communication, finance, and insurance, (2) construction and transportation, and (3) accommodation and food services (Table 1). Investments track record and their structure on Svalbard is reflected in the Norwegian statistical outlook and particularly by its industry statistics; it does not present, however, FDI disaggregated profile and major trends for Svalbard. The only indirect estimate of FDI stock can be done due to the largest non-Norwegian company reports, that is, Russian Arktikugol. Its noncurrent assets in Svalbard exceed $23.4 million (RBC, 2021).

There is a major current trend on Svalbard – its economy is being rebranded with a shift from coal mining to tourism, scientific research, and education. Until recently, coal mining has been dominating the Svalbard economy, and the major settlements of Longyearbyen and Barentsburg were founded around coal mining. Coal production has a stable downward trend since 2007, and today, coal mining is not the leading economic sector on Svalbard as it used to be (Table 2). Tourism is turning to be one of the key industries in the archipelago. The mining industry employed about 400 people in 2009, while in 2020 the number was reduced to about 100. On the other end of the scale, employment in tourism was about 280 people in 2009, but by 2018 this figure increased by approximately to 600 (Glomsrud et al., 2021), although the COVID-19 pandemic starting in 2020 has led to changes, as will be discussed later. The main economic activities on Svalbard are performed mostly by Norway and Russia.

The specifics of Svalbard's economy affect the investment climate: The economy of Svalbard is not diversified. Due to its geographical location, the Svalbard expenditures in transport, logistics, and telecommunication infrastructure are high. A significant limitation for FDI is insufficient or completely missing infrastructure and logistics for business and economic activity. Relatively strict labor laws are enforced, and they accelerate appropriately high wage costs. Limited community infrastructure and system for health care and local welfare are not among the strong points. For example, the hospital services in Longyearbyen have a general practitioner's office by day and it has only one ICU bed. Those in need of urgent health care must take a 90-min flight to Tromsø on the mainland; pregnant women also need to fly to the mainland to give birth. Public subsidies for health care sector are at a quite low level (Table 1).

There is no indigenous population on Svalbard. Most of its inhabitants – 2900 in 2020 – move there to work. Wages on Svalbard are high, and annual income of its residents is 23% higher than on the mainland in Norway. Today, the highest wages across sectors are in construction, transportation, accommodation/food service, and education (Table 1); in coal mining, they have been declining. Most residents live in Longyearbyen, Ny-Ålesund, and Barentsburg. Very few people remain on Svalbard after their retirement (the proportion of children and older people is much lower than in the Norwegian mainland, and the predominant age group is 25–39 years). The share of foreign residents is about 30% of the total population, and the local communities have diversity of residents from about 40 countries (Glomsrud et al., 2021). Although Norway does not offer significant tax benefits to both domestic and

Table 2 Svalbard: Trends in coal production, 1991–2019 (tones)

Years	Svalbard total, coal shipped	Russian mines, coal shipped	Norwegian mines		
			Coal shipped	*Coal shipped to Norway*	*Persons employed*
1991	770,183	482,798	287,385	59,197	358
1992	665,171	438,000	227,171	39,640	339
1993	691,948	414,000	277,948	60,900	299
1994	776,939	485,600	291,332	136,600	296
1995	674,060	412,488	261,572	100,740	287
1996	610,670	378,171	232,499	93,241	269
1997	618,077	562,834	255,243	88,660	246
1998	601,998	245,835	356,163	79,598	201
1999	755,477	355,538	399,939	122,436	226
2000	1,050,928	361,002	689,926	91,870	223
2001	1,717,184	151,682	1,565,502	84,413	248
2002	2,243,448	110,000	2,133,448	98,905	225
2003	3,186,765	377,533	2,809,232	116,399	233
2004	2,991,166	132,077	2,859,089	125,612	265
2005	1,863,337	95,077	1,768,260	101,211	314
2006	2,419,745	88,140	2,331,605	62,451	315
2007	3,690,075	106,923	3,583,152	178,106	396
2008	3,468,901	39,756	3,429,145	53,084	387
2009	2,436,821	–	2,436,821	48,701	368
2010	1,648,513	–	1,684,513	66,423	337
2011	1,749,617	110,000	1,639,617	39,998	370
2012	1,370,355	66,478	1,303,877	17,733	396
2013	2,221,073	111,913	2,109,160	41,638	336
2014	1,747,145	112,038	1,635,107	23,501	356
2015	1,272,494	67,921	1,204,573	77,200	207
2016	1,049,361	117,528	931,833	0	106
2017	183,990	66,749	117,196	2663	105
2018	145,995	65,030	80,965	0	92
2019	195,146	117,818	77,328	0	97

Source: Compiled by the authors based on Industry Statistics for Svalbard (2021). *Statistics of Norway*. Retrieved from: https://www.ssb.no/en/

foreign investors across its counties, the tax breaks are significant in Svalbard. Minimal taxation in Svalbard and lower social security payments, lower tax rates, and extra deductions – as in all sparsely populated areas in the northern parts of the country – characterize the specific context for FDI investments on Svalbard.

There is a growing scientific discussion about the future development of transportation infrastructure, including the potentially growing importance of Svalbard for the schemes of Arctic ports logistics, the role of the archipelago in future Arctic transit shipping routes connecting Europe and Asia, and arguments about the under-explored potential for port development on the archipelago (Galvao et al., 2020).

Among the core challenges is the high dependence of large-scale port development on attracting outside investment and linkages with international business perspectives, particularly in cruise, cargo, and fishing ocean transportation in the changing Arctic. There is growing evidence that interests of China to such an endeavor and its ambitious Polar Silk Road are consolidating. Also, there are many suggestions about the prospective use of a nonfreezing port of Barentsburg for providing services for the Northern Sea Route, including icebreaker services and repair.

Svalbard and its featured extraterritoriality status is a useful example of economic activities and foreign investments used as an instrument for supporting the national political interests of the parties to the Svalbard Treaty. They are undertaken to "maintain presence" at the archipelago. For example, traditionally this relates to Russia (and previously to the USSR) and its economic activities on Svalbard, mostly to coal production in Barentsburg, and in currently closed mines near Pyramiden and Grumant. Russian investments have been essential for maintaining its presence and for preserving its jurisdiction over its sites and property, since, according to the Norwegian regulations, the maximum time period is fixed for abandoned cites. Thus, the existing former infrastructure of conserved mines in Pyramiden and Grumant is used for research and tourist purposes. Other parties of the Treaty, including, for example, China, have recently been inclined to demonstrate their presence on Svalbard and maintain activities there.

Coal Mining

Since the early twentieth century, coal mining has been the core economic activity on Svalbard and its major settlements; they were founded around coal mining and extraction. Today, Svalbard's coal production has a stable downward trend after its peak in 2007 when its production increased up to 3.7 million tones (0.8 million tons in 1991) (Table 2). Global coal prices have been declining recently, with reductions in its consumption in the OECD countries: by 2.9% during 2009–2019 (today OECD coal consumption has fallen to its lowest level according to BP data series since 1965 (BP, 2021)). Together with other factors, this has had impacts on coal industries of Svalbard; an anticipated restructuring in the global energy balance to meet carbon neutrality and reduce the carbon footprint is also of an influence. Currently, Svalbard's total amount of coal shipped accounted for 195 thousand tones in 2019. According to official statistics of Norway, about 60% is produced by the mines of Russia and the rest by those of Norway (Table 2). Only about 6% of people employed on Svalbard are now engaged in coal production. The turnover in this economic sector declined to 4% of Svalbard's total. With declining coal production, this sector remains highly subsidized by the Norwegian government: public subsidies to mining sector by Norway are still comparatively high, ranking 3rd among other sectors and accounting for 21% from the total Norwegian subsidies on Svalbard in 2019 (Table 1).

The first foreign investor on Svalbard was the American John M. Longyearbyen, who founded the *Arctic Coal* company in 1906 on the island of Spitsbergen. Ten years later, his company was purchased by the Norwegian state company *Store Norske*, which has been involved in coal production since then. Svalbard coal mining by Norway increased considerably at the beginning of this century, reaching its peak by 2007. After closure of a comparatively new Svea Nord mine (which started its operations in 2002), along with several others which were to be cleaned-up, only one Norwegian mine (Gruve 7) remained in activity. The estimated costs of clean-up are quite high, accounting for about $132 million (Glomsrod et al., 2021). All coal shipped from the Norwegian mine (77.3 thousand tones in 2019) is used on Svalbard for local purposes.

The Russian coal mine in Barentsburg started coal mining in the 1930s, and the coal production has been operated since then by the state company *Arktikugol*. It also operated mines in other parts of Spitsbergen – in Grumant and Pyramiden – but they have been closed recently. Therefore, only one Russian mine in Barentsburg remains in production.

Tourism

The variety of investment opportunities in the tourism sector is broad. The tourism and leisure industry in Svalbard has become a rapidly growing economic sector since a commercial initiative launched in 1995 in Longyearbyen. It was part of the government policy of economic diversification to support other economic activities, while coal reserves and production had been declining. Ecotourism and visiting the unique pristine nature of the archipelago is a niche within the tourist attractions. It has been a strongly growing industry over two last decades. The number of enterprises engaged in accommodation and food service increased during 2008–2018 from 11 to 23; these had a comparatively high turnover, accounting for $45 million in 2018, with a considerable number of staff engaged in tourist services, accounting for about 15% of the total employment on Svalbard (Statistics of Norway, 2020). The state-of-the-art tourist sector is reflected by domestic statistics of Norway under the entry "accommodation and food services." During 2010–2019, the accommodation statistics indicated at more than a doubling in the number of guest-nights stayed in Svalbard during this period (Gromsrud et al., 2021).

It had been a highly promising economic sector, until the COVID-19 pandemic severely affected especially this branch of Svalbard's economy. As a result, there has been a considerable decrease in the number of guest nights spent at the hotels and camping sites during 2019–2021, although Svalbard successfully managed to solve the problem: no local COVID-19 cases have yet been registered. Svalbard's governor mandated masks even outdoors, and violations could lead to fines and six months imprisonment. Few tourists had been quarantined due to having contact with infected on the mainland; a negative test is required for entrance of Svalbard (Jesionka, 2021). The revenues of the hotels on Svalbard declined proportionally to the downward trend of guest-nights stayed there. In this collapsing situation, the Norwegian state has allocated and more than additional $2 million for the tourism industry on Svalbard to support the companies affected.

Until then, the tourism on Svalbard used to be seasonal, with fewer visitors arriving in the autumn and winter and more in the spring and summer. The majority of tourists coming to Svalbard are Norwegians. However, the number of foreigners who were particularly attracted to this diamond in the Arctic tourist crown has increased recently. Visitors from Europe outside Scandinavia make up the category with the largest growth among the foreign tourists. Particularly popular were sea cruises, with arrivals either by cruise liners or by private yachts. The number of huge cruise liners that call on Svalbard for one or two days as a part of the longer journey has been quite stable during the last decade – about 30 were bringing on average more than 40,000 guests arriving annually (Statistics of Norway, 2016); in 2019, there were 50,000 cruise tourists and 166,000 overnight stays in the hotels (Staalesen, 2021), which considerably surpass the number of the local population.

The controversial issue is that, together with profits and additional job opportunities for the locals, they brought significant pressures on local communities and fragile ecosystems. Recently, the option for tourists coming by plane and joining 4–7 days expedition cruises around the archipelago was also becoming very popular. There is a wide variety of organized tours such as dog sledging, snowmobile and boat trips, hiking, and glacier crossing. Specific coal tourism is organized at the cleaned mines in Longyearbyen and Pyramiden, closed for production, respectively, in 1995 and 1998. Tourism is strongly controlled and regulated by the Svalbard governor (originally called *Sysselmannen* and changed in July 2021 to *Sysselmesteren*), who defines strict rules for tourist activities, including safety issues and search and rescue. For example, heli-tourism is forbidden so that wildlife is not disturbed. Permits are required for private tours beyond the zone of the main settlements for safety reasons, as well as medical insurance and mobile satellite connections.

Foreign Investors in Svalbard

Russia: Innovations in the National Strategy for Svalbard

Russia is the key foreign investor on Svalbard; since the 1930s, it has performed its economic activities according to the Svalbard Treaty. For almost a century, it maintained its presence of the archipelago mostly through the coal mining sector.

During the last decade, there have been a number of innovations in the national policy of Russia regarding Svalbard. In 2012, the new national strategy of the Russian presence on Svalbard had been introduced (Decision, 2012) and the road map for its realization was enacted in 2015. Its strategic foci had shifted significantly. Similarly to Norway, the major diversification of economic activities had been undertaken, and a rebranding of the Svalbard strategy with the shift from *coal production* to *scientific research* and *tourism* was undertaken. Although limited coal mining would remain a part of Russian economic activities on Svalbard in a short-term perspective, the main national interest and its priority are linked to the development of fundamental and applied research. Svalbard is regarded as a unique site for the further development of Arctic science; prospects for consolidating international scientific cooperation are encouraging. Practical actions are undertaken in this field. In 2014, the Russian science center and permanent Arctic expedition had been established with their research facilities based on existing infrastructure at Barentsburg and Pyramiden. A detailed concept and research program for Svalbard had been adopted (Concept, 2014). About ten leading research institutes in Russia are performing research programs at Svalbard on various aspects of the Arctic change – in climatology, glaciology, oceanography, geophysics, geology, archeology, history, environmental monitoring, and remote sensing; the coordinating institute is the Arctic and Antarctic Research Institute based in St. Petersburg. Among other innovations in strategic planning is the support for development of the tourist sector on Svalbard. Recent novelty in the Russian Federation's strategy for Svalbard is directly linked to the adoption of the national policies in the Arctic and the introduction in 2014 of the strategy of the Russian Federation's Arctic zone development with its new amendments for the period up to 2035 (Official Portal of Legal Information, 2020), outlining ambitious targets including the economic development, resource extraction, shipping, logistics, and infrastructure.

Corporate Level: Arktikugol

Russian mining on Svalbard started in 1912 and took off when the Soviet state company *Trust Arktikugol* (literally: Arctic Coal; hereafter *Arktikugol*) bought the Dutch interests in the settlement of Rijpsburg in 1932, renaming it as Barentsburg. The coal company was established in 1931 to take over the Soviet mining interests on Svalbard. Since then, it turned from a specialized coal mining enterprise into a federal state unitary enterprise owned by the Russian Federation's government. Its total assets accounted for $30.4 million (in contrast to $31.6 million in 2019 and $65.1 million in 2012). Arktikugol's noncurrent assets, which can be seen as a rough estimate for FDI stocks, also decreased from $40.5 million in 2012 to $20.7 million in 2019, but in 2020 their volume reached $23.4 million. Turnover is rather small (e.g., $8.8 million in 2019 and only $4.5 million in 2020 due to the COVID crisis). During all recent years, the company demonstrates losses (e.g., $6.8 million in 2020) (RBC, 2021).

Today the town of Barentsburg, along with the closed mines and settlements Pyramiden (closed in 1965) and Grumant (in 1961), as well as a port in Colesbukta, is owned and managed by *Arktikugol*, which, according to the Russian Federation's legislation, was allocated with city-forming functions. Apart from its coal mining activities, it is also responsible for maintaining technical and social infrastructure, logistics, sourcing labor, and healthcare. On Svalbard, it owns territory of about 251 km^2 (Arktikugol, 2021). Besides mines and supporting technical facilities and port infrastructure for coal shipments, its other assets include apartment buildings, the power station, the hospital, the hotel, the food court, the library, the swimming pool, the cinema, and the fitness center. It is quite actively involved in performing its corporate social responsibility strategy.

Currently *Arktikugol* performs limited coal mining in Barentsburg. Production has a downward trend starting from its peak in 1997 when 562 t of coal were shipped (Table 2). In 2019, about 117.8 t of coal were shipped from Barentsburg mines. It was used for local purposes to fuel its power station and it is also exported to Western Europe at low market prices. During the entire 87-year period, about 12 million tonnes of coal had been produced (Arktikugol, 2021).

Arktikugol is an official agency through which Russia exercises its Svalbard policy and in particular implements its national strategy to maintain its presence on the archipelago. From 2000, the government of Russia decided that all activities in Svalbard will be financed through *Arktikugol*. All federal budget subsidies for support of Russian organizations on Svalbard are consolidated through *Arktikugol* (Agreement, 2017), including federal budget allocations for the new Russian research program on Svalbard. *Arktikugol* is a company heavily subsidized by the government; however, poor accountability and low effectiveness of diversification policy was reported by the Accounts Chamber of Russia at the beginning of the 2000s. New management was appointed in *Arktikugol* in 2008, and a series of investments were undertaken to meet environmental and safety requirements to comply with the Norwegian regulations.

To implement the Russian Federation's new national strategy for Svalbard, the company started diversifying. Efforts were undertaken to promote Russia's scientific research program. Starting from 2014, the consortia of research institutes initiated the activities of the Russian Research Center for the Spitsbergen Archipelago, and the new research station was opened in Barentsburg, making it the second-largest employer in the town; its expeditions are also using the facilities and infrastructure of Pyramiden.

Arktikugol announced other plans for rebranding, including the entry into a tourist market on Svalbard, converting facilities of Barentsburg from a polar mining settlement to a tourist destination, building a fishing station, modernizing sport and spa facilities, converting some of the buildings into a hotel, and starting production of bottled water. In 2015, the tourist company *Grumant* was organized to offer a variety of tours to visit Svalbard, and professional guides and modern equipment had been recruited. All these actions essentially had been destined for realizing the core political challenge of the national strategy to maintain the presence of Russia on Svalbard.

Non-Arctic States: China

Under rapid Arctic change, many non-Arctic states express growing interest in accessing the region, its transport routes, tourism, economic activities, and resources. China is at the top of the list and had already have made substantial investments in the region, with the strategic intent to do more. It quite aggressively performs its recent national strategy to realize its polar interests that have been summarized in its 2018 Arctic Policy white paper (State Council Information Office of the People's Republic of China, 2018). Through labeling itself as "near-Arctic," it has massively expanded its involvement in the region, particularly to make its new Polar Silk Road a reality, which is among its top priorities in its Arctic strategy; the launch in 2018 of innovative Arctic infrastructure networks to support China's global shipping deliveries is among its core ambitions. Until recently, China has primarily realized its interests through investments in transport infrastructure along the Northeast Passage, innovative technologies and shipbuilding, and participation in the projects with Russia and its companies in the energy sector (Wenger, 2020). The question remains whether existing legal and regulatory regimes are capable of dealing with significant new FDI while at the same time ensuring the sustainability of the Arctic and protecting its environment and communities (Rosen & Thuringer, 2017).

China has been a member of the Svalbard Treaty since 1925, and nowadays economic activities on Svalbard are a part of its Arctic strategy. However, the People's Republic of China "rediscovered" the Svalbard Treaty only in 1991 in line with its inner economic reforms (Liu, 2021). Its core interests for the archipelago center upon transportation, logistics infrastructure, research, and tourism. As a first step, in 2003, it built its *Arctic Yellow River* research station in Ny-Ålesund to study the *aurora borealis* and microbes in the ice-pack while monitoring glaciers and the atmosphere. However, the role of the Norwegian state and controls over economic activities on Svalbard is strong, and it has been illustrated recently in the tourist sector. In 2021, there have been rumors about China buying into Svalbard via possible purchase into the British private company *Hurtigruten* group, which has been recently experiencing financial difficulties due to the effects of the pandemic. Chinese companies have already leased three of Hurtigruten ships and welcomed Hurtigruten investments and its presence in the Chinese market, thus intending to attract potential polar travel customers from China and also to enhance access, tourism, and investment opportunities related to the Svalbard archipelago (Wenger, 2020). Hurtigruten Svalbard AS was among the largest cruise ship tourist companies on Svalbard and owned a large property, office buildings, and several hotels and shops in Longyearbyen, but was severely affected by the pandemic. Ultimately, in spring 2021, after the announcement of the group that it was selling all its properties in the archipelago, the Norwegian state-controlled company *Store Norske* won the deal instead (€69 million) (Staalsemen, 2021). As such, the joke that Norwegian trolls along the main street in Longyearbyen inviting guests to visit souvenir stores would be soon replaced by red dragons will not seemingly come true. Nevertheless, it looks like, in the nearest future, a stable trend towards consolidating the Arctic ambitions of China on and around Svalbard might be a reality. In 2014, Chinese billionaire and property tycoon Huang Nubo mentioned that he would bid for a 218 square kilometer property on Spitsbergen located near Longyearbyen, and he planned to build a resort for Chinese tourists. This acquisition attempt was halted through the intervention of the Norwegian government.

Prospects of FDI in Svalbard in Comparison to Russian Yamal

The example of the Yamalo-Nenets Autonomous Okrug shows that the Arctic regions can attract significant FDI. According to the Bank of Russia, at the end of 2020, inward FDI stock in Yamal amounted to $31.6 billion. Compared to the end of 2014, the indicator increased by more than 5 times (from \$5.9 billion) (Bank of Russia, 2021). The main part of FDI is related to investments in the extraction of raw materials. At the same time, the development of resources is stimulated by the gradual revival of the Northern Sea Route due to the improvement of navigation conditions due to global climate change.

Can Svalbard repeat the path of Yamal? On the one hand, the investment attractiveness of Yamal is associated with gas extraction and LNG production. Many northern regions are typically attractive for FDI due to the most diverse resources. Even when they receive much less capital than in Yamal, their inward FDI stocks are still significant. For instance, inward FDI stock in Chukotka Autonomous Okrug with its ore mines increased from \$383 million to \$446 million during 2015–2020 (Bank of Russia, 2021). On the other hand, there are no such reserves of raw materials in Svalbard with its traditional specialization in coal mining. Indeed, the development of the Northern Sea Route is more promising for Svalbard. This route supported with new infrastructure introduced by significant FDI can serve the transportation of raw materials from more profitable fields in other Arctic regions, and decades later, possibly, transit cargo flows from Asia to Europe and back.

An example of Svalbard's port development strategy analyses in accordance with FDI concepts has been already introduced. Svalbard is well-placed to service the hypothetical future Trans-Arctic Route, but still, many transarctic shipping companies can continue to rely on larger ports with existing facilities in Germany or the Netherlands instead of participation in development of new infrastructure in Svalbard. Nowadays, Longyearbyen's port activity falls into four major categories: tourism, cargo, research and monitoring, and fishing. International cruise ships bring the most people to Svalbard, while fishing vessels are the most numerous. Cargo ships, however, are fewer in number, with only two ships making regular runs to the archipelago and 5–6 others making occasional visits. In addition, coal ships visit about 25–35 times per year, freezer vessels remain year round to work with fishing vessels, two to three bulk carriers visit the island, and about 10 vessels act as suppliers for the cruise ships (Nyman et al., 2020). Due to that report, some significant OLI-advantages (i.e., *ownership*, *localization*, and *internalization* advantages in terms of J. Dunning theory) for FDI can be seen in Svalbard.

For instance, ownership advantages can be connected with tourism, oil and gas, fishing, and transportation companies, which have already entered Arctic business activities. Localization advantages are connected with the touristic attractiveness of the archipelago on Svalbard for cruise ships and the geographical proximity to resource fields in other cases. Internalization advantages for FDI can be seen in the potential reduction of transaction costs. However, supporters of the heyday of Svalbard's port activity understand that Svalbard is a small island archipelago with a remote location and extreme weather conditions. It has a multinational, non-native population with high yearly turnover. Most importantly, it faces potential issues with varied interpretations of the Svalbard Treaty.

Even now, Norwegian experts explain fears that the 1920 treaty will be used by third powers to internationalize business in Svalbard. A typical example is scientific activity. On the one hand, R&D activities increase the awareness of potential investors (especially since the link between FDI and state Arctic strategies is well traced). On the other hand, Norwegians do not like the autonomy of leading scientific stations, which can become an occasion for the political consolidation of non-Arctic powers in the Arctic. It is useful to stress that the British, Dutch, Chinese, and Franco-German stations (not to mention Russian R&D activities) actually ignore Norway's proposal to develop an international scientific center, but under the auspices of Norway, which has sovereignty over Svalbard (Pedersen, 2021). It is possible that the demonstration of the flag by South Korea, Japan, India, Italy, the Czech Republic, Poland, or Turkey will also become a starting point for expansion in the Arctic in the future. All these countries are active in the field of FDI (typically private multinationals invest abroad, but state support is also present). Excessive regulation by Norway could lead to the refusal of potential investors to develop any business in Svalbard.

The best example of possible limitations for future FDI from Norway can be seen in regulations of Russian business activities. In some aspects, Norway makes efforts to "balance" Russian interests and to lower its actual status to the level of other powers. The gradual reduction of unprofitable coal mining and the presence of more than a dozen countries in R&D sector casts doubt on the special status of Russia in Svalbard in another promising branch of economic development, namely tourism (Grydehøj, 2020). Russian coal mines do not have impressive prospects. As a result, Arktikugol tries to develop R&D and touristic business. At the same time, it meets various Norwegian limitations in terms of ecology, security, etc.

For example, a piece of Norwegian legislation – the Svalbard Environmental Protection Act – tightly constrains Russia's ability to open new mines connected to Barentsburg; however, this law was only passed after Norway had improved its own mining. Similarly, efforts by the Trust Arktikugol mining company to initiate tourist-oriented helicopter transport to Barentsburg from Longyearbyen (the site of Svalbard's sole commercial airport) were halted by the Norwegian courts, citing environmental protection (Åmund, 2009). There is no need to dispute the validity of some measures. However, for example, the actual quarantine of Svalbard, which meant the archipelago avoided any COVID-19 cases at least in the first year and a half of the pandemic, caused serious damage to the tourism business here.

Conclusions

The results of our analysis indicate that despite a variety of challenges ahead, there is a promising potential for Svalbard to turn into one of the bright stars in the prospective vision of sustainability in the changing Arctic. There are clear messages from the polar regions and northern communities that they are gradually shifting away from high dependence on natural resources towards more innovative and diverse sustainability models benefiting from a combination of enormous human resources from the northerners, green investments, advanced technologies including information and communications technologies (ICTs), and instruments for enhancing cooperation between stakeholders to promote responsible and wise interactions between humans and the environment. At the same time, such a strategy does not need huge FDI. Moreover, there is no intention from the Norwegian side to deepen the internationalization of Svalbard. In contrast to Yamal, which is in a core part of Russian Arctic and could increase the presence of foreign capital without any danger to its political status, Svalbard can be seen as a “window to the Arctic” by China and other capital-rich non-Arctic countries due to possible interpretations of the specifics of the 1920 Svalbard treaty.

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Part IV

Energy

Global Energy Standoff

The Arctic Dimension

Alexander G. Simonov

Contents

Abstract

This chapter is devoted to a comprehensive Arctic development agenda on a global scale. Undiscovered Arctic oil and gas resources, as well as prospects of new transportation routes, pose both a challenge and an opportunity not only for the Arctic states but also for all economic actors worldwide. Globalization has caused a tight interdependence among countries, industries, and businesses. Any new event may cause a landslide effect. The Arctic is becoming a factor of increasing uncertainty (i.e., a black swan) for all players involved. First, the Arctic may be a game-changing factor in terms of the upcoming energy transition. Second, the region is probably to become a rising (potentially leading) logistic hub, connecting Eurasia and America. Third, the outcome of disputes on seabed allotment may drastically influence international relations paradigm of the twenty-first century. And fourth, new Arctic rules may become a solid basis for sustainable development of global economy generations in the future. The author has endeavored to provide a fair insight into Arctic issues based on data provided by multiple sources.

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Nevertheless, the reader can reconsider some qualitative evaluations themself based on the objective data provided and their own expertise. The author welcomes a productive discussion on the issues tackled by the chapter.

Keywords

Global competitiveness · Supply chain · Energy transition · Energy sources race · Economic efficiency · Cooperative rivalry

Introduction

Energy procurement has been a fundamental basis for economic and social development from the very beginning of civilization. The problems of heating houses (even when there were caves instead) and preparing food have always required vast amounts of external energy supply. The Industrial Revolution required increasing energy sources, with entire forests in Europe being exploited for energy and construction uses, which demonstrated a rigid scarcity of natural resources and designated would-be clashes for energy supplies. Extensive industrialization and railroad network development caused a massive exploration and exploitation of inland natural resources. The invention of the internal combustion engine and its massive implementation (which only happened by the middle of the twentieth century) shifted the thrust of leading nations in terms of their strategic peaceful as well as military development (some historians name World War II as a battle of motors and machinery, in contrast to all previous conflicts with man power being a key to the victory).

Despite the relatively stable global political system in the postwar period and a general trend for postindustrialization of leading powers (accelerated development of the tertiary sector and shifting industrial capacities abroad), the role of energetics has increased in most developed countries, with fossil fuels providing 80–90% of total energy supply. The forming of the global oil market by the last quarter of the twentieth century, followed by an ongoing merger of regional coal and especially natural gas markets, resulted in a tight link and interdependence among countries and industries. A well-developed transport and financial infrastructure has caused global economic equilibrium to have a low level of tolerance to any even slight changes.

A number of factors (ice loss, inland resources depletion, surging commodities prices, technological development, and political instability) have advanced the Arctic region to the forefront of the economic and political agenda. Unlike previous transformations caused by gradual technological developmental, and regional economic, changes, the Arctic factor may become a game changer, completely reshaping global economic and political relations.

Literature Review

The problems of global warming, energy transition, political sanctions, and the Arctic resource race have become topical over the last decade. Nevertheless, it should be noted that these issues, posing a significant challenge for the global economy and the further development of our civilization, have been studied mainly independently, with little stress upon their interlink and systematic influence.

The alleged long-term process of global warming and its anthropogenic (mostly energy related) origin have been studied in many scientific and analytical works by Haines (2003), Pittock (2009), and Cook et al. (2016). Although there are disputes over human influence upon warming and its weight, there is a certain consensus that this process is ongoing (Cook et al., 2016).

The warming has been addressed by most governments and international organizations, including the United Nations; a number of treaties were made, including such prominent ones as Kyoto Protocol of 1997 (signing with subsequent ratification or not by the parties), which was further amended in Doha (effective 2012–2020), and the acting Paris climate agreement of 2015, currently being the only global framework targeting environmental issues, including energy-related ones.

The topic of energy transition in global and regional dimensions, as well as modern and historical ones, has been studied by chronologists, economists, and engineers. One of the most outstanding research and classification of energy transitions was created by Czech economist and philosopher Smil and Praeger (2016). The interconnection between long cycles and energy factors was researched heavily by Mastepanov (2020). The transformation of regional and global market models and patterns were studied by Karpova et al. (2014) and Konoplyanik (2019). The influence of technical development upon energy markets and the ways of energy transportation and consumption were investigated by academic Bushuev (2020). The questions of energy security were explored by Farah (2015).

The scope and scale of undiscovered Arctic resources were evaluated by independent researches as well as by state institutions (Gautier et al., 2009). The experience and best practices of Arctic territories' economic development were mastered by Sakharov and Andronova (2020).

The problem of political and economic sanctions is widely reflected in a number of works by Gross (2016), Overland (2015), Ronzitti (2016), and Telegina and Khalova (2019).

The Arctic factor requires a systematic and comprehensive approach as this region may become either a gate to a new stage of our civilization development and prosperity or an apple of discord, affecting economic and international relations.

Arctic Energy Resources in Sights

Arctic oil and gas resources can exceed 20% of the total world resources (Gautier et al., 2009), namely up to 13% (90 million barrels) of oil and up to 30% (1669 trillion cubic feet) of undiscovered conventional gas resources. The distribution of these resources is not even: There are several basins which form several Arctic regions, which can independently pose interest for potential stakeholders. According to a US Geological Survey, about 84% of these resources are located offshore. The alleged distribution of Arctic resources is shown in Table 1.

It should be noted that oil and gas fields in the Arctic region are also distributed among basins unevenly: Most undiscovered oil resources are attributed to Arctic

Table 1 Oil and gas undiscovered resources distribution

Province code	Province	Oil (MMBO)	Total gas (BCFG)	NGL (MMBNGL)	BOE (MMBOE)
WSB	West Siberian Basin	3659.88	651,498.56	20,328.69	132,571.66
AA	Arctic Alaska	29,960.94	221,397.60	5904.97	72,765.52
EBB	East Barents Basin	7406.49	317,557.97	1422.28	61,755.10
EGR	East Greenland Rift Basins	8902.13	86,180.06	8121.57	31,387.04
YK	Yenisey-Khatanga Basin	5583.74	99,964.26	2675.15	24,919.61
AM	Amerasia Basin	9723.58	56,891.21	541.69	19,747.14
WGEC	West Greenland-East Canada	7274.40	51,818.16	1152.59	17,063.35
LSS	Laptev Sea Shelf	3115.57	32,562.84	867.16	9409.87
NM	Norwegian Margin	1437.29	32,281.01	504.73	7322.19
BP	Barents Platform	2055.51	26,218.67	278.71	6704.00
EB	Eurasia Basin	1342.15	19,475.43	520.26	5108.31
NKB	North Kara Basins and Platforms	1807.26	14,973.58	390.22	4693.07
TPB	Timan-Pechora Basin	1667.21	9062.59	202.80	3380.44
NGS	North Greenland Sheared Margin	1349.80	10,207.24	273.09	3324.09
LM	Lomonosov-Makarov	1106.78	7156.25	191.55	2491.04
SB	Sverdrup Basin	851.11	8596.36	191.20	2475.04
LA	Lena-Anabar Basin	1912.89	2106.75	56.41	2320.43
NCWF	North Chukchi-Wrangel Foreland Basin	85.99	6065.76	106.57	1203.52
VLK	Vilkitskii Basin	98.03	5741.87	101.63	1156.63
NWLS	Northwest Laptev Sea Shelf	172.24	4488.12	119.63	1039.90
LV	Lena-Vilyui Basin	376.86	1335.20	35.66	635.06
ZB	Zyryanka Basin	47.82	1505.99	40.14	338.95
ESS	East Siberian Sea Basin	19.73	618.83	10.91	133.78
HB	Hope Basin	2.47	648.17	11.37	121.87
NWC	Northwest Canada Interior Basins	23.34	305.34	15.24	89.47
MZB	Mezen' Basin	NQA	NQA	NQA	NQA
NZAA	Novaya Zemlya Basins and Admiralty Arch	NQA	NQA	NQA	NQA
TUN	Tunguska Basin	NQA	NQA	NQA	NQA
CB	Chuckhi Borderland	NQA	NQA	NQA	NQA
YF	Yukon Flats (part of Central Alaska Province)	NQA	NQA	NQA	NQA
LS	Long Strait	NQA	NQA	NQA	NQA
JMM	Jan Mayen Microcontinent	NQA	NQA	NQA	NQA
FS	Franklinian Shelf	NQA	NQA	NQA	NQA
	TOTAL	**89,983.21**	**1,668,657.84**	**44,064.24**	**412,157.09**

Source: Compiled by the author based on the US Energy Information Administration (2008). *US Geological Survey*. Retrieved from: http://pubs.usgs.gov/fs/2008/3049/fs2008-3049.pdf

Alaska (33%) and Amerasia Basin (about 10%), while the majority of Arctic natural gas is anticipated to be found in West Siberian Basin (above 39%) and East Barents Basin (almost 19%).

Another important factor besides geographic distribution is the economic feasibility of production. The cost of extraction may be twice as much relative to continental oil and gas projects in operation. For instance, according to some assessments (Bourne, 2016) the cost of oil production in Arctic is evaluated ca. $79 per barrel, slightly beyond that for oil sands. This estimation makes Arctic exploitation still limited by the current hydrocarbon prices (e.g., crude oil price has been within a range of $40–75 per barrel this year). However, further increase in prices and technological development in combination with climate change can significantly facilitate break-even opportunities for Arctic oil and gas projects.

Market Analysis: Global Energy Transition, State and Corporate Approach

According to classification by Smil and Praeger (2016), there have been several energy transitions. The first natural energy source (natural biomass – mainly firewood and dung fuel in some regions) was subsequently substituted by coal (the first energy transition), which in turn was significantly competed by oil and its products (the second energy transition). The third energy transition (shifting to natural gas) has only just started in many countries. However, there are disputes about any future (fourth) transition to new energy sources (which are expected to be renewable, i.e., solar or wind, and with a near-zero carbon impact upon the environment). At the same time, nuclear and hydro energy are nowadays almost never considered, although these sources were widely observed as candidates to oust traditional fossil fuels a few decades ago (Bromberg, 1982). However, the share of total primary energy supply (TES), based on fossil fuels (coal, oil, and natural gas) and nuclear power, is identical to that 50 years ago and achieves 85% (Fig. 1).

The cost analysis of major oil sources (Table 2) reveals a significant gap ($10–15 per barrel) between Arctic and onshore oil costs in Russia and North America. This gap constitutes about 15% of the current market crude oil price, which may soon turn Arctic field development into a profitable business. The main issue is attracting long-term investments, and this may become a real challenge for private companies having faced a significant pandemic decline.

The pandemic crisis has badly hit almost all leading oil and gas companies, significantly undermining their market capitalization (Table 3). Only a few companies from several Arctic states succeeded to keep or increase their capitalization: US Chevron, Norwegian Equinor (former Statoil), US EOG Resources, and Russian Lukoil. The rest oil and gas majors fell significantly in global ratings. The situation may be explained by the sharp decline in oil prices in 2020, as well as by overall pandemic economic meltdown. The recovery may pose a significant opportunity for the companies also in terms of exploiting new resource basis, which, nevertheless, require additional investments and respective legal base.

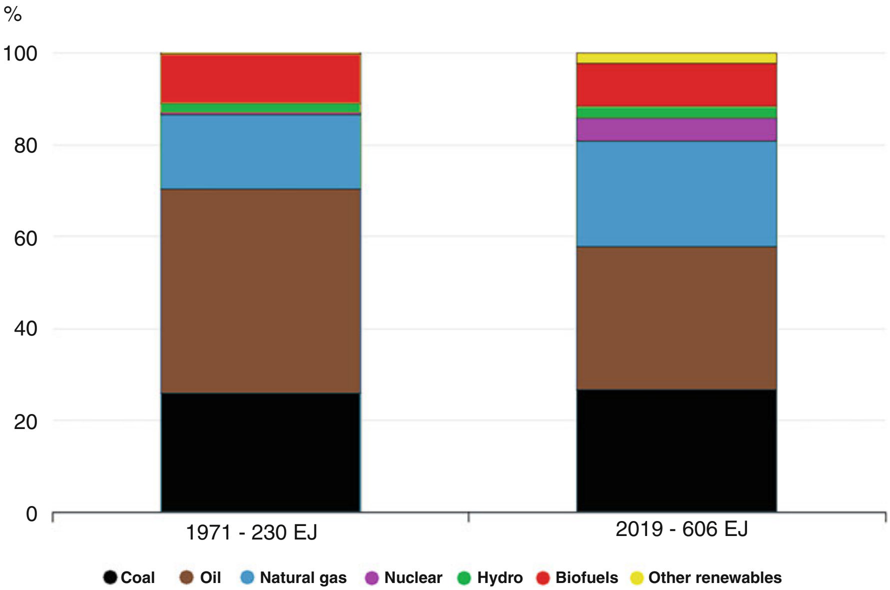

Fig. 1 World total energy supply, 1971 and 2019. (Source: Compiled by the author based on data from the International Energy Agency (2019). Retrieved from: https://www.iea.org/reports/world-energy-balances-overview/world)

Table 2 Per-barrel break-even prices for different oil sources, $

Source	Break-even price
Oil sands	$79.3
Arctic	$78.6
Shale oil, North America	$68.1
Extraheavy oil	$66.9
Onshore, Russia	$64.6
Ultra-deepwater	$62.7
Deepwater	$61.6
Offshore shelf	$59.3
Onshore, rest of the world	$58.9
Onshore, Middle East	$43.7

Source: Bourne, J.K. Jr. (2016). In the Arctic's Cold Rush, There Are No Easy Profits. *National Geographic*. Retrieved from: https://www.nationalgeographic.com/magazine/article/new-arctic-thawing-rapidly-circle-work-oil

Risk of Global Market Failure and Arctic Demarcation

Despite a significant risk of Arctic conflict caused by overlapping territorial claims, there is another substantial risk on the other side of the coin. Lack of regulation in terms of title and responsibility distribution may result in negative externalities (Stiglitz, 1989), which may exceed benefits of stakeholders in a global scale.

Table 3 Market capitalization and ranking of leading oil and gas companies in 2010, 2015, and 2021

2021 ranking	2015 ranking	2010 ranking	Company	Headquarters	Market value ($ billion)		
					2021	2015	2010
46	2	2	ExxonMobil	USA	228.5	356.5	316.2
88	26	19	Royal Dutch Shell	UK	151.0	192.1	177.0
65	23	25	Chevron	USA	185.8	197.3	152.3
95	6	1	PetroChina	China	141.8	329.7	329.3
115	57	34	Total	France	127.5	118.5	136.6
197	58	18	BP	UK	82.2	118.3	177.6
214	55	36	Sinopec	China	77.2	119.1	133.9
149	170	33	Gazprom	Russia	105.1	56.6	138.0
444	145	53	Eni	Italy	44.5	63.0	94.1
228	172	74	Equinor (Statoil)	Norway	74.1	56.5	73.9
271	273	13	Petrobras	Brazil	64.8	39.3	183.8
225	111	69	ConocoPhillips	USA	74.6	76.7	76.1
866	175	80	Occidental Petroleum	USA	23.3	56 0.3	68.7
246	213	62	Rosneft	Russia	70.1	46.0	84.1
416	142	75	CNOOC	Hong Kong	47.0	63.1	73.5
–	248	103	BG Group	UK	–	42.0	58.4
505	193	365	EOG Resources	USA	39	50.3	23.5
334	271	140	Lukoil	Russia	56.3	39.6	48.3
945	249	124	Oil & Natural Gas	India	20.9	41.9	52.3
1024	328	229	Imperial Oil	Canada	18.9	33.9	32.2
1137	441	174	Surgutneftegas	Russia	16.3	27.5	39.4

Source: Adapted by the author from FT Global 500. *Largest Companies by Market Cap*. Retrieved from: https://companiesmarketcap.com

Currently, there are only a pair of operating oil platforms (namely Prirazlomnaya, being operated by Russian Gazprom, and Goliat, being a production asset of joint venture by Norwegian StatoilHydro and Italian Eni). The third oil platform, Polar Pioneer, got suspended after its first partially unsuccessful drilling operations and the subsequent decision of its shareholder, Dutsch Shell. The anticipated growing number of Arctic oil and gas projects, further expanding northward offshore, optimizing costs for achieving better economic indicators, will increase risks of deepwater ruptures in solitary waters with few resources and manpower to eliminate emergencies.

Arctic states as well as oil and gas companies require elaborating clear rules for safety and efficient Arctic operations.

Although demarcation may pose a significant challenge for states involved with long-lasting disputes, it shall be performed for the sake of business, Arctic Indigenous people, and wild world. The latter receive guaranties of preserving safe and stable environment, while the former acquire guarantees of favorable business climate and legal environment as well. The Goliat project, located in the Norwegian sector of Barents Sea, is predominantly (65% share) owned by Italian Eni, while the hosting party (Statoil) only holds a 35% share. This is a prominent example of business efficiency in solving economic issues in harsh environments.

The lack of clear allocation creates uncertainty, which significantly increases business risks and adversely affects any business activity in the region. Due to economies of scope in oil and gas business, vast joint projects with several investors involved may become a key to Arctic fortunes.

Arctic Logistics: Reshaping Global Trade Routes

Arctic ice thawing creates new transport opportunities for oil and gas as well as other industries. Overall Arctic development and providing a competitive alternative to traditional trading routes (e.g., the Suez Canal) may turn Arctic waters into an efficient transportation hub for American and Eurasian producers and consumers. Unlike the artificial Suez or Panama canals, Arctic routes are not susceptible to technological obstruction; nevertheless, the risk of ice blockage is very high especially in winter, which requires icebreaking support for transit.

In terms of the global gas market, the increasing demand for LNG (liquefied natural gas) in combination with lower temperatures in the Arctic compared to most of the other regions (in particular the Middle East) creates a competitive advantage for the Arctic producers, as gas liquefaction is substantially facilitated in a cold environment. Since liquefaction costs may constitute up to 50% of the total production costs, any cost cut may turn Arctic producers into cost leaders against OPEC suppliers, traditionally holding top positions by this benchmark.

Another point to be observed is the list of Arctic states. Currently Canada, the Kingdom of Denmark, Finland, Iceland, Norway, the Russian Federation, Sweden, and the USA are members of the Arctic Council. This list includes developed market economies, currently being (with the exception of Russia and partially the USA) net importers of fossil fuels. Arctic fields' development and exploiting Northern Sea routes can significantly reshape global trade logistics via shortening oil and gas transportation legs. It can significantly enhance energy security of northern countries and provide for a more even distribution of supply and demand on a global scale.

Complex Competition and Technological Supremacy

Being a completely unique region in terms of climate and geology, the Arctic is, on the one hand, a terra nova with no certain borders, no local businesses, and no proven technologies, while on the other hand, this region may significantly change the existing global economic equilibrium in terms of raw resources procurement, logistic schemes, and business activities.

The Arctic countries, via interactions, preliminary agreements, and disputes, are creating the basis for further exploitation of the region. The involved parties have different competitive advantages and pursue self-consistent policies.

The United States and Russia, holding large Arctic territories and having historically political contradiction, represent a key Arctic dilemma of cooperative rivalry, which includes partially contradicting interests and a variety of specific resources, required by each of the parties.

For instance, Russia has gained a strong superiority in terms of its operational icebreaking fleet: above 40 vessels, including nuclear ones, against 2 American vessels; Canada operates 15 icebreakers, while Norway operates 2.

Another few areas of technical imbalance are geological exploration and well drilling. The importance of these issues is visually demonstrated by market oil and gas corporations' assessment: Despite controlling larger oil and gas reserves and having higher production capacities, Russian companies lack essential technologies. For instance, Rosneft delivers almost twice as much oil to the market as Exxon Mobil does and has been increasing proved reserves with double pace as well; nevertheless, market cap of Russian company is thrice lower than that of American entity. What are the key factors of success in this case? Besides institutional and market differences, it shall be admitted that Exxon Mobil enjoys better qualified human resources with a main thrust upon engineers and explorers, holding (and actively applying) a higher number of patents and know-hows as well as scope and scale of capital assets (primarily exploration and drilling equipments) (Karpova et al., 2014).

Russia's Arctic Projects and American Sanctions

The Arctic oil and gas race is gaining traction, and competition develops in several dimensions. The USA is expected to consistently pursue a policy toward Russia's deterrence/containments via sanctions (e.g., permanent pressing upon Nord Stream 2 and financing allocation). One of the most vivid goals of this policy is eliminating the oil and gas market competitor, possessing larger reserves, and enjoying lower production costs (Lavrov & Simonov, 2021). On the other hand, Russia possesses an overwhelming icebreaking fleet but lacks high-end exploration and drilling technologies. A case study of the recent progress in major Russian projects may provide insight regarding the development of the Arctic rivalry.

Immediately after imposing sanctions, US exports of about 68% of the equipment previously being imported to Russia were restricted. For instance, ice class floating drilling platforms deficit reached 20 units. The situation with drilling components was quite similar. By 2015, the number of delayed orders for drilling complex equipment by the major supplier NOV exceeded 21,000 units.

Sanctions covered imports of large and super large gas carriers, tankers, pipelaying vessels, and dozens of other machineries. Nowadays the access of Russian customers even to samples is restricted as well.

The result may be a postponement of North Sea Route intensive operations by 10–15 years (Lavrov & Dyakin, 2019). The year after sanctions became effective, Russian drilling operations declined in half.

Russian companies had to search alternative ways out. A number of low and medium capacity LNG terminals (up to 100,000 tons of LNG per year) were launched in Kaliningrad, Pskov, and Kingisepp. A 600,000-tone terminal is being developed in the Vysotsk sea port. These projects have high economic performance as the main equipment suppliers (joint stock company Kriogen and its affiliate Kriogenmash) are located in Russia and nominate prices in local currency. The produced LNG is designated for Poland, Finland, and Germany. The equipments being produced are also shipped to China. There are 90 plants operating Russian equipment amid 260 LNG plants in China.

Russian companies endeavor to develop modern domestic oil and gas technologies, software, hardware, shale machinery, and sea vessels. Several nuclear ice breakers were constructed, built, and commissioned.

A modern shipyard is being erected near the city of Bolshoy Kamen. This is a joint project by Rosneft, Gazprombank, and several partners from China, the Republic of Korea, Germany, the Netherlands, Singapore, and Norway. The first phase was commissioned in 2016, and the completion is scheduled for 2024. The shipyard is designated to build medium and large vessels for the Arctic implementation, drilling rigs, exploration, and production platforms. The construction of the first Russian LNG tankers (Aframax class ships) are to be allocated in site.

Despite a forced slowdown in Arctic development, a number of new projects were started, some of which have been already commissioned.

In 2017, a new significant oil and gas field in the Khatagan area in the Laptev Sea was discovered; its resources are estimated to exceed 9.5 billion TOE.

Rosneft has been investing ₽250 billion under its Arctic program in 2017–2021, which is twice as much as before.

Due to sanctions, Exxon Mobil quit a joint venture with Rosneft at the Pobeda field in the Kara Sea. It has reserves of 130 million tons of superlight oil and 490 billion cubic meters of gas. Rosneft has suspended the first well but has been advancing with exploration.

Lukoil has been extracting hydrocarbons from the Payakhinskoe field in the Yamalo-Nenets Autonomous Okrug with reserves of 86 million tons of oil and 261 billion cubic meters of gas condensate. Horizontal wells are massively used to increase yield tenfold compared to previously used drilling technology (inclined drilling). The produced oil is transported by pipeline to Zapolyarie pumping station and further on to pipeline Zapolyarie-Purpe, which is part of general Russian ring, commissioned in 2016.

Gazprom Neft has successfully acquired a stable oil yield at Prirazlomnaya platform and Novoportovskoe field. The project output is 20 million tons.

Novatek carries out extraction in the Gulf of Ob. It attracted foreign partners into a joint venture: Total (20%), CNPC (20%), and SRF – Silk Road Fund (9.9%).

Yamal LNG commissioned the first phase in 2017, which is 6.5 million tons of annual output. The overall capacity shall gradually be increased to 16.5 million tons.

The total capital expenditure shall reach $27 billion. Economic efficiency may surpass Qatar analogues. The company has carried out project studies for a second plant "Arctic LNG." Its designed annual capacity is 18 million tons, but due to typical solutions, capital expenditures will be 30% lower. Construction may take another 2 years.

All in all, Russia has been expanding in the Arctic. The share of this region in fossil fuels production is about 18% for oil and 30% for natural gas. Despite sanctions against Russian oil and gas, as well as the financial sector, there is no critical impact upon the Arctic program. Initial interruption of some drilling and construction project was further eliminated via applying domestic equipment and cooperation with foreign partners mainly from Europe and Asia.

Conclusion

The Arctic oil and gas race is gaining traction. The amount of resources, being at stake, can reach almost a quarter of total global resources. Despite relatively high extraction costs, only a 10–15% increase of current market prices can turn Arctic undertakings into a profitable business. However, oil and gas field allocation is not even, which makes a potential dispute among Arctic states even stiffer. The number of Arctic states is rather limited (8 members only), but the list of promising deposits looks really short, which shall further catalyze discussions upon public legal procedures on Arctic waters and seabed allotment. Clarifications of legal issues shall provide for higher investor appeal and potential negative externalities elimination (environmental hazards like oil ruptures, strip overproduction, Indigenous people's living conditions deterioration, etc.).

The number of launched projects (two in operation and one suspended) proves the high risks and uncertainties of Arctic investments. Only two oil platforms were commissioned and are being operated, while the third one was suspended.

Further climate change may also cause a landslide change in Arctic economics. Increasing thawing may enhance the attractiveness of Northern Sea routes globally, resulting in the substitution of several traditional paths, connecting Asia, Europe, and North America. However, the value of icebreaking powers is to increase.

Due to the increasing potential economic benefits of Arctic exploitation, a rigid competition on the international level is expected. Currently the main manifestation thereof can be observed between Russia and the USA. The essence and results of political sanctions, targeting definite technologies, and goods and services can serve as a demonstration model of the real Arctic virtues: It has become proved in practice that well and drilling and icebreaking technologies (as well as associated human resources and capital assets) are two main keys to Arctic fortune and prosperity. This result risks turning an unfruitful contest in cooperative rivalry if not cooperation, which may significantly increase the benefits of all economic actors.

Elaborate combination of political will, professional qualification, technological craft, and a responsible approach toward nature may turn the currently economically lifeless Arctic region into a land flowing with milk and honey for several generations ahead.

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Arctic Energy Sector Under Low-Carbon Transition

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Abstract

The energy sector, which is crucial for the Arctic economies and communities, has entered into a major transformation phase reflecting world market trends. The ongoing low-carbon transition is largely spurred by the global warming, international climate policies (notably the 2015 Paris Agreement), a rapid progress of renewable energy, and information technologies. The chapter provides a general analysis of Arctic energy trends and country-specific profiles, addressing each

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nation's policy papers, current activities, and development plans. All Arctic countries focus strongly on climate goals and developing renewable energy sources, but the industry landscape and policy approaches differ strongly.

Oil and gas, regarded earlier among the most promising Arctic industries, have suffered from the growing environmentally motivated pressure, often discouraging exploration results, and the rapid expansion of renewable generation, which is expected to reverse the growth of the global oil demand between 2028 and 2040. Only Norway and Russia remain politically committed to Arctic petroleum, and only Russia has approved development plans beyond 2024. Renewable energy (primarily solar and wind generation and hydrogen technologies) enjoys a high priority, which is reflected in the adoption of national strategies, large-scale research, and numerous pilot projects. On the whole, this development is still in the initial phase, creating both new opportunities and challenges for all Arctic nations.

Keywords

Arctic · Low-carbon transition · Energy · Oil · Gas · Renewables · Hydrogen

Introduction

Throughout the history, especially since the beginning of the industrial age, the energy sector has been a key pillar and a critical infrastructure element of any Arctic economy. The cold climate, long distances, and dispersed population pose human activities in the Arctic with characteristic technological and logistic challenges in providing the citizens' well-being and the long-term resilience of small remote settlements. Northern regional economies tend to be 30–50% more energy intensive than the national average.

Many Arctic regions also play important roles in the national supply of fossil fuels. Petroleum production and coal mining, together with other primary sector branches (like minerals extraction or fishery), have traditionally been among the principal Arctic industries, generating regional economic growth, creating jobs, and providing the Arctic with distinct niches in the domestic and global markets.

With few exceptions (like Iceland, Northern Norway, or Murmansk District in Russia), energy consumption in most Arctic nations used for decades to rely predominantly on petroleum products, particularly on diesel and fuel oil, used extensively for transportation, heating, and power generation. Diesel is often indispensable for remote areas with autonomous power supply. For example, there are some 50,000 diesel generator units with a total capacity of over 500,000 kW in Arctic Russia alone. They consume about 1 million tons of diesel fuel per year (Elistratov et al., 2017).

However, the post-industrial age and the ongoing restructuring of the global energy sector are amending these traditional patterns in many respects. While fossil fuels (predominantly oil and gas) still dominate the international primary energy consumption, they are being increasingly challenged by renewable and environmentally friendlier energy sources. This development is yet at the initial stage, but it has already influenced current energy business and even more so its future plans, creating both new opportunities and risks. The aim of this chapter is to provide a brief overview of the present status and ongoing changes in the Arctic energy sector, seen against the background of the global energy transition.

Literature Review

Many Russian and foreign scientists pay special attention in their research to the Arctic region. In the last decade, Arctic energy research has been dominated by a focus on fossil fuel exploration, primarily the Arctic oil and gas development (Bird et al., 2008). Holland and Gardner (2012) call the Arctic the "last energy frontier," as this region may become the last unexplored storehouse of natural resources. At the same time, today, the Arctic is characterized, on the one hand, by a huge volume of natural hydrocarbon reserves – the main sources of electricity generation – and, on the other hand, by serious problems with the region's electricity supply. Arctic communities are concerned with access to energy supply in the face of geographic isolation and high transportation costs. Issues of ensuring energy security in the Arctic are considered by DeWitt et al. (2019). Energy supply of remote regions of Russia is analyzed by Elistratov et al. (2017).

The development of renewable energy is a global trend, conditioned both by the need to ensure the energy security and by concern for the natural environment. The global transformation process called "the energy transition" is taking place in the global energy sector. It is a pathway towards transformation of the global energy sector from fossil-based to zero-carbon. Therefore, special scientific interest is paid to the global energy transition towards sustainability (Morgunova & Kovalenko, 2021), as well as the environmental impact caused by developing energy resources in the Arctic region (Suter et al., 2019). Nefedova and Solovev (2020) highlight the problems and features of the energy complex functional in the regions of the Russian Arctic amid the global climate change. Due to the specifics of the research area, a large number of national strategies and official documents were examined.

The present chapter is a comprehensive research concerning the current issues of energy transformation in the Arctic region in the light of climate change and the global transition to renewable and hydrogen energy.

Low-Carbon Transition in the Arctic: Key Drivers and Impacts

The unfolding energy transition is a combination of several major, interconnected trends, which have acquired a truly universal nature in the course of the past few years.

The accelerated global warming has turned into a visible worldwide problem, bringing about major climatic changes, natural disasters, and other extreme weather events. According to the Intergovernmental Panel on Climate Change (IPCC), the global surface temperature in 2011–2020 was 1.09 (0.95–1.20) degrees Celsius higher than in the period of 1850–1900, taken as the proxy for the preindustrial age. This increase had been driven above all by the human-caused emission of CO2 and other greenhouse gases (IPCC, 2021). A further increase of over 2 degrees Celsius would with high confidence cause major negative effects for ecosystems, cultures, and biodiversity, plus amplify the risks of large-scale singular negative events (IPCC, 2014).

These problems are very highly relevant for the Arctic environment and policies. The regional states and non-Arctic observer states to the Arctic Council contribute jointly to nearly 70% of global CO2 emissions (Middleton, 2021). The global warming develops twice as fast in the Arctic as the world average, and this trend is very likely to continue. The region is already undergoing irreversible changes. In 2011–2020, the annual average Arctic sea ice area reached its lowest level since at least 1850. This opens up additional opportunities for high-latitude shipping, fishery, and extractive industries. At the same time, the retreat of glaciers and the ice cap and the melting of tundra permafrost create much bigger damage and risks, including fundamental changes in the traditional ecosystems and habitats, forced migrations, degradation of Arctic waterfronts with heavy impact on coastal settlements' resilience, etc. Suter et al. (Suter et al., 2019) estimated that a continued melting of permafrost would affect 26% of assets of Arctic airports and 15–20% in other infrastructure categories by 2059. In Russia alone, this may bring about damages to residence buildings, industrial and critical infrastructure worth a total of some $105 billion (Streletskiy et al., 2019).

Due to the efforts of the international research community and environmental NGOs, these trends have attracted a major attention of governments and the broad public, moving to the top of the global policy agenda. The 2030 Agenda for Sustainable Development adopted by the UN General Assembly on September 25, 2015, identified the 17 Sustainable Development Goals (SDGs), therein notably SDG 13 – Take urgent action to combat climate change and its impacts (United Nations, 2015). To this end, the world leaders reached the Paris Agreement at the UN Climate Change Conference in December 2015. The Agreement sets the long-term goal for all nations to reduce greenhouse gas emissions substantially in order to limit the global temperature increase in this century to 2 °C while pursuing efforts to limit the increase even further to 1.5 °C. The Agreement entered into force on November 4, 2016. As of August 2022, 192 countries plus the European Union had joined it.

While the continued global warning and the rise of climate awareness have augmented the need for changes in the global energy sector, the rapid progress of technologies has contributed to making such changes practically doable and more economically viable. Some technologies, like wind generation or energy-efficient construction materials, have long been available, but it is only now that a whole array of breakthrough solutions have started to produce important synergies, reinforcing each other and creating a new energy mix.

The contemporary energy transition is based on the “three Ds”:

- Decarbonization, i.e., replacing fossil fuels with “green” electricity generated from renewable sources like solar and wind and stored in efficient heavy-duty accumulators;
- Digitalization, with extensive use of computer-aided solutions and artificial intelligence both in energy production, transmission, and consumption
- Decentralization whereby electricity is generated by numerous interconnected sources, including households (“prosumers”) which operate small generators and supply excess power to the grid

Combined use of these technologies helps to create smart oil wells, grids, houses, and cities which help to supply consumers with affordable and cleaner energy while cutting its carbon footprint dramatically and increasing the energy efficiency of industries and households.

It is noteworthy that the popular visions of the world going completely “green” and getting rid of oil and gas in the foreseeable future are nonrealistic. Petroleum products will be indispensable for decades to fuel the bulk of the global car park and the overwhelming majority of sea and air vehicles. Electrically driven ships and aircraft are merely at the initial test stage at present. Natural gas, which has the lowest environmental (particularly carbon) footprint among fossil sources, is eventually going to play an important role as a “transit fuel” on the way from the contemporary, petroleum-dominated global energy mix to a new one, based primarily on clean generation. The troubles in the US and EU energy markets in 2021, caused by the cold winter and massive blackouts at Texan wind farms, as well as the gas shortage in Europe, clearly illustrated the existing supply vulnerabilities. Still, the overall trend seems clear, leading to a major reshaping of the petroleum industry worldwide.

All the Arctic nations focus strongly on the climate policy. The Nordic countries and Canada have set the ambitious goals of becoming global leaders in reducing the net CO2 emissions. For example, Finland aims to reach carbon neutrality by 2035 (Government of Finland, 2021). Norway plans to cut emissions by 50–55% by 2030 and by 95% by 2050 (Government of Norway, 2021a). [Despite the cabinet shift in October 2021, these goals will most likely be continued or even reinforced, given the strong national consensus on the issue.] The United States left the Paris Agreement under President Donald Trump, but made a return in January 2021 under Joe Biden, who also summoned the Global Climate Summit 3 months later. Climate policy measures, like support to clean energy manufacturing or electrification of transports, constituted an important part of Biden’s $2 trillion worth infrastructure plan launched under his *Build Back Better* initiative (Zarracina et al., 2021).

The Russian case is somewhat special. Climate change has until recently not been among the key public policy priorities. That was partly due to the fact that the lengthy economic recession in the 1990s had resulted in a significant reduction of the national greenhouse gas emission as compared to 1990, which was the benchmark year for the Kyoto Protocol (Mitrova et al., 2020). The situation is changing, with the government aiming on major CO_2 emission cuts by 2050 and climate goals declared among the priorities of the Russian Chairmanship in the Arctic Council (Arctic Council, 2021). The contemporary approaches, as presented by President Vladimir Putin at the 2021 Global Climate Summit, are based on the following key points:

- Given the lasting nature of carbon dioxide, one should address not merely the current emissions, but also the absorption of the volumes already present in the atmosphere. In this regard, he made a special mention of the Russian ecosystems, which are capable of absorbing some 2.5 billion tons of CO_2 equivalent per year.
- All the factors of the global warming should be accounted and monitored, without any exceptions. For example, methane stands for 20% of man-made emissions, while each ton of methane produces a greenhouse effect which is 25–28 times bigger than that of a ton of CO_2. If the global methane emissions are cut by half within the next 30 years, that will reduce the global temperature by 0.18 degrees by 2050, which alone represents about 45% of the gap between its current level and the Paris Agreement target.
- The entire global community shall unite its efforts in combating climate change. Russia is ready to suggest a number of joint projects and provide incentives for both Russian and foreign companies willing to invest in clean technologies.
- The global development shall be not merely "green," but sustainable, in all respects and for all nations. So, the climate efforts shall also be closely linked to the progress of combating poverty and reducing the development gaps between countries (Putin, 2021).

The activities under the auspices of the national governments and the United Nations are complemented by those of other entities, like the International Maritime Organization's ban on the use of heavy fuel oil in Arctic shipping, the recent EU Border Carbon Tax, or numerous NGO campaigns against Arctic oil and gas operations. Taken together, the above trends have started changing the Arctic development significantly, in terms of both energy production and consumption.

Arctic Fossil Fuels

There has been industrial exploration and production of coal in the Arctic since the early twentieth century, but it plays a very moderate role at present. The industry has suffered greatly from international economic turmoils; hard competition with cheaper coal from Europe, Australia, or developing countries; and recently also from its high level of black carbon footprint.

The Soviet Union, with its centrally planned and autarchic economy, was the only country to continue a large-scale development of its Arctic coal resources until its very breakup in 1991. Several mines have been closed down since then, but the industry is still important for several Arctic towns like Vorkuta in Komi Republic. The regional authorities plan to maintain the present production level of 12–15 million tons per year through 2030 (TASS, 2020); new projects are mulled in

Chukotka and Taimyr. However, Arctic mines will only stand for mere 5–6% of the nationwide production under the most optimistic scenario.

The Norwegian archipelago of Spitsbergen (Svalbard) is the other, rather peculiar exception. Only Norwegian and Soviet mines remained there after the Great Depression of the 1930s. The economic activities of both countries have among others a major symbolic value of maintaining national presence in the politically important Arctic Archipelago with a unique and controversial legal status. However, the scope of mining operations in the Norwegian and Russian settlements diminishes over time, being replaced by new, less contaminating and capital-intensive activities like tourism, education, research, and development.

The medium- and long-term prospects of Arctic petroleum resources look more positive, still much less optimistic than at the beginning of century. The large-scale development of Arctic oil and gas started in the 1960s and 1970s. It received a strong impetus from the Oil Crisis, which made Arctic resources economically viable, as well as highlighted the importance of the security of supply. Western Siberia, including its Arctic part, has since then been the key Russian oil and gas province. In the United States, the oil production in Alaskan North Slope (first of all, in the unique Prudhoe Bay field) peaked in 1988 at 1.97 million barrels a day, when Alaska stood for about quarter of the national crude output. Since then, however, it started decreasing to the present-day plateau of some 0.5 million barrels a day (Alaska Department of Revenue, 2017; Ragsdale, 2008). The first-ever Arctic offshore fields were also developed in shallow waters off Alaska's north coast from artificial gravel islands, like Endicott in 1987. Exploration and development activities on the Norwegian continental shelf started at that period, too, from its southern part, moving gradually to the north. An extensive geological exploration in the Canadian Arctic also resulted in discoveries of large resources of oil and gas, primarily in Mackenzie Delta and the adjacent Beaufort Sea shelf, but the actual development did not start for economic and administrative reasons.

The oil price fall in 1986 and the subsequent low prices through the end of the twentieth century, followed by a new market collapse in 1998, plus the continued trade liberalization, made new Arctic developments unattractive. In Russia, the radical market reforms exacerbated these global trends, as most oil companies struggled to survive and had to postpone new developments till later.

The investors' interest to the Arctic oil resources revived again in the mid-2000s, in line with the protracted oil price rally in the aftermath of the 2003 US military operation in Iraq and with the growing geopolitical attention to the Arctic. The US Geological Survey (USGS) made its contribution in 2008 by issuing the well-known Circum-Arctic Resource Appraisal, where it estimated undiscovered resources north of the Arctic Circle at 89.983 billion barrels (12.329 billion tons) of oil and 1,669 trillion cubic feet (45,054 trillion cubic meters) of natural gas. Some 64% of this potential was concentrated in three provinces: West Siberian Basin (Russia), Arctic Alaska (USA), and East Barents Basin (Russia and Norway) (Bird et al., 2008).

The subsequent developments may be schematically summed up as follows:

- 2004–2008: Increasing expectations of an Arctic oil boom, triggered by the record high prices; ongoing revolution in offshore technologies and intensified

discussions on Arctic sovereignty issues; predictions of an "Arctic (resource) race" and resulting international tensions (Howard, 2009).
- 2008–2014: Stronger realism and reduced speculative moods resulting from the flourishing peaceful cooperation in the Arctic, the oil price fall in 2008, the breakout of the US shale revolution, the 2010 *Deepwater Horizon* accident in the Gulf of Mexico, and emergence of new, competing oil and gas provinces. The region still enjoyed a high political priority, but the expectations of rapid resource development prone with international conflicts were fading away.
- 2014–now: The new oil price fall in 2014 and the consecutive lengthy period with pertaining moderate prices, followed by the 2020 slump, undermined the economy of most Arctic projects (Lasserre, 2021). The Arctic as a geopolitical region has moved sufficiently down the politicians' priority lists, overshadowed by a long array of acute international crises across Europe and Asia, trade wars, and the COVID-19 pandemic. Arctic petroleum development, especially in the shelf, suffered additionally from the international tensions, among others, from the western sectoral sanctions against supply of Arctic and deep-sea drilling technology to Russia (Morgunova & Westphal, 2016).

In the course of the past few years, the unfolding low-carbon transition has sufficiently complicated the industry development. In political terms, petroleum business worldwide faces an increasing environmentally motivated pressure as a major source of greenhouse gas emissions, under both the extraction and the consumption of its products. The industry becomes much less popular among the broad public, even in producer countries. This pressure is particularly strong in case of Arctic operations prone with higher risks of accidents and oil spills. Canadian Inuit from a small Nunavut settlement in Baffin Island, supported by Greenpeace, appealed the decision by Canada's National Energy Board in 2014 and got a court ruling to prohibit 2D seismic surveys in Baffin Bay and Davis Strait. Similarly, environmentalists had earlier protested against 3D seismic surveys offshore the Beaufort Sea as potentially harmful for bowhead whales. In Norway, influential environmental NGOs even challenged, albeit unsuccessfully, the results of the 23rd licensing round in 2016, when 40 blocks in the Barents Sea were awarded, with the Supreme Court (so called "climate lawsuit") (Supreme Court of Norway, 2020). A number of leading American banks refused to extend loans to drilling in Alaska National Wildlife Refuge in 2020 (Economist, 2020).

The oil companies adapt to this pressure and try to improve their public image. In North America, they mainly stick to their core business while also increasing the investments in new and greener technologies like carbon capture, utilization, and storage (CCUS). ExxonMobil set a benchmark in 2021 when it announced a plan to invest $100 billion in a CCUS program in Houston and offshore saline reservoirs in the Gulf of Mexico (Blackmon, 2021). In Europe, companies diversify their operations and try to get rid of the petroleum image by actively pursuing renewable power generation and positioning themselves as versatile "energy producers." These efforts often include corporate rebranding and even renaming, like DONG (acronym for Danish Oil and Natural Gas Company) turning into Ørsted or the Norwegian Statoil transforming into Equinor.

In economic terms, Arctic oil and gas experience a harsher competition from renewable energy, which is subsidized in several countries like the EU member states and undergoes a rapid cost reduction. The changes in consumer priorities, like the growing popularity of electric cars, also affect the demand structure. Under the circumstances, industry analysts are abandoning the traditional visions based on M. King Hubbert's famous "peak oil" theory (King, 1956; Priest, 2014). Instead, they have started talking about an upcoming "peak oil demand" followed by an oil market slump, arguing more about its specific timing; most predictions range between 2028 and 2040 (Makarov et al., 2019). Meanwhile, the shrinking global petroleum demand would gradually squeeze to developing countries in southern latitudes, further away from the Arctic, jeopardizing the economy of new large-scale Arctic oil and gas projects.

Attitudes of the European Arctic governments towards petroleum industry vary a lot, which is clearly manifest in the recent editions of their Arctic and energy strategies adopted in 2020–2021. Finland and Sweden, which possess no hydrocarbon or coal resources, oppose it strongly. Sweden's strategy for the Arctic region stresses explicitly that extraction of fossil fuels "threatens global efforts to achieve the aims of the Paris Agreement and must be phased out as soon as possible" (Government of Sweden, 2020). The Government of Greenland announced in July 2021 that it suspended all offshore oil exploration as a way "to take co-responsibility for combating the global climate crisis" (Greenland bans all oil exploration in 2021), although this decision also clearly reflected the discouraging exploration results in the Greenlandic shelf, with no commercial petroleum reserves discovered. Meanwhile, Norway and Russia, the big fuel producers, take a more balanced line, trying to reconcile climate and industry priorities.

In the 2020 white paper on High North policy, then Norwegian government, while reiterating its ambitious climate goals, simultaneously pledged to "facilitate a profitable oil and gas production by maintaining predictable framework conditions and holding regular licensing rounds on new acreages," plus "continue petroleum relevant R&D and competence development in and for the High North" (Government of Norway, 2020b, *own translation*). The 2021 white paper on energy policy forecasts a massive, although decreasing, petroleum production in the Norwegian continental shelf through 2040 and beyond. The biggest hopes are vested in the Arctic shelf, especially the Barents Sea, which is least explored and may contain the largest undiscovered resources. The government declared its commitment to holding regular licensing rounds on new acreages, a continued mapping of the petroleum resources (including the areas not yet available for exploration), maintaining the national system of CO2 emission quotas and taxes, plus monitoring the oil companies' efforts on emission cuts. A special attention is devoted to a successful coexistence of the petroleum industry and other offshore activities, as well as to enhancing the industry efficiency, digitalization, and innovations (Government of Norway, 2021b).

Besides its dominating contribution to the national economy in terms of exports, public income, and employment (including the service branches), the oil and gas industry also plays an important role for the Norwegian international positioning in the Arctic and in the hi-tech markets. Actually, every development in the Norwegian Arctic shelf (Snøhvit gas field and LNG plant in 2007, Goliat in 2016, Aasta Hansteen in 2018) has been a major milestone. All of them introduced groundbreaking technologies and helped reinforce the country's leadership in cold climate offshore solutions and project management. It is noteworthy that Goliat (operated by the Italian Eni) was the only field not developed under the control by Statoil/Equinor. The large Johan Castberg oilfield (about 560 million barrels), to be delivered in 2024, is set to become the northernmost field in Norway. By applying advanced technologies, Equinor managed to cut the project cost by half and the breakeven oil price from $80 to $35 per barrel within 3 years (Equinor, 2017). According to the plans, Johan Castberg shall produce oil in 30 years, while the Snøhvit lifecycle may be extended till 2050.

In 2020, marked with oil market shocks, the authorities sent clear messages of their desire to enhance exploration and production, like major tax breaks introduced in June and the controversial 25th licensing round announced in November, even before the Supreme Court ruling on the "climate lawsuit." Under this round, four production licenses, all of them in the north, were offered to seven Norwegian and foreign companies (Ministry of Petroleum and Energy of Norway, 2021). However, Johan Castberg was the last Barents Sea field development underway as of late 2021. Contrary to the expectations, the massive seismic shooting and exploratory drilling in the area have resulted in few Arctic discoveries like Wisting, Alta, and Gohta. Their development prospects remain unclear, particularly under the low oil prices.

Russia is the Arctic country with the most deliberate and outspoken policy favoring an accelerated Arctic petroleum development. Like in Norway, the authorities and companies declare that an environmentally safe exploitation of Arctic resources is both achievable and compatible with sustainable development goals. The national Energy and Arctic Strategies through 2035, both adopted in 2020, envisage a stabilized, eventually a lower, oil output over the period, while coal production shall grow between 10% and 52%, natural gas extraction between 18% and 35%, and gas liquefaction by a factor of 4–7.2, with a major contribution from the Arctic Zone of the Russian Federation, AZRF (Table 1). Western Siberia, the main petroleum-producing area since the 1970s, has entered into a mature phase, the exploration and production activities move gradually to Eastern Siberia, the Far East, and the Arctic. The government supports this development with tax incentives. The AZRF share in the national oil and LNG production shall increase significantly through 2035. Natural gas production is already concentrated in the Arctic region of Yamal Nenets Autonomous Area, where it also moves even further north.

After a rather long pause with few Arctic projects (except for Zapolyarnoe and Yuzhno-Russkoe gas fields in Yamal), in the recent few years Russian companies, often jointly with foreign investors, have delivered a whole array of world-class, greenfield onshore developments:

- Yamal Megaproject of Gazprom, the Russian national gas company, with a projected total gas output of 310–360 billion cubic meters a year. It started with

Table 1 Fuel production goals, Russian Arctic and Energy Strategies through 2035

	2018 (base level)	2024	2035
Oil incl. gas condensate, million tons	555.9	555–560	490–555
Therein in AZRF, percent	17.3	20	26
Natural gas, billion cubic meters	727.6	795.1–820.6	859.7–1,000.7
Therein in AZRF, percent	82.7	82	79
Liquefied natural gas (LNG), million tons	18.9	46–65	80–140
Therein in AZRF, percent	8.6	43	91
Coal, million tons	439.3	448–530	485–668

Source: compiled by the authors on the basis of President of the Russian Federation, 2020; Government of the Russian Federation, 2020

the unique Bovanenkovo field phased in gradually in 2012–2018 and capable of producing 115 billion cubic meters a year, which is one-fifth of Gazprom's entire production today. In 2019, Gazprom launched the development of Kharasavey gas field further north, with a projected lifecycle through the twenty-first century (Gazprom, 2020).

- Yuzhno-Tambeyskoe gas field, gas liquefaction plant and offloading port in Sabetta, commissioned at full capacity of 16.5 million tons a year of LNG in late 2018, a year ahead of schedule. Yamal LNG is a joint venture of Novatek, a Russian private gas producer (50.1%), Total from France (20%), and two Chinese entities, China National Petroleum Corporation (20%) and Silk Road Foundation (9.9%). The total project cost was over $27 billion.
- Novy Port oilfield delivered by Gazprom Neft, Gazprom's oil subsidiary, in the east coast of the Yamal Peninsula in 2014, which became the first in Russia to win the prestigious Excellence in Project Integration Award. There are large expansion plans; the production license for Novy Port field has been extended till 2150.
- The northernmost oilfield in operation in Russia, Vostochno-Messoyakhskoye, commissioned successfully by Gazprom Neft and Rosneft, the Russian national oil company, in 2016, and Novatek's ongoing Arctic LNG 2 project, both in the Gydan Peninsula east of Yamal.
- Vankor oilfield in Taimyr Peninsula commissioned by Rosneft in 2009, with an annual production above 22 million tons, operated jointly with Indian companies which hold 49.9% of the shares.
- Rosneft's Vostok Oil megaproject to develop a number of fields north and east of Vankor, with a total resource potential of over 5 billion tons (36.5 billion barrels) of oil and planned production capacity of up to 100 million tons a year (2 million barrels a day). The investments are estimated at ₽10 trillion or about €115 billion (Rosneft, 2020). Trafigura, a Singapore-based trading company, purchased 10 percent of Vostok Oil in late 2020; Indian and Chinese companies have also indicated their interest.

The new Arctic oil and gas projects are some of the biggest post-Soviet industrial developments in entire Siberia (Kryukov et al., 2020). Within a decade, they have created a new petroleum province of global scale in Yamal and founded similar ones in Gydan and Taimyr further east. They have also contributed to a massive AZRF infrastructure buildup and to achieving another national Arctic priority, a dramatic increase of navigation along the Northern Sea Route (Grigoryev, 2019). Its cargo turnover grew from 2 million tons in 2010 to 35 million tons in 2021, with plans to reach 90 million tons in 2030 and 130 million tons in 2035.

At the same time, the Russian Arctic shelf, which contains some 41% of its Arctic petroleum reserves (TASS, 2019), remains largely underexplored (particularly in the east) and poorly developed. An actual production takes place on merely two deposits: Novatek-operated Yurkharovskoe, a nearshore gas field developed from land applying horizontal wells, and Gazprom Neft's Prirazlomnoe oilfield with its unique ice-resistant gravity base platform, which is Russia's only Arctic offshore installation so far. Despite the ongoing exploration and new major discoveries, only few medium-sized projects are being implemented, all of them nearshore. The historical development path, heavy ice conditions and insufficient infrastructure in the Arctic, lack of proprietary technologies and experience in developing continental shelf, Russian legal restrictions on foreign involvement, and Western sectoral sanctions are among the key reasons. The Russian authorities have indicated their desire to revive the Arctic shelf by introducing new tax breaks and opening for private (therein foreign) access. However, while the national Energy Strategy through 2035 stresses the long-term importance of the continental shelf, it does not contain specific production goals.

The approaches to Arctic oil and gas development in North America are sufficiently more restrictive and politicized. US President Barack Obama and Canadian Prime Minister Justin Trudeau released a joint statement in March 2016, which allowed for commercial activities in the Arctic "only when the highest safety and environmental standards are met, including national and global climate and environmental goals, and Indigenous rights and agreements," plus specific, science-based standards for oil and gas development and exploration (U.S.-Canada Joint Statement, 2016). Soon after, both leaders introduced moratoria on Arctic offshore operations.

Trudeau remained in power until the end of the moratorium in 2021. This rigorous, climate-motivated petroleum policy, strongly backed by many environmental NGOs and Indigenous communities, has contributed heavily to leaving the enormous petroleum reserves of the Canadian Arctic untapped. While the Arctic territories and companies lobby their development, as many as 65% of people in the territories and 58% in the provinces supported extending the ban for five more years as of late 2019 (CAPP, 2019; Van Dusen, 2016; WWF-Canada, 2019). [The outcomes of the parliamentary elections in September 2019 may eventually result in a new Cabinet and affect the fate of the ban; the authors undertake to add an update at a later point.]

In the United States, the discussions on Alaskan oil and gas are expressly partisan and concentrate round three main themes. The first regards licensing (leasing in US terms) new onshore acreage in the North Slope, where most lands lie within the National Petroleum Reserve-Alaska (NPR-A) and Alaska National Wildlife Refuge

(ANWR), strongly protected by federal laws and local environmentalists. The other relates to new offshore lease sales. The third concerns Alaska LNG, a megaproject estimated at $43.4 billion, which includes development of a big gas field at Point Thompson in the North Slope, constructing a 1,300-kilometer-long gas pipeline to the Cook Inlet and a large LNG plant in Nikiski with a total output capacity of 20 million tons a year.

Republican George W. Bush (the US President in 2000–2008), who had close ties with the Texan oil business and whose Presidency was bearing a major impact of the September 9, 2001 terrorist attacks, was a strong proponent of leasing more of Alaskan shelf acreage and of renewed drilling in the ANWR, quoting the national energy security needs. Democrat Barack Obama (2008–2016), to the contrary, was critical to oil and gas industry, especially after the *Deepwater Horizon* accident in 2010. He set ambitious climate goals, promoted renewable energy, and eliminated numerous tax breaks for oil companies. Under Obama, most of the Alaskan shelf was exempted from leasing. This policy, combined with unsuccessful offshore drillings by Shell, which lost about $7 billion in its Beaufort Sea venture, and a stalemate in Alaska LNG project discouraged investors, and most oil companies withdrew from the state in 2015–2016. Republican President Donald Trump (2016–2020), with his expressed skepticism about climate change theories, was a strong lobbyist of unbundling the Alaskan petroleum potential. During his Presidency Eni began oil exploration drilling in the Beaufort Sea in 2017, Chinese companies were invited to join Alaska LNG, and authorities issued a permit for constructing the first artificial island off North Slope in many years, as well as ConocoPhillips' plan to develop Willow prospect in the NPR-A.

President Joe Biden, in his turn, halted any ANWR drilling right after his inauguration on January 20, 2021 (Schreiber & Rosen, 2021). On the nationwide level, industry analysts have depicted his climate-oriented agenda and clean energy plan mean as an intent "to phase out the U.S. oil and gas industry" (Blackmon, 2021; Duesterberg, 2021). Biden won a bipartisan support in the Senate which approved a $2 trillion infrastructure bill in summer 2021. It remains yet to be seen how far-reaching the consequences will be for petroleum companies. In any case, however, given the long-term nature of oilfield lifecycles, any sizeable projects in Alaska seem unlikely as long as the issue remains politically controversial.

Summing up, the development of Arctic oil and gas resources remains concentrated in specific provinces onshore Northern Siberia and offshore Northern Norway. Norwegian and Russian governments, as well as many petroleum companies, remain committed to the area. Overall, however, the "Arctic petroleum euphoria" that dominated the speeches of politicians and industry leaders in the 2000s is essentially gone, and it is unlikely to return under the current long-term trends.

Renewables: When and How?

The main focus of this section is to consider the structure of renewable energy generation and to highlight the projects under realization in the Arctic region.

According to the International Energy Agency (IEA), the share of renewable sources of energy in power generation varies significantly between the countries of the Arctic Council (Fig. 1).

As a whole, the Arctic region can be regarded as a leader in renewable energy development, with more than double the global average in the share of power generated from renewable sources. Countries like Iceland and Norway source virtually 100% of their energy generation from renewables. The United States is actively working with partners across the region to share best practices and enhance the region's overall energy resilience. In an estimated 250 locations, diesel fuel is augmented with local sources of renewable energy such as hydropower, wind, solar, biomass, and marine hydrokinetic or geothermal energy. Alaska has played a leading role in incorporating renewable sources into community-scale microgrids, with over 75 community energy grids powered in part by renewable energy, including small hydro, wind, geothermal, biomass, and solar systems.

The climate of the northern regions is characterized by long winters (up to 300 days a year) with frosts up to −50 °C. In the short (about 3 months) summer period, the temperature sometimes rises up to +20 °C. In winter, as well as during the transition period (from spring to autumn), winds are stable and strong. This means that the potential for wind energy development is high in the northern regions. Nevertheless, despite the average annual wind speeds about 6–8 m per second, the use of wind energy in the Arctic region is associated with very high risks due to frequent cyclones and snowstorms, which pose the threat of icing to turbine blades. Climatic changes are increasingly becoming the cause of various natural disasters (Nefedova & Solovev, 2020).

The potential for solar energy project development is high in the southern regions of the Arctic. Solar energy seems the most cost-efficient source there. However, solar generation is limited by the generation only in daylight hours. And during the Arctic polar night, in some areas daylight is quite a small period of time – from May to September. Besides, it is quite problematic to clean solar photovoltaic modules after

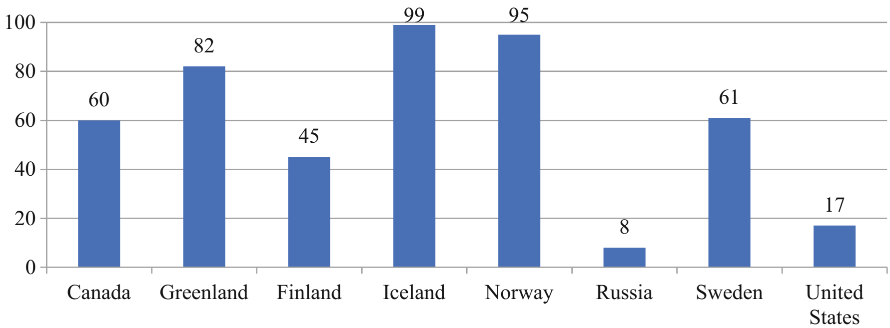

Fig. 1 Share of renewable energy in power generation in 2019 (percent). (Source: compiled by the authors on the basis of data from International Energy Agency. Retrieved from: https://www.iea.org/data-and-statistics/data-browser/?country=USA&fuel=Energy per cent20transition per cent20indicators&indicator=ETISharesInPowerGen)

snowfalls. Despite these shortcomings of solar energy, the technology is developing quite successfully in the Arctic.

The global energy industry is looking more closely at hydrogen: excess electricity generated by wind and solar power plants can be converted into hydrogen by electrolysis and then used as a fuel. Over the past two decades, the growth of hydrogen production has averaged 1.6% per year. A large number of pilot projects have been implemented in developed countries to create autonomous hybrid energy systems (wind-solar-hydrogen) in off-grid remote regions. The main advantages of hydrogen are its eco-friendliness, the convenience of its storage, and the possibility of long-distance transportation via the existing infrastructure. In addition, hydrogen energy is more flexible in terms of possible adaptation to changes in consumer demand compared with solar and wind energy, which is crucial in the Arctic region. The principles of zero-emission and carbon-neutral production are becoming increasingly important (Morgunova & Kovalenko, 2021). Below the experience of the Arctic Council countries in terms of renewable energy is considered.

Canada

Canadian Energy Strategy sets Framework for growth in renewable electricity provinces pledge to work together to "unlock the full potential" of renewable electricity. Leading the movement towards renewable power, Canada has a high potential to become one of the world's leaders. With more than 65% generating from renewable energy, Canada is a leader among the G7 group (Canadian Council on Renewable Electricity, 2021).

Hydropower is the main renewable energy source in Canada (British Petroleum, 2021). It accounts for nearly 90% of renewable energy generation (Fig. 2). The country is the world's second largest producer of hydropower (385 terawatt-hours in 2020) after Brazil. Wind energy accounts for 8.3% of renewable energy generation (36 terawatt-hours), while the share of solar energy barely exceeds 1% (4 terawatt-hours). Canada also has a high potential for geothermal energy development, especially in the northern regions.

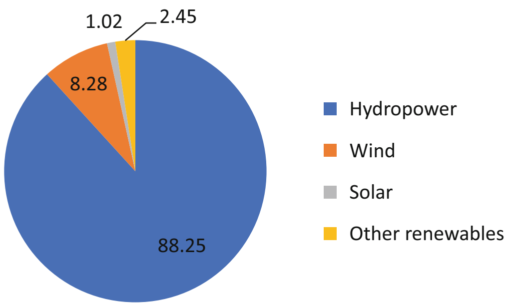

Fig. 2 Renewable energy generation in Canada in 2020 (percent). (Source: compiled by the authors on the basis of data from British Petroleum Statistical Review of World Energy. Retrieved from: https://www.bp.com/en/global/corporate/energy-economics/statistical-review-of-world-energy.html)

The northern regions of Canada – the Yukon, the Northwest Territories, and Nunavut – make up almost 40% of the country's territory. Northern communities are not connected to the large North American grids; therefore, most of them rely only on independent diesel generation. In 2007, the Governments of the Yukon, the Northwest Territories, and Nunavut approved a joint concept for the accelerated development of renewable energy. Today the Yukon is the only territory with an electrical grid that connects most communities. Generation and transmission are provided primarily by the Yukon Energy Corporation (YEC). The Yukon mainly generates renewable electricity from hydropower – 93.9% in 2018. The remaining is generated by diesel and LNG. According to the YEC, hydroelectric power plants account for 76% or 95 MW of the installed electricity capacity.

The *Aishihik* hydro plant, located about 110 km northwest of Whitehorse, has provided renewable electricity to Yukoners since 1975. The original plant included two hydro units that could produce up to 15 MW of renewable power each. In 2011, another hydro generator was added (7 MW).

The *Whitehorse* hydro plant has served Yukoners since 1958. In summer, it can produce 40 MW, but in winter, when flow in the Yukon River is reduced, it can only produce about 25 MW.

Two wind turbines (installed in 1993 and 2000) on Haeckel Hill are no longer in operation and are scheduled for decommissioning (Yukon Energy, 2021).

In March 2021, the Government of Canada announced $2 million in funding for the Government of Yukon to explore the potential of geothermal energy as a long-term renewable energy source (RES) for communities currently powered by diesel.

In August 2021, the Yukon's northernmost First Nation's community has officially completed an ambitious energy project "Sree Vyah." It is a solar energy farm that will help to reduce the dependence of remote regions on diesel generation by a quarter annually. The farm consists of 2,160 single-sided mono-crystalline panels that are configured in an east-west orientation to maximize solar generation during the long summer daylight hours and the wide arc of the Arctic summer sun. Solar energy is considered as one of the promising sources of ensuring energy security of the northern communities.

By 2030, the Yukon has set some targets – to generate 97% of electricity from renewable sources and to reduce diesel electricity generation in off-grid communities by 30%. Besides, the region plans to achieve net-zero emissions by 2050 (Rylan Urban, 2021).

Denmark/Greenland

Hydropower is the main renewable energy source in Greenland (Fig. 3). The island has increased its hydropower potential by about ten times over the past quarter of the century. However, the installed capacity of the hydroelectric power still does not exceed 100 MW. But if we take into account the water reserves that Greenland has and its relief, we will have to admit that the possibilities of its hydropower are almost limitless.

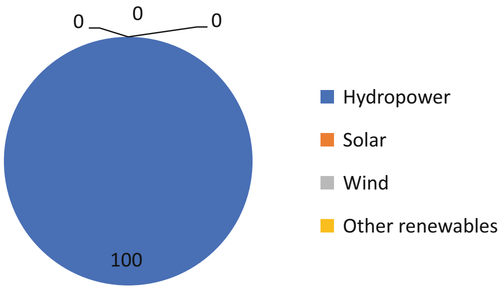

Fig. 3 Renewable energy capacity in Greenland in 2019 (percent). (Source: compiled by the authors on the basis of data from International Renewable Energy Agency. Retrieved from: https://www.irena.org/IRENADocuments/Statistical_Profiles/North per cent20America/Greenland_North per cent20America_RE_SP.pdf)

In 2019, Greenland generated 82% of electricity from hydropower (401 gigawatt-hours). The remainder was generated by fossil fuels. According to IRENA, hydroelectric power plants accounted for 49% or 91 MW of the installed electricity capacity (International Renewable Energy Agency, 2021).

The power grid system is decentralized on the island; each community has its own sources of electricity generation. Many communities in Greenland are small, and the grid comprises today 69 decentralized, stand-alone energy systems with no option for the distribution of renewable energy. However, two cities – Qaqortoq and Narsaq – are connected to the same hydro power plant in Qorlortorsuaq.

Greenland has been partly self-sufficient with energy since 1993 by the help of hydropower plants. The national energy production is increasing, but still Greenland depends on imported oil, primarily gas oil, diesel, and petrol. Today there are five hydroelectric power plants with a capacity of 1.4–45 MW, generating more than 80% of electricity in Greenland. The HPP in Ilulissat (22.5 MW) is the only underground hydroelectric power plant in the world built in the permafrost zone. The station is fully automated and located in an isolated fjord, 45 km away from the city of Ilulissat (Zhilkina, 2017). The energy company Nukissiorfiit is responsible for delivering energy (electricity, heating) and water across the country.

For Greenland, hydropower is the preferred renewable energy source, but the resource is limited, and the investment costs are high, and this moves the focus to other sources, such as wind and solar power. The biggest barriers to implementing these sources are the lack of knowledge about the resources and their geographical distribution. Since 2013, the Government of Greenland has promoted private production of renewable energy by use of solar cells and wind turbines in communities with no hydropower plant.

Greenland has hydropower in its larger cities, but the smaller cities and villages rely on diesel for heat and electricity. As the island has difficulties with energy self-sufficiency, solar and wind energy could solve the problem. Greenland's first test solar power plant appeared in 2016 and the first wind turbine in 2018 (DeWitt et al., 2019). According to IRENA's estimates, Greenland has a very high wind and moderate solar potential. So, the development of these energy sources seems very attractive in the medium term, especially amid the decision to ban oil exploration on the vast territory of Greenland and the ambitious goal to become a sustainable island with 90% of renewable energy by 2030.

Finland

Hydropower is the main renewable energy source in Finland (Fig. 4). It accounts for nearly 45% of renewable energy generation (16 terawatt-hours). Bio-, wind, and solar energy account for 11, 8, and less than 1 terawatt-hours, respectively. According to Finland's Energy and Climate Strategy, the share of renewable energy in the end consumption will increase to approximately 50% and the energy self-sufficiency to 55% by 2030.

Finland's Arctic Strategy was adopted in 2013 and updated in 2021. In 2017, an Action Plan was developed in addition to the Strategy. The adopted strategies are focused on environmental issues and economic benefits of the Arctic, paying special attention to the development of the northernmost region of Finland, Lapland. The country has a high potential in bioenergy, wind, and hydropower development.

Lapland became the biggest producer of renewable electricity in the post-war era due to the damming of River Kemijoki. Hydroelectricity accounts for nearly 25% of electricity generation (more than 16 terawatt-hours per year). There is currently one more power plant in the pipeline. However, its construction has been delayed due to lengthy administrative procedures.

Due to its northern geographical position with strong winds, Lapland has good positions in wind energy development. The wind power generation has grown from nearly 0 to 1 terawatt-hour per year. Geothermal and solar energy seem to be very popular energy sources in rural areas.

Bioenergy is the most widely used RES in Lapland. The bioenergy generation amounted to 8.5 terawatt-hours in 2017. It is mostly used in district heating and as

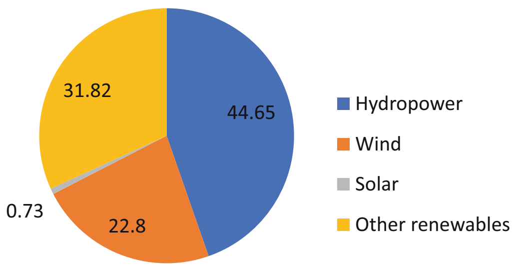

Fig. 4 Renewable energy generation in Finland in 2020 (percent). (Source: compiled by the authors on the basis of data from British Petroleum Statistical Review of World Energy. Retrieved from: https://www.bp.com/en/global/corporate/energy-economics/statistical-review-of-world-energy.html)

side streams in powering the paper industry. Part of the production is based on cogeneration, which also creates electricity. Bioenergy in Lapland is mostly wood-based. Natural Resources Institute Finland (Luke) has shown that the use of fuel-wood could be sustainably increased fivefold in Lapland. This would be beneficial for increasing the carbon sinks of Lapland's forests (Interreg Europe, 2019).

In 2020, Finland has taken the first steps in its hydrogen path by presenting a national roadmap. The roadmap emphasizes that hydrogen will play a "key role" in combating climate change and achieving Finland's national goal of carbon neutrality by 2035 (Business Finland, 2020).

In 2021, Hitachi ABB Power Grids (Zurich, Switzerland) and P2X Solutions (Helsinki, Finland), a producer of green hydrogen and a pioneer in power-to-x technology, have signed partnership agreement to electrify a 20-megawatt hydrogen production plant. The first Finland's industrial-scale green hydrogen production plant is expected to start operating in 2024.

Iceland

Iceland is a pioneer in the use of renewable sources of energy. Due to its geographical peculiarities, the country uses hydro and geothermal energy which account for 69% and 31% of renewable energy generation, respectively (13 and 6 terawatt-hours) (Fig. 5).

Iceland has the highest share of renewable energy generation in the world, with 99% of the total primary energy supply derived from domestically produced renewable energy sources. Unlike Greenland, which meets the energy demand with imported hydrocarbons, Iceland relies on local renewable energy sources. Geothermal water is used to heat around 90% of Icelandic homes. According to The Arctic Institute, increased energy production from hydro and geothermal sources has a negative impact on Iceland's natural landscape, demanding more dams to be built across rivers and streams, as well as destructing the natural environment, because of the construction of geothermal plants (The Arctic Institute, 2021). The latter emit

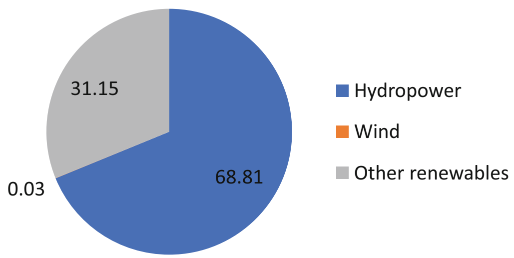

Fig. 5 Renewable energy generation in Iceland in 2020 (percent). (Source: compiled by the authors on the basis of data from British Petroleum Statistical Review of World Energy. Retrieved from: https://www.bp.com/en/global/corporate/energy-economics/statistical-review-of-world-energy.html)

hydrogen-sulfide, which is both corrosive and toxic. It should be noted that Iceland's dedication to renewable energy sources has made it a global leader in clean energy and one of the lowest greenhouse gas emitters in energy sector.

The first hydropower plant (HPP) was founded in 1904 in Hafnafjörður. Later, in 1921 and 1922, HPPs appeared in Reykjavík and Akureyri. So, at that time the electricity market was created in Iceland. In 1965, the national power company Landsvirkjun was founded to develop energy projects within the country. More active hydropower development began in the early 1970s. Today, the country has an installed hydropower generation capacity of 2,204 MW.

The first geothermal power plant was founded in 1969, followed by two larger plants in 1978 and 1979. With a total installed geothermal power generation capacity of 756 MW, Iceland is in the top 10 countries of the world in terms of geothermal electricity generation. It is used not only for district heating but also for bathing and swimming, greenhouse operations, fish farming, etc. (Iceland Renewable Energy Cluster, 2021).

Despite its location in the North Atlantic with strong and constant wind, the wind power energy is almost not used. Although in 2013, the national power company Landsvirkjun set up two wind turbines with a combined capacity of 2 MW. And the national authorities expect wind energy to become a promising direction.

In this regard it is extremely important to mention that the Iceland Renewable Energy Cluster is developing infrastructure to produce green hydrogen, for either export or domestic use in the transport sector of the future. In the early 2000s, Iceland launched a pilot project with hydrogen-powered busses. In October 2020, Landsvirkjun and the Port of Rotterdam have signed a Memorandum of Understanding to perform a pre-feasibility study of exporting green hydrogen from Iceland to Rotterdam. Hydrogen energy is a national priority of Iceland. In the nearest future, the country may become the world's first fully hydrogen economy and create the hydrogen society.

Norway

Hydropower is the main RES in Norway (Fig. 6). In 2020, it accounted for 93% of renewable energy generation (131.88 terawatt-hours), followed by wind with 6.54% (9.32 terawatt-hours). Norway is the 7th largest hydroelectric power producer, able to look back on a century-long history of hydro energy production. In the last decade, wind power has been actively developing. The number of wind turbines increases every year.

Norway is developing renewable energy cooperation with other European countries. On May 2021, Norway's Zephyr Company announced *Poseidon* wind energy project with a capacity of 1.4 GW on the Swedish shelf (Global Energy, 2021). It is planned to start operation in 2031.The intensive erection of onshore wind parks claiming major land areas has already provoked rather strong sentiments of "NIMByism" (acronym for the popular slogan "Not In My Backyard") among reindeer herders and other northerners.

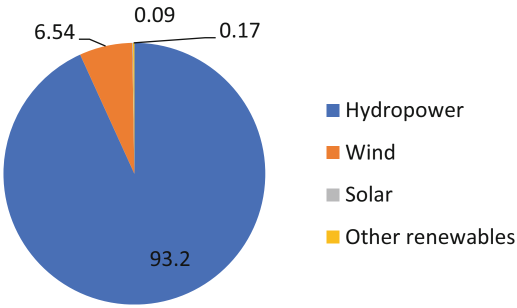

Fig. 6 Renewable energy generation in Norway in 2020 (percent). (Source: compiled by the authors on the basis of data from British Petroleum Statistical Review of World Energy. Retrieved from: https://www.bp.com/en/global/corporate/energy-economics/statistical-review-of-world-energy.html)

Given Norway's largest natural gas reserves, it has an opportunity to develop a large-scale hydrogen production from natural gas. In June 2020, the two key Norwegian ministries issued the Government's Hydrogen Strategy, which sets an ambitious goal to increase the number of pilot and demonstration projects in Norway, by contributing and supporting infrastructure buildup, technology development, and commercialization. The Strategy aims among other at an increased natural gas-based production of hydrogen with a 100% CO2 storage offshore, as well as an accelerated introduction of hydrogen fuel in heavy industry and transports (Government of Norway, 2020a).

In August 2021, energy companies St1 Nordic Oy and Horisont Energy signed a memorandum of understanding for the joint development of an environmentally friendly ammonia project in Finnmark, Northern Norway. The partnership is aimed at the production of green ammonia by electrolysis of water using the energy from Davvi wind park (800 MW). However, there are some difficulties with the project's realization. In the meantime, the trajectory of the green ammonia project is developing in conjunction with another ammonia project Horisont Energi has in Finnmark: using natural gas from the Snøhvit field to produce blue ammonia. The plant is expected to be built in either Hammerfest or Nordkapp at the coast of the Barents Sea, with an investment decision ready towards the end of 2022.

Another project is being developed by Aker Clean Hydrogen and Varanger Kraft – a green hydrogen and ammonia plant (100 MW) in Berlevåg, sourcing renewable power from Varanger Kraft's Raggovidda wind park. It is planned to start operation in 2024.

Besides, Norwegian oil and gas company Equinor and British SSE announced the building of the world's first hydrogen power plant in the United Kingdom by 2027. Keadby Hydrogen plant would have a peak demand of 1,800 MW of hydrogen, generating around 900 MW of electricity.

In July 2021, Shell joined a blue hydrogen project in Norway, aimed at hydrogen production as a marine fuel. It is planned to produce hydrogen using natural gas from Shell's terminal located at Nyhamna, in Aukra.

Several Norwegian companies, also in the Arctic, test hydrogen-fueled ferries and trucks. However, this is no mainstream fuel, and at this stage research and development is the main priority.

Sweden

Sweden is one of the most energy-efficient economies. Its energy policy is focused on the transition from nonrenewable to renewable energy sources. Today renewables account for 61% of the country's energy generation (Fig. 7).

In 2016, Sweden adopted Energy Agreement which sets ambitious targets – to achieve a net-zero carbon economy and to increase renewables' share in electricity generation to 100% by 2040. Sweden has embarked on a full transition to eco-friendly production and green energy on the Arctic territory. A budget of $ 120 billion was allocated for green projects in the Arctic in June 2021.

Sweden has been actively investing in hydro and wind energy since the middle of the twentieth century. Since the 1980s, electricity generation has been based on hydro- and nuclear power, representing a combination of stability and flexibility. In recent years, due to the support system for renewable electricity, wind power has grown fast. Today it provides for 20% of electricity. Sweden is a part of a harmonized and integrated Nordic electricity market with several interconnections with neighboring countries.

In 2019, Sweden's total installed renewable electricity capacity amounted to 30,984 MW or 73% (International Renewable Energy Agency, 2021). Sweden's energy supply is characterized by high shares of hydropower, nuclear power, and bioenergy, which together account for 95% of domestic energy production. In recent years, wind power has grown rapidly and made Sweden a net exporter of electricity. According to the Swedish Wind Energy Association (SWEA), the volume of energy produced by wind over the next 20 years will increase up to 90 TW.

Besides, the country has a world-leading pulp, paper, and wood engineering industry, which also utilizes forest materials from the Arctic region.

The main challenge for the next decade is to transfer production in Sweden to green energy. At the same time, the country's manufacturing sector has similar experience. The company H2 Green Steel, which develops mineral deposits in the north of Sweden, has switched to the use of green energy both in mining and in the further processing of minerals at plants located in the Arctic zone.

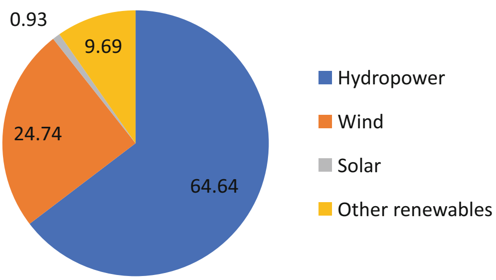

Fig. 7 Renewable energy generation in Sweden in 2020 (percent). (Source: compiled by the authors on the basis of data from British Petroleum Statistical Review of World Energy. Retrieved from: https://www.bp.com/en/global/corporate/energy-economics/statistical-review-of-world-energy.html)

Russia

Hydropower is the main renewable energy source in Russia (Fig. 8). It accounts for 98% of renewable energy generation (212 terawatt-hours).

The environmental performance of the Russian energy sector on the whole has a low carbon footprint thanks to an extensive use of natural gas, hydropower, and nuclear energy; the government maintains the latter is indispensable for the low-carbon transition. Deputy Prime Minister Alexander Novak stated in 2021 at the high-level dialogue on energy under the UN General Assembly that non-carbon or low-carbon sources produced about 87% of energy in Russia; therein, natural gas stood for 46%. By 2035, the share of renewables may increase to 45% (Government of the Russian Federation, 2021).

There is a high potential for the development of wind energy in the northernmost latitudes and solar energy in the eastern Arctic regions (e.g., in Yakutia). The resource of renewable energy in the Arctic region is significant, and the development of renewable energy projects will allow reducing the dependence on diesel fuel. In the energy supply of remote regions of the Russian Federation, an important role belongs to small-scale energy, which provides for 70% of its territory with electric and thermal energy.

Nowadays, some wind farms are already operating in the AZRF: an experimental wind power station in Labytnangi and the Polaris Project with four wind power plants in the Yamal-Nenets Autonomous Area, the Anadyr Wind Power Plant at the Cape of Observation with ten wind generators in the Chukotka Autonomous District, a wind farm in the village of Tiksi with three wind turbines, and an experimental wind power station "Bykov Mys." After 2021, the first wind power plant in the North with a capacity of 201 MW will start operating in the Kola District near Murmansk; it will be the largest wind power plant in Russia. The total capacity of all Russian Arctic wind power plants is 210 MW. Usually, the installations are used either separately or together with solar panels and diesel generators.

Solar power plants operate in the Yamalo-Nenets Autonomous District, in the villages of Batagai, Betenkes Batamai, Dzhargalakh, Dulgalakh, Kudu-Kyuel, Uluu, Yunkur, Verkhnyaya Amga, Stolby, Innah Toyon-Ary, Kubergan, Eyik, and Delgey. The total power of the energy produced by these solar power plants is about 1.4 MW.

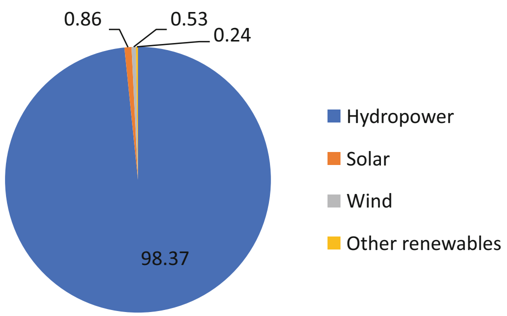

Fig. 8 Renewable energy generation in Russia in 2020 (percent). (Source: compiled by the authors on the basis of data from British Petroleum Statistical Review of World Energy. Retrieved from: https://www.bp.com/en/global/corporate/energy-economics/statistical-review-of-world-energy.html)

Sakhaenergo (part of the RusHydro Group) successfully operates 21 solar power plants with a total capacity of 1,606 MW. In 2015, as part of an agreement with the Government of the Republic of Sakha (Yakutia), the largest polar solar power plant with a capacity of 1 MW was built in the village of Batagai in the Verkhoyansky District of the Republic. The SPP in the village of Batagai is also listed in the Guinness Book of Records as the northernmost solar station in the world (RusHydro, 2021). In 2021, Hevel Energoservice completed the construction of autonomous hybrid power installations in the rural settlements of Snezhnoye and Kanchalan of the Anadyr District in the Chukotka Autonomous District – the first similar projects in the AZRF. Cumulative power of two projects is 2,600 kW (Hevel, 2021). The use of solar generation and storage devices will significantly reduce fuel consumption by up to 30% and extend the life of diesel generators.

Besides, there is also hydropower energy in the region. There are 17 hydroelectric power plants in the Murmansk Region alone, as well as 2 in Yakutia, and 1 in the Arkhangelsk Region. The Kislogubskaya tidal power plant with a capacity of 1.7 MW operates near the village of Ura-Guba in the Murmansk Region. In the Long-Eastern Bay on the Kola Peninsula, the construction of the Northern tidal power plant is expected to begin soon, with a capacity of 12 MW with an annual energy output of 23.8 million kilowatt-hours. This will be the first tidal power plant in Russia, which will reach the industrial level of energy generation. In the Mezen Bay of the White Sea, it is planned to build another tidal power plant with a capacity of 8 GW. Its annual output is expected to amount to 38.9 billion kilowatt-hours – the same as that of the entire Volga-Kama cascade of hydroelectric power plants (Mitko & Sidorov, 2020).

In 2020, Russia adopted two key policy documents outlining its hydrogen development plans. The first is the Energy Strategy until 2035, which was adopted in June 2020, and is premised on the continuing importance of hydrocarbons while also setting the goal of making Russia one of the world's leading producers and exporters of hydrogen. The export targets in the Strategy stand at 0.2 million tons by 2024 and 2 million tons by 2035.

The second document, the Roadmap for Hydrogen Development until 2024, was adopted in October 2020 and assigned a special role to Gazprom and Rosatom in meeting the goals set in the Energy Strategy. The Roadmap emphasizes Russia's perceived competitive advantages in hydrogen (such as technological know-how and R&D, the existing resource base, significant spare capacity in the power generation system, a developed transport infrastructure, and geographic proximity to major consumers) and outlines the first steps to be taken (Westphal & Zabanova, 2021).

Currently, serious scientific and technological developments are underway on the use of hydrogen in various types of energy and transport. Besides, in 2022, *Snowflake*, the first fully autonomous carbon-free international Arctic station, is expected to start operating in Yamal. It will use hydrogen, wind, and sun energy. The station will become a new platform for international cooperation between engineers, researchers, scientists, and students working on bold solutions that constitute a basis for life and work in the Arctic. In the future, the *Snowflake* will save remote areas' residents the diesel dependence (Snowflake international Arctic station, 2021).

United States

The renewable energy mix of the United States is quite balanced (Fig. 9). Hydropower and wind energy account for the largest share in energy generation – 75% (630 terawatt-hours).

The northernmost state of the United States – Alaska – is located in similar climatic conditions to northern Canada; therefore, its energy system is similar to the energy systems of its Canadian neighbors. Most of the settlements in Alaska are isolated from large power grids, except the cities connected to the Railbelt regional power system.

In 2019, renewables accounted for 30% of electricity generation. Hydropower supplied nearly 90% of the whole renewable electricity. In 2010, the state legislator has set an ambitious goal to generate 50% from RES by 2025. It is a big challenge to achieve the remaining share within the next few years.

Hydroelectric power is the main RES in Alaska. It provides for almost a quarter of the state's electricity. Large HPPs are located in the southern part of the state, in mountainous regions with high rainfalls. Smaller projects produce power to the rural communities. In 2018, 50 hydro projects provided power to Alaska utility customers, including the Alaska Energy Authority-owned Bradley Lake Project (120 MW), which supplies about 9% of the Railbelt's electricity. Alaska is also exploring tidal and ocean technologies that could supply renewable energy to coastal communities (Renewable Energy Alaska Project, 2021).

One of the promising areas for renewable sources development is geothermal power. The Aleutian Islands and the coast of Alaska are parts of the Circum-Pacific Belt or the "Ring of Fire" – the home to over 75% of the world's active and dormant volcanoes. The only geothermal power plant was built in 2006 at China Springs

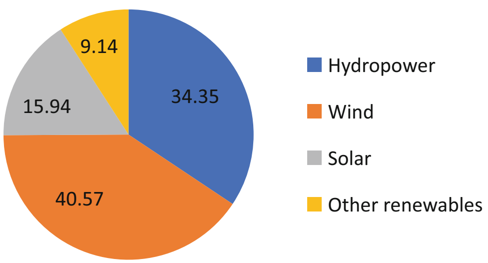

Fig. 9 Renewable energy generation in the United States in 2020 (percent). (Source: compiled by the authors on the basis of data from British Petroleum Statistical Review of World Energy. Retrieved from: https://www.bp.com/en/global/corporate/energy-economics/statistical-review-of-world-energy.html)

(400 kW). But the challenge in the development of geothermal facilities is that the resources are located far from population, so it makes not much economic sense.

Wind accounts for 8% of renewable generation from more than 100 wind turbines (67 MW) situated alongside Alaska's coastline. Wind farms provide power to off-grid rural communities, traditionally using diesel generators, so often they use wind-diesel hybrid power systems. On the Railbelt, three wind firms were installed (44 MW) in order to diversify the energy mix. In 2009, Kodiak Electric Association (KEA) installed the state's first megawatt-scale turbine and then doubled the size of its wind farm in 2012. The project's six 1.5 MW turbines now supply more than 18% of the community's electricity.

Solar energy is another important RES, especially in rural areas. Alaska's largest solar farm consisting of about 1,800 solar photovoltaics (563 kW) is located south of Fairbanks. Small-scale solar generating systems (each less than 1 MW in capacity) produced 4,000 megawatt-hours of electricity in 2019 and accounted for 0.2% of the state's total renewable generation (U.S. Energy Information Administration, 2021).

According to the National Renewable Energy Laboratory (2021), the current prospects for Alaska's renewable energy include (1) wind resources, most notably in the mountain-funnel geographic area around the Cook Inlet and in the Alaska Range; (2) local biomass for heat; (3) Mt. Spurr geothermal; and (4) tidal, run of river, lake tap, and various hydropower dam projects ranging from high head/small footprint in the mountains to large downstream dam sites.

Amid the US house panel passed the bill protecting Alaska's Arctic National Wildlife Refuge and other continental shelf from oil and gas drilling, much attention of the energy companies should be paid to renewable energy projects. According to Agarkov et al. (2018), intensified search and extraction of hydrocarbons in the Arctic will lead to increased pressure on the Arctic ecosystems. At the same time, the state government will face serious contradictions as Alaska is the only state that does not have a state sales tax or a personal income tax, as revenues from Alaska's oil and gas industry fund 85% of the state government. Alaska has the best renewable energy potential in the United States in three areas at once – hydropower, geothermal energy, and tidal energy. However, this potential is still very poorly used.

Conclusions

The Arctic development, also in the energy area, has always been heavily dependent on the international market trends and on high-level political decisions taken in capital cities. The unfolding global shift towards low carbon and renewables is further amplifying this trend. To the contrary of the previous energy transitions (relating to the rapid introduction of coal, oil, and natural gas), the contemporary one is, to a high degree, a result of deliberate actions by the global community and individual governments, like emission cut goals, restrictions on the use of fossil fuel, and dedicated tax incentives for solar and wind generation. This important feature makes the low-carbon transition more multifaceted and less predictable, with a broad variety of approaches reflecting the respective national agendas, which are also subject to fluctuations over time. The above examples of the Arctic countries are a clear illustration.

It seems highly realistic, however, that the medium- and long-term development of the Arctic energy sector will develop under a strong influence of the following trends:

- A continued global warming, which is going to be more tangible in the Arctic than in the moderate climate areas. All Arctic nations, notably Indigenous Peoples, will face large and complicated adaptation challenges, also in the area of energy supply.
- An increasing, environmentally motivated pressure on Arctic fossil fuels on the part of international organizations, national governments, and the broad public. The existing industry practice already includes legislative bans and moratoria, environmental NGO campaigns, Indigenous communities' protests, legal actions, and restrictive bank policies. Their scope and magnitude levers are likely to expand in line with the global warming.
- New Arctic oil and gas developments will concentrate onshore Northern Siberia and potentially offshore Northern Norway, the latter being subject to new major discoveries in the Barents Sea. At present, only Russia has approved plans stretching beyond 2024. In Canada and the United States, the oil and gas industry future is likely to remain a controversial domestic policy issue, which will pose the investors with high political and commercial uncertainties. On the whole, Arctic oil and gas, although important for national energy supply and for the respective regions, are not going to play any significant role in the global market.
- Renewable energy sources cannot replace fossil fuels, but their role in the future energy security of many Arctic remote regions is crucial. Today the application of renewable energy in the Arctic region is minimal. Diesel is the primary energy source for approximately 80% of Arctic communities, and Russia is no exception. The transition to renewable energy will allow to both provide the region with energy resources and combat climate change, helping to preserve the Arctic nature for future generations. There is a high potential for wind and solar energy development at relatively low generation costs. In remote Arctic settlements, wind power is often competitive against diesel, with its excessively high transportation costs.
- The transition towards hydrogen may enhance sustainability and energy security of the fossil fuel consumers. The global hydrogen market is poised to both expand rapidly and experience a harsher competition, primarily in the area of advanced technologies. This development will create new market niches for the Arctic nations while also challenging the present energy exporters. This is especially relevant for Russia, given its large-scale resource development plans and the explicit EU desire to reduce its energy import dependence on this country.

Seen from the viewpoint of regional development, the fading prospects of a large-scale pan-Arctic oil and gas industry affect many northern communities, which hoped to be involved in the process. Unmanned, alternative energy plants like wind generators, while contributing to the regional security of supplies, may not produce the same ripple effects in terms of new jobs, demand for local goods and services, or improved transport routes. At the same time, the low-carbon transition also creates new opportunities for an efficient, sustainable Arctic development applying environmentally friendly technologies to boost the "blue economy," tourism, or data centers with access to broadband communications.

The Norwegian government's idea of coexistence between Arctic industries (while launched originally for rather tactical reasons to calm fishermen's protests against offshore drilling) seems to be the right approach, not merely at sea. Fossil fuels, hydrogen, and renewable energy will coexist and interact for a long time, with a potential for strong and "cleaner" synergies. These include diesel-wind cogeneration (which for now is the only reliable solution for autonomous power supply in remote areas), CCUS projects, supplying offshore oil and gas installations with "green kilowatts" from land to avoid the use of offshore gas turbines, etc.

These trends are going to change not merely the Arctic energy mix, but the entire economic development and peoples' lifestyles. New environmental standards, changing industry landscapes, decline and restructuring of older mining or petroleum-oriented towns, development of new businesses like data processing and other Web-based solutions, etc. will transform the Arctic, creating both new opportunities and challenges for the peoples and authorities.

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Hydrogen Production Prospects in the Conditions of Climate Change in the Arctic

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Contents

Abstract

The Arctic plays an important role in shaping the climate on the earth; in this regard, many experts are currently expressing concerns about the melting of ice and climate change in this area. Reducing the impact of black carbon on the Arctic is becoming an important task for most governments; this includes Russia, which has opportunities to take a leading role in the international arena. The global goals to ensure sustainable development and increase environmental friendliness create new challenges and prospects for governments, enterprises, and local communities.

In addition, many experts note an anticipated decrease in the volume of oil exports and production in the near future, meaning now it will be necessary to form vectors for the development of energy transfer. The crisis of hydrocarbon markets during COVID-19 also instigated its own adjustments, affected business, and led to a certain change of consciousness in the oil and gas industry. In the midst of the coronavirus pandemic, the oldest market participants – oil production

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pioneers like BP and Shell – announced their intention to become carbon neutral companies by 2050 (i.e., to reduce net carbon emissions to zero); total is going to achieve such measures by the same deadline for its European divisions. Besides the development of green generation, the most obvious way for oil and gas companies to diversify their business is hydrogen production.

Under these circumstances, hydrogen may become an effective energy resource to replace hydrocarbons while contributing to solving the problem of climate change and the need for governments to reduce CO_2 emissions. The issue of the "green economy" has been on the agenda for a long period of time, and still causes a lot of controversy, especially in the Arctic, and therefore the purpose of the chapter is to identify the main vectors of development of the Arctic region in terms of sustainable development, decarbonization and ecology. A distinctive feature of this chapter is to substantiate the need for the development of hydrogen energy in the Arctic as one of the current trends in the global energy market, as well as to disclose the backgrounds and prospects for the hydrogen energy development.

Keywords

Arctic climate change · Methane · Gas hydrates · Hydrogen energy · Ammonia · Hydrogen strategy · Decarbonization

Introduction

Currently, there is active talk at the global level concerning the need to protect the environment, reduce carbon footprints, and fulfill the terms of the Paris Agreement. The Arctic region is exposed to melting ice, and experts believe that warming in the Arctic has recently accelerated. Climate change leads to negative consequences for both indigenous peoples and local fauna (Box et al., 2019). Computer maps are being compiled based on scientific data that reflect the dynamics of the reduction of the ice area, and as well as decreasing in area, the thickness of the ice cover has shrunk significantly: if earlier this parameter varied within 3–4 m, now the thickness of the ice is on average no more than 1.5 m (IPCC, 2021). Several factors simultaneously contribute to these changes. The leading reason is oil and gas activity in the region, which is accompanied by the formation and deposition of gas hydrates both in the reservoir and in the systems of underground and ground equipment of oil and gas fields. It is important to note that this process is directly related to the release of latent heat of hydrate formation, which can lead to a significant increase in temperature in a porous medium. At its core, gas hydrate is solidified methane, also known as "combustible ice," which, along with hydrogen energy, is currently considered the "energy of the future," despite the fact that, from an environmental point of view, these energy carriers cause a number of disputes and disagreements (Chuvilin et al., 2019).

Over the past few years, hydrogen energy, climate change, and the need to reduce the carbon footprint have been talked about more and more often (Gutterres, 2021). Decarbonization has become a trend in the twenty-first century, and it opens up new prospects and opportunities for energy transition and economic development.

The Arctic is a region covered with ice and snow, making up about 20% of the land area reflecting solar radiation. The distinguishing characteristic of the region lies not only in the wealth of resources, but also in the indigenous peoples, flora, and fauna. Furthermore, sustainable development of the Arctic zone of the Russian Federation is one of the priorities of state policy according to the Decree of the President of the Russian Federation No. 645 as of October 26, 2020. Among the priority tasks of the Arctic development, noteworthy ones include the formation of energy, transport, and telecommunications infrastructure, the solution of environmental safety, and social development issues.

Literature Review

Environmental problems of the Arctic region are widely covered in the works of Russian and foreign scientists (Gudzenko et al., 2018; Serov, 2017; Mastepanov, 2014; Yakushev, 2007). In recent decades, it has been noted that the process of climate warming in the Arctic is happening 2–3 times faster than in other parts of the earth. Basniev & Sukhonosenko (2010) in their work note that the uncontrolled release of methane into the atmosphere can lead to an acceleration of global warming. In turn, Arutyunov & Strekova (2021) draw attention to the fact that the increase in the average temperature of the Earth's surface, which has been going on for several decades, stimulates interest in the wider use of "carbon-free" energy sources, in particular hydrogen. Zohuri (2019) and Zhiznin et al. (2020) in their works reveal the prospects of using hydrogen energy, which has the most minimal impact on the environment and is a viable, promising, albeit insufficiently studied, alternative fuel. Rosen & Koohi-Fayegh (2016) and Zou & Chen (2020) also emphasize that hydrogen will play a key role as an energy carrier in the future as fossil fuel reserves decrease and environmental problems increase. International prospects for the development of hydrogen energy are given by Gardarsdottid & Sundseth (2021), Jay (2020), and Sannikov (2020).

The lack of knowledge of hydrogen is due to the fact that the use of hydrogen energy is just beginning to gain momentum, but many countries, concerned about the need to reduce emissions, treat hydrogen as one of the ways to solve this problem. At the same time, it requires the establishment of demand and mechanisms that will allow the integration of hydrogen energy into the fuel and energy complex, since the use of hydrogen on a small scale is expensive for most industries. In particular, it is necessary to expand cooperation between states in order to increase demand and exchange knowledge and experience, along with the creation of hydrogen centers that will allow the distribution of costs and risks between sectors.

Challenges for a Cleaner Future

One of the most discussed problems is global warming, the heating of the Earth caused by the intensification of the greenhouse effect and gas hydrates and methane emissions, giving cause for concern in the Arctic. The specific absorption by methane of the Earth's thermal radiation (radiation activity) is much higher than that of CO_2. As noted, the uncontrolled release of methane into the atmosphere can lead to an acceleration of global warming on the planet (Basniev & Sukhonosenko, 2010; Piskulova & Pak, 2017). With an increase in temperature, the scope of deviations of almost all hydrometeorological indicators increases, as evidenced by the increase in the number of abnormal weather events. According to the report of extreme events in the Arctic by the National Oceanic and Atmospheric Administration of the United States (NOAA), by the end of 2020, snow cover had sharply decreased, which has not been observed in the last 54 years, and the year was the second record for warmth since 1900. The area of sea ice has also broken records for decreasing: thin annual ice has displaced strong multi-year ice. Large forest fires in the Sakha Republic (Russia) in 2020 coincided with unprecedented warm air temperatures and a record shortage of snow in the region (Melia et al., 2016). Thus, the Arctic is subject to significant climatic changes, which requires timely intervention primarily from the Arctic governments.

When the extraction of methane from gas hydrates moves from the stage of experimental work to the stage of industrial operation, the technology of developing methane hydrates by introducing carbon dioxide into the layers will be able to partially contribute to solving the environmental problem. Most specialists dealing with the problem of gas hydrates, in particular including technologies for the development of their deposits, consider this process potentially environmentally hazardous. However, there are other points of view. Thus, the head of the research program of Hydrate Energy International Michael Max emphasizes that gas hydrates are the only environmentally safe hydrocarbon raw materials for production on the Arctic shelf, and therefore, in order to preserve the nature of the region, their extraction should be carried out. According to him, the transition to the extraction of gas hydrates will help preserve the fragile ecosystems of the region. The depth of occurrence of gas hydrates does not exceed 1 km, while the depth of an offshore oil well sometimes reaches about 9 km (Leonov, 2014). Mechanisms for the primary treatment of methane hydrates need to be installed at the bottom, then the extraction and transportation process correspond to the technologies adopted for working with conventional natural gas. As such, environmentalists' concern about potential methane emissions into the atmosphere, which are as likely to occur during the extraction of gas hydrates as oil spills during its extraction, is almost equivalent (Mastepanov, 2014). At the same time, despite significant volumes of gas, natural hydrates do not pose a danger in terms of significant methane emissions and climate change (Yakushev, 2007).

Nevertheless, the little-known origin of gas in the Arctic, as well as the geological processes controlling its release, should be acknowledged. Scientists note that one of the sources of methane release is precisely decomposing gas hydrates. The methane content in gas hydrates is several orders of magnitude greater than the amount of methane in the atmosphere and the greenhouse effect is estimated at 4–9% and is second only in importance to carbon dioxide and water vapor. Over the past 150 years methane emissions have increased more than three and a half times (Serov, 2017). Long-term observations in the Arctic region have revealed the largest methane emission maximum on the planet here, the presence of which cannot be explained either by anthropogenic factors or seasonal emissions of terrestrial northern ecosystems, since the Arctic maximum exists year-round and is located far from the regions of human activity. Currently, it is known that the largest amount of methane in the atmosphere of the Arctic region is located on the shelf of the seas of the Eastern Arctic – the Laptev Sea, the East Siberian Sea, and the Russian part of the Chukchi Sea. There are several sources of methane emissions in these cases: as already noted, these are primarily emissions from gas hydrates, large deposits of which are found just on the shelf of the seas of the Eastern Arctic. Moreover, methane emissions occur in the permafrost layer, as its thawing increases, as well as the flow of endogenous methane through deep fault zones in genesis of rift zones (stretching of the Earth's crust due to deformations) (Lobkovsky, 2018).

It is important to note that the radiation activity of methane is about 21 times higher than the activity of carbon dioxide, and its concentration is expected to double in the next 50–60 years. In the middle of the last century, the greenhouse effect of methane was 6% relative to the effect of carbon dioxide; now this figure has already reached 10%, and in half a century it will be 14%. The main risk is that, as the Arctic warms up and ice melts in the Arctic seas during the summer period, a sharp destruction of the permafrost layer will occur, and a large mass of methane will be released into the atmosphere at the same time, which will undoubtedly affect climate change beyond the Arctic region. Unlike the methane emissions which have long been known about in the Sea of Okhotsk, where sips (methane yield) are located at a depth of 2–3 km and methane does not reach the surface dissolving in the water column, in shallow water (the depth of the East Siberian shelf is about 50 m) methane escapes into the atmosphere at high speed (Gudzenko et al., 2018).

The currently available simplified estimates of changes in the temperature profiles of the Earth's crust lead to the following conclusions. Submarine gas hydrates, which are located within the waters of the World Ocean, inland seas, and lakes, do not cause concern right now, and will remain so over the next century. The greatest danger is represented by hydrates, which are already located in permafrost territories. The gas hydrate deposits of the continental Arctic shelves are particularly susceptible to climate change. Due to the sea level rising, they are washed by the waters of the Arctic Ocean and have experienced an increase in surface temperatures by 10 degrees or more over the last 10000 years. The amount of methane emission from it is already about 5.6×109 cubic meters per year – that is about 1% of all known sources of atmospheric methane. For it, the critical temperature is from -2 °C to 0 °C, above which the self-preservation effect ceases to work and the collapse decomposition of gas hydrates begins. In general, the solution to the problem of the relationship between climate and gas hydrates is at the initial stage, computer modeling does not provide an unambiguous forecast of climate development, and existing hypotheses are very controversial as estimates or approximate calculations give a wide range of results (Gudzenko et al., 2018).

International Focus on Hydrogen Energy

With the gradual development of hydrogen energy technologies and the constant increase in global pressure on climate change, the development of hydrogen energy attracts a lot of attention. Japan, the United States, the European Union, and other developed countries or regions have raised the level of development of hydrogen energy to the level of a national energy strategy. The Netherlands, Germany, Norway, Portugal, France, and the EU approved their national hydrogen strategies in 2020, and Germany and France presented them in the context of plans to restore economies that have weakened due to the current COVID-19 pandemic.

With regard to the development of hydrogen energy, the experience of Japan should be considered separately. Japan, which for many years has not been particularly interested in the topic of climate change, has decided to seriously take up the fight against global warming (Iida, 2020). Interest in hydrogen energy originated in Japan long before the modern meaning of the concept of "energy transition" was formed in the world public consciousness, although now it is hydrogen energy that is considered worldwide as one of the main components of this transition. The country is going to accelerate the transition to new types of energy, but unlike many others, it does not rely on wind or solar, but on hydrogen (Timofeev, 2019). To date, Japan has more than 40 years of research and development experience in the field of hydrogen technologies and fuel cells, but a full understanding of Japan's energy policy in the field of hydrogen arose only after the accident at the Fukushima Daiichi nuclear power plant in March 2011.

In 2017, the Government Council formed the Basic Hydrogen Strategy, the first comprehensive government plan in Japan for the development of hydrogen technologies and fuel cells, summarizing and optimizing a number of programs implemented by various ministries. This strategy took into account not only new achievements in the field of hydrogen technologies but also the tasks of Japan arising from its signing of the Paris Climate Agreement. With the publication of this document, Japan became the first country to have a comprehensive government plan for the development of hydrogen technologies.

In June 2019, the Ministry of Economy, Trade, and Industry of Japan (METI) and the New Energy and Industrial Technology Development Organization (NEDO) conducted an assessment of hydrogen and fuel cell R&D with the aim of activating relevant activities in industry, academia, and government. Based on the identified problems, the Hydrogen and Fuel Cell Strategy Council in September 2019 adopted the Hydrogen and Fuel Cell Technology Development Strategy. This document defines ten points of technological development in three areas that should be given priority to achieve the goals set out in the Strategic Roadmap for Hydrogen.

In June 2020, the Mizue factory gas turbine power plant with an installed capacity of 80 MW started operating on a new fuel – hydrogen at the Tao Oil refinery in Japan (Sannikov, 2020). The companies Chiyoda, Mitsubishi, Mitsui, and Nippon Yusen started the project back in 2015. They formed the general research unit – Advanced Hydrogen Energy Chain Association for Technology Development (AHEAD) –

which built a hydrogenation plant (for hydrogen binding) in Brunei and a dehydrogenation plant in Japan.

In this project, however, hydrogen is generated by steam conversion of methane supplied to Brunei by tankers in liquefied form. Then it is bound to toluene to obtain methylcyclohexane, which, at normal temperature and atmospheric pressure, is a liquid that can be stored and transported in tanks.

Other companies are also preparing to use hydrogen as a fuel for power generation. For example, Siemens should be preparing a modification of the SGT-400 industrial gas turbine adapted for burning pure hydrogen. It will be installed in France at the thermal power plant of the Smurfit Kappa PRF paper recycling plant. All major manufacturers of energy gas turbines – Mitsubishi Hitachi Power Systems, GE Power, Siemens Energy, and Ansaldo Energia – are currently developing their models capable of operating on pure hydrogen both at constant load and at peak consumption (Sannikov, 2020).

Thus, although Japan is not an Arctic state but has its own different geographical features, its experience can be very useful for other states that are just beginning to engage in hydrogen energy research.

The Netherlands plans to switch all public transport to "hydrogen" traction in the next couple of decades. In addition, numerous variants of turbines operating on a mixture of natural gas and/or hydrogen are being developed. In addition, according to some strategies of renewable energy producers, offshore wind farms are proposed to be located off the coast of the Netherlands, directly connected with the electrolysis production of hydrogen. The resulting electricity can be distributed throughout Europe, depending on local hydrogen production. At the same time, experts note that in relation to remote Arctic territories, the use of hydrogen fuel will reduce energy consumption by a third, and in this case, the combination of renewable energy and hydrogen will be a very advantageous option (Berdinet al., 2017).

In Germany, hydrogen trains were launched on a regular basis in 2018. The company Alstom, which produced them, received an order for 27 cars. In the UK, an experimental hydrogen express was launched in 2019. By 2040, the country is going to completely get rid of the fleet of diesel locomotives. The British company Electric Aviation Group has announced the creation of an eco-friendly regional aircraft – H2ERA airliner powered by hydrogen.

The Canadian government published its hydrogen strategy in December 2020. This strategy aims to help Canada achieve net zero emissions by 2050. Canada is currently one of the world's top ten hydrogen producers, producing about three million tons of hydrogen per year (Government of Canada, 2020). Natural Resources Minister Seamus O'Regan said Canada would need \$5 billion to \$7 billion in short-term investments to develop the hydrogen industry (Jay, 2020). Canada Strategy relies and builds on existing policy measures, including Canada's recently announced Climate Plan, carbon pricing, the Clean Fuel Regulations, the \$1.5 Billion Low-carbon and Zero-emissions Fuels Fund, and the Incentives for Zero-Emission Vehicles program (IPCC, 2021). During the first 5 years (2020–2025), the focus will be on planning and developing a new hydrogen supply and transportation infrastructure. In the period 2025–2030, the main focus will be on the growth and diversification of the hydrogen sector, and, at the last stage, the strategy provides for the expansion of the hydrogen market. In October 2020, the province of Alberta published its vision and strategy, in which hydrogen is positioned as one of the key growth areas of the natural gas sector in this region. Alberta's strategy is aimed at introducing hydrogen and hydrogen-based technologies in the transportation and home heating sectors, further using hydrogen as a fuel for electricity generation and other industrial processes, and becoming a major exporter of hydrogen to domestic and international markets. Alberta's strategy offers two important goals: achieving large-scale production of blue hydrogen alongside the introduction of hydrogen for various commercial purposes throughout the province by 2030, and exporting hydrogen and hydrogen-derived products to domestic and global markets by 2040. The Strategy also outlines a number of short-, medium-, and long-term measures that appear to be aimed at contributing to the achievement of these goals. Action points include establishing common interests and opportunities for partnership with the federal government, coordinating hydrogen-related policies between the western provinces, and establishing partnerships with industry leaders.

Another Canadian province, British Columbia, is actively developing in the field of hydrogen energy. In particular, Ballard Power Systems has been developing hydrogen fuel cell technology for decades and is currently implementing hydrogen fuel cell technology for transportation around the world. In September 2020, the provincial government announced funding for the construction of an additional ten hydrogen refueling stations and expressed its intention to develop a hydrogen strategy aimed at further investment and steps in the hydrogen industry.

It is also worth noting that Canada, together with the German steel supplier Thyssenkrupp, is launching the construction of the largest plant for the production of environmentally friendly hydrogen in Canada. This facility will be built for the Hydro-Quenbec energy company and will have to provide annual supplies of 11000 tons of green hydrogen for the Canadian transport sector (Government of Canada, 2020).

Based on these intentions from a number of states, it can be concluded that hydrogen energy is on the agenda of many countries as one of the ways to decarbonize and implement the provisions of the Paris Agreement.

A good example of the development of hydrogen energy is Norway, whose strategy aims to ensure that by 2025 the number of electric vehicles and cars with hydrogen fuel cells should reach 50000. Their purchase is not subject to VAT, and the owners are not required to pay transport tax until 2023 (Norwegian Ministry of Petroleum and Energy, 2020).

Norway's long-term experience in the field of natural gas processing and renewable energy sources can be used in hydrogen-based solutions. Research platforms and collaboration with industry are necessary to create first-class competencies and business opportunities to become a world leader in hydrogen solutions. Perhaps the most important reason for R&D investment in hydrogen, however, is to encourage more widespread use in many sectors. This scaling of hydrogen provides the greatest cost reduction, making hydrogen more attractive for other applications.

Gardarsdottir & Sundseth (2021) note that, for the introduction of hydrogen in the transport, marine, and other industries, it is necessary for companies to be much wealthier to emit greenhouse gases compared to the production of hydrogen and the introduction of appropriate technologies. For example, the Norwegian public sector can be used to require suppliers to implement more environmentally friendly solutions, including hybrid ones. The development of hydrogen infrastructure on a national scale will help reduce costs by eliminating some of the uncertainties associated with the choice of hydrogen. Hydrogen is of great value if it is integrated into society as a whole, but using hydrogen on a small scale is prohibitively expensive for most industries. There are 9000 km of underwater pipelines in the North Sea for the transportation of natural gas. Currently, the possibility of using such pipelines for the transportation of pure hydrogen gas is being studied (Gardarsdottid & Sundseth, 2021).

The European Union has also developed its own strategy for the development of hydrogen energy. At the same time, the emphasis on hydrogen as the main element of the decarbonization of the energy economy forms a new approach to financing. The European Investment Bank (EIB) allocates €1 trillion in its investment portfolio for green projects in the period up to 2030 (EIB Group Climate Bank Roadmap 2021–2025 2020). The Bank will completely stop financing in the oil and gas industry by the end of 2021 and airports by the end of 2022, and by 2025 half of its assets are focused on green projects. The investment section in the EU strategy says: “In the period from now until 2030, investments in electrolyzers will amount from €24 to 42 billion. Additionally, in the same period, €220–340 billion may be required for the construction and direct connection to the electrolyzers of solar and wind generating capacities of 80–120 GW Investments in equipping half of the existing power plants with carbon capture and storage systems are estimated at about €11 billion. In addition, €65 billion will be required for the creation of hydrogen transportation and storage systems, including hydrogen filling stations. Investments in production facilities in the European Union for the period up to 2050 they will amount to €180–470 billion” (European Commission, 2020, p. 7).

Hydrogen production is also lobbied by the private sector. The largest electric power companies and associations in Europe (Akuo Energy, BayWa re, EDP, Enel, Iberdrola, MHI Vestas, SolarPower Europe, Ørsted, Vestas, and WindEurope) have addressed an open letter to the European Commission, in which they noted: Investments in clean hydrogen have great potential in terms of creating new jobs and ensuring economic growth.

It is also worth noting that Russia has a large extent of Arctic territory, which creates prerequisites for strengthening cooperation between Russia and the EU in the field of hydrogen energy. The European Union is on the way to cardinal decarbonization, in addition to energy conservation and renewable energy sources – the EU is focused on the development of hydrogen energy, but the production of “green” hydrogen remains expensive. On the part of the Russian Federation and Gazprom PJSC, it was proposed to export hydrogen to the EU countries by processing Russian methane, when carbon dioxide formed during the production of raw materials will remain in Russia.

Experts note that such a scheme of hydrogen supply to the EU is much cheaper than the production of "green" hydrogen. It is quite possible that this path of hydrogen energy development will become the main one for the EU. As for Russia, it can become a partner of the European Union in the production and promotion of hydrogen energy. It will be possible to use the existing Nord Stream-1 and Nord Stream-2 gas pipelines for transportation.

A number of pilot projects have been implemented in developed countries to create autonomous hybrid power systems using wind, solar, and hydrogen energy, aimed at life support of island or remote regions. One of the first projects of this type was the wind-hydrogen power system of Utsira Island, launched in 2004, located 20 km from the west coast of Norway (Øystein et al. 2010). Initially, a diesel generator was used on the island, but it was completely replaced by hybrid wind-hydrogen generation. The Utsira project was implemented by a consortium of the Norwegian energy company Statoil ASA and Enercon, which own technologies for hydrogen electrolysis and the construction of wind power plants, respectively. Local authorities, members of the local community, and representatives of local businesses were actively involved in the creation and management of the hybrid power system. The innovative power system provides a high-quality and reliable power supply to ten households, and it can operate for up to 18 months in an autonomous mode. Further development of this project consists in increasing the level of wind energy utilization, multipurpose use of hydrogen, diversification of generation, increasing the efficiency of hydrogen storage systems, and scaling up wind-hydrogen power systems in the island territories of the European Union (Ulleberg et al. 2010).

Another example of the use of hydrogen energy in isolated areas is the project of Unst Partnership Ltd. "PURE," implemented on the island of Unts in northern Scotland. The high potential of renewable energy sources made it possible to create a local energy system consisting of two wind turbines, an electrolyzer and a storage of hydrogen gas, and a hydrogen car with a fuel cell.

General Electric, together with BC Hydro, implemented the HARP project in Canada (British Columbia) as part of the electrification initiative for remote communities, which consisted in the use of hydrogen technologies and Smart grids. The project is aimed at optimizing diesel fuel consumption and reducing greenhouse gas emissions.

At the same time, regarding these projects, a number of factors should be taken into account: the level of RES implementation, the availability of communication with centralized power supply systems, the average level of energy consumption, the peculiarities of the economic structure, the degree of development of the local economy, etc. In all projects, the active involvement of local communities in the design, construction, and operation of hybrid power systems was indicated as the main condition for their payback. Thus, Russia, which is on the path of introducing hydrogen energy in the Arctic region, should consider the involvement of the indigenous peoples of the North, which, in turn, will form the sustainable development of this region. It is due to the formation of the economy in combination with the goals and way of life of the indigenous peoples that the development of the Arctic territories will take place, in accordance with advanced trends and goals, taking into account the expediency, payback, and economic development. In Russian conditions, the development of mechanisms for involving the indigenous peoples of the North in innovative processes is an essential condition for the integrated development of the northern territories. Research by Siberian Federal University has revealed that the priority for all isolated villages and remote territories is the production of cheap electricity and water, on the basis of which it is possible to sustainably develop the local economy.

Hydrogen Production Prospects for Russia

The trend of increasing the research and development in the field of hydrogen energy technologies is typical for most countries, due to the desire to ensure energy security, carbon neutrality, and the search for publicly available energy sources. Returning to the issues of environmental friendliness and hydrate formation, it should be noted that there are several technologies using gas hydrates: reducing pressure in the reservoir below equilibrium; heating the reservoir above equilibrium temperature; injection of thermodynamic inhibitors (brines, methanol) into the reservoir and replacement of methane bound in hydrate with carbon dioxide. China and Japan are conducting experiments on the extraction of hydrated methane, despite the fact that it is not very cost-effective. For example, in 2017, the Geological Survey of China conducted tests of methane production in the South China Sea from the accumulation of hydrates in clay rocks. Unfortunately, Russia has some lag in the development of such technologies, along with the lack of systematic research. Moreover, it requires additional financing and attracting investments. However, the issue of ecology, Arctic melting, and methane emissions remains open, and in this case, such energy sources as hydrogen and ammonia can become very attractive with regard to reducing CO_2 emissions and, as consequence, restricting the melting of Arctic ice, provided oil and gas production on the Arctic shelf and using methane for hydrogen production is reduced.

On the Russian market, the most promising areas for the introduction of hydrogen are transport, energy, and industry. In addition, it can potentially be used for a power supply to consumers of energy-isolated areas and territories with special environmental requirements. When hydrogen is burned, heat is released that is several times higher than the heat from the gas. Its advantage in production also lies in the fact that the water formed during the oxidation of hydrogen to generate electricity can be reused.

Depending on the methods of hydrogen production, it is classified by colors: green, blue, turquoise, yellow, gray, and brown (Fig. 1).

Green hydrogen is the most environmentally friendly because it is produced by electrolysis. If electricity comes from renewable energy sources (RES) such as wind, solar, or hydropower, then there are no CO_2 emissions. *Yellow hydrogen*, like green, is produced by electrolysis, but nuclear power plants are the source of energy. There are no CO_2 emissions, but the method is not absolutely environmentally friendly. *Turquoise hydrogen* is obtained by decomposition of methane into hydrogen and

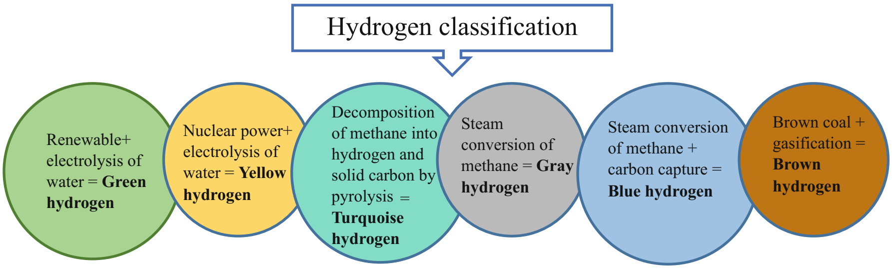

Fig. 1 Classification of hydrogen depending on its production methods. (Source: Compiled by the authors based on data from International Energy Agency, Gazprom, and Novatek. Retrieved from: www.iea.org, https://www.gazprom.ru, https://www.novatek.ru)

solid carbon by pyrolysis. The production of turquoise hydrogen gives a relatively low level of carbon emissions which can either be buried or used in industry (e.g.,, in the production of steel or batteries); that way it does not enter the atmosphere. *Gray hydrogen* is produced by steam conversion of methane. The raw material for such a reaction is natural gas. This process is easily feasible from a practical point of view; however, carbon dioxide is released during the chemical reaction, and in the same volumes as during the combustion of natural gas, so in order to reduce emissions, the development of CO_2 capture technologies is required. *Blue hydrogen* is hydrogen produced by steam conversion of methane but under the condition of carbon capture and storage, giving about a twofold reduction in carbon emissions. This type of hydrogen production is very expensive. Finally, brown coal is used as a feedstock to produce *brown hydrogen*, which due to using gasification technology forms a synthesis gas: a combination of carbon dioxide (CO_2), carbon monoxide (CO), hydrogen, methane, and ethylene, as well as a small amount of other gases. The first two of these gases are useless in the production of electricity, making the process very unsustainable compared with other methods.

Although the production of "blue" hydrogen is inferior in environmental friendliness to the production of "green," nevertheless, "blue" hydrogen will be needed in the coming years, despite its greenhouse gas emissions, because it will simply be impossible to meet demand solely at the expense of green hydrogen. In addition, according to Bloomberg calculations, in order to switch from "gray" hydrogen to "green," all wind and solar energy currently installed around the world will be required. Moreover, usage of "green" hydrogen in transport and heating is not characterized by high energy efficiency (only 30%) – this is due to energy losses in the process of electrolysis, storage, and distribution of hydrogen, and the conversion of hydrogen back into electricity inside the car – and for the Russian Arctic, the problem with transport and energy supply is the most significant; therefore, Russia has the potential in the production of "blue" hydrogen and in providing them to the Arctic.

From the standpoint of the economics of hydrogen production, the most efficient way is to use technologies using methane: combined with water vapor at high temperatures and pressure, this forms a gas with a hydrogen content of up to 75%

(Korobkova, 2020). At the same time, methane can be sold as natural gas (a cleaner energy source than coal) or used in chemical production. Such a method will increase the need to introduce technologies for capturing methane, which is in abundance in the Arctic region, solving several problems simultaneously. Again, however, the question of financing and investment attractiveness of such projects arises, which requires timely solutions and the formation of a regulatory framework.

Another method of hydrogen production is electrolysis, which requires a large amount of additional energy. One of the options that, in some cases, solves this problem may be renewable energy sources, which will not only enable the extraction of hydrogen but also reduce the carbon footprint. For example, Toshiba has launched the H_2O mobile power plant, where the energy needed for electrolysis is generated by solar panels, despite the fact that batteries make it possible to accumulate energy in case of worsening weather conditions. The extracted hydrogen, in turn, is sent either directly to energy production or to storage, so there is always a reserve of both electricity and hydrogen at the station. In the Arctic region of the Russian Federation, such a mechanism could work in combination with wind energy, since the production of solar energy in such climatic conditions may be ineffective. However, it is worth considering the fact that the maintenance of wind turbines in isolated Arctic regions is expensive and the equipment requires special low-temperature manufacturing. As an example, we can cite a wind farm near the city of Labytnangi in the Yamalo-Nenets Autonomous Okrug, first launched in 2014 and adapted to harsh Arctic conditions at temperatures up to minus 50 °C. It is worth noting that in some areas of the coastal Arctic zones the wind speed exceeds 5–7 meters per second which is considered an extremely favorable condition for the cost-effective use of wind energy. In the coastal areas of the White and Barents Seas, as well as on the territory of the Novaya Zemlya and Franz Josef Land archipelagos, the wind speed reaches 5–8 meters per second, and according to the forecasts of climatologists, as warming in the region, there will be a multiple increase in its frequency and strength.

Besides, cold air has a higher density than hot air – therefore, the energy efficiency of such an installation at the same windspeed will be higher. Another example is Enel, which has planned the construction of the Kola wind farm in the Murmansk region, which will become the largest wind farm in the Arctic zone of Russia. The launch of this installation is scheduled for the end of 2021.

Russia can produce three types of hydrogen: gray hydrogen, using fossil fuels such as natural gas; blue hydrogen, using fossil fuels, but with carbon capture technology; and green hydrogen, which meets the low-carbon threshold through the use of renewable energy sources. Russia is considering the possibility of using nuclear power plants to produce green hydrogen.

It is assumed that the first hydrogen producers will be such Russian companies as PJSC Novatek, PJSC Gazprom, and GC Rosatom. In the period from 2021 to 2024, Gazprom should develop and test a methane-hydrogen gas turbine, after which it will study the use of hydrogen and methane-hydrogen fuel in gas installations (gas turbine engines, gas boilers, etc.) and as motor fuel on various types of transport (Klimentyev & Klimentyeva, 2017). According to the IEA forecast, by 2070 the growth of global demand for hydrogen will exceed 500 million tons per year

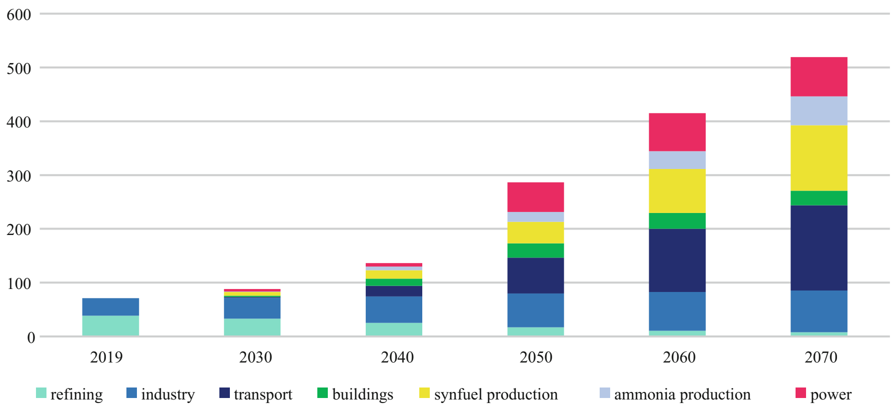

Fig. 2 Forecast of global hydrogen demand for 2019–2070. (Source: Compiled by the authors of the article based on data from the International Energy Agency. Retrieved from: www.iea.org)

(IEA, 2019) (Fig. 2). As governments and automakers abandon traditional internal combustion engines and, consequently, the use of oil-based motor fuels, the transport sector is expected to become the largest consumer of hydrogen, with 158.2 million tons by 2070 (IEA, 2019).

The Russian company Novatek looks the most ready to enter the hydrogen market, since its buyers are largely the same as those of LNG. The company is exploring the prospects for the production of hydrogen from methane from a technical and economic point of view, given that the resource base makes it possible to implement projects for the production of both liquefied natural gas and hydrogen, but their economic and technical viability is important. At the same time, the issue of sea transportation of hydrogen remains open, complicated by the flammability of the substance.

Gazprom has also repeatedly claimed that it considers hydrogen as a way to diversify its business and increase the efficiency of gas use. In particular, the company emphasized the prospects of methane pyrolysis – this technology does not emit CO_2 and does not require the construction of storage facilities for it, and the resulting pure carbon by-product may even find its own commercial application. The company notes that, despite the growth of hydrogen consumption around the world, there is no global market for this product yet. The monopoly enterprises annually produce about 350000 tons of hydrogen, mainly for the production of ammonia, methanol, and motor fuels. At the same time, there is a need to form their own technological competencies in the field of hydrogen energy, allowing them to occupy a niche in the emerging market (Dyatel, 2020).

Rosatom, along with other energy companies, aims to develop hydrogen energy. It plans to build a hydrogen-powered test site for rail transport on Sakhalin by 2024, and Rosenergoatom, its subsidiary, is due to start hydrogen production at the Kola NPP in 2023. The Kola nuclear power plant was selected as a pilot project for the production of hydrogen in Russia, due to the fact that it has excess volumes of generated energy at low cost, along with the availability of the necessary infrastructure and experience in producing hydrogen in small quantities for the needs of the plant. It is planned that in 2023 the complex with electrolysis plants will be put into operation, with the generated capacity initially being 1 MW, and then it is planned to increase it to 10 MW (Dyatel, 2020).

It is worth noting that the hydrogen direction for Rosatom is currently one of the priorities in terms of scientific and technological development of state corporation. It was reported that Rosatom plans to create a hydrogen cluster on Sakhalin as well. In September 2019, Rusatom Overseas and the Agency for Natural Resources and Energy of the Ministry of Economy, Trade and Industry of Japan signed an agreement in Tokyo on cooperation of joint development in 2020–2021 of a feasibility study for a pilot project for exporting hydrogen from Russia to Japan. According to this pilot project, the possibility of producing hydrogen for the Japanese market by electrolysis is being considered (i.e., to produce environmentally friendly hydrogen).

In Russia, the demand for hydrogen is not high at this stage, but the situation may change significantly in the context of the global trend to reduce the carbon footprint, at which point Russian exporters of the oil and gas industry, metallurgy, and chemistry will inevitably have to look for new mechanisms for further implementation of their activities in order to stay afloat and not incur losses. Currently, there are many disputes between experts regarding the advantages and disadvantages of hydrogen production, noting that hydrogen projects in Russia are not economically feasible. The energy costs of producing steel using hydrogen will be five times higher than the costs of using natural gas. Nevertheless, already in the medium term, hydrogen can become more competitive – both due to stricter regulation and as a result of technology scaling. However, it is expected that by 2030 Russia should occupy 20% of the global hydrogen market (Novak, 2019).

To fulfill all the tasks set by the Government of the Russian Federation, the concept of hydrogen energy development has been approved. The document defines the goals, objectives, and strategic initiatives, as well as key measures for the formation of this industry in Russia for the medium and long term. The main idea of the concept is to create several hydrogen production clusters on the territory of the country at once, focused mainly on the export of both hydrogen itself and its production technologies. At the same time, it is planned to implement pilot projects for the production and export of hydrogen, the use of hydrogen-based energy carriers within the country, the creation of large enterprises that will be able not only to meet domestic demand but also to ensure supplies abroad. According to the Russian hydrogen strategy, the development of hydrogen energy in Russia is planned in three stages.

The *first stage* (2021–2024) involves the creation of hydrogen clusters and the implementation of pilot projects to achieve the export of hydrogen up to 0.2 million tons by 2024 (Russian Hydrogen Strategy 2021) as well as the use of hydrogen energy carriers in the domestic market. At this stage, the necessary legislative and regulatory framework should be created, and measures of state support should be developed. During this period, it is planned to launch the first pilot projects for the production of hydrogen from fossil fuels, including using the technology of carbon dioxide capture, storage, and use, as well as water electrolysis using various types of low-carbon generation. At the same time, it is planned to create world-class scientific and technological centers and landfills for the development of domestic hydrogen energy technologies.

The *second stage* (2025–2035) involves the launch of the first commercial hydrogen production projects with the achievement of export volumes up to two million tons, and in an optimistic scenario up to 12 million tons per year by 2035 (Kremlin, 2020). During this period, the serial and mass application of hydrogen technologies in various sectors of the Russian economy will be launched, large-scale production of equipment, electrolyzers, fuel cells, gas turbines, hydrogen power plants, hydrogen gas stations, hydrogen transport, and robotics will be created. The emergence of global demand for hydrogen is expected during this period.

The *third stage* (2036–2050) involves the large-scale development of the global hydrogen energy market. The volume of hydrogen supplies to the world market may reach 15 million tons by 2050, and in an optimistic scenario – 50 million tons (Russian hydrogen strategy 2021).

The cost of hydrogen production based on renewable energy sources will get close to the cost of hydrogen production from fossil raw materials which will allow the implementation of large projects for the production and export of low-carbon hydrogen produced on the basis of renewable energy sources. At the third stage, Russia plans to become one of the largest exporters of hydrogen and energy mixtures based on it, as well as industrial products for hydrogen energy to the countries of the Asia-Pacific region and Europe.

The development of hydrogen energy in the Arctic territory involves the implementation of the Snowflake project, the launch of which is scheduled for 2022. "Snowflake" is an Arctic hydrogen station, which is planned to be used as a testing ground for testing various technologies necessary for further implementation in the Arctic. "Snowflake" is a closed-type station, involving the production of clean energy. For Russia, this is the first experience of building such facilities, the reference point for which was the Belgian Antarctic station "Princess Elizabeth," operating in the "zero emission" mode, despite the fact that the necessary amounts of energy are generated by solar panels and wind generators. The main distinguishing feature of the "Snowflake" from the Antarctic "Princess Elizabeth" is that according to the project, it will generate energy all year round, due to the fact that solar and wind energy will be used in the summer, and hydrogen batteries in the winter. The construction of the Russian project involves the participation of Japan, South Korea, Canada, the USA, and Scandinavian countries, despite the fact that the Russian side already has agreements with Japan.

It is planned to install three "wind turbines" with a capacity of 110–120 KW on the territory of the station. The energy generated with their help will go to the supply of the complex itself, but given that in the case of wind generation, you can count on excess energy, the "surplus" when entering the electrolyzers will be processed into hydrogen. Such hydrogen can be stored indefinitely and safely in compressed form in pressurized cylinders. Special domes are provided for the generation of hydrogen from electricity on electrolyzers and its long-term storage.

A large "hydrogen battery" can be used if there is not enough wind energy or it is completely absent, which is not excluded in such latitudes. Hydrogen, mixing with oxygen available in the atmosphere, gives electrical, thermal energy and clean water at the output. Water in a closed cycle goes back to the electrolyzers – so you do not need to constantly take water from nature, it goes in a closed cycle, and electrical and thermal energy from fuel cells comes directly to the object.

It is assumed that the "Snowflake" will provide energy not only for its performance, but also for energy-insulated territories close to it, to which diesel fuel has to be imported, which is a very expensive process. However, the use of stations like "Snowflake" in the future will allow to abandon the supply of diesel fuel in the Arctic territories. The Government of the Yamalo-Nenets Autonomous District is interested in the appearance of modern, including scientific, facilities on the territory of the district. At the same time, serious attention is paid to protecting the interests of indigenous minorities, for whom it is important to preserve the way of life that has been established for 200–300 years.

The sharp reduction in CO_2 emissions into the atmosphere implied by the Paris Agreement depends on the global transition to "green" energy. According to WRI (World Resources Institute, 2021) estimates, transport accounts for 15.9% of global emissions, industry – 18%, and construction and housing and communal services account for 20.4%. This means that it is necessary not only to introduce renewable energy sources, it is important to transfer all these industries to low-carbon energy resources. Without this, it will not be possible to halve anthropogenic emissions by 2050. Hydrogen can become one of the promising opportunities on the way to solving this problem. First of all, this is due to the fact that hydrogen burns completely clean, leaving nothing but water vapor, that is, water, and the most promising method for producing hydrogen is water electrolysis. Thus, a kind of closed cycle is formed, when gas resources will be replenished when it is consumed. No other "green" energy resource provides such an opportunity. Biofuels, coke oven gas, ammonia – all emit a large amount of greenhouse gases into the atmosphere during combustion.

The Arctic region – characterized by harsh climatic conditions and saturated with various reserves of natural resources in such remote regions of Russia as Kamchatka, Chukotka, and Magadan – requires special mechanisms aimed at reducing the carbon footprint. Regions with decentralized energy supply in the Russian Federation account for about 70% of the territory, where about 20 million people live (Ministry of the Russian Federation for the Development of the Far East and the Arctic 2020). The use of expensive imported fossil fuels in power plants on internal combustion engines is characterized by low efficiency and causes significant harm to the environment. The solution may be the use of renewable energy in combination with the accumulation of hydrogen energy, which can be converted into electricity with high efficiency, which will avoid energy losses and significantly increase environmental safety compared to batteries and diesel generators currently used for this purpose (Borzenko, 2020).

In addition, remote regions face problems in the transport infrastructure, and taking into account the environmental component, the key to solving this problem

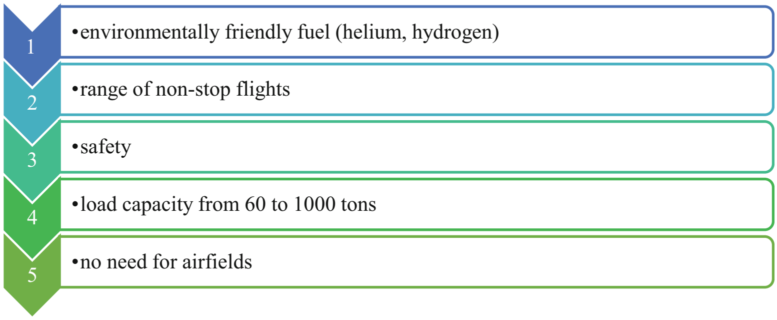

Fig. 3 Advantages of the hydrogen-powered airship construction. (Source: compiled by the authors)

may be the hydrogen-powered airship construction. In most cases, the main modes of transport in the Arctic are air and sea transportation, which do not have a regular character due to the freezing of ports. The development of airship construction (Fig. 3) will not only increase the regularity of transportation, but will also reduce the carbon footprint and minimize environmental pollution. The possibility of using airships makes it possible to organize transportation with a non-stop flight, for comparison: helicopters have a non-stop flight range of 0.5–1000 km (with a load capacity of 5–25 tons), 5–10000 km by airplanes (2–120 tons), 10–15000 km and airships (60–500 tons) (Zvorykina, 2021). At the same time, it is important to note that airships use ecological fuel and, in particular, hydrogen energy, and hydrogen is characterized by a lower cost compared to helium, is the lightest gas and has a large lifting force, which makes it more promising in airship construction compared to helium.

Currently, Sakhalin is being considered as an experimental hydrogen site, taking into account the advantages of the region, which include the availability of gas reserves for the production of "blue" hydrogen, the potential for renewable energy as a consequence of obtaining "green" hydrogen; the availability of pipelines for transporting hydrogen, as well as ports capable of receiving large gas carriers and close placement from potential markets (China, Japan, and South Korea).

Thus, due to the development of hydrogen energy and airship construction, it is possible to immediately solve several global problems regarding the further development of both the Arctic region and the Russian economy. The combination of the development of airship construction and energy conversion to hydrogen can become a driver of development, bearing in mind the main trends in the field of sustainable development and the planned indicators for reducing CO_2 emissions. The use of hydrogen-fueled airships in areas where there is no busy airspace, without a carbon footprint and taking into account the level of security, can become one of the promising projects for the Russian economy. However, the desire to develop hydrogen energy in the Russian market should be supported by various incentive measures and state support (Kardas, 2020). Today, Russia does not have a special program or mechanisms that stimulate environmental modernization. In 2021, it is planned to launch two new green financing instruments for the environmental modernization of production in the Arctic zone of the Russian Federation: subsidizing part of the income on bonds that will be attracted by Arctic investors for the purpose of environmental modernization of production. It is expected that the result of this will be a reduction in emissions and subsidizing the interest rate. At the same time, a project related to environmental modernization will be provided separately in this mechanism (Ministry of the Russian Federation for the Development of the Far East and the Arctic 2020).

Nevertheless, the issue of hydrogen transportation remains important. With the development of the global use of hydrogen, both its bunkering and export are promising in the Russian Arctic. However, this must be not in gaseous form (the cost of pumping it is significantly higher than that of natural gas) and not in liquefied form (hydrogen cryogenic technologies are significantly more expensive than methane), but in a bound form (ammonia, methanol, and other compounds), followed by the release of hydrogen or its direct use without emissions of carbon compounds into the atmosphere.

Conclusions

The Arctic region is very unique by its nature, not only because of its climatic conditions and resources, but also because of the indigenous population living in it. The sustainable development of these territories should begin firstly from the point of view of ecology and the protection of these peoples. Therefore, it is extremely important that the technologies brought to the Arctic be “clean” and useful primarily for the local population, and also contribute to its development. Mining at the new stage should be accompanied not only by a careful attitude to the nature of the Arctic territories, but also by reducing emissions of carbon dioxide and methane into the atmosphere, which make up the so-called “carbon footprint” of exported products. Global warming not only facilitates the passage of ships along the Northern Sea Route, but also requires more capital and costly measures to exclude the possibility of environmental disasters of regional and planetary scale.

Currently, there is no hydrogen market, since it is produced, as a rule, directly at the places of consumption (mainly at gas chemistry, metallurgy, and oil refining facilities), so transportation is minimized; however, the development of hydrogen energy, along with the development of RES, can solve a number of problems in these isolated territories. In addition, the Arctic region – characterized by harsh climatic conditions and saturated with various reserves of natural resources in such remote regions of Russia as Kamchatka, Chukotka, or Magadan – requires special mechanisms aimed at reducing the carbon footprint. The development of hydrogen energy can provide for the population, and the introduction of hydrogen transport can minimize emissions. In addition, the Arctic region is facing the problem of melting ice, methane emissions, and gas hydrates, which also requires a timely solution to the problem. The cold climate of the Arctic and the presence of permafrost contribute to the occurrence of hydrate formation in the mining equipment, and installations for preventing the formation of hydrate plugs are functioning in the northern fields, getting rid of which is a very complex and expensive process. As a rule, the formation of hydrate plugs is prevented by pumping methanol, glycols, or salt solutions: under constant pressure, the dissolution of these substances in water leads to a drop in the equilibrium temperature of hydrate formation, which is unecological.

It should also be noted that it is already being said that suppliers of Russian goods with a large carbon footprint will pay at least €1.1 billion a year to the EU budget when the authorities of European countries begin to fully levy a cross-border carbon tax (Tkachev & Kotchenko, 2021). The introduction of this tax by the EU already started being discussed in 2020, and this could cause big losses for a number of Russian exporters, which will greatly affect their profits, which is why it is already necessary to take drastic steps to reduce emissions.

Hydrogen energy is one of the most promising areas of the formation of a new world energy, as it is found almost everywhere, and it can be used wherever it is produced. Unlike batteries, which cannot store large amounts of electricity for a long time, hydrogen can be produced from excess renewable energy and stored in large quantities. We are living in a period of energy transition, and hydrogen energy opens up wide opportunities for the development of the global fuel and energy sector.

Hydrogen can become one of the key elements in meeting the world's needs for clean and affordable energy, including by expanding its use in production, as a fuel in transport, use as fuel cells for energy storage, and energy storage from renewable energy sources.

Summing up, it is important to emphasize that the Arctic plays an important role in the formation of the climate across the earth, as the territory is covered with ice and snow and about 20% of the land area that reflects solar radiation is here. At the moment, many experts are expressing concern about the melting of Arctic ice and a sharp increase in temperatures in the region. The problem of black carbon emissions is also being raised at the international level, but this requires comprehensive attention from individual states. Russia, as the largest country in the Arctic region (by length), should first of all make every effort to reduce emissions and slow down the rate of ice melting; therefore, the development of hydrogen energy and universal hydrogen technologies could be one of the solutions to this problem, given that hydrogen is a way of supplying isolated territories and a "clean" energy carrier for the Arctic.

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Energy Security in the Arctic Zone

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Contents

Abstract

The development of the electric power industry and ensuring energy security is at the heart of the social and economic development of any region. The development of the electric power industry in the Arctic is difficult due to the remoteness of the regions and the harsh climate. One of the main challenges to the energy security of the Arctic Zone of the Russian Federation is the high share of local electricity generation based on the use of economically inefficient and environmentally unsafe diesel fuel. Based on a comparative analysis of the energy policy and approaches of the countries of the Arctic region (Russia, the United States, Canada, Norway, Denmark, Finland, Iceland, and Sweden) to ensure energy security and the development of the electric power industry, several approaches of ensuring reliable energy supply to the northern Arctic territories were identified. The North American countries rely on the large-scale use of renewable energy sources and the development of decentralized energy supply in energy-

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isolated areas. The Nordic countries are in favor of increasing the share of renewable energy sources in the energy balance and gradually abandoning traditional generation technologies. The Arctic region of the Russian Federation is characterized by the largest territory, population, as well as the largest amount of installed power capacity and electricity produced. When considering the direction of the development of the electric power system of the Arctic region in the interests of strengthening its unity with the economic space of Russia, it was concluded that the most promising areas for this development can be: the development of generation technologies using renewable energy, the construction of low-power nuclear power plants (including floating nuclear power plants), and the use of high-voltage direct current power lines for the transmission of electricity over long distances with minimal losses. At the same time, the greatest efficiency will be achieved when using the entire range of available technologies.

Keywords

Energy · Energy security · Arctic · Energy policy · Power supply · Renewables

Introduction

In the light of the development of the world economy and such changes in world markets as the demand growth for electricity, increasing energy efficiency standards, and tightening environmental regulations, the issues of ensuring global and national energy security are becoming highly relevant. At the same time, ensuring energy security in the Arctic region is becoming even more urgent. Firstly, ample deposits of energy resources are concentrated in the region. Secondly, the creation of comfortable conditions for the functioning of human society and the quality of its life in the region is associated with a number of difficulties due to the extreme climate and infrastructure isolation.

Literature Review

The Arctic region occupies a special place among the studies of Russian and foreign scholars, but it is worth noting that the region is not fully considered from the point of view of ensuring energy security.

Due to the growing processes of urbanization, informatization, and climate change, the role of the electric power industry as a sub-sector of the global energy supply system is steadily increasing, and at the same time, the interest of researchers is also growing.

Issues of ensuring security in Arctic are considered by Zagorskii (2019). The presence of serious challenges and threats to energy security is reflected in the works of Borovsky (2012). The need to ensure reliable, safe, and affordable energy supply as a key element of ensuring energy security is emphasized separately in the works of Shvets (2016), Nefedova and Soloviev (2018), Morgunova and Solovyov (2016), and Witt et al. (2021).

For the completeness of the study, it is necessary to conduct a comparative analysis of the approaches of foreign countries of the Arctic region to the development of the Arctic, ensuring energy security, and the development of national electric power complexes.

Researchers pay considerable attention to the policy of the European Union and North American countries in the Arctic. The strategies of foreign states in the Arctic are studied in the works of Konyshev and Sergunin (2018), Kotlova (2019), Govorova (2016), and Nong et al. (2018).

The issues of development of energy cooperation in the Arctic are covered in the works of Salygin et al. (2015), Zagorsky (2015), Zhiznin and Timokhov (2017), Guliyev and Mehdiev (2017), and Konyshev and Sergunin (2018).

In addition, based on the analysis of the approaches of the Arctic countries to ensuring energy security, the main directions of the development of electric power technologies were identified in this study. The most promising are: the development of renewable energy (Witt et al., 2021; Boroukhin, 2021; Gritsan, 2021), the development of low-power nuclear generation facilities (including floating nuclear power plants) (Sotnikova et al., 2018; Zhiznin and Timokhov 2017), and the development of centralized power supply using direct current technologies (Travin, 2018).

Taking into account the specifics of the research topic, a wide range of regulatory documents of the countries of the Arctic region was used: national strategies for the development of the Arctic, national strategies for ensuring energy security and strategies for the development of the electric power complexes, and national strategies and legislative acts in the field of the development of renewable energy sources.

Challenges and Threats to Energy Security in the Arctic Zone of the Russian Federation

Approaches to the definition of the term "energy security" may differ depending on whether a country is a net exporter or a net importer of energy resources. According to the Energy Security Doctrine of the Russian Federation, "energy security" is a state of protection of the economy and the population of the country from threats to national security in the energy sector, which ensures compliance with the requirements for fuel and energy conservation of consumers provided for by the legislation of the country, as well as the fulfillment of export contracts and international obligations of the Russian Federation.

In scientific circles and many publications of Russian and foreign authors (Witt et al., 2021; Zhiznin and Timokhov 2017; Borovsky, 2012; Shvets, 2016), energy security is identified primarily with "security of energy supply" or guaranteed access of the country to the necessary and affordable amount of energy.

Today, the Arctic is characterized, on the one hand, by a huge amount of proven hydrocarbon reserves, and on the other hand, by serious problems with the region's electricity supply. The northernmost regions of Russia are not included in the centralized power supply system (via high-voltage power lines) and are traditionally supplied with electricity from obsolete diesel power generators and small coal-fired stations.

Fuel is supplied to the Arctic as part of the deliveries of goods to the Northern Territories, and due to the high remoteness of the northern regions, limited delivery times in the summer period, and the obsolescence of existing diesel generators, the cost of electricity for them is very high. In addition, due to frequent interruptions in supplies, the local population is forced to provide diesel fuel reserves for an average of 1.5–2 years. Diesel power plants have a low efficiency and a very high cost of electricity production, which reaches ₽80–120/kWh (Boroukhin, 2021).

With the share of the population of the Arctic regions less than 2% of the whole of Russia, their electricity consumption is 3.6% of the total national electricity consumption. The energy intensity of the economy of the Arctic territories (the ratio of electricity consumed to the gross regional product) is lower than the average Russian level: 0.028 compared to 0.032 kWh/₽, respectively. However, the consumption of primary energy resources in the Arctic regions per unit of gross regional product is higher than the national average. This is largely due to the inefficiency of the energy system and the high level of losses during the transmission of electricity to the final consumer: 14% against 10% on average in Russia. A serious problem is the deterioration of the energy infrastructure, as the average wear of the main generating equipment exceeds 60% (Berdin et al., 2017).

At the moment, the total installed capacity of power plants in the Arctic Zone of the Russian Federation is approximately 13.501 MW, and the volume of electricity generated in 2019 was about 57,000 million kWh (Table 1).

According to the "Strategy for the development of the Arctic Zone of the Russian Federation and Ensuring National Security for the Period up to 2035," the main dangers, challenges, and threats that form risks for the development of the Arctic Zone remain a high proportion of local electricity generation based on the use of economically inefficient and environmentally unsafe diesel fuel. In addition, the Strategy contributes to the development of the infrastructure of the Arctic Zone by developing and implementing a mechanism for state support for projects to improve the efficiency of electricity generation carried out in isolated and hard-to-reach territories and involving the use of liquefied natural gas, renewable energy sources, and local fuel. Thus, one of the most urgent factors of ensuring the energy security of the Arctic today can be a safe and reliable energy supply to the population and enterprises.

At the same time, the Arctic coast of Russia, the Russian Arctic islands, the Russian shelf of the northern seas, and the Arctic Ocean are of particular strategic importance. Thus, the main possible major consumers of electricity on the Arctic coast and islands that need reliable power supply are:

1. Military bases, garrisons, airfields, and other objects of the Ministry of Defense on the polar coast and islands

Table 1 The volume of installed capacity and electricity generation of the territories of the Arctic zone of the Russian Federation in 2019

Arctic Regions of Russia	Installed capacity (MW)	The volume of generation per year (million kWh)
Murmansk region	3613	16,500
Arkhangelsk region – including isolated power districts	2371	7883
	35	
Komi Republic	2576	9215
Nenets Autonomous District	567	2254
Yamalo-Nenets Autonomous District – including the Northern isolated energy district	805	12,471
	819	
Norilsk-Taimyr isolated energy district, Krasnoyarsk Territory	2246	7792
North-Yakut isolated energy district, Republic of Yakutia (Sakha)	186	119
Chukotka Autonomous District	283	749
Total	13,501	56,983

Source: Compiled by the authors based on National statistical resources. Retrieved from: https://rosstat.gov.ru, https://megawatt.sakhaenergo.ru, https://megawatt.chukotenergo.ru, https://komiesc.ru, and https://megawatt.oao-ntek.ru

2. Polar ports and other necessary infrastructure facilities to ensure the smooth operation of the Northern Sea Route – the most efficient maritime transport artery connecting China, Japan, Korea, and other countries of Southeast Asia and the Pacific coast of the United States with Europe
3. Offshore oil and gas production platforms
4. Remote areas of Siberia with large deposits of oil, gas, ferrous, non-ferrous and rare metals, and diamonds

Considering the Strategy for the Development of the Arctic Zone of the Russian (2020), Russia's Energy Strategy (2020) and Ensuring National Security for the Period up to (2020), as well as the Federal Law "On the basics of Russia's state Policy in the Arctic for the period up to 2035 and beyond," it can be noted that the concept of the Russian Federation lays the most complete foundations for the country's leadership's understanding of pressing problems, and offers the most thorough ways to solve the tasks set in the Strategy. Among them, the Strategy mentions the development and use of renewable and alternative energy sources, the differentiation of power supply schemes, including the construction of nuclear power plants (including floating ones), and increasing energy efficiency and energy independence of the municipalities of the Arctic zone of the Russian Federation. It is also proposed developing a dialogue with the regions of other Northern countries. The social component of the economic development of the region, which involves the creation of high-tech production and energy clusters, has been worked out.

Energy Policy of the Arctic Countries

Strategic guidelines for ensuring energy security are also outlined and traced in the strategies of the countries of the group of Arctic regions (the United States, Canada, Norway, Denmark, Iceland, Sweden, and Finland).

A review of the energy strategies of the countries of the Arctic region shows that they are aimed at a significant increase in energy efficiency and self-sufficiency with energy resources, with the availability of energy resources at an affordable price (Konyshev and Sergunin, 2011).

Speaking about the current state of affairs in the electric power complex of the Arctic Council member countries, it is necessary to understand what goals and objectives for the development of this sector of the economy are set by national governments in the relevant program documents.

In fact, based on the presented excerpts, the electric power complex is assigned one of the main roles in the development of the regions of the Arctic zone, while attention is paid to the development of both social and industrial infrastructure. The pivotal role of the Northern Sea Route is also emphasized.

Regarding the countries included in the North American sector of the Arctic region – the United States and Canada – it should be noted that in the case of the United States, all statistical information reflects the situation in the state of Alaska, while in Canada, data on the territories of Yukon, Nunavut, and the Northwest Territories are taken into account. Greenland, which is a self-governing territory of Denmark, is geographically more similar to North America, with the natural and climatic conditions of the island generally similar to those on the islands of the Canadian Arctic Archipelago. Therefore, it is logical to consider the electric power industry of the island in conjunction with the northern regions of the United States and Canada (Table 2).

The United States Arctic Strategy, adopted in 2019, defines the main trends in the development of the Arctic region:

1. Environmental changes (reduction of the area of the ice cover, global warming, and the opening of new sea transport routes)
2. Multilateral cooperation in solving common tasks. It is indicated that the Arctic states are committed to the principle of multilateral cooperation and respect for national interests

Table 2 Capacity and electricity generation in the Arctic regions of North America in 2019

Region	Installed capacity (MW)	Generation (million kWh)
Alaska, United States	2760	6071
Yukon, Canada	124	542
Northwest territories, Canada	208	688
Nunavut, Canada	78	190
Greenland, Denmark	106	540
Total	3276	8031

Source: Compiled by the authors on the basis of national statistical information. Retrieved from: https://www.eia.gov/electricity/state/, https://www5.statcan.gc.ca/cansim/a47, and https://stat.gl

3. The legal status of maritime transport arteries
4. Strengthening the military presence

The issues of energy supply security remained the responsibility of the authorities of the state of Alaska, which was reflected in the “Alaska Affordable Energy Strategy.” The Strategy highlights the need to develop the electric power industry within the framework of the concept of sustainable development, which is a key element of the US national security strategy in the region.

Many rural communities in Alaska rely mainly on diesel power generators, and Alaska ranks the second state in the United States after Hawaii in terms of the share of electricity – 15% in 2019 – that is generated from petroleum fuel (Fig. 1). Alaska has set an optional goal to generate 50% of electricity from renewable and alternative energy sources by 2025; in 2019, renewable sources accounted for just under 25% of electricity generation in the state (Alaska Energy Authority, 2021).

In 2008, the Renewable Energy Fund was established in Alaska with annual contributions of $50 million. At first, the fund was planned to be created for 5 years, but in 2012 it was extended for another 10 years (Guliyev, 2017). The Fund is managed by the Alaska Energy Authority, which is an independent state corporation responsible for promoting the development, operation, and financing of energy projects in the state of Alaska. The Foundation’s mission is to reduce the cost of energy and increase energy security. Other programs, such as the “Rural Power System Upgrade Program,” help rural communities with a population of less than 2000 people to improve the efficiency of their generators. Since the introduction of this program in 2000, almost $100 million has been raised (Kiushkina, 2018).

Canada’s energy policy is aimed at achieving a balance between economic development and profit maximization, preserving the resource base, constantly improving the quality of life, human potential, and further sustainable economic development, preserving and expanding energy power and potential, expanding the sales markets, and increasing the use of renewable energy and reducing

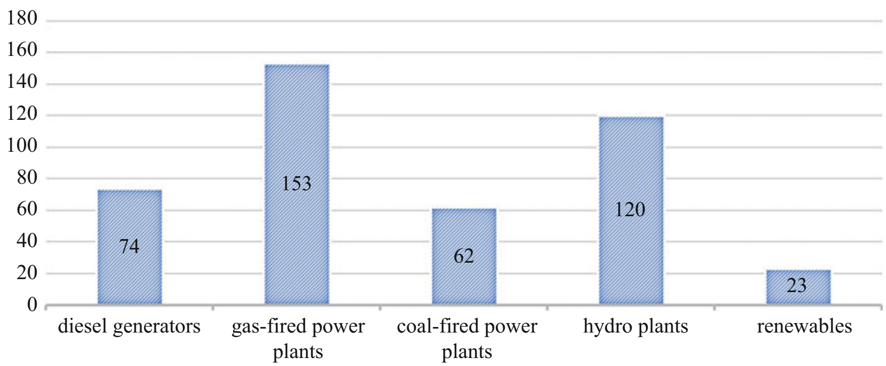

Fig. 1 Electricity production by type in Alaska in 2019 (MWh). (Source: Compiled by the authors based on US national statistical resources. Retrieved from: https://eia.gov)

greenhouse gas emissions into the atmosphere. The further development of the country's energy sector is indicated through the development of renewable energy (CanNor, 2021).

The Northern Strategy of Canada indicates, among other things, the intention of the authorities to support a private-public initiative to develop a network of hydroelectric power plants. The focus is on the socioeconomic development of the Arctic territories as an integral part of Canada. Other plans of the Canadian government are the creation of a number of tidal power plants to provide energy to remote municipalities and military bases (CanNor, 2021).

The Arctic territories of Canada (the states of Nunavut, Yukon, and the Northwest Territories) are characterized by different energy potential, with the predominance of hydropower in some (Yukon), or diesel generation in others (Nunavut) (Fig. 2). At the same time, the energy supply system in the region is decentralized. The plans of the states of Canada clearly indicate a trend toward increasing the share of renewable energy in the energy balance and reducing the use of diesel fuel while connecting isolated power systems to centralized energy supply (the so-called concept of the Government of Canada "Improving and Devolving Governance: empowering the people of the North").

While the Canadian government's immediate goal is to reduce CO_2 emissions by 30% compared to 2005 by 2030, the long-term goal is even more ambitious – a reduction of 80% compared to 2005 by 2050. To achieve this, the government of Canada introduced several programs to support projects in the field of renewable energy sources. The program was created to support innovations in the field of

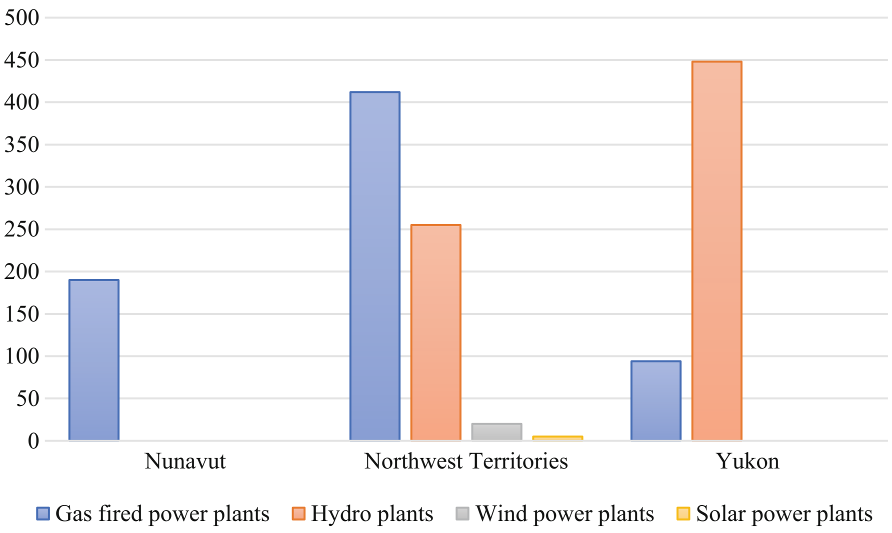

Fig. 2 The structure of electricity generation in the Arctic regions of Canada. (Source: Compiled by the authors on the basis of national statistical data. Retrieved from: https://www5.statcan.gc.ca/cansim/a47)

clean energy. The program "Emerging Renewable Power program" is more focused on producers. This program mitigates the risk of emerging renewable power projects through federal government funding, allowing emerging renewables to play a larger role in Canada's electricity supply mix. The program will establish new industries in Canada by supporting renewable power technologies that are either already established at the commercial level abroad but not yet in Canada, or demonstrated in Canada but not yet deployed at utility scale (CanNor, 2021). The Green Infrastructure Program has a subcategory "Clean Energy for rural and remote communities." The goal of the program is to reduce dependence on diesel fuel and create local and clean sources, such as wind, solar, biomass, and hydropower.

Speaking about similar indicators of the Scandinavian countries, it is necessary to characterize the electric power complex of Norway, Sweden, and Finland. Taking into account the small total population of these countries (Sweden with about ten million people, Finland and Norway with more than five million people), as well as the low population density of the northern provinces of the Scandinavian states, the volumes of installed capacities and generated electricity are significantly less than in Russian Federation, the United States, and Canada.

In the absence of such significant volumes of generation, the countries of Northern Europe rely on the use of renewable energy in electricity production (Fig. 3), on the application of energy-saving technologies at the design and construction stage of industrial and social infrastructure facilities. Already constructed buildings, primarily municipal institutions and power generation facilities, are also equipped with these technologies (Bokeriya et al., 2020).

Norway's energy policy is based on the optimal and balanced use of renewable and non-renewable types of energy resources, on the promotion of environmental

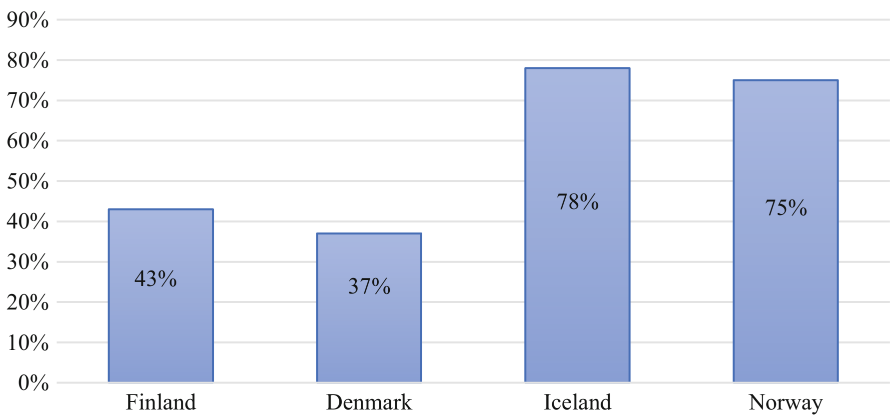

Fig. 3 Share of energy from renewable sources in Finland, Denmark, Iceland, and Norway in 2019 (%). (Source: Compiled by the authors on the basis of data from Eurostat. Retrieved from: https://ec.europa.eu/eurostat)

projects with the strategic importance of the oil and gas sector (Norway's Arctic Strategy – Between geopolitics and social development, 2020).

The Danish government pays great attention to the development of renewable energy sources and, above all, to the new policy of using wind energy, at the same time abandoning nuclear energy, reducing electricity consumption, and increasing energy storage. Currently, it is planned to create an energy system that does not use fossil fuels by 2050 – 100% of electricity consumption based on renewable energy sources. In Greenland (an autonomous territory belonging to the Kingdom of Denmark), large localities receive energy from hydroelectric power plants. Thus, the share of renewable energy sources in the total energy balance is very large, amounting to about 70%. In 2016, the first test solar power plant was opened, and in 2018, the first wind turbine was installed in Greenland (Kiushkina, 2019).

Iceland has set a goal to consolidate efforts to solve problems in the field of reducing emissions, storing electricity, and maintaining competitiveness in the electricity market.

Sweden's strategy is aimed at implementing the innovative concept of "an economy without oil dependence" – the transfer of energy, transport, and heating systems to renewable energy (Sweden's Strategy for the Arctic Region, 2011).

The key principles in the Finnish energy security policy are: priority development of nuclear energy, expansion of the use of liquefied natural gas, construction of a network of gas terminals, introduction of energy-efficient, resource-saving, and clean technologies, and increasing the share of renewable energy sources (Finland's Strategy for the Arctic Region, 2010).

Among all the areas of development of energy projects, the Finnish government highlighted the increasing efforts to improve energy efficiency, the development of solar generation technologies, and the use of recycled secondary raw materials, such as peat. The necessity of constructing new power lines, including in areas of decentralized energy supply, is also indicated.

In accordance with the main tasks set out in the Integrated Arctic Policy (environmental protection and control of climate change, ensuring the sustainable use of resources, deepening international cooperation), the European Union intends to act in three key areas (Govorova, 2016):

1. Support of scientific research on solving environmental and climate problems in the Arctic
2. Achieving sustainable economic development in the Arctic on the basis of reasonable use of resources and environmental expertise
3. The intensification of constructive interaction and dialogue with the Arctic states, indigenous peoples, and other partners

Thus, despite the differences in approaches to determining the energy policies of the states of the Arctic Zone, there are a number of similar problems associated with providing the population and large industrial enterprises with reliable electricity at an affordable price (The EU 2030 Energy Strategy, 2014).

Possible Options for Energy Supply to the Arctic Regions

Taking into account all the geographical diversity of various regions of the Arctic, as well as the different availability of natural resources there, it is logical to assume that the schemes for the development of the electric power complex in the Arctic countries will differ not only in the field of technical regulations and standards, but also in the overall long-term vision of this development.

Theoretical developments on this topic have not been finalized. By analyzing the actual material, including plans and directions for the development of the electric power complexes, the following options for electricity supply in the northern regions were identified (Table 3).

When justifying the choice of an option, first of all, the question of choosing between centralized and decentralized power supply schemes should be solved. This primarily is due to the peculiarities of the economic development of the Arctic region, its focal development.

Industrial centers of the development of the North are characterized by significant localization. In addition, there is a difference in the natural resource base of individual

Table 3 Options for organizing electricity supply in the northern regions

<table>
<tr><th>Options for organizing electricity supply</th><th>Common features</th></tr>
<tr><td>Development of small-scale generation facilities, creation of small energy-isolated areas that are fully provided with electricity from their own generation</td><td rowspan="2">The actual exclusion of thermal power plants operating on coal and fuel oil from the energy balance</td></tr>
<tr><td>Development of generation technologies using renewable energy sources</td></tr>
<tr><td>Coupling of small diesel power plants and generation technologies using renewable energy sources</td><td rowspan="2">Striving for the maximum renewal of the technical component, its modernization, and optimization of the utilization of existing capacities</td></tr>
<tr><td>Expanding the use of hydroelectric power plants without creating generation facilities using renewable energy sources (wind and solar)</td></tr>
<tr><td>Electrification of the region with the use of high-voltage direct current power transmission</td><td rowspan="3">The actual basis for the development of the presented options, based on the actual experience of the development of national electric power farms</td></tr>
<tr><td>Operation of gas and combined-cycle gas turbines, diesel power plants in the areas of their current operation, and coupling of their operation with the operation of a national power system</td></tr>
<tr><td>Construction of nuclear power plants, including the floating nuclear power plants</td></tr>
</table>

Source: Compiled by the authors on the basis of national strategies for the development of the electric power complexes of Russia, the United States, and Canada. Retrieved from: https://minenergo.gov.ru/view-pdf/20706/156298, https://www.denali.gov/wp-content/uploads/2018/10/Alaska-Affordable-Energy-Strategy.pdf and https://www.nrcan.gc.ca/climate-change/green-infrastructure-programs/emerging-renewable-power/20502 areas, including the importance of the climatic factor that determines the possibility of using certain types of energy sources. If a decision is made in favor of an autonomous power supply scheme, it can be considered as a separate supply scheme, when heat and electric energy come from different generating facilities, whereas cogeneration is when the two mentioned functions are performed by a low-power thermal or nuclear power plant. Also, the centralized supply option shows great advantages when it is used along major highways of roads or railways, especially electrified ones (Petrov et al., 2020).

Whatever the options and schemes that are used by the world community in solving the problem of ensuring uninterrupted energy supply to the northern regions, the effectiveness of their application depends on a number of factors, the key of which is the correlation of the selected options with the real capabilities of countries and regions for their application (Chemezov and Dekalchuk, 2018). For example, the development of small-scale generation facilities and the creation of small energy-insulated areas is not suitable for the Scandinavian countries due to the small area of their territory, as well as a significant population density even in the northern regions of the Scandinavian Peninsula. It is much more reliable and easier in this regard to include the already mentioned areas in a single energy supply system, actually connecting it to the NordPool mechanism.

Also, for objective reasons, nuclear generation technologies are not used in the Nordic countries. Firstly, this is due to the negative attitude of the public toward nuclear power plants. Secondly, for reasons of environmental safety, the Scandinavians have put forward an initiative within the framework of the Arctic Council to turn the Arctic region into a nuclear-free zone (Kotlova, 2019). The initiative is directly directed against Russia's plans both to increase the number of nuclear icebreakers operating in the structure of the Northern Sea Route, and to put into operation two power plants in Pevek and Vilyuchinsk.

Virtually all the trends associated with an increase in the share of renewable energy use fit into the general course of the Nordic countries. This also includes the target installation for the use of many small hydroelectric power plants (Govorova, 2016).

In the Arctic region of the North American continent – in the territories of Canada, Alaska, and Greenland – slightly different power supply schemes have found their application due to the following features:

1. A significant territorial range, both from north to south and from west to east of the Arctic zone of the North American continent.
2. The geographical remoteness of the Arctic zone of the North American continent from Northern Europe and Russia, hindering the development of cross-border infrastructure.
3. The presence of large full-flowing rivers – the largest of which is the Yukon; the concentration of industrial enterprises around the nodes of railways and highways brought to the fore the construction of hydroelectric power plants. As such nodal points stop being so crucial, the share of diesel fuel use increases, which is the backbone of the generation of the Arctic regions of the United States and Canada.

For instance, Alaska, by the standards of the northern territories, has a developed social and industrial infrastructure and needs significant amounts of electricity. The largest area of concentration of enterprises that consumes up to half of the total amount of energy produced is the so-called “Railbelt,” the backbone of which is the Alaska Railroad (Tysiachniouk & Petrov, 2018).

It would be appropriate to develop a unified American electric power system in the northern direction, since the two most developed regions of the state of Alaska – the area of the Alexander Archipelago on the Pacific coast, and the area of the so-called “Railway Belt” at the organizational level – are included in this system in the form of the Alaska division of the Western Council for Coordination in the field of Electric Power. Even despite the fact that the Alaskan system actually consists of two energy-isolated areas, in this regard, it is rather worth paying attention to the approach to the organization of the electric power industry of individual districts of the state that find themselves in a zone of high population density and a significant concentration of production capacities.

Considering the case of Canada ensuring energy supply to its north regions, it should be noted that the Canadian Arctic sector has certain local specifics. For example, Canadians do not have significant local reserves of oil, gas, and coal, which suggests that the north of Canada is not sufficiently provided with its own hydrocarbon resources, even despite such a small population – only about 130,000–135,000 people. In addition, Canada is characterized by a significant volume (on average, 70% of the total generation) of the use of hydroelectric power plants, including small hydroelectric power plants.

In general, in the absence of an actual alternative in the form of purchases of American raw materials or the inclusion of the northern territories of the country in the coverage areas of the unified energy system of North America, the authorities of Canadian municipalities and territories make a choice between small hydrogenation facilities and the use of diesel generators.

An example of a successful energy supply with an overwhelming share of renewable energy sources is Greenland. In describing Greenland, it should be noted that it is a very special situation. In general, Greenland has already undergone a massive transition to hydrogenation, which occurred in the period from the early 1990s until the mid-2000s. This revolution was marked by the commissioning of the Buksefjord hydroelectric power station, serving the Nuuk metropolitan region, with a capacity of 45 MW, and the construction of the Ilulissat hydroelectric power station with a capacity of 22.5 MW.

Another different option of energy supply should be considered on the example of Russia. The country has a huge potential both in terms of territory and the possession of significant mineral, oil, and gas resources lying directly in the regions of the Far North of the country. Also, Russia is characterized by the greatest variability in the organization of energy supply to its Arctic zone. There is an active development of small-generation facilities and the creation of small energy-isolated areas. Their work is being interfaced with the functioning of the national united power grid. In addition, the key features of Russia are significant experience in the creation and use of nuclear power plants, including successful experience in the operation of the Kola and Bilibino nuclear power plants operating in the Arctic, and in the use of a wide range of unconventional energy sources – from small hydroelectric power plants on the rivers of North Karelia to tidal stations and solar power plants installed in Yakutia.

However, the problematic aspects of the Russian approach to the development of the electric power complex continue to be the insufficient development of generation technologies based on the use of renewable energy sources, their coupling with small diesel generators. Unfortunately, the freezing of material and technical cooperation with Western countries has also disrupted the emerging positive trend in the field of energy-saving technologies. At the moment, a number of measures have been successfully used, but it does not yet reach their mass application already at the stage of construction of facilities.

Summing up, all the identified options for energy supply to the northern territories by these countries have had some successful application. At the same time, the Russian Federation is distinguished by the largest range of applied approaches and the resource base for their development.

Low-Power Nuclear Plants

Due to the high energy intensity of nuclear fuel and its ecological purity, the use of nuclear energy in remote and hard-to-reach regions of the Arctic is profitable and effective (Sotnikova et al., 2018). Two of the world's northernmost nuclear power plants are operating in the Arctic zone of Russia: Bilibinskaya and Kola nuclear power plants. By 2030, it is planned to introduce new nuclear facilities with a total installed capacity of up to 600 MW, in the Russian Arctic region (Rosatom, 2021). At the same time, nuclear energy technologies can play a significant role in the transition to low-carbon energy (Petrov et al., 2020).

The use of nuclear generation in the Arctic has a number of advantages:

1. High standards of environmental and industrial safety.
2. At the moment, there is no threat of terrorism in the Arctic, which confidently eliminates the risk of an attack on generation facilities.
3. This technology makes it possible to provide large-scale energy-isolated or energy-deficient areas with large amounts of energy.
4. The problem of importing fossil fuels is automatically solved, and the need to adapt renewable energy technologies to the harsh conditions of the north is removed.
5. The risk of natural disasters has been minimized due to the weather and climatic conditions in the high Arctic latitudes that have not changed for centuries.
6. The comparative cheapness of electricity generation with significant capital investments can be seen at the initial stage of construction.

In addition, it should be remembered that almost all Arctic countries have plans for the development of oil and gas resources on the Arctic shelf, even despite the freezing of plans for drilling exploration in the current economic and political conditions. Meanwhile, the extremely difficult climatic conditions of the region only enable effectively developing focal centers of the economic development of the region.

For the exploration and development of hydrocarbon deposits found in the Arctic region, it is necessary to have the most suitable and reliable energy sources for local conditions, which, according to research, are precisely small-capacity nuclear installations (up to 300 MW).

According to the criteria of reliability, independence from the fuel component, and the impact on the environment, small-capacity nuclear installations are the most attractive energy alternatives. Existing small-capacity nuclear projects are characterized by a high degree of adaptability of their technical, economic, and operational characteristics to solve the problems of small-scale energy development. It is worth highlighting the possibility of underground and above-water placement, as well as a wide range of capacities of existing small-capacity nuclear projects: from several units to hundreds of megawatts.

No less important is transportable nuclear energy. It is such reactors that can become the basis of the energy of local hard-to-reach territories of the Arctic region. One of the most important types of maritime economic activity in the Arctic region is the transportation of cargo by transport vessels, the operation of which is provided by icebreakers. Floating nuclear thermal power plants will play an important role in providing energy to the Arctic. The floating station can be used for generating electric and thermal energy, as well as for the desalination of seawater.

Today, only low-power nuclear plants are in operation, including CNP-300 (China), PHWR-220 (India), and the VK-50, EGP-6, and the Akademik Lomonosov floating nuclear power plant with KLT-40 reactors in Russia. In addition to existing and ongoing projects, the International Atomic Energy Agency database contains more than 50 projects of small- and medium-sized reactors and nuclear power plants based on them. Nevertheless, out of all the Arctic states, only Russia is, in fact, promoting this initiative, and in two of its forms at once – through the construction of floating nuclear power plants and the mass use of nuclear icebreakers.

Electrification of the Region with the Use of High-Voltage Direct Current Power Transmission

The second promising way of organizing power supply to the objects of the Arctic Zone of the Russian Federation, in the absence of the possibility of joining the unified energy system of Russia, is the use of high-voltage direct current power transmission (HVDC transmission). It has a number of important technical and economic advantages compared to alternating current (AC) power transmission lines equivalent in terms of transmitted power, voltage class, and length (Travin, 2018), that is:

1. It provides the possibility of asynchronous connection of AC systems, including those with different frequencies (50 and 60 Hz).

2. The transmitted power and the length of the HVDC transmission are limited only by the parameters of the converter and transformer equipment, while the power and length of the AC line are limited by the problems of static and dynamic stability of AC systems.
3. Unlike AC power lines with very slow regulation of the transmitted power within small limits, the power transmitted via the HVDC can be regulated very quickly and practically from zero to maximum.
4. The HVDC transmission is a natural limiter of short-circuit currents both on the overhead or cable line of direct current, and in the receiving system of alternating current.
5. Power losses in HVDC transmission are significantly less than in equivalent AC power transmission lines.
6. The reliability of power transmission via HVDC is significantly higher than via an air or cable AC power line.
7. HVDC converter substations are more complicated and more expensive (about three times) than conventional equivalent AC substations, since they contain a lot of additional equipment. On the other hand, direct current (DC) overhead and cable lines are simpler and cheaper than AC lines. Therefore, the amount wires or cables required for an air power transmission system is much less, supports are much simpler and lighter, the line route is 70% narrower, the construction cost is less, and the specific cost of a DC line (per 1 km of length) is 2–2.7 times less than for an equivalent AC power line.

HVDC transmissions are widely used in different countries for the transmission of electricity from powerful power plants to load centers; for combining electrical systems with different electricity quality standards (electricity export) or with different frequencies; for power supply to islands or remote regions that do not have their own electricity sources; for the integration of generating plants based on renewable energy sources; for deep power inputs to megacities; or for increasing the capacity of AC power lines by switching it to direct current, creating direct current networks. The use of power electronics is the future of the electric power industry. Even now, there is a technical possibility to combine all the world's electric power systems with the help of ultra-high voltage DC power lines and get huge economic benefits of covering load maxima in different time zones. However, this requires the cooperation of all countries, and the full confidence of each country in its energy security.

Having analyzed the climatic, natural, demographic, and economic conditions and features of the Arctic coast and islands of Russia, it can be concluded that these complex factors contribute to the use of DC power lines for the electrification of these regions instead of AC power lines.

A promising area of the application of HVDC transmission is the power supply of oil-producing platforms on the offshore shelf. There are two options for their power supply – with the help of autonomous electric power installations on the platforms, or by obtaining electricity from the shore via underwater cables. The power supply of an oil-producing platform from the shore makes it possible to significantly simplify its energy complex and to reduce the costs of its operation, maintenance, and repair (Travin, 2018).

The power supply of oil-producing platforms from the shore via underwater AC cable lines is possible for distances of no more than 30 km, since with a longer length, cable losses become unacceptably large. Therefore, at present, fully controlled underwater DC cable lines with voltage converters on high-power bipolar transistors with an isolated gate are widely used for the power supply of most offshore oil production platforms around the world. Modern technologies allow bringing tens and hundreds of megawatts of power to the platforms via underwater DC cable power lines at a distance of up to 300 km or more. At the same time, the length of the underwater DC cable line is practically unlimited. The longer the underwater cable line and the required load power, the more attractive the use of direct current is. Currently, hundreds of oil and gas production platforms are operating in the world in a temperate climate, for which underwater DC cable lines are used to supply electricity from the shore.

Currently, for the electrification of the Russian Arctic coast, islands, and the shelf of the northern seas, it is not necessary to use all the advantages of DC power transmission described above. For example, there is no need to transmit large amounts of power over long distances, connect powerful power systems, limit short-circuit currents in large systems, introduce large capacities in megacities, etc. The analysis of the state of power supply systems in various regions of the Arctic, conducted above, showed that in the next 5–10 years, individual loads in these regions are unlikely to exceed 100 MW, which means that the capacity of generating plants will also not exceed 100 MW (the capacity of the Lomonosov nuclear power plant is 70 MW, whilst the next-generation nuclear power plant is 100 MW). For example, the maximum capacity required for the power supply of mining and processing plants with local infrastructure will not exceed 40–80 MW. Therefore, as the main option for the initial application of DC power transmission in the Arctic regions of Russia, a two-pole DC power transmission with a capacity of 100 MW and a voltage of $\pm$100 kV is proposed, and the length of the air, cable, or cable-air line is not limited (determined at the stage of consideration and development of a specific project).

It should be borne in mind that as the Arctic regions develop, a significant increase in the power transmitted through all the already built power transmission lines will inevitably be required. It follows from this that when calculating and designing the first DC power lines, it is advisable to choose the power transmitted via an overhead or cable DC line with a large margin. Further development of the application of HVDC transmission technology in the Arctic Zone of the Russian Federation lies in the creation of DC networks based on separate lines. DC networks are generally combinations of DC power transmission lines.

Renewables

The development of renewable energy is a global trend that is caused by economic, geopolitical, social, and environmental factors. At the same time, the development of renewable energy sources can become economically profitable in the Arctic zone, due to high electricity tariffs and the complexity of fuel delivery routes.

Reducing the risk of disruptions of the fuel delivery and cutting down dependence on imported fuel but using local energy resources are the most serious arguments in favor of the development of renewable energy in the Arctic. Of course, the Russian Arctic has its own difficulties in the development of renewable energy sources: most of Russia's Arctic Zone is characterized by very harsh climatic conditions with sharp storm winds and temperatures up to −50 °C. Also there is a considerable unsuccessful experience in wind generation. At the same time, the Arctic regions of Russia have significant potential for the development of renewable energy sources. In areas where the average wind speed is 6–7 m/s, wind energy can develop. The average annual energy intake of direct solar radiation in the Arctic varies from 2 to 5 kWh/ m^2/day (Berdin et al., 2017).

It should be emphasized that the interest in renewable energy is much higher in remote places where it is very difficult to deliver fuel, there are few chances to conduct power lines, there are no other local energy sources, and the diesel generators need to be replaced. This well explains the location of existing and planned solar stations in Yakutia. If the delivery of fuel is relatively simple, then it is advisable, first of all, to pilot projects designed to gain experience in installation and operation in difficult climatic conditions. This is exactly the situation in Amderma, Labytnangi, and Tiksi (Yakutia). Local municipal authorities are ready to participate in these projects only if they are financed by external foreign or Russian funds that do not affect local budgets. Fuel economy is another important factor in favor of using renewable energy in the Arctic zone. With its help, it is possible to achieve a gradual reduction of the huge difference between the economically determined tariff (from ₽15 to 1₽50/kWh) and how much the population pays at the subsidized tariff (₽2–₽9/kWh).

The reduction of the difference between tariffs is determined by two factors. The first is by replacing diesel generators with modern ones; in many cases, old generators are not only worn out, but also have excessive power – they are not fully loaded, which leads to additional fuel consumption and wear. The second is an additional connection of a wind or solar source; the greatest effect is achieved where the generators are very old, and the possibilities of using renewable energy are already well established and supported by incentive measures.

In the Arctic, there are long winters with a small amount of daylight, and due to the high latitude, direct insolation is relatively low even on long summer days. However, in direct contrast to winter daylight, summer daylight in the Arctic makes photovoltaics an interesting source of energy for some remotely located infrastructure facilities, such as communication infrastructure, agriculture, and summer or hunting lodges. Photovoltaic panels can be seen on the roofs of some Arctic settlements, but it is difficult to collect accurate data on the installed capacity of photovoltaic panels, since these are privately installed and privately used systems, not connected to the network and therefore not included in official statistics. Even commercial photovoltaic systems are relatively small in size – approximately 30% of the identified photovoltaic installations have an installed capacity of less than 10 kW, which is typical for individual residential use. Many of the remaining 70% of the identified photovoltaic installations have an installed capacity of less than 10 kW, and only very few of them have an installed capacity of more than 100 kW.

The production of electricity using solar energy in the Arctic is characterized by high seasonal variability. In winter, electricity production reaches a low plateau and almost completely stops. Another shorter plateau can be observed in the summer in June and July. The cold Arctic climate is an advantage for solar panels, since the cold increases the efficiency of photovoltaic panels. In addition, during the transition periods between summer and winter, the reflectivity of snow increases the radiation that can be collected by solar cells, which may explain the bursts that can be observed in spring and autumn. At the same time, the expected service life of photovoltaic panels is about 25 years and, in order to recoup the costs, it takes up to 2 years.

In addition, the lower the ambient temperature, the more efficient solar cells work: at 0 °C, the solar cell will have a 10% higher efficiency than at 20 °C. As a result, the average annual intake of solar energy in the Arctic during the daytime can reach up to 2–5 kWh, and in some areas up to 5–6 kWh (Witt et al., 2021).

The use of low-power panels in the Arctic regions of the Russian Federation is quite successful. In particular, in the Murmansk Region, they are used in several places as an additional element of wind-solar installations working together with diesel generators; they are used for telephone communication and on navigation beacons (Boroukhin, 2021). In the Yamal-Nenets Autonomous District, Gazprom widely uses low-power solar panels as part of combined installations for powering the control equipment of gas wells. Wind-solar installations are also used by Rosneft's subsidiary Purneftegaz. Solar power plants are also operating in the Yamalo-Nenets Autonomous District, in the villages of Batagai, Betenkes, Batamai, Dzhargalakh, Dulgalakh, Kudu-Kyuel, Uluu, Yunkur, Verkhnyaya Amga, Stolby, Toyon-Ary, Kubergan, Eyik, and Delgey. The total power of the energy produced by them is about 1.4 MW. In the Arkhangelsk Region, solar panels together with small wind generators are used to illuminate roads. There is a small wind-solar installation on the basis of the Russian Arctic National Park on Cape Desire. The process of equipping infrastructure and individual objects with solar panels will continue. There are good developments in portable devices and energy storage devices designed for the Arctic.

However, in general, these are small batteries that do not solve the issue of energy supply to isolated settlements. The large-scale solar energy in the Russian Arctic regions is developing well only in Yakutia, where its potential is much higher than in other parts of the Arctic. The problem is partly that the greatest electricity needs occur in winter, when lighting is needed during the polar night, and the solar panels do not work. Therefore, solar stations should save so much diesel fuel during the polar day that this effect is enough for the whole year. Therefore, it is not surprising that only solar Yakutia demonstrates good progress, where the company RAO "Energy Systems of the East" is moving from the construction of medium-power solar pannels (with a capacity of 10–100 kW) to large stations (with a capacity of more than 1 MW). The first of them is already working in Batagai (1 MW). The plans include the construction of solar panels in the settlements of Ust-Kuiga (1.1 MW), Moma (1.4 MW), Olenek and Zhigansk (2.1 and 2.0 MW respectively), Deputatsky and Zyryanka (2.6 MW each), and San-gar (4.7 MW).

Wind is a widespread source of energy in the Arctic, with high potential in coastal areas. The wind potential is available throughout the year with seasonal fluctuations. The advantage of wind energy is that such projects can be scaled depending on the desired power, and even a small power can be obtained. According to the United States Department of Energy, the performance of wind turbines increases by 20% in very cold climatic conditions. This increase in power is associated with the density of air in colder conditions, which allows the blades of wind turbines to perceive a greater wind force. Due to strong winds in the Arctic regions, the aerodynamic profile of the blades often has to be changed or a variable angle mechanism of the blades is used so that wind turbines can continue to operate in strong wind conditions. Although this leads to a decrease in productivity, the only alternative is to stop the wind turbine.

The obstacles to the implementation of wind energy projects are related to the influence of Arctic weather conditions on the relevant technologies. Some studies on technological adaptation to the cold conditions of the Arctic have already been conducted. A cold climate can affect the properties of materials, especially at temperatures below 40 °C, examples of which are the deformation of composite materials due to differences in thermal expansion properties and the increased brittleness of some metals. This can lead to a decrease in the structural integrity of wind turbines. Another problem associated with the use of wind turbines in cold climates is icing; icing can change the shape and, consequently, the aerodynamics of wind turbine blades, thereby reducing their efficiency. In addition, ice can block the vents, which can lead to overheating, and ice can break off from the blades and cause damage (Witt et al., 2021).

Approximate cost calculations show that potential wind energy projects in the Arctic will be two to three times more expensive than projects in temperate regions. According to the United States Department of Energy, the cost of 1 kW of installed capacity is from $2500 to $7000 (EIA, 2021). For wind energy projects, it is necessary to take into account that it is associated with the complexity of building strong foundations for wind turbines on permafrost; this often leads to high construction and maintenance costs. The cost of electricity production is reduced to operation and maintenance after a payback period of approximately 10 years (Ahmed et. al 2015). The actual service life of a wind turbine is 20 years, although it can be longer if the operating and maintenance costs are at an acceptable level. Due to the construction and maintenance in the Arctic, smaller wind turbines are preferred. This contradicts the global trend of increasing the size of wind turbines.

It is known that in the coastal areas of the White and Barents Seas, as well as on the territory of the Novaya Zemlya and Franz Josef Land archipelagos, the wind speed reaches 5–8 m/s and, according to Gritsan (2021), as the region warms, there will be a multiple increase in its frequency and strength. In addition, cold air has a higher density than hot air, meaning the energy efficiency of such an installation at the same wind speed will be higher. Together, all this creates extremely favorable conditions for the development of wind energy. Currently, there are a number of wind farms already operating in the Arctic: an experimental wind power station in Labytnangi and the Polaris project with four wind power plants in the Yamalo-Nenets Autonomous District; the Anadyr Wind power plant at the Cape of Observation of the Anadyr District with ten wind generators in the Chukotka Autonomous District; a wind farm in the village of Tiksi with three wind turbines; an experimental wind power station "Bykov Mys"; and after 2021, the first wind power plant in the North with a capacity of 201 MW will start operating in the Kola district near Murmansk, which will be the largest wind power plant in Russia. The total capacity of all Russian Arctic wind power plants is 210 MW. Usually, the installations are used either separately or together with solar panels and diesel generators.

In addition to the sun and wind, there is also hydropower. There are 17 hydroelectric power plants in the Murmansk Region alone, 2 in Yakutia, and 1 in the Arkhangelsk Region. The Kislogubskaya tidal power plant with a capacity of 1.7 MW operates near the village of Ura-Guba in the Murmansk Region. In the Long-Eastern Bay on the Kola Peninsula, the construction of the Northern tidal power station will soon begin, with a capacity of 12 MW with an annual energy output of 23.8 million kWh. This will be the first tidal power plant in Russia that will reach the industrial level of energy generation. In the Mezen Bay of the White Sea, it is planned to build another tidal power plant with a capacity of 8 GW. It is expected that its annual output will amount to 38.9 billion kWh – the same as that of the entire Volga-Kama cascade of hydroelectric power plants.

In a more complete form, the current state of renewables development in regions of the Russian Arctic is shown in Table 4.

Finding the optimal combination of primary energy resources is crucial for achieving energy security. The choice of energy sources should be carried out in accordance with a good energy policy, which takes into account three criteria: environmental safety, reliability of energy supply, and accessibility.

In general, according to Berdin et al. (2017), promising areas for the development of wind and solar energy in isolated locations of the Russian Arctic can be divided into the following categories:

1. Wind-diesel complexes in places with relatively mild climatic conditions (Murmansk and Arkhangelsk regions, Kamchatka Territory)
2. Wind-diesel complexes in places with high wind potential, but very harsh climatic conditions (the Arctic coast of Yakutia, Chukotka, the Yamal-Nenets Autonomous District, and the Nenets Autonomous District)
3. Solar stations in the villages of Yakutia
4. The development of renewable energy sources with the financing of large oil, gas, and mining companies operating in the regions (Chukotka, the Yamal-Nenets Autonomous District, and the Nenets Autonomous District, Taimyr)

Simultaneously with the accumulation of experience in the successful operation of renewable energy sources, it is fundamentally important to improve the tariff policy and the allocation of subsidies. It is still too early to talk about a significant

Table 4 State of renewables development in Arctic regions of Russia in 2020

Arctic regions of Russia	State of renewables development
Murmansk region	Wind-solar diesel complexes in four villages on the Tersk coast. Wind-solar telephone communication installations for 21 localities. Wood-fired boilers
Arkhangelsk region	More than 400 boiler houses on wood fuel. The use of wind and solar installations for road lighting
Nenets Autonomous District	Experimental wind farm in Amderma, designed for extreme working conditions
Yamalo-Nenets Autonomous District	Experimental wind farm in Labytnangi, designed for extreme conditions (accumulation of work experience). More than 200 wind-solar installations in places of hydrocarbon production
Republic of Sakha (Yakutia)	16 solar stations, including a large one in the village Batamay (capacity = 1 MW). An experimental wind farm in Tiksi, designed for extreme conditions
Chukotka Autonomous District	An experimental wind-diesel station

Source: Compiled by the authors on the basis of Schemes and Programs for the development of the electric power industry of the Arctic regions of Russia. Retrieved from: https://minenergo.gov-murman.ru/documents/npa/tek/reg/, https://docs.cntd.ru/document/570789897, http://publication.pravo.gov.ru/Document/View/2900202104290004, https://gkh.adm-nao.ru/energetika/shemy-i-programmy-razvitiya-elektroenergetiki-neneckogo-avtonomnogo-ok/, and https://rek-yamal.ru/documents/active/26586/

reduction in subsidies, but it is absolutely timely to introduce targeted subsidies aimed at developing renewable energy sources, while increasing fuel efficiency and energy efficiency (Gritsan, 2021).

In Russia, the problems of isolated territories are regional, and their financial support at the state level is not systemic; the exception is the support of the population through the establishment of preferential tariffs. In some regions, other consumer groups are also supported by setting a lower tariff.

Decree of the Government of the Russian Federation No. 47 of 23 January 2015 defines the procedure for implementing the mechanism for supporting renewable energy in retail markets in price and non-price zones of the wholesale market, as well as in geographically isolated energy districts. This resolution defines the procedure for the formation of long-term tariff regulation of renewable energy generating facilities in the retail markets, as well as the rules for their functioning. The procedure and conditions for conducting competitive selections for the inclusion of renewable energy generating facilities in the scheme of developing the electric power industry of the region, as well as the requirements for the relevant investment projects for the construction of renewable energy generating facilities and the criteria for their selection, are established by regional authorities.

The adopted regulatory legal acts allow the regional authorities of the constituent entities of the Russian Federation to independently make decisions on supporting renewable energy generating facilities, taking into account their economic and environmental feasibility and the sufficiency of resources to provide them in each specific case.

An excellent example of state guarantees is the regional law of Yakutia on supporting the development of renewable energy sources, which gives real practical results. In Yakutia, the peculiarities of pricing for electric energy generated by renewable energy sources in isolated systems are the establishment of tariffs for any owner of renewable energy facilities without certification and qualification procedures, as well as the guarantee of the immutability of the tariffs set. The principle of saving operating expenses has been adopted – the return period of investment capital is 15 years. Such state support at the regional level leads to the progressive development of solar energy.

In addition, in May 2021, the Government of the Russian Federation developed a roadmap to attract private investment in the development of energy in remote and isolated areas of the Far East and the Arctic, including on the basis of renewable energy sources. The roadmap was developed by the Corporation for the Development of the Far East and the Arctic. Among its main provisions is the development and approval of the program "Development of distributed generation in remote and isolated areas." It is planned to create a mechanism for attracting private investment, and it is proposed to provide local governments with expanded powers to develop energy supply programs and improve the energy efficiency of settlements in the zone of decentralized electricity supply. The document proposes giving the development institutions of the Russian Federation the authority to provide preferential long-term state financing for the implementation of projects for the development of distributed generation in remote and isolated areas, as well as to determine the terms of financing.

Conclusions

The issues of ensuring energy security play a central role in determining the development strategies of the Arctic. The most significant threats to the energy security of the Arctic are: the deterioration of generating equipment, the high cost of imported fuel, the remoteness of territories, and harsh climatic conditions.

There are several approaches to ensure the reliable energy supply to the northern territories developed by the countries of the Arctic region. The American version relies on the large-scale use of renewable energy sources and the development of a decentralized energy supply in energy-isolated areas. The Nordic countries are in favor of increasing the share of renewable energy in the energy balance and gradually abandoning the technologies of traditional generation and nuclear energy.

The analysis of the energy supply systems of the northern territories showed that when choosing a specific option, it is necessary to take into account such factors as the availability of natural resources in the region, transport infrastructure, population density, the presence of large industrial facilities, and climatic conditions.

Among all the countries of the Arctic region, the Russian Federation is distinguished by the largest volume of installed capacities and produced electricity, which also implements the most active economic activities in the region. In addition, the Arctic zone of the Russian Federation is the longest and most densely populated.

Thus, the development of the electric power industry in the Arctic zone of Russia seems appropriate using the full range of available technologies. Among the most promising areas for the development of the electric power industry in the Arctic zone of Russia are: energy supply to remote areas with harsh climatic conditions through the construction of low-power nuclear plants (including floating nuclear power plants), energy supply to large oil and gas platforms on the offshore shelf using high-voltage DC power transmission, energy supply to settlements and infrastructure facilities using renewable energy sources in regions with a suitable climate, and combining the use of renewable energy sources with diesel generators in order to reduce fuel costs.

The large extent of the Arctic circle and the long coastline of the northern seas of the Arctic zone of the Russian Federation lead to the fact that the efficiency of different methods of electricity supply varies under different local conditions. This creates opportunities for the introduction of various technologies and solutions. The practical implementation of the entire pool of solutions for the power supply of objects of the Arctic zone of the Russian Federation will make it possible to clarify the conditions for the most effective use of each of their methods, as well as to conduct a comparative assessment of economic indicators.

In addition, there is a need to strengthen international cooperation in the development of the electric power industry of the Arctic region, which will effectively increase the scale of economic development of the Arctic region, while implementing cross-border projects that promote the exchange of experience and strengthening the energy security of the entire region.

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Strengthening Multilateral Energy Cooperation for Indigenous Resilience in the Arctic

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Contents

Abstract

The Arctic is a special region where the implementation of the SDGs is particularly hard due to various natural, climatic, social, economic, and historical features of this region. Nevertheless, ensuring the resilience of the indigenous population, as well as the infrastructure of the region, as the main basis for achieving the SDGs in this region is our main priority. Today, many problems increase the risks to the local population. First of all, one has to highlight the degradation of the environmental situation. The growth of the region's GDP increases the demand for energy carriers, the problems with the supply of which (especially to remote areas) have existed for many years. All this determines the priority of the development of alternative energy as a key factor in increasing the resilience of the indigenous population and the infrastructure of the Arctic. This chapter analyzes the multilateral energy cooperation in the Arctic, namely, the impact of various international alternative energy projects on improving the resilience of indigenous peoples, cities, and enterprises.

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Keywords

Sustainable development · Sustainable development goals · Alternative energy sources · Resilience of the Arctic region · Multilateral energy cooperation · Hydrogen economy

Introduction

Achieving the Sustainable Development Goals (SDGs) is a priority of the UN until 2030 (UNDESA). The Arctic is a special region where the implementation of the SDGs is particularly hard due to various natural, climatic, social, economic, and historical features of this region. Nevertheless, the priority of ensuring the resilience of the indigenous population, as well as the infrastructure of the region, as the main basis for achieving the SDGs in this region is obvious. Today, several problems increase the risks to the life of the local population. First of all, one has to highlight the degradation of the environmental situation. For example, the accident at the CHPP-3 of the Norilsk-Taimyr Energy Company, which occurred in May 2020, led to the bottling of more than 20,000 tons of petroleum products, which caused huge damage to the surrounding flora and fauna, as well as to the pollution of local reservoirs: the Ambarnaya River and its tributary Daldykan, Lake Pyasino, and the Pyasina River which flows into the Kara Sea. Huge damage was caused to an area exceeding 180,000 m^2 (The New York Times, 2020).

The growing GDP of the region increases the demand for energy carriers, problems with the supply of which (especially to remote areas) have existed for many years. The remote Arctic regions of Russia are not supplied by the central electricity, so energy carriers are delivered to the Arctic by “northern delivery.” This method of providing energy to the local population is already quite outdated; residents suffer from frequent interruptions in supplies and undeveloped infrastructure. All this determines the priority of the development of alternative energy as a key factor in increasing the resilience of the indigenous population and the infrastructure of the Arctic.

The development of alternative energy in this region is impossible without multilateral cooperation. First of all, this is due to the need to improve the domestic regulatory framework and the development of national standards. Besides, the issue of joint development of advanced technologies, creation of joint infrastructure, and international clusters are important for the development of alternative energy. All this is important for Russia to successfully integrate into the world economy of alternative energy.

Today, the main emphasis in the Arctic region is on bilateral relations as well as on the development of traditional energy sources. The development of the Arctic Council as the main platform for multilateral cooperation should become a priority task for Russia during the period when the country chairs this organization.

We should analyze the multilateral energy cooperation in the Arctic, namely, the impact of various international alternative energy projects on improving the resilience of indigenous peoples, cities, and enterprises.

Studying Multilateral Energy Cooperation in the Arctic

To study the issues of ensuring the resilience of indigenous peoples, cities, and enterprises of the Arctic by strengthening multilateral energy cooperation, comparative analysis methods were chosen; indicators of environmental problems of the Arctic region, the resilience of the population, economic indicators of bilateral cooperation in the field of traditional energy sources, as well as projects of multilateral cooperation in the field of renewable energy were compared. In the context of achieving the SDGs in the Arctic region, the priority is to ensure the sustainable development of indigenous peoples, cities, and enterprises, the development of infrastructure, ensuring an uninterrupted supply of energy while preserving the fragile ecosystem of the Arctic.

This study was primarily based on case studies in Russia and abroad. The works of Academician Yu.I. Chernov became the basis for assessing environmental problems (Chernov, 1989). A large number of works on natural and climatic changes, the social structure of indigenous communities of the Arctic, as well as the development of the region's economy, have been created by members of the Scientific Council of the Russian Academy of Sciences for the Study of the Arctic and Antarctic. The monograph "Socio-economic development of the Russian Arctic in the context of global climate change" was published under the editorship of Academician B.N. Porfiriev. It presents the results of a study of the impact of climate change on the socioeconomic development of the Arctic, as well as on ensuring the national security of the Russian Federation (Porfiriev, 2017).

In 2007, Edward K. Carmack, a researcher at the Department of Fisheries and Oceans from Sydney, led a research project called "Canada's Three Oceans" (C3O) to study changes in the Arctic Ocean due to global warming, including the retreat of the ice sheet, species extinction, hypoxia, and acidification (Carmack et al., 2008).

Dr Murray is Executive Director of the Arctic Institute of North America. She focuses on modern climate change and its impacts on people and the environment in the Arctic (Ibarguchi et al., 2018).

To obtain statistical data, we studied the data provided by the US National Snow and Ice Data Center (NSIDC), a US information and reference center that supports polar and cryospheric research. NSIDC archives and distributes digital and analogue data on snow and ice, as well as stores information about snow cover, avalanches, glaciers, ice sheets, freshwater ice, sea ice, ground ice, permafrost, atmospheric ice, former glaciers, and ice cores. The data was taken from the US Polar Research Center (PSC), which conducts fundamental and applied research in the field of oceanography, climatology, meteorology, biology, and ecology of ice-covered regions on Earth and elsewhere in our Solar System. The scope of PSC research and fieldwork includes the Arctic and Antarctic, as well as sea ice, glaciers, and continental ice sheets (PSC).

The statistics on renewable energy sources were obtained from the following websites: the International Renewable Energy Agency (IRENA), an intergovernmental organization that supports countries in their transition to a sustainable energy future, and serves as the main platform for international cooperation, a center of excellence and a repository of policy, technology, resources, and finance. The International Energy Agency (IEA) was established in 1974 to help coordinate collective responses to serious disruptions in oil supplies. Although oil safety remains a key aspect of the work, the IEA has expanded significantly since its inception. Applying an approach based on the use of all fuels and technologies, the IEA recommends policies that improve energy reliability, availability, and sustainability.

Challenges and Opportunities for Strengthening Multilateral Energy Cooperation for Resilience in the Arctic

The energy sector is one of the main sources of environmental problems in the Arctic region. One should distinguish two main clusters of problems. First, it is the extraction of energy sources, such as oil and gas. The natural features of the Arctic cause various accidents at oil and gas industry facilities. They include oil spills. Besides, the extraction of energy sources is accompanied by a large emission of greenhouse gases, which are especially harmful to the fragile ecosystem of the region. Secondly, there is a problem with the energy supply to the region. The populated territories of the Arctic are not included in the central heating zone of Russia, so the energy carriers are delivered by the "northern delivery," the infrastructure of which is significantly outdated, which cannot but affect its efficiency and increase in energy risks for the local population.

One of the key problems of oil production in this region is the lack of effective ways to respond to oil spills in Arctic conditions. Therefore, today, the only way to preserve the ecosystem of the region is to reduce the oil production in the region until effective ways to respond to such man-made disasters are developed. Some features can lead to serious consequences of oil bottling in the Arctic seas. They include extremely low water temperature, icing, as well as low salinity profiles. Severe Arctic conditions, such as short daylight hours, unpredictable weather conditions, create additional risks (WWF, 2011).

One of the sad examples was the environmental disaster that occurred in May 2020 – a diesel fuel leak in Norilsk. This disaster has become one of the most significant in the history of the Arctic region. The accident at the CHPP-3 of the Norilsk-Taimyr Energy Company led to the bottling of more than 20,000 tons of petroleum products, which caused huge damage to the surrounding flora and fauna, as well as to the pollution of local reservoirs: the Ambarnaya River and its tributary Daldykan, Lake Pyasino, and the Pyasina River, which flows into the Kara Sea. Huge damage was caused to the territory exceeding 180,000 m^2. This incident created a threat to the existence of the arctic flora and fauna (The New York Times, 2020).

Another problem related to the extraction of energy resources in the Arctic is the emission of greenhouse gases. Extracting energy resources is accompanied by the release of a large amount of methane and carbon dioxide. Besides, the melting of glaciers and the extending shipping period in the Arctic also release a large number of various gases into the atmosphere of the region. If we take the 2011 report published with the support of the European Geosciences Union (data is shown in Fig. 1 for carbon dioxide, Fig. 2 for sulfur dioxide, Fig. 3 for nitrogen oxides) (Lindholt & Eide, 2011), we can draw obvious conclusions about what the future holds for the region. If the development of energy resources, as well as transport activity, increase at a real pace until 2050.

It can be concluded that the main part of emissions will fall on oil production and other transportation in 2030 and 2050. However, one can notice minor changes in the total number of emissions due to the improvement of the emission factor. Depending on the pollutant, various activities will prevail in future emissions in the Arctic. However, one cannot assess future activities in the Arctic more accurately due to the

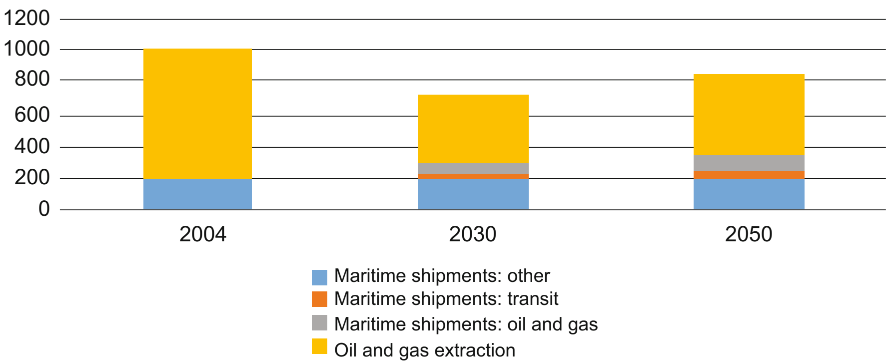

Fig. 1 Comparison of different sources of CO_2 emissions in the Arctic region (10Mt CO_2). (Source: Adapted by the author from Lindholt & Eide, 2011)

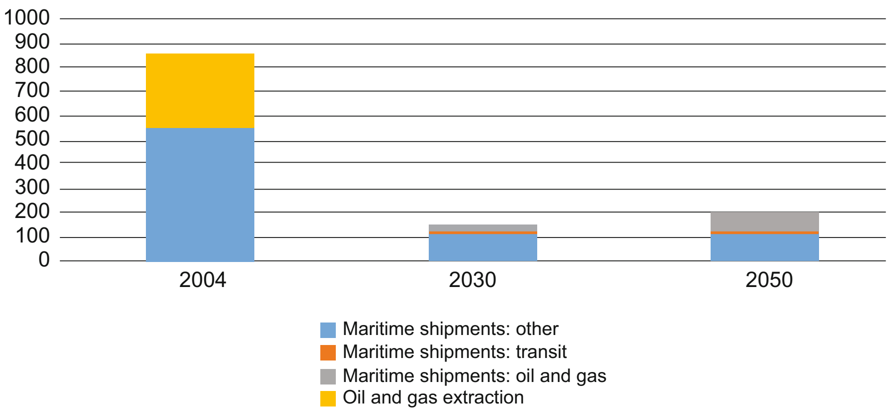

Fig. 2 Comparison of different sources of SO_2 emissions in the Arctic region (2kt SO_2). (Source: Adapted by the author from Lindholt & Eide, 2011)

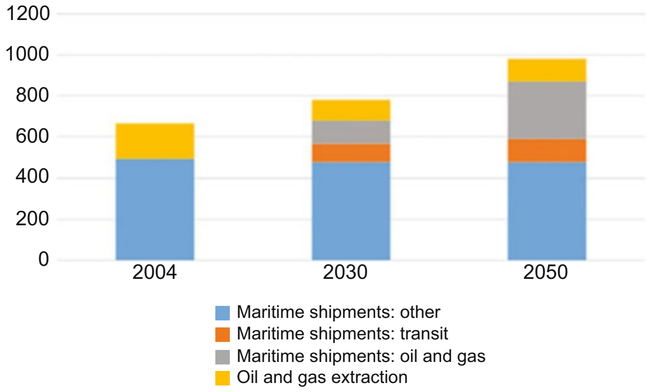

Fig. 3 Comparison of different sources of NOx emissions in the Arctic region (kt NOx). (Source: Adapted by the author from Lindholt & Eide, 2011)

Table 1 Forecast of GDP growth and electricity consumption in the region

	2007	2013	2017	2020
Energy intensity of real GDP (thousand kilowatt per hour/ ₽)	28.3	24.5	25.4	24.9
Total electricity consumption (billion kilowatt per hour)	31.7	42.0	58.2	69.8
The volume of the region's GDP (billion ₽)	1121	1711	2290	2814

Source: Compiled by the author based on Smolentsev (2012)

great uncertainty about the extent of sea ice in the future, the availability of resources, future economic development, and future policies.

However, even though the Arctic is a storehouse of various energy carriers, the indigenous population has problems with the supply of fuel to remote areas, which increases various risks and reduces the resilience of indigenous peoples, cities, and enterprises. Today, most of the communities still use diesel-electric generators and coal-fired stations to produce electricity. These types of energy production are extremely harmful to the environment; besides, the outdated infrastructure leads to supply disruptions.

It is necessary to pay attention to the fact that the ability to supply energy carriers with the help of "northern delivery" is limited to the warm seasons of the year. Due to the development of the economy, the gradual involvement of the northern territories in national energy and transport projects, the region's GDP and the need for electricity and fuel are increasing. As one can see from the data in Table 1, GDP growth almost tripled from 2007 to 2020 causing an increase in total electricity consumption

Thus, the sharp growth of the Arctic's GDP runs counter to the progress in the field of energy. Apart from improving the efficiency of the energy sector, eliminating the deterioration of infrastructure, one has to gradually reduce the energy intensity of enterprises. These problems can seriously affect the improvement of the region's resilience, as well as socioeconomic indicators, and jeopardize the achievement of the SDGs.

The energy strategy of the Russian Federation for the period up to 2030 covers some problems related to the supply of electricity to remote regions of the country. The main problems include gaps in the implementation of small-scale energy projects, the development of alternative energy sources, insufficient development of the legislative framework in many regions, the lack of development programs, and insufficient vertical coordination of projects and programs for the development of local energy. The key point of the energy strategy is the development of alternative energy sources in regions where there is no centralized electricity supply.

Switching from diesel generation to wind or solar-diesel hybrid energy can help ensure energy supply in an environmentally friendly way and at more affordable prices in these regions (IEA, 2012; Edenhofer et al., 2011). Alaska and Canada have a positive experience in creating similar projects in the form of autonomous renewable energy systems (RES) in the polar regions (Bhattarai & Thompson, 2016; Weis et al., 2008). These projects served as an example for the International Energy Agency, which used them to develop a regulatory framework and new approaches in the field of renewable energy development. Besides, this organization has created several special regulatory and legal documents adapted to the natural and climatic features of the Arctic region.

The International Renewable Energy Agency and the World Bank have developed some effective tools for implementing best practices for deploying small-scale renewable energy in remote areas. This set of measures, among other things, includes tools for replacing diesel fuel with alternative energy sources.

If we take the Russian Federation, this process has begun in the regions of the Far East, where the government has developed some measures to encourage the development of renewable energy sources, a gradual transition to more environmentally friendly energy sources instead of diesel fuel.

The International Arctic station “Snowflake” is a striking example of the development of autonomous energy on the territory of the Arctic (Snowflake, 2020). This object is a station for the residence of researchers. The station can operate all year round. It does not require traditional power sources, such as diesel fuel. This project was created in such a way that it is completely autonomous and runs on renewable energy and hydrogen fuel. The project as well as the opening of the station were timed to coincide with the Russian presidency of the Arctic Council in 2021–2030. This project has no analogues; it is aimed at developing international cooperation, attracting highly qualified personnel to the Arctic: scientists, researchers, various professionals, engineers, as well as students from all over the world.

Today, the development of renewable energy is a new global trend, which is caused primarily by the need to reduce harmful emissions, as well as improve the energy supply of remote regions. Many EU countries are trying to gradually abandon traditional energy sources, or partially replace them with renewable energy sources. Figure 4 shows statistics on the percentage of traditional and new energy sources in the EU countries, as well as the UK for 2005, 2014, and 2020 (Eurostat, 2020).

However, it is necessary to remember the natural and climatic features of the Arctic region. For example, one cannot use solar panels there. However, there is a huge space for the use of other energy sources, such as wind power in the most

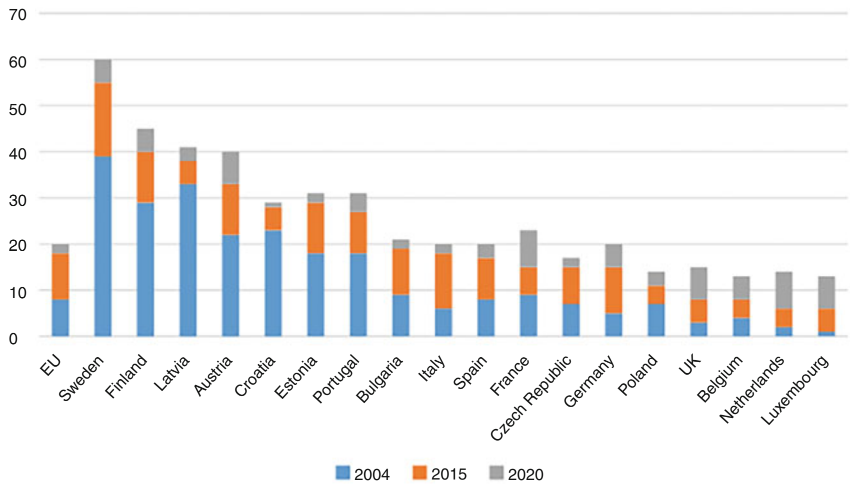

Fig. 4 The share of renewable energy sources in total electricity consumption in the EU: indicators for 2004, 2015, and 2020. (Source: Compiled by the author based on Eurostat, 2020)

northern regions, as well as hydrogen fuel. Today, there are several successful wind energy projects in this region: the Green House furniture factory (since 2015) (the city of Murmansk), 500 kW; the fishing and tourist complex of Mudyug Island, the lighting system (since 2014), Arkhangelsk region, 1.5 kW; the Polaris Project (implemented under the Kolarctic international program), with 4 wind power plants (since 2016), Nenets Autonomous Okrug, 200 kW; the Anadyr wind power plant at the Cape of Observation of the Anadyr district, 10 wind generators (since 2002), Chukotka Autonomous Okrug, 2 MW. It should be remembered that alternative energy sources cannot be actively developed without an effective legal framework that would regulate the development of these projects in the Arctic regions. Today, Russia lacks this kind of technology. One has to accurately translate the existing European analogues while taking into account the peculiarities of the Arctic regions of Russia, as well as Russia's interests at the international level. All this should help to increase the resilience of the indigenous peoples of the Arctic as well as solve serious environmental problems.

However, despite the advantages of the development of renewable energy technologies, traditional energy projects based on bilateral cooperation still prevail in the Arctic region. Norway, Canada, Russia, the United States, as well as China are trying to expand their influence, and, as a result, bilateral energy cooperation in this region. In recent years, there has been considerable interest in the Arctic as a provider of natural resources, a commercial transit zone, and a potential place for future conflicts. Today, the attention to the region has increased due to the apparent reduction of ice cover and longer ice-free navigation periods associated with climate change (Perovich et al., 2007; Ibarguchi et al., 2018).

As the era of cheap and easily accessible oil and gas is coming to an end, the Arctic shelf is increasingly seen as the world's next hotspot for hydrocarbon development – largely due to recent assessments of its huge resource potential. In 2008, the US Geological Survey (USGS) estimated that up to 22% of the world's oil and gas reserves are located in the Arctic.

More than three-quarters of these resources are located on the shelf of five coastal states of the Arctic Sea, namely, the United States, Canada, Russia, Norway, and Greenland, of which the first four are already the main oil-producing countries (USGS). As climate change decreased the thickness and area of ice, these resources are becoming more accessible, opening up new opportunities for industrial development and transportation to world markets, for example, through the Northern Sea Route (BBC, 2012).

The geographical position of the Arctic regions: Russia is vast and covers just over half of the total coastline of the Arctic Ocean and includes six seas – the Barents, Pechora, South Kara, Kara, Laptev, and Chukcha (the Sea of Okhotsk in the Russian Far East is also often called Arctic waters due to local climatic conditions) (DIC). That is why the Arctic is an area of great internal and geopolitical importance. It is not surprising that with such a huge territory and a huge potential of fossil resources (USGS), Russia is one of the key partners of bilateral relations in this region.

Shtokman is a giant gas field located in the Russian part of the Barents Sea. The development of this field is a traditional example of an attempt to develop bilateral energy projects. It was discovered at the end of the Soviet era, in 1988, and has become one of the key strategic projects of Russia. At that time, Gazprom was beginning to develop its general LNG plan for Russia, which was based on Shtokman as the main source of gas exports to the United States – then a growing market where gas production was declining and imports were supposed to grow. The debate between the partners concerned the use of underwater technologies, but even after a compromise was reached, the high cost and difficult weather conditions could affect the logistics and success of the project. Subsequently, there was no place on the US market.

Gazprom and Rosneft continue to use the opportunities in the Arctic region. Rosneft has become a leading player: It has 46 marine licenses, 25 of which are located in the Arctic seas of Russia (Rosneft). The following table shows the main partners of Rosneft in the Arctic region for 2014 (Table 2).

The above data shows that the Arctic will remain a zone of significant interest for both Russian and international oil companies due to its huge potential. The following figure shows the volume of estimated oil production in the Arctic for 2025 by country (Fig. 5).

To sum up, the total volume of developed oil for 2025 may be about 450 mtn, and it may exceed 600 mtn at a low cost (Peters et al., 2011). All this can have disastrous consequences for the ecosystem of the region and the resilience of the population.

All of the above makes it necessary to develop a multilateral partnership in the field of more sustainable energy sources. Another important factor in the need to introduce renewable energy is climate change, which has a particularly strong impact on life in the Arctic region. Climate change has a serious impact on water supply and sanitation, housing, education, self-determination, and the right to conscious and

Table 2 Rosneft's partnership in the Russian Arctic

Company name	Country	Arctic part	Other offshore companies	Total offshore resources (gross billion barrels of oil equivalent)	Other Russian assets	Share in research (%)	International assets
ExxonMobil	USA	3 licenses in South Kara Sea, 3 sq. The Laptev Sea, 3 blocks in The Chukchi Sea	1 license in the Black Sea	Oil – 46, Gas–90, Total – 136	Limited oil assets in Western Siberia	33.33	West Texas (unconventional oil), Alberta (unconventional oil), Gulf of Mexico (deep-water research)
ENI	Italy		1 license in the Black Sea	36	–	33.33	ENI North access to African assets
Statoil/ Equinor	Norway		3 licenses in the Sea of Okhotsk	26	–	33.33	Statoil access to Norwegian license in The North Sea and the Barents Sea
CNPC	China			13	Severny Komsomolsky (heavy oil), Stavropol license (Shale oil)	33.33	Sale and pre-purchase of oil through ESOP
INPEX	Japan		2 blocks in the Sea of Okhotsk	12	–	33.33	–

Source: Adapted by the authors from Oxford Institute for Energy Studies (2014)

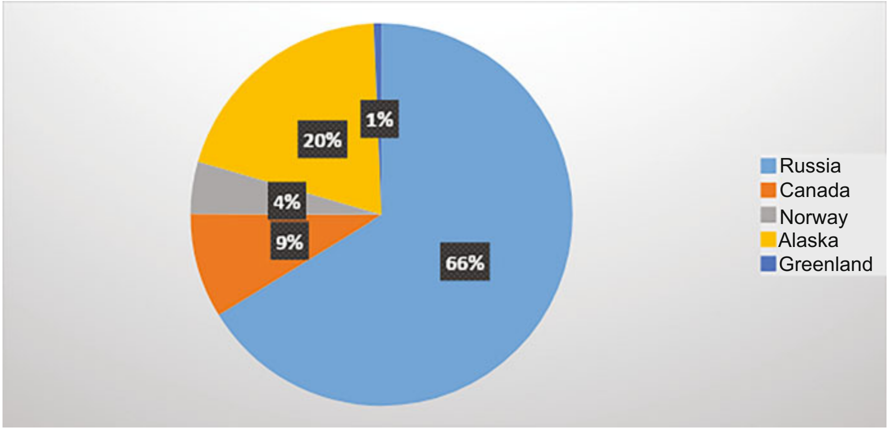

Fig. 5 Estimated oil production in the Arctic at an oil price of $80 per barrel of oil equivalent for 2025. (Source: Adapted by the author from Peters et al., 2011)

meaningful participation of the local population in the Arctic (Yumashev et al., 2019). Studies of the Arctic show that the weather and climate in the region are changing rapidly due to global warming, and it is happening twice as fast as the global average. This change leads to the melting of ice, snow cover, permafrost, sea level rise (Yumashev et al., 2019), loss of fish stocks, marine mammals and birds in the region.

Today, the Arctic Council is a key platform for multilateral cooperation in the Arctic region. The Arctic Council is a regional forum at the intergovernmental level. Its main task is to develop constructive interaction in the Arctic of the leading countries of the world, conduct a productive dialogue with the indigenous population, as well as to create conditions for the sustainable development of the Arctic territories. The Arctic Council includes forums of representatives of the local population (the Council of the Arctic Athabaskans, the International Association of Aleuts, the International Council of Kuchins, the Circumpolar Council of Inuit, the Association of Indigenous Peoples of the North, Siberia and the Far East of the Russian Federation, and the Saami Council), is a unique instrument of interaction that has no analogues.

The Arctic Council promotes cooperation between Member States, monitors and evaluates the changing climate in the region, and makes recommendations on its conclusions. Its goal includes protecting the biodiversity and peoples of the Arctic region by encouraging the reduction of emissions and pollutants and assisting in emergency preparedness and response mechanisms. The Ottawa Declaration officially established the Arctic Council in 1996 and contains important aspects of these goals (Arctic Council, 1996).

The Arctic Council is making efforts to implement strategies for the use of renewable energy sources and encourages the Member States to act following their international obligations and national action plans in the field of climate and green energy solutions. In this regard, multilateral cooperation is necessary for the development and application of practical solutions for green energy in the Arctic region. This goal is being achieved through initiatives in the field of offshore networks in cooperation with the Member States. This should contribute to decarbonization and zero emissions in the future for action to combat climate change (Beck, 2020).

Multilateral cooperation is necessary because renewable energy sources of the world's oceans can mitigate the effects of climate change. However, their operation requires the supply and distribution of electricity through a large-scale maritime infrastructure that extends through the maritime jurisdictional zones of many countries (Roeben, 2013).

Offshore networks are underwater energy transmission cables that link land-based networks to supply energy coming from offshore renewable sources, such as wave, wind, and tidal energy to land-based networks. Interconnections allow energy to be traded between different countries and offer opportunities for the use of renewable energy sources and storage options, as well as increase the security of electricity supply (RGI).

The initiative, which is of a model nature, was undertaken by the States bordering the North Sea, within the framework of the joint "Initiative of the North Sea countries to create Marine Networks" (NSCOGI). This initiative allows neighboring countries to jointly create and share large-scale electric infrastructure for the exploitation of their coastal wind resources (EC). The following figure shows a comparison of the fuel and energy balance (in TWh) along the perimeter of the NSCOGI in 2020 (Fig. 6).

Even though gas capacity increases by 70% and coal capacity decreases by 8%, energy production behaves inversely: there is a decrease of 18% for gas and an

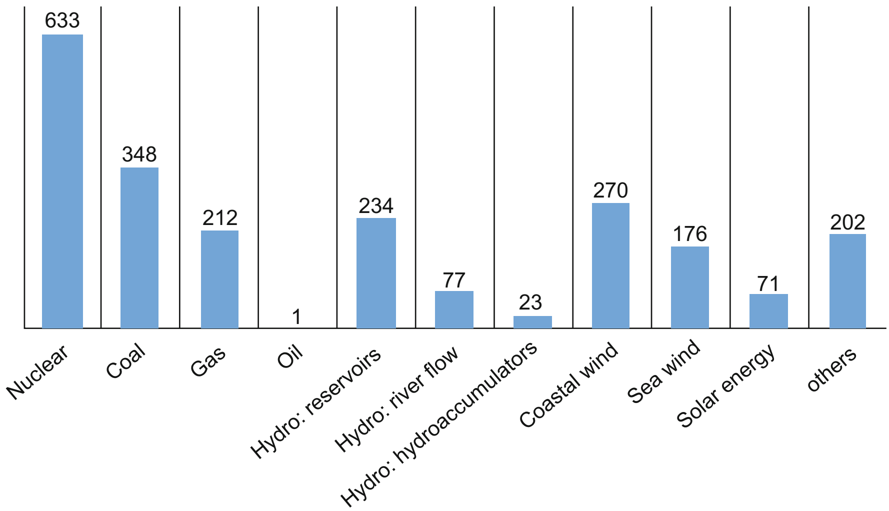

Fig. 6 Comparison of the fuel and energy balance (in TWh) along the perimeter of NSCOGI in 2020. (Source: Compiled by the author based on European Commission, 2020)

increase of 190% for coal due to the influence of the accepted quality order. This should play an important role in the countries' import/export positions and related infrastructure needs.

The initiative for a transboundary marine network requires a reliable distribution of competencies regarding the use of the ocean between countries as a precondition for such cooperation; agreement on the principles of such cooperation, and creating a structure for making synchronized decisions (Roeben, 2013).

The 2010 Agreement on Maritime Delimitation and Cooperation in the Barents Sea and the Arctic Ocean between Norway and Russia provides this legal certainty. Elements of the coalition structure support this initiative in the Arctic region, and it will promote joint financing and the development of renewable energy sources to solve a common problem (Jensen, 2011).

Another important initiative in the Arctic region is the development of hydrogen energy. The exploitation of hydrogen resources should bring significant benefits to the economy of the Arctic states, but will also have an impact on the environment of the polar region. There was a general call for resource-rich countries to use emission reduction approaches to meet their obligations under the Paris Climate Agreement and the UN Sustainable Development Goals.

One of the possibilities that may be suitable for the development of renewable energy in the Arctic may be the use of hydrogen storage facilities with an electrolyzer/fuel cell system. In this configuration, hydrogen is generated during periods of excessive wind through an electrolyzer and subsequently used during times of wind shortage by a fuel cell to generate electricity to power the load (Chadea et al., 2015).

The stored hydrogen can also be used as fuel for vehicles or boats belonging to the island community. This could become the basis of a local hydrogen economy that would make remote areas independent of external sources of fossil fuels. In addition, it is hydrogen that can make the Arctic communities fully energy-independent in the future.

The Arctic Council has also created the following initiative: the application and demonstration of the Arctic hydrogen energy (AHEAD) to create the Snowflake Station (Snowflake, 2020), which will be based on fully autonomous hydrogen energy to refine, test, and promote solutions in the field of environmental technology sustainment of the future, and other technologies to improve living conditions in remote areas of the Arctic. These include medicine, biotechnology, agricultural clean technology, telecommunications, robotics, the Internet of things and "smart house/village," new materials, and construction technologies. This project is a new step on the way to using carbon-free technologies in the Arctic. The new Russian research station operating on a year-round basis will be fully powered by renewable energy sources. It offers a platform for testing and demonstrating environmentally friendly energy solutions for remote Arctic communities and will serve as a center for international cooperation to create a sustainable Arctic. This ambitious plan is supported by the project AHEAD of the Working Group on Sustainable Development.

The futuristic innovation laboratory will be located in the foothills of the Polar Urals, on the land of the Nenets. The spherical modules of the international Arctic station "Snowflake" should provide all the amenities of a modern research station: laboratories, offices, rooms for teleconferences and seminars on-site – while its work will be provided exclusively by renewable energy sources and hydrogen fuel. Moscow Institute of Physics and Technology (MIPT) has created a project of a unique new platform for international cooperation that unites engineers, researchers, scientists, and students from all over the world to work on bold solutions that form the basis for living and working in the Arctic.

We need cluster projects on the territory of the Arctic to exchange technologies and best practices internationally. Such projects can be very useful for improving domestic legislation in the field of renewable energy sources. All this will allow Russia to strengthen its position in the international market of renewable energy sources and develop the domestic hydrogen economy.

Such projects should increase the productive involvement of the indigenous peoples of the Arctic, as well as the resilience of local cities and enterprises. One has to develop educational projects in the field of the SDGs. The local population should be aware of the prospects for sustainable development and modern opportunities to improve the quality of life of the northern territories.

An example of the development of such a dialogue is the Polar Research and Policy Initiative (PRPI) created during the Finnish presidency of the Arctic Council in 2017. This initiative was created to support the UN Agenda for Sustainable Development for the Period up to 2030 and has taken a leading role in organizing a high-level dialogue on the SDGs in the Arctic since October 2017. The project recognizes that the 17 SDGs provide a valuable comprehensive framework that critically integrates the human, environmental, and economic dimensions of the Arctic, which are truly interconnected, interdependent, and indivisible. This initiative is a platform that allows different groups of stakeholders to report their problems, coordinate their activities, and cooperate on priorities following mutually understandable goals and indicators. PRPI seeks to encourage all stakeholders in the Arctic to more effectively integrate SDG commitments into their Arctic discussions, decisions, and agenda, in which climate security remains an integral and irreplaceable goal through its high-level dialogues. However, such issues as energy, food, and water security, as well as access to education, employment problems, housing, health, transport, telecommunications, and infrastructure (SDG) should not be ignored.

Discussion

Multilateral cooperation in the field of alternative energy is a key to ensuring the viability of the Arctic region. This is primarily because alternative energy increases the stability of electricity supply to remote northern regions, and if used properly, does not cause such significant damage to ecosystems as the development and transportation of fossil fuels. Multilateral cooperation is carried out through the Arctic Council through such bodies as the Association of Indigenous Peoples of the North, Siberia and the Far East, the Circumpolar Council of the Aleuts, the

International Council of Gwich'in, etc. It allows indigenous people to take a direct part in the development of their region.

The gap in the awareness of the local population about this can be filled with the help of large-scale public consultations on RES. These events can open a discussion about the current situation in the north, introduce community members to renewable energy sources, and provide residents with the opportunity to get answers to their questions. RES can also be included in school programs so that children can receive information from their parents. Getting acquainted with renewable energy, children learn lessons from applied sciences and study the advantages of alternative energy sources, the need to be energy-efficient, and better understand the impact of diesel energy on health and the environment.

Once the Alternative Energy Viability Fund is established in the region and a certain level of public awareness of technologies is achieved, it will be important for various levels of government to explore opportunities for creating partnerships with enterprises and nonprofit organizations to support the northern regions. Scientific research in this area should provide appropriate incentives and develop a structure to support new projects.

The creation of jobs related to alternative energy sources can also have a positive impact on the region's economy.

The north cannot but face some problems when implementing the SDGs soon. Nevertheless, if we create optimal prerequisites for the transition to sustainable energy, we can ensure the stable development of the region and gradually build up the potential to achieve the SDGs in the future.

Long-term planning for the development of the energy sector in the Arctic region should be based on a wide range of tasks, not just the natural and climate agenda. This range of tasks is presented in the SDGs.

One of the priorities for the development of the Arctic is to increase LNG production, the development of which is more environmentally justified. When producing LNG, the amount of harmful emissions is reduced, which has a favorable effect on the ecosystem. At the same time, it is a fairly efficient type of fuel that can replace diesel fuel or coal.

Conclusions

Given the rich reserves of traditional energy sources, fossil fuels as well as the huge potential for the development of alternative energy, we can safely consider the Arctic region one of the best places for investment, which should contribute to the entry of Russian companies into the European market.

The development of alternative energy sources may allow Russia to strengthen its position in the Arctic region.

One has to develop multilateral cooperation based on scientific clusters, which should become platforms for the creation and trial use of modern energy sources, productive international cooperation.

One has to invest in the development and further study of the interaction of alternative energy sources with permafrost, as well as flora, fauna, and water sources.

One has to continue developing new, promising alternative energy projects in the Arctic. These projects include REC "North: Territory of Sustainable Development," the International Arctic station "Snowflake."

Future research should be based on the humanitarian, applied, and technical plane. First of all, it is the creation of a regulatory framework for alternative energy sources, especially the use of hydrogen. In particular, we have to update part of the national standards: GOST R 55226-2012 following ISO 19880-1: 2020 Gaseous hydrogen-fueling stations – Part 1. In addition, some technical studies are being conducted to improve the efficiency of the existing devices in specific Arctic conditions (e.g., new methods for diagnosing ice, etc.). Besides, we should research in the field of improving the energy efficiency of Arctic enterprises to reduce their impact on the fragile nature of the north.

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Arctic Projects in the Russian Oil and Gas Industry

Implementation Features Under the Current Economic Environment

Lydia S. Leontieva and Ekaterina B. Makarova

Contents

Abstract

The Arctic Ocean is of great socioeconomic importance for Russia. This includes the Northern Sea Route (which provides cargo to the regions of Siberia and the Far East), the future transit of the goods with round trips from the countries of the Pacific region to Europe, the biological and mineral resources (the exploitation of which has been intensively conducted in recent years), and workplaces. Over the past 20 years, for Russia, the Arctic has been marked by the economic interests with the consolidation of important strategically valuable industries in the region, including, significantly, the development, exploration, and production of hydrocarbons and other minerals. The proactive land use planning, development, and management of the Russian Arctic territory is accompanied by a number of problems, among which the most significant and high profile are environmental and economic issues. The main group of problematic factors is revealed by the

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authors in the process of evaluating the activities and operations of oil and gas enterprises. The main purpose of this chapter is to assess the effectiveness of the implementation and realization of oil and gas projects in the Arctic zone of Russia, taking into account the current economic situation and environment. As a result, the efficiency of the project implementation of the oil and gas enterprise was evaluated, the dependency of the index of effectiveness on current oil prices was revealed, and indicators for the development of the oil and gas generating potential operations and development were determined. Comprehensive measures have been developed and defined for the further successful development of the region. A distinctive feature of the research is the evaluation of projects in accordance with the current taxation system of the oil and gas industry, as well as an analysis of the resource hydrocarbons base of the Arctic region.

Keywords

Arctic · Oil and gas project · Efficiency assessment

Introduction

Oil is referred to as a nonrenewable energy resource. Proven oil reserves are 239 billion tons (BTO) (June 2016) or 1700 billion barrels of crude oil (Bbo), whereas unexplored resources are estimated to be 42–208 BTO (300–1500 Bbo). Global proven reserves at the beginning of 1973 were estimated to be 80 BTO (570 Bbo). In the past, explored reserves were growing alongside the oil consumption – during the last 40 years, it has grown from 20.0 to 35 Bbo per annum.

Starting from 1984, annual oil production has exceeded explored volumes. Global oil production in 2017 amounted to 4.55 BTO per annum (34 Bbo/year). With the current rate of production, the explored oil is enough for 50 years or more, and unexplored may be enough for additional 10–50 years.

It is impossible to overemphasize the role of the Arctic region for Russia and the world as a whole (Melnikov & Kalashnik, 2015). About 25% of all undiscovered hydrocarbon resources of the planet are located on this territory. The region's open oil and gas reserves amount to 191 billion barrels of oil equivalent (BBOE), while the potential resources put the estimate at 525 billion barrels (Table 1).

The Russian Federation accounts for 43% of the Arctic area, which is about 9 million kilometers squared. The total value of mineral raw materials exceeds $30 trillion dollars in the depths of the Arctic regions of Russia, and two-thirds of this amount is accounted for by energy resources (Bogoyavlensky & Bogoyavlensky, 2019).

The shelf of the Arctic Ocean contains about 23 BBOE of the expected oil reserves. At the same time, about 22% of the world's undiscovered hydrocarbon resources are accounted for by the Russian Arctic (Kolzina & Mindubaeva, 2020).

A large number of oil and gas fields have been discovered in the Arctic Ocean, which account for 90% of the recoverable hydrocarbon resources of the entire

Table 1 Distribution of potential hydrocarbon resources of the Arctic across countries (BBOE)

Country	Total volume	Oil	Gas	Gas condensate	Including those located on the shelf
Russia	316	36	251	29	23
USA	101	34	60	7	55
Greenland (Denmark)	48	16	23	9	46
Canada	36	15	19	2	29
Norwegian	25	5	20	–	25
Total	525	106	373	47	178

Source: Compiled by the authors based on National Petroleum Council. Retrieved from: https://www.npc.org/

continental shelf of Russia, the main part of which (about 70%) is extracted on the shelf of the Kara and Barents Seas (Kolzina & Mindubaeva, 2020).

Production of 91% of Russia's natural gas and 80% of the proven reserves of industrial categories of this raw material is concentrated in the Arctic (Table 1) (Kolzina & Mindubaeva, 2020).

The main tasks relating to the shelf for the future are annual oil production at the level of 500 million tons, with the geological study and phased development of new prospective crude-oil production areas (Krivorotov, 2013).

For example, in the waters of the Russian Arctic, four companies are actively producing hydrocarbons:

- PJSC Gazprom (30 licenses for fields).
- PJSC Gazprom Neft (three projects Novoportovsky, Prirazlomny and Vostochno-Messoyakhsky fields).
- PJSC NK Rosneft (28 licenses).
- PJSC NOVATEK, being not only a gas producer, was also the first company that supplied LNG (liquefied natural gas) along the Northern Sea Route.

It is a common fact that, in the past 30 years, the Russian economy has been dependent on the production and reselling of hydrocarbons. The revenues received by the budget (Fig. 1) make the oil and gas industry strategically and vitally important for the sustainable development of the country as a whole, ensuring the security of the energy supply and the functioning of the other industries.

In addition, the Arctic oil and gas projects are a driver for the development of the entire Russian industry. As of the current data, the industrial cluster "Zvezda" has successfully begun its commercial operations in Russia. The industrial cluster "Zvezda" has started producing hard-service ice-class vessels for the Arctic Ocean operations, as well as producing the oil and gas equipment for work on the shelf, in particular, drilling platforms.

Among other things, the Arctic projects are an essential and important instrument for the social development of the territories in the Far North (Muravyeva & Stepin, 2019). Such projects will attract much attraction for qualified labor provision to the

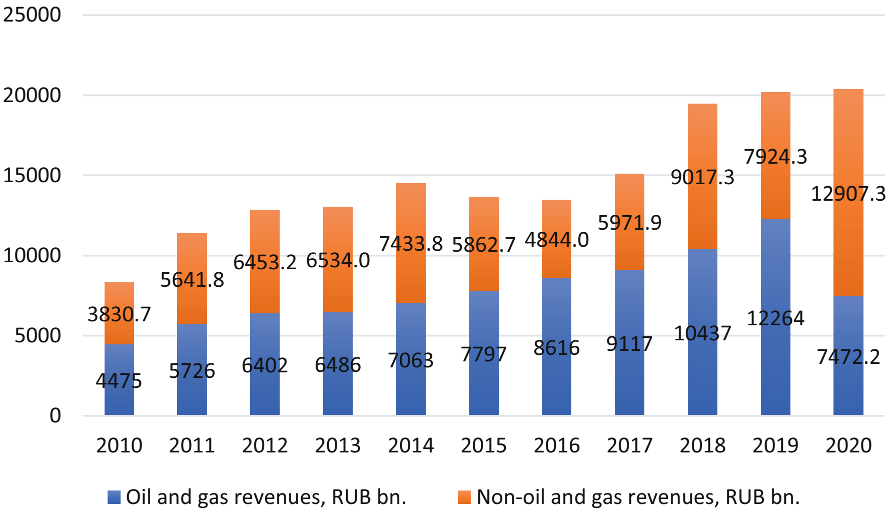

Fig. 1 The structure of the federal budget revenues of Russia in recent years 2010–2020 (₽ bn). (Source: Calculated and compiled by the authors based on data from the Ministry of Finance of the Russian Federation. Retrieved from: https://minfin.gov.ru/en/)

northern regions of the country, also creating the full-fledged infrastructure for comfortable life and habitation of people.

At the same time, the implementation of projects in the oil and gas industry is influenced by a number of factors, the primary one being the oil and gas prices, as well as the official exchange rate of the US dollar against the ruble, the share of costs for field exploration and its development, customs payments for the export of the petroleum products, the production volume, etc. (Parshakov, 2021).

The purpose of this study is to assess the effectiveness of the implementation of the Arctic oil and gas project with consideration to the current economic situation.

Economic Assessment of Oil and Gas Projects

Within the framework of studies, an economic assessment of the oil and gas project was carried out in the realm of the development of the Zapadno-Messoyakhskoye field, located on the Gydan Peninsula in YNAO (the Yamalo-Nenets Autonomous District).

The object of economic assessment is the reserves of the oil and gas field located in the Arctic.

There are lots of methods and approaches for how to assess the effectiveness of the implementation and realization of an investment project. Such methods and approaches allow us to analyze its attractiveness for future comparison and selections by the investors. However, the existing methods and approaches are not adapted for the activities and operations of the oil and gas industry enterprises.

Therefore, a significant role is played by the application of comprehensive assessment methods regarding the effectiveness that industrial enterprises, including oil and gas, have upon the investment projects, as well as an analysis of the attractiveness of its implementation for investors. The application of these methods allows us to do a cost-benefit analysis and to predict the anticipated effect from the implementation of an oil and gas project.

Thus, the economic assessment of the effectiveness of the project implementation is carried out and realized by the DCF (Discounted Cash Flow) method. The result of the economic assessment helps to determine the efficiency of the field development based on the NPV criterion in the current economic conditions.

The sequence of the economic assessment is determined by the specifics of the formation of the oil and gas projects profile, which is based on a variety of factors: an analysis of the structure and quality of the raw material base; the forecast of the cost and economic parameters of the projects; and the calculation of the indicators of the project economic efficiency.

The information base was the financial and production indicators of oil and gas enterprises, data from open sources, and the media.

Research Results

Characteristics of the Yamalo-Nenets Administrative District

Yamalo-Nenets Autonomous District is located in the northern part of the West Siberian Plain, and its territory contains the main explored reserves and undiscovered potential resources of hydrocarbon raw materials of Russia. The structure of the gross regional product (GRP) reflects the specifics of the region's economy. Thus, more than 58% of GRP is industry, the basis of which (about 94%) is the extraction of oil, gas, and other minerals (Ministry of Economic Development of Russia, 2018).

Regarding the state balance of mineral reserves (oil), as of 01.01.2020, the Yamalo-Nenets Autonomous District counted 161 fields (69 oil, 9 gas-oil, 1 oil and gas, and 82 oil and gas condensate) with drilled technological recoverable reserves: at the developed and explored fields of cat. A+B1–2, with 211.450 million tons, and at the explored cat. C1 with 309.181 million tons, totaling (cat. A+B1+C1) 2520.631 million tons. The undrilled recoverable oil reserves (estimated) at the developed fields are cat. B2–1 with 169.845 million tons, and on the explored cat. C2 with 810.515 million tons, totaling (cat. B2+C2) 1,980,360 million tons.

According to the current recoverable oil reserves (cat. A+B1+B2) and (cat. C1+C2), as of 01.01.2020, three fields in the Yamalo-Nenets Autonomous District are considered as unique (33.36% of developed reserves); 30 are considered as large (51.48% of developed and 66.56% of explored reserves), 58 are considered as medium (13.75% and 27.21%, respectively), 37 are considered as small (1.27% and 5.18%), and 33 are considered as very small (0.15% and 1.06%).

The Yamal-Nenets Autonomous District has large reserves of natural gas. The largest fields in terms of gas reserves fields are Urengoyskoye, Yamburgskoye, and Medvezhye. They account for a significant part of Russian natural gas production. In total, more than 11 trillion cubic meters (TCM) of natural gas have been extracted from the gas-bearing fields of the Yamal-Nenets Autonomous District, which is about 12% of the initial total resources (National Portal, 2021).

The Messoyakha group of fields in the Yamalo-Nenets Autonomous District was discovered in the 1980s, but the lack of transport infrastructure, as well as a complex geological media, postponed the start of development until the second decade of the twenty-first century.

The Yuzhno-Messoyakhskoye gas and oil field was discovered in 1983 by oil-well No. 4 of the Main Tyumen Production Geological Department (Glavtyumengeologiya). The Yuzhno-Messoyakhskoye field is located 555 km northeast of the city of Salekhard.

Within the territory of the field, two gas and five gas condensate reservoirs of layer-uplifted and massive types were discovered. Since 2020, PJSC Lukoil has been implementing the Yuzhno-Messoyakhskoye field project. The field belongs to the large-scale deposit type. The reserve of recoverable oil is about 100 million tons of oil equivalent (MMTOE) and almost 112.5 billion cubic meters (BCM) of gas (Table 2).

The Tax Treatment of Oil and Gas Industry Enterprises in the Yamalo-Nenets Administrative District

The tax burden on oil production in Russia remains one of the highest in the world. At present, the government receives up to 50–55% of the revenue and over 80% of the free cash flow generated by the oil and gas companies.

High base mineral extraction tax (MET) rates lead to the fact that the oil and gas industry enterprises are trying either to get tax benefits for their fields, or are beginning to optimize the project portfolio by selling mature fields (with a high tax burden) and concentrating on the development of new projects with tax benefits.

In accordance with the Russian Tax Code, the oil and gas enterprises, while executing their projects in the Arctic, are liable for the following taxes payment:

Table 2 The largest Arctic projects of PJSC Lukoil

Field	Reserves of oil (MMTOE)	Reserves of gas (BCM)	Production per year (MMTOE)	Start of production
Yuzhno-Messoyakhskoye	100	112.5	N/A	2020
Pyakyakhinskoe	69	253	1/1,3	2016
Nakhodkinskoe	65	275	3/10	2005

Source: Compiled by the authors based on data from PJSC Lukoil. Retrieved from: https://www.lukoil.com

Table 3 Taxes and payments of the oil and gas enterprise in the Yamal-Nenets Autonomous District

Type of tax	Per cent
VAT	20
MET (first 12 years)	0
Tax on additional income from hydrocarbon production	50
Property tax	0
Income tax	20
Export customs duties	0

Source: Compiled by the author based on *The Tax Code of the Russian Federation Part 1, Part 2 of 31.07.1998 N 146-FZ* (ed. of 20.04.2021) (with amendments and additions, effective from 01.07.2021). Retrieved from: http://www.nalog.gov.ru

VAT, MET, tax on additional income from hydrocarbon production, property tax, income tax, and export customs duties (Table 3).

For fossil fuels deposits (hydrocarbon deposit), the mineral extraction tax benefits were changed after the introduction of the tax on additional income from hydrocarbon production for certain license areas such as the north of the Yamal-Nenets Autonomous District, the Krasnoyarsk Territory, the Republic of Sakha, the Irkutsk Region, and the shelf of the Caspian Sea.

Tax on additional income from hydrocarbon production is levied on the financial result, and not on the revenue, as the mineral extraction tax, and is paid only if the development of the field turned out to be profitable (Evgenyeva, 2019). In addition, this tax contributes to a more equitable distribution of efficiency between the government and license holders: it provides a progressive withdrawal of rent for high-margin projects and stimulates high-cost projects at the initial stage that will bring revenue to the budget later. For such Arctic projects, at the initial stage of development, the preferential treatment applies for mineral extraction tax and export duties, and the mineral extraction tax itself is not levied until the project reaches payback (Chuzhmarova & Chuzhmarov, 2020; Osipov, 2020).

In addition, the tax on additional income from hydrocarbon production takes into account the changes in the economic and geological conditions of the production during the field development. As the field is depleted, the income received becomes costly and reduced and, as a consequence, the amount of tax decreases. Also, the release of funds at the initial stage of development encourages the investment into the new efficient oil production technologies and geological exploration, which will ultimately lead to an increase in the average project oil recovery coefficient and the replenishment of the mineral resource base.

Arctic projects belong to the fifth category when calculating the tax on additional income, while the MET rate is reset to zero for the first 12 years from the start of production. After this, the transit period will be in effect over the course of 5 years (during which the MET rate will increase from 0% to 100%), and from the eighteenth year of production, MET for Arctic projects will be calculated on a general basis.

It is worthwhile noting that, according to the Tax Code of the Russian Federation, the current tax preference item or tax privilege for the field on the continental shelf, export customs duties are equal to 0 until 2042.

The Results of the Economic Assessment of the Efficiency of the Oil and Gas Project

Methodological recommendations for the preparation of technical projects for the development of fields with hydrocarbon crudes No. 12-r dated May 18, 2016 suggest using a discount rate of 15%. The discount cash flow rate of 15% makes possible the high reliability of the calculations, since it takes into account the risks related to the escalation of inflation and the Bank of Russia key rate, as well as possible changes in exchange rates.

The total capital costs of the oil and gas project, excluding discounting, amount to about ₽537 billion. Taking into account the base price of Urals crude oil in the amount of $42.4 per barrel (set for 2020), the total revenue of the project amounted to ₽2538 billion, with current operating costs being ₽1439 billion.

Commercial oil production begins from the fifth year (Fig. 2) and reaches its peak 6 years later (43.3 million barrels).

According to the results of the analysis, the NPV of the project amounted to about ₽20 billion (Table 4). The obtained results show that the Arctic project for the development of the Yuzhno-Messoyakhskoye field is cost-effective. It is worthwhile noting that it is necessary to focus on a higher discount rate, which enables accounting for the high risks of development in the Arctic. Still, even with a discount rate of 15%, the NPV of the project has a positive value, and the values of the cost

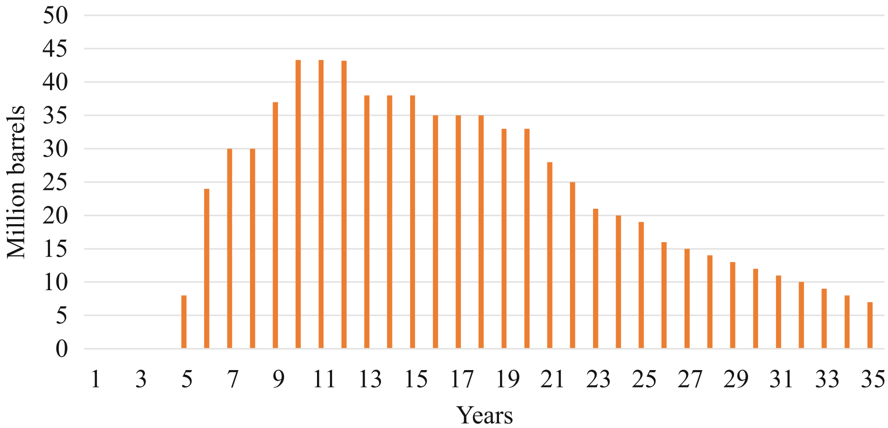

Fig. 2 Oil production profile of the Yuzhno-Messoyakhskoye field (million barrels). (Source: Compiled by the authors based on data from PJSC Lukoil. Retrieved from: https://www.lukoil.com)

Table 4 Evaluation of the economic efficiency of the Yuzhno-Messoyakhskoye field under the current economic environment

Economic figures	Units	Value
Fields square	kilometers squared	150
Project life	years	35
Exploration period	years	4
Oil price	$ per barrel	42.4
Proven oil reserves	million tons	100
	million barrels of oil equivalent	771.8
Capital expenditures	₽ billion	2537
Current operating costs	₽ billion	1439
NV (net cash flow)	₽ billion	2538
IRR	per cent	23.1
Payback period	years	10
NPV (discount 15%)	₽ billion	20,184
Payback period (discount 15%)	years	14
Cost Return Index (discount 15%)	unit	1.1
Investment Return Index (discount 15%)	unit	1.3

Source: Calculated by the authors based on data from PJSC Lukoil. Retrieved from: https://www.lukoil.com

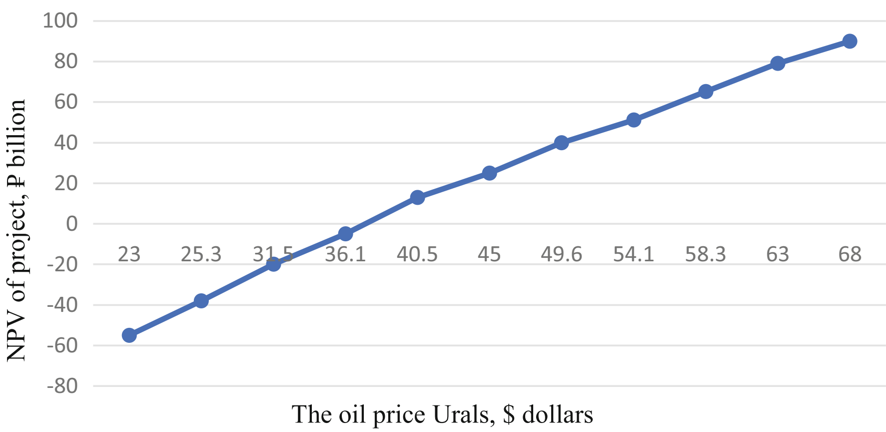

Fig. 3 The dependence of the project NPV from changes in oil prices. (Source: Calculated by the authors based on the performed analysis)

index and the net present value of returns index, respectively, are higher than 1. At this discount rate, the project pays off in 14 years.

To assess the impact of one of the most volatile parameters—oil prices—it is necessary to calculate the price deviation in the range from −50% to +50% with steps of 10%. All indicators included in the cash flow were recalculated, taking into account changes in oil prices. Figure 3 shows the dependence of changes in the NPV of an oil and gas project from the changes in oil prices.

Thus, the oil price in the range of $35–36 per barrel of Urals oil is the threshold at which the projects of the region will remain effective. At the same time, all calculations were carried out within the framework of the current tax legislation, taking into account changes related to the introduction of the tax on additional income from hydrocarbon production.

Conclusions

Within the framework of the raw materials model of the current Russian economy, this position of the resources industry strengthens the corresponding economic specialization of the territory and opens up new opportunities for its socioeconomic growth, primarily on the basis of the diversification of oil and gas production and the transportation of hydrocarbons. Under these conditions, the steady pace of development for the region's economy will be ensured, primarily through the implementation of the largest Arctic oil and gas projects, which are integrated into the Program of Integrated Development of the Yamalo-Nenets Autonomous District.

At the same time, the raw material nature of the YANAO economy makes it dependent on the prices of hydrocarbons on the global and domestic markets, as well as on the volume of supply and demand for the current and future periods. Thus, the hydrocarbon market has a significant impact on the revenues of the regional budget, constraining the opportunities for the development of social and transport infrastructure in crisis periods, which are mainly developed at the expense of budget funds and investments.

Thus, the Arctic continues to be one of the most promising regions in terms of developing Russia's oil and gas potential. At the same time, the Arctic zone, both offshore and continentally, is very capital-intensive from the point of view of the project implementation.

However, the poor development of land transport and urban, port, industrial, and other infrastructures within the studied and explored Yuzhno-Messoyakhskoye field and the adjacent territory does not allow us to fully predict the elements of the arrangement of production and the further transportation of raw materials. At the same time, it is advisable to recommend to oil and gas enterprises the choice of a cluster strategy for the development of the territory under consideration in order to obtain a synergetic effect from the joint development of the geographically close promising geological fields and to minimize overall costs.

At the same time, the importance of forming an institutional environment for increasing the attractiveness of Arctic projects from the point of view of attracting investors is on the rise.

Before the introduction of tax incentives, such Arctic projects in Russia remained unprofitable, and the taxation system was constantly undergoing changes, which mainly concerned specific fields. Such a measure as the introduction of the tax on additional income from hydrocarbon production, according to the expert community, was not effective, which was confirmed by the Russian Federation's government's plans for further reform of this area.

Calculations have shown that, at the moment, the implementation of projects is highly dependent on oil prices, which in turn have extremely high volatility. Thus, the current economic environment for the implementation of oil and gas projects in the Arctic are not sufficiently formed. If the oil price falls below $35 per barrel, oil and gas projects in the Arctic will be unprofitable.

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Russia's Arctic Oil Transportation Export Strategy

The Geographical Aspect

Tatyana I. Pototskaya and Yulia V. Gnezdova

Contents

Abstract

The work describes the results of the study of the Arctic strategy of Russia's oil exports, which is formed as a result of changes in the economic and geographical position of Russia (caused by the collapse of the USSR) and the problems of relations between the countries of the post-Soviet space. The authors understand the offshore oil transportation strategies of Russia's export as purposeful activities, intending to create a set of offshore oil terminals located on the Russian coasts as well as oil pipeline systems suitable for running only through the Russian territory so as to ensure oil export. A comparative economic and geographical analysis of Russia's existing offshore oil transportation export strategies (Baltic, Black Sea, Pacific, Arctic) is carried out. Their common features are highlighted (solving a set of tasks: they contribute to Russia's leaving the zone of influence of transit countries; they contribute to the geographical diversification of sales markets; they increase the profitability of oil exports by reducing

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transportation routes and allocating export groups of oil quality; and they stimulate the development of a new resource base for solving regional socio-economic problems), as are the distinctive features of the Arctic strategy (focus on the transportation of oil produced in the Arctic region itself; initial orientation to sea transportation of oil based on oil terminals without trunk oil pipelines; the presence of a natural resource base ensuring the functioning of oil pipelines of other maritime strategies; performing not only the oil transportation function but also the ability to stimulate the transformation of the Northern Sea Route into an international transport highway as a whole). Along with the main factors influencing the formation of the Arctic Strategy, the following constraining factors are highlighted: the stagnation of oil prices on the world market and, as a result, Russia's signing the OPEC+ Agreements aimed at reducing oil production; Russian oil companies implementing international standards that regulate the principles of sustainable development; and complex and poorly studied environmental conditions for the development of the resource base and the oil transportation region. The importance of Russia's relations with the countries of Europe, America, and the Asia-Pacific region is emphasized in this strategy.

Introduction

The Arctic Ocean is one of the most popular regions in the modern academic community. This is due to its rapid physical and geographical transformation and the resulting opportunities to use its features (from a rich natural resource potential to a favorable economic and geographical location) for the political and socio-economic development of individual countries and the world as a whole. This study focuses only on those characteristics of the region that allow us to solve particular geopolitical problems of Russia (the problems of international relations arising from certain properties of the territory). The collapse of the USSR, after which post-Soviet countries appeared, strengthened the continental position of Russia and, as a result, made its oil exports to Europe (the main trading partner) dependent on the nature of relations with transit countries through whose territories these trade operations were carried out through oil pipelines and seaports (Latvia, Lithuania, Belarus, Ukraine, etc.). The result of the desire to eliminate this dependence was a purposeful activity to create a set of offshore oil terminals located on the Russian coasts and suitable oil pipeline systems running only through the Russian territory that would provide oil exports. Therefore, offshore oil transportation strategies have been created and used for the country's oil exports: in Russia, these include the Baltic, Black Sea, Pacific, and Arctic strategies. Their composition, geographical content, and economic and geopolitical assessment are given in a number of our works (Pototskaya, 2018; Pototskaya et al., 2016).

In contrast to the above strategies, the Arctic strategy, associated with the use of the seas of the Arctic Ocean, is influenced by a larger number of factors. This study is aimed at identifying and studying their influence.

The Geographical Aspect of the Existing Arctic Transport Strategy for Russian Oil Exports

One of the main features of the strategy under consideration is its initial orientation to the sea transportation using oil terminals located along the Northern Sea Route, without using main oil pipelines (only field and inter-field). The oil is produced in the Arctic region (Table 1). For example, oil from the Peschanoozersky field is delivered to tankers via a floating oil pipeline and then delivered to Murmansk; oil from the Prirazlomnaya field is delivered via shuttle tankers to the Umba storage tanker located in the Kola Bay (Murmansk); oil from the Varknavtskoye field and the A. Titov field is delivered first to the port of Varandey and then to the Kola storage tanker located in the Kola Bay (Murmansk); and oil from the Novoportovskoye field is delivered first to the Gate of the Arctic (Cape Kamenny), then to the storage tanker Umba, which is also located in the Kola Bay (Murmansk). In 2018, the total volume

Table 1 The composition of Russia's Arctic Offshore Oil Transportation Export Strategy

Oil pipelines	Characteristics of oil pipelines	Oil export port	Resource base	Commissioning
		Murmansk	Peschanoozerskoye	1986
		Murmansk	Prirazlomnaya	2013
Southern Khylchuyu-Varandey	158 km, 4 million tons.	Varandey-Murmansk	Varknavtskoye field, named after A. Titov	2014
The New Port-Gates of the Arctic	100 km, 600 thousand tons.	Gates of the Arctic (Cape Kamenny)-Murmansk	Novoportovskoye	2016
Nyuksenitsa-Vitino-Murmansk	3,600 km, 80 million tons.	Murmansk	Timan-Pechora oil and gas province	Project
Usinsk-Murmansk	2,500 km, 80 million tons.	Murmansk		
Haryaga-Indiga	419 km, 12 million tons.	Indiga		
Purpe-Salekhard-Belusha Lip	1950 km, 50 million tons.	Belusha lip	West Siberian Oil and Gas province	Project
Zapolyarye-Tabede Yakha	400 km. (without the underwater part), 35–40 million tons.	Sabetta		
Payakhskoye field-the port of the Bay of the North	413 km, 25–115 million tons.	North Bay (Taimyr Peninsula)	West Siberian oil and gas province, Yenisei-Khatanga oil and gas region	2024–2030

Sources: Rosneft (https://www.rosneft.ru/), Transneft (https://www.transneft.ru/), The Investment portal of the Arctic zone of Russia (https://arctic-russia.ru/).

of oil exports along the listed sea routes amounted to about 17 million tons, including 30 thousand tons from Peschanoozersky, 3.2 million tons from Prirazlomnaya, 6.6 million tons from Varknavtsky and A. Titov field, and 7 million tons from Novoportovsky (Oilcapital 2019). This is 4–5 times less than in other implemented strategies (104 million tons in the Baltic, 98 million tons in the Black Sea, and 72 million tons in the Pacific). Oil is mainly exported from these fields to the Netherlands, Belgium, and Norway, which is due to the logistical availability of the region and the presence of refineries specializing in the processing of various grades of oil produced in the Russian sector of the Arctic.

The Natural Resource Base of Russia's Arctic Oil Transportation Export Strategy

At the same time, the continental fields of this region located in the Timan-Pechora oil and gas province (Bagan, Vostochno-Veyak, Veyakoshor, Srednemakarikhin, Sandivey, Salyukin, Nyadeyu, Khasyreyskoye, Cherpayu, Osoveyskoye, Labaganskoye, Naulskoye, etc.) are the resource base for the oil pipeline system that is part of another offshore strategy (the Baltic Pipeline System 1, or BTS-1). The fields of this region located in the West Siberian oil and gas province (Urengoy Group, Suzunskoye, Tagulskoye, Russkoye, Russko-Rechenskoye, Messoyakhskoye, and Vostochno-Messoyakhskoye, Pyakyakhinskoye, etc.) are the resource base for the oil pipelines that are part of the Black Sea Strategy (the Caspian Pipeline Consortium (CPC) oil pipeline) and the Pacific Strategy (Eastern Siberia-Pacific Ocean (ESPO). This feature can be used to redistribute ("transfer") the export flows of Russian oil from one region to another (if Russia's relations with the countries of one of the importing regions – Europe, the Asia-Pacific region – are complicated). However, this can be done only if all the listed oil pipeline strategies (Baltic, Pacific, Arctic) are connected (but they are not) and the oil pipelines that form them have equal capacity.

The Geographical Aspect of the Promising Part of the Arctic Transport Strategy for Russian Oil Exports

The desire to create transport connectivity of the existing oil pipeline strategies, in turn, generates ideas for creating new oil pipeline projects that compete with each other in terms of possible routes for transporting export oil through the ports of the Arctic Ocean (Bambulyak & Frantsen, 2019). They are based on oil fields that are already being developed, start at the existing export trunk oil pipelines, and end at one of the existing oil terminals located along the Northern Sea Route.

For example, the project of *the Murmansk oil pipeline*, which connects the oil fields of the West Siberian and Timan-Pechora oil and gas provinces with the port of Murmansk, involves two routes: the southern (around the White Sea: Nyuksenitsa-Vitino-Murmansk) and the northern one (along the bottom of the White Sea: Usinsk-Murmansk). The advantages of this project include such an aspect as the ability of Murmansk to accept supertankers, which is associated with the deepwater and ice-free water area of the port. This, in turn, determines the profitability of oil transportation over long distances up to North and South America (today, this is one of the least developed areas of Russian oil exports, comprising about 1%). Moreover, this eliminates such a disadvantage of Russia's Baltic and Black Sea oil transportation strategies as a dependence of Russian oil exports on the countries through whose territorial waters cargo is transported (the Danish Straits-Denmark, Sweden; the Bosphorus, the Dardanelles-Turkey).

At the same time, given the length of the Murmansk oil pipeline (2500–3500 km) and the inability to ensure its full loading (80 million tons), a shorter route (419 km) was proposed with smaller volumes of transported oil (12 million tons) that allows separate pumping of the extracted oil: It is the oil pipeline *Haryaga-Indiga*. However, the insufficient depth of the water area at the port of Indiga, combined with its freezing, limits the possibility of receiving large-capacity tankers, which ultimately did not allow the implementation of this project.

As an alternative to Murmansk and, accordingly, the Murmansk Oil Pipeline, the possibility of building the Belushya Guba port on Novaya Zemlya and bringing the *Purpe-Salekhard-Belushya Guba* oil pipeline to it was considered (Shumovskiy, 2011). Arguing the feasibility of implementing this project, they noted, on the one hand, the depth of the water area and a favorable ice regime that guarantees year-round navigation, and on the other hand, the shorter pipeline component and the lower cost of oil delivery compared to other pipelines transporting oil to Europe through ports (BTS-1, BTS-2, project Murmansk).

In turn, the completion of the Zapolyarye-Purpe oil pipeline, which provides oil to the ESPO and CPC oil pipelines, and the construction of the Sabetta seaport, focused on the shipment of liquefied gas produced at the Yamal LNG plant, gave birth to the idea of building the *Zapolyarye-Tabede Yaha*. It can connect the oil fields being developed on the right bank of the Gulf of Ob with the seaport of Sabetta, located on its left bank. At the same time, it was assumed that this oil pipeline would be filled with oil from the Zapolyarye-Purpe oil pipeline operating in reverse mode, which would deprive the ESPO of part of the resource base. The high cost of the project, combined with the lack of excess oil produced, acted as constraining factors.

It is not surprising that the intersection of different offshore oil transportation export strategies on the same territory and the associated potential interchangeability of oil pipelines provoked a discussion about the profitability of different logistics schemes that ensure the export of Russian oil to Europe.

The Development of Russia's Arctic Oil Export Strategy Under the Influence of Market Diversification

The complicated political and, as a result, economic relations between Russia and the EU/US determined restrictive measures against Russian businesses (including energy exports to Europe), which prompted Russia to take actions to geographically diversify sales markets (including oil) and enter the markets of the Asia-Pacific countries (China, the Republic of Korea, Japan, etc.). This not only stimulated the formation of the Pacific Oil Transportation Strategy for Oil Exports (Baklanov et al., 2018) but also, in the context under study, initiated the study of the Northern Sea Route that could be used for these purposes. Taking into account the growing interest of the Asia-Pacific countries in the Northern Sea Route to reduce transport costs of trade with European countries, ideas (with varying degrees of economic and technological validity) for creating new oil transportation routes in the Arctic Ocean that can combine the possibility of implementing both groups of interests (Russian – in the transportation of oil in the East; foreign – in the transportation of goods in the West) were considered.

One of the types of such projects involves replacing the storage tankers collecting oil from Arctic fields in the west of the Arctic Ocean in the Belushya Guba bay (Novaya Zemlya Archipelago) and in the east in the Bay of Providence (Anadyr Bay), followed by transporting oil on shuttle tankers in ice conditions and outside the zone of ice on tankers-transporters to the end consumer. At the same time, tankers must combine the functions of a tanker and a container ship to move liquid cargo in one direction (in the eastern direction) and containers when moving in the opposite direction (in the western direction). It is proposed to organize oil refining on the board of tankers to increase the efficiency of this scheme. However, the authors of the project set the task of finding ways to improve the use of the Northern Sea Route for cargo transportation in general. In this regard, the project does not contain a pipeline component, focusing, perhaps, on the transportation of oil only from offshore fields.

At the same time, active geological exploration activities in the Krasnoyarsk Kray revealed several oil and gas fields with significant reserves, which allowed us to develop and start implementing the project for creating the *Vostok Oil* Arctic cluster. It involves the development of the fields of the Vankor cluster (Vankor, Suzun, Lodochnoye, Tagul, Ichemminskoye), Payakh fields, the West-Irkinsky section, and the fields of the East-Taimyr cluster with the subsequent transportation of the extracted oil along the Northern Sea Route, both to Europe and to the Asia-Pacific region. Leaving aside the characteristics of this project, its economic justification, and the impact on the development of the territory, we will note only the aspects indicating that the project can become not only part of the Arctic oil transportation strategy of Russia's export but also its essence. An oil loading terminal "Port Bukhta Sever" should be built on the eastern shore of the Yenisei Bay based on the expanding seaport of Dixon and an oil pipeline with a length of 770 km, of which 413 km will be on the segment from the Payakh group of fields to the port. The potential of the oil supply volume is estimated at 25 million tons in 2024, 50 million tons in 2027, and up to 115 million tons by 2030.

In the context of the topic under study, it is obvious that this project will allow the Arctic Oil Transportation Strategy of Russia's exports to take a leading place among other maritime strategies of the country.

Constraints on the Development of Russia's Arctic Oil Export Strategy

At the same time, the prospective increase in oil production and, accordingly, oil exports, which the strategy is focused on, raises some questions related to the signing by Russia of the OPEC+ Agreements (2016–2022) aimed at reducing oil production to coordinate price policy on the world oil market. The discovery of new oil fields in Russia can only increase oil production/export volumes in the long term. This means that there is a need to use new oil pipelines for its transportation.

Moreover, since the strategy under consideration is based on the resources of its region, many scientists, noting that dangerous processes and phenomena in it are underexplored, express concerns about plans for large-scale development of the Arctic at this stage.

A limiting factor in the formation of the Arctic Oil Transportation strategy is Russian oil companies implementing the international standards regulating the principles of sustainable development of companies (Slavinskiy et al., 2015), which provide them with competitive advantages when establishing relations with foreign partners. This improves the environmental and social situation in the territories of oil production and transportation. However, the containment of the increase in the business' resource intensity and the simultaneous increase in the cost of its management leads to the production of goods/services that are not competitive in price (in the context of the world economy globalization). Only the transition of companies to the production of goods/services with higher added value – in the context of the topic under study, this is the production of petroleum products, the use of more technologically advanced means of transporting oil along the Northern Sea Route, up to airships (Turenko, 2020) – and deglobalization, the signs of which are more and more noticeable today, can make the project of the Arctic oil transportation strategy of Russia's export profitable in the long term.

Conclusions

All in all, we can say that, firstly, the Arctic strategy of the oil export of Russia, as well as other maritime strategies (Baltic, Black Sea, Pacific), solves a set of tasks: promotes Russia's exit from the zone of influence of transit countries, promotes the geographical diversification of the sales markets, increases the profitability of oil exports by reducing transportation routes and allocating export groups of oil quality, and stimulates the development of a new resource base for solving regional socio-economic problems.

Secondly, the strategy under consideration has some unique features: It focuses on the transportation of oil produced in the Arctic region itself; it is initially focused on the sea transportation of oil based on oil terminals without involving main oil pipelines; there is a natural resource base that ensures the functioning of oil pipelines of other marine strategies which creates both conditions for competition and interchangeability the foreign policy (foreign economic) conjuncture changes; it is considered not only in the context of oil transportation but also as a powerful impetus to the transformation of the Northern Sea Route to the international transport highway.

Thirdly, the constraining factors of its formation include the stagnation of oil prices on the world market and, as a result, the signing by Russia of OPEC+ Agreements aimed at reducing oil production, the implementation by Russian oil companies of international standards regulating the principles of sustainable development of companies, and complex and poorly studied environmental conditions for the development of the resource base and the oil transportation region.

It is obvious that the main factor influencing the formation of offshore oil transportation strategies for Russia's exports in general, and the Arctic strategy in particular, is the geographical location of the country and the associated nature of relations with neighboring countries, which emphasizes the geopolitical nature of the phenomenon under consideration. The use of offshore oil transportation strategies makes it possible to reduce the impact of negative relations between countries on oil exports, making it more stable in conditions of changing political relations.

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Part V

Agriculture and Fishery

Food Systems in the Arctic

Inclusiveness and Traditionalism

Lilia S. Revenko and Olga I. Soldatenkova

Contents

Abstract

One of the key tasks of the world society, declared by the United Nations in the last decades, is to ensure the effective functioning of food systems to achieve the Sustainable Development Goals in order to eliminate hunger in the world. In the context of the global problems being solved at the present stage, a revision of approaches to the main definitions and performance indicators of the world food system is underway. One of the most important areas is to ensure the inclusiveness of food systems supported by the widespread use of innovative solutions in production, distribution, and consumption of food.

The Arctic is an extremely vulnerable region in the context of providing food for the indigenous population, residents of different types of settlements, and employees of enterprises working on a temporary basis.

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The Arctic countries (Denmark, Canada, Norway, Russia, and the USA) are characterized by a rather complex picture of food systems. Their primary classification can be carried out according to the level of economic development.

Speaking of the Arctic zone, there are systems in each country of the region typical to the pre-industrial forms of production and highly developed industrial production. The Arctic food systems are also heterogeneous in terms of food preferences of population, food security in a country, the level of state regulation, and other indicators.

Keywords

Arctic · Food systems · Inclusiveness of systems · Food security · Public policy · Indigenous peoples

Introduction

Nowadays, the most important global problem is the provision of the world's population with food. The long-term efforts of the world community aimed at solving it still have not yielded the desired result; hunger and malnutrition have not been eliminated yet. In this regard, the United Nations has set the task of transforming the world food system as a whole and its constituent elements in order to reverse the situation. As part of these efforts and in line with the implementation of the Sustainable Development Goals (SDGs), the United Nations conducted the Food Systems Summit in September 2021. The main purpose of focusing efforts might be to increase the efficiency of the functioning of the world food system, since the achievement of SDG-2 with the target to end hunger in the world is assessed as unreachable at the present stage. The situation was aggravated by the COVID-19 pandemic that added an additional 132 million to the number of hungry people. At the same time, 12% of the produced food is lost, and 17% is spoiled (FAO, 2021).

The extensive discussion of this global problem by the world community revealed a tendency towards a conceptual rethinking of categories, definitions, trends, and practical ways of solving food supply problems (Revenko, 2021, p. 214). The set of the developed concepts allows us to speak of developing a new paradigm for the modern food systems. One of the central places in this paradigm is the justification of the need to improve inclusive food systems based on their individual characteristics.

The Arctic, as a geographic region with extremely difficult circumstances of life and economic activity, has always had special conditions for providing the population with food, and these conditions differ depending on the type of society, the nature of the population's production activities, and natural opportunities for self-sufficiency. The mixed picture of the forms and methods of food supply makes it possible to distinguish several types of inclusive Arctic food systems.

Literature Review

Modern scientific and practical literature provides with a comprehensive bibliography on the transformation of food systems and the problems of providing food to the population of the Arctic countries. The authors of this chapter focused on studies that allow assessing the peculiarities of the development of the Arctic region's food systems taking into account their inclusiveness and traditionalism.

In the context of the characteristics of the Arctic region's food systems, the results of the research project "The Arctic as a Food-Producing Region," carried out in 2016 under the patronage of the Arctic Council' Sustainable Development Working Group, are of interest. A group of scientists from Iceland, Norway, Canada, Greenland, and Russia conducted an analysis of food production in these countries and assessed the potential for increasing production and the food added value produced in the Arctic (Arctic Council, 2019).

The study of current problems of food security in the circumpolar region conducted by a group of scientists (Hossain et al., 2020) is also of particular interest. The distinctive feature of this work is that the problems of food security, sustainability, sovereignty, and supply chains in the Arctic are studied with a focus on the indigenous peoples. Offering interdisciplinary ideas, the study highlights the importance of traditional food products to meet the dietary needs of the local and indigenous peoples. Food security issues and regional cooperation to ensure food security in the European region, including the Arctic countries, are considered in the work of L.S. Revenko, O. I. Panteleeva, and T.M. Isachenko (2019). The authors admit that despite the indisputable importance of cooperation at the international level, efforts at the regional level are the most effective in practical terms due to the geographical, natural, cultural, and industrial closeness of the countries in the region.

The processes associated with global climate change are the most clearly embodied in the Arctic and have a multidirectional impact on the region's food systems. Any serious food security crisis in the region will affect not only one sector but many other areas such as public health, social and economic development, environment, and policy. The issues of managing the food crisis in the Arctic are practically not considered in the contemporary scientific literature. In this regard, the research of C. Pursiainen (2020) should be mentioned. The author considers three possible scenarios for a food crisis in the Arctic in case of radiation precipitation and radiation pollution, possible epidemics of animal diseases, and the negative impact of oil spills on fisheries.

Inclusiveness of food systems implies the involvement of all groups of the population who are not only food consumers but also can actively participate in the functioning of these systems through the development of their own businesses. From this point of view, the attention should be paid to the work of S. Johansen (2014) on the sustainable development of small businesses, particularly food producers and distributors, in the Arctic countries. The author notes that small local businesses are more likely to be interested in environmentally and socially sustainable practices due to their links to the local communities and physical location. The main factor in increasing the sustainability of small- and medium-sized businesses is the evolution of the related knowledge among management dealing with strategy's development and organizational structure of the northern enterprises.

The subject of the research study "Arctic Policies and Strategies – Analysis, Synthesis, and Trends" is the policies, strategies, and statements of the Arctic states and observer states of the Arctic Council, as well as organizations of the Arctic indigenous peoples (Heininen et al., 2020). Interestingly, food security is generally not the focus of programs. It is surprising since access to quality and safe food is an integral part of the health condition and well-being of the local population.

A number of studies are devoted to various aspects of the functioning of the Arctic food systems and ensuring food security in the Arctic countries. Using the example of Northern Canada, where the indigenous peoples experience food insecurity more than twice as often as all Canadian households, D. Islam and F. Berkes (2016) propose an integrated approach to assessing food security, through the lens of local fisheries, both commercial and subsistence, of the northern indigenous communities. Any unexpected changes, for example, in hydrology due to climate warming and permafrost melting, can significantly complicate the already difficult conditions for the "natural" way of life of the indigenous peoples. The impact of the changing Arctic climate on food and water security has been studied by a group of researchers at the University of Alaska Fairbanks (White et al., 2007). N. Carlo examines the creation of a monitoring system for the Arctic in a changing climate from the point of view of the involvement of the indigenous peoples. He notes that the understanding of the Arctic environment and the cultural heritage of the indigenous peoples will lead to a broader and stronger monitoring system for the Arctic (Carlo, 2020).

Various aspects of the current state of food systems in the Russian Arctic zone have been examined by several groups of Russian researchers. The study of the scientists from the Northern (Arctic) Federal University on food security of the indigenous peoples of the Arctic zone of Western Siberia is of particular interest. It contains a comprehensive analysis of the impact of socioeconomic and environmental risks on food security and food independence, the quality of life of the indigenous peoples in the context of transformation of traditional lifestyles, climate change, and industrial development of the Arctic (Andronov et al., 2020). Among other factors, the authors consider the impact of climate change and the changes in the diet on the health of the indigenous population.

In the study within the framework of the project "Arctic Specifics of Food Supply and Development of Agriculture of the European Northeast of Russia," V.A. Ivanov and E.V. Ivanova indicated the focal points of increasing the level of food self-sufficiency for the population of the territories under study: the increase in the production of local agricultural products, the creation of rear food bases, and the delivery of food from the main agricultural regions of Russia (Ivanov & Ivanova, 2017).

A group of scientists from the Institute of Economics of the Ural Branch of the Russian Academy of Sciences has justified the need to form a model of an agro-innovation system to provide food for the Arctic population. According to the authors, such a system will make it possible to form and distribute food flows based on forecasting the food demand and the development of an entrepreneurial sector from agricultural producers and food distributors, as well as the food distribution infrastructure (Tatarkin, 2015; Tatarkin et al., 2015).

The problem of developing transport infrastructure to provide the population of the Arctic zone with food has been raised in several studies. For example, the study of S.N. Polbitsyn, V.V. Drokin, and A.S. Zhuravlev focuses on the model of centralized food supply for the population of the Russian Arctic regions. The authors conclude that it is necessary to develop a logistic form of food supply based on the import of most of the food and on the organization of uninterrupted transportation of food, in particular, the so-called "northern delivery" (Polbitsyn et al., 2012). The problems of providing the Russian northern regions' population with food, taking into account the insufficient transport infrastructure for the year-round delivery of perishable goods, are considered by I.O. Poleshkina. The author concludes that the development of multimodal delivery methods using small aircraft is the optimal way to deliver perishable food products to the settlements in the Arctic zone of Russia (Poleshkina, 2018).

The issues of the modern food systems' innovative development are considered in the works of L.S. Revenko (Revenko & Revenko, 2019a, b). In particular, she notes that digital platforms allow entities from various food systems, including the inclusive ones, to integrate into the global trade system.

The authors of this work have used the materials of the Food and Agriculture Organization of the United Nations (FAO), the Organization for Economic Cooperation and Development (OECD), the Arctic Council, and the Arctic Economic Council while carrying out the study.

Food Systems of the World: Current Transformation Tracks

Throughout all stages of solving the food problem, there was no uniform understanding of the concept and category of the "world food system," but in a broad sense, it is understood as a four-level system of industries for production and distribution of food products. In the twenty-first century, there has been a pronounced evolution of both the concept of food system itself and its individual elements. During the preparation process for the Food Systems Summit 2021, the United Nations and other international organizations designed a new approach to the development of the world food system, which consists of an integrated impact on the system to achieve progress in food security, farm efficiency, and environmental sustainability simultaneously.

The United Nations defined the food system as follows: "Food systems represent the entire range of actors, activities and the biophysical and socio-economic environments involved in producing, processing, distributing, regulating and consuming foods" (United Nations, 2020). According to the FAO definition, "Food systems encompass the entire range of actors and their interlinked value-adding activities involved in the production, aggregation, processing, distribution, consumption and disposal of food products that originate from agriculture, forestry or fishery, and parts of the broader economic, social and natural environments in which they are embedded" (FAO, 2018, p. 1).

The High-Level Panel of Experts of the Committee on World Food Security "identified three interacting elements of food systems, i.e. food supply chains, food environments and consumer behaviour." At the same time, they highlighted "the central role of the food environment in facilitating healthy and sustainable consumer food choices." The food environment is defined as "the physical, economic, political and socio-cultural context in which each consumer engages with the food system" (HLPE, 2017, p. 9). In turn, the OECD defines that the food system includes "all the elements and activities related to producing and consuming food, and their effects, including economic, health, and environmental outcomes" (OECD, 2021b).

No matter how diverse the interpretations of food systems and conceptual approaches to their structure and interaction of elements are, it cannot be denied that, as before, various industries, subjects, and institutions are involved in the process of providing food. They function simultaneously in different environments – natural, resource, market, institutional, political, cultural, and religious. All changes in these environments affect the food system as a whole and its parts.

The existence of new interpretations of the world food system's category can be explained by the desire to justify the complex nature of the impact on its main elements in order to achieve progress in food security, farm efficiency, and environmental sustainability simultaneously (OECD, 2021a). Accordingly, the concept of transformation of the world food system is the development and justification of an effective set of measures in production, processing, transshipment, storage, distribution, marketing, access, procurement, consumption, prevention of loss, and waste of food products. The expected results of the world food system's transformation are focused on the economic, social, and environmental dimensions.

Over the past decade, the specialized institutions of the UN system, research groups, and the business community have been paying increasing attention to the inclusiveness of food systems. The need of it has been evident especially during the COVID-19 pandemic. Thus, the annual report of the International Food Policy Research Institute in 2020 is devoted to the creation of inclusive food systems that will allow the most vulnerable groups of the population to expand opportunities for participation in food value chains. The inclusiveness of food systems implies ensuring access of all people, especially socially and economically disadvantaged individuals and social groups, to affordable, safe, and nutritious food, as well as enabling everyone to enjoy their economic benefits equitably (IFPRI, 2020).

The key element of the new approaches to the food system is "transformation to increase sustainability." Sharing these views as a whole, the authors are aware that changes in the nature of relationships between counterparties, especially under the impact of innovations, can also carry serious social, economic, and gender risks. For some food systems, transformation, especially based on disruptive technologies, may carry additional risks associated with a change in the nature of employment, "blurring" traditional food consumption patterns and eliminating local crafts and industries. Schemes of integration into food chains that are attractive for some businesses, for example, through digital platforms (Revenko, 2021, p. 214), can deprive entire groups of small entrepreneurs of business prospects in the food sector at the global and national levels.

Food Systems of the Arctic Countries

The food systems of the Arctic countries are very diverse, despite some common features of economic activity, due to the natural and climate conditions of the region and the history of its development. Food is produced both for local consumption and for national and foreign markets. Fishing and aquaculture in the Arctic countries are the large-scale export-oriented industries in most cases. The agriculture is much less developed compared to the southern regions of the Arctic countries.

Besides traditional agriculture, the other branches of rural economy in the Arctic are hunting, gathering, and tourism, which also impose their features on the food systems of the Arctic countries. Some regions have the potential to better use and increase the added value of these branches in a more efficient manner. All of the Arctic countries produce raw agricultural materials as well as niche products with high added value for both local and international markets (Elde et al., 2018, p. 6).

The typology of food systems in the Arctic countries is multilayered, and systems can be classified according to the following characteristics (Table 1).

Every food system functions to ensure the food security of the population. The authors adhere to the definition of the Committee on World Food Security: “Food and nutrition security exists when all people at all times have physical, social and economic access to food of sufficient quantity and quality in terms of variety, diversity, nutrient content and safety to meet their dietary needs and food preferences for an active and healthy life, coupled with a sanitary environment, adequate health, education and care” (CFS, 2012, p. 7). However, the features of the food systems of the Arctic region make it necessary to include in this concept the preservation of knowledge of the indigenous peoples, which are associated with traditional methods of harvesting and processing food, as well as knowledge of the weather and navigation through the landscape.

Speaking of the safety and quality of food, the peculiarities of the nutrition of the peoples in the Arctic need to be taken into account: even high-quality imported goods can disrupt the balance of nutrients that are necessary to maintain the body in harsh climate conditions. Environmental pollution, including the increased radioactivity of marine mammals, plays a significant role in the increasing disease rate among the indigenous population (Elde et al., 2018, p. 5).

Although all the Arctic states belong to countries with a high food security index (Table 2), the food security level in the territories of the Arctic zone may differ significantly from the one in the whole country. At the same time, currently there is no comprehensive study of food security in the Arctic countries.

Speaking of the general features of the food systems of the Arctic countries (Denmark, Canada, Norway, Russia, and the USA), it needs to be mentioned that not all of their territories belong to the Arctic zone. Alaska State is in the Arctic zone of the USA; the northernmost provinces (Yukon, Labrador, and the northern part of

Table 1 Classifications of food systems of the Arctic countries

The main classification feature	Type of food system
The level of diversification of food produced and consumed	Closed, highly specialized, based on a limited number of types of products Highly specialized in the production of one or more types of food, but universal in consumption (depending on the possibility of food delivery) Widely diversified in the production and consumption of food types
The degree of territorial localization of communities that produce and consume food	Food system of indigenous communities that are traditionally remote from transport routes and infrastructure Food system of settlements with a mixed population composition according to the type of migration Food system of settlements around objects of industrial activity with a temporary visiting population
Basic production	Oceanic (products of fishing, aquaculture, whaling) Reindeer herding Hunting All three, supplemented with objects of collecting wild plants Classic agricultural products In high-tech enterprises for producing various crops
Degree of involvement in global value chains	With a relatively high degree of involvement in global chains due to a production base focused on other regions for processing local food raw materials With occasional involvement in global chains; it is based on the implementation of mainly cross-border projects With a zero degree of involvement due to the remoteness and lack of appropriate traditions and mentality
By the degree of inclusiveness	With a low degree of inclusiveness characterized by a low involvement of the indigenous population in providing food to the entire population of the territory, as well as the presence of population groups with limited access to food With an average degree of inclusiveness, characterized by the involvement of the indigenous population in providing food to the population of the territory and the presence of groups with an insufficient level of food supply With a high degree of inclusiveness, characterized by the involvement of the indigenous and local population in providing food to the population of the territory in an amount and quality sufficient to lead a healthy lifestyle and maintain working capacity

Source: Compiled by the authors

Quebec), the Northwest Territories, and the territory of Nunavut are in the Canadian Arctic zone. The districts of Nordland and Troms og Finnmark belong to Northern Norway; the Arctic zone of the Kingdom of Denmark includes the Faroe Islands and Greenland. The Russian Arctic zone includes the Murmansk Region; the Chukotka, Yamalo-Nenets, and Nenets Autonomous Districts; parts of the territories of the Republics of Karelia, Komi, and Sakha-Yakutia; the Krasnoyarsk Territory; and the Arkhangelsk Region.

Table 2 Global Food Security Index in the countries of the Arctic region in 2020[a]

Country	Global Food Security Index	Accessibility	Availability	Quality and safety	Natural resources and sustainability
Denmark	76.6	92.2	64.1	89.7	57.6
Norway	76.2	81.1	65.0	90.6	73.5
Canada	77.2	85.3	72.0	94.5	54.5
Russia	73.7	87.2	64.7	84.1	55.0
USA	77.5	87.8	72.2	94.3	51.4

Source: Compiled by the authors using Global Food Security Index 2020. The Economist Intelligence Unit. Retrieved from: https://foodsecurityindex.eiu.com/

[a]The Global Food Security Index has been calculated since 2012 on 59 indicators that characterize the level of accessibility and consumption of food, its availability and sufficiency, quality, and safety. It is published by the Economist Intelligence Unit with the support of the American multinational company DuPont

Although these areas of the Arctic countries are characterized by severe natural conditions and have many similar socioeconomic problems, there are many interregional and intraregional differences (e.g., in microclimate, soil composition, duration of the growing season, choice of crops or varieties, infrastructure, markets and economy). The history of development, food policy, food security, and food self-sufficiency of the countries make up these regions also differ (Stevenson et al., 2014, p. 283).

The following can be distinguished as general characteristics of the food systems in the Arctic countries:

1. Low availability of locally produced food due to extreme natural and climate conditions and dependence on the import of food from the southern regions of the country or from abroad. The leader in food self-sufficiency in the Arctic region is Denmark, where food exports exceed imports by two or three times and self-sufficiency in meat and dairy products exceeds 100%. In Norway, the food self-sufficiency rate has been relatively stable at about 50% over the past 50 years (Stevenson et al., 2014, p. 273).

Most states of the USA maintain a reasonable balance between locally produced products and imported and exported food. In Alaska it is estimated that local agricultural products account for only about 5% or less of food demand, and the remaining 95% or more are imported (Stevenson et al., 2014, p. 272). The remoteness of Alaska from the rest of the USA means that it is thousands of miles far from the main part of the country's food reserves and, in case of a food crisis, the population of Alaska will be vulnerable. Rural residents are at the very end of the supply chain, although they tend to be less dependent on imported food than urban residents. At the same time, the urban population of Alaska, living closer to the main transport hubs, can get physical access to food faster than rural residents. The transportation network, needed to meet the most basic food needs of Alaskans, includes several thousand miles by air, sea, and land. Although this allows to provide the population of Alaska with food, fuel prices have a significant impact on food prices (Stevenson et al., 2014, p. 272).

Access to food in some areas of Greenland (especially in the capital and major cities) is largely dependent on imports, mainly from Iceland and Denmark. A significant problem related to food production and distribution is the lack of land transport infrastructure. In Greenland, there are no roads connecting cities and towns; therefore, all goods are transported by sea or by air (Elde et al., 2018, p. 5).

In most northern regions of Russia, more than 80% of total food consumption is delivered from other regions of the country (Poleshkina, 2018, p. 826). The average delivery time, for example, to the territory of the Republic of Sakha-Yakutia, can vary from 220 to 260 days, and it exceeds 365 days for several northern regions (Poleshkina, 2018, p. 829). Cargo delivery in the republic has a complex structure and is carried out mainly by water transport. Rivers become the main transport ways during the navigation period; the duration of navigation on rivers is 110–160 days. A significant amount of food delivery is carried out by temporary winter roads, the operation of which depends on weather conditions and ranges from 120 to 210 days (Polbitsyn et al., 2012, p. 6). Food delivery schemes differ for each territory of the Russian Arctic zone and depend on the availability of transport and storage infrastructure.

Limited transport and storage infrastructure as well as long distances between settlements complicate the conditions for agricultural production and restrict access to production resources and markets.

2. Coastal or marine fishing and aquaculture play an important role in the household economy and food security in the Arctic. The long coastal zone and climate conditions of the Arctic countries are favorable for fishing and aquaculture, whose products are not only sold within the country but also exported. For example, in recent decades, Norway has become the largest producer of salmon in the world. According to some estimates, 95% of Norwegian seafood is exported to more than 140 countries around the world (Elde et al., 2018). Alaska's export value of fish products exceeded $11 billion from 2012 to 2016 to 65 countries (Arctic Council, 2019, p. 7). Fishing and aquaculture are also developed in Northern Canada. In 2016, Canada exported over 75 million kg of marine foods from the Arctic and more than $66.6 million worth of seal products to 48 countries from 2005 to 2014 (Arctic Council, 2019, p. 1). Fishing and the production of fish products is one of the most important sectors of the economy of the Far North of Russia. In 2020, 492 thousand tonnes of fish were caught in the Northern Basin (Fishretail, 2021).

The fishing industry is the largest sector of the Greenland economy, and 90% of the country's exports is fish. Fishing is carried out both in the coastal zone and in the open sea. The sea catch is processed onboard and sent directly for export through Denmark, and the coastal catch is unloaded and processed in Greenland at local factories. The fishing of Polar Prawn, Greenland halibut, and other species is regulated by the quota and licensing rules established by the Government on the recommendation of the Greenland Institute of Natural Resources (Elde et al., 2018, p. 4).

Whaling and the consumption of products made from whales play a significant role in the oceanic food system of the Arctic countries. The activities permitted by the International Convention for the Regulation of Whaling include commercial fishing (conducted by Norway and Iceland), aboriginal fishing to meet the nutritional needs of indigenous communities (Chukotka, Russia; Greenland, Denmark; Alaska and Saint Vincent and the Grenadines, the USA), and scientific fishing. The topic of whale fishing is very controversial in the ecological context and in terms of preserving the living resources of the ocean, but whale fishing is the basis of life and physical survival for some indigenous communities in the Far North.

3. The food systems of the Arctic countries are presented by a combination of the traditional for this area food systems formed under the influence of the indigenous culture and the food systems traditional for agriculture of the Arctic region. In addition to fishing and aquaculture, pasture animal husbandry, hunting, and gathering are developed in most countries of the region. Crop production is insignificant.

In Northern Norway, the main agricultural production is grass-based animal husbandry, sheep and goat breeding. The main advantages of meat producers in Northern Norway are the high degree of animal welfare and disease control, as well as low use of antibiotics (Elde et al., 2018, p. 61). The development of reindeer husbandry in Norway is closely connected with culture and heritage of the Sami. Only persons of Sami origin can own reindeer, and this right is protected by law (Arctic Council, 2019, p. 11).

Despite the harsh natural conditions in Alaska, farmers manage to grow vegetables and raise cattle in the south of the state on the Kenai Peninsula and the Matanuska Valley. The reindeer husbandry is well developed in the western part of the state. In addition, more and more Alaskans have started farming in recent decades. The number of small agricultural farms increased by 67% from 2002 to 2012 with a significant increase in direct sales of products to local residents. Local farmers often indicate climate change and cheaper technologies as the main reasons for this trend. On the one hand, climate warming has provoked drastic changes in the local ecosystem, but on the other hand, plants that could not survive before are now successfully growing there (Proposition, 2017).

The northern regions of Canada, which occupy 70% of the country's territory and are rich in natural resources, are home to less than 1.5% of the country's population. These are mainly indigenous peoples as well as visiting residents of small settlements near the mines. All major Canadian cities with developed industries and almost all agricultural land in the country are located in a strip stretching from east to west within 160 km from the border with the USA (Cherkasov, 2005). In the north of Canada, animal husbandry and fishing are the most developed. Activities such as hunting, fishing, trapping, and gathering wild plants have been part of the way of life of the indigenous peoples, Metis and Inuit, for thousands of years. This practice has persisted despite the effects of colonization and is essential for enhancing cultural identity and meeting the nutritional needs of the local population as well as the local economy. Under two-thirds (65%) of Inuit in Inuit Nunangat participated in hunting, fishing, or trapping in 2017 (Statistics Canada, 2021). The western Arctic zone of Canada near Sachs Harbor and Holman is known for the commercial harvest of muskoxen to obtain meat, hides, wool, and horns. Northern communities sell these products to the markets of southern Canada. In addition, muskoxen attract tourists, which is also a source of income for the northern communities (Arctic Council, 2019, p. 11).

The Russian Arctic in the context of the inclusiveness of food systems can be conditionally divided into two parts: European and Asian. The Russian European Arctic is the most economically developed, which can be explained by the earlier widespread settlement of these territories. The traditional agriculture of the Russian population has existed there historically as the main independent type of activity. The higher population density, the level of the territories' economic development, and the transport accessibility of the main economic centers of the Russian European part have predetermined a higher level of agricultural development in this part of the Russian Arctic compared to the Asian part. The commodity basis of the food systems of the Russian European North includes dairy and beef cattle breeding, fur breeding, reindeer breeding, potato, vegetables, and fodder production.

The permanent Russian population and settlements in the Asian part of the Russian Arctic appeared only at the beginning of the twentieth century. Before that, the Asian part was inhabited by the indigenous peoples of the North who carried out their activities to provide food in these territories (reindeer husbandry, hunting, and fishing). Agriculture in its classical form almost does not exist in this zone, since most of the territories of the Asian part of the Arctic specialize in the extraction of natural resources (oil, gas, precious and rare earth metals, gems), and agriculture has begun to develop here as an auxiliary industry to provide the population of new oil and gas cities of the North with food (Elde et al., 2018, p. 73).

In Greenland, only the coastal zone is suitable for life as 81% of the territory is covered with ice. Greenlandic Inuit make up 80–90% of the population, most of whom live in settlements mainly along the west coast. Along with the Faroe Islands, Greenland is part of the Kingdom of Denmark; the autonomous territory has its national flag, Greenlandic is the official language, and almost 90% of the population is people born in Greenland. In this respect, Greenland differs from other countries/ territories of the Arctic as it does not have an indigenous population (Elde et al., 2018, p. 4).

The agricultural sector of Greenland consists of 37 farms and is dominated by sheep breeding. Almost 99% of the cultivated areas (2014) provide the grass for winter fodder, and only 1% of the area is used for growing potatoes. The natural and climate conditions are severe and are expected to fluctuate even more in the future due to climate change (Bojesen & Olsen, 2019, p. 7). Fishing and hunting play a crucial role in providing food for the population of Greenland, and the fishing industry ensures the economic viability of households (Elde et al., 2018, p. 5).

4. Local small and medium-sized enterprises play an important role in production, processing, and distribution of food in the Arctic territories that face some common problems. One of them is the outflow of the population, especially young people, from small settlements to large cities or other countries. This leads not only to difficulties in attracting workers to food production but also to a reduction in the capacity of local markets as well as a decrease in the number of local enterprises.

Since local food producers are often small and closely connected to their communities, they will be more seriously affected by climate change or environmental pollution. Unlike larger companies, they will not be able to easily relocate their business without significant, and in some cases critical, costs (Johansen, 2014).

Small companies also have to deal with the high competition from large food producers, which are more efficient and have specialized distribution systems and greater leverage over suppliers. For example, four retail chains control almost all food consumption (for household use) in Norway and have a combined market share of almost 100%. One of the four chains said that it would have to reduce the number of its grocery stores in Northern Norway (mainly in rural areas) if it was not allowed to do business with another of the Big Four on procurement and distribution (Johansen, 2014). Among the main constraints to the sector growth in Northern Norway are the supermarkets' requirements for large-scale supply agreements, which make access to supermarket shelves for local producers quite difficult (Elde et al., 2018).

New regulations and control regimes aimed at improving food safety often favor large firms that can afford to make the necessary investments in human resources, equipment, and organization. Small firms have to comply with the same set of rules, but such investments are more costly for them. On the other hand, stricter regulation of CO_2 emissions may rather benefit local food producers than larger multinational corporations that transport food on hydrocarbon-fueled ships (Johansen, 2014).

5. The development of the food industry differs significantly across the countries of the Arctic region and depends on its structure. For example, the Norwegian food industry is dominated by large farmer cooperatives, but with the growing demand for locally produced food, the number of small- and medium-sized farms is growing (Elde et al., 2018).
6. The complex distribution system of resources for food production and fluctuations in energy prices lead to significant differences in retail food prices for the population of northern communities compared to retail food prices in the southern regions of a country.

Despite the numerous negative factors affecting the transformation of the food systems of the Arctic countries, there is a significant potential for increasing food production, both to meet the nutritional needs of the local population and to export locally produced food.

Vectors of Innovation in the Arctic Food Systems

Innovation in all its forms plays a key role in the new paradigm of the development of the world's food system. The use of innovative solutions to increase the productivity of resources, the volume of production, the efficiency of production process, and food delivery to all population categories is vital for the Arctic regions. The special role of innovations in the food system of the region is explained by the need to maintain the stability of ecosystems, societies, and economic entities.

In some inclusive food systems of the Arctic, the trend towards intellectualization of economic activity in the raw materials and processing sectors is becoming a reality. This applies to a greater extent to the harvesting and processing of biological resources of the Ocean and to the "urban agricultural sector," that is, to the cultivation of crops in greenhouses and vertical farms. The technologies of precision farming, machine-to-machine interaction, and "smart" animal breeding, which have become widespread in other latitudes, are not yet applicable in the raw sector of the Arctic food system. However, with the development of agricultural robotics, there are some possibilities of using agrobots with narrow specialization in the Arctic and other regions with difficult weather conditions. It contributes to improving the economic efficiency of processes as well as to solving environmental problems.

In the processing sector in industrial enclaves and emerging clusters, we can see new approaches to automation through the implementation of artificial intelligence elements. Industrial and service robots are used quite actively in all developed countries, including the Arctic ones. Since robots can help with improving of product quality and a sanitary level of food production, reducing labor intensity, and increasing productivity, companies are trying to scale this experience in the High North as well.

The digital stage of scientific and technological progress in the Arctic countries is manifested in the active use of information technologies to ensure communication of remote economic entities on all problems of economic and social activity. Geospatial, information, and market digital platforms created by both international organizations and private businesses are used in the countries of the region. According to the FAO, we can improve production, food quality, the state of the environment, and the quality of life by digitalization of food systems (FAO, 2021).

The similarity of living conditions for the population of the Arctic countries determines the need to exchange experience and knowledge on improving food systems despite the territorial remoteness and economic disunity of local communities. Therefore, cooperation on an innovative basis is essential. The authors could not find fundamentally new methods and technologies for production of basic kinds of food in the food systems of the indigenous peoples, which could be an object of such cooperation, in the scientific literature.

Speaking of sectors, modern technologies are being actively implemented in fishing and aquaculture and processing of reindeer products, wild plants, and certain types of local agricultural products.

A project of the Arctic Food Innovation Cluster (AFIC) (Arctic Council, 2021) has been developed within the framework of the Arctic Council. The cluster approach as a type of organizing economic activity in the Arctic is typical for all countries of the region, including Russia. The AFIC project is aimed at food production within the three types of food systems: traditional, artisanal, and industrial. It is assumed that the innovations in the food sector will make it possible to organize the processing of local raw materials not only to ensure the food consumption of local population but also to supply local food products to other regions of the countries and for export. In this case, the essence of the cluster approach is to introduce modern production methods and consumption patterns in the region. It is assumed that the cluster approach to innovation in the food systems should unite food producers in the Arctic with governments and communities of the indigenous peoples, as well as with technology development centers (universities and research institutes).

AFIC's multitasking is explained by its focus on achieving the sustainability of food systems in the Arctic. The cluster's tasks include the analysis of the actual state of the food system in the Artic and its potential for developing adequate government responses to ensure economic growth through sustainable food security and food safety and adaptation of innovations in food production to the needs of the indigenous population.

Another important track is the inclusion of food products of small- and medium-sized businesses in the Arctic in global and regional food value chains. Moreover, the focus on expanding economic linkages based on the innovative component with the southern regions of the Arctic countries is one of the project's priorities, as it can improve the social and economic development of the Arctic communities. The project's idea "to expand commercial food production in the North and for the North" is combined with the expansion of contacts on food supply along the North-South cooperation.

The innovative components of the Arctic food system are currently the part of some joint international projects that are being formed at the official bilateral level. For example, within the framework of the Russian-European program "Kolarctic," a project for processing reindeer meet and wild berries with a budget of $2.5 million is being implemented in Russia and Finland. The feature of the project is the development of innovative technological solutions and their implementation into production and processing of reindeer meet and wild berries (RIA Novosti, 2018).

Within the Artic countries, there is an exchange of the Arctic technologies in aquaculture, greenhouse farming, vertical farms, and the development of enterprises producing finished products from local raw materials.

Conclusions

The food systems of the Arctic countries, with some common conditions for the production, sale, and consumption of food, are distinguished by a high degree of diversity, depending primarily on the historically circumstances of life of the peoples inhabiting the Far North. In the twentieth century, the industrial development of the Arctic zones, which are rich in mineral resources, determined the movement of the population from other parts of the countries to the Arctic zone to conduct economic activities on a temporary or permanent basis. This type of labor migration has predetermined the development of food systems according to the main needs of the majority of the population of the countries. In fact, in each Arctic country, there is a combination of the food systems based on the unique way of life of ethnically diverse communities and the food systems that are typical for a country and neighboring states. There is a diffusion between them, the degree of which is determined by many factors – from the distances between the main settlements to the level of sustainability of the traditions in production and consumption.

The low inclusiveness of the Arctic food systems has historically created spatial and natural inequalities. In the new paradigm, proclaimed by the organizations of the UN system in 2021 in the context of solving the global problem of food security, such forms of inequality should be eliminated by all possible economic measures. This emerging new paradigm of food system's development is complex, and it is based on innovative components. The new paradigm contains a clearly expressed focus on the involvement of local food systems in the global food value chains to obtain a decent profit and to solve the problems of providing the population with safe and high-quality food as well as social and environmental problems.

However, in the context of the development of inclusive food systems in the Arctic zones, in our opinion, the set of these tasks is still difficult to achieve. The main reasons are the natural and climate conditions, which have formed a unique way of life of the indigenous population for centuries. At the same time, the active industrial development of the Arctic, which entails the increase in migration flows, requires the intensification of the local food production and an increase in the volume of food import from other regions. Yet local food production is characterized by low competitiveness of the Arctic traditional products and the food traditionally consumed by the visiting population.

Optimization of the northern food delivery is one of the most important parts of the state programs and strategies of the Arctic and subarctic countries. Even with the active development of all forms of public-private partnership in the Arctic, the role of the state should remain high. Only such an approach can ensure the elimination of the inequality in access to food for the population of the Arctic zone countries in the context of a high degree of inclusiveness of food systems.

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Vertical Greenhouses in the Arctic

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Contents

Abstract

Agriculture has a major impact on the global economy; however, growing crops is exceedingly dependent on climate. This especially affects the Northern regions of the world, Arctic in particular. With low farming self-sufficiency, this region has to rely on food imports. This creates a deficit, which leads to very high prices of vegetables and fruits, as well as Arctic inhabitants lacking balanced nutrition. Analysis of official statistics stated that in 2019 average annual consumption of vegetables per person was 41% below the normal level. It indicates disbalanced nutrition and lack of essential vitamins, like C, B1, or B2, and minerals like magnesium and iodine. The purpose of this research is to propose a solution of this problem, based on Internet of Things (IoT) technologies and vertical farming. Currently, there are little or no projects that provide a reliable way of growing crops in the harsh Arctic climate. Implementation of such a project will boost the

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region's food security and will have a positive impact on the availability of vegetables. This chapter estimates economic and social value of such project and gives insights on its technological design.

Keywords

The Arctic · Vertical farming · Internet of Things · Food security · Project · Innovation

Introduction

For centuries, the economic model of the Russian Far North has not changed fundamentally, despite radical political changes: The economy is based on the export of raw materials and the import of technical and vital resources. The Arctic's production costs are much more expensive due to severe natural and climatic conditions, and poor development of transport communications and other infrastructure elements. Due to the length of transportation, logistics costs are 50–70%, with an average of 10–25% in the Russian Federation, and due to the "northern" allowances and regional coefficients for labor remuneration, the cost of production increases by 20–30% (Zvorykina & Zvorykin, 2018).

The paradox is that, on the one hand, the government is interested in the development of these territories, and on the other, a production and transport infrastructure is not developed enough for independence from external supplies.

Thus, three directions from the point of the problems and opportunities of Arctic's food supply industry development were considered:

1. *National projects and support from the Russian government*. The Program of the socioeconomic development of the Arctic is implemented in Russia. It includes 145 projects with a total cost of ₽5 trillion, including ₽1 trillion of budget funds, 17 of which are identified as priority. Each of these projects is a system-forming one, designed to solve the problem of integrated development of the Arctic territory. It has an intersectoral and interterritorial character, and also creates multiplicative effects for other local projects in the region.
2. *Global warming and international collaboration*. Global warming is a huge catastrophe as well as a great opportunity that opens up for the development of the Northern Sea Route and Arctic territories. It is accompanied by a number of complex factors, including in the field of healthcare, based on the specifics of life in the Northern regions. The organization of the healthy lifestyle system of the population is largely determined by the impact that the uncomfortable climatic and geophysical conditions have on human health combined with unfavorable anthropogenic load on ecological systems and negative socioeconomic processes in the industrial region and the proper organization of nutrition and work and recreation.
3. *Artificial intelligence (AI) and Internet of things (IoT).* The Internet of Things becomes accessible to humans with AI. This can predict the need for repairs,

analyze the production process, and determine when and which part needs to be replaced before a breakdown causes damage. AI helps to increase work efficiency and save millions of dollars.

Main Research Focus

This chapter is an overview of the socioeconomic development of the Arctic region as from the point of food supply issues. The Russian government proposes many options to accelerate the development of Arctic: 1 ha of land in the region for free, benefits for construction, and accommodation, financial support, etc. However, the specific deference and the main problem of Arctic, and people living there, are that most products have no possible alternative production in other regions of the country, or food is purchased by import.

The study focuses on the economic mechanism of northern import. Special attention was paid to agricultural production, which is poorly developed in this region due to the harsh climate and the high cost of energy. Due to all the mentioned problems of the Arctic's food supply industry, an innovative project of vertical greenhouses with AI presented as the solution in the chapter. It addresses the objectives of assessing the effectiveness of the innovation in terms of maintaining living conditions in terms of sustainability and closed loop economy, Arctic dependence from external supplies, and the implementation of high technologies (AI) adjusted to the severe climate conditions.

The chapter presents the analysis of international experience in the field of vertical greenhouses and AI, currently implemented solutions, and an overview for the next decades in the regions with severe climatic conditions. The study provides information on the project, which is recommended for implementation in the Northern regions and Arctic.

Use of Greenhouses for Food Production in the Arctic

The Arctic region has major problems with food security. For example, the Russian Ministry of Healthcare stated that average annual consumption of vegetables should be 140 kg per person. However, regions of the Russian Arctic are below this target level. Analysis of official statistics stated that in 2019 average annual consumption of vegetables per person was 41% below the normal level (Table 1). This indicates imbalanced nutrition and a lack of essential vitamins, like C, B1, or B2, and minerals like magnesium and iodine (Istomin et al., 2018).

Another major indicator of the food crisis in the Arctic region is its low self-sufficiency in vegetable production. Based on the Russian Food Security Doctrine, the optimal level of vegetable self-sufficiency should be above 90%. Current gross production of vegetables in these regions satisfies only 82% of the normal level of vegetables consumption. Thus, current production rates are not satisfying the

Table 1 Annual consumption of vegetables per person in Arctic in 2019

Russian Arctic Region	Arctic population in 2019, people	Average annual consumption per person in 2019, kilograms	Per cent of normal level
Murmansk Region	748,056	102	73
Nenets Autonomous Region	43,829	68.2	49
Yamalo-Nenets Autonomous Region	541,479	103.1	74
Chukotka Autonomous Region	49,663	36	26
Republic of Karelia	41,605	91	65
Komi Republic	74,756	91	65
Republic of Sakha	25,963	69	49
Krasnoyarsk TerriroryTerritory	21,383	98	70
Arkhangelsk Region	643,215	85	61

Source: compiled by the authors based on Istomin et al. (2018)

demand, even without considering the overall populations of these regions, which is several times higher than their arctic inhabitants.

To overcome the current food production situation in the Arctic region, the authors propose a project, the main goal of which is the creation of smart greenhouses, based on AI technologies, that will have a major impact on the food market and the balanced diet of northern inhabitants.

Building greenhouses is the best solution for Arctic farming. Even though global warming creates more opportunities for land development, it can be dangerous for the fragile ecosystem of the Arctic (Kenny, 2019). Converting the pristine soils of the Arctic to agriculture alters their properties affecting soil stability, increasing risks of soil erosion, and accelerating GHG emission and loss of nutrients (Unc et al., 2021). The example of this is the Virgin Lands campaign that took place in the USSR from 1954 to 1965 and resulted in the destruction of millions of hectares of various natural areas caused by wind and chemical erosion.

Traditional agricultural land development is not a viable option for this region because of the low population density in remote Artic regions. Other factors are traditional ways of land and food management in these areas (based on hunting and fishing), as well as low interest of qualified specialist in living in working in the Arctic, due to poor infrastructure and the harsh climate.

Creating a mostly automated greenhouse, on the other hand, is an effective solution for the lack of human resources. Smart technologies based on the Internet of Things (IoT) and Artificial Intelligence (AI) will manage the whole cultivation process, giving the operators and farmers advice for decision making.

A closed system of smart greenhouse will provide good volumes of indoor production of food with high nutritional value (MCXAC, 2021). Another positive factor of the proposed greenhouse is its high energy efficiency and low carbon footprint, which is essential for fragile arctic ecosystem. It will also protect crops from human-caused environmental pollution, which is crucial because the level of food contamination in Arctic is two times higher than normal.

The proposed technology is based on the usage of smart sensors and an AI-powered microcontroller, which will manage every aspect of the greenhouse, from the temperature and hydration to the application of fertilizers.

In order to reach maximum land and resource efficiency, the greenhouse will be organized by vertical farming principles. Every square meter of floor space given over to vertical farming produces approximately the same amount of vegetable crops as 50 m^2 of conventionally worked farmland and saves up to 95% of water (IE, 2021). It also should be based on hydroponic technology, which is easier to manage automatically and doesn't require good soil which can be hard to obtain in remote northern regions.

The main advantages of smart greenhouse include:

1. automated temperature regulation and comfortable temperature maintenance;
2. optimal air humidity, which has major impact on crop yield;
3. extra light in the greenhouse, which will support balanced crop growth;
4. resource consumption control, which greatly reduces costs by saving energy, water, and fertilizers;
5. year-round growing and reduced cultivation cycles that are not affected by weather conditions and pollution;
6. an ecological way of growing crops which does not negatively affect soil and environment;
7. real-time analytics and risk management advice presented via dashboards on mobile app.

The vertical hydroponic farm includes a grower, a structure consisting of at least multiple tiers of troughs made up of polyvinyl chloride (PVC) pipes. The gutters are connected to a chain-sprocket system so that it will rotate for the checking and caring for the plants and harvesting the crops. Water is supplied at the upper-middle trough from a tank. The proposed construction is specifically designed to be almost completely self-controlled. Manual control is implied only for risk management, harvest, and some other functions.

The AI-controlled module of smart greenhouse that is responsible for automation of the majority of its processes consists of (CFO Russia, 2018):

- timers – time simple actions like lighting phases;
- sensors – record and transfer data about current state of the greenhouse;
- actuators – perform commands from microcontroller;
- heating, ventilation, and air conditioning system (HVAC system), based on ultraviolet (UV)/light-emitting diodes (LED) lamps and heating and air conditioning – create optimal atmosphere for crops;
- low-power wide-area network (LPWAN network) – connect microcontroller with sensors and actuators;

- microcontroller – translates commands from cloud server;
- cloud server – the main analytical center of the system. The AI-based core of the system performs calculations using data collected from sensors and automatically makes decisions, for example to inject fertilizers or correct temperature level.

Vertical farming has the following advantages compared to traditional farming practices. First, there is year-round crop production, as it requires no soil rejuvenation and soil mineral recovery ordinarily observed in land-based farming. Second, it significantly reduces farm inputs and the use of fossil fuels causing damage to the environment; land-based agriculture requires land plowing using farm implements burning gasoline and other petroleum products. Third, the technology can be put up anywhere. Fourth, it minimizes weather and crop failures as it is under a controlled environment the farmer themself sets. Fifth, it helps in restoring the farmland to the ecosystem.

To apply this solution on the market, we suggest creating a project and attract venture investments. Thus, it is necessary to analyze its approximate costs (Table 2).

Land costs are not included, because project will be a part of the Arctic Hectare program, initiated by the Russian Government. Participants of this program will receive a hectare free with 5 years of gratuitous use.

The monthly production capacity of a smart greenhouse is 47,700 kg of crops. A smart greenhouse will produce several base vegetables, including cucumbers, bell peppers, garlic, carrots, tomatoes, and herbs. The average cost of per 1 kg of proposed crops varies from ₽300 to ₽500 – this means that the average income from production will be ₽400 per kilogram, which results in ₽228,960,000 annually.

Table 2 Estimated costs of the smart greenhouse project

Item	Cost (₽)
Initial costs	
Equipment	201,560,000
Civil works	40,500,000
Planning	1,000,000
Total initial costs	243,060,000
Annual costs	
Salary	15,800,000
Insurance contributions	3,240,000
Cloud server maintenance	1,660,000
Depreciation	1,000,000
Taxes (6% farming tax)	4,276,800
Transportation	4,000,000
Energy and water	11,710,000
Raw material (seeds, etc.)	1,600,000
Total annual costs	43,286,800

Source: compiled by the authors based on approximate costs and calculation

In order to estimate smart greenhouse implementation, a risk analysis has been performed. For assessment of most important project risks, authors used FMEA method, results of which are presented in Table 3.

To roughly assess the risks of this project, we have also conducted a SWOT analysis. The planning horizon is the Present.

Notation: S – strengths, W – weaknesses, O – opportunities, T – threats
Scores: Z-score, P-importance for us, V-significance (calculated as Z*P).

Each indicator is evaluated considering its significance (V) – an assessment of its importance for doing business, taking into account the certainty of this assessment.

The introduction of these estimates makes it possible, among other things, to display the significance of strengths, weaknesses, opportunities, and threats on diagrams, compare them with each other, and visually assess the attractiveness of the starting position of a new business (Fig. 1).

Strengths
S1: Local products (vegetables, mushrooms, fruits) Z:9 P:10 V:0.9;
S2: Russian technologies Z:9 P:9 V:0.81;
S3: Under national project Z:8 P:8 V:0.64;
S4: Possible pivot for greenhouses in the regions of Far East Z:7 P:8 V:0.56;
S5: Sustainable and energy efficient Z:9 P:9 V:0.81;
S6: AI controls system Z:8 P:8 V:0.64;
S7: Assortment of greens can differ Z:9 P:10 V:0.9;
Opportunities
O1: Lack of innovations in the region Z:9 P:9 V:0.81;
O2: Support from Green Universities of Russia Z:9 P:7 V:0.63;
O3: Passive usage of energy (accumulative tech) Z:8 P:8 V:0.64;
O4: Development of territories Z:7 P:7 V:0.49;
O5: Support from governmental funds Z:8 P:9 V:0.72;
Weaknesses
W1: Large investments Z:9 P:10 V:0.9;
W2: Availability of infrastructure (Internet, electricity, etc.) Z:9 P:10 V:0.9;
W3: Product price is higher than average in the market Z:9 P:9 V:0.81;
W4: Lack of specialists in the field of construction in the Arctic Z:9 P:9 V:0.81;
Threats
T1: Untimeliness Z:4 P:9 V:0.6;
T2: Lack of interest in the Arctic Z:4 P:8 V:0.32;
T3: AI lags Z:9 P:10 V:0.9;
T4: Unstable economic situation Z:8 P:8 V:0.64.

Strengths and Opportunities – The project is investment attractive due to the use of Russian technologies and the unique complex solution for the current problems in the regions with severe climate conditions. The proposed solution might help to make up the lack of greens in the market, thus reducing the dependence on external supplies.

Table 3 FMEA analysis of the smart greenhouse project

Risk event	Risk root cause	S	O	D	RPN	Solution if risk happens	Preventive actions
Bad timing of the project	Poor market analysis	10	2	4	80	Stoppage of the project development	Additional market analysis, strategic sessions, foresights with experts
Wrong stakeholder analysis	Lack of target audience understanding	4	2	2	16	Reconceptualization of the project	Additional market analysis, strategic sessions, foresights with experts
Technical project failures	Incompetence of technical specialists	6	4	6	144	Temporary stoppage of the project, creation of the new technical project	Hire professional construction company
Equipment malfunction	Use of low-quality sensors, programming errors	7	3	3	63	Search for the source of the fault and its elimination	Verification of each sensor and actuator
AI malfunction	System errors caused by cloud server integration issues or voltage jumps	6	4	3	72	Search for the source of the fault and its elimination	Regular technical support, automated malfunction notifications from the system
Lack of demand on production	Wrong market choice	9	2	7	126	Search for another markets with vegetable supply shortage	Additional market analysis, test selling of small part of production
Lack of specialists	Incompetence of team organizers and specialty of the region	9	3	6	162	Attract the specialists with grants; participate in hackathons and accelerators	Start with the help of mentors, participate in the field events, collaborate with universities

Source: compiled by the authors

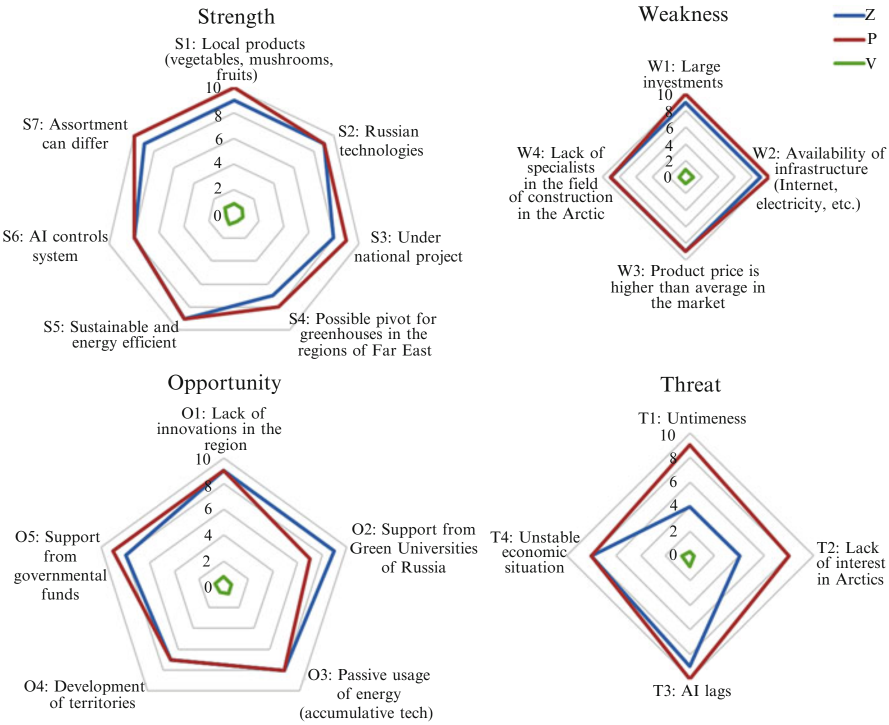

Fig. 1 Attractiveness of the starting position of a new business in vertical greenhousing. (Source: compiled by the authors)

Strengths and Threats – Threats will be covered if the project organizers participate in thematic events, collaborate with stakeholders (universities, funds, eco-friendly organizations), and undergo continuous learning and skills improvement. In case government would not support projects in the Arctic, the project could be implemented in other regions.

Weaknesses and Opportunities – With support from the Association of Green Universities, the project could find and employ specialists in the field of construction in the Arctic among students and teachers in the universities.

Weaknesses and Threats – The project needs appropriate marketing and financial planning in order to be ready for any issue, and to attract investors, especially on the final stages.

Discussion

The key task of the project is to create a source of high-quality farming products that would make the life of people who live in severe climate better, by solving problem of the unbalanced diet and enormous crop prices, as caused by the lack of supplies and poor farming conditions (Kenny et al., 2018). It is necessary to find investments to implement such a project. In order to estimate the possible interest of investors in project implementation, the authors analyzed its investment effectiveness.

1. IRR – 43%
2. NPV – ₽464,910,000;
3. Payback period – 2.3 years
4. Area: 1 ha, 5000 m^2 of which is a production area;
5. Products: organic farming products (cucumbers, tomatoes, herbs, bell peppers, garlic, carrots, onions, etc.).

The discount rate used for the analysis was 15%. This was calculated by the summation of Russian Central Bank refinance rate, which equals 5.5% current inflation ratio in Russia – 4.5% and risk premium, that was set at 5% (CBR, 2021). Estimated indicators show that project has potential and high chances of attracting investors. Its Initial Rate of Return is 18%, which is high enough and indicates a good safety margin. Even if the project encounters moderate risks or requires more resources, it will still be profitable.

Moreover, the proposed project has a significant socioeconomic value for Arctic territories. Several smart greenhouses will greatly improve the food security of the region. For example, the overall impact of implementation of one such greenhouse in the Chukotka Autonomous Region – the least self-sufficient region of Russian Arctic in food production, where vegetable consumption is only 26% from the normal level – will be massive. One greenhouse will produce around 10% of all regional vegetables' internal supplies. The development of the greenhouse cluster in this region will potentially stabilize the enormous prices of vegetables that are several times higher than normal.

Conclusions

The proposed smart greenhouse project in severe climatic conditions in the regions of the Arctic, Antarctic, sub-Arctic, and sub-Antarctic climatic zones of the Earth is an effective and socially necessary facility that might be implemented under the national goals of the Russian Federation (Yankovskaya et al., 2020). It is capable of significantly improving the food security of the region and providing its inhabitants with balanced nutrition.

Being a controlled environment, vertical greenhouses can be placed almost anywhere, and the climate and weather conditions completely lose their significance (Gomez-Zavaglia et al., 2020). Local production means a positive impact on the local community, leading to an increase in jobs and contributing to the development of smaller farms. This practice reduces the number of "food miles," which means a reduction in the global carbon footprint. Studies have shown that vertical farms reduce total CO_2 emissions by 67–92% compared to conventional greenhouses. Causing minimal damage to the environment and obtaining maximum benefit is one of the main advantages of indoor vertical farming. They retain water, nutrients, and electricity, and also do not produce garbage. Also, importantly for the Arctic, they can create comfortable conditions for plant growth for the whole year autonomously.

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Fishery Cooperation of the Arctic States

Current Aspects

Lilia S. Revenko and Nikolay S. Revenko

Contents

Abstract

Cooperation between fisheries occupies a special place in the system of international economic cooperation of the Arctic countries (Denmark, Canada, Norway, Russia, the USA). The extraction of fish and other biological resources of the Arctic Ocean has been the basis of the economic activity of the peoples of the North for centuries. The products of marine fisheries form the basis of the local food ratio. The extraction of biological marine resources in the region acquired an industrial character in the twentieth century; this is why the competition for these resources arose between the Arctic countries, leading to the current need for international regulation of fishing rules.

There is a system of measures to regulate the withdrawal of biological resources of the ocean, but the spatial and geographical specifics of the Arctic region dictate the need for a special approach to this area.

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The current stage of development of fisheries cooperation in the Arctic can be represented as a multilevel branched process of multidirectional impulses with different degrees of formalization. The general idea of such cooperation can be described as searching for ways to revise the principles of stakeholders' interaction under the influence of changing conditions and factors.

The main reasons that transform the fisheries cooperation in the Arctic include freeing part of the Arctic Ocean from ice under the influence of climate change, unresolved problems of delineating the shelf and 200-mile economic zones, the active participation of non-Arctic states, the formation of new Arctic development strategies, and the introduction of the principles of sustainability of the economic activity. Innovative technologies of the new stage of the industrial revolution are also contributing to fisheries cooperation, being introduced into the extraction, processing, and cultivation of water resources.

With a complex combination of causes and phenomena that form multidirectional trends in fisheries cooperation, optimism is inspired by the traceable desire of the Arctic states, their closest neighbors, and third countries to agree on the development of scientific research, the exchange of production and fishing technologies, the provision of quotas, and other issues.

Keywords

Arctic · International cooperation · Fisheries · Aquaculture · Research · Innovation

Introduction

Coastal countries attach much importance to the extraction, processing, and consumption of ocean resources. Fisheries management has been and remains not only a source of income, food supply, and employment, but also an important element in the formation of the social and cultural identity of the Northern peoples living in the Arctic region. Difficult weather and living conditions and the distribution of the population have generated a lot of similarities in the economic life of the peoples of the Arctic countries with clearly expressed current political realities.

For decades, the Arctic has been a territory of both cooperation and contradictions of neighboring countries on many problems. Fisheries relations were a component of almost all international initiatives in the region.

The current stage can be considered a period when a new paradigm of fisheries cooperation of the Arctic countries is being formed against the background of general transformations of all forms of their international interaction.

According to international practice, the Arctic countries include five states that have direct access to the Arctic Ocean: Denmark, Canada, Norway, Russia, and the USA. However, their economic interests (including fisheries) in the Arctic are on various grounds (one of which is the fact that part of the country's territory is located beyond the Arctic circle), and the nearest neighbors – Iceland, Finland, Sweden – are actively implementing it.

In the last decade, non-Arctic states – the EU countries, the UK, China, Japan, and other countries of the Asia-Pacific region – have actively declared their interests in the Arctic. Although exploration and processing of biological resources are not a priority in their economic claims to the Arctic, these countries are actively introducing themselves into the political and regulatory discourse, distorting the conditions of competition in various sectors of activity. They are also forming a new paradigm of fisheries cooperation.

Despite the importance and significance of international cooperation in the field of fisheries management for the countries geographically belonging to the Arctic, many aspects of the relevant issues do not yet find practical development vectors that are adequate to the needs. The reason for this can be considered the general turbulence in all areas, spheres, and branches of international cooperation that has developed in the last decade.

The basic principle of using the methodology of the chapter to study the problems of international cooperation in the fisheries sector can be considered an integrated approach to the analysis of the socioeconomic system. The basis of this approach is interdisciplinarity, since international legal, economic, environmental, technological, and social aspects converge in this topic. The complex analysis included the methods of trend research, comparison and systematization, and historical comparative studies.

The theoretical part was based on the works of Russian and foreign researchers on the problems of countries' interaction in the Arctic in economic, environmental, historical, and social contexts. Priority is given to practice-oriented research on the problems of international cooperation. This approach predetermined the identification of elements of a new paradigm of fisheries cooperation between the Arctic countries in the context of climate change, new competitive conditions, and the activation of the activities of non-Arctic countries in the region in the twenty-first century. One of the basic elements of this paradigm can be stability at the macro and micro levels.

The use of analytical information from international organizations, national authorities, and companies of the fishing business is methodically justified for generalizing the idea of the development of the object under study. When analyzing the traditional areas of international fisheries cooperation, the authors used the methods of logical and historical unity, as well as substantive, qualitative analysis.

To generalize the existing concepts and approaches, the author's method of object classifications and typologies is applied. At the same time, the authors prefer to concentrate on generalizing data on real episodes of international fisheries cooperation in the Arctic that is practically significant for Russia, giving priority to a group of methods for obtaining, processing, and systematizing empirical knowledge with elements of comparative studies, which is typical for other works of this research group.

Literature Review

Theoretical and applied sciences provide an extensive bibliography on Arctic research. The authors, in their study, focused on those that enabled an assessment of the state and prospects of fisheries cooperation in their evolutionary and current interpretation, with an emphasis on Russian priorities.

In this context, the works of well-known experts on international maritime law have provided invaluable assistance in understanding the stated topic. These experts include K. A. Bekyashev (2012, 2015b) and D. K. Bekyashev (2017), A. N. Vylegzhanin (Vylegzhanin & Kienko, 2021; Vylegzhanin & Dudykina, 2017), experts of the Russian International Affairs Council A. V. Zagorsky, A. I. Glubokov, and E. N. Khmeleva (2013), and the team of authors from the Higher School of Economics under the leadership of S. A. Karaganov (Karaganov et al., 2021) and V. R. Avkhadeev (2020), who consider a complex set of interrelated processes that affect all forms of international cooperation, including fisheries.

P. A. Gudeev's approach to the problem of forming an international legal regime of economic activity, including fisheries, in the Arctic was interesting; in the work "The Arctic as a 'global commons'?" Gudeev considered the features of the Ilulissat Declaration and its specifics, and concludes that this document is important for forming the principles of cooperation (Gudeev, 2016). In a later report, V. Konyshev and A. Sergunin (2018) noted the causes of conflict between the five Arctic countries that signed the Declaration (Denmark, Canada, Norway, Russia, the USA) and those subArctic countries (Iceland, Finland, Sweden) who do not have access to the Arctic Ocean and were not invited to sign this document, as well as with third parties interested in the economic development of the Arctic. The authors note that the level of conflict has begun to smooth out in recent years, which makes it possible to consider the current forms of fisheries cooperation with a certain optimism.

The theoretical aspects of the economic development of the Arctic zones in the context of the need to develop a new concept based on the Russian, Western European, and North American approaches are considered in the work of A. N. Pilyasov and N. Y. Zamyatina (2019).

From the position of Russia's interests, Zilanov considers the evolution and prospects of fisheries cooperation in the Arctic in his work; analyzing the changes taking place in the Arctic, he highlights, along with climate issues and the definition of the boundaries of 200-mile economic zones and the shelf, such important aspects as the adoption of national doctrines for the development of Arctic zones, the growth of scientific and economic interest of non-Arctic states (Zilanov, 2015), increased competition for all types of resources among various groups of states, and the desire for sustainable use of living ocean resources (Zilanov, 2016). K. S. Zaikov, N. A. Kondratov, E. V. Kudryashova, S. A. Lipina, and A. I. Chistobaev assess the potential for the development of the Arctic zone of Russia through the prism of climatic and geopolitical changes; their work also highlighted the strategies for developing the Arctic in the countries of the region (Zaikov et al., 2019: 7). In the earlier works of A. I. Glubokov, P. K. Afanasyev, and S. P. Melnikov (2015), as well as A. M. Gornova (2016), the authors analyze the resource potential of fisheries cooperation. L. S. Revenko and T. M. Isachenko considered the connection between the formation of the country's industrial policy and international fisheries cooperation in the Far North (Revenko & Isachenko, 2017a).

The problems of regulating the production of aquaculture and fishing products in the Arctic, based on the example of the USA and Norway from the standpoint of the blue economy concept, are considered by A. Raspotnik, S. V. Rottem, and A. Osthagen (2021: 132–140), indicating the inconsistency and conceptual instability of many aspects of such regulation.

A block of works on the problems of the interest of non-Arctic states in fisheries cooperation in the region seems to be quite interesting. A researcher from the UK, D. Depledge (2018) estimates the share of fish products consumed in the country in the last decade which came from the Arctic seas – namely from Canada, Denmark, the Faroe Islands, and Norway. Analyzing the UK's interest in participating in economic activities in the region, A. A. Todorov and D. N. Lyzhin also note the practical importance of fishing in the Arctic seas for the UK (Todorov & Lyzhin, 2019).

China's interest in the Arctic agenda is also an object of scientific interest for Russian and foreign researchers. For example, V. Perskaya, V. Remyga, N. Revenko, A. Ogryzov, and L. Krasavina, who summarized the motivation and specific areas of Russian-Chinese cooperation in the Arctic, highlighted the economic background of China's long-term interest in the sectoral components of this process (Perskaya et al., 2019).

The problems of assessing the innovative potential of the Arctic regions of foreign countries and Russia are highlighted in the study of N. E. Egorov and G. S. Kovrov, who believe that it is difficult not only because of the lack of clear criteria reflecting the specifics of the technological development of these countries but also because of the objective spatial and economic difficulties of making such comparisons (Egorov & Kovrov, 2020).

The authors of this work also actively used the materials of international organizations: the Arctic Council and the Arctic Economic Council, the Northwest Atlantic Fisheries Organization (NAFO), the Northeast Atlantic Fisheries Commission (NEAFC), the United Nations Food and Agricultural Organization, etc.

Conditions and Factors of International Fisheries Cooperation in the Arctic

Fishing as a branch of human economic activity has been conducted in the Arctic for centuries. If it was a traditional type of food extraction of the indigenous peoples who live in the coastal areas at the previous stages – that is, it had a local significance – then fishing became industrial in the twentieth century, which posed the problem of competition for living resources, first for coastal waters, and then for more remote waters. As a result of this evolution, a complex and extensive system of regulation of many aspects of fishing in the region has emerged through the efforts of the global community. At the same time, conflict zones were formed in the conditions of serious contradictions.

In fisheries practice, the Arctic includes the water area of the Arctic Ocean and its seas. This water area is legally heterogeneous, represented by the open part of the North Pole with the center at the North Pole and the 200-mile zones of five countries that are Arctic: Denmark (Greenland), Canada, Norway, Russia, and the USA. This spatial and geographical reality forms both the main tracks of international fisheries cooperation and is the basis of many contradictions and conflicts.

According to biologists, about 150 species of fish and 17 species of mammals are represented in the waters of the Arctic Ocean, although not all of them are of commercial importance, and catches in coastal Arctic waters are decreasing with low productivity and declining potential. Among the common and cross-border fish stocks for industrial purposes, saika, capelin, cod, haddock, herring, whiting, mackerel, and perch are the most promising (Zilanov, 2015).

Coastal fishing is carried out by vessels of Russia, Iceland, Norway, and Denmark, for which the conservation of fish stocks is of particular importance. To implement it, the Arctic countries are directing efforts to use innovative technologies in the study of bioresource potential, fishing, and the processing of catches. The cooperation of the Arctic countries in these areas has as long a history as the fishing itself, although it is full of contradictions.

Over the last decade, the economic development of the Arctic acquired truly planetary significance. Long-term priorities in building fisheries relations are formed and defended not only by the Arctic states but also by their neighbors. Besides, contenders to the future development of living ocean resources in the Arctic have emerged in almost all regions of the world: countries located very far from the polar latitudes increasingly declare their interest in Arctic projects. This process is characterized by an explicit "work ahead of the curve," which is understood as building relationships and summing up legal grounds not so much for the present as for future cooperation. This predetermined the need to change the international legal status of the Central Arctic water area as well as some aspects of the activities of fishing vessels of non-Arctic countries in the 200-mile economic zones of the "Arctic Five."

The climate factor plays a big role here. The Arctic is dominant in the development of all types of economic activity, but the last decades have been characterized by such a sharp melting of ice in the Arctic Ocean that, according to many researchers, this process should provoke serious changes in nature management of the Arctic region in general and fishing in particular within 40 years (Zaikov et al., 2019: 7).

The Arctic is considered one of the most vulnerable ecosystems in the world. Even in the last decade, experts were quoted as saying that the rapid ice melting would kill the Arctic flora and fauna, but at the same time the water area would be freed and we would be able to extract valuable biological resources, including commercial fish species. Many studies emphasize that the vacated water area of the five Arctic states outside their 200-mile exclusive economic zones can presumably be equal to the one of the Mediterranean Sea (Bekyashev, 2015a).

The Arctic water area where fishing is theoretically possible is 2.8 million square km (Fishery Murman, 2017), but environmental, legal, and economic restrictions do not allow economic entities to operate in this region in the same manner as in other seas. Moreover, ice melting reveals a tendency to move living resources from the 200-mile zones of the Arctic states to the open sea.

Following the change in the ice boundary, such major commercial fish species as capelin, herring, sea bass, halibut, and cod move following pelagic plankton, which is explained by the so-called feed migration. These types of biological resources in the open part of the Arctic Ocean require new fishing rules and new approaches to cooperation in this area, since those countries that do not have these resources in their zones and are not involved in the processes of their conservation and quotas have begun to show interest in fishing. This exacerbates the contradictions between the Arctic countries and nonregional states, since with appropriate technological innovations, attracting players from third countries to the region can reduce the stability of an already rather fragile ecosystem and deprive the Arctic countries of the fishing resource base.

With the clearly expressed interest of other Arctic states, this topic is especially important for Russia, since vast water areas of its seas (Barents, East Siberian, Kara, Chukchi, Laptev) are already opening up from ice for several months a year. The Arctic neighbors, especially Norway, faced the same situation.

The previous stages of the fishing industry development in the interested countries have shown that there is no other way but to agree on practically significant areas of cooperation on the existing international legal framework, making it as mutually beneficial as possible at the current transition stage and in the long term.

At the same time, a whole range of conditions and factors of such cooperation that influence it and determine its modern paradigm is distinguished (Fig. 1).

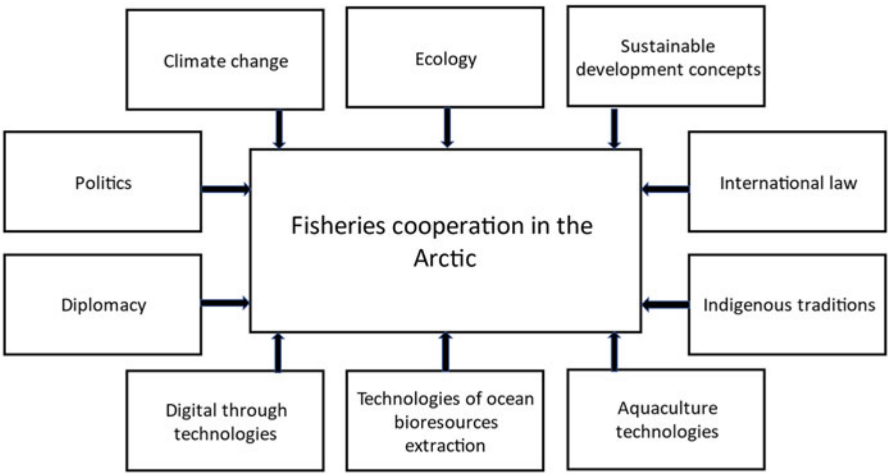

Fig. 1 Conditions and factors forming a new paradigm of fisheries cooperation in the Arctic. (Source: Compiled by the authors)

Given our understanding of the extreme importance of expanding international fisheries cooperation in the region, one cannot but state the fact that other sectoral types of international cooperation in the Arctic are much more active today. This statement mainly refers to the development of hydrocarbons and other types of mineral resources on the Arctic shelf. The priorities also include ensuring security, as well as developing transport and industrial infrastructure. Each of these areas is connected to one degree or another with the development of marine living resources: either through sustainable development, environmental impact, and violation of the habitat conditions of objects of current or potentially possible fishing, or through competition for investment and state support for economically significant projects, or through the problems of delimiting 200-mile zones and the continental shelf.

At the same time, many aspects of Arctic fisheries cooperation were, according to experts, "open" in the past decades (Zagorsky, 2013: 24), but new challenges with unresolved past problems have appeared. The Higher School of Economics analytical report highlights the role of international cooperation as a tool for developing the Russian Arctic (Karaganov et al., 2021: 43–49), especially in the context of the exchange of innovative technologies for working in this region. At the same time, one cannot but agree with the authors that national efforts for the region's economic development are still a priority.

The process of freeing the waters of the sea from ice under the influence of warming creates an objective opportunity for violating the existing balance of forces and models of fishing regulation. This is especially true for the northwestern part of the Arctic zone. This situation also implies the need to focus the efforts of interested parties in conducting in-depth scientific research not only on the bioresources of this sector, but also on the future possibility of their movement to the open waters of the Arctic and, accordingly, to develop new rules for regulating economic development that may affect fishing activities on this basis. In this regard, the Arctic countries have an understanding of the need for a joint proactive response not only to climate change, but also to economic activity in the region, which has an impact on biodiversity and the state of fish stocks.

All in all, the current fisheries cooperation of the Arctic states is based on the pragmatic basis of fishing activities' non-interruption in the ice-free waters of the Arctic Ocean. For non-Arctic states, their participation in Arctic research and discussions, without exaggeration, is preventive when it comes to all aspects of economic activity. When it comes to fisheries management, this means creating opportunities for commercial fishing of the Arctic Ocean in the future.

A characteristic feature of the current stage of fisheries cooperation is the presence of appropriate efforts at various levels of interstate and inter-company interaction, which forms a chaotic, rather stable network of interested players. It includes not only the Arctic Council but also other regional and subregional structures, international organizations of the UN, and international nongovernmental organizations. Although according to some researchers, such a complex organization of the Arctic management system does not affect its effectiveness and transparency (Konyshev & Sergunin, 2018), we suppose that a more flexible and specialized mechanism will be developed over time to ensure the interests of all parties to fisheries cooperation in the Arctic. Moreover, according to Food and Agricultural Organization experts, the global regulation in the field of fisheries and aquaculture in recent years can include the transition from focusing on the growth of production and economic results to the integration of fisheries and aquaculture in the complex of ecosystem management within the region (FAO, 2016: 91).

The author's classification of the levels of fisheries cooperation in the Arctic is shown in Fig. 2.

There is a functional orientation towards sustainability in all its manifestations – from ecosystem to microeconomics at all the levels indicated above. Sustainability as an element of the paradigm of fisheries cooperation is defined by the UN Sustainable Development Goals until 2030 (SDG-2030), in which the problem of the sustainability of the world's oceans is highlighted in a separate goal – SDG-14 "Conserve and sustainably use the oceans, seas and marine resources for sustainable development," each of the tasks of which fully relates to the development of Arctic waters (SDG Compass, 2016).

The difference in the fisheries interests of the three groups of countries (Arctic, near-Arctic, and extra-regional) made the "Arctic Five" join forces to formalize their ideas. As a result, the Ilulissat Declaration (National University of Singapore, 2008) was signed in 2008, which is the basis for developing cooperation in the Arctic, including in the fisheries sector. The Declaration outlined the leading role of the five Arctic countries in the protection of biological resources and the marine environment in general. The ideas of the Ilulissat Declaration are also developed in other documents important for the cooperation in the region – the Agreement to Prevent Unregulated High Seas Fishing in the Central Arctic Ocean signed in 2018 (Ministry of Foreign Affairs of Japan, 2018) and the Agreement on Enhancing International Arctic Scientific Cooperation in 2017 (Arctic Council, 2017).

The Arctic countries aimed at fisheries cooperation with other states are the driving force of this process after the signing of the Ilulissat Declaration. As Konyshev and Sergunin noted, these countries initiated the ban on commercial fishing in the central part of the Arctic Ocean. In 2017, a special agreement was signed with the participation of third countries – Iceland, China, Republic of Korea, and Japan, as well as the European Union (Konyshev & Sergunin, 2018). However, discussions on the development of areas of cooperation on the issues of fishing for living resources and on the problems of scientific research of bioresources in the open part of the Arctic Ocean were actively conducted long before the signing of these agreements. Therefore, in the abovementioned Agreement, the "Arctic Five" committed not to conduct industrial fishing in this water area until reliable scientific data on resources is obtained and a legal mechanism for their withdrawal has not yet been developed. To develop the ideas of the Agreement, discussions and negotiations were held not only within the "Arctic Five" but also with the involvement of countries interested in fisheries cooperation in the Arctic (representatives of Denmark, Canada, Norway, Russia, the USA, China, Iceland, Japan, and the Republic of Korea, as well as the countries of the European Union agreed on the document).

Given the importance of all types of agreements, it should be noted that scientific international Arctic cooperation can be put in one of the first places since it has a

The level of international fisheries cooperation in the Arctic	The main goals and objectives of cooperation
Global for all problems (UN, FAO, other specialized international organizations)	• Development of common approaches to cooperation • Theoretical justification of problems, prospects, risks • International legal aspects • Response to climate change • Problems of sustainable development • Food security, access of the population to adequate nutrition • Ecological balance, environmental protection • - Collection and analysis of data on fish stocks, production, trade in fish products
Global Fishery Management (NEAFC, NAFO, other fishery management organizations)	• Development of marine bioresources • Organization of rational environmental management within the mandate of the relevant structure • Cooperation in fishing activities • Sustainable use of fish resources • Use of digital technologies for the exchange of data on shipping and fishing • - Ensuring the interests of the population of coastal countries
Regional interstate (Arctic Council, Arctic Economic Council, Barents Sea Council/Euro-Arctic region, Associations of Indigenous Peoples of the North)	• Common problems of economic cooperation • Environmental issues, conservation of Arctic flora and fauna • Scientific cooperation • Establishing business contacts • Creation of a regulatory framework for cooperation • Promoting the exchange of knowledge and information • - Development of the small business while preserving the traditional way of life of the indigenous peoples of the North

Fig. 2 (continued)

Bilateral interstate (intergovernmental commissions on fisheries cooperation, agreements, and other types of arrangements)	• Exchange of views on general and special issues of fisheries cooperation • Formation of the institutional structure of cooperation • Research activities • Exchange of quotas • Construction and repair of ships • - Training of personnel for the fishing industry
Bilateral commercial (intercompany)	• Exchange of experience in catching and producing fish products • Creation of new high-tech fishing tools • Construction and repair of ships • Investment cooperation • Arctic aquaculture technologies • Foreign trade in fish and other marine products • - Foreign trade in services and provision of business services for enterprises of the fishing sector

Fig. 2 Levels of international cooperation in the fisheries sector in the Arctic. (Source: Compiled by the authors)

clearly expressed practical component. The Agreement on Enhancing International Scientific Cooperation, signed in Fairbanks, USA, on May 11, 2017 (Arctic Council, 2017), entered into force on May 23, 2018. It was signed by Canada, Denmark, Finland, Iceland, Norway, Russia, Sweden, and the USA, which agreed to join forces and assist each other in exploring the Arctic zone. The agreement provides for the mutual provision of access for research purposes to the relevant national infrastructure, databases, services, and the provision of all forms of assistance in the activities of research teams. The Agreement also specifies administrative entities or territories, as well as the water areas related to its scope. Real international studies of the resource base of the Arctic Ocean are carried out, and other vectors are being implemented on its basis.

The development of ideas for cooperation in the fisheries sector is largely facilitated by international forums, conferences, and scientific seminars held in the Arctic countries. Meetings of the International Arctic Forum are held regularly in the Arctic countries, where the participants offer their projects for the development of the Arctic zone for international consideration and participation. The annual forums "The Arctic: the Territory of Dialogue" held in St. Petersburg, and scientific conferences at the Northern (Arctic) Federal University in Arkhangelsk and the Nord University Bodø (Norway), help to identify positions and priorities. The international projects of the National Arctic Scientific and Educational Consortium and the Arctic Floating University project are successfully working. Many conferences in the Arctic region are focused on the topic of sustainability, for example, the Northern

Forum on Sustainable Development, which is attended by representatives of Great Britain, Germany, Iceland, Canada, China, Norway, Russia, the Republic of Korea, the USA, Finland, France, Sweden, and Japan.

The pandemic also had a destructive impact on activity in the scientific sphere, but later scientific contacts in many areas became more active. For example, the International Forum "Eco-Barents-2021" was held in Arkhangelsk. Its main goal was to establish an effective cross-border dialogue on the protection of the Arctic ecology (TASS, 2021a).

In the last decade, the development of common approaches to solving economic problems in the Far North regions within the framework of the Arctic Economic Council (established in 2014) has become an important and practically significant area of international cooperation in the region.

The main objectives of the AEC are the following: to establish strong market ties between the Arctic states; to create a regulatory framework for cooperation; to develop the public-private partnership in the region; to promote the exchange of knowledge, information, and data between participants; and to develop small businesses while preserving the traditional way of life of the indigenous peoples of the North.

The most promising areas of international economic cooperation at the present stage are the creation of infrastructure facilities in all sectors (the so-called interconnected Arctic projects), the implementation of scientific and educational projects (competent Arctic), the joint solution of problems of search and rescue operations, and the implementation of environmental protection measures (safe Arctic).

One of the promising forms of such cooperation is the project approach when a set of projects to be implemented by structures from several countries is formed on a competitive basis (Revenko & Isachenko, 2017b).

An interesting project of international cooperation in this area is being implemented by J. P. Klausen & Co., which in turn represents the Smart Business Associates (SBA) project. The SBA international project implements "smart" business services in fishing organizations at any stage of their development. The project creates new opportunities for participants of the fish market in the field of the processing and sales of fish products, taking into account the needs of buyers in different parts of the world. The project manager believes that the technological reequipment of the industry should be accompanied by a change in approaches to doing business, innovative methods of doing business which are part of the proposed system of services (Klausen, 2021).

Since a new institutional framework for the industrial development of the Arctic zone with a high share of innovation components is being actively formed in all Arctic countries, this direction can be considered very relevant and promising. In the context of the development of the innovative component of the multilateral format of fisheries cooperation, we can give an example of the development of a digital track aimed at implementing the VMS FLUX system for transmitting data on fisheries between NEAFC countries. The UK, Iceland, Norway, Russia, the Faroe Islands, and the European Union have agreed to introduce a new FLUX system, which many countries are already using on their ships in testing mode. It is assumed that both data transmission formats will be used within 2 years, and all NEAFC countries will switch to VMS FLUX by 2023.

The new approach to control is also extremely relevant for the Arctic zone of the Northeastern Atlantic. Since the main goal of the NEAFC as an intergovernmental organization is to ensure rational fishing and optimal reproduction of biological resources, digital methods will greatly simplify the control process and make it more accurate. Although the NEAFC regulates fishing in a small part of the Arctic Ocean (namely 8% of its total area), the new control system is very significant for the region. This approach can be extended to other multilateral and bilateral structures whose functions include monitoring the living resources of the Arctic.

Practice of Bilateral Fisheries Cooperation

Many countries – Russia, Denmark (Tsaturov & Klepikov, 2012), Canada (Leksin & Porfiryev, 2017), Iceland (Roberts et al., 2018), Norway (Bring et al., 2017), the USA (Conley & Kraut, 2013), Finland, Sweden, China, and India – adopted Arctic development strategies indicating a wide range of interests in establishing or expanding existing international fisheries relations in the twenty-first century. However, the practical component of such cooperation at the present stage is maximally represented at the bilateral level.

The traditional form of bilateral fisheries cooperation in the region is the exchange of fishing quotas for fish resources, but it is characterized by a different degree of activity. If countries do not have an economically significant exchange of fish resources (e.g., Russia's exchange with Canada, the USA, Finland, and Sweden), these countries still maintain contacts within the framework of cooperation on conservation and joint research of biological resources, combating IUU fishing and other topical issues.

To prevent poaching, countries use information exchange. There is also such a form of cooperation as the mutual provision of data on the unloading of biological resources, their import and export, as well as on all types of violations of the existing agreements.

Bilateral fisheries cooperation between Russia and Norway can be considered the longest and most extensive one, the main principles and areas of which are determined by the Joint Russian-Norwegian Fisheries Commission. First of all, it contributes to the rational management of fish stocks in the Barents Sea, since following interstate agreements, the biological resources of the Barents and Norwegian Seas are considered the joint property of the two countries. Besides, the commission establishes the total allowable catch of aquatic biological resources, including cod, haddock, capelin, and halibut, and also determines the procedure for conducting scientific work and its content.

Russia actively cooperates with Norway in aquaculture, including the Arctic region (Federal Agency for Fisheries, 2020). Norway has modern fish breeding technologies that are of interest in the activities of the breeding center in Karelia.

Another interesting form of cooperation is the creation of an aqua luster on the initiative and within the framework of the Norwegian-Russian Chamber of Commerce, which includes 15 leading Norwegian companies in all segments of aquaculture.

We can also highlight the activity of Iceland within the framework of bilateral cooperation. With Russian-Icelandic cooperation, there are such accents and tracks as the mutual possibility of supplying fish catches and other biological resources to the processing enterprises of partners, expanding contacts on resource management or on the transfer of aquaculture technologies, and the production of finished fish products. Shipbuilding and ship repair are being implemented. The training of specialists in the fishing industry and the exchange of production experience of partner countries are also relevant. Experts believe that the cooperation in the field of innovative technologies and Icelandic know-how in the fishing industry can be called the most promising one. It is noted that Iceland offers its partners high-tech and highly efficient equipment for fishing, its processing directly on board and at fish processing enterprises (Russian Fish, 2021a).

Even despite the commonality of many approaches to fisheries management, each of the countries of the region has its pronounced features not only of the economic structure but also a conceptually different vision of the general problems of ocean development, which is reflected in the Arctic theme. For example, analyzing the problems of regulating the production of aquaculture and fishing products in the Arctic on the example of the USA and Norway from the standpoint of the blue economy concept, an international team of researchers has wittily designated the set of conditions and factors affecting economic activity in this area in the Arctic in recent decades as a “perfect storm” (Raspotnik et al., 2021: 123, 132–140).

For some countries – for example, the UK – the Arctic fisheries is not a priority. It gives way to mineral and raw material aspects of cooperation, but the interest in fishing in the Arctic seas is also of practical importance for providing the country’s domestic market with fish. Moreover, this interest extends both to the coastal regions and to the enclave of the Arctic Region, where a temporary ban on fishing is in effect under an International Agreement of 2018 (Todorov & Lyzhin, 2019). Researchers from the UK cite the data that 95% of the cod consumed in the UK in the past decade came from the Arctic seas, namely from the suppliers from Canada, Denmark, the Faroe Islands, and Norway (Depledge, 2018: 91).

China is characterized by a steady increase in efforts in the Arctic as a whole in all sectors. In the fisheries sector, such priorities as infrastructure, resource development, tourism, ecology, and environmental protection in the Arctic region have been identified and confirmed in recent years. For example, it was stated at the highest level that Russia and China would cooperate in the field of polar scientific research, biodiversity conservation, climate projects, and joint Arctic expeditions on research vessels, as well as continuing contacts within the framework of the International Arctic Forum “The Arctic: Territory of Dialogue” (Fishnews, 2019).

Japan also demonstrates its interest in developing the Arctic. At the beginning of 2021, the Japanese side presented a project of cooperation with Russia in the fisheries sector, which contained proposals for cooperation in the Arctic zone. It proposed to participate in scientific research of bioresources and conservation of fish stocks, in the creation of transport infrastructure and facilities of the fish processing industry, including the export-oriented ones (Fishnews, 2021).

Current Tracks of Arctic Fisheries Cooperation in Russia

Within the Russian Arctic zone, fishing activities are represented by three main sectors: industrial marine fishing, traditional fishing of the indigenous peoples of the Far North, and aquaculture. International cooperation in the first two sectors has a long history: for example, in aquaculture, relations between market participants have been actively formed in the last decade as the regulatory environment has been created.

To optimize the activities of the fishing industry in the country, the "Strategy for the Development of the Fisheries Complex of the Russian Federation until 2030" (Government of the Russian Federation, 2019) was adopted, which contains a separate part of the "International Cooperation" project. This particularly emphasizes the need to strengthen the country's position in the regulatory process regarding fisheries, mainly through international agreements. The region also includes sections of international cooperation to ensure favorable conditions for economic activity, as well as to increase the added value of export products, including in the field of aquaculture.

Almost every one of the tasks set out in the strategy contains innovative components, meaning each such task is associated with the development and application of new technologies, namely, researching the resource base, exploring promising types of important biological resources, studying the prospects of industrial fishing in traditional and new fishing areas of the World Ocean (including the Arctic and Antarctica), creating scientific centers for the development of industrial aqua and mariculture, and constructing a new research fleet (Russian Fish, 2021b).

Improving the production base for the extraction and processing of fish and seafood can be considered the most important task for Russia in the context of developing cooperation in the Arctic zone. According to representatives of the Russian Federal Fisheries Agency, one has to improve the efficiency of coastal fishing vessels in the Northern Seas of Russia by introducing innovations; now there are about 5000 tons of catches per year per vessel (Fishretail, 2017). To do this, the region has to replace at least 50 vessels with modern ones over a decade.

Innovative technological processes should increase the added value of finished products and, accordingly, business efficiency, which will change the investment attractiveness of projects. The principle of waste-free production of fish products and the use of elements of fish raw materials for related industries practiced in the Arctic partner countries of Russia is quite in demand in Russia, but has not yet been properly developed, although it is indicated in regulatory documents. For example, Paragraph 2 of the Decree of the President of the Russian Federation No. 164 of March 5, 2020 "On the Fundamentals of the State Policy of the Russian Federation in the Arctic for the Period up to 2035" contains a direct indication of the need to improve the efficiency of production and processing of catches of industrial fishing and aquaculture. Paragraph 16 sets the task of developing international cooperation in the scientific and technical spheres, in the development of oceanic biological resources, while preserving the principles of greening in multilateral and bilateral formats both with the "Arctic Five" and other countries (Official Internet Portal of Legal Information, 2020). The two documents mentioned above create a basis for expanding contacts between business representatives of the Arctic states.

The regional level of cooperation is important for the Russian Arctic, which is based on the interest of individual administrative units in the development of the fisheries sector. The example of Russia is interesting because it combines national and regional programs for the development of the territory and industry. In 2019, the Arctic Fishing Cluster was created; it included fishing, shipbuilding, and ship repair enterprises, and the educational and scientific organizations of the Arkhangelsk, Murmansk, and Leningrad regions, as well as St. Petersburg. The number of participants should be increased at the expense of the economic entities of the Vologda and Kaliningrad regions and Karelia. The cluster extracts and processes fish, develops aquaculture, and also carries out scientific research and development of advanced technologies. It should construct, repair, and maintain ships, and create transport and warehouse infrastructure facilities.

The declared areas of expansion of fisheries activities have revived the interest of foreign partners in cooperation at the level of economic entities. The expected effects of such cooperation for the country include increasing the production of fish and other biological resources, optimizing the production processes, and solving social issues.

In recent years, the main income in the fishing industry of the Arctic zone of Russia is formed due to ocean fishing, within which annual quotas in the Barents and Norwegian Seas are almost completely taken up, but production volumes have been lessened due to the reduction of quotas for the main objects of fishing – cod and haddock. One should follow the example of the Arctic neighbors and take into account the developing cooperation to create a cluster within which a flexible combination of spheres of activity is technologically and organizationally possible.

The results of such an integrated approach to development are manifested not only in providing the fish products for local needs, but also in expanding exports. News agencies reported that two Russian enterprises from Karelia (LLC "Fish Trading Network" and LLC "Barents Group"), which are part of the cluster, managed to enter the markets of the European Union and the UK having successfully passed the certification of the entire technological chain. Fillets and frozen carcasses of cod and haddock were produced at the enterprises that were built in Kondopoga in 2020 under the investment quota program. The total capacity of these enterprises for making the products of a deep degree of processing is over 60,000 tons of raw materials per year, and more than 100 jobs will be created (TASS, 2021b).

Aquaculture has taken a leading place in the fisheries complexes of all the Arctic states. Russia understands the importance of developing this sphere in Russia, but the lack of the necessary infrastructure, technological solutions, and skills hinder the aquaculture industry. Efforts are being made to develop measures to support this area in the Arctic part of the country, taking into account the experience of neighboring countries and the Russian Far East.

It is important to note that natural conditions prevent aquaculture from developing in all administrative units of the Russian Far North, but in the Murmansk and Arkhangelsk regions and the Republic of Karelia at the current level of technology development. In the Arctic regions, there are favorable natural conditions for breeding freshwater and marine fish species that are in demand on the market. For example, there are good conditions for salmon production in the Murmansk Region, sturgeon in the north of the Krasnoyarsk Territory, and trout and whitefish can be successfully bred in Karelia.

The current stage can be considered very promising for foreign partners of Russian economic entities that are forming or developing their contacts for implementing the projects and business ideas related to high-tech industrial activities in the Arctic zone of Russia. Over the past decade, almost all the basic documents on the development of the Arctic region of Russia have laid the foundation for expanding such cooperation in the industrial sphere using the latest achievements of science and high technologies (Revenko & Isachenko, 2017a). This allows us to assume that the business climate in this area should improve and the effectiveness of cooperation should increase.

At the present stage, cooperation on the allocation of quotas, research in the open ocean, and the development of processing and transport infrastructure, ship improvement, and the technological reequipment of the industry as a whole at the regional level is still of great importance for Russia as an Arctic state with the maximum length of the coastline in the Arctic and traditional economic interests. At the same time, new areas of international cooperation are becoming increasingly relevant to create opportunities for optimizing fisheries in the Arctic zone. The prospects for creating the territories of advanced development, the planned large-scale infrastructure solutions, the conditions for port activities, and fish transshipment are all elements that lead to the assumption that inter-company cooperation has become very active in the region.

The creation of "apical points" in the Russian Arctic cannot be imagined without an effectively functioning fishing sector. At the same time, the international factor is one of the possible components of economic activity with unconditional national priorities.

Conclusions

The fisheries cooperation of the Arctic states is at a difficult stage of revising the basic principles, approaches, and concepts that form a common paradigm. There are no grounds to single out any reason for this turbulent state of cooperation; only a complex set of reasons that affect it can be identified. Among the main transforming conditions and factors are the international legal issues of delineation of the shelf and 200-mile economic zones that are under long-term resolution, climate change that is destabilizing all players, the presence of non-Arctic states in the region, changes in the sectoral priorities of economic development of the Arctic in the Arctic countries themselves, and the desire for the sustainability of all types of activities.

A complex tangle of these and other contradictions – primarily related to the need to develop relevant measures for regulating fisheries – delays many issues of international cooperation and leaves many of them to the next generation. However, even in this difficult situation, several promising and practically significant areas of fisheries cooperation in the Arctic can be identified: scientific research of marine bioresources and their possible dynamics in connection with climate change, improving the infrastructure of the fishing industry and updating the fleet of the Arctic states, innovative fishing technologies for processing bioresources of the World Ocean, and developing aquaculture. At the same time, cooperation at the state level in the scientific sphere is of the greatest importance when we speak of the economic entities – in Arctic aquaculture, the innovative infrastructure of the fishing industry, digital technologies. Each of these areas of cooperation contains clearly expressed innovative components.

Fisheries cooperation in the Arctic has good prospects against the complex background of a combination of centrifugal and centripetal trends. The understanding of the need to transform the system of regulation of fishing activities in the Arctic, based on a multilevel approach that allows the interests of all participants in the process to be accounted for as much as possible, cannot but cause optimism.

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Part VI

Digitalization Agenda

Digitalization of the Arctic

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Contents

Abstract

Russia's Arctic digital transformation is a strategic priority for the state. It is supposed to facilitate the socioeconomic development of the Russian Far North, which remains partly cut off from broadband connection and basic Internet services. Another role of digitalization is to enhance transportation and logistics in the Arctic to further explore its resource potential and advance the Northern Sea Route (NSR) as a viable alternative to existing shipping routes connecting Europe and Asia. Over recent years, a number of initiatives were introduced in this sphere, inter alia Gazprom Neft "Kapitan" system or the NSR integrated digital platform; these are aimed at modernizing port infrastructure and workflow, saving transportation costs, and ensuring year-long navigation along the Arctic

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coast considering environmental risks, weather, and ice conditions. The NSR is also viewed as a short and reliable route for transmitting data via submarine cables with two competing projects on the table – the private “Arctic Connect” and the state-funded “Polar Express.” The chapter addresses the questions of the Arctic digital transformation in terms of digital technologies development, certain countries’ experience with a special emphasis on the Russian digital projects, and strategic interests.

Keywords

Digitalization · Digital transformation · Russian Arctic · Digital logistics · Digital divide · Digital projects

Introduction

Communication plays a crucial role in the economic development of the information society. In recent years, scientific discussions over Arctic digital projects have been actively evolving, which should provide a new level of international communication. Control over communication lines and hubs in the Arctic will provide an economic and political advantage for states since the use of such networks is beneficial to both private companies and public sector. This is because, geographically, the Arctic provides the shortest communication distance between Europe and Asia. This in turn means that fewer wires are required to transfer information between the continents.

The complete digitalization of the Russian Arctic remains a challenge for decades ahead; it will require coherent efforts and adequate funding from both public and private sectors. However, the expected benefits of new technologies for the development of the Far North, as well as for Russian economic and strategic interests, outweigh any hurdles along the way.

The problem of the digitalization of the Arctic region is highlighted in the works of many authors. At the same time, it is necessary to note the highly specialized nature of most of the materials. For example, a number of authors (Nordrum, 2014; Gahrn et al., 1987) touch upon exclusively applied aspects of the development of communication systems in the region. At the same time, there is a lack of overview work covering various dimensions of the digital transformation of the region. To a certain extent, this topic was covered by a monograph on the digital divide in the Arctic (Kuersten, 2018). It is important to note the efforts of domestic researchers (Mordvinova, 2021; Marchenko & Babyr, 2021) who conducted an in-depth interdisciplinary analysis of the digitalization of various industries – energy, transport, mining, and transportation of minerals in the Arctic. Data from international organizations – the Arctic Council, the International Telecommunication Union, as well as official documents of the Arctic states – have also become a valuable source of information for this chapter.

Telecommunications as the Basis for Digitalization in the Arctic: Technology and Government Policies

Studying the digital transformation of the Arctic is impossible without addressing the development of telecommunications and data transmission systems in the region, both in terms of technologies used and in the context of certain countries' experience.

In the case of the Arctic, considering the difficult natural conditions, as well as the presence of vast and sparsely populated territories (especially for areas in which it is difficult for private companies to operate), government support measures play an important role.

The development of the communication system, data transmission, and processing technologies is the key to digitalization, whatever the region. It is important to understand that at the present stage in the Arctic, none of the telecommunication technologies, such as satellite communications, fixed lines, mobile, or other types of communications, is universally applicable; each has its own advantages, disadvantages, and limitations of use.

For instance, communication between remote settlements is conducted using fixed-satellite service (FSS) geostationary satellites. Service providers can aggregate traffic at a given location via a ground station and relay it via satellite or provide access to end users directly. The development of technologies and the increase in the communication channel bandwidth has increased the availability of satellite services for the local population and created the prerequisites for introducing the residents of the region to distance education and telemedicine.

At the same time, a significant limitation of the use of FSS communications is the location of satellites. Being in geostationary orbit above the equator at an altitude of 35,786 km above sea level, the satellite, due to the curvature of the Earth at latitudes above 70°, is observed very low above the horizon and can be hidden by protruding objects and terrain relief, which makes signal transmission difficult or impossible.

A possible solution would be to use non-geostationary satellites in low Earth orbits, or in highly elliptical orbits.

Experts include Inmarsat, VSAT, and Iridium, among the most demanded systems (Bekkadal, 2014).

As the authors of the "Telecommunications Infrastructure in the Arctic; A Circumpolar Assessment" report note, "satellite networks have a distinct advantage over terrestrial systems, in that they cover a very large area (whether land or high seas) without the same need for distributed ground-based infrastructure (like fiber and copper lines or transmission towers) that can be vulnerable to damage caused by weather, etc., and which can also be more expensive on a per-destination basis to expand and maintain over time" (Arctic Council, 2017). At the same time, one cannot but pay attention to the high cost of development and operation of such systems, resulting in a significant cost of the service for the end user.

One of the most proven and easy-to-use means of communication remain fixed lines. These include fiber-optic, coaxial, copper, and other kind of cables. Wired communication is reliable and cost-effective, but at the same time, in the context of the Arctic region, it also has a number of disadvantages. The increased load due to subzero temperatures contributes to faster wear of the network and predetermines the need for special maintenance. Considering the relatively lower demand for communication services in sparsely populated areas, the cost of laying cables in the vast expanses of the Arctic, and the need for their systematic maintenance, the use of wire communication may be economically impractical.

At the same time, it should be noted that submarine communication cables have great potential. The key economic advantage of such wire lines is the reduction in signal transit time. For example, when discussing the project of a submarine fiber-optic communication cable between the UK and Japan, one of the main arguments in favor of laying the line was a decrease in the corresponding indicator by 24 ms (Nordrum, 2014). In the case of high-frequency trading, as well as in the context of security issues, such improvements are of great importance.

Copper wires, despite their prevalence, have a serious drawback in the context of application in the Arctic. The digital subscriber line (DSL) technology deployed based on existing telephone lines is highly sensitive to distance.

Fixed wireless communication is another promising technology in the Arctic. The placement of radio repeaters to create a microwave radio relay system in some cases may require them to be in line of sight.

But even this circumstance in the Arctic zone is not an insurmountable obstacle. For instance, "since 1972 the Greenland Telecom Service has been operating a 1500-kilometer microwave radiolink from Cape Farewell to the Diskobay area on the west coast of Greenland" (Gahrn et al., 1987). Despite the relatively lower bandwidth compared to certain wired solutions, fixed wireless communication, considering the lower demand in the Arctic zone, can provide the required quality of communications. In addition, the construction of the appropriate infrastructure is associated with lower costs than laying cables and requires fewer administrative approvals.

In the case of mobile communications, it is important to keep in mind that only the owners of subscriber devices have the ability to move within the coverage area without losing the signal. At the same time, the infrastructure of mobile communications (base stations, power supply systems, and other elements) is fixed. Moreover, base stations are often connected to the main network via fiber-optic cable or through a fixed wireless connection. Thus, in the Arctic region, mobile communication is more common in populated areas. For example, "Faroese Telecom Mobile provides broadband over 4G LTE, which has been deployed and is made available everywhere on the Faroe Islands" (TFICA, 2017). However, the possibilities of using mobile communications in sparsely populated areas are limited.

Government Policies

It is useful to consider the approaches of the Arctic zone countries to the development of communications and digitalization and compare the results obtained.

The Arctic Council includes eight states of the region (Russian Federation, Iceland, Denmark, Norway, Sweden, United States, Finland, and Canada). China is also showing significant activity in the Arctic zone; nevertheless, due to geographical reasons, the country will not be considered in this part of the work.

For the purposes of this study, to compare the experience of the Arctic states and their achievements in the development of communication systems, the International Telecommunication Union's ICT Development Index will be used.

It is no coincidence that *Iceland* ranks first in the ICT Development Index. The country has a developed telecommunications market. As noted by the authors of the Measuring the Information Society Report 2018, "the market shares of the three main operators – Nova, Siminn, and Vodafone – are almost equal. Nova and Operator 365 started their services in 2007, further boosting competition in the market. Mobile-broadband penetration is high and well above the European average" (ITU, 2018). According to the Electronic Communications Office of Iceland, the share of data traffic on mobile networks is steadily increasing. For instance, in 2020 alone, this indicator increased by 49.4% compared to the previous year (ECOI, 2021).

The Parliament of Iceland (Althing) has set the goal of providing broadband Internet access to 99.9% of all users in the country by 2022 (Alþingi, 2012).

Denmark has one of the highest broadband penetration rates in the world, mainly driven by cable networks and DSL technology. Since 1996, the telecommunications market in the country has been one of the most open and competitive in the world. The number of barriers to entry for new companies is minimal.

The Danish authorities are combining effective tax policies with government financial support for areas with low access to high-speed Internet. In particular, tax incentives are provided to households that connect to broadband networks.

Denmark today is in a transition from digitalization to digital transformation. On a strategic level, this is reflected in the completion of Digital Strategy 2016–2020 "A Stronger and More Secure Digital Denmark" (Agency for Digitalization of Denmark, 2016), with a greater emphasis on ICT development, and the transition to the Strategy for Denmark's Digital Growth (Ministry of Industry, Business and Financial Affairs of Denmark, 2018) with a more universal scope.

Norway, like the countries described above, has one of the most developed telecommunications markets in the world. One of the factors in its development is balanced regulation. For example, the Norwegian authorities created conditions for the development of virtual mobile operators in the country, which gained access to Telia's infrastructure, through the thoughtful application of antitrust measures while approving the takeover of Tele2 by Telia in 2015.

The Current Digital Agenda for Norway Strategy places significant emphasis on certain issues, such as developing digital competencies, effectively digitizing the public sector, and ensuring reliable data protection and information security (Norwegian Ministry of Local Government and Modernization, 2015).

The Norwegian authorities attach great importance to the development of telecommunications infrastructure. Thus, in 2004, the Svalbard Undersea Cable System, which connected Svalbard and the mainland with 1400 km fiber-optic cable, was designed and installed to provide data transmission to the Norwegian Space Center (now Norwegian Space Agency).

Sweden is also included in the global and regional list of leading countries in the development of telecommunications and digitalization.

As noted by the European Commission, "according to the broadband strategy 'A Completely Connected Sweden by 2025' (Ministry of Enterprise and Innovation of Sweden, 2016), the focal point has to be people's need for broadband access, whether they live in densely populated areas, scarcely populated areas and rural areas, or in areas situated in between. Sweden is committed to be at the forefront of the development of 5G" (European Commission, 2021).

It is noteworthy that according to the Arctic Council, 99.98% of households in the Sweden Arctic zone have access to LTE networks (Arctic Council, 2017).

The United States, in accordance with the Implementation Plan for National Strategy for Arctic Region, adopted in 2014, sets itself the goal of actively promoting American interests in the Arctic. Among the measures aimed at achieving this goal is the development of communication infrastructure. The responsible agency is the Department of Commerce (National Telecommunications and Information Administration) (The White House, 2014).

Currently, as experts note, there is a digital divide between Alaska and the rest of the states. According to the U.S. Federal Communications Commission, as of 2015, 81% of households in the state did not have access to the Internet at speeds of 25 megabits per second or higher (Kuersten, 2018).

In 2015, the BroadbandUSA program was launched to develop local high-speed Internet access infrastructure. Through the National Telecommunications and Information Administration, which is responsible for the initiative, various organizations in the state of Alaska received more than $31 million for the implementation of various projects related to the development of infrastructure and ICT in the American North (NTIA, 2021).

Finland is one of the leading countries in the implementation of new telecommunication technologies and digital solutions. In particular, back in 1999, the country was the first in the world to hold a tender for 3G licenses. Also, during the 2000s, the Finnish company Nokia held a dominant position in the global mobile phone market.

Finland continues to play a significant role in the digital industry today. The Finnish authorities are implementing a balanced package of initiatives. The main focus is on providing broadband Internet access via fiber-optic cable networks. The state provides financial support to areas where the level of service in the field of communications is considered insufficient. One of the central initiatives of the Finnish government is advisory support to municipalities in setting up joint ventures with other municipalities or private companies to create broadband infrastructure.

In the field of telecommunications and digitalization, the Finnish authorities rely on the "Towards the Internet of Things: Broadband Implementation Plan" (adopted in 2016) and turning Finland into the world leader in communications networks – Digital Infrastructure Strategy 2025 (2018) (LVM, 2019).

In particular, Finland is striving to achieve the goal that 99% of all households and businesses should be located no more than 2 km from a fiber-optic or cable network that provides an Internet connection with a speed of at least 100 megabits per second.

In *Canada*, despite high Internet penetration in urbanized areas, only 41% of rural households have Internet access. To address this issue, the Government of Canada launched the Connect to Innovate program with more than 1 billion of Canadian dollars in public-private funding.

In particular, the Canadian authorities are planning to lay the Dempster Fiber Link, which will connect Dawson City (Yukon) to Inuvik (Northwest Territories) and will close the Canada North Fiber Loop, providing increased reliability of Internet access for the local population. Another example is the Tamaani Internet Phase 5 Project, which combines various technologies – submarine fiber-optic cable, radio stations, and satellite communications – to provide quality Internet access to residents of Nunavik (Québec) (TFICA, 2017).

In *Russia*, the fundamental document defining key approaches to activities in the Arctic is the Strategy for the Development of the Arctic Zone of the Russian Federation and Ensuring National Security for the Period up to 2035 (Kremlin, 2020a).

The strategy states the lack of development of information and communication infrastructure and competition in the telecommunications sector in the region, but at the same time it is noted that "the share of households with broadband access to the Internet in the total number of households in the Arctic zone has increased from 73.9% in 2016 to 81.3% in 2019" (Presidential Administration of Russia, 2020). At the same time, the strategy pays special attention to the issues of the functioning of networks and communication systems. Thus, the document stipulates "the creation and development of highly elliptical orbit satellite constellation which provides satellite communications for users in the Northern Sea Route region" and "the creation of a trans-Arctic submarine fiber-optic communication line with the branch lines to the largest ports and settlements of the Arctic zone" (Presidential Administration of Russia, 2020).

Taking into account that telecommunication systems are the basis for the digitalization of the Arctic, it seems that the digital transformation of processes in the region will be preceded by the initiatives of the Arctic states to develop the infrastructure for data transmission and processing. The intensification of the relevant work, as outlined above, has been observed over the past decades and, undoubtedly, will continue to grow.

Transport Infrastructure Digitalization

The global information era makes digitalization a key factor in transforming the economy and modernizing society. The use of digital technologies improves connectivity, enhances logistic processes, and speeds up data exchange and analysis.

The impact of digitalization is felt even more in underdeveloped regions with long distances between settlements and poor infrastructure. This is clearly the case for the Russian Federation; its Arctic region, called the Far North, comprises about one third of the country's territory and just 7% of its total population (The Federal State Statistics Service, 2021). With harsh weather conditions and permafrost, the Russian Arctic is an extremely uncomfortable place to live in; at the same time, it possesses enormous mineral and natural resources and has a growing potential for maritime transportation via the Northern Sea Route (NSR).

Harnessing the potential of the Russian Arctic requires complex development of its infrastructure, utilizing hardly accessible resources, and most importantly improving the lives of people living there and attracting new settlers to the Far North. All this is impossible without the digitalization of the Arctic. With ever-increasing demand for online services, e-commerce, and technological solutions, the digitalization agenda is already a top priority in Russia and is one of its national development goals.

In the Russian Arctic, digitalization has emerged as a cross-cutting solution for many challenges identified in the Strategy for the Development of the Arctic Zone of the Russian Federation and Ensuring National Security in the Period up to 2035. The first and foremost goal of digitalization for the Russian government is to improve the socioeconomic conditions of the Arctic region. At the present time, its lack of adequate telecommunications, infrastructure, and Internet access is one of the main reasons why people leave the Far North. The improvement of digital connectivity can help stop out-migration from the region and even attract new settlers by providing better living conditions (Mordvinova, 2021).

The Russian Arctic is a clear example of the so-called digital divide, especially comparing the villages of Northern Siberia and the Far East with urban areas in the European part of the country. Small-numbered remote indigenous communities are the most vulnerable to digital isolation. Although indigenous peoples of the North in Russia are included in the special census category and enjoy certain benefits, in many spheres they remain dependent on public services provided remotely, for instance, health care through telemedicine.

The second key factor to consider the digitalization of the Russian Arctic is its enormous resource potential. This region is one of the most attractive and promising areas in terms of hydrocarbon production. According to the strategy, Arctic offshore and coastal basins would account for 26% of total crude oil and 79% of total gas production in Russia by 2035 (2035 Strategy 2020).

The energy sector is extremely capital and labor-intensive, so both huge investments and adequate manpower are required in the Arctic well into the foreseeable future. The main task for digitalization here is to help choose an optimal transportation route and create an effective logistics system for offshore fields. The development of digital connectivity is the cornerstone for building up infrastructure and exploring energy resources along the Arctic shore (Marchenko & Babyr, 2021).

At the same time, the Russian government is aware of the fact that the resource-based economic model is reaching its limit and is looking for new drivers for growth. Domestic and foreign private capital is needed to spur the economic activity in non-energy sectors, and it is extremely dependent on digital connectivity. The creation of network infrastructure would provide much better conditions for setting up medium- and small-sized companies to invest in the Far North.

The above-mentioned reasons behind the digital transformation of the Russian Arctic have already spurred numerous initiatives in different spheres to digitalize the most remote and harsh region in the world.

One of the simplest yet most effective solutions already being implemented is digitalization of port infrastructure. Managing port traffic, loading and unloading operations, and ensuring safety of personnel all are impossible without information technologies. Many Russian sea ports have already implemented selected technologies or installed automated systems such as electronic workflow. However, complex digital solutions are yet to be introduced.

The first attempt to digitalize Russian Arctic ocean ports was made by the Ministry of Transport. In 2017, it launched a unified communications system for the Arctic transport which provides comprehensive cartographic, hydrometeorological, navigational, and communication services for cargo and passenger transportation in the Arctic zone (Mordvinova, 2021).

Ports in the Western Arctic are leading the digital transformation process. As early as in 2019, they introduced a single electronic workflow system to cut time and labor costs for documentation and make it more transparent. Eastern Arctic ports are far more isolated, interact with each other in a limited way, and still rely much on paper-based workflow. Thus, the key challenge here is to enhance electronic communication and integration between ports in order to create logistical corridors that ensure fast, easy, and effective transportation.

Digitalization of ports is only a part of broader efforts to advance and develop the Northern Sea Route (NSR). This shipping lane running along the Russian Arctic coast is emerging as a globally competitive transport corridor. The recent week-long Suez Canal blockage has also contributed to the popularity of the NSR, now being viewed as a way to hedge logistical risks and make global trade more sustainable.

At the same time, there is a variety of challenges related to the effective development of the Northern Sea Route, such as environmental risks and threats to the safety of navigation. There is an evidence-based belief that digitalization could mitigate these risks and increase the efficiency of the route, thus making it more attractive, especially for foreign users (Shagina & Buchanan, 2021).

Rosatom State Corporation – as the infrastructural operator of the route and owner of Russian nuclear ice-breaker fleet – has started developing an integrated platform for NSR digital services on August 2020. The platform will be used for planning and coordinating navigation along the Russian Arctic shore, taking into account ice conditions and weather data. The new digital solution will use machine learning and big data technologies that can optimize vessel escort time and fuel consumption, and eventually increase the volume of cargo transported along the route.

A truly unprecedented and innovative solution is needed, as no other route operates in such harsh and unpredicted weather conditions as the NSR.

It is useful to imagine the challenge which this service will confront. Within hours it should track a 12-day route through the Russian Arctic with exact arrival time at the destination port. To achieve this, the system should use precise calculations and complex algorithms based on multiple input sources such as wind direction and speed, ice density, and drift. The artificial intelligence would be able to analyze and interpret hundreds of satellite images and synchronize its actions with other IT platforms including the ice-breaker navigation system.

As Deputy Director of the NSR Administration Kirill Volovik noted, "if such a megatask is achieved, this will be a real breakthrough never ever achieved for the route with such harsh ice conditions" (Russian Sea News Portal, 2021).

A separate task to be implemented by the digital platform is environmental monitoring. International experts are concerned about the fragile Arctic ecosystem and consider that ecological risks related to utilization of the route are rising as its traffic volume increases. To mitigate these threats, the digital service would track ten layers of environmental indicators including ice color, exhaust emissions produced by diesel vessels, conservation of wildlife habitats, and underwater biodiversity.

What is beneficial for the Russian economy is that local IT companies and contractors are involved in developing the digital platform. At the same time, they will use international experience in digital logistics to further connect the NSR platform with major world logistic services.

It is worth mentioning that some Russian energy corporations have already adopted digital solutions for their logistics in the North. In 2019, Gazprom Neft launched the first ever digital Arctic-logistics management system called "Kapitan (Captain)." The company operates the Prirazlomnoye field – the only Russian hydrocarbon production project implemented on the Arctic shelf – and the Novoportovskoye field located on the Yamal Peninsula. Crude oil produced from both projects should be delivered uninterruptedly year-round through the NSR to its East Asia customers.

The Kapitan system is a multidimension solution which integrates long-term and operational planning, control and scheduling of Gazprom Neft Arctic fleet, and artificial intelligence analysis. It makes use of various data sources such as production volumes, crude stocks, the location of vessels, and en route ice and weather conditions.

The system's AI capacity allows an integrated and real-time analysis of the fleet efficiency, speed, load volumes, and fuel consumption. According to the company, Kapitan processes 15,000 input variables, issues optimal logistic solutions from more than 66.5 million options, and corrects them immediately in response to any deviations (Gazprom Neft, 2019).

Early data shows this digital system has facilitated significant time savings in planning and coordinating oil shipment operations and optimizing transportation costs. Gazprom Neft records a 12% reduction of maritime logistics costs due to Kapitan's implementation, or ₽900 thousand (circa $12,000) per one ton of Arctic crude oil exported. Benefits include better fuel economy, lower expenditures on ice-breaker support, and less downtime.

The head of Gazprom Neft Logistics and Operations Directorate Vadim Sidyakin said: "The Kapitan system has proved itself not just as a unique digital solution, operating on cutting-edge machine-learning technologies, artificial intelligence, and neural-network algorithms, but as a key element in the complex logistics system of the Arctic. The solutions it offers can be used not just by Gazprom Neft but also by other market participants operating along the Northern Sea Route" (Gazprom Neft, 2021).

From the digital perspective, the NSR is not just the shortest cargo route from Europe to Asia, but is also the fastest way for transmitting information via fiber cables. Submarine cables, not the satellites, are the backbone of the Internet as they provide over 95% of international communications (Lehto et al., 2019).

Shorter cables mean shorter latency (the delay in which information moves between origin and destination). Many sectors and technologies rely on latency, including the global financial system, 5G Internet, and big data. Thus, international players have their eye on the prime latency that Arctic digital venues provide.

Moreover, most traffic from Europe to Asia routed via the Red Sea and Egypt is subject to high risks due to overload, several bottlenecks, and attacks on critical infrastructure. Over the past decades, global operators have expressed concern about the vulnerability of the existing network and looked for diversification to secure the ever-increasing traffic volume. The Northern route was considered to be a viable alternative with reduced chance of disruption caused by human activity (Shagina & Buchanan, 2021).

Until recently, an ambitious project in this sphere was a trans-Arctic data cable dubbed "Arctic Connect." The joint project – by Finnish state-owned company Cinia Oy and Russian telecommunication company MegaFon – was launched in 2016 with a goal to link Europe and Asia via a 13,500-km-long submarine cable laid along the Northern Sea Route. It is not only an international project supposed to improve connectivity between the two continents with reliable high-speed Internet; "Arctic Connect" also has a nationally oriented dimension. A separate cable system is expected to connect Russian Arctic coastal cities to broadband Internet and thus boost economic development of the Far North.

According to MegaFon, the total estimated cost of the project is around $1.2 billion, and the founders still struggle to find the necessary funding. In 2020, Japanese Sojitz Corporation entered the deal to finance the cable construction but later the Russian side blamed it for delaying negotiations and implementation of the project.

As a result, in May 2021, MegaFon and Cinia announced the suspension of "Arctic Connect" for its further assessment. Experts think uncertainty about the project's profitability, as well as a COVID-related price increase, might have been the reasons behind this decision (Vedomosti, 2021). However, the project remains on the table and may be revived if other international partners, perhaps from China, South Korea, or Northern Europe, show interest.

The Russian government itself demonstrated its belief in the viability of such initiatives by launching its own subsea cable project – "Polar Express." In November 2020, the Ministry of Transport, together with the Federal Agency for Maritime and River Transport (Rosmorrechflot) and Federal State Unitary Enterprise Rosmorport, announced the construction of a 12,500-km fiber-optic link between Murmansk and Vladivostok – two main ports on opposite sides of the world's largest country (Rosmorrechflot, 2020).

All regions of the Russian Arctic coast are to be connected to the submarine fiber-optic network and the network itself is to be included in the existing trunk of international data routes. The Russian government also views the "Polar Express" as a permanent and reliable communication channel to operate Arctic ports and the NSR navigation.

This year, nine ships will start laying the underwater cable with six pairs of optical fibers, capable of withstanding temperatures from −50 °C to +50 °C. The cable landing station was already built in Teriberka in the Murmansk region in 2020. The project is scheduled for completion in 2026 (Morsvyazsputnik, 2021).

Given the troubled history behind different long-stagnated cable projects in Russia, the future of both initiatives is unclear. However, as Russian Arctic digital projects remain outside the remit of Western sanctions, this sphere represents one of few viable investment opportunities for foreign capital in the country after 2014.

One of the most promising digital trends apart from cables are data centers. With ever-increasing need for data processing and storage capacity, investors look for ways to save costs on electricity and cooling equipment. The Arctic with its frigid environment and relaxed tax regime provides a natural fit for data centers. Following a successful case of Nordic countries, Russian companies also plan to harness the potential of the Far North in this regard. For instance, Rostelecom just announced the construction of a data processing hub in Murmansk region (RIA Novosti, 2021).

The harmonization of these initiatives with sea cable projects could create a considerable digital boost for developing Big Data, the Internet of Things, and other cutting-edge trends in the Russian Arctic.

Considering the Arctic as a zone of strategic importance, the Russian government definitely spares no effort in supporting connectivity projects in the region through state participation and financing. State guiding documents outline particularly the socioeconomic impact of digitalization. Inter alia, the need to close the digital divide in the Arctic was formulated as a state priority by the Federation Council deputy head Andrey Turchak (United Russia, 2020) and in the Strategy for Spatial Development of the Russian Federation for the Period up to 2025 (Ministry of Economic Development of Russia, 2019).

A lot of small- and middle-sized communities in the Far North, and even whole regions – like Chukotka at the northeast edge of the country – remain cut off from the broadband Internet and have to rely on expensive and unstable satellite connection.

The state digitalization program will provide broadband connection to all settlements in the Arctic with a population above 250 people in 2021, and with population from 100 to 250 people in 2022. ₽14 billion (roughly $190 million) were allocated for these purposes just for the current year (United Russia, 2020).

Recent achievements in this sphere include laying a 400 km fiber-optic cable to the northern part of the Republic of Yakutia, which has made possible for remote districts to switch from satellite to 4G-Internet connection (arctic.ru, 2020a).

Digital Projects Overview: Positioning Russia

The Arctic region has a great potential in the development of digital projects, such as projects in the field of telemedicine, unmanned vehicles, distance learning technologies, digital services for transport and logistics services, environmental monitoring systems in the Arctic zone using information and telecommunication technologies, and the creation of data processing centers.

In relation to digital projects development, the following features of the Artic zone are of high importance:

- Extreme weather and climate conditions, extremely low population density, and the level of the development of transport and social infrastructure
- High sensitivity of ecological systems to external influences, especially in areas where the indigenous peoples live
- Climate change, contributing to the emergence of both new economic opportunities and risks to economic activity and the environment
- Stable geographic, historical, and economic link with the Northern Sea Route
- Unevenness of industrial and economic development of certain territories of the Arctic zone, orientation of the economy to the extraction of natural resources, its export to industrially developed regions of the world
- High resource intensity of the economic activity and life support of the population, dependence on the fuel supply, food and other vital goods from other regions
- Growth of the conflict potential on the Arctic

The world community is actively involved in the development of the scientific and technological infrastructure of the Arctic. At the moment, Russia and China are two key actors in the digital development of the Arctic zone. Moreover, if part of the Arctic climate zone belongs to the territory of Russia, the People's Republic of China has to look for foreign policy reasons for the development of large-scale Arctic projects. For example, in 2018, the country declared its interest with the Polar Silk Road project as a program under the Belt and Road Initiative project.

The Polar Silk Road project should be implemented in the period from 2021 to 2025. Within its framework, it is planned to build a new Arctic cargo route through the northeast, northwest, and central parts of the Arctic zone, connecting Europe and Asia. It is also planned to launch a satellite group to track cargo transportation and the state of the Arctic ecosystem (the launch of satellites is scheduled for 2022) (Reuters, 2021). In 2015, the Digital Silk Road was presented again as an integral part of the Beijing One Belt, One Road initiative (now referred to as the Belt and Road Initiative). The program represents a set of projects in the field of telecommunications or data-related business transactions. In 2018, China and Finland signed an agreement to create a joint research center at the Arctic Space Observatory, as well as a data exchange service.

Given the weak infrastructure development of the Arctic territories, IT corporations pay attention to the quality of communication on the territory of the proposed location of the IT cluster. The team of the World Economic Forum developed the Network Readiness Index methodology to provide an aggregated assessment of the quality of communication and communication infrastructure (World Economic Forum, 2021). In this case it is vitally important for the public sector to ensure the stability of the Internet access throughout the territory, despite the difference in population density. Private telecommunications operators are not interested in investing in sparsely populated areas, so the development of such areas often remains the responsibility of the public sector.

The length of the data transmission wires is still important – a shorter cable length means less signal delay; in industries like finance, it is critical. For example, organizations using automated exchange trading algorithms (trading bots) in New York locate their data centers as close as possible to the exchange building in order to reduce the distance of information transmission over cables – these milliseconds of speed can play a decisive role in exchange trading. Accordingly, communication delays are becoming an increasingly critical factor in the development of digital technologies, and the solution to this problem is attracting the attention of transnational companies and states. However, at this stage, the issue of mobile and wired Internet in the region has not yet been resolved, which remains the primary task of digital development.

In general, three main types of data-related business can be carried out in the Arctic:

- Processing large amounts of data with an emphasis on information storage (Facebook, Google)
- Special calculations for R&D
- Cryptocurrency mining and digital networks operations

Another priority area for the development of digital projects in the Arctic is the creation of a network of data centers. At the present moment, IT projects in the Arctic are reduced mainly to laying telecommunication channels and building data centers.

Although the idea of building data centers in the Arctic is controversial, a number of factors can determine the success of the idea:

- Territories of permafrost are not very suitable for life, and therefore are free for commercial needs.
- Low air temperatures eliminate the need for expensive and energy-intensive cooling systems.
- The heat generated by computer machines can be used to heat neighboring buildings.

Lulea, in northeastern Sweden, is home to Node Pole, Facebook's first data center outside the United States. Facebook Corporation opened this Arctic data center in 2011. In the same year, Google opened its data center in the Finnish city of Hamina. Large IT companies began to pay attention to locations with cold climates to save on cooling systems, which make up a significant part of the operating costs of data centers. The temperatures in the subarctic zones are low enough to cool the devices by overflowing air from the street.

The construction of the Swedish data center is a response to huge amounts of data generated around the world, which is doubling every 18 months (The Guardian, 2015). The location was chosen not only because of the low air temperatures that naturally cool the storage, but also because of the availability of electricity. In the last century, Sweden began building hydroelectric dams for its steel and iron industries. The number of factories declined, leaving the northern region with a surplus of energy.

At the same time, the price of electricity remains a significant factor for IT companies' operation in the Arctic. For example, Iceland, with a population of 350,000 people, has a large number of factories for the production of energy, including renewable ones, which allows European companies to reduce energy costs when basing data centers in Iceland fivefold compared to the mainland. Consequently, the attractiveness of the Arctic zone for IT clusters is determined by the optimally low temperatures and the low cost of electricity.

If the region provides optimally low temperatures for the operation of data centers throughout the year, then there is no need to install complex cooling systems. Construction of such structures costs an average of 15 million U.S. dollars per 1 megawatt of capacity. Refusal of a mechanical cooling system will save up to 40% of the cost of capital construction (The Register, 2016). At the same time, the construction of data centers in the Arctic requires the laying of wide communication channels, and, along with saving on cooling, does not exclude the need for heating to provide the necessary microclimate for the data center. The most suitable climatic conditions for natural cooling are in the subarctic zone or at the very beginning of the arctic zone.

For Russia, the development of Arctic digital projects also means the chance of attracting domestic and foreign investment in non-resource sectors of the economy. This fact is especially important against the background of the growing instability of the global raw material market. The Arctic regions have a chance to move away from the economic model of resource extraction to the development of the tertiary sector of the economy and become more economically independent. The foundation of a digital network infrastructure coupled with targeted development programs can attract small and medium-sized business to the Arctic regions.

The development of digital projects in the Russian Arctic has the following goals:

- Social-economic development of the region
- Development of a national telecommunications network to provide digital services to the population
- Reduction of the digital divide in the Arctic zone
- Control of emigration from the Arctic regions by raising the standards of living
- Development of the Northern Sea Route
- Development of military and resource extraction projects

The topic of the digitalization of the Arctic from the development of communications to the development of urban infrastructure is reflected in Russian strategic planning: In March 2020, the President of Russia signed a Decree on the Foundations of the State Policy of the Russian Federation in the Arctic for the Period up to 2035 (Kremlin, 2020b). In addition, the "Strategy for the Development of the Arctic Zone of the Russian Federation and Ensuring National Security for the Period up to 2035 has been adopted" (The Council of the Russian Federation, 2020).

The Decree of the President of the Russian Federation “On the Strategy for the Development of the Arctic Zone of the Russian Federation and Ensuring National Security for the Period up to 2035” clearly states three major theses (Kremlin, 2020a). First of all, the decree implies a regional approach to the Arctic region with a priority attitude towards such areas as the Arkhangelsk Region, the Republic of Karelia, the Komi Republic, and others. Secondly, the decree sets out the strategic development goals, which include the common maritime infrastructure located at the strategic junctions of the Northern Sea Route in the Barents, White, and Pechora Seas. Thirdly, the need to expand the digitalization of services in the field of transportation and delivery of goods is especially emphasized.

The share of the households with broadband Internet access in the total number of such households in the Arctic zone increased from 41% in 2014 to 59% in 2019. Sea cables account for 99% of all telecommunications data flows in the world (The National Interest, 2021). In the early 2000s, the Russian company Polarnet launched its R.O.T.A.C.S (Russian Optical Trans-Arctic Submarine Cable System) project, which was estimated at $1.9 billion. This cable was supposed to connect London to Tokyo via the Northern Sea Route (CommsUpdate, 2013). The project was never implemented due to numerous funding problems.

The project was revived in 2016, when the Finnish state-owned company Cinia announced the Arctic Connect project, which provides for the creation of an underwater fiber-optic communication line stretching along and beyond the entire Northern Sea Route. It is planned to lay a 10,000-km-long communication cable along the bottom of the Russian water area (99% on the Internet cables are located at the bottom of the sea). The project should provide a new quality of the Internet connection between Europe and Asia with much shorter signal latency and better connection stability. A key feature of the northern water area is poor navigation, which is often the main factor in mechanical damage to marine Internet cables. At the same time, within the framework of the project, two telecommunication highways are being implemented – one will connect Europe and Asia with a stable Internet connection, the other will provide access to the coastline territories of Russia to the broadband Internet (The National Interest, 2021). The project cost is tentatively estimated at $0.8–1.2 billion. The international consortium (apart from the Finnish infrastructure operator Cinia) also includes the Russian telecommunications company MegaFon. The broadband Internet should open new opportunities for the development of digital projects in the Russian Arctic, since a stable connection will allow the introduction of Industry 4.0 technologies: the Internet of Things, high-speed wireless communication of the fifth generation, and other technologies that are important for increasing production efficiency. At the time of 2021, the project was frozen as a result of negotiations with one of the projects participants – the Japanese trade and investment company Sojitz Corporation.

Russia is also implementing its own Internet communication projects. The Ministry of Transport of the Russian Federation, together with “Rosmorrechflot” and “Rosmorport,” launched their own project for laying a 12,500 km cable with the ability to transfer data at a speed of 52–104 terabits per second in the northern water area, connecting Murmansk with Vladivostok by 2026 (Arctic.ru, 2020b).

Following the Nordic countries, there is a surge in the construction of data centers in the Russian Arctic, which is a proactive step given that the need for data processing and storage capacity will only increase. In the Russian Federation, the initiative is supported by the Federal Council (RBC, 2020). Plans have already been announced by Rosatom, the Russian state corporation, to build a data center based on the Kola nuclear power plant to ensure the operation of digital platforms for the development of the Northern Sea Route and the Arctic zone.

The Russian lawmakers are assessing the possibility of locating data centers in the Arctic as an opportunity to stimulate domestic production of sophisticated electrical equipment. The Council for the Development of the Digital Economy under the Council of the Russian Federation recommends launching a program to open a network of data centers in the Arctic on Russian hardware and software systems (RBC, 2020). The construction of such complexes as conceived by the legislators should be carried out by private business with grant support from the state, since the economic benefits of building IT clusters in the harsh Arctic conditions are completely clear. Moreover, the state can buy the capacity of such centers to service state scientific and practical projects.

The development of mining farms also has a potential for growth in the Arctic. The first crypto farm on the territory of Norilsk was founded near a stopped nickel plant, taking advantage of the harsh climate and cheap energy from the Norilsk Nickel (Russian mining and metallurgical corporation) power plant, which mainly uses gas and hydroelectric power plants (Forbes, 2021). The BitCluster data center opened in 2020 as part of an international infrastructure project headquartered in Switzerland. The principle of operation is a "mining hotel," which means that devices for clients are placed on the territory of a crypto farm.

Another type of digital projects is information modeling of physical objects. The Far East Development Fund, Vnesheconombank, the Russian Ministry for the Development of the Russian Far East, and Lomonosov Moscow State University are developing a digital twin of the Northern Sea Route based on the platform "Arctic Labs."

This digital twin is a dynamic mathematical model through which scenarios can be plotted for the development of the Arctic territories – its logistic routes are based on more than 10,000 parameters (natural resources, transport, infrastructure, logistics, etc.). Such a comprehensive model will make it possible to assess the impact of investment projects on the economy and ecology of the region, as well as on the welfare of the entire country (Tadviser, 2021).

The construction and development of data centers and other projects in the Arctic will not be possible for private business without state support, either expressed in administrative, tax measures, or in the application of the mechanism of public-private partnerships and concessions. Already in 2020, the Decision of the Council for the Development of the Digital Economy under the Federal Council of the Federal Assembly of the Russian Federation, following the meeting on the topic "Prospects for the digital development of the regions of the Arctic zone," draws a recommendation for the authorities to amend the legislation regarding concession agreements and public-private partnerships in terms of improving the application of these mechanisms and attracting extra-budgetary investments for the implementation of projects in the field of information technology and communications in the Arctic zone.

Also, the mechanism of experimental legal regimes in the field of digital innovations in the Russian Federation can be mentioned (Federal Law No. 258 of July 31, 2020), which allows certain provisions of federal and regional laws to be suspended for testing digital innovations. For example, unmanned vehicles in most of the world's jurisdictions have restrictions that prevent their use on public roads. At the same time, the development and adoption of a set of legal changes that ensure the freedom to operate drones can take years. The application of the mechanism of experimental legal regimes will allow in a test mode to provide the necessary and reasonable freedom to drones in a few months.

Using such a mechanism in the Arctic, coupled with the territory's low population density (and, consequently, lower risks for the population), the state can attract not only Russian corporations, but also foreign ones engaged in the development of innovative products. Already nine experimental legal regimes are being launched in the Russian regions in the field of unmanned ground and air transport, telemedicine, communications, finance, big data, and the use of robotics systems.

These initiatives can be strengthened by the implementation of a special economic regime in the Arctic, the idea of which is reflected in the Arctic Development Strategy. The design of such an economic regime should be aimed at stimulating the development of all the necessary sectors of the region's economy, in particular the high-margin information technology industry. Such an initiative will attract private capital and business models that cannot be implemented under standard conditions for legal or economic reasons.

Conclusions

Basing on the analysis of the Arctic states' experience, one can argue that they all face common problems in the development of communication systems. Among them there are the limits of use of such technology due to the geographical and climatic characteristics of the Arctic. The sparse population of vast territories can also make the implementation of certain infrastructure projects economically unviable. However, it can be stated that the interest of both the countries of the regional and nonregional players in the Arctic is steadily increasing, as well as the level technology and the number of the population.

Given the advantageous geographical location of Russia, especially the access to the Arctic Ocean, China sees Russia as a partner in the digital program of the Polar Silk Road. This will allow attracting capital investments in the Russian Arctic. Moreover, it is technologically more profitable for Russia to develop independent digital projects: otherwise, developed tech giants from China (like Huawei) will sweep Russian nascent developments out of the market. Russian Arctic projects are still outside the field of sanctions activity, which potentially opens up opportunities for international commercial cooperation in the Arctic and attracting foreign direct investment. On the Russian side, Arctic projects are implemented mainly by state forces – such state-owned companies as Rosatom, Rostec, and Rostelecom. The involvement of private companies and capital is complicated by regulatory constraints and the need for large-scale capital investments with a long return on investment. Such mechanisms as experimental legal regimes and public-private partnership can help to attract private capital in the Arctic zone digital projects.

The challenge remains as huge as the territory of the Russian Arctic. The complete digitalization of the region requires a systematic approach and the concerted effort of the government, state-owned enterprises, and the private sector.

Examples demonstrated in this chapter prove there is no shortage of well-intended initiatives and projects driven by socioeconomic necessity, the need for energy exploration, and state interests. External factors including climate change and increasing data traffic between Europe and Asia are also favorable to digitization efforts. However, enormous funding requests and troubles with creating a conducive developmental environment in Russia represent a hurdle that will take years to overcome.

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Digital Technologies of Oil and Gas Companies in the Development of the Arctic Shelf

A. V. Sheveleva

Contents

Abstract

Harsh climatic conditions, as well as the geopolitical situation, hamper the development of projects on the Arctic shelf. Practically year-round subzero temperatures, long polar nights, ice cover in the Arctic seas, and drifting ice make production processes for oil and gas companies more difficult and expensive and more dangerous for the environment. The development of the Arctic shelf in Russia is complicated by the technological sanctions imposed in 2014 by the United States and European countries, which prohibited foreign companies from participating and investing in projects of deepwater development of the Russian Arctic shelf zone, as well as supplying the country with equipment and technology necessary for the work. As a result, oil and gas companies were forced to look for the best ways to solve these problems. One such way at the present stage was the active introduction of digital technologies – in particular digital twins, robots, and big data – into the production and economic activities of oil and

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gas companies. Digital technologies may be able to intensify production processes while reducing the cost of production and increasing the efficiency of operations. Based on the example of some foreign oil and gas companies, the potential benefit of their use has been proven. At the same time, the author proposes possible new directions of digital technology application in the development of the Arctic shelf by oil and gas companies, which are designed to provide solutions not only to the problems of the companies themselves, but also to more global issues, such as the preservation of the unique ecosystem of the Arctic shelf and ensuring its sustainable development.

Keywords

Digitalization · Oil and gas companies · The Arctic · The Arctic shelf · Arctic shelf development · Sustainable development of the Arctic shelf

Introduction

At a time when the most accessible fields are being depleted and there is a possibility of starting a new cycle of the world oil price increase, the Arctic shelf fields become the most important strategic resource for the Arctic countries (Russia, the USA, Canada, Norway, and Denmark), which are beginning to actively develop them.

Interest in the Arctic shelf zone is also due to the presence of significant resource potential (Table 1).

In extreme climatic conditions, the difficult ice situation, the lack of developed logistics, and the presence of significant environmental risks – exacerbated due to the slow process of self-restoration of the Arctic shelf ecosystem – oil and gas companies engaged in its development require nonstandard technical solutions and innovative approaches to the processes of exploration, drilling, production, and transportation of oil and gas. Digital solutions are among these approaches. When

Table 1 Resource potential of the Arctic shelf, as of 2020

	Proven reserves			
		Arctic shelf		
	Global	Natural indicator	Share in the global volume, percent	Share in the global volume, percent
Oil, billion barrels	1732.4	83.0	4.8	13.0
Gas, trillion cubic meters	188.1	50.0	26.6	30.0

Source: Compiled from data of Statistical Review of World Energy 2021, 70th edition. Retrieved from: https://www.bp.com/content/dam/bp/business-sites/en/global/corporate/pdfs/energy-economics/statistical-review/bp-stats-review-2021-full-report.pdf; Estimates of the U.S. Geological Survey USGS. Retrieved from: https://www.usgs.gov/; The Ice Has Broken: The Arctic Shelf Will Become a New Oil and Gas Province of Russia. Retrieved from: http://rapsinews.ru/incident_publication/20,200,311/305560010.html an offshore field is remote from the mainland, its development and operation require significant financial resources, and wells are more complex and technological in comparison with onshore fields; appropriate technologies – in particular Internet of Things, robots, drones, digital twins, or big data technology – are needed to make operational decisions, increase efficiency of operations, and reduce financial costs. However, it should be noted that, at the same time, it is also necessary to comply with stricter environmental requirements on the Arctic shelf during the development of oil and gas fields, to preserve its unique ecosystem and ensure sustainable development of the region.

In this regard, the hypothesis of this study is that digital technologies can not only improve the operational efficiency of oil and gas companies – due to the fact that they reduce costs, ensure increased production volumes, and increase the oil recovery factor – but can also ensure environmentally safe development of the Arctic shelf and solve the urgent problem of climate change.

Literature Review

The author has studied a number of sources on the aspect under study, which made it possible to identify already existing points of view and give the author's suggestions on this issue: That the goals of using digital technologies by oil and gas companies, especially in the development of the Arctic shelf, should not be limited to purely internal goals of oil and gas companies themselves; they should address more global issues, in particular in the field of environmental protection and the preservation of the unique nature of the Arctic shelf.

Modern scientific literature already includes a large number of studies that address the main features that characterize the Arctic shelf and the oil and gas fields located within it, in comparison with the fields located on the mainland territory. Also, these studies pay special attention to the problems that oil and gas companies face in the process of development and exploitation of the Arctic shelf (Antipova, 2018; Boyarinov & Litvinova, 2021; Dzyublo et al., 2020; Kruk et al., 2018; Nenko & Olimpieva, 2017; Starkova, 2019; Tasmukhanova & Shigapova, 2018; Tsvetkov et al., 2018).

Since one of the possible solutions to some problems of the Arctic shelf development by oil and gas companies could be digitalization, there are a number of scientific papers, both by Russian and foreign authors, devoted to the digital transformation of the global oil and gas industry in general and the use of digital technology by international oil and gas companies in particular (Vasilev et al., 2020; Voronina & Evseev, 2019; Cann & Goydan, 2019; Dmitrieva & Romasheva, 2020; Kazanin, 2020; Khodkovskaya & Stoyaltseva, 2018; Litvinenko, 2020; Lyasnikov et al., 2020; Peskova et al., 2018; Petukhov, 2020; Sheveleva & Zagrebelnaya, 2020; Suloeva & Martynatov, 2019; Fadeev & Lisunova, 2021; Zhukov, 2021; Inozemtsev, 2021; Savoskin & Rozhkova, 2021).

At the same time, we would like to note that, in almost all the studies conducted on the issues of the digitalization of production and economic processes of oil and gas companies in general and the Arctic shelf development in particular, digital solutions act as one of the ways to improve the efficiency of the companies themselves, which should result in minimizing their costs and maximizing profits. However, the author of the chapter proposes to consider the introduction of digital technologies by oil and gas companies in the development of the Arctic shelf also in terms of possible solutions to global and local environmental problems, primarily the problems of climate change and pollution of the atmosphere and the aquatic environment of the Arctic seas.

Peculiarities and Problems of Arctic Shelf Development

The activity of oil and gas companies in the development of resources is associated with problems: Among which, firstly, the high degree of field depletion, low oil recovery factor, accidents accompanied by emissions of pollutants into the atmosphere, and destroying the natural environment are noted. Considering that most of the oil and gas reserves are concentrated on the shelf – in particular in the Arctic – and, accordingly, their development is carried out there, a number of other problems, in addition to the above-mentioned ones, are added (Dzyublo et al., 2020; Kruk et al., 2018; Nenko & Olimpieva, 2017; Tasmukhanova & Shigapova, 2018).

These issues include: firstly, the extreme nature of the natural and climatic conditions of the Arctic shelf; secondly, the poor geological study of the Arctic shelf; thirdly, the undeveloped or often complete absence of infrastructure of the Arctic shelf; fourthly, the remoteness of the Arctic shelf from the supply market of resources required for oil and gas companies; fifthly, the unstable environmental system of the Arctic shelf and a high probability of environmental pollution; sixthly, the variety of technologies for field development and drilling on the Arctic shelf; and seventhly, the need to invest significant amounts of financial resources in the development of projects on the Arctic shelf and the high level of costs for oil and gas production.

The extreme nature of the natural and climatic conditions of the Arctic shelf is manifested in the following:

- Negative temperatures last 8–9 months a year – even in the warmest month the temperature is around zero
- Long polar nights, which can last up to 5 months
- Permafrost, which causes the presence of permanent ice cover, icebergs and hummocks, ice compression, and active ice drift
- Constant strong winds that cause storms and significant fluctuations in the level of the Arctic seas

Such a harsh climate on the Arctic shelf poses a great threat to the activities of oil and gas companies. The above-mentioned extreme natural phenomena are the cause of almost 30% of accidents that occur during the operation of offshore facilities where oil and gas are produced. Arctic ice and salt water damage oil and gas production platforms. Free navigation of vessels is possible in summer time; in winter, only vessels with special ice reinforcement can navigate. Companies have to organize seasonal work and use specific expensive equipment and technologies.

Natural and climatic conditions of the Arctic shelf also create obstacles for its geological study. Together with the need for large financial expenses having a longer payback period in comparison with the costs of exploration and development of onshore fields, they provide a weak geological study. It is difficult to get information about the bottom topography and soil characteristics in order to choose the right equipment and technologies for wells drilling, oil and gas production, and subsea pipeline installation. This leads to geological risks for oil and gas companies associated with economic inexpediency of field development on the Arctic shelf.

The development of the Arctic shelf requires oil and gas companies to create the appropriate infrastructure, most of it at sea. It is necessary to develop various kinds of communications, transportation, logistics, energy, and information and communication systems, as well as systems to ensure the maintenance of production platforms, comprehensive life safety, environmental safety, and environmental monitoring. In addition, companies have to develop coastal infrastructure, in particular, to build new seaports or reconstruct old ones, create railroads, helipads, power lines, storage, and technical facilities, and develop the social structure of Arctic cities.

The Arctic shelf is very far from the regions where the main industrial centers, fuel, food, and essential goods are concentrated, which makes it highly dependent on supplies of equipment and resources required by oil and gas companies for field development. This increases the risk of untimely logistics, which, in turn, causes the problem of slowing down the development of oil and gas fields on the Arctic shelf.

The Arctic shelf has a rather vulnerable and unstable environment, with an extremely high sensitivity to oil spills. In addition, birds are wintering in the Arctic shelf area – some species of fish and marine mammals are seasonally present.

Resource development by oil and gas companies causes irreparable environmental damage to the Arctic shelf ecosystem. In the process of exploration works, marine organisms suffer. Seismic surveys cause a water hammer effect and a high level of noise; during drilling operations, a large number of pollutants are released into both the marine environment and the atmosphere; formation water, spent drilling muds, and drilled cuttings are released from wells. Also, drilling operations on the Arctic shelf are often accompanied by accidents that occur if areas where formation pressure is extremely high are penetrated, so liquid and gaseous hydrocarbons are suddenly released from the well.

Another fairly common source of harmful emissions into the environment is associated gas, which in the process of combustion releases a large amount of hydrocarbons into the atmosphere and which gets deposited on the sea surface in the form of a film.

In general, when developing oil and gas fields on the Arctic shelf, companies' equipment may fail, either due to personnel errors or due to the impact of harsh natural conditions. Arctic ice can cause damage to drilling and production equipment and pipelines. In this case, oil spills occur.

Besides, long-term operation of an oil and gas field on the Arctic shelf becomes one of the reasons of increase of the seismic hazard situation, since a large volume of rocks is extracted from the subsoil and the upper layers may collapse, as a result of which an earthquake and a shock wave often occur.

Pollution of the Arctic water environment can occur when oil and gas are transported from production platforms by tankers or underwater pipelines, and unforeseen accidents or otherwise premeditated emissions and discharges occur.

The process of oil and gas fields development on the Arctic shelf has its own technological peculiarities. For each field, the technologies of arrangement and drilling are chosen individually as the factors of remoteness from the coastline, from the markets, sea depth, its roughness, wind strength, and the volume of oil and gas deposit are taken into account,

Development of the Arctic shelf is a rather time-consuming and labor-consuming process that requires significant investments. The biggest expense in the development of the Arctic shelf is offshore platforms. Also, the amount of operating costs is affected by the depth of production, the accumulation of icebergs and drifting ice, the strength of underwater currents, the remoteness of the field from the shore, and the complexity of the seabed topography in the areas from the shore to the production site. In addition, as environmental requirements for Arctic shelf development become stricter, the costs of ensuring safe operations and preventing harmful emissions and discharges into the marine environment and the atmosphere are increasing.

For example, according to the estimates of experts of the Central Dispatch Administration of the fuel and energy complex, the average exploration work on the Persian Gulf shelf requires investments of $4 million, $5 million on the shelf off the coast of Indonesia, and $11 million on the Arctic shelf.

According to the results of Deloitte's analysis, based on the data of the independent energy research company Rystad Energy, the break-even oil projects at the Arctic shelf are achieved at the oil price of $75 per barrel. At the same time, Vadim Yakovlev, the deputy head of exploration and production at Russian oil and gas company Gazprom Neft, considers the oil price of $70 per barrel to be acceptable for the development of the Arctic shelf.

Specifics of Participation of Oil and Gas Companies in the Development of the Arctic Shelf

A special feature of Russia's Arctic shelf development was the imposition of economic sanctions by the United States and European countries in 2014, when restrictions were imposed on interaction with Western countries. The US and EU sanctions prohibited foreign companies from participating in the exploration and production of oil on the Russian Arctic shelf. In addition, it was forbidden to provide services and supplies, either directly or through an intermediary, to export and re-export equipment and technology required for deepwater oil and gas production on the Arctic shelf. This required Russian oil and gas companies to diversify their purchases and implement an import substitution policy, when they had to start producing new technologies for the Arctic shelf development themselves.

Since 2016, the Russian government imposed a moratorium on issuing new licenses for offshore fields. At the same time, according to the Law of the Russian Federation “On Subsoil,” only companies with at least 50% state participation and with at least 5 years of experience in offshore projects are allowed to develop the Arctic shelf. Thus, such Russian oil and gas companies as Gazprom and Rosneft are currently working on the Arctic shelf.

The Russian oil and gas company PJSC Gazprom Neft, majority-owned by PJSC Gazprom, was one of the first companies to start oil production at the *Prirazlomnoye* field offshore the Arctic in 2013. The license for exploration and production of hydrocarbons at the Prirazlomnoye field belongs to Gazprom Neft Shelf LLC, which is a 100% subsidiary of PJSC Gazprom Neft. Oil production at the Prirazlomnoye field started in December 2013. In April 2014, the first batch of Arctic Oil (Arctic Oil) was shipped. A total of 32 wells are to be commissioned under the project. The recoverable oil reserves amount to more than 70 million tons. By November 2020, 15 million tons of oil had been produced.

In June 2021, it was decided that Gazprom Neft and NOVATEK would set up a joint venture to develop the *Severo-Vrangelevsky* license area on the Arctic shelf. NOVATEK will hold a 49% interest in the authorized capital of Gazprom Neft-Sakhalin (a subsidiary of Gazprom Neft), which holds the license for geological survey, exploration, and production of hydrocarbons at the Severo-Vrangelevsky block. Gazprom Neft’s share in the joint venture will be 51%.

Rosneft began developing the Arctic in August 2012. On the continental shelf of the Western Arctic, Rosneft holds licenses for 19 license areas in the Barents, Pechora, and Kara Seas; on the continental shelf of the Eastern Arctic, it holds licenses for nine areas in the Laptev Sea, the East Siberian Sea, and Chukchi Seas. In 2012–2020, the company carried out 144 thousand kilometers of 2D seismic works and 28.7 thousand kilometers squared of 3D seismic works and discovered four new deposits on the Arctic shelf. In addition, the company is actively working to create a unique production base of offshore equipment. As a result, the Consortium comprising Rosneftegaz JSC, Rosneft PJSC, and Gazprombank JSC established the Zvezda shipbuilding complex in 2015. It is responsible for the production of large-capacity vessels, elements of offshore platforms, ice-class vessels, special vessels, and other types of marine equipment. In 2020, the first Aframax reinforced ice class tanker manufactured at Zvezda was launched.

On April 01, 2020, amendments to the Tax Code of the Russian Federation came into force, which represent an additional incentive to boost offshore production in the Arctic. For the development of new offshore fields in the northern part of the Sea of Okhotsk, in the southern part of the Barents Sea, and in the Pechora Sea, the mineral extraction tax rate was reduced, its level being 5% for oil and 1% for gas for the first 15 years from the start of commercial development.

However, in August 2020 amendments were made to the Federal Law of the Russian Federation “On environmental expertise,” according to which Russian oil and gas companies must conduct state environmental expertise of design documentation of drilling wells in the Arctic.

In the USA in early 2021, President Joe Biden, taking into account the requirements of environmentalists, suspended oil and gas production in the National Arctic

Reserve of the USA, located in Northeast Alaska, which has an area of 78,000 square kilometers. As a result, the US Court of Appeals blocked an oil project of the US oil and gas company ConocoPhillips worth $2 billion. At the same time, it should be noted that the measure is temporary – until the results of an environmental study are available, detailing what consequences the activities of oil and gas companies drilling and producing in the region have for the Arctic ecological system and the lives of polar bears, waterfowl, caribou, moose, wolves, wolverines, eagles, and other representatives of fauna.

The Canadian federal government imposed a moratorium on offshore oil and gas development in the Arctic back in 2016 as a response to climate change. At the end of 2021, it is scheduled to be revised.

Norway, despite the climate change scenarios discussed all over the world and the numerous lawsuits filed in the Norwegian court by the North European branch of the environmental organization Greenpeace and the Norwegian environmental nonprofit organization Nature and Youth, continues – and even plans to intensify – the development of new hydrocarbon reserves.

In 2020, the Norwegian Ministry of Petroleum issued 27 licenses for the development of the Arctic shelf on predetermined areas, of which nine licenses were obtained by Equinor, while the rest were distributed between large international companies and small Norwegian exploration companies.

From January to June 2021 alone, Norwegian companies discovered eight new fields, the total reserves of which (according to preliminary estimates) amount to about 60 million cubic meters of oil equivalent. By the end of 2021, there are plans to drill about 40 exploration wells, which is 25% more than in 2020. According to the Norwegian Petroleum Directorate, by the end of 2022, the holders of licenses for the development of oil and gas fields of the Arctic shelf will make investment decisions in respect of about 50 projects.

In Denmark, in order to comply with the provisions of the package of laws adopted in December 2019 to combat climate change, according to which the volume of emissions of gases polluting the atmosphere must be reduced by 70% by 2030 and reach zero by 2050, it was decided to completely stop the exploration and production of oil and gas in the Arctic shelf by 2050. At the beginning of 2021, tenders and licenses for the development of resources in this region were cancelled. As for the existing oil and gas projects, the conditions for their development until 2050 will remain.

Applied and Planned Digital Solutions in the Development of the Arctic Shelf by Oil and Gas Companies

Oil and gas companies have been incorporating various digital technologies into their operations for more than 60 years in an effort to increase production and reduce the cost of finding, exploring, and developing fields. Firstly, companies used them to model reservoirs, later to process field data, and finally to construct three-dimensional seismic models.

Table 2 Effectiveness of digital technologies in the oil and gas complex

Company	Digital technologies	Impact on operational performance	Impact on financial performance
BP	The field of the future	Increase of production by 1–2%	N/A
Chevron	Smart field	Increase in the oil recovery factor to 6%, increase in production to 8%	N/A
Halliburton	Real-time operations	N/A	Reduction of capital costs to 20%
Petoro	Smart operations	N/A	Reduction of capital costs by up to 50%
Royal Dutch Shell	Smart field	Increase in the oil recovery factor to 10%, the gas recovery factor to 5%	Reduced downtime by up to 10%, Costs up to 20%
Statoil	Integrated operations	Increase of production to 20%	N/A

Source: adapted by the authors based on VYGON Consulting. (2018). *Digital Oil Production: Tuning for the Industry*. Retrieved from: https://vygon.consulting/upload/iblock/d11/vygon_consulting_digital_upstream.pdf

Among the key digital technologies used by oil and gas companies at the present stage are technologies of big data, industrial internet of things (IoT), robots, drones, digital twins, 3D printing, blockchain, and smart materials (Sheveleva & Zagrebelnaya, 2020).

The example of foreign oil and gas companies has already proved the effectiveness of the above digital technologies (Table 2).

Russian companies have also begun to actively implement digital technologies in their business practices, and after the government program "Digital Economy of the Russian Federation" was adopted in 2017, the digitalization process became one of the areas of their development strategies.

Having tested the digitization of the technological cycle at onshore fields, non-field companies began to apply digital solutions in the development of offshore fields, including in the Arctic region.

The Russian oil and gas company Gazprom Neft has a lot of experience in this area. In an effort to improve the efficiency of organizational processes and bring projects whose economic feasibility was questioned to a profitable level, PJSC Gazprom Neft is creating a production, logistics, production, and sales management system that integrates "smart" fields, oil refineries, and gas stations into a single ecosystem.

The company's digital projects for offshore production are combined in the Poseidon program, which is an integrated multi-component system, all elements of which are united by the Production Optimization Center (POC). The Poseidon program transforms the operation of the Prirazlomnaya platform on the Arctic shelf. As part of the program, the Integrated Modeling project is being implemented, which makes it possible to create a digital model of the entire production and technological chain of the oil producing asset. It allows a complex analysis of the functioning of all elements of the chain: in particular, reservoirs, wells, oil gathering, and treatment systems. This digital model is a digital replica of the *Prirazlomnoye* field, in which key characteristics of the field, its infrastructure, and production platform are duplicated and their state under different conditions is reproduced. This makes it possible to optimize the operation of equipment and reservoir management and make the best managerial decisions that optimize production, capital, and operating costs. The Poseidon program is used to develop forecasts of the main production indicators and improve control and safety of the production process.

The program is supported by a number of modern digital technologies:

- IoT technology – using a large number of sensors installed on the platform and the equipment serving it, operational information about their operation and state is collected.
- Big data technology – it is used to process a large amount of data coming from the platform, even if it is poorly structured.
- Machine learning technology – thanks to it, it becomes possible to predict the behavior of equipment under various circumstances.
- Neural network technology – it helps identify patterns of equipment operation based on large amounts of information that has been collected in a certain period.

To ensure safe and efficient implementation of the company's exploration and production projects in the Arctic seas on the Arctic shelf, PJSC "Gazprom Neft" created an Ice Management Center. The Center processes large volumes of hydrometeorological data, using digital technologies, to plan optimum routes for tankers, reduce their idle time during periods of ice load, and reduce the probability of accidents.

In addition, in order to ensure the year-round uninterrupted export of oil from offshore fields in the Arctic, Gazprom Neft created the Digital Arctic Center of Excellence.

This Center manages the company's tankers that transport oil from the Prirazlomnaya platform on the Arctic shelf, simulating the transport system of the field, while taking into account vessel movements, the degree of filling of oil storage tanks, and the ice conditions along the tanker route. This minimizes transportation costs and reduces the risks of logistic operations on the Arctic shelf.

As part of the Digital Arctic Center, the company created the unique digital system "Captain," which optimizes tanker and icebreaker traffic, controls oil shipments and oil storage capacity, and takes into account production parameters of the field and changes in the ice situation on the Arctic seas. The program analyzes 15,022 parameters on a daily basis, calculates more than one million different situations, and offers the best logistics solution, significantly reducing the level of unit costs for transportation. Gazprom Neft's digital logistics management system on the Arctic shelf can be represented as the following diagram (Fig. 1).

The experience of applying digital technologies in the development of the Arctic shelf by PJSC Gazprom Neft may be useful for other oil and gas companies operating in this region and seeking to improve the efficiency of their operations.

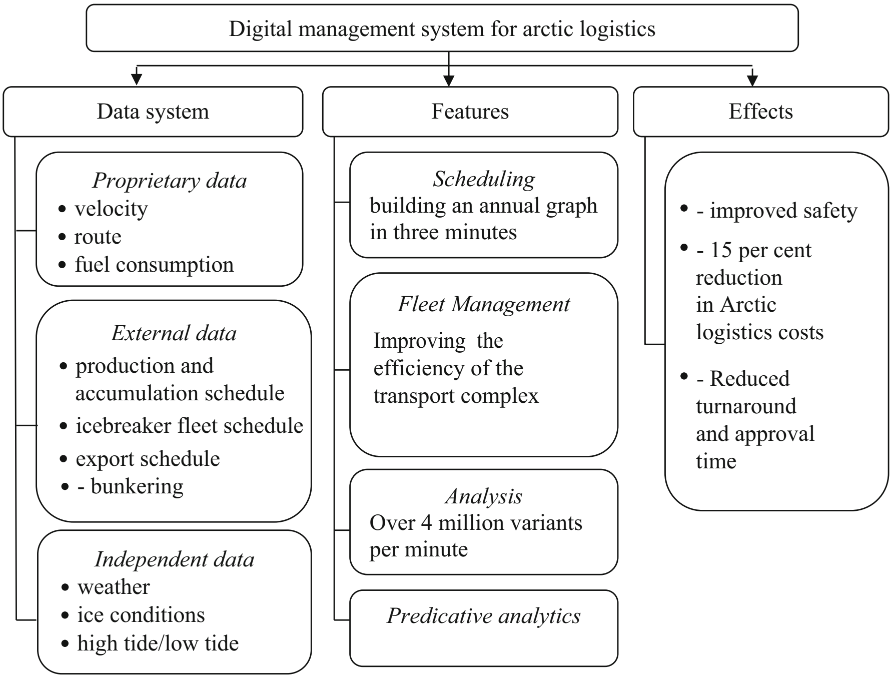

Fig. 1 Digital logistics management system on the Arctic shelf of PJSC Gazprom Neft. Source: Compiled by the author based on Gazprom Neft (2019). *Gazprom Neft: Results of 2019*. Retrieved from: https://www.gazprom-neft.ru/press-center/sibneft-online/archive/2019-december/4019246/

In Canada, for oil and gas companies engaged in the development of the Arctic shelf, the Canadian Hydraulic Center has developed special equipment:

- Telecams
- Digital acoustic transceiver for profile studies and for measuring ice piling in front of the structure
- A large amplitude ±4-meter motion mechanism to measure vessel maneuvering characteristics in ice and to simulate changes in ice direction

The Norwegian Petroleum Directorate will upgrade and supply the Norwegian national repository of seismic, well, and production data for the oil and gas industry to Halliburton, an American company that provides services in the oil and gas industry, during the implementation of an 8-year contract signed in April 2021. In addition, Halliburton will supply the oil directorate with cloud services to ensure the high quality of the data that comes from the Norwegian Arctic shelf, as well as provide visualization and interpretation of the data.

For Norwegian oil and gas companies, Halliburton will provide applications that are based on machine learning and artificial intelligence technologies, which allows analyzing data on the subsurface, drilling wells, and oil and gas production.

Possible New Applications of Digital Technologies by Oil and Gas Companies to Solve the Problems of Developing the Arctic Shelf

Digital solutions that are already being applied by oil and gas companies in the development of the Arctic shelf mainly contribute to improving the efficiency of the oil and gas companies themselves, but have little to do with the problems associated with ensuring the sustainable development of the region, preventing pollution, and preserving its ecosystem.

In this regard, the following directions of digital technology application can be proposed.

First, ensuring environmentally safe exploration and production of oil and gas in the harsh natural and climatic conditions of the Arctic shelf.

Second, to optimize the operation of industrial facilities and equipment in order to prevent possible accidents.

Third, environmental monitoring, emergency forecasting, and the prevention and elimination of emergency oil spills.

Fourth, to reduce emissions of greenhouse gases and other pollutants into the atmosphere, as well as into the aquatic environment of the Arctic shelf.

In order to ensure environmentally safe exploration and production of oil and gas, given the extreme natural and climatic conditions of the Arctic shelf, it is advisable to develop and apply:

- Underwater robots exploring oil and gas fields using 3D/4D format
- Sensors and multichannel receivers enabling safer and more efficient underwater exploration of offshore oil and gas fields
- Software that allows collecting and analyzing large amounts of geological information using supercomputers
- Underwater robotic production complexes, which have automatic operation mode and remote control
- Technical means, which would provide continuous monitoring of the state of oil and gas field reservoirs with a high degree of resolution and allow the incoming information to be processed on a computer using 4D visualization of the results obtained

To optimize the operation of industrial facilities and equipment in order to prevent accidents that may occur during the development of the Arctic shelf by oil and gas companies, digital technologies have particular skills:

- Artificial intelligence will increase the efficiency of preventive maintenance of equipment, allowing for more rational and efficient repair work.
- IoT will help to establish communication with sensors on equipment, remotely control them, promptly analyze work parameters, correct possible deviations, and prevent failures and malfunctions before their possible occurrence.

- Digital twins visualize the production process, thus helping to eliminate possible problems in time.
- Digital solutions such as these will be able to conduct environmental monitoring, predict emergencies, and prevent and respond to oil spills, including in difficult ice conditions.
- Digital modeling of probable emergency situations enables assessing their impact on the Arctic shelf environment and developing optimal solutions for their prevention or elimination.
- Digital modeling of climatic changes allows oil and gas companies to determine what impact the construction of a particular industrial facility may have on the climatic conditions of the Arctic shelf, which, in turn, will enable them to choose the optimal location, designs, and technologies that minimize the negative impact on the region's climate.
- Remote environmental can monitor the Arctic seas.

In order to reduce emissions of greenhouse gases and other pollutants into the atmosphere, as well as into the aquatic environment of the Arctic shelf, oil and gas companies should:

- Use cloud platforms, which also apply visualization, forecasting, machine learning, and data analytics technologies to help optimize and transform key business processes of oil and gas companies to reduce their carbon footprint.
- Implement artificial intelligence technologies that will enable oil and gas companies to obtain real-time data on emissions, account for them promptly, and use more effective ways to reduce them.
- Create a unified dispatch control system, which will make it possible to promptly respond to emergency situations and thereby reduce the likelihood of harmful emissions.

Thus, new possible applications of digital technologies by oil and gas companies in the development of deposits on the Arctic shelf will solve a number of environmental problems, both in the region itself and in the global problem of climate change around the world.

Conclusions

The presence of significant amounts of oil and gas reserves in the Arctic shelf attracts oil and gas companies and causes the intensification of the development of offshore fields in this region.

However, the projects of oil and gas fields development on the Arctic shelf have significant differences from the projects of development of the mainland fields. The implementation of typical works on the shelf requires the use of special technologies, the organization of operations, and the construction of marine production facilities, which causes higher costs and environmental risks associated with oil spills and emissions and discharges of harmful substances into the atmosphere and aquatic environment of the Arctic seas. In addition, a number of other problems arise in the process of developing the Arctic shelf for oil and gas companies.

The harsh natural and climatic conditions of the Arctic shelf increase the risk of accidental spills during oil and gas exploration, production, and transportation. Drifting ice and icebergs disturb the integrity of industrial facilities of oil and gas companies and transport vehicles (tankers and icebreakers).

Undeveloped or often completely absent infrastructure of the Arctic shelf requires oil and gas companies to spend time and money to create the necessary transport, logistics, energy, information and communication, and life-supporting systems for the development of fields.

The remoteness of the Arctic shelf from suppliers of fuel, food, and other resources necessary for oil and gas companies' activity causes the risk of their untimely delivery, which slows down the already slow development process of the Arctic shelf fields.

The instability of the Arctic shelf ecological system and the high probability of environmental pollution requires oil and gas companies to comply with strict environmental requirements aimed at preventing environmental pollution of the region by harmful emissions into the atmosphere and discharges into the aquatic environment.

In addition, there are also country-specific features of Arctic offshore development by oil and gas companies of the Arctic states (Russia, the United States, Canada, Norway, and Denmark).

For example, in Russia, the development of oil and gas fields in the Arctic shelf, since 2014, has been complicated by economic sanctions imposed by the United States and EU countries, under which foreign companies were banned from exploring and producing oil in the Russian Arctic shelf, as well as technological sanctions that prohibit the provision of services and the export and re-export of equipment and technology required for deepwater oil and gas production in the Arctic shelf. Since 2016, the Russian government itself imposed a moratorium on issuing new licenses for offshore fields. In addition, the Arctic shelf can only be developed by companies with a state share of at least 50% and at least 5 years of experience in offshore projects. Also, from 2020, a mandatory state environmental impact assessment was introduced for design documentation of drilling wells in the Arctic.

In the United States and Canada, under the influence of environmental organizations concerned about the ongoing global climate change, a temporary ban on the development of offshore oil and gas fields in the Arctic was imposed, until the results of environmental research show the impact of oil and gas companies' activities on the ecological system and fauna in the region.

In Norway, despite the efforts of environmentalists, the development of the Arctic shelf by oil and gas companies continues, at an increased rate. However, it should be noted that the Norwegian oil and gas companies strictly observe the environmental requirements and standards established by both the government and environmental organizations.

Denmark, planning to achieve zero greenhouse gas emissions by 2050, stopped holding tenders and issuing licenses for the development of oil and gas fields on the Arctic shelf since the beginning of 2021.

Thus, it is clear that the Arctic states are concerned about the environmental problems of the Arctic shelf, worsening as a result of increased activities by oil and gas companies to develop fields in this region.

Digitalization is one of the solutions to the above-mentioned problems of Arctic shelf development by oil and gas companies at the present stage.

Oil and gas companies around the world, including those in the Arctic states, have begun to incorporate technologies of big data, industrial internet of things, robots, drones, digital twins, 3D printing, blockchain, and smart materials into their activities.

In particular, the most striking example of the application of digital solutions in the development of Arctic offshore fields is the Russian oil and gas company PJSC Gazprom Neft. All of the company's digital projects for offshore production are integrated into the Poseidon program, and a digital model of the entire production and technological chain of the Prirazlomnaya platform was created, which duplicates the key characteristics of the field and its infrastructure and reproduces their condition under various situations in order to optimize equipment operation. PJSC Gazprom Neft also established the Digital Arctic Center of Competence, which makes it possible to simulate the transport system of the Prirazlomnoye field. Within the framework of the Center "Digital Arctic," there is a unique digital system "Captain," which, after taking into account a large number of parameters and calculating more than one million different situations, offers the best logistic solution.

However, it should be noted that the digital solutions, already applied by oil and gas companies in the development of the Arctic shelf, are aimed primarily at solving the problems associated with production and economic activities of the companies themselves, such as poor geological study of the Arctic shelf, the remoteness of the Arctic shelf from the supply market of resources necessary for the activities of oil and gas companies, and the need to invest significant amounts of financial resources in the development of projects on the Arctic shelf and high.

Instead, foremostly, it is necessary to focus efforts on ensuring sustainable development of the Arctic shelf itself, in particular to solve such problems as the unstable ecological system of the Arctic shelf and the high probability of environmental pollution.

In this connection, it is possible to suggest such possible new directions of digital technologies application as ensuring environmentally safe exploration and production of oil and gas, optimization of industrial facilities, and equipment operation to prevent possible accidents, environmental monitoring, forecasting of emergency situations, prevention and elimination of emergency oil spills, and the reduction of greenhouse gas and other pollutants emissions into the atmosphere and into the aquatic environment of the Arctic shelf.

Underwater robots, artificial intelligence, digital twins, and the Internet of Things will allow oil and gas companies to remotely control devices and equipment in real time, thereby obtaining operational analytical information, making predictions, and preventing malfunctions and failures before they occur; therefore, they could avoid or prevent leaks and accidents that could lead to greenhouse gas emissions into the atmosphere. This will preserve and protect the unique ecological system of the Arctic region and minimize the negative impact of the global problem of climate change. In this case, perhaps, the governments of the Arctic countries will lift restrictions on the activities of oil and gas companies developing resources on the Arctic shelf, and environmental organizations will be less likely to hinder the implementation of projects to develop oil and gas fields in this region.

Thus, it is not only oil and gas companies will benefit from digital technologies, but also society and the environment.

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Part VII

Northern Sea Route as the Basis of the Arctic Transport Infrastructure

Logistics and Its Role in the Exploration and Development of the Arctic

Frank Detlef Wende, Darya V. Shvandar, and Marina A. Ponomareva

Contents

Abstract

The chapter has reviewed both historical and economic tracks of logistics support for the exploration of Arctic projects. More specifically, a comparative analysis of the production capacity of the seaports of the Northern Sea Route allowed the research to identify major dimensions of the further development of maritime transport logistics in the Arctic, broken down to increasing the transit volumes, transshipment of cargo of all types, container transportation, stevedoring, and ship-repair work. While analyzing the prospects of the development of land logistics in the Russian Arctic, it has been figured out that domestic design solutions in combination with a satellite monitoring system possess the maximum economic effect and might contribute to the implementation of national target programs for the development of the Arctic, as well as large commercial projects for the utilization of the resource base of the region. Besides, Russia's national interests, as well as its adherence to developing international exploration of the Arctic, generally require an increase in the region's logistics efficiency and induced transit potential to ensure the stability of international economic relations. The comprehensive implementation of federal targeted projects for improving the infrastructure of seaports in the Arctic region might contribute to the intensification of their economic activity, while the instruments of state support

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for entrepreneurial activity in the Arctic might allow to ensure a competitive level of logistics costs of transportation along the Northern Sea Route.

Keywords

Logistics · The Arctic · The Northern Sea Route · Maritime terminals · Land logistics

Introduction

The development of the Arctic and its adjacent territories, with fundamental and applied scientific research in this area, are significant areas of national policy of countries with entrance to the Arctic Ocean and circumpolar territories. The relevance of the study of logistics in the Arctic is due to the high need to reduce costs in the process of material flow while producing a finished product, here relating to the industrial development of the resource base of the Arctic territories, export-import, and transit operations in the direction of "West-East-West" (Pak & Sarkisov, 2014; Pak, 2021). The study of factors, whose degree of impact depends largely on the stability of international relations of the countries participating in the development of the Arctic shelf and the northern territories, will allow us to identify promising areas for the development of logistics in this region.

The Arctic as a Region for International Economic Cooperation

The *Arctic* (from Greek ἀρττικός means *bear*; referring to the *constellation Ursa Major (Big Dipper)*; *northern*) is, from the geographical point of view, the northern polar region of the Earth, which includes the northern borderlands of the Eurasia and North America continents (except for the southern part of Greenland island and the Labrador Peninsula), the Arctic Ocean (except the eastern and southern parts of the Norwegian Sea) with islands, and adjacent parts of the Atlantic and Pacific Oceans (Great Russian Encyclopedia, 2021). The geopolitical and economic interests of eight states intersect in the Arctic, five of which have access to the Arctic Ocean (the USA, Canada, Russia, Norway, and Denmark), and three of them have circumpolar territories without direct access to the ocean (Iceland, Sweden, and Finland). In order to stabilize international economic relations in the Arctic region, these countries formed the Arctic Council in 1996 by signing the Ottawa Declaration, operating as an independent intergovernmental forum for business cooperation, solving priority tasks in the field of environmental protection and sustainable development of the region.

Each member of the Arctic Council (The Arctic Council, 2021) has declared its priorities to the region with transport and logistics agenda at the bottom of each dimension (Table 1).

Table 1 represents that Iceland, Finland, and Sweden are the most prospective countries for Russia in the field of international cooperation related to Arctic

Table 1 Members of the Arctic Council and their policies to the region: transport and logistics agenda

Country	Arctic and Northern territories	Population of the region	Priorities in the Arctic
Iceland	The whole of island	365,000	• Sustainable usage of natural marine and energy resources • Development of IT technologies in the Arctic • Research of water pollution: microplastics • Green energy • Blue bioeconomics • Sustainable navigation • Strengthening cooperation in the field of Arctic research
Canada	• Northwest Territories • Nunavut • Yukon and Northern parts of many provinces including Monitoba • Newfoundland and Labrador • Quebec	About 150,000	• Socio-economic and cultural development • Environmental protection • Climate change research • Strengthening relationship with indigenous peoples
The Kingdom of Denmark	• Denmark • Greenland • Faroe Islands	• Greenland: 55,992 • Faroe Islands: 52,124 • Denmark: 5,822,763	• Prevention and management of potential oil spills in the Arctic • Search and rescue in the Arctic
Norway	• Nordland • Troms and Finnmark • Svalbard and Yan Mayen • Arctic sea area: 1,500,000 sq.m	490,000	• Coal mining • Tourism • Research • Fishing and aquaculture • Conservancy of biodiversity • Sustainable energy: development of hydro and wind energy • Processing of liquefied natural gas • Development of export harbors • Observation and assessment of climate change • Economic development with considering the interests of the indigenous peoples of the Arctic • Search and rescue cooperation between the states, who are members of the Arctic Council

(continued)

Table 1 (continued)

Country	Arctic and Northern territories	Population of the region	Priorities in the Arctic
The Russian Federation	• Murmansk Region • Nenets Autonomous District • Chukotka Autonomous District • Yamalo-Nenets Autonomous District • Lands and islands located in the Arctic Ocean • Komi Republic (partially) • The Republic of Sakha (Yakutia) (partially) • Krasnoyarsk Territory (partially) • Arkhangelsk Region (partially) • Republic of Karelia (partially)	2,500,000	• Efficient and harmless development of the Arctic • Development of the resource base that ensures the resolution of the tasks of socio-economic development • Preserving the unique ecological systems of the Arctic and ensuring environmental safety • International cooperation in the Arctic • Development of the Northern Sea Route as a national unified transport line in the Arctic • Creation of modern IT infrastructure
USA	• The territory to the north and west of the border formed by the Porcupine, Yukon, and Kuskokwim Rivers • Adjacent seas, including the Arctic Ocean and the Beaufort, Bering, and Chukchee Seas • The Aleutian Chain	50,000	• Development of the mining industry • Research in the field of oil pollution • Fishing • Sustainable tourism development • National security • Climate change research • Development of medicine: telemedicine and epidemic surveillance • Development of research in the field of mental health in severe climatic conditions • Cooperation in search and rescue operations • Development of maritime navigation • Solving issues of telecommunications infrastructure
Finland	• Northern Ostrobothnia • Kainuu • Lapland	• Lapland: 180,000 • Finland: 5,500,000	• Environmental protection and environmental technologies in the Arctic • Interdisciplinary studies of the impact of global changes and the consequences of human intervention in the natural balance of the Arctic • Strengthening the EU's presence in the European North

(continued)

Table 1 (continued)

Country	Arctic and Northern territories	Population of the region	Priorities in the Arctic
			• Construction in the arctic conditions • Development of the Arctic infrastructure • Ice navigation
Sweden	• Vesterbotten County • Norrbotten County	520,000	• Functioning and development of logistics platforms for environmental research • Environmental monitoring • Marine research expeditions in the Arctic and Antarctic Oceans • Commercial transport navigation by using of icebreaker fleet

Source: compiled by the authors based on data of the *Arctic Council*. Retrieved from: https://arctic-council.org/ru/about/states/

logistics. Iceland's activities, as a member of the Arctic Council, are aimed at enhancing relations and cooperation between countries involved in Arctic research for more effective use of financial, scientific, technological, and educational resources. Finland has scientific knowledge and technologies in the area of construction in Arctic conditions, the creation of logistics infrastructure, and ice-breaking shipping. The traditions of cooperation between Russia and Finland in the Arctic can also contribute to the more efficient utilization of the resources available for both countries in order to improve logistics and to minimize logistics costs while implementing Arctic projects and expeditions.

Sweden has an icebreaking fleet, logistics platforms for Arctic research, and commercial shipping at its disposal. In Northern Sweden, there are scientific stations in Abisko and Tarfala, as well as the EISCAT12 radar in Kiruna. The scientific station in Abisko provides services for arrangement and coordination of experiments by scientists from different countries. The environmental monitoring program includes the analysis of temperature, humidity, ice melting, and local flora and fauna. The Tarfala Research Station, located in the Kebnekaise Mountains, conducts general research, observation for glacier, meteorological and hydrological analysis, and studies of snow chemistry and glaciers. Sweden also conducts marine research expeditions by the icebreaker "Oden" in the Arctic and Antarctic Oceans.

Having the icebreaker fleet (e.g., icebreaking and pilotage), Russia actively develops the Northern Sea Route and uses space technologies to create a modern information and telecommunications infrastructure in the Arctic region. The satellite monitoring system is actively used in the routing of transport logistics, as well as control over oil spills in the waters of the Arctic and Pacific Oceans and adjacent seas. The exchange of experience, knowledge, and technologies between countries within the framework of the activities of the Arctic Council provides the most favorable conditions for the development of logistics in the Arctic, reducing pressure on the federal budget by decreasing logistics costs in Arctic state and private-state projects.

International collaboration in the field of transport logistics in the Arctic is also being applied in the projects of the European Union, such as "Northern Dimension," "Development of Logistics in the Barents Transport Corridor" within the framework of the Kolarctic Neighbourhood Program, "Logistics in the Barents Region," and "Barents Logistics-2," within the framework of the Kolarctic IESP–PS Program (enterprises and organizations from Russia, Finland, and Sweden became partners of this project) (Fadeev, 2021). This can be noticed in the concept of more environmentally secure and smart transport. Other examples of international collaboration in the area of transport are the joint Russian-Norwegian oil and gas project "RU-NO Barents," whereby a special direction "Logistics and Transport" was created as well as the Northern Air Bridge Project, providing for the establishment of air routes from Asia to North America through the Arctic. Here we will cover some projects in more detail.

The Northern Dimension Projects are being implemented through four partnerships: The Northern Dimension Environmental Partnership (NDEP), the Northern Dimension Partnership for Health and Social Well-Being (NDPHS), the Northern Dimension Partnership for Transport and Logistics (NDPTL), and the Northern Dimension Partnership for Culture (NDPC) (Northern Dimension Partnership on Transport and Logistics, 2021). The activities of the Northern Dimension Partnership for Transport and Logistics (NDPTL) are aimed at the development of electrification of transport infrastructure, technical re-equipment of land and sea transport for the more environmentally secure utilization of hydrogen fuel and liquefied natural gas, the digitalization of the maintenance of Arctic roads, the implementation of unmanned cargo transport based on the Platon system in hard-to-reach and climatically difficult areas of the Arctic, and the usage of specially designated transboundary corridors for testing new logistics solutions.

The project "Barents Logistics-2" within the framework of the Kolarctic IESP-PS Program is aimed at transferring knowledge in the field of logistics, developing and implementing a joint practice-oriented internship program in international logistics, and establishing scientific research in the Arctic region. The project involves: the Russian Federation (NP "Sotsium+ (Society)," ANO "Arctic Center," Association "Murmanskshelf"); Finland (University of Oulu, Port of Kemi, Port of Oulu), and Sweden (Lulea University of Technology) (Ministry of Arctic Development, 2021).

The project "Logistics and Transport" within the framework of the Russian-Norwegian oil and gas project "RU-NO Barents" INTSOK (2021) focuses on collaboration in transport and infrastructure logistics for the production and transportation of oil and gas, which includes:

- Improvement of meteorological forecasts to prevent icing of ships
- Monitoring of ice movement
- Ensuring operational efficiency (multipurpose floating establishments, including supply, and storage units and helipads) and the safety of logistics operations
- Icebreaking support of transport caravans

- Transportation of modules and shipment in the severe climatic conditions of the northern seas
- Ensuring the regularity of personnel transportation to industrial facilities

The countries that are members of the project "Logistics and Transport" have the opportunity to identify issues of economic activity in the Arctic and receive a comprehensive logistics solution as part of international working groups.

International economic cooperation in the field of logistics in the Arctic is a priority direction for the development of the countries of the Arctic region, since it provides for the exchange of knowledge, experience, and technologies in the field of supply chain and transport logistics of major industrial, environmental, and scientific projects and expeditions. Collaboration between the countries representing their interests in the Arctic has a high transport and transit potential and also ensures the sustainability of geopolitical processes through integration and cooperation on mutually enabling economic environment. The participation of countries in international Arctic organizations, trade, and industrial partnerships ensures the efficiency of the development of the northern territories and the Arctic shelf by accumulating various kinds of resources, synthesizing advanced technologies, and reducing the share of logistics costs in the added value of the finished product.

The Northern Sea Route is the Basis of Arctic Transport Logistics

The Northern Sea Route (NSR), which was called the North-Eastern Passage until the beginning of the twentieth century, is the main shipping route in the Russian Arctic and passes through the seas of the Arctic Ocean, connecting European and Far Eastern ports from the Kara Gate to Providence Bay (Prokhorov, 1989). The NSR serves the main ports of the Arctic and major rivers for the delivery of fuel, equipment, food, industrial raw materials, and other types of goods as for internal trade exchange as for export-import operations. The main ports of the NSR are Igarka, Dudinka, Dixon, Tiksi, and Provideniya (Providence). However, the NSR connects the transport corridors of the Eastern and Western Arctic, the Barents-Euro-Arctic, and the Asia-Pacific corridors; therefore, in a wider consideration, the NSR may include the major base ports of St. Petersburg, Arkhangelsk, Murmansk, Dixon, Tiksi, Pevek, Egvekinot, Provideniya (Providence), Petropavlovsk-Kamchatsky, and Vladivostok. The Rosmorrechflot (*FAMART - Federal Agency for Maritime and River Transport of Russia*) classifies the ports of the NSR and adjacent transport corridors according to the register, as follows:

- Ports of the Western Arctic: Murmansk, Arkhangelsk, Kandalaksha, Vitino, Onega, Mezen, Varandey, Naryan-Mar, Sabetta, Dudinka, Dixon, Khatanga
- Ports of the Primorsky Territory and the Eastern Arctic: Vladivostok, Vostochny, Nakhodka, Zarubino, Olga, Posyet, Tiksi, Anadyr, Pevek, Provideniya, Egvekinot, Beringovsky

- Ports of the Baltic Sea: the Great Port of St. Petersburg, Primorsk, the Passenger Port of St. Petersburg, Ust-Luga, Vysotsk, Vyborg, Kaliningrad
- Ports of the Okhotsk Sea and the Tatar Strait: Vanino, Sovetskaya Gavan, De-Kastri, Nikolaevsk-on-Amur, Okhotsk, Magadan, Cape Lazarev
- Ports of Sakhalin, Kuril Islands and Kamchatka: Korsakov, Kholmsk, Shakhtersk, Poronaysk, Alexandrovsk-Sakhalinsky, Prigorodnoye, Nevelsk, Moskalvo, Petropavlovsk-Kamchatsky (Rosmorrechflot, 2021)

The NSR is actively being developed in the direction of commercial shipping, export-import operations, and logistics support for oil and gas projects in the Arctic. The possibilities of transport logistics are closely related to the production capacities of ports and their infrastructure: navigation period, bandwidth, the number of berths, storage capacity, and the availability of ship repair enterprises. It is advisable to compare the production capacities of several NSR ports: Murmansk, Dixon, Tiksi, Pevek, Provideniya (Providence), Egvekinot, Anadyr (Table 2).

Table 2 shows that the port of Murmansk, which is located in the North-Western part of the NSR (the Barents Sea, the southern knee of the Kola Bay), has the largest production capacities. Year-round navigation provides a high throughput of cargo and passenger terminals. The availability of indoor and outdoor warehouses makes it possible to arrange logistics for storage and distribution to accommodate the receipt of goods from other ports of the NSR, the navigation period of which has seasonal restrictions. The port of Tiksi, located in the Laptev Sea, Buor-Khaya Bay, Tiksi Bay, has a large area of the seaport's water area and a high capacity of dry cargo terminals. The area of the outdoor port's warehouses is four times larger than the indoor ones. Logistical arrangements include stevedoring operations and storage operations for cargo transshipment. However, the navigation period in the seaport is limited only to 2.5 months.

Table 2 Production capacities of ports of the Northern Sea Route

Name of port	Water area of port (square kilometers)	Berth (quantity)	Total cargo terminal capacity (thousand tons per year)	Total storage capacity (thousand square kilometers)	Period of navigation in port
Murmansk	53.7	111 berths 2 piers	26,611.2	308.04	year-round
Dikson	0.182	2	120	6.00	01.06–01.10
Tiksi	96.78	2	67.0	36.18	15.07–30.09
Pevek	8.9	3	330	81.98	03.07–25.10
Provideniya (Providence)	13.02	4	345.4	3.00	01.06–01.12
Evgekinot	5.75	2	174	5.07	01.07–01.11
Anadyr	45.33	6	900	15.14	01.07–01.10

Source: compiled by the authors according to Rosmorrechflot (FAMART – Federal Agency for Maritime and River Transport of Russia). Retrieved from: http://morflot.gov.ru

The port of Pevek in the East Siberian Sea (the Gulf of Chaunskaya Guba) has a high capacity of dry cargo terminals, as well as a system of indoor and outdoor warehouses, through which loading and unloading activities are carried out with regard to dangerous goods (classes 1, 2, 3, 4, 5, 6, 8, 9). The Provideniya (Providence) Port is geographically based in the Bering Sea (at Provideniya (Providence) Bay), with a high capacity of cargo terminals, mainly dry, and partially liquid, which increases the efficiency of loading and unloading operations due to the technical equipment of the port. Four berths ensure stable vessels mooring according to the schedule. The port of Anadyr is located in the Bering Sea, the Anadyr Bay, and the Anadyr estuary. It has a large area of sea water and a high capacity of cargo (900 thousand tons per year) and passengers (20,000 people per year). The area of outdoor warehouses is not significant, so the port carries out cargo operations directly, without storing goods on warehouse territories. The availability of repair docks for vessels with a cargo capacity of up to 500 tons is a clear advantage of the port of Anadyr, and the disadvantage is a restricted navigation period. The ports of Dixon and Egvekinot, despite the smaller number of storage areas, the number of berths, and the maritime area, have an average throughput of cargo terminals, operate actively 4 months a year as part of summer navigation, and are strategically important support ports of the NSR.

The logistics development of the ports of the Northern Sea Route is closely connected to federal infrastructure projects in the field of maritime transport, which are aimed at increasing the production capacities of Russian ports. For example, the federal project "Seaports of Russia," as part of the transport part of the Comprehensive Plan for the Modernization and Expansion of the Main Infrastructure within the period up to 2024 (Decree of the Government, 2018), includes 39 activities for the development of port infrastructure and 10 interventions in the field of shipbuilding, also in the Arctic basin:

1. *Murmansk Seaport*:
   - Reconstruction of the facilities of the third cargo area
   - Construction of an LNG marine transshipment terminal
   - Marine specialized transshipment terminal of bulk cargo
2. *Arkhangelsk Seaport*:
   - Construction of a mining and processing plant on the basis of the Pavlovskoye (Novaya Zemlya) lead-zinc deposit facilitated by FGUP Rosmorport
3. *Pevek Seaport*:
   - The reconstruction of federal property objects has been completed (Decree of the Government, 2018).

Building productive capacities of the ports in conjunction with development of transportation logistics at a new technological level will help strengthen Russia's competitive advantages in the Arctic region. The Arctic nuclear fleet plays a special role because of its participation in icebreaking pilotage of trade caravans along the Northern Sea Route: icebreakers of the Arctic and Taimyr types, nuclear container vessels of the SEVMORPUT (the Northern Sea Route) type, and auxiliaries including floating technical platforms, vessels for collecting and storing liquid radioactive waste, or multifunctional container ships for transporting irradiated nuclear fuel (Atomflot, 2021). The integrated approach to the utilization of the nuclear fleet in the Arctic Ocean, considering the modern requirements of international environmental legislation and state regulatory instruments (e.g., VAT reset on sea transshipment services and icebreaking pilotage of export cargo (Government.ru, 2020)), opens new prospects for using the Northern Sea Route, as the shortest route between Europe and Asia.

Land Logistics in the Arctic: Features and Prospects of Development

Current trends in the development of land logistics in the Arctic are associated with the exploration of new mineral deposits, providing access roads to the ports of the Northern Sea Route and increasing the level of economic connectivity of Russian territories. However, the special climatic conditions and soil composition of the Arctic region require nonstandard solutions for the transportation and storage of goods. The infrastructure of Arctic deposits is often located on swampy soils, next to rivers and streams that seasonally change their course. This makes it difficult to travel and deliver personnel and cargo to the mining sites. An important role in such conditions is played by transport routes called winter roads, the operation of which is possible only at subzero temperatures and requires constant preparation and roadbed filling. Access roads to the ports operate on a permanent year-round basis, are built and reconstructed taking into account the peculiarities of the soil and operation in northern latitudes, and are financed by the state and large private companies. Problems with logistics can arise at the stage of designing field development, when logistics costs are not included in the estimate, and in the Arctic conditions, this is one of the significant cost components. The solution to such problems is to involve not only industry specialists in the project, but also logistics companies operating in the Arctic region and knowing most of the difficulties that field developers may face.

A further feature of the Arctic region is the low concentration of settlements, making construction of highways ineffective: The cost is high, the terms are stretched over time, and the payback is low. There is a demand for food products, fuel, and medicines from other climatic zones. Cargo delivery to remote northern regions and shift settlements is partially solved by small northern aviation. However, it strongly depends on weather conditions. In this regard, the logistics direction, based on all-terrain vehicles, has been developed recently. For example, CHETRA transport caravans are adapted to Arctic conditions and able to provide reliable daily transport connection in the complete absence of roads and hard weather conditions (Kulikov & Belokonev, 2016). The main advantages of using all-terrain vehicles are low operating costs (including fuel consumption), high maintainability, stable performance, the possibility of long-term autonomous operation in remote areas, and low professional requirements for operators and drivers of all-terrain vehicles. Caravans are formed from at least three vehicles to ensure the safety of transportation. The load capacity of the all-terrain vehicle is 4 tons while maintaining the buoyancy function. Different all-terrain vehicles in the caravan can be equipped for the transportation of goods, fuel and lubricants, or the transportation of passengers (8 "coupe" type berths) ("CHETRA" LLC, 2021), as well as a waste disposal complex, an ambulance, or an emergency rescue complex. Equipping the caravan with a satellite navigation system increases the safety of transportation in the absence of roads and difficult weather conditions.

A prospective logistics solution is also the usage of unmanned vehicles that are resistant to the severe climatic conditions of the Arctic: unmanned trucks, unmanned amphibian aircraft, or drones. The main task that drones can perform is to increase the level of connectivity of territories by delivering cargo to remote settlements and shift camps. Researchers in the USA, Canada, and Australia prefer pilot testing of unmanned light amphibian airplanes and drones (Cherenkov et al., 2020) for the delivery of food and medicines, which is owning to the higher population density of the northern territories (primarily Canada). Russian scientists focus on the technological capabilities of unmanned automobile and railway vehicles, since the main area of application is the industrial mining and exploitation of mineral deposits. Accordingly, in 2020, KamAZ unmanned trucks successfully overcame 2.5000 km at the Vostochno-Messoyakhskoye field in the Yamalo-Nenets Autonomous District. Tests of driverless cars have shown the ability to run off through a predetermined course with high accuracy, exchange information based on duplicated communication systems, and recognize obstacles and predict the trajectory by analyzing the current road situation. Control over the trucks was carried out from the control center of the Vostochno-Messoyakhskoye field while testing. The main advantages of unmanned trucks are their high durability and safety; the disadvantage that requires improvement is the provision of stable communication with the control center in all weather conditions. The application of UAVs (unmanned aircraft and vehicles) will reduce logistics costs during the development and exploitation of Arctic deposits and increase their efficiency.

The role of logistics in the Arctic is closely connected to the main national interests of Russia in this region: the utilization of the resource base to solve problems of socio-economic development, the use of the internal and external potential of the Northern Sea Route, and the preservation of unique ecosystems and the Arctic as a zone of peace and cooperation. Therefore, the priority directions for the development of Arctic logistics are international cooperation, the development of science and technology, the establishment of a modern information infrastructure, increasing the level of connectivity of territories, and creating favorable conditions for economic activity.

The study of current trends in the field of international cooperation in Arctic logistics has shown the effectiveness of knowledge, experience, and technologies exchange, in the logistics of transportation, supply and distribution, material management, and supply chains of commercial projects and scientific expeditions.

Integration and cooperation processes increase the transport and transit potential and ensure the sustainability of international economic relations, including Russia's participation in international Arctic organizations, trade, and industrial partnerships.

Conclusions

The review of the historical and economic experience of logistics support for scientific and foreign trade expeditions demonstrated the cumulative effect in creating an information base for modern and future Arctic projects, as well as the important role of a comprehensive scientific approach in their preparation and establishment. Thus, the maximum positive effect in the implementation of the tasks set was achieved by the expeditions, whereby the principle of state planning and control, as well as close intersectoral collaboration, was involved.

The comparative analysis of the production capacity of the ports within the Northern Sea Route allowed us to formulate the main prospects for the development of maritime transport logistics in the Arctic: increasing the volume of transit transportation, transshipment of cargo of all types, container transportation, stevedoring, and ship repair work. The comprehensive implementation of federal targeted projects to improve the infrastructure of ports in the Arctic region will contribute to the intensification of their economic activities and increase their share in the creation of gross domestic product, and the instruments of state support for entrepreneurial activity in the Arctic will ensure a competitive level of logistics costs for transportation along the Northern Sea Route, including icebreaking and pilotage.

The prospects for the development of land logistics in the Russian Arctic lie in the plane of new technological solutions that combine the principles of innovation, functionality, and economic feasibility. The remoteness of settlements from each other, severe climatic conditions, and the need for material and technical or transport support determined the vector of development towards the introduction of unmanned and all-terrain vehicles. Domestic design solutions, in combination with a satellite monitoring system, ensure the maximum economic effect and contribute to the implementation of national target programs for the development of the Arctic, as well as large commercial projects for utilization of the resource base of the region.

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Northern Sea Route and Its Geoeconomic Importance

Martin Grešš and Mariia I. Ermilova

Contents

Abstract

With the melting of the Arctic ice in recent decades, new opportunities arose for Asian countries to ship manufactured goods. Instead of using the old Southern Sea Route via Strait of Malacca and the Suez Canal, the ships may be able to use shorter route along the Russian coast in the Arctic area. We also note the increased interest in the Northern Sea Route in recent years reflected in the rising number of articles in scientific journals in the past decade. The aim of the chapter is to identify the main factors related to the Northern Sea Route that can contribute to the growth of the attractiveness of this route as well as the factors limiting the

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commercialization of this route broken down to the cases of energy shipments from Sabetta and Novy Port facilities.

Keywords

Arctic region · Northern Sea Route · Novy Port · Sabetta · Russian Federation · Yamal LNG

Introduction

Mutual trade relations between Asian and European countries are at a high level, especially in view of the fact that the economies of Asian countries such as China, India, Taiwan, Malaysia, and others are among the largest producers of finished products, and the economies of European countries, especially those of the Member States of the European Union, are among the largest consumers of finished products. For this reason, the issue of transporting finished products from Asia to Europe is an important one. At present, the Southern Sea Route is mainly used for this transportation. However, in the light of new developments, the Northern Sea Route, which winds around the coasts of the Russian Federation and Norway and terminates in ports of the Member States of the European Union, such as Rotterdam, is emerging as a possible alternative to the Southern Sea Route. One of the main factors contributing to the growth of international shipping activities along the Northern Sea Route is the relatively recent trend of melting ice in the Arctic region caused by climate change (Milakovic et al., 2018). Average annual air temperatures in the Arctic have increased at twice the rate of global average temperature increase over the last three decades (Janský & Janská, 2011).

In terms of the geographical and climatic demarcation of the Arctic region (as this could be a potential source of conflict between states bordering the area), it is bounded by the Arctic Circle, according to Janský and Janská (2011). In biogeographical terms, it is in turn the line of northernmost tree range. The entire Arctic region covers an area of approximately 28 million square kilometers. Of the total area, approximately 10 million square kilometers are land, and the remaining two-thirds are the water areas of the Arctic Ocean and its marginal seas. The Arctic states include five countries, or the so-called Arctic Five – Denmark (Greenland), Canada, Norway, Russian Federation, and the United States. The coasts and continental shelves of these five states extend directly into the Arctic Ocean. In addition to these five states, Finland, Iceland, and Sweden are also considered Arctic states, as they encroach to some extent with their territory into areas north of the Arctic Circle. In terms of climate, the Arctic is defined as an area where the average temperature does not reach more than 10 °C even in the summer months (Dávid et al., 2020). As reported by Dávid et al. (2020), the Arctic Ocean extends over most of the Arctic, being completely covered by ice or partially thawed with floating ice floes during most of the year. The rest of the area is made up of the northern parts of Asia, Europe, and Greenland. The Arctic covers 8% of the Earth's surface and, due to climate change, is the place where global warming is most pronounced. According to David et al. (2020), the greatest loss of frozen areas occurred in 2012. The frozen area was 14.5 million square kilometers in the area around the North Pole, which was about 1.1 million square kilometers less than the long-term average for the period 1981–2010. The state of the frozen area in the Arctic region in 2021 and a comparison with the 1981-2010 median is shown in Fig. 1.

The Northern Sea Route was opened to international shipping as early as 1991, yet it was not until 2012 that the route saw a higher rate of ship traffic (PWC, 2020). It can be stated that the growth of interest in this alternative route to the Southern Sea Route was primarily due to the 2013 amendment to the Federal Law of the Russian Federation No. 155 "On Internal Waters, Territorial Sea and Contiguous Zone." On

Fig. 1 Sea ice extent, 2021. Note: yellow line – median ice edge 1981 – 2010. Source: NSIDC (2021)

the basis of the Decree of the Government of the Russian Federation No. 358 of March 15th, 2013, the Northern Sea Route Administration was established to organize and ensure navigation in the Northern Sea Route area. One of the Administration's objectives is to issue permits for navigation through the Northern Sea Route. In addition to the establishment of the Administration, the boundaries of the Northern Sea Route have also been officially defined (PWC, 2020). A further increase in interest in the Northern Sea Route occurred in 2017 when the Yamal LNG project was commissioned. According to PWC (2020), freight traffic increased fivefold in 2018 compared to 2014 and doubled compared to 2017, precisely due to the launch of Yamal LNG.

Another important document that contributed to the growth of interest in the Northern Sea Route was the Maritime Doctrine of the Russian Federation, a new edition of which was signed by President Vladimir Putin in 2015. The original version of the doctrine was adopted back in 2001, setting out the outlook up to 2020. Due to the fact that in the course of the first decade of the twenty-first century as well as in 2010–2015, there were significant changes in the world economy (the global financial crisis of 2008–2009) as well as in the position of individual countries, a new version of the naval doctrine was adopted. This new version also reflected the changing position of the Russian Federation in global economic, political, and security terms. During the early twenty-first century, on the one hand, the Russian Federation's position as a naval power was strengthened, along with an increase in Russia's presence through its navy in the world's oceans. In addition, there has also been a change in the economic status of individual countries and their influence on the world economy. This has been particularly evident in the rise of China's economic status, which has become one of the world's economic superpowers and the world's largest exporter of finished goods during the early twenty-first century. In this respect, it is possible that the importance of the Northern Sea Route will increase in the future and that many more finished goods will be transported from China, but also from other Asian economies, via this route, to the detriment of the Southern Sea Route. From a security point of view, there has been an increase in various regional and local conflicts. These conflicts involve not only the countries that are directly affected by them, but also countries whose interests may be affected by these conflicts. In terms of the structure of the doctrine, it addresses four basic functional areas, with the key areas for the purposes of this chapter being maritime transport and minerals. Other areas include naval activities and naval science. In terms of the regional directions that appear in the doctrine, the Arctic regional direction is particularly important. In addition to this, the doctrine also defines five other directions covering the rest of the world (Atlantic, Pacific, Indian Ocean, Caspian, and Antarctic). As far as regional directions are concerned, great importance is attached in particular to the Atlantic direction (due to the expansion of the North Atlantic Alliance and its proximity to the borders of the Russian Federation) and the Arctic direction. As far as the Arctic is concerned, in the Russian Federation's view, this direction is determined primarily by the free access of the Russian Federation's fleet to the Atlantic and Pacific Oceans, but especially by the Northern Sea Route and the mineral reserves located on the continental shelf in the Arctic region (Article

59 of the Doctrine). In accordance with the development of the Northern Sea Route and, in a broader sense, the Arctic region, the national maritime policy is based in particular on (Article 60 of the Doctrine):

- reducing threats to the national security of the Russian Federation and ensuring strategic stability in the Arctic region;
- strengthening the naval potential of the Russian Federation and developing the forces of the Northern Fleet;
- strengthening the economic potential of the Russian Federation through the exploitation of the resources of the continental shelf, including geological exploration;
- creating conditions for the activities of the Russian Navy and the Russian oil and gas industry in the Arctic region and the Northern Sea Route area;
- assisting in the implementation of measures by other Arctic countries which have a special responsibility for the protection of the marine environment and its living organisms and which ensure the sustainable development of the Arctic region;
- the development of the Russian Northern Sea Route and the improvement of navigational, hydrographic, and hydrometeorological support for navigation in its waters;
- the development of a search and rescue system for the rescue of persons and the development of a system for the prevention and recovery from oil spills in the Arctic region
- stimulating the use of energy-saving and environment-friendly technologies and research in the Arctic region;
- strengthening the leadership of the Russian Federation in Arctic marine research and exploration.

Besides, *25 objectives* have been set to fulfill the above-mentioned fundamentals of the Maritime Doctrine for the Arctic region. It should be noted that these are long-term goals, as the original version of the Maritime Doctrine was adopted in 2001 with a view to 2020. The current version of the Arctic strategy envisages a view to 2035. The following objectives, defined in Article 61 of the Maritime Doctrine, are crucial for the further development and growth of the Northern Sea Route in terms of geoeconomic importance and in particular for the transport of oil and gas:

- exploration and exploitation of natural resources, including fossil fuels;
- unconditional respect for the interests of the Russian Federation and Russian oil and gas producers and transport companies in the delimitation of the maritime boundaries and the seabed of the Arctic Ocean;
- the creation of an industrial and technological base for the economic development of the Arctic coastal territories and adjacent water areas;
- conducting geological surveys, updating existing data on mineral deposits and the safe development of economically viable natural resource deposits on the continental shelf of the Russian Federation.

In 2018, the Northern Sea Route Development Project was added to the 2019–2024 Comprehensive Long-Haul Infrastructure Modernization and Expansion Plan with a projected budget of $9.25 billion. In addition, Rosatom (the state nuclear and energy company) announced a plan to build a commercial shipping company to compete with large foreign container shipping companies such as Maersk, COSCO, Hapag-Loyd, and others. Despite the efforts to compete with large foreign shipping companies, it should be noted that the vast majority of the cargo transported is not containers or general cargo and their transit, but the export of LNG, gas condensates, crude oil, and petroleum products from the territory of the Russian Federation to foreign countries.

On the basis of the above, it can be concluded that the interest in further development of the Northern Sea Route was primarily driven by two main reasons. *First*, climate change and the associated melting of the Arctic ice. *Second*, the Russian Federation's interest in developing the area because of the need to transport fossil fuels and products from them. In addition, other reasons can be identified, such as the growth of world trade in goods or the profit margin of international shippers of goods and minerals.

The aim of this chapter is to identify the main factors related to the Northern Sea Route that can contribute to the growth of the attractiveness of this route as well as the factors limiting its commercialization. From a methodological point of view, the chapter focuses on the analysis of scientific and professional book and journal literature of domestic and foreign provenance.

Literature Review

The growth of interest in the Northern Sea Route is also reflected in the fact that there has been a significant increase in the number of scientific articles dealing with this topic during the twenty-first century. In terms of the issue under study, we present in the literature review two metastudies in particular, which were published in 2018 and 2021 (Theocharis et al., 2018; Panahi et al., 2021). Both studies map articles in scientific journals that are related to exploring the potential of exploiting the Arctic region and its sea routes. In the case of Theocharis et al. (2018), the period of publication of scientific articles ranges from 1980 to 2017. Theocharis et al. (2018) focused their metastudy mainly on comparative studies related to Arctic Sea routes and traditional sea routes. In addition, they also focused on articles that addressed the selection factors and decision-making process for choosing a traditional southern or alternative northern sea route. In their conclusions, they analyzed the competitiveness of Arctic Sea routes from an economic and environmental point of view. In their paper, they conclude that the results suggest that although Arctic routes may be more cost-effective and energy-efficient compared to traditional routes, especially in the long term, they may only serve as seasonal alternatives in the short term for bulk and specialized shipping (which are essential for Asia-Europe trade).

Panahi et al. (2021) examined the period of 1980–2019, focusing on articles published in the English language. They note that until 2006, only a minimum of articles was published annually (0–5 articles per year). However, the situation has changed since 2007, when 10 articles were published, and especially after 2010, when as many as 58 articles were published in 2019 with the issue of maritime navigation in the Arctic region. We also note that their primary focus was not the Northern Sea Route, but all three Arctic sea routes – the *Northern*, *Northwest,* and *Transpolar* Sea Routes. In particular, they compared research between the Northern Sea Route and the Northwest Passage, noting that developments in the Northwest Sea Route have lagged behind those in the Northern Sea Route, which may be due to the fact that the Northwest Sea Route is not expected to be commercially exploited in the near future, unlike the Northern Sea Route.

Aksenov et al. (2017) are primarily concerned with the future use of Arctic shipping routes. They note that the rapid reduction of frozen areas in the Arctic region during the summer in the last decade has opened discussions on the possibilities of cargo transportation in this region. They state that the average voyage along the Northern Sea Route has been reduced from 20 days in the 1990s to 11 days in 2012–2013, helped by the melting of the ice in the area.

Blunden (2012) states that the Northern Sea Route is already used mainly as an important channel for the export of regional raw materials. In addition, she mentions that the Russian government also strongly supports the further development of the Northern Sea Route, with the aim of retaining exclusive national jurisdiction over the route.

Dávid et al. (2020) discuss the Northern Sea Route from the perspective of freight transport as a new alternative route for the maritime transport of goods from the Far East to Europe. They conclude their article by stating that the full integration of the Northern Sea Route into the main maritime shipping corridors can be expected within the next two decades. They point out that, although this route is considerably shorter than the routes currently used, its main disadvantage is the lack of rescue measures in the event of a ship sailing along this route getting into a dangerous situation. In addition, they also mention that by using this route, the risk of piracy, which is widespread along the Southern Sea Route, can be eliminated.

Van Hussen et al. (2020) analyzed the prospects and impacts of commercial navigation through the Northern Sea Route. They address global trade flows and the geopolitical context, as well as the challenges for the commercial use of the Northern Sea Route. They conclude that the Northern Sea Route will be much less used than current sea routes in the next four decades. They state that the number of transits as well as local voyages is likely to increase, but that these will be more focused on the transport of local cargos. Furthermore, they state that in the long term, the 4.7% share of world trade via the Northern Sea Route may not be reached until around 2200.

Kuzmin et al. (2019) in their conference paper address the issue of the possibility of using the Northern Sea Route for the transit of cargos within the global economic environment. In particular, they analyze the reasons for the low demand for this route. They conclude that the global hydrocarbon market as well as the price of oil will largely determine global trade flows as well as the use of the different sea shipping routes in the future. In addition, they state that the need to develop oil and gas fields in the Arctic will also require the development of transport infrastructure to support further field development. This will be critical to the further development of the Northern Sea Route in terms of transportation services aimed at both domestic and export consumption. The profitability of using the Northern Sea Route is expected to be achieved assuming an oil price of more than $80 per barrel.

Lasserre (2014) reports that official Russian tariffs associated with the use of the Northern Sea Route are prohibitively high. On the other hand, however, he notes that the Russian authorities are trying to put into practice flexible tariffs that will help with attracting customers. In addition, he states that the profitability of using the Arctic sea routes is not directly dependent on the cost of fuel, but rather on the average speed that ships are able to reach when sailing.

Liu et al. (2021) address infrastructure along the Northern Sea Route, particularly port development. They discuss the implications of Russia's Arctic strategy for port development, noting that this strategy was not successful in 2003–2012. They note that there has been underinvestment in the development of transport infrastructure in the past and that the growth of port throughput is overly dependent on the exploitation of energy resources in the Russian part of the Arctic region. This, they argue, is the reason that the economy and foreign trade in the hinterland of the ports have not played a more positive role in the development of the ports. They state that in the long term, the Russian Federation should strengthen investment in transport infrastructure in the Arctic region, especially investment in ports, railways, and highways. In addition, it should also support the production of icebreakers as well as emergency, rescue, and support vessels.

Melia et al. (2017) report that most of the investment in Arctic shipping projects come from China and Northern European countries. They focus in particular on the economic opportunities arising from the use of this route for the UK. Like other authors, they conclude that Arctic Sea routes will not replace the Suez and Panama Canal sea routes currently in use in the twenty-first century. On the other hand, they note that the Northern Sea Route is likely to remain the most popular commercial option due to the favorable geographical conditions resulting from the melting of frozen ice in the Arctic region.

Min and Jin (2020) analyzed the impacts of using the Northern Sea Route on Asian and European economies. Based on their analysis, they concluded that the Netherlands and Japan stand to benefit the most from the use of the Northern Sea Route, followed by Germany, the UK, and France in Europe, and South Korea and China in Asia.

Russia's policy for the Northern Sea Route has been analyzed by Moe (2020). He states that the regime introduced since 2013 was specifically aimed at attracting foreign users and transit traffic, but recent changes have moved away from this goal. Thus, the focus is not currently on rapid growth in transit traffic; rather, the predominant focus is on supporting the development of hydrocarbon transport. This view is supported in particular by the development and completion of two projects – Yamal LNG and Novy Port. As Moe (2020) notes, plans for the development of natural resource exploitation projects along the Siberian coast have become the basis of state policy, which has shifted away from using the Northern Sea Route as a transit route to a destination route.

Selin (2016) proposes measures that will contribute to the positive dynamics of cargo flows along the Northern Sea Route as well as to the protection of the national interests of the Russian Federation in Arctic waters. Among them are, for example, the provision of a favorable regime for international shipping, along with the creation of special economic zones in ports and the creation of an international maritime corridor "Europe-Asia." In addition, he also proposed a federal program to develop the transport system in the waters of the Northern Sea Route, which should be devoted in particular to meteorological and hydrographic support, improving port infrastructure, maintaining the fleet of icebreakers, including the construction of new ones, and creating attractive conditions for ships using the Northern Sea Route.

Skripnuk et al. (2020) discuss the potential of the Northern Sea Route as an international transport corridor in their conference paper. They conclude that the Northern Sea Route meets the criteria for long-distance transport lines, is connected to the rail transport system, the icebreaker fleet and port infrastructure are being developed, and that the technical conditions for improving navigation safety are gradually being put into practice and continuously upgraded. They state that the increased attractiveness of the Northern Sea Route is conditional on increased investment in Arctic infrastructure, growth in the number of icebreakers, modernization of ports and the introduction of more favorable tariffs compared to competing sea routes. Zhao et al. (2016) in their study propose that the Northern Sea Route, even though shorter and faster, cannot replace the Southern Sea Route for certain southern ports along the Suez Canal making the Suez Canal a better choice for these ports.

Zhang et al. (2016) focused on a direct comparison of transport efficiency between the northern and southern routes. The authors developed a profit estimation model for container shipping and a cost estimation model for oil shipping and then compared the shipping efficiency. They report that for both types of transport, there is a potential reduction of 10 days per transit when using the Northern Sea Route due to the shorter distance. On the other hand, they note that container transport loses profit margin when using the Northern Sea Route. They conclude by stating that the Northern Sea Route is economically disadvantageous for container shipping but may be useful for small and medium tanker operators.

Results

Factors Leading to Increased Attractiveness of the Northern Sea Route

Among the new facts that have a positive impact on the possibility of import alternatives for finished products to the countries in Europe, we can include the following factors in particular:

- Changing conditions in the Arctic region;
- The interests of the Russian Federation in the Arctic region and in particular in the Northern Sea Route;
- Advantages of using the Northern Sea Route.

Regarding the changing conditions in the Arctic region, it is believed that the melting of ice in the region since the mid-twentieth century is the main factor, with further ice melt expected in the coming decades up to 2100. As Dávid et al. (2020) note it, since 1979 there has been a decrease in the glaciated area in this region of almost 40%. They also note that if the trend of a 3.8% reduction in ice cover every 10 years continues, it is possible that by the second half of the twenty-first century there will be no ice in the Arctic region during the summer. According to Wan et al. (2021) from 1979 to September 2018, there has even been a decline of up to 75% in Arctic ice. In our opinion, this fact may be one of the advantages of using the Northern Sea Route for large container ships, which will be able to sail this route more days a year.

As far as Russia is concerned, on the basis of the Federal Law "On Internal Waters, Territorial Sea and Contiguous Zone" dated 1998, the Northern Sea Route is considered as the national unified transport communication of the Russian Federation in the Arctic region. As of today, the cargo base of the route mainly consists of raw materials such as crude oil and petroleum products and liquefied natural gas are mainly transported. Containers are also transported, but to a lesser extent.

Other advantages of using the Northern Sea Route include, in particular, the additional possibilities of using the Suez Canal, which is beginning to reach its maximum capacity, with the construction of ever larger and faster ships that may find it difficult to maneuver in this relatively narrow canal. Another advantage of the Northern Sea Route is the absence of pirates, who pose a significant threat on the Southern Sea Route, particularly off the coast of Aden and in the Strait of Malacca (Blunden, 2012).

Factors Limiting the Commercialization of the Northern Sea Route

According to Wan et al. (2021), the main factors limiting further opportunities for increasing the attractiveness and commercialization of the Northern Sea Route can be divided into three main groups:

- Natural conditions;
- Economic conditions;
- Services provided.

With regard to *natural conditions*, with regard to the region, it can be stated that the climatic conditions along the Russian coast are highly variable, which is mainly due to the number of bays, peninsulas and islands. The variability of the weather consequently has an impact on the possibilities of the sailing period for ships in the region and the safety of their operation. Wan et al. (2021) divide natural conditions into several subcategories: (1) sea ice, (2) water depth, and (3) extreme weather.

Sea ice is a critical factor limiting the commercialization of the Northern Sea Route, although recently global warming has reduced both the area and thickness of Arctic Ocean ice to a significant degree.

According to Dávid et al. (2020), there has been a significant extension of the navigation period in the Northern Sea Route from July to September to June to November in recent years.

Water depth may also be an important limiting factor, as the Northern Sea Route is quite complex and full of narrow waterways and shallow reefs. While the average depth of the East Siberian Sea and the Chukchi Sea is more than 50 m, the shallowest waters in the straits can be as shallow as 8 m, which severely limits the transit capacity of large container ships (Wan et al., 2021).

In addition to the factors already mentioned, extreme weather conditions such as dense fog, low temperatures, length of the polar day and night can also threaten the navigation of ships.

As the Northern Sea Route is expected to become, or may become, an alternative to the Southern Sea Route, *economic factors* appear to be key in deciding the route of transoceanic container ships. The key economic factors, in terms of expected profits and projected costs, may include: (1) fuel costs, (2) the cost of constructing ships in a particular ice class, and (3) ice-breaking charges.

According to Furuichi and Otsuka (2013), fuel cost is a key component of the cost of shipping, accounting for approximately 50% of the total unit cost of shipping for all ship sizes.

The cost of ship construction is also an important component of the total cost in ice classes. Due to natural conditions, ships sailing the Northern Sea Route have to meet special requirements for framing, hull, and hull thickness, which means that the cost of such ships can be 6.5–30% higher compared to ships sailing the Southern Sea Route (Wan et al., 2021).

The Northern Sea Route should also include the provision of support services for ships sailing along the route. This means that the infrastructure and support services for shipping along the Northern Sea Route should match the requirements of shipping companies and must be seen as important components of the further development of the Northern Sea Route. In terms of infrastructure, there are currently a sufficient number of 41 ports along the Russian coastline along the Northern Sea Route, but they lack modern facilities, and, on the other hand, large container ships may be limited by the depth of water in these ports (Wan et al., 2021).

As regards to support services for navigation, the use of icebreaking services is currently on a voluntary basis, although they are used almost constantly due to natural conditions. A certain problem limiting the wider use of the Northern Sea Route for large container ships and the need to use icebreaking services is the maximum width of the largest icebreakers of 34 m, which means that only narrower ships with a capacity of up to 5000 containers can navigate, which have a maximum width of 32.31 m. Larger container ships with a capacity of 10,000 containers already have a maximum width of 49 m. However, as reported by PWC (2020), a new type of icebreaker called the "Leader" is currently being designed that will be able to break through the ice at a width of 50 m, which should be sufficient for ships with a capacity of up to 12,000 containers. The first icebreaker is scheduled to start operation at the end of 2027. The Russian Federation is expected to commission three icebreakers of this type by 2033 at the latest as per the Northern Sea Route Infrastructure Development Plan to 2035 approved by the Russian government in 2019 (Government of Russia, 2019). The "Leader" project is important not only in terms of transporting finished goods, but also in transporting oil and gas. If all three new icebreakers are put into operation, the year-round navigation of ships transporting oil and natural gas from the Arctic regions of the Russian Federation to foreign countries should be ensured. This is primarily for the export of oil and natural gas to the Member States of the European Union, but also to countries in the Far East, such as China, Japan, and South Korea. On the other hand, however, we must point out that even this new class of icebreakers will not be able to break through the ice in such a width that the largest ships, which are capable of carrying more than 20,000 containers, can be used for the transit of containers. Such ships normally use the Southern Sea Route through the Suez Canal.

According to a study conducted by PWC (2020), the main factors influencing the choice of transport route can be ranked (from most important to least important):

- Cost of delivery;
- Reliability of the route;
- Delivery time;
- Cargo owner's operational requirements and delivery flexibility;
- Quality of infrastructure and services offered;
- Positive experience of using the route and statistics available for the route;
- Customs clearance.

As can be seen from the above overview, the most significant items in deciding to use a particular sea route are the cost of delivery and the reliability of the route, which may appear to be an advantage. Due to the fact that the Northern Sea Route is considerably shorter in terms of distance and therefore nautical miles, shipping is faster and cheaper. On the other hand, however, we have to mention the fact that sailing the Northern Sea Route may incur additional costs in the form of payment for permission to use this route, icebreaker hire fees, or other charges related to the services provided along the Northern Sea Route. However, one of the biggest obstacles is that the largest container ships cannot be used for the Northern Sea Route, as the current icebreakers are not able to penetrate the 50-meter-wide corridor. This is precisely the width needed for the largest container ships capable of carrying 20,000 or more containers in a single sea voyage. If a shipping company wanted to use the Northern Sea Route, it would need two ships to transport that number of containers, making it more expensive and the delivery costs higher than using the Southern Sea Route. This would lose the geographical advantage of the Northern Sea Route, which is the shorter distance between ports in Asia and ports in Europe. Another issue is the reliability of the route as the second most important factor in transporting cargo.

Oil and Gas Transport: Cases of Yamal LNG and Novy Port

As mentioned above, the 2019 update of the Russian Maritime Doctrine has seen a certain shift in Russian state policy for the Northern Sea Route away from transit transport toward the transport of mineral resources from the territory of the Russian Federation to destinations in European Union Member States and Far Eastern states (Moe, 2020). This is supported primarily by the implementation of two main oil and gas production and export projects, Yamal LNG and Novy Port. The development of these projects, but also in general of projects to exploit mineral resources along the Siberian coast, has become a cornerstone of Russian state policy. This has led to a certain shift away from the use of the Northern Sea Route as a transit route for container traffic from the Far East countries toward the Member States of the European Union.

The first project contributing to the development of the Northern Sea Route is the Yamal LNG project, a joint venture between several companies from the Russian Federation, France and China. The largest share is held by the Russian gas company Novatek (50.1%), followed by France's TotalEnergies (20%), China National Petroleum Company (CNPC) (20%), and the Silk Road Fund (9.9%). Novatek is the largest independent gas company in the Russian Federation and has been in the market for 25 years. TotalEnergies was founded as Total in 1924 in France to process oil and gas. CNPC is China's largest oil and gas production and supply company, with assets and interests covering more than 30 countries worldwide. The Silk Road Fund was established in 2014 to provide funding and support for the development of trade and economic cooperation under the Belt and Road Initiative and Maritime Silk Road Initiative.

The project, as the name suggests, is located on the Yamal Peninsula, with the port city of *Sabetta* playing a particularly important role for natural gas transportation (Vukovic et al., 2019). Sabetta was founded in the 1980s, but its importance has grown following the discovery of large oil and gas deposits and the adoption of a national Maritime Doctrine that also addresses the development of the Northern Sea Route as a transport corridor for Russian oil and gas exports. The Russian government has identified this project as a matter of national interest with an estimated cost of approximately $27 billion. The project processes natural gas from the Tambeyskoye field, which was discovered in 1974.

In addition to natural gas, the field also contains 550 million barrels of oil condensate. There are two main elements that contribute to the competitiveness of this project. The first is the significant volume of natural gas, currently estimated at 1.3 trillion cubic meters, with low costs for further development and production. Secondly, it is a favorable geographical location close to European markets, but with a reach also to markets in Asia. Meanwhile, the project is able to supply both European and Asian customers with natural gas year-round. In 2021, the project reached a milestone when it transported 50th million ton of liquefied natural gas (LNG) since the project's launch in 2017. In 2020 alone, 18.8 million tons of LNG were produced, representing approximately 5% of the global LNG market share. Meanwhile, the project plan envisaged an annual natural gas processing capacity of 16.5 million tons.

The *Novy Port* project and further development of production from the Novoportovskoye field on the Yamal Peninsula is one of the strategic projects of the Russian company Gazprom Neft. The Novoportovskoye field was the first to be discovered on the Yamal Peninsula, with significant oil and gas reserves documented as early as 1964. However, due to the lack of infrastructure and natural conditions, it has not been fully developed. An important part of the exploitation of fossil fuel reserves from this resource is the downstream supporting infrastructure that can be used to transport oil and gas to its destination, in this case the countries of northern Europe, which are relatively close to the Yamal Peninsula. The Northern Sea Route, which has the potential to export raw materials from Yamal to European countries, thus, appears to be important enough. The first shipments of oil and gas from the Novy Port area to Europe were dispatched in the summer of 2014. Winter deliveries began in 2015. Due to the thawing of frozen areas, we can assume that there will be further growth in exports from this area over the next few years.

In addition, it can be stated that due to the geographical conditions, the transportation of oil and gas from this area to Europe via the Northern Sea Route seems to be the optimal choice, as Novoportovskoye is the closest oil field to European countries. Also important is the fact that the oil from the Novoport area is light, meaning that it contains a low sulfur content. Meanwhile, European countries have refineries specifically for processing light crude oil. Part of the infrastructure for transporting oil and gas is the loading of these resources. As the coastal waters of the Yamal Peninsula are too shallow and there is a constant alluvial flow, oil and gas are loaded 3.5 km offshore using the Arctic Gate terminal. This fact also allows the use of very large crude carriers with a capacity of 200 to 320 thousand deadweight tons, which is approximately 2 million barrels of oil. Total annual capacity of the Arctic Gate is almost 66 million barrels. Total current known hydrocarbon reserves in the Yamal Peninsula are estimated at around 1.39 trillion barrels of oil equivalent, representing a potential production of 21 years if the full annual capacity of the Arctic Gate is used. If annual production is constant and no new hydrocarbon reserves are discovered, production from this area can be expected over the next 27 years (assuming annual production at the 2018 production level of 51 million barrels).

For both projects, the Northern Sea Route appears to be an important infrastructure support. Changing conditions in the Arctic region, particularly climate conditions, mean that it can supply both the European and Asian continents year-round, even with the use of large tankers with a capacity of 2 million barrels of oil.

Conclusions

The research has identified the main factors supporting and limiting further commercialization of the Northern Sea Route as an alternative for importing finished products from Asian economies and oil and gas and their products from the Russian Federation to the EU member states. Among the main factors increasing the attractiveness of the territory, we can include the changing conditions in the Arctic region, of which the Northern Sea Route is a part, the interests of the Russian Federation in the Arctic region and, in particular, in the further development of the Northern Sea Route, and the advantages of using the Northern Sea Route. Conversely, factors limiting the further potential development of the Northern Sea Route as an alternative to the Southern Sea Route include in particular natural conditions, economic conditions, and the services provided by ports and other entities operating along the Northern Sea Route.

In the light of the scientific and professional literature we have studied, we note the increased interest of scientists, experts, academics, and shipping companies in the possibilities offered by the Arctic region and, in particular, in the possibilities offered by the Northern Sea Route as a possible alternative to the Southern Sea Route, by means of which the vast majority of finished products are currently transported from the Asian countries to the Member States of the European Union.

The Northern Sea Route is also emerging as an important transport corridor for the export of Russian oil and gas from the Yamal Peninsula, where two projects of national interest to the Russian Federation – Yamal LNG and Novy Port – are being implemented. Given the changing climate conditions in the Arctic region, we can assume that both oil and LNG exports from the Yamal area will grow in the future, which will contribute to the positive development of Russia's trade balance as well as to the growth of export revenues from the sale of oil and gas to customers in Europe and Asia. It can therefore be assumed that the Northern Sea Route project will bring significant synergies for development in the remote areas of Siberia and the Urals in the coming years in connection with the increase in the transport of local cargo and minerals.

For the purpose of further research, we foresee the use of the identification of factors increasing the attractiveness of the Northern Sea Route as well as factors limiting its future potential commercialization within the SWOT analysis, where they could form part of the individual components, especially in *opportunities* and *threats* segments.

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Global Competitiveness of the Northern Sea Route

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Contents

Abstract

The chapter studies the global competitiveness of the Northern Sea Route (NSR) and determines the prospects for its development as a transport artery both domestically and internationally. The research is centered around the content analysis of the existing literature, statistical reports, and SWOT analysis to measure the global competitiveness of the NSR, as well as to structure the factors of its internal and external environment. Thus, the areas under investigation include the assessment of the current state of NSR development; analysis of the volume and structure of cargo traffic; rethinking the prospects of the cargo base

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given the implementation of the related energy projects; and factors determining the global competitiveness of the NSR. The authors conclude that the prospects for the growth of transit cargo traffic in the NSR in the period up to 2024 are nearly zero. Besides, the development of the NSR is associated with the economic security of the Russian Federation. The NSR can provide primarily Russian coastal transportation, and its global competitiveness will depend on the degree of development of infrastructure facilities.

Keywords

Northern Sea Route (NSR) · Transport and logistics system · Maritime transportation · Transit transportation

Introduction

For a long time, the international community did not position the Northern Sea Route (NSR) as a potential route from Europe and Asia. The key reasons for this are the harsh climatic conditions, the need for icebreaking, and the ban on international shipping until 1991.

Recently, the interest to this route is beginning to increase, due to climate changes and the warming of the Arctic region (NSIDC, 2017). According to experts, by 2030, the NSR waterways will be ice-free 6 months a year; in the period 2035–2050, the NSR will become navigable for most of the year or even a full year without mandatory icebreaking support; and by 2050, there will be no ice on the route in the summer (Zelenkov, 2019).

Prospects for the transformation of the NSR into an international transit route, as well as related economic and legal aspects of ensuring transit, were considered by Todorov (2017). Zelenkov (2019) evaluated the transport and logistics system of the NSR, identified positive aspects in comparison with transportation on traditional routes through the Suez and Panama Canals, and analyzed the problems of transit along the NSR. Grigoriev (2019) presented an assessment of transit traffic on the NSR in 2010–2018, determining the dynamics and commodity structure of transit, as well as the dynamics of transit traffic of the main types of cargo (Grigoriev, 2019).

Stroganov (2016) considered the history of the Russian transport system, its risks, and opportunities for the elements of the Russian transport and logistics system: the Trans-Siberian Railway, the BAM, and the NSR, related to the implementation of China's "One Belt, One Road" initiative. Xiuwen (2017) reflected on the problems and prospects for the development of the Northern Sea Route within the framework of the concept of maritime cooperation of the "Belt and Road" initiative, and assessed the possibilities of linking the NSR and the "Belt and Road" initiative. Faury and Cariou (2016), by means of modeling, assessed the competitiveness of the NSR as an alternative route for oil delivery from Murmansk to South Korea.

Assessing Global Competitiveness of the NSR: Theory and Practice

The transformation of the NSR into a transport route began in 1932. The growth of cargo traffic occurred only in 1950–1980s; in 1987, it amounted to 6.5 million tons, the historical peak of the Soviet period. Traditionally, the NSR was used to supply the northern regions of the state, which do not have year-round rail and road connections with the rest of the country.

The transition to market relations and the collapse of the USSR had a negative impact on the volume of traffic, which decreased by more than 4 times to 1.95 million tons in 1998 (Selin et al., 2015). During the first decade of the 2000s, the volume of traffic fluctuated in the range of 1.6 to 2.2 million tons, though since 2011, there has been an increase in traffic. By 2016, 7.3 million tons were transported, which for the first time the figures of 1987 were exceeded. In 2018 and 2019, the volume of traffic was 20.2 and 31.5 million tons, respectively. The cumulative average annual growth rate of traffic volume in the NSR in 2010–2019 was 35.5%.

The key commodity groups transported along the NSR are traditionally mineral resources and energy sources. In 2020, the volume of domestic traffic amounted to 32 million tons, or 96.2% of the volume of all traffic on the NSR for the specified period (State Commission for the Development of the Arctic, 2020).

In 1991, the Rules for Navigation along the NSR routes were approved, which established a notification procedure for access for ships of all states. A relatively active growth in transit freight traffic began only after 2010.

In 2010, the volume of transit traffic was only 0.1 million tons. Since 2011, there has been a significant increase in transportation volumes, reaching an all-time high of 1.4 million tons in 2013. In the same year, the maximum transit share was reached, amounting to 34%; this was reached, on the one hand, by the high volume of transit traffic, and, on the other hand, by the low base of domestic traffic (in comparison with 2014–2019).

Since 2014, the volume of transit traffic along the NSR began to decline. The reason for this decline could be variety of factors: the launch of the second channel of the Suez Canal in 2015, severe ice conditions, the high workload of icebreakers at the construction of the Sabetta port, the imposition of sanctions against Russia, or the deterioration of political relations with Western countries, including with countries members of the Arctic Council (i.e., Canada, Norway, USA, Sweden, and Finland).

The commodity nomenclature of transit freight traffic is similar to the domestic one; the main transit groups are mineral resources and energy sources. Transit cargo traffic in 2020 amounted to 1.25 million tons or 3.8% of the total traffic (State Commission for the Development of the Arctic, 2020).

Currently, the main users of the NSR are Russian companies, including Novatek, Rosneft, and Norilsk Nickel. It should be noted that the functions of the operator of the NSR are entrusted to the State Atomic Energy Corporation Rosatom, which is responsible for icebreaker assistance and the development of ports within the boundaries of the transport corridor; ports outside the NSR and the rest of the

Table 1 SWOT analysis of the implementation of the NSR project

Strengths	Weaknesses
1. The distance is shorter compared to alternative transport arteries 2. Less congestion 3. No piracy 4. Free pass 5. From the perspective of regional energy projects, equidistance from the European and Asian markets 6. Possibility of infrastructure development based on energy projects, in particular, port-forming territories (cities, settlements); creation of new jobs	1. Difficult climatic conditions 2. The need to build a specialized fleet 3. Long wait for icebreaker assistance 4. Underdeveloped infrastructure 5. Increased requirements for special professional competencies of the crew 6. Environmental risks 7. Increased insurance premium rates 8. Increased fuel costs
Opportunities	Threats
1. Warming and, accordingly, an increase in the navigation season 2. Limited capacity of the Suez and Panama Canals 3. Economic development of four subjects and 45 municipalities of five regions that are part of the Arctic zone; due to this, the quality of life of 2.5 million northerners will be improved. 4. Unstable geopolitical situation (including in the Middle East) 5. The interest of third countries in the development of the NSR, for example, China	1. Lack of legal status 2. Loss of control due to the globalization of the Arctic 3. Risks to the economic security of the Russian Federation from third countries 4. Loss of Russia's leading role in the development of the Arctic

Source: compiled by the authors

transport infrastructure are the responsibility of the Ministry of Transport of the Russian Federation (The Russian Government, 2020).

A significant role in the planned cargo traffic is assigned to the projects of the Novatek company for the construction of enterprises producing LNG. In the early stages, construction required the import of the necessary materials, which had a positive effect on increasing the volume of transportation, and the subsequent launch of production provided export products.

Oil projects by Gazprom Neft, Rosneft, and Neftegazholding play an important role in the export of oil products along the NSR. In addition to the "federal players," the region is represented by the company "Neftegazholding," which is implementing the "Payakha" project on the basis of the Payakhskoye field.

According to the passport of the federal project "Northern Sea Route," it is planned that, by 2024, within the framework of the projects "North Star" and "Vostok Coal," 23 million tons of coal per year will be transported along the NSR (Burmistrova & Podobedova, 2019).

To assess global competitiveness, as well as structuring the factors of the internal and external environment, a SWOT analysis was used (Table 1).

Strengths

To turn the NSR into a large transit hub (capable of competing with the Suez and Panama Canals), there are a number of objective prerequisites: shorter distances than traditional routes, less congestion, no piracy, the need to pay for transit in the summer.

Using the traditional route connecting Pacific and European ports through the Suez Canal (the second most important transport artery in the world after the route across the North Atlantic between the United States and Europe), the distance between the port of Vladivostok and the port of Bremerhaven, one of the largest sea hubs in Europe, is 10.5 thousand nautical miles – to overcome this takes about 34 days. The distance along a similar route through the NSR is 7.2 thousand nautical miles, which can be covered in 23 days (Ferris-Rotman, 2018). The savings provided by the Arctic route are 3.3 thousand kilometers or 11 days of travel. Reducing distance and travel time translates into fuel savings, increased ship turnover, reduced carbon dioxide emissions, and lower crew costs. Also, unlike the Suez Canal, in the absence of the need for icebreaker assistance, there are no fees and charges for passing the route.

According to the Ministry of Energy, natural resources located in the Arctic region of Russia can amount to 260 billion tons, or 60% of all recoverable hydrocarbon resources in the country. For export-oriented projects located along the NSR, equidistance from European and Asian markets creates an additional competitive advantage: the ability to carry out shipments in both directions at comparable transport costs. However, the realization of this advantage, as well as the organization of economic activities for the extraction, processing, and export of resources, is impossible without the involvement of the arteries of the NSR and significant investments in the development of shipping infrastructure and the construction of a specialized fleet, the use of which will not be limited only to the activities of raw materials companies (Osipov & Roncevic, 2021). The systemic cargo flow created by commodity companies will demonstrate the possibility of systematic year-round navigation along the entire length of the NSR and the transit potential of the transport artery.

Weaknesses

Due to difficult climatic conditions, navigation along the NSR without the involvement of icebreakers is possible only for a short part of the year. An increase in the short summer navigation period, from July to October, is possible due to the construction of specialized vessels with a reinforced hull (ice class) and preparations for navigation in polar waters; however, these vessels are characterized by high fuel consumption, and therefore, the zone of economic feasibility of their use will be limited to the arctic region.

For year-round navigation along the entire length of the route, it will be necessary to expand the icebreaker support for cargo transportation and the construction of new nuclear icebreakers. Without providing the necessary volume of the icebreaker fleet, transit can only be considered as a possibility. Even with the current workload, the waiting time for icebreaker assistance may exceed the net time of navigation on the NSR, which makes it impossible to calculate the economic effect of the voyage – a key aspect for a commercial carrier – and creates an uncertainty factor that is absent during transportation through the Suez Canal.

In addition to the construction of a specialized fleet, to ensure regular and safe navigation, significant investments will be required both in the development of port infrastructure and in security systems, navigation services, and hydrometeorological services. On most of the NSR, there are no ports and settlements, which calls into question the possibility of providing prompt assistance in case of an emergency; in the polar regions located above 70–75 °N, none of the satellite communication operators work, and due to the high regional geomagnetic activity, there are malfunctions in the operation of navigation systems.

The intensification of traffic along the NSR is associated with an increase in environmental risks for the Arctic zone of Russia. In addition to the traditional threats associated with shipping in the region, such as pollution from transport and coastal infrastructure, there are difficult ice conditions, due to which the threat of emergencies, such as those related to oil spills, is increasing.

These factors are associated with additional requirements for the qualifications of the crew; in addition, they have a negative impact on the size of the insurance premium for ships heading to the Arctic region.

A key advantage of the NSR compared to traditional routes is that a shorter distance that saves fuel can be reduced by lowering world oil prices: at high oil prices, reducing distance in order to save fuel is a key driver to reduce transportation costs.

Opportunities

Climate change, ice melting, and a decrease in the thickness of the ice cover can have a significant impact on the development of navigation along the NSR, which will lead to an increase in the summer navigation period, reduce the requirements for the ice class of ships, and reduce the volume of investments in the construction of a specialized fleet for sailing in the ice of the NSR. On average, over a decade, the ice thickness decreases by 13%; if this trend persists, by 2030, during the summer navigation period, the ice will completely disappear, and the navigation season will be more than 6 months a year.

The key competitor of the NSR, the Suez Canal, allows ships with a displacement of up to 240,000 tons and a draft of up to 20.1 m. In 2015, the second channel of the Suez Canal was launched, which made it possible to increase the throughput of the artery from 49 ships per day to 97, as well as to reduce the waiting time for passage from 18 to 11 h. In 2019, about 50 ships passed through the canal every day, according to the administration of the canal, and by 2023, the number of ships passing the canal is expected to double. The unstable political situation in the Middle East may also have a negative impact on the expansion of shipping on the Suez Canal.

The countries of Northeast Asia are showing interest in the development of the NSR, especially China. China, based on its needs, can become a key for the development of the Arctic region for Russia, about 30% of the Yamal LNG project already belongs to the Chinese National Oil and Gas Corporation (20%) and the Silk Road Fund (9.9%). In addition, approximately 3% of the cargo turnover between

China and Western Europe is frozen food, which is approximately 210 million tons per year. Consequently, it is advisable to develop competition for the "Suez" line focusing on loads for which speed and thermal insulation are key requirements. In addition to financial participation, the Chinese side provides technological support in the form of the construction of six gas carriers, and also assumes responsibility for operating 14 out of 15 gas carriers (Mikhaylichenko, 2019).

Threats

Currently, the Arctic region is attracting the interest of not only of the Russian Federation, but also of the other key geopolitical players. This is due to the huge resource potential and the significant volume of the occupied territory. The region covering the Arctic Ocean, parts of the Atlantic and Pacific, and the outskirts of North America and Eurasia does not have a clear legal status, which leads to a clash of sovereign national interests and international competition not only among the countries participating in the Arctic Council, but also among non-Arctic states, from the point of which the Arctic region should be globalized.

In this regard, in 2018, the PRC published a White Paper on the country's Arctic policy, where it considered how interesting and important this region is for China, and also outlined the principal positions of the Chinese side on the Arctic issue (Pilyasov, 2018). China sets itself the goal of creating a better management regime for the Arctic territories, making adjustments to the international order of behavior in the region, ensuring the rights of all interested players. At the same time, this concept contradicts the national interests of the Arctic and subarctic countries, undermining their exclusive rights to the Arctic region, which also does not meet the national interests of Russia, for which control over the NSR is important.

China is actively investing not only in Russian Arctic projects such as Yamal LNG, but also in research in the fields of ecology, shipping, and the exploration and development of natural resources. In our opinion, this activity may conceal an effort to intercept the initiative for the development of the Arctic and strengthen the role of an extraregional player.

In addition to significant economic preferences in the Arctic region, there are also aspects of national military security. One of the main instruments of nuclear deterrence is the Northern Fleet, which is the most powerful operational-strategic formation of the Russian Navy. The intensification of navigation along the NSR may negatively affect the provision of the economic security of Russia; however, any future active economic activity by foreign states in the Arctic zone of the Russian Federation, perhaps under the pretext of ensuring security, may serve as a reason for requesting free access warships. Consequently, this factor will have a negative impact on the country's defense capability.

According to the presidential decrees in May, by 2024 the volume of traffic on the NSR should reach 80 million tons (President of Russia, 2018). A key role in achieving this indicator is assigned to projects of Russian companies in the Arctic, aimed at exporting natural resources extracted in the region.

To ensure export and year-round navigation in a comprehensive plan for the modernization and expansion of the main infrastructure for the period up to 2024, measures are envisaged to increase the capacity of the port infrastructure by 21.6 million tons; construction of the Utrenny LNG terminal in the port of Sabetta, as well as construction of four icebreakers on liquefied natural gas to ensure year-round LNG shipment from the designated terminal. ₽587.5 billion are planned for the implementation of this project (The Russian Government, 2018).

As part of the development of the transit potential, in accordance with the plan for the development of the infrastructure of the Northern Sea Route until 2035, measures are envisaged to ensure the safety of navigation in the water area of the NSR. The possibility of systematic year-round navigation along the entire length of the NSR should be demonstrated to the world community. On the horizon until 2024–2026, this role is assigned to Russian projects in the Arctic.

Conclusions

A key role in achieving the target of 80 million tons in the field of transportation via the NSR is assigned to large investment projects associated with the development of mineral deposits in the Arctic. By 2024, the structure of cargo traffic will remain, and the key volume of traffic on the NSR will be provided by the export of LNG, oil, and coal.

Large-scale tax incentives, including a deduction from the severance tax for the construction of infrastructure, can serve as an incentive to reorient cargo traffic in the direction of the port under construction "Sever Bay."

The launch of large energy projects will create a system of regular commercial and industrial shipping in the Arctic, realize the possibility of effective use of the NSR as a year-round transport and logistics artery, and "launch" a new stage in the development of the transit potential of the NSR. The development of the NSR is an additional impetus for the LNG industry, which will have a significant positive effect on the Russian economy. The Federal Law "On State Support for Entrepreneurship in the Arctic Zone of the Russian Federation" came into force, which provides for a preferential MET rate for the production of gas directed to LNG production, as well as the right of Russian subjects to reduce to zero the regional part of corporate income tax for LNG producers; VAT on services of sea transshipment and icebreaker escort of export cargo was zeroed. That forms objective prerequisites for the development of the NSR as one of the drivers of economic growth in the Russian Federation.

Thus, we can conclude that the development of the Northern Sea Route is primarily associated with the economic security of the Russian Federation. In addition, the NSR can provide, first of all, Russian cabotage transportation, and its global competitiveness and GDP growth will directly depend on the equipment of this route.

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Northern Sea Route from the Russian and EU Perspectives

Ideals and Realities

Egor V. Pak and Isabell Burmester

Contents

Abstract

International transport corridors (ITCs) are becoming a decisive instrument of geoeconomic and geopolitical dominance. Given the Arctic's profound mineral resources and relevant security agenda, controlling the region's main transport artery – the Northern Sea Route (NSR) – becomes vital for any actor concerned. Russia, possessing the largest Arctic coastal line, decisively justifies the right to do so. As of today, shipping via the route is subject to official permission with all related logistics services to be provided by Russia only turning it into a specific and politicized ITC. In fact, such a *status-quo* is generally accepted by the international shipping society. NSR's transit potential is severely underutilized, yet it has marked a number of milestones as an ITC. For instance, after 2014 there has been a rise in volumes of transit goods transported, including both cabotage

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and international transit, as well as a number of permissions granted, including foreign-flagged vessels (with Germany ranked second after China). Thus, there is little evidence of Russia's deliberate increasing protectionism over the NSR. In fact, Russia's second-to-none ice-breaker fleet opt for an all-year round navigation, which might be a good springboard for greater international connectivity. However, making the NSR commercially viable is hampered by higher freight rates, outdated and insufficient infrastructure, unstable weather conditions, and bathymetry constraint. When looking at the economic potential of the NSR for the EU, the researchers believe that linking the NSR with the European transport network might bring economic benefits for the Northern member states. However, the lack of a common approach by the EU and geopolitical tensions with Russia stir such cooperation. This may be changed by a more active engagement of the Northern member states.

Keywords

Northern Sea Route · The Arctic · Connectivity · International transport corridor · Geopolitics · EU

Introduction

Connectivity issues are shaping global economic and political processes (Simonia & Torkunov, 2015; Torkunov, 2018). In fact, their influence is multidimensional, ranging from purely technical aspects to geopolitical ones. Specifically, the research views connectivity from the perspective of international transport corridors (ITC). As such, this category no longer constitutes a channel for cargo movement and related transport services only, but is constantly linked with environmental, social, digital, political, and security dimensions. Furthermore, regional integration – that is, in formats of the European Union (EU) and the Eurasian Economic Union (EAEU) – is also altering its track given the creation of common customs territory, the elimination of related nontariff barriers, and motion towards a common transport policy. Thus, connectivity viewed through the lens of the ITC has become one of the instruments of geoeconomic and geopolitical dominance.

In the same vein, the Arctic – usually referred to as the last untapped region – holds substantial, *albeit* hurdling, connectivity potential. Its major transport artery – the Northern Sea Route (NSR) – offers roughly delivery dates twice as short in the China-EU trade direction than that via the Southern Sea Route (SSR). Given the rising volumes of trade between the Asia-Pacific region and Europe, infrastructure constraints of its southern competitor (for instance, capacity-related of the Suez Canal and its vulnerability seen in the Evergreen case), and prospects of all-year round navigation, the NSR could be perceived as a promising alternative. Nevertheless, still predominantly energy cargo base, higher freight rates, limited navigation period, lack of modern and specialized infrastructure as well as fleet, and uncertainty about international legislation remain the route's major failing points.

Russia, with its far-fetching northern coastal line, is the most essential actor and, simultaneously, beneficiary to greater connectivity in the Arctic region. Large distances, scattered premises, and ample off-shore energy resources predetermine Russia's strive for exploiting the NSR. Its development can bridge national territories, utilize transit potential, foster socio-economic development of the Arctic Zone of the Russian Federation (AZRF), and raise the country's global competitiveness.

Under Russia's Arctic Strategy through 2035, the route is referred to as a strategic, "historically established," unitary, and exclusively national artery. The *status-quo*, with a permissive character of shipping (both merchant and military) via the NSR to be granted by Russia, has been fairly maintained since 1932. However, such positioning – being exacerbated on the one hand by global warming and induced ice-melting, and on the other by a return of Russian military presence into the region – represents a research conundrum to break. Thus, the question is to what extent Russia's stance to develop the NSR as an international corridor and, consequently, cherish transit flows can coincide with the route's current nationally oriented governance and nationally supervised sailing.

Literature Review

The discourse on NSR is predominantly evolving in the classical realm of the political economy. The economic emphasis is given to the ideals and realities of trans-arctic shipping, including both cabotage and international sailing, while the political one is to the confrontation between the West and Russia coupled with induced security concerns. As Moe (2020) clearly captures it, the NSR has become a major topic in discourse on Russia as a tool for re-asserting the country's status as a super-power.

To begin with, legal aspects of shipping via the route have been scrutinized by Young et al. (2020), Okochi (2020), and Solski et al. (2020), pointing at a relative gap when applying Russian and international law. Specifically, revisiting the NSR from both domestic and international regulation Vylegzhanin et al. (2020: 287) asserts that the current legal regime of the route is an "outcome of a combined legal effect of relevant customary rules of international law and UNCLOS." In fact, Article 234 of the United Nations Convention on the Law of the Sea (UNCLOS) grants Russia extended rights on governing ice-covered territories in the region. Besides, under the Polar Code, it "has the right to adopt and enforce non-discriminatory laws and regulations for the prevention, reduction and control of marine pollution from vessels in ice-covered areas within the limits of the exclusive economic zone" (Todorov, 2021: 35). Being in the same vein, Van Den Bossche et al. (2019) stress that the NSR predominantly falls into a 200 nautical miles exclusive economic zone of Russia.

These arguments are constantly questioned by a few states, that is, the USA (nonparty to the Convention), as they find they now must ask Russia to take passage permission, ice-breaker assistance, pilotage, and national-flagged vessels for oil and gas carriage, as well as cabotage, as forms of the Kremlin's protectionism in the region (Moe, 2020). However, Gunnarsson and Moe (2021) stresses that despite these dissents, as of today international shipping society generally admits Russia's interpretation of NSR governance.

Several scholars have traced the transit potential of the route by critically reviewing the number and condition of transit shipments (Moe, 2014; Lasserre & Alexeeva, 2015; Gunnarsson and Moe 2021; Gutenev, 2019; Eliseev & Naumova, 2021; Theocharis et al., 2019). Taking the same perspective, Sur and Kim (2020) have empirically proved the viability of the NSR as an alternative to the SSR for a group of Asian (China, Korea, and Japan) and European (the Netherlands, UK, Germany, and France) states, with Japan and the Netherlands to be the most wining parties to commercial shipments via the route. In his turn, Grigoryev (2019) unveils that international as well as cabotage voyages (e.g., shipments of energy products and frozen fish between Russian ports) within the NSR as of today are insubstantial. On the contrary, exports of liquified natural gas (LNG) to China and Japan via the NSR are on the way and look promising enough (Kholopov & Sokolova, 2020). As Gutenev (2019: 84) puts it, shipping via the NSR may save on around \$0.5 million per voyage; yet, despite some progress in national shipbuilding (the case of "'Zvezda" wharf), Russia is still dependent on foreign ice-class carriers for the needs of the NSR (Kravchuk, 2019).

From the environmental perspective, ice-melting in the Arctic and, consequently, prospects of all year-round navigation may lead to Russia's loss of its exclusive rights on governing the NSR under the Article 234 (Zhuravel & Nazarov, 2020; Galimullin & Benedyk, 2019). Besides, increasing merchant sailing in the region may also cause a negative effect on its ecosystem, for instance, due to short-lived pollutants (Fedorov et al., 2020).

Shipping via the NSR is neatly intertwined with security issues both of social and military origin (Sergunin & Gjørv, 2020; Sergunin & Konyshev, 2017; Zagorskii, 2019). Rising geopolitical tensions between the West and Russia force the latter's perception of the NSR and the AZRF at large as targets of NATO's growing military presence in the region (Gudev, 2018). When broken down to USA-Russia relations, severely deteriorated since 2014, security concerns looming over the NSR are getting even harsher (Raikov, 2020; Galimullin & Benedyk, 2019). As Graham (2016) puts it, the navy is a steadfast guarantee of the US interests on the freedom of navigation throughout the world and the NSR is not an exception. Nonetheless, Sergunin and Gjørv (2020) conclude that, as of today, Russian authorities mainly focus on soft security threats to shipping (i.e., safety measures, environmental standards, etc.) rather than hard ones.

Finally, despite all the tensions, the NSR could also become a part of a more balanced and inclusive international cooperation on connectivity. For instance, under the Belt and Road Initiative (BRI), the route is referred to as *Polar (Ice) Silk Road* and is considered as a reliable vein for Chinese containerized exports to the EU and the USA, as well as for Beijin's energy imports from Russia (Ostrovsky, 2019; Zoidov & Medkov, 2019). In their turn, Van Den Bossche et al. (2019) refer to the NSR and Polar Silk Road as second-tier alternatives, pointing at still uncertain conditions and procedures that may hamper the just-in practice. At the same time, Russia may also count on Chinese investments into its coastal and landline infrastructure throughout the NSR (Ghiasy et al., 2018). Besides, as Pak (2020, 2021) recalls it, conjunction of BRI and NSR could be also institutionalized on a broader and more inclusive basis of the *Greater Eurasia* concept, involving the Eurasian Economic Union (EAEU) and Shanghai Cooperation Organization (SCO).

In its turn, the EU, given its recent environmental initiatives (i.e., the *EU Green Deal* and *Blue Economy*), may contribute to the development of the NSR in terms of maritime safety, maritime surveillance, fuel standards, weather forecasting, and preserving biodiversity (Tianming et al., 2021). Moreover, Deandreis (2020) points at the possibility of bridging the NSR with Scandinavian-Mediterranean and North Sea-Baltic corridors under the Trans-European Transport Network (TEN-T) with "high environmental protection standards." Yet, as Riddervold and Cross (2019) show it, the geopolitical factors generally lead the development of the EU Arctic policy. They identified the planting of a Russian flag at the North Pole in 2007 and the geopolitical events in Georgia and Ukraine as the drivers of the EU policy. These findings are in line with Blunden's (2012) assessment of the NSR as a contested waterway due to diverging jurisdictional claims by Russia and the USA. So far, Russian de facto control and management of the NSR has not been challenged, but the possibility of a re-definition of the Arctic's international legal status is not ruled out.

Thus, the chapter stresses that deployment of the NSR as an international corridor with tangible cargo volumes in the foreseeable future is a multidimensional and thorny task. To put it differently, changing transport routes often incur changes in economic and political power balances as well.

Northern Sea Route: An International Transport Corridor?

As of today, there is no single commonly accepted definition of an ITC (Vardomsky & Turaeva, 2018; Pak, 2020). The research adheres to the definition given by the Inland Transport Committee of United Nations Economic Commission for Europe (1998). Under this approach, an ITC is a "part of a national or international transport system which maintains considerable international cargo and passenger transportation between certain geographic regions and includes the rolling-stock and immovable structures of all modes of transport working on the respective route, and all technological, organizational and legal conditions for such transportation" (EDB, 2009: 10).

When viewed as an international corridor, the NSR has several peculiar features. First, unlike other ITCs passing via Russia (for instance, *East-West* and *North-South*), the NSR has a centralized regulative body – Administration of the Northern Sea Route. Second, the NSR lacks the essential characteristics of an ITC, such as harmonization of procedures at various modes of transport, unified technologies of cargo flows, and synergetic approach to infrastructure building present (as, for example, in the *Pan-European (Crete) corridors*). Third, there are no regular passenger flows via the Route, although there are a number of tourist excursions.

Fourth, its operation is mainly seasonal. Fifth, the NSR is primarily an energy concerned itinerary with LNG as the most commercially viable cargo to ship, whereas international transit remains modest enough.

NSR was introduced as an "international Euro-Asian transport corridor" (in fact, as of today, a commonly accepted synonym to the international transport corridor) as a result of the 1st International Euro-Asian Conference on Transport (1998). However, the history of merchant sailing via this water area, albeit fragmented, goes back to the sixteenth century to the times of Mangazeya Sea Passage (Armstrong, 1984). The artery saw a first through passage of an icebreaker *A. Sibiryakov* in 1932 – the year of route's opening to commercial navigation and foundation of specialized governing body. Yet, during the USSR, the route was closed for foreign vessels.

The first international transit voyage was conveyed in 1995 when a Russian-flagged bulker *Kandalaksha* performed a demonstrative voyage from Kirkenes (Norway) to Yokohama (Japan). In 2010, *Nordic Barents* was the first non-Russian bulker to carry iron ore between Kirkenes (Norway) and Lianyungang (China). Another cargo milestone of the NSR as an international corridor was marked in 2017 when a Russian LNG carrier *Christophe de Margerie* sailed from Norway to South Korea without assistance from an ice-breaker. The same vessel, backed up with an ice-breaker, performed a shipment from Sabetta (Russia) to Jiansu (China) in January 2021, showing that the navigation could be fairly an all-year round business. Speaking about the containerized cargo, the route experienced a trial voyage of *Venta Maersk* from Busan (Korea) to Bremerhaven (Germany) called Saint-Petersbug on its return sailing.

In terms of passengers, the route is severely underutilized, though is used for nonregular cruises. For instance, in 2016, the route saw a cruise of *Kapitan Khlebnikov* carrying 120 passengers from Anadyr to Murmansk.

The route's governance is actually twofold: The Administration of the Northern Sea Route (headquartered in Murmansk) is mainly responsible for issuing the passage permits, whereas Rosatom is set as operator of the route rendering ice-breaker assistance, pilotage, and responsibility for related infrastructure building.

It has been revealed that Russian-flagged vessels dominate in the overall permissions granted in 2013–2020, with foreign-flagged vessels constantly accounting for roughly 15%. Specifically, in 2010–2013, under the permissions granted, the majority of foreign-flagged voyages were carried by Nordic shipping companies (i.e., Denmark, Sweden, Finland), whereas after 2016 it was China Ocean Shipping Company (COSCO) and several German shipping companies ranked first and second, respectively. Simultaneously, the number of rejections given to the foreign-flagged vessels also remained stable enough. Thus, there is not much evidence on deliberate protectionism displayed by Russia, for instance, after the deterioration of relations with the West in 2014. In fact, a reduction in voyages of western shipping carriers via the NSR might be a consequence of the volatility of world prices on energy resources and the on-going political turbulence (Table 1).

When shipping in China-EU direction, the route offers shorter delivery dates, relatively same speed, and, thus, fewer greenhouse gas emissions compared to the SSR. According to UNCTAD (2020), almost 98% of trade between China and the

Table 1 Number of permissions granted for sailing via the NSR in 2013–2020, (units)

	2013	2014	2015	2016	2017	2018	2019	2020
Overall permissions granted	635	631	715	718	662	792	799	1014
Permissions granted to foreign-flagged vessels	121	107	122	143	105	89	92	142
Overall applications rejected	83	30	15	3	2	16	2	19
Applications of foreign-flagged vessels rejected	18	16	6	2	2	5	1	4

Source: Compiled by the authors based on data of the *Federal State Budgetary Institution 'The Northern Sea Route Administration'*. Retrieved from: http://www.nsra.ru/en/rassmotrenie_zayavleniy/razresheniya.html

Table 2 Transport trade-off between the NSR and SSR

	Average delivery dates (days)	Average speed (knots)	Distance covered (kilometers)	Average fuel oil consumed (tons)
Northern Sea route	18	14	13,623	625
Southern Sea route (via the Suez Canal)	32	15	21,455	875

Source: Compiled by the authors on data from CNHL Information Office. Retrieved from: https://arctic-lio.com/; Van Den Bossche, M. et al. (2019). Prospects and Impacts of Commercial Navigation along the Northern Sea Route. *ECORYS*. Retrieved from: https://www.itf-oecd.org/sites/default/files/docs/northern-sea-route-bossche.pdf

EU is seaborne, with less than 2% shipped via the NSR. To put it differently, transit flows via the NSR are 1000 times less than that via the Suez Canal. However, when broken down to the Yokogama-Hamburg leg, the distance to cover via the NSR is almost 40% lower and requires on average 30% of fuel oil less than a voyage via the Suez Canal (Table 2).

The navigation via the NSR is seasonal, executed in the winter-spring period (December–May) and summer-fall period (June–November). The most favorable navigation window occurs from July to October when the NSR is practically ice-free. As Gutenev (2019: 85) puts it, the route has seen an increase in navigating dates from 84 days in 1979 to 129 days in the late 2000s. In fact, sea-ice shrinking in the last 10 ten years has been quicker than in the previous 20 years. According to Rosatom estimates, should Russia succeed in strengthening its icebreaking fleet, all-year round navigation via the route could start from 2025 at best. Overall, given the pace of global warming, ice-free summers are expected to occur already by 2050 even if the annual warming is below 2 degrees Celsius and not necessarily equal to 1.5 degrees Celsius (Sui et al., 2021).

In terms of freight rates, shipping via the NSR turns out to be more expensive than that via the Suez Canal. For example, it costs on average \$20–30 to deliver one ton via the Northern route compared to \$5 via the Suez Canal (Oreshenkov, 2019). Broken down to types of bulk, freight rates for thermal coal and iron ore equal to

$25 and $5 thousand per ton, respectively. As of today, LNG (the second main position to be transported via the route after the iron ore concentrate as of 2020) turns out to be the most commercially viable cargo to ship via the route at a freight rate of $350 per ton. According to Novatek estimates, delivery of 1 British thermal unit via the NSR is $0.8 less than via the Suez Canal, which could annually generate almost $3.2 million savings (Vedomosti, 2018).

Thus, the research concludes that the NSR eventually meets the criteria of an ITC under the definition applied. However, its transit potential is still shady due to navigation period, primarily resource-oriented cargo base, and higher freight rate.

Main Results

The research stresses that despite obvious challenges and limitations, there is some progress in deploying the potential of the NSR. Overall, the route has seen an increase in cargo transported, including both international transit and cabotage, as well as the modernization of the fleet. As such, the chapter deliberately focuses on the international transit as one of the decisive indicators of NSR's status of an international corridor.

Shipments via the NSR could be generally broken down to three categories: (1) *international transit* (when port of loading and port of unloading are of non-Russian origin), (2) *export/import operations* (when at least one of the two ports is Russian), and (3) *cabotage* (when both ports are Russian). International transit is generally executed in the following directions: from Europe to Asia (so-called Western direction), from Asia to Europe (so-called Eastern direction), and from North America to Asia.

Tracing the history of sailing via the NSR since 1932, the volumes of cargo transported peaked in 1987 and leveled at 6.6 million tons. Following the dissolution of the USSR and the induced deterioration of the economic situation in Russia, these volumes were outperformed only in 2016 with further constant growth till 2020. It is planned that, by 2024, the NSR could handle 80 million tons, by 2030 120 million tons, and by 2035 180 million tons (Interfax, 2021). However, these figures are highly subject to alterations given relatively low oil prices and inability of national coal industry to load the route.

Cargo volumes transported via the NSR have been on the rise since 1996, with the most tangible pace starting since 2014. In their turn, international transit and cabotage have been volatile enough, yet there is a fragile uprising tendency. As of 2020, the overall cargo transported via the route amounted to 32.90 million tons, out of which transit accounted for less than 4%. In its turn, international transit (voyages between non-Russian ports) leveled at around 1% only (Table 3).

As can be seen from the table, the number of international transit voyages was relatively stable in 2010–2016, whereas in 2019–2020, it surged from 14 to 45. Apart from traditional bulk voyages rocketed thanks to growing LNG shipments, the route has experienced a rise in general cargo shipments. As of 2020, 11 voyages

Table 3 Shipments via the NSR in 2011–2020

	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Total cargo transported (million tons)	3.11	3.50	3.93	3.98	5.39	7.27	10.69	20.20	31.50	32.90
Transit cargo transported, including cabotage (million tons)	0.20	0.82	1.17	0.27	0.04	0.21	0.19	0.49	0.69	1.28
International cargo transit (thousand tons)	185.2	337.4	633.8	72.5	34.9	201.9	154.4	339.1	285.2	400.0
Number of international transit voyages (units)	4	9	14	4	6	8	12	17	14	45

Source: Compiled by the authors based on *CNHL Information Office*. Retrieved from: https://arctic-lio.com/; *State Atomic Energy Corporation Rosatom. Performance in 2019*. Retrieved from: https://rosatom.ru/upload/iblock/0c1/0c106b40899f365fd8c2a6be935b092b.pdf; Gunnarsson, B. (2021). Ten Years of International Shipping on the Northern Sea Route: Trends and Challenges. *Arctic Review on Law and Politics*, 12, p. 8. Retrieved from: https://arcticreview.no/index.php/arctic/article/view/2614/5113#FR2 were made by general cargo vessels operated by COSCO toward Denmark, Finland, Lithuania, Germany, and Sweden (CNHL Information Office 2020).

The development of the Russian fleet operated in the NSR is also on the way. As of 2020, there were 40 icebreakers (five of which are nuclear) engaged in pathlaying via the route keeping Russia at the cutting edge. For instance, in 2020 the nuclear ice-breaker *Arktika* – the head vessel in the new series 22,220, able to cut a 2.8 meter-height ice – made its first voyage via the route. Early 2022 it was strengthened by *Sibir'*. Another breakthrough project in this area is the nuclear ice-breaker *Rossiya* (of *Lider* series) – to be built on the Zvezda wharf and put into operation by 2027 – which will be able to sustain an all-year round navigation via the NSR cutting a 4 meter-height ice. In this regard, rendering ice-breaker assistance might be a good business, as the cost of Russian ice-breaker assistance per voyage is roughly $100 thousand (Gutenev, 2019).

In terms of vessels to be used on the NSR, including that of Arctic class, the Russian Federation is still heavily dependent on ships built in South Korea, Japan, and China. Nonetheless, Russian leading oil and gas companies have been advised by the state to place orders at national wharfs. For instance, the Zvezda wharf has 12 orders on gas-fueled and autonomic-shipping *Aframaks tankers*. In 2020, the head-series tanker *Vladimir Monomakh* was handed over to its operator.

Thus, the research has captured positive signs of deploying the connectivity potential of the NSR both on domestic and international itineraries. Again, there is not much evidence on Russia's transport protectionism in the region, as there has a been a solid growth in cargo volumes and number of international transit voyages via the NSR.

Key Challenges

The main obstacles on the NSR's way to commercial attractiveness (mainly among foreign shipping companies) lie in the following areas: higher freight rates, outdated and insufficient infrastructure, unstable weather conditions, and bathymetry constraint.

Freight rates remain the most fundamental constraint to the commercial viability of the NSR. The rate predominantly implies higher fuel costs (because of specialized fuels), insurance rates and other costs (which are 50–200% higher than elsewhere), costs of ice-breaker assistance (tariffs set by Russia are not transparent enough), and special crew training. As of today, freight rates via the NSR are roughly 36% higher than, for instance, via the Suez Canal (Interfax, 2021). Specifically, according to Eliseev and Naumova (2021), a vessel operating in the NSR consumes 78.76 tons per day; insurance costs are equal to 0.343% of the overall price of the vessel annually; the cost for ice-breaker assistance during the winter-summer navigation period varies from $7.22 to $14.44 per ton of gross tonnage and from $2.91 to $5.83 in the summer-fall window; the monthly salary of the crew ranges from $100 to $115 thousand.

The existing transport and logistics infrastructure of the NSR is mainly outdated and is not designed for all types of cargoes. As Zhuravel (2019) stresses, 66 out of 71 ports on the itineraries within the NSR annually handle less than 100 thousand tons each or do not function at all. In fact, all the ports require technical overhaul and deepening works to service large vessels, including containership. Much building is to be done in Murmansk and Arkhangelsk, positioning themselves as key transit ports of the NSR.

As far as vessels are concerned, initial investments into construction of an Arctic-tailored vessel (i.e., of an Arctic class) are 20–30% higher than for a conventional vessel to be exploited elsewhere (Van Den Bossche et al., 2019). For instance, the construction of an LNG tanker of Arc7 class at the Zvezda wharf is around $330 million, whereas the cost of one *Lider* ice-breaker is estimated at $1.8 billion (Kholopov & Sokolova, 2020).

Moreover, still there are problems with the telecommunication infrastructure of the NSR. Leading providers of satellite phone services, such as *Thuraya* and *Inmarsat*, do not operate in the regions above 70–75 degrees of northern latitude. As such, shipping companies are anxious about planning voyages in these territories in case of emergency.

Despite the ascendancies of global warming, the ice situation on the route remains unpredictable, with ice massifs posing danger to several itineraries within the NSR and, logically, to delivery dates. Besides, fog conditions generally complicate the sailing. Therefore, deliveries of time- and temperature-sensitive cargo in containers via the NSR might be a challenge to commercial viability of the route.

Bathymetry represents another stumbling point of the route. For instance, given the drafts of the Dmitry Laptev and Sannikov Straits of 6.7 and 13 meters, respectively, it is impossible to ship high cargo vessels via these itineraries. According to Van Den Bossche et al. (2019), container vessels carrying more than 2,500 twenty-foot equivalent (TEU), and bulkers as well as tankers with more than 50,000 deadweight, are to be shipped to the north from the nearby Novosibirsk islands only.

Thus, shipping via the NSR is subject to a number of technical, infrastructural, and induced financial issues. The research reveals that voyages via the NSR are viable enough given high oil prices; once they drop shorter, though, delivery dates and induced fuel economy might no longer be a solid argument, as still uncertain weather conditions complicate a just-in time delivery. In its turn, bridging the weather and bathymetry parameters under the Representative Concentration Pathway (RCP 8.5) framework has modeled that sailing via the Dmitry Laptev and Sannikov Straits can become profitable for bulkers and tankers (more than 50,000 deadweight) around 2035, and for container ship (more than 2,500 TEU) around 2051.

Northern Sea Route: A View from the EU

Although no EU member state is an Arctic coastal state (Greenland is a coastal state of the Arctic but withdrew from the European Economic Community in 1985), the EU has developed its own Artic Policy over the years containing an eye on the NSR.

Already in 1999, the *Northern Dimension* – a joint policy between the EU, Russia, Norway, and Iceland – was initiated to facilitate cooperation in the geographic region that stretches from the European Arctic to the Baltic Sea and from Russia to Iceland and Greenland. The first Action Plan for the Northern Dimension set out specific actions for policy areas such as energy, transport, and telecommunication infrastructure, the environment and natural resources, nuclear safety, public health, trade, research, and cross-border crime (Council of the European Union, 2000). However, it was not until 2008 that the European Commission defined its objectives for the Arctic region: "to protect and preserve the Arctic, to promote the use of sustainable resources, and to contribute to multilateral governance" (Commission of the European Communities, 2008).

In 2012, the Northern Sea Route was mentioned in EU documents for the first time. In an inventory of its activities in developing the EU Arctic Policy, the Commission, together with the European External Action Service (EEAS), noted the economic potential of the NSR following an increased use of the route by EU and European Economic Area (EEA) (The EEA extends the EU's single market to Iceland, Liechtenstein, and Norway) maritime companies (European Commission and European External Action Service, 2012b). The following year, the EU applied for observer status in the Arctic Council. Still, a decision on the application – which requires unanimity among the members – has not yet been reached. The reluctance of the current members is due to disagreements over seal hunting, the strained EU-Russia relations, and the lack of a clear EU vision for its Arctic policy (Ringbom, 2017).

However, the EU can still play an active role in shaping the regional dynamics in the Arctic through its member states and the EEA. Continuing to develop its Arctic Policy, one of the EU's stated aims is the development of sustainable shipping on the NSR. The main concerns being environmental impact and safety, the EU supported the development of the *Polar Code* by the IMO, and the use of the *Galileo* satellite system for Search and Rescue (SAR) activities in the Arctic (European Commission and European External Action Service, 2012a).

The 2016 Artic Policy identifies the north-Norwegian ports of Narvik and Hammerfest as important interlinks between maritime and land transport under the TEN-T framework (European Commission and European External Action Service, 2016). With a view to updating this policy, a public consultation was carried out by the EEAS in 2020. The results highlighted the need for discouraging environmentally unsustainable practices and a strong link between the EU's climate policy, the *European Green Deal*, and the updated Artic Policy (European Commission Directorate-General for Maritime Affairs and Fisheries and European External Action Service, 2021). These policy documents, expressing the EU's aims and objectives, are nonbinding. Nevertheless, under certain circumstances and in certain policy areas, the EU can impose binding regulatory measures.

The EU has several internal and external legislative competencies with regards to the Arctic. It shares legislative competence for most of the policy areas relevant to the NSR (such as transport, agriculture and fisheries, and environmental policy). However, legislation with regards to the Customs Union, the conservation of marine biological resources, and the Common Commercial Policy fall under the exclusive competence of the European Union (European Parliament, 2010b). Furthermore, EU and EEA member states are port and flag states operating along the NSR.

With 81% of the EU's external trade being seaborne (Eurostat, 2021), the NSR is of economic interest to the EU and its member states. Globally, the EU ranks second after China in container port throughput (UNCTAD 2021) and six of the top 16 non-Artic countries passing through the NSR in 2019 were EU countries (SRM and Intesa Sanpaolo, 2020). The route reduces the shipping distance between Northwestern Europe and ports in Northeast Asia by 40%. For the large North European ports such as Rotterdam and Hamburg, the NSR allows for significant time savings when shipping to the Asian ports of Shanghai, Yokohama, and Hong Kong. However, for shipments between Singapore and Hamburg (or more Southern European ports), the Suez Canal is shorter than the NSR.

It is worth stressing that the NSR does not have a competitive advantage for all Europe-Asia routes as the sailing distance between German and Vietnamese ports is the same via the Suez Canal or the NSR (SRM and Intesa Sanpaolo, 2020). Still, even where the shipping distance is shorter, the EU does not see the NSR as a viable alternative to other routes. The unpredictability of the ice-situation and higher costs related to building, operating, and insuring vessels suitable for sailing in the Arctic are the major constraints of the NSR identified by the EU (European Parliament, 2010a).

However, the EU is not a unitary actor, and there are differences in the member states' views on the NSR and its possibilities. The Northern member states for which the NSR presents significant time savings for shipments to Asia naturally have an interest in developing the NSR. Their position is relevant because the Northern European ports are the largest EU ports in terms of freight handled – Rotterdam (Netherlands), Antwerp (Belgium), and Hamburg (Germany) being the top three. These three ports also score high on the Liner Shipping Connectivity Index (LSCI): Rotterdam 95.67/100, Antwerp 93.21/100, and Hamburg 80.87/100 (Data for the second quarter of 2021) (UNCTADstat, 2021b). In terms of ownership, Germany has the second largest merchant fleet in Europe (UNCTADstat, 2021a) and, as the world's third largest trading nation, relies heavily on international trade (BMWi, 2019). Trade with China has been growing significantly over the last 20 years (both in exports and imports), and thus, it is unsurprising that regular shipping along the NSR is a possibility for both Germany and China (Blunden, 2012). In addition, the largest carrier in global container shipping – the Danish-owned *Maersk* – is assessing the opportunities of the NSR. In 2018, its containership Venta Maersk (3600 TEUs) was the first to complete an international transit between Busan (South Korea) and Bremerhaven (Germany) on the NSR (SRM and Intesa Sanpaolo, 2020). This data suggests that although Arctic shipping and the NSR are not high on the EU agenda, its Northern member states have a significant economic interest in using the NSR.

The Southern EU members benefit less from shipping through the NSR because sailing distances are longer compared to the SSR. Though Malta, Cyprus, and Italy are among the six EU non-Arctic countries that used the NSR in 2019, this data indicates only the flag state of the vessel. For obvious reasons, there were no departures from or arrivals to Southern European ports. The second largest company in terms of global container shipping – the Swiss-Italian *MSC* – dominating the Mediterranean route has not manifested any interest in developing the NSR either (SRM and Intesa Sanpaolo, 2020). However, the political and economic weight of the Northern EU members – first of all Germany – has the potential to determine EU policy on the NSR in the future.

At the moment it is clear that even these member states are aware of the environmental and financial limitations und uncertainties of the NSR. Usage of the NSR is still exploratory and at best complementary to other routes. Infrastructure investments are not only needed to develop the NSR but also to ensure connectivity with the European transport network. The TEN-T is a comprehensive network of infrastructure for railways, maritime, air transport, roads, inland waterways, and rail-road terminals aiming for cohesion, efficiency, sustainability, and increasing benefits for users. The Regulation 1315/2013 lays out specific technical requirements to ensure the safety, sustainability, and interoperability of infrastructures. In the Annex to the regulation, the EU has published maps identifying infrastructure projects for the core and comprehensive networks to be completed by 2030 and 2050, respectively. However, the realization of these projects is the responsibility of the member states and their national infrastructure programs (European Parliament and Council of the EU, 2013). The Northern European ports that have the most potential to use the NSR for trade with Asia are part of the core network allowing for further inland transport of freight. Most of the inland waterways, rail-road terminals, railways, and motorways identified in the TEN-T maps are completed increasing the ports' connectivity on the European continent. Rotterdam and Antwerp are connected to all Dutch and Belgian ports through inland waterways and to neighboring France and Germany via railways and roads. From the port of Hamburg, freight can be further transported on the Elbe-Lübeck and Elbe-Seitenkanal and the high-speed railways to Bremen, Hanover, and Berlin. The motorways leading north and south are to be upgraded to enhance connectivity.

Furthermore, the EU seeks to extend the TEN-T to non-EU countries. Thus, the Norwegian ports of Narvik and Hammerfest, which have been identified as relevant for EU Arctic shipping, are also part of the TEN-T. The maps annexed to Regulation 1315/2013 define road and railways to be upgraded for better connectivity of these ports to neighboring Sweden. Lastly, the Russian ports of Murmansk and Archangelsk are to be better connected through railway and road upgrades in Finland and the Baltic states. The *Rail Baltica* network seeks to connect North-West Russia and the Baltic states, thereby providing important transport links between the NSR and Central and Eastern Europe. Plans for an Arctic railroad in Finland (connecting Rovaniemi and Kirkenes) and the discussions for a tunnel connecting Helsinki and Tallinn open up possibilities for the Finnish and Russian ports on the NSR. However, differences between rail gauges used in Finland and Russia on the one hand and the Baltic states on the other as well as political tensions between Estonia and Russia could hamper connectivity (Prause, 2019).

It follows that there is a possibility for effectively linking the TEN-T with the NSR that yields economic potential for both Russia and the EU. For now, the uncertainties of the sailing conditions and related costs, together with the political tensions between the EU and Russia, hamper the development of the NSR as a viable shipping route for European trade with Asia. As a consequence, the EU focuses on existing routes and the Black Sea basin as a bridge to Asia instead of the Arctic (European Commission and European External Action Service, 2018). However, problems with existing routes (i.e., the Evergreen case) could increase momentum for the Northern member states to push for the adoption of a more active policy regarding the NSR. Even if the lack of political will at the EU level persists, member states could still cooperate with Russia bilaterally. Germany in particular has been advancing its economic interests independently of the EU in the past (in the Nord Stream 2 case, even against the preferences of the other member states).

Conclusions

The role of connectivity issues viewed from the ITC perspective in settling the global economic and political order has risen. In tackling the research question, the chapter concludes that the NSR could be overall treated as an established international corridor, yet it is severely politicized given the deteriorating relations between Russia and the West. In holding the status of an ITC, granted by the Euro-Asian Conference on Transport in 1998, the NSR contains a number of distinctive features in comparison, for instance, to *East-West* and *North-South* ITCs, as well as *Pan-European (Crete) corridors*. First, it has a centralized governance. Second, there is no ITC-essential harmonization of procedures at various modes of transport. Third, voyages via the route are dominantly subject to weather conditions and broken to navigation windows. Fourth, volumes of containerized cargo handled over the NSR remain insufficient.

Nonetheless, the NSR as international corridor has gained some credit. It has seen a constant, *albeit* fragile, increase in volumes of cargo transported in 2011–2020 in export/import, cabotage, and international transit directions. Besides, the NSR experienced a rise in permissions given to foreign-flagged vessels with Chinese and German shipping companies at the front after 2016. Finally, Russia's recent initiatives in modernizing and increasing its ice-breaker fleet as well as construction of eco-friendly vessels are on the way.

In the nutshell, the shorter distance in the East-West trade direction via the NSR is generally counter-weighted by higher freight rates, outfashioned infrastructure, and unpredictable weather conditions, questioning the deliveries of just-in time cargo. Furthermore, and more fundamentally, the permissive character of shipping, ice-breaker assistance, and pilotage to be exclusively rendered by Russia, as well as its growing military presence in the Arctic at large, do generally stop foreign shipping companies from voyages via the NSR. On the one hand, this might be because of deliberate politicization of the route by both Russia and the West under mutual controversies, while on the other, voyages via the NSR are still far from being commercially viable. As such should Russia aims at raising the global competitiveness of the route, it will have to meet halfway in adding more competition into the route itself and the process of rendering related services.

The economic benefits of the NSR are also known to the EU and its Northern member states. Some of these have manifested their interest in developing the NSR despite the difficult sailing conditions and potentially high costs. Possibilities for linking the NSR with the TEN-T are mainly hampered by the politicization of EU cooperation with Russia. However, the lack of political will in Brussels and the lack of interest on the part of the Southern member states could be offset by the Northern member states acting in their own economic interest.

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Northern Sea Route as Driver of Economic Growth

Impact on the Arctic Economy's Future

Katarína Brocková, Ľudmila Lipková, and Vladimir S. Osipov

Contents

Abstract

The chapter discusses the role of the Northern Sea Route (NSR) in the development of the economy of the Russian Federation. The NSR has a long history. Its new development starts with climate change leading to warming and the melting

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of glaciers. The melting of the ice sheet is making previously inaccessible natural resources available to those states located in the Arctic region. The largest part of the Arctic, and the largest part of its mineral wealth, is located on territories belonging to the Russian Federation. The extraction of mineral resources requires the construction of new transport routes. Russia is building the NSR to ensure the transport of its natural resources from producers to consumers and as a complementary transport route to other international transport routes. So far, the NSR is mainly used for domestic transport within the Russian Federation and to a lesser extent for the international transport of goods. The extraction of mineral resources, especially oil and gas, in the new conditions and the increased use of the NSR will constitute one of the drivers of the development of the Russian economy, especially its Arctic region.

Keywords

Arctic · Global warming · Northern Sea Route · Natural resources · Economic development of the Russian Federation

Introduction

Transportation of goods is an important part of both international and domestic trade. With the intensive economic development – especially of Asian countries, such as South Korea, Taiwan, Vietnam, China, and others – the export and import of goods is increasing. With economic development, their consumption of more and more mineral resources is increasing, leading to an increase in the volume of international transport of goods towards these states.

Throughout history, states have sought optimal routes for the international transportation of goods. Regions along which international transport routes have run have benefited from these activities since antiquity, and this is still the case today. The largest and most important cities were built where major crossroads of trade routes were located. In addition to those routes that took advantage of natural conditions, such as land and water (river and sea routes), artificial canals were also built. It has always been important for traders to shorten trade routes. A breakthrough in world maritime transport was the construction of two canals which shortened the transport of goods by thousands of kilometers: the Suez Canal and the Panama Canal. The Egyptian and Panamanian economies benefit from these two major transport arteries. Today, China is spearheading the construction of the New Silk Road, building new land-, rail-, and waterways and modernizing existing infrastructure.

Global warming is making it possible to increase capacity for sea and river freight transport in the Arctic. Maritime transport routes can develop in two parts of the Arctic: the Arctic Ocean seas on the territory of Russia and in the territory of Canada a potential maritime route in the Northwest Passage.

The Arctic is the northernmost part of the Earth, located around the North Pole. The Arctic regions include the territory of several countries: Denmark (Greenland), Finland, Iceland, Norway, the Russian Federation, and the USA (Alaska).

The territory of the Arctic is divided into national sectors belonging to the abovementioned states. Most of the territory of the Arctic is covered by ice. Global warming is leading to a rapid reduction of the Arctic ice cover each year, making the vast mineral deposits in this part of the world more accessible. The Arctic contains vast reserves of the world's natural resources: fresh water (20%), estimated unexplored natural gas reserves (13%), and oil reserves (30%) (National Geographic, 2021). Currently, global oil and gas production in the Arctic is 10% and 25%, respectively (Jørgensen-Dahl, 2010). Oil production in the Arctic began in the 1920s in north-west Canada in the Mackenzie Delta (Robinson, 2021). In the 1960s, huge deposits were discovered in the Yamal-Nenets Autonomous Okrug in the Russian Federation ("Lukoil-Western Siberia" Ltd., 2021). In northern Alaska in the USA, oil production began in the 1970s (API, 2021). Most of the Arctic's mineral wealth is in Russia's Far North. In addition to hydrocarbon fuels, several solid minerals are extracted from the Arctic, notably apatite, phosphates, copper, lead, zinc, nickel, titanium, chromium, iron ore, rare earths, precious metals, precious stones, etc.

Literature Review

Many practitioners and many theoreticians are working on the Northern Sea Route and have published their works in prestigious journals (Boylan, 2021; Lee et al., 2021; Vicentiy, 2021; Kseniia et al., 2021). The Northern Sea Route (NSR), viewed as an alternative maritime route between Asia and Europe, possesses several advantages, which shorten the transport distance from the Far East to the European part of Russia. At the same time, unresolved problems arise, associated with the need to construct new icebreakers, the irregular and lower traffic speeds along this route, navigation problems, etc. (Dunbar, 2019).

Gutenev (2019) also deals with this issue, examining the strategy of the Russian Federation in the Arctic. He pays special attention to cooperation in building the Northern Sea Route with foreign partners.

Harakaľová (2018), reviewing Arctic issues of two European Union Member States (Denmark and Sweden), discusses the strategy and the interests of these two Nordic states in the Arctic region. The article does not specifically address the Northern Sea Route, but the economic, political, and, most importantly, international legal issues that these two states are dealing with in the Arctic region (Harakaľová, 2018).

In their conference paper "The Northern Sea Route: Is There Any Chance to Become the International Transport Corridor," Skripnuk et al. (2020) analyze the potential of the NSR as an international transport corridor.

Mitko (2019) in his article "Arctic exploration: problems and solutions" analyzes the problems associated with the use of the resources of the Arctic zone, such as the distance from the main industrial centers, the high costs and dependence on supplies from other regions, the ongoing negative demographic processes in the region, the absence of domestic technical equipment for geological exploration, and subsequent extraction from subsea oil and gas deposits and underdeveloped infrastructure (Mitko, 2019).

Nikulin (2017) in his article “Mineral resources of the Arctic Zone of Russia: potential and development prospects” deals with the problems of the division of mineral deposits in the Arctic zone by individual states. Under international law, only those states whose territory extends into the Arctic Ocean have the right to exploit them. Although these are Nordic states, they do not include Iceland, Finland, and Sweden, which do not have access to the Arctic Ocean. However, claims are being made by the European Union, where 25% of the raw materials from the Arctic go, and by China. Some states are of the opinion that access to Arctic minerals should be granted to all states that have the appropriate financial and technical conditions for this.

Granberg (1998) in his article “The northern sea route: trends and prospects of commercial use” discusses issues related to the use of the Northern Sea Route for the development of the Arctic regions of Russia. The author analyzes the geopolitical and economic development conditions of contemporary Russia, the state policy for the development of the Arctic regions, support for the construction of the Northern Sea Route, and its impact not only on the development of freight transport but also on the economic development of the northern regions of Russia and the entire national economy of the Russian Federation.

Moe (2020) in “A new Russian policy for the Northern Sea route? State interests, key stakeholders and economic opportunities in changing times” examines the Northern Sea Route as a factor in the exploitation of mineral resources in the Arctic regions of Russia. In particular, he looks at the problems in the development of maritime transport in the Northern Sea Route system, changes in the approach to its construction, and the role of the state-owned company Rosatom in these activities. He examines the possibilities of cooperation in maritime transport of Russian companies with foreign carriers along the NSR.

Bryzgalov (2011) in his article “Northern Sea Route: State and Development Prospects” examines how the Northern Sea Route represents an alternative to the southern routes for the transport of goods that run through the Suez Canal. He points out that the volume and commodity structure of goods transported from the Arctic regions to the rest of the world are constantly increasing and changing in connection with the increase in mining in the region. He analyzes the advantages of the NSR – which include shorter transport distances and the increasing possibilities of using this route in the context of global warming – and identifies the problems associated with the development of this transport artery, namely, the need for large-scale investment, possible time delays for transported goods caused by weather conditions, safety issues in adverse climatic conditions, etc.

Results

Change in Climatic Conditions

Global warming, which is indisputable, is having a visible effect on the environment. The average temperature in the Arctic is rising faster than in other parts of the world. The Earth’s temperature has increased by an average of 0.8 °C over the last

137 years. In the Arctic alone, the average temperature has increased by up to 0.75 °C in the last decade (Niller, 2019).

Climate change associated with the warming of the planet is generally seen as a negative phenomenon, as it changes living conditions for fauna, flora, and humans. On the other hand, climate change also has a positive effect. As the planet's temperature rises, previously unavailable mineral resources are being made available. Global warming is making maritime transport possible where there is an ice sheet that is several meters thick almost all year-round. The dreaded global warming, which is melting glaciers in the polar regions and threatening the coastlines of continents, will have significant economic benefits. It will significantly shorten sea journeys between European and Asian Far Eastern ports. These benefits associated with climate change can primarily be enjoyed by the Arctic states. There is also a secondary positive effect for other states, which can also benefit from international cooperation with the Arctic states, either by using new transport routes or by importing raw materials extracted in the Arctic.

Northern Sea Route

Of particular importance is the exploitation of the northern seas in the Russian Federation, whose territory extends the furthest of any country into the Arctic. Russia is surrounded by 13 seas and 3 oceans: the Pacific Ocean, the Atlantic Ocean (to which the Sea of Azov, the Black Sea, and the Baltic Sea are connected), and the Arctic Ocean (Nat World, 2021). Despite this, Russia still does not have the status of a maritime power. Changing climatic conditions are the main reason for the revival of the Northern Sea Route. By 2080, according to Norwegian scientists, there should be no ice left in the Arctic (Shukman, 2012). The navigation period here lasts for 2–4 months of the year so far (June to September), and in the other months ships can only sail accompanied by icebreakers (Arctic Russia, 2021).

The route of the Northern Sea Route starts from the ice-free port of Murmansk, before it runs through the Barents Sea, the Kara Sea, the Laptev Sea, the East Siberian Sea, and the Chukchi Sea to the Bay of Provideniya. However, it can be extended westwards as far as the port of St. Petersburg and eastwards to Vladivostok, which form key maritime transport hubs in Russia. The distance between them is 14,000 km (Macjong, 2019). There are 23 ports along the entire length of the Northern Sea Route. In addition to the two terminal ports mentioned above, there are other ports along the NSR route: St. Petersburg, Murmansk, Arkhangelsk, Mezen, Naryan-Mar, Varandei, Amderma, Sabetta, Igarka, Dudinka, Dikson, Khatanga, Tiksi, Cape Green, Pevek, Cape Schmidt, Provideniya Bay, Petropavlovsk-Kamchatskiy, Magadan, Korsakov, Vanino, and Nakhodka (Vladivostok) (Russia Discovery, 2021).

In 2019, 31.5 million tons of goods were transported along the NSR, which in 2024 will already increase to 80 million tons and in 2035 will reach up to 160 million tons (Arctic Russia, 2021). In 2020, the NSR administration issued 1003 permits for navigation on the NSR. Ships flying foreign flags were issued 153 permits

(Port News, 2020). The Northern Sea Route will become a global artery, and its trade potential will grow.

The main objective of the NSR is to make available the mineral resources found in the Russian Arctic. This is the main driving force behind its construction. Securing this task will be accompanied by large-scale investments in other areas of the region as well.

NSR Infrastructure

At present, the NSR is underutilized due to the underdeveloped port infrastructure, which lacks the requirements of transporting quantities and types of goods. For effective use of the NSR, a comprehensive infrastructure and logistics facilities need to be developed – ports, ship repair yards, rail, and road networks will be key to fully service the transport of goods across the NSR. Currently, many commodity groups are traded, each with specific requirements for handling in transit. It will be important to provide the technical facilities at the ports to handle certain types of cargo. The NSR will link the major Siberian rivers, railways, and roads into a common transport network and will allow cabotage and transit traffic. Ports will come to life and become new points for new types of goods and new routes. An example of modern infrastructure is the port of Sabetta in Yamal. The port was built specifically for the supply of liquid gas to the whole world. A railway trunk line is also being built in Yamal, which will connect the Trans-Siberian Railway to the port of Sabetta.

In Arctic conditions, the support of icebreakers is essential to ensure the passage of ships, which will keep the fairway free of ice during the winter months. Icebreakers are now, and will continue to be, a key technical component of the NRC. The State Atomic Energy Corporation "Rosatom," and its subsidiary Rosatomflot, plans to operate the Northern Sea Route year-round by 2030 (Rosatomflot, 2021).

Alternative Routes

Goods from Asian states and the Russian Far East were transported to European states and often to the European part of Russia via the Suez Canal or even the Panama Canal. The possibility of navigating the Northern Sea Route has one major advantage: a shorter route compared to the transport of goods through the Suez Canal and, in the extreme case, the Panama Canal.

The Northern Sea Route can transport goods to any point on the planet: to China, to the USA, and to European ports. The distance from St. Petersburg to Vladivostok via the Northern Sea Route is 14,000 km, and via the Suez Canal it is 23,000 km. From Murmansk to Yokohama via the Northern Sea Route is 5770 km or 12,840 km via the Suez Canal. 20,000 ships pass through the Suez Canal every year. Only a thousand cross the Northern Sea Route currently (Macjong, 2019).

The 193-km-long Suez Canal has been connecting the Red Sea and the Mediterranean Sea since 1869 (Smith, 1999). Annually, 1200 million tons of goods are transported through the Suez Canal, and 20,000 ships pass through it

(McCarthy, 2021). Naval ships have used this route for 150 years. It carries 10–12% of the world's maritime cargo turnover. Most vessels prefer the southern route, even though it is longer and more congested, canal tolls must be paid, and the threat of pirates lingers when sailing in the Indian Ocean. The Suez Canal has the advantage of stable climatic conditions. It is a traditional and reliable route, except for military conflicts or accidents in the canal. When transporting goods from East Asia to Europe, the route is considerably longer than via the NSR. Shippers cannot be expected to change their shipping traditions in the short term. The recent accident in the Suez Canal and its disabling for several days is proof of the need to build alternative global transport routes and diversify the transport of goods.

The Northern Sea Route is a suitable complement that can relieve the pressure on the Suez Canal at a time of overcrowding. However, the Northern Sea Route has no ambition to replace the canal.

The Northern Sea Route can reduce the transport of goods from the Far East to Europe by up to 11 days. Shorter voyages will save fuel for the naval ships, thus reducing the anthropogenic burden on the environment. Goods will thus be transported shorter, faster, cheaper, and safer.

Russia itself used the Suez Canal and, exceptionally, the Panama Canal to transport goods, mainly fish and fish products, from the Far East to the European part. This fact increased the final price of the products. After the opening of the NSR, Russia will not use the Suez and Panama Canals to transport goods from the Far East and the Arctic to Europe.

International Cooperation

Russia regards the Arctic as an area of promising international cooperation. Asia's largest states are already exploring the NSR as an alternative route for shipping goods via the congested Suez Canal. China is particularly interested in the Northern Sea Route and is keen to diversify the transport of goods to Europe. China's economic future is linked to the New Silk Road, which includes the Ice Silk Road, i.e., a route through the Arctic. China may become a major supplier of goods via the Northern Sea Route. It is expected that in the future, this transport route will be increasingly used by foreign companies in addition to Russian shipping companies. European shipping companies are very interested in the Northern Sea Route project.

Since 1991, the Northern Sea Route has been made available not only to Russian ships but also to foreign naval vessels. The route is predominantly used for freight transport and to a much lesser extent for passenger transport. The share of foreign ships sailing along the Northern Sea Route is still very low, less than 10% (Arctic Russia, 2021). Once the Northern Sea Route is built, Russia will become an intercontinental transport hub, linking the Far East and the western regions of Russia, Asia, and Europe.

Many projects in the construction of the Northern Sea Route are frozen due to the imposition of economic sanctions on Russia by Western countries. Russia is therefore looking for new partners in Asia, especially Chinese and Indian ones. The main area will be the development of international multipurpose transport on the

Asia-Europe-Asia route. China's economic development in the future will also depend on imports of mineral raw materials, which it can secure with supplies from Russia via the NSR. The Arctic deposits are of interest to the Chinese economy. China will also invest in them and thus increase its own raw material security. Marc Lanteigne from Troms, Norway, believes that Russia and China will work together to make the Northern Sea Route project a reality, even if the financial payback will be long. This is more about strategic interests than trade (Lanteigne, 2018).

US Admiral Paul Zukunft is of the opinion that the Northern Sea Route should have the status of an international transport corridor or transit route in direct proportion to the melting of the ice caps and should be freely accessible to American vessels (Formichev, 2018).

Threats and Risks of the NSR

Transporting goods along the Northern Sea Route carries not only advantages but also many risks. The main advantage of the route, which is a significant reduction in transport distances, can be eliminated by unforeseen circumstances. Warming temperatures result in more frequent weather changes, storms, and strong winds, which can slow down transport, and therefore there will always be a risk of long delays in the delivery of goods. The instability of glaciers can pose an additional risk along the route; their melting leads to the breaking off of massive chunks of ice that can cover sea routes and disrupt the flow of traffic. It will therefore be important for floating ships to strengthen information services to monitor iceberg movements and anticipate hazards. However, thanks to warming and milder weather, there are fewer and fewer dangerous spots. Special, more expensive ships must be used to navigate in the Arctic, which are resistant to adverse weather conditions. Another negative phenomenon is that ships sail for long periods of time away from civilization, so the demands on the qualifications and experience of the crew and on the technical equipment of the ships are higher and more expensive.

Many buyers in international trade demand "just in time" deliveries from suppliers. However, this is one of the risks of NSR, as was discussed in the previous section. This requirement will not always be able to be met due to climatic conditions. For deliveries of some types of goods, the "just in time" requirement may not be critical. China is tolerant of inaccurate deliveries, although it must be considered that delivery delays cause increased costs to customers. The mentality of the Japanese, who do not accept deliveries other than "just in time," is quite different. The Japanese therefore argue that NSR can never be profitable because of the risks.

The Importance of the NSR for the Economy of the Russian Federation

The use of North Sea shipping routes along the borders of the Russian Federation opens new opportunities for the Russian economy. The extraction of mineral resources, the exploitation of other natural resources (fishing, logging), and their domestic and international transport from producers to consumers will be a stimulus for the economic development of Russia's Arctic regions. A service industrial base will develop here, linked to the development of maritime and river transport (shipbuilding and ship repair), infrastructure services (ports, hotels, restaurants, and other services), etc.

As a global infrastructure project, the Northern Sea Route is intended to personify an idea of its time. It will be the result of the synergistic effect of several factors – global climate change, melting glaciers, the opening of mineral deposits, the export of raw materials from the Russian North to European and Asian countries, and the economic development of China in particular. The NSR will be the engine of development not only of the Arctic regions of Russia but also of the whole of Russia. Its commissioning will depend on the development of many industries and services and will contribute to the achievement of a qualitatively new economic level in the region. It can be expected that some of the maritime traffic that has so far been routed through the Suez Canal will be diverted to the Northern Sea Route. If this assumption is fulfilled, it will boost its international importance and will be a geopolitical victory for Russia.

The Arctic and Mineral Wealth

With climate change, the Arctic and the Arctic Ocean are becoming increasingly commercial. The part of the territory in the Arctic that will benefit most from global warming belongs to Russia, which is actively exploiting the Arctic territory for its economic objectives.

Russia has underlined the economic importance of the Arctic by adopting two important documents relating to the development of the Arctic regions. In 2012, the "Law on the Northern Sea Route" (NSRA, 2012), which defines the use and state regulation of commercial navigation in the NSR, was adopted. In 2008, another important document "On the basis of the state policy of the Russian Federation in the Arctic for the period up to 2020 and for further perspectives" (Government of the Russia Federation, 2008) was adopted. The document highlights the main interests of Russia in the Arctic region, the main goals and objectives, strategic priorities, the implementation of the state policy of the Russian Federation in the Arctic, the system of strategic planning measures for the socioeconomic development of the Arctic zone, and ensuring the national security, sovereignty, and territorial integrity of the Russian Federation. In accordance with this document, the NSR is to become competitive on a global scale. Emphasis is placed on strengthening Russia's position as an economic power in the Arctic.

In accordance with the UN Convention on the Law of the Sea, Part V, Article 55, Russia uses the relevant territories in the Arctic as an exclusive economic zone, located within 200 nautical miles (370 km) from the coast. In this area, Russia reserves the right to geological exploration, further exploitation, conservation of natural resources, etc. In accordance with the UN Convention, the exploitation relates to the waters above the seabed and the seabed itself as well as the area beneath it (TASS, 2019b).

The Arctic has been described as a treasure trove of the most diverse natural resources, particularly mineral resources, of which very little has been geologically explored to date. There are several reasons for this. The world has so far made do with more readily available resources, particularly energy raw materials, and geological exploration in the Arctic and the building of infrastructure are considerably more expensive than in other parts of the world. Oil, natural gas, and gas condensate are essential for industrial development, transport, housing development, etc. As their more accessible deposits are being depleted, extraction is shifting to the Arctic region. More than half of the Russian Federation's reserves of hydrocarbon fuels – oil and gas – are in the Arctic (Kuchumova, 2020).

The Arctic is a promising area, but it is extremely difficult to exploit this wealth on the other side. Oil and gas reserves in the Arctic are playing an increasingly important role. More than two thirds of the Arctic's hydrocarbon resources are in the Russian segment of the Arctic.

The extraction of raw materials is still relatively poorly developed. The complexity of extracting raw materials from the Arctic regions is limited by adverse natural conditions, long distances from producers to final consumers, and difficult, poorly developed logistics. Extraction in the Arctic is taking place and expanding as deposits become available.

There are vast reserves of mineral resources in the Arctic that have been inaccessible, both physically and economically. Their extraction is becoming increasingly profitable because of climate change. The Arctic contains around 22% of the world's geologically unexplored hydrocarbon fuel reserves (13% oil, 30% natural gas, 20% gas condensate). Overall, 84% of these resources are located on the Arctic Ocean shelf at depths of up to 500 m. This means that a large part of the reserves is located within the exclusive economic zone of the five Arctic states (Turunen, 2019). The richest reserves are found on the shelf of Alaska and natural gas on the shelf of the Kara Sea and the Barents Sea and 16% on the onshore territories of the Arctic states (Turunen, 2019). There are 107 known deposits of strategic metals in the Arctic zone, which are at various stages of exploration: 42 in Russia, 19 in the USA in Alaska, 22 in Canada, 6 in Greenland, 9 in Sweden, and 3 in Finland. Russia is the largest producer of mineral resources among the Arctic states (Murmansk State Technical University, 2015). Most of the Arctic's oil reserves and almost all its natural gas reserves are concentrated in the Russian Far North (Arctic.ru 2021).

Currently, almost 80% of Russian gas comes from this region, accounting for about a third of European consumption (TASS, 2021). Russia mines 90% of its nickel and cobalt, 60% of its copper, 95% of its platinum, and all its barite and apatite in the Arctic regions (WMT Consult, 2019). Up to 20% of Russia's exported goods come from the Arctic (Commersant, 2021). These results were achieved by Russia before the supposed development of the NSR. The Northern Sea Route is expected to become a key route for the export of hydrocarbon fuels in the future, in particular for the transport of liquefied gas from the Sabetta port terminal on the Yamal Peninsula. Russia will take advantage of the annual ice melt to shorten its route to the European market (Oil Capital, 2021).

As an economic zone rich in mineral resources, the Arctic plays a significant role in Russia's economy. Only 2.5 million inhabitants of the Russian Federation live in the Arctic, but 15% of the country's GDP is produced here (Ria Novosti, 2021). Arctic projects are a priority in the current economic policy of the Russian Federation. The state supports the extraction of raw materials, provides companies with tax benefits, and takes administrative decisions that promote the further economic development of the Arctic region. The prospects for the exploitation of Arctic mineral deposits, in addition to the vast reserves, are conditioned by the availability of the Northern Sea Route and navigable rivers, which significantly increases the profitability of exploiting the deposits.

Russia plans to invest ₽735 billion in the development of the Northern Sea Route by 2024. Of this, ₽274 billion will come from the state budget. Only the construction of new, more powerful icebreakers will be financed from the state budget. The development of new icebreakers plays a key role in harnessing the Arctic's natural resources. Most of this funding, amounting to ₽460 billion, will come from private sources. Private companies such as Rosatom, Novatek, Rosneft, etc. will invest (TASS, 2019a).

The Russian government plans to spend more than ₽19.5 billion on the Arctic socioeconomic development program by 2024. The goals of the initiative are to accelerate the development of the territories that are part of the Arctic zone and increase their contribution to the economy (Ministry of the Russian Federation on Far East and Arctic Development, 2019b).

The development of the Arctic is of strategic importance for the further economic development of Russia. Russia's economic prospects are largely linked to the Arctic. The Government of the Russian Federation plans to develop a large-scale raw materials complex in this region in the near future, which will be connected to the Northern Sea Route. In the twenty-first century, Russia's geopolitical interests are shifting to the North, to the Arctic. The development of the Arctic is an important phenomenon for the development of Russia as a whole. The Arctic is part of Russia. Russia's mineral resources and industrial development are linked to the Arctic.

For Russia, the commissioning of the Northern Sea Route will mean a significant increase in strategic potential. The development of the NSR will have a positive impact on the development of the northern territories, on trade and tourism, and will promote an increase in the standard of living of the Arctic population.

Activities of Major Russian Companies in the Arctic

All major Russian oil and gas companies are already doing business in the Arctic. They must overcome harsh climatic conditions, the technical complexity of extraction and transport, and long distances. The use of the latest scientific and technical knowledge is crucial for the development of economic activities in the Arctic. Modern technologies are important for the efficient exploitation of mineral resources. This involves large-scale investments, which is why large companies are pooling their investments in the Arctic and cooperating with foreign companies. For example, as we have already seen, Rosneft has previously entered into an agreement with ExxonMobil and jointly operated the Pobeda deposit in the Kara Sea (Interfax, 2020). Chinese companies are important investment partners (Ministry of the Russian Federation on Far East and Arctic Development, 2019a).

The most important Russian companies producing oil and gas in the Arctic are Gazprom, Gazprom Neft, Rosneft, Lukoil, and Novatek. At present, only two companies with state ownership, Gazprom and its subsidiaries and Rosneft, have direct access to the exploitation of Arctic deposits (Ria Novosti, 2018). These two companies have obtained 90% of the licenses for oil and gas production in the Arctic. The other 10% of the licenses were obtained by private companies (Vavina & Petlevoy, 2019).

Rosneft currently holds 52 licenses for oil production in Russia, 28 of which are in the Arctic regions, the Western Arctic (Barents, Pechora, and Kara Seas) and the Eastern Arctic (Laptev, East Siberian, and Chukchi Seas) (Rosneft, 2021). Rosneft is involved in the socioeconomic development of the Arctic, building settlements near oil and gas fields, an airport, a port, and pipeline routes. The company has agreed additional tax preferences with the central government. A minimum price of $45 per barrel of oil was set as a condition for receiving the tax benefits. With the price of oil falling on world markets, the minimum price per barrel has been lowered to $25, at which point Rosneft can receive tax benefits for its Vostok Oil project (Fadeeva, 2020). The project's oil reserves are estimated at 6 billion tons of crude oil, with an annual production volume of 115 million tons. This is high-quality, low-sulfur crude oil that can be classified as Brent (Interfax, 2021b). In 2013, Rosneft, together with the US company ExxonMobil, prepared several joint projects in the field of geological exploration and scientific research in the field of oil extraction, and in 2014, the Pobeda field in the Kara Sea was put into operation (Interfax, 2020). In 2014, ExxonMobil withdrew from the cooperation due to sanctions, and the work was suspended (Ria Novosti, 2018).

Rosneft is working with *Gazprom* on several projects, such as the commissioning of the Messoyakh group of fields. Gazprom is the largest gas company in the world. It is a leader in the production, transportation, and realization of gas in Russia and abroad (Tinkoff, 2021). Gazprom produces 66% of Russia's natural gas and accounts for 11% of global gas production (Gazprom, 2021a). Gazprom has set up several subsidiaries to produce oil in the Arctic. Gazprom and its subsidiaries produce 138 hydrocarbon fields (Kuchumova, 2020). The main production center for the company is the Nadym-Pur-Taz oil and gas field in the Yamalo-Nenets Autonomous Region (Interfax, 2021a). For efficient exploitation of the Novoportovskoye field, the subsidiary Gazprom Neft Yamal was created, which produces 30% of its total production in the Arctic (Gazprom, 2021b). *Gazprom Neft* uses sea transport for oil and gas transportation. It also uses a year-round logistics scheme thanks to the construction of the Vorota Arktiki river terminal. The terminal is operational even at temperatures of minus 50 degrees (Gazprom, 2021c). Gazprom Neft's subsidiary Salakhalin has formed a joint venture with private company Novatek to jointly produce oil and gas in the Arctic (National Association of Oil and Gas Service, 2021). Gazprom Neft also has its own fleet, owning two icebreakers.

The Fishing Industry in the Arctic

The development of the fishing industry in the Arctic is of particular importance to Russia's economy. Aquatic biological resources are of vital strategic importance for the development of the economy and ensuring Russia's national security.

Legislation in the field of fisheries is developing dynamically – fishing industry companies and social organizations are actively participating in this process – and yet many problems remain unresolved. There is insufficient information on fish stocks, and in processing areas, which could lead to a reduction in catch quotas of biological resources. Funding for the World Ocean Program has been suspended since 2013. As a result, there is a lack of information on potential reserves of processing industry areas, including the North Basin. This can lead to extremely negative consequences, due to the absence of scientifically justified positions of Russia in the international arena, and the catch quota of biological resources can be cut; therefore, it is important to restore state funding for regular research expeditions in the seas of Russia and in key areas of the Pacific Ocean. The World Ocean Program, including research in the Arctic seas, should be reinstated, as well as the restoration and central part of the Arctic Ocean; the scientific research and expedition fleet should be renewed too.

In addition, to secure Russia's interests in the Arctic region, it would be useful to create a separate subchapter in the State Program for the Development of the Fishery Economic Complex, which would examine the implementation of measures for the development of fishery complexes in the Arctic zone. The fishing fleet is becoming obsolete. These issues also require state support. Support for fisheries includes the availability of credit, favorable lending for the implementation of equipment upgrades, and the exploitation of aquatic biological resources by the indigenous peoples of the North.

Environmental Risks

The Arctic is an area with unique natural resources – flora, fauna, birds that have chosen this part of the Earth as a place to live and breed, and a way of life for indigenous peoples. As has already been seen, the sources of drinking water are significant, representing about a fifth of the world's supply (National Geographic, 2021). The natural wealth of the Arctic is also represented by the territory itself, which, because of global warming, may even become suitable and comfortable for human life and greater economic activity, for denser settlements, economic activities, and recreation. Increased economic exploitation of the Arctic regions is associated with positive expectations, but also with ecological risks. Economic activities associated with the Northern Sea Route will interfere with the delicate ecological balance in the Arctic. The importance of the biological natural resources of the Arctic lies not only in nature conservation but also in the preservation of biodiversity. Many of the animals that live in the Arctic are also of economic importance – for example, the industrial harvesting of many species of fish (cod, salmon, etc.). As the climate changes, the species of fish that live in the Arctic region will change, and with the more catches of them, biodiversity will change. Many animals such as reindeer are part of the way of life of indigenous peoples.

The exploitation of the Northern Sea Route, in addition to the economic benefits, will have potentially negative effects on the Arctic areas. Increased economic activities will threaten to devastate wilderness. Oil and gas extraction increases the risk of pollution, which is much more severe in fragile northern ecosystems than in milder zones. With the development of maritime transport, the waters of the Arctic seas will be polluted, which will have a negative impact on marine animals and the overall environment. The use of LGP will be important, as will the gasification of transport in the NSR and the ban on the use of solid fuel oil as fuel for naval ships in the Arctic. Oil transport is dangerous for the ecosystem, for marine animal life, and for plant life in cases of tanker accidents.

Environmentalists and environmental activists are calling for protection for indigenous peoples in one of the few affected areas of the world and for reassurance that there will be no plundering of the vast resource wealth, which includes oil, gas, other minerals, and timber. There must therefore be a strategy for the sustainable development of the Arctic. As we have already mentioned, a law has been adopted on the "Foundations of the State Policy of the Russian Federation in the Arctic for the period up to 2020 and beyond" (Government of the Russian Federation, 2008). The document also focuses on environmental protection, as well as the protection of the indigenous habitat and the traditional way of life of indigenous peoples.

The International Energy Agency has confirmed the need to support the Paris Climate Accords' objectives to stop searching for new oil deposits (Taraldsen, 2021). All the giant oil companies around the world are facing pressure from environmental activists.

Conclusions

Global warming is changing the natural and economic conditions on the planet. In general, changing climatic conditions are considered a threat to humanity. In some parts of the world, however, they are leading to positive changes. The Arctic regions are a prime example of the positive link between climate change and economic change. The melting of the Arctic ice sheet is making mineral resources more accessible and expanding the possibilities for navigation. Due to their geographical location, the Arctic states can exploit this as a comparative advantage. The expansion of maritime transport in the northern seas is particularly significant for the Russian Federation, which is an all-round supporter of the Northern Sea Route. The Northern Sea Route and the activities associated with it – the extraction of mineral resources, the constant increase in the volume of goods transported, and the construction of infrastructure and new industrial facilities along its route – are an important engine for the development of the domestic economy. The Arctic is already an important economic region. Less than 2% of Russia's population lives in the Russian Arctic, but the region produces 15% of the country's GDP. The economic importance of the Arctic for the Russian Federation is indisputable. By building infrastructure along the Northern Sea Route, using a larger fleet of more powerful icebreakers, it will be possible to exploit the Arctic's wealth even more. The Northern Sea Route has the ambition to become an international transport artery between Asia and Europe and, for all its risks, may even be a complementary transport route from Asia to Europe to the Suez Canal. Finally, it should be remembered that the intensified exploitation of the Arctic – the extraction of raw materials and intensified maritime transport, for all their positives – is an ecological risk for the northernmost part of the world.

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Northern Sea Route

Geopolitical Importance

Ján Koper, Branislav Kováčik, and Rudolf Kučharčík

Contents

Abstract

The Northern Sea Route is geopolitically one of the most important regional projects in the world. The reasons are obvious – its geographical location, the consequences of climate change, natural resources, and its distance to great powers boundaries. All those elements point out the economic importance of the Northern Sea Route area. It is not area of interests only for great powers directly connected to the zone – such as Russia or the United States – but also for actors looking for new economic and political challenges – for instance, China, the second most visible player in the area. There is no doubt that the Northern Sea Route area will be a region of major disputes in the very near future. Of course, this topic can be discussed only in the broader context of the geopolitical importance of the whole Arctic region.

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Introduction

Sea routes are one of the most important corridors of international trade. Sea and ocean routes have a great tradition: they connected people from an ancient age, and have contributed to trade and the exchange of ideas. The significance of the sea routes is not connected only with the past; this kind of transport of goods is irreplaceable. It is calculated that about 80% of world merchandise trade by volume and 70% of global trade by value is carried by sea (Arvin, 2021). The Northern Sea Route (NSR) mentioned in this chapter has the potential, without any doubt, to be one of the most important sea routes. Its relevance is becoming bigger due to many direct and indirect factors, including climate change. According to some estimations, the NSR should be free of ice about 2050 in summers if the polar cap continues to melt at current rates (Didenko & Cherenkov, 2018).

The NSR has deep and rich historical roots. The history of the navigation in this area started in the seventeenth century. Even before that, three different routes were identified to pass through the Arctic: the Northwest Passage (NWP) between the northern archipelagos of the North America; the Northeast Passage (NSP) in the northern coastline of the Eurasia; and a Trans-Polar Route (TPR) straight across the Arctic Ocean (Depledge, 2016). During the Soviet period, the NSR was used to supply the Far North regions of the Soviet Union. Under Mikhail Gorbachev's office, it was opened for international trade. Although the route was already formally opened in 1991, the main challenge for the modern Russian state in this issue is still to modernize and convert the NSR in a "reliable and economically efficient and almost year-round transportation corridor" (Didenko & Cherenkov, 2018).

Of course, the opening of the new sea route would have global consequences and could change the position and the influence of the relevant players of the Arctic zone. According the Depledge (2021), "the NSR is starting to become a vital bloodline for an economically struggling Russia, which can charge tolls, icebreaker support fees, and extract and export natural resources to markets that need them. It is inevitable to add in this point that "Russia is planning to develop the Northern Sea Route along its Siberian coast as an alternative to southern routes through the Suez Canal and is investing in the construction of the only icebreakers capable of operating in the Arctic Ocean" (Guo & Wilson, 2020).

Of course, the geopolitical significance of the NSR cannot be explained without understanding of broader Arctic context. Arcanjo (2020) in this context mentions that "the exploitation of natural resources, economic opportunities via new shipping routes, and continued disputes over state boundaries are making the region (the Arctic) an arena for security competition as many states want to influence the future of the region." It becomes evident that the "future Arctic is likely to have very little in common with the Arctic of the past" (Depledge, 2016).

Literature Review

There are plenty of works related to the geopolitics of the Arctic and the geopolitical significance of the NSR. The reason is obvious – the Arctic region is becoming the topic of interest of different scholars, whether specialists in political science, economy, geopolitics, theory of international relations, and/or specialists in natural sciences. We chose for our purpose about 30 papers dealing with the Arctic and NSR. Didenko and Cherenkov (2018) are writing about the development of the NSR in regards to its economic and geopolitical aspects. They emphasize the role and the position of Russia. They also remind about the military importance of the region for Russia in regard of increasing its military presence in the Arctic. Arvin (2021) points out the geopolitical importance of the NSR (cutting off the sea routes), but she also remarks political and environmental threats and the role of the Arctic Council in solving the disputes between relevant Arctic players. Gosnell (2018) raises importance of the Arctic and NSR for global trade and restates the significance of decreasing of transit time in this context. Deandreis (2020) reminds the necessity of the strategy on the Arctic by the European Union. Humpert and Raspotnik (2012) deal with an alternative route – the *Transpolar Sea Route (TSR)* – but they also point out the position and importance of non-Arctic states in issues in the Arctic region and underline environmental and climatic uncertainties. Bennet et al. (2020) discuss the issue of climate change and TSR as a regional alternative. Østreng (2010) clearly explains the geopolitical significance of the Arctic states and categorizes them. The political and economic aspirations of China are explained by Kundu (2017). Geopolitical issues are also discussed by Blunden (2012), Gricius (2021), Dubois (2018), Heininen (2018), Klimenko (2019), Marshall (2017), Østhagen (2019), Østerud and Hønneland (2014), and Samarina et al. (2020). Guo and Wilson (2020) also point out geopolitical issues, but they regard closely to common and concurrent interests of China and Russia in the area too. Climate change and its impacts in the context of the Arctic are discussed by Arcanjo (2020) and Pflüger (2020); they point out that climate change and its impacts could be between security challenges in the future. Greaves (2019) details the relationship between the climate changes and the geopolitical importance of the Arctic. Charron (2020) stresses security questions and major threats, and also points out the key position of the Atlantic Council despite the lack of the hard power of the institution.

Geopolitical Aspects

The Arctic is governed by the domestic laws of the Arctic state, primarily the littoral Arctic Ocean states – Canada, Denmark, Norway, Russia, and the United States. However, the region is also subject of various agreements – bilateral, international, and even regional. One of the most important is the UN Convention on the Law of the Sea from 1982. In reality, "no institution has the authority to regulate and police the entire region" (Council of Foreign Relations, 2021).

The Arctic is about 8% of the Earth, and this region is not important only for so-called "Arctic Eight" countries – Canada, Denmark, Finland, Iceland, Norway, Russia, Sweden, and the United States. It is estimated that about 22% of world's oil and natural gas reserves of our planet are in the Arctic (Didenko & Cherenkov, 2018).

Heininen (2018) underlines two different approaches in the discussion about the Arctic regarding international relations. The dominating one stresses the geopolitical stability of the region in the twenty-first century; this stability is based on intergovernmental cooperation and the Arctic is described as the zone of peace. The second discourse states that the Arctic is facing a race of resources, new conflicts, and even a new Cold War. Heininen (2018) reminds that "despite different perceptions, discourses and approaches, the post-Cold War Arctic is with a high geopolitical stability based on institutional, international cooperation." He argues that the Arctic does not face armed conflicts and serious border disputes. Post-Cold War Arctic geopolitics is, according to him, based on climate change and hype of exploitation (Heininen, 2018). As Klimenko (2019) puts it, "despite alarmist predictions of a scramble for the Arctic, however, the region has remained a zone of 'low tension." The reasons are obvious – commitment by the Arctic states to keep the Arctic as the zone of the peace.

The Arctic became the region of the real geopolitical importance only very recently – after the Cold War. As Greaves (2019) notes, during the Cold War, the region was "at the geographic center of strategic competition and nuclear deterrence between the United States and Soviet Union." Also, Østerud and Hønneland (2014) write about the Arctic as about the region of strategic confrontation during Cold War.

During that period, the region was heavily militarized and politically sensitive. The importance of the region declined in the 1990s. The situation changed in recent years, connected with climate change. Greaves (2019) explains the past of the region very clearly: "when the Arctic Ocean was frozen for most of the year, states had little incentive to quarrel over disagreements such as maritime boundary disputes. Arctic boundaries had little effect on their core national interests, and states were unwilling to risk the global strategic balance or their diplomatic relations over trivial Arctic issues." Østerud and Hønneland (2014) stress the new position of Arctic in the twenty-first century. They write that "in the new century, the geopolitical importance is again increasing. Climate change, technological advances and the quest for resources are the major drivers of change. The Arctic is an expansion field for national sovereignty in the quest for resources and passage. The geopolitical status of the High North is being transformed from outer to inner crescent – a strategic zone with new modes of cooperation, but also with international disagreement over maritime areas and access routes beyond the circumpolar land area." Arcanjo (2020), in relation with current geopolitical importance of the Arctic, repeats that "the Arctic is rich in natural resources and minerals. According to the US Geological Survey assessment from 2008, 30% of the world's undiscovered gas and 13% of undiscovered oil reserves lie close to the North Pole. Rivalry over such enormous volumes of resources will likely intensify as they become easier to access. This tends to be the reason for countries to be locked in territorial tussles."

As was already mentioned above, the geopolitical significance of the region is increasing. Possible instability in the region could negatively impact the global economy and security. Charron (2020) sees in this context as the main threats in the region following factors:

1. The growing nationalist/globalist divide in world politics (Who is in charge of the Arctic? Only the Arctic states?)
2. Emboldened states
3. Political churn
4. The growing requirement for deterrence

Gricius (2021) underlines that "with new trans-Arctic routes, including the Northern Sea Route (NSR) and the Northwest Passage (NWP), as well as newly built and refurbished ports from Russia, political and military interests are reevaluating the region as one of the geopolitical competition." This situation is very different from the past. Gricius also notes that, within the terms of security, the US Congress has reached conclusions that the Arctic could become an area of geopolitical conflict between Russia, the United States, and China.

The context of the new situation is understandable – the region is changing, opportunities are changing and expanding, and so the behavior of the regional and world powers is also changing. Nobody wants to lose influence; nobody wants to lose chance.

Dubois (2018) writes about two main factors contributing to increasing of international attention to the Arctic regions: the opening of sea lanes and increased access to natural resources. However, there are also other important events increasing position and relevance of the Arctic for the decisive world and regional players:

- The discovery of an offshore natural gas field in Greenland
- The granting of observer status in the Arctic Council to China and India in 2013
- New records of air temperature and new lows in ice extent in 2015
- NATO military training exercises in Arctic conditions (led by Norway)
- The discovery of large oil reserves in the Norwegian Arctic (2017)
- The completion of a new Russian military base there (2017)
- NATO Parliamentary Assembly held at the Svalbard Archipelago (2017)
- Interception of Russian military aircraft in the American and Canadian air identification zone

From the list above, it is notable that the Arctic is becoming the zone of interest of different players, and different *kinds* of players – not only Arctic states. It should be evident that the national interests of them are often competitive and that the Arctic could become area of the conflict – because of its geographical position, natural resources, and importance for the international trade in the future. On the other hand, it is necessary to remember that the majority of the territorial disputes have already been solved. As an example, the dispute between Russia and Norway was resolved in 2010, equally dividing about 67,000 square miles of water in the Barents Sea

(Council of Foreign Relations, 2021). Of course, some of the territorial disputes persist including some disputes between Russia and Norway. New territorial disputes can occur as the result of climate change in the world and especially in the Arctic.

Regarding the geopolitical importance of Arctic, a crucial factor is its geopolitical features. For the purpose of our chapter, we chose the main geopolitical features of the Arctic mentioned by Østreng (2010). These are:

1. Its geographical location between three continents – America, Europe, and Asia
2. The assumed abundance of strategically important industrial resources and mineral deposits (gas)
3. Sea lanes – inside and outside of the region
4. Dwindling sea ice regime due to global warming and climate change (more easy access to resources and better exploitation)
5. Unique environmental fragility, vulnerability, and eco-systemic interconnections with ecosystems in southern latitudes
6. Affinity to existing global ocean conventions

According to Østreng (2010), all these features are related to national interests of big powers of the Arctic able to create an "informal operational regime for the region for other states to accept and/or comply with – willingly or unwillingly."

Within the relations and influence on the region, Østreng (2010) also categorizes four groups of players:

1. *Big Arctic insiders* – the United States and Russia
2. *Small Arctic insiders* – Norway, Denmark, Finland, Iceland, and Canada
3. *The Arctic insider* and *outsider* – the EU
4. *The Arctic outsiders* – Japan, China, South Korea, and India

The growing importance of the Arctic region would probably cause tensions of various intensity between relevant players there. As Humpert and Raspotnik (2012) point out "the Arctic region has become increasingly politicized, affecting its future development and influencing the policy decisions of Arctic Countries." In this context, Arvin (2021) restates the role of the Arctic Council (the leading international forum based on the cooperation in the region established in 1996 by the Arctic states; in 2013, India, Italy, Japan, Singapore, South Korea, and China became observer states) as a sort of "ad hoc international system trying to deal with everything in the Arctic, from who has access to what minerals to how to manage traffic." Gosnell (2018) stresses the importance of the Arctic Council as of a "useful forum for cooperation on critical issues like the protection of indigenous peoples, environmental concerns, and search and rescue." Also, Charron (2020) stresses the role of the Atlantic Council. According to her, "greatest defense against conflict in and about the Arctic are the existing governance structures driven by the Arctic coastal states" (Charron 2020). Any provocative actions (including those by NATO) could upset any cooperative atmosphere. Charron also stresses that, despite the lack of hard power, "the Arctic Council remains the most important international forum for the discussion of Arctic issues."

Geopolitical Impact of Climate Changes

The Arctic is the area of the world where the climate change is, arguably, the most visible. Nowhere in the world can the global population see the modification of the scenery as there: melting ice, new sea routes, disappearing traditional animals, or animals combating for the remaining habitable spaces. What is important to remember is the fact that the consequences of climate changes of the Arctic will have a global impact. They will be notable in Maldives, Bangladesh, and the Netherlands (Marshall 2017). Depledge (2016) underlines that climate modelers predict that climate change can have two possible consequences in the Arctic: an increased area of open water in summer, and reduced area of multi-year ice so the transiting ships could travel further out from the coast in deeper waters. Greaves (2019), in the context of climate change, argues that "ecological phenomenon is also occurring geopolitically as Arctic security dynamics transform due to climate change." Pflüger (2020), in relation with climate change, writes that "the opening up of passages, including the Northeast and Northwest, due to melting ice gives rise to new questions, which center around determining who has the right to control the seaways and benefit from vast undiscovered natural resource deposits."

According to the Intergovernmental Panel on Climate Change, the Arctic temperatures rises will exceed the global ones (Humpert & Raspotnik, 2012). Melting ice in the Arctic will ease navigation through the region more than is already seen. According to the Intergovernmental Panel on Climate Change's projections, an ice-free sea may be the fate of the Arctic by about 2050 (Bennet et al., 2020). According to those projections, it will happen regardless of whether emissions are controlled.

This situation will bring major challenges – investments in the region, increasing of energy production, and new zones for fishing and shipping. On the other hand, all these activities will be connected with new security demands – increasing of the military in the Arctic and constabulary presence (Council of Foreign Relations, 2021).

Despite climate change and its impact, Gosnell (2018) still brings back an important limitation – the Arctic is still a hostile region with temperature dropping to about minus 40 in winter, with ice not melting on seasonal basis (ships should require icebreakers as the security escort for them), with unpredictability of ice flows, with heavy fog in summer, with the water depth in some parts of Arctic as limiting factor to commercial shipping, etc.

Weitz (2021) draws the attention to the fact that the melting of the sea ice can make the region even more dangerous. According to him, breakaway ice floes pose risks to ships and also oil platforms. He also writes that opening waters can attract not only more shipping but also mineral exploration.

Thus, the environmental results of these activities are questionable.

Economic Impact of Climate Change

The economic impact of climate change is an important part of discussion of the current geopolitical importance of the Arctic and the NSR.

It is estimated that the distance between Northwest-European ports and Far East area could shortened about 40% if the NSR is used. The alternative route of this comparison is a traditional route – the Suez Canal or so-called Maritime Silk Road (Didenko & Cherenkov, 2018). Gosnell (2018) underlines that the shipping route is about 11,200 nautical miles from East Asia to Northern Europe using the Suez Canal and is only about 6500 nautical miles through the Arctic. All this contributes to the visible reduced costs for the shipping industry. On the other hand, traditional sea routes via the Suez Canal or the Panama Canal are approaching their capacity. New Arctic routes could be acceptable alternatives, enhancing international trade and contributing to economic growth in the world. This alternative is important also from geostrategic point of view. If some part of the world becomes unstable and some of the route is closed (or the shipping is not safe), there is still another way for distributing the goods. The Suez crisis is such an example. So, it is necessary for great powers (but not only for them) to seek stable water routes – because of economic security. Blunden (2012) in this context states that "should serious problems arise with the alternative cargo route through the Suez Canal, the picture could change dramatically."

In the past, international trade followed the North-South vector. The reason was obvious – due to geographical and climate reasons, the global north was not navigational. Now, however, the situation changes rapidly, and ships can use the east-west route. For theoreticians of international trade, it would be very interesting to compare the relative significance of north-south and east-west sea routes in the future. For example, for China, the NSR means cutting its route by half as in the past it had to go around south India and through the Suez to Europe (Arvin, 2021). The significance of the NSR would be important also for international trade with other Asian countries, including Japan and Vietnam, and even for non-Asian countries such as Australia (Arvin, 2021).

The worth of the Arctic for international trade is still growing. For example, in 2017, 9.7 million tons of cargo shipped along the NSR – about 35% more than in 2016 (Gosnell, 2018). Almost 2000 voyages were completed by the ships in 2019, transporting about 31.5 million ton of goods. The prediction is about 92.6 million tons of goods in 2024 (Deandreis, 2020). It is also important to mention that the NSR can cut time and distances for Asia-Europe trade by around 2 weeks.

Of course, the current Covid-19 pandemic is causing a reduction of cargo shipping and also demand for such goods as gas or oil. The impact of the Covid-19 pandemic on those predictions will be seen in very near future. However, "despite COVID and global restrictions, shipping along the NSR has increased, *albeit* by a modest 2.9%, approximately. Shipments include liquid natural gas (LNG) and oil, as well as goods from Asia to Europe (e.g. Indian fine coal exports, South Korean electronics, Russian fish, and Chinese exports of computer and mobile tech)" (Depledge, 2021).

According to Blunden (2012), "shifts in economic geography are favoring the development of the NSR as a potential transit route linking Asia to the consumer markets of Europe." Her main argument is the distance and trade between China and Europe. She adds that "shifts of this kind in economic centers of gravity favor development of the NSR, and regular use of this route would further stimulate the economic growth of the northern Europe and Asian areas" (Blunden, 2012).

On the other hand, there are still some limitations for more rapid development of the region – the most important one is the lack of infrastructure in the region (despite visible Russian investments), including poor communication and satellite coverage (Gosnell, 2018).

Important Players and Special Position of Russia and China in the Arctic Geopolitics

The key player of the Arctic region seems to be Russia (the real interest of the United States is questionable, as it is evident that the United States does not include the Arctic between the regions of the vital interest). In 2007, Russia demonstrated its claim to Arctic territory by planting its flag on the North Pole's seabed.

It is estimated that 70% of natural gas and 41% of oil in undiscovered Arctic regions is owned by Russia (Deandreis, 2020). Didenko and Cherenkov (2018) also point out the military importance of the Arctic for Russia, as they note that Russia is increasing its military presence and military activities in the region (military forces, organized military drills, reconstruction of military bases, creating of icebreakers, establishing radar stations, etc.). In Russian Military doctrine from 2017, the Arctic is a region where armed forces of the country must protect the Russian national interest (Didenko & Cherenkov, 2018). Talking about the Russian presence in the Arctic, it is necessary to remember that Russia is also rebuilding and reopening its military bases there (Weitz, 2021) and building new ports along the territory.

According to Kundu (2017), "the NSR gives Russia enormous strategic latitude and commercial gains." Russia also claimed sovereignty over the NSR territorial water of Russia. This claim was disputed by the United States and the EU states. On the other hand, it was recognized by Canada. Alternatively, Russia recognized the claim of Canada over Northwest Passage (also this claim was not recognized by the United States or the EU countries – they all argue that Northwest Passage is international territory) (Gricius, 2021).

Already in 2011, Vladimir Putin (then Prime Minister) underlined the Arctic area, saying "the shortest route between Europe's largest markets and the Asia-Pacific region lies across the Arctic" (Gosnell, 2018).

According to Didenko and Cherenkov (2018), some general considerations can be formulated in regard to the economic significance of the NSR:

1. The share of foreign participation in the NSR has been geopolitically susceptible.
2. International economic aspects of using the NSR have become prevalent in the geopolitical ones.

3. Russian government politics should be accentuated on domestic transportation tasks, and success achieved in this strategic direction should be the best PR for the NSR's services worldwide.

In their turn, Guo and Wilson (2020) stress two interests of the Russia in the Arctic:

1. Exploitation of oil and natural gas in the region
2. To become the critical player in the development of shipping routes through the Arctic

In the same vein, Samarina et al. (2020) point out these reasons of the significance of the Arctic for Russia:

1. The Arctic is a depository with truly unlimited natural resources, both in volume and in the content of mineral products.
2. The Northern Sea route, linking the Western and Eastern hemisphere and passing through the ports of the Russian Arctic, favors the development of international economic ties.
3. Successful and systematic development of natural resources in the territory of the Russian Arctic provides the possibility of implementing a systematic and comprehensive sustainable economic development.
4. The development of the Arctic spaces and its natural resources is one of the main determinants of the world economy transition to a new technological method.
5. The Arctic acts as a zone of strategic interests of the economic security of the Russian Federation.
6. The Arctic acts as a zone of strategic interests of the military-political security of Russia.
7. The Arctic is an object of international influence of the developed states and the application point of their political, military, economic force, influence, and authority.

As mentioned before, the Arctic region is not attracting only Arctic countries, but also other powers, including China, Japan, or India. Humpert and Raspotnik (2012) raise the issue of China and the country's demand for natural resources as well as its exported oriented economy. Both of these factors would enhance China to find an alternative trade route. This alternative is supported also by experts and academics in China. Humpert and Raspotnik (2012) quote Professor Guo Peiqing in this context; according to him, "Arctic shipping will change the structure of global trade and may result in the emergence of a new, circumpolar super-economic belt made up of Asia, North America and Northern Europe." Another Chinese scholar, Li Zhenfu, explains: "Whoever has control over the Arctic route will control the new passage of world economics and international strategies" (Humpert & Raspotnik, 2012). Even more, Chinese experts and politicians are describing China as a near-Arctic state (Humpert & Raspotnik, 2012).

Kundu (2017) has tried to explain Chinese positions. He points out that the China is an "energy deficient country" so "the Arctic's energy resources is also part of its interest to settle its energy needs," China, in its Arctic Policy (official Chinese Arctic policy was established via white paper in January 2018), highlighted the so-called Polar Silk Road. Taking into account real activities, it seems that China is becoming the second most important player in the Arctic. The international politics experts are divided on the question if good relations of Russia with China (including the Arctic issues) are "true strategic alliance or merely a marriage of convenience" (Guo & Wilson, 2020). Proponents raise the agreements signed by the countries. Some scholars point out that despite mutual interest some goals of both countries are diverse – also in the Arctic (Guo & Wilson, 2020). As mentioned before, for Russia, the NSR is the opportunity to become critical player in the area. It is also this for China, as the country is trying to increase influence there and "refine its image as a global player" (Guo & Wilson, 2020). China also stresses the global character (not regional) of the Arctic issues – trying to legitimize its participation (Guo & Wilson, 2020). Also, Østhagen (2019) draws attention to the role of China in the Arctic, despite the fact that China is not an Arctic state. He writes that "China has now emerged as an Arctic actor. With Beijing continuing to assert its influence on the world stage, the Arctic will be only one of many regions where China's presence and interactions are components of a broader global expansion of both soft and hard power."

However, it is not only China; also, other Asian powers are aware of importance of sea routes and so they are seeking new safe routes. Japan applied for the Atlantic Council in 2009 and became an observer. According to the Japanese scholar Shigeki Toriumi, "being close to the Bering Straits, the entrance to the passage (NSR) gives Japan advantage in terms of location as a hub port, compared with Singapore, Hong Kong or Pusan" (Blunden, 2012).

The position of the United States is also interesting, as the country stated in its 2013 strategy for the Arctic regions that "the melting of Arctic ice has the potential to transform global and climate ecosystem as well as global shipping, energy markets, and other commercial interests" (Gosnell, 2018).

The EU issued two documents involving the Arctic in 2016: The Global Strategy, referring to importance of limiting tensions in the Arctic; and the Integrated EU policy for the Arctic, addressing EU priorities there (Deandreis, 2020). On the other hand, the role of the EU in the region is affected by the position of Russia and the United States, as both countries opposed the recognition of the EU as an official observer in the Arctic Council (Deandreis, 2020). Paul (2021) suggests a new strong position of the EU in Arctic issues. This position should involve security issues able to challenge Russia in geopolitical and geostrategic issues of the Arctic. According to him, only that kind of strategy could be realistic.

Conclusions

The Arctic region offers many economic opportunities for involved players – fishing, shortening of the shipping routes, and huge economic resources. With the NSR, its utilization will depend not only on climate change in the future but also on other factors playing visible role – usually connected with the political and security situation (Kundu, 2017). The NSR is also only one of the Arctic route alternatives. The other, often mentioned by experts in the field, is the TSR – potentially the shortest route between Europe and Asia with about 2100 nautical miles linking the Atlantic Ocean and the Pacific Ocean via North Pole. However, as Bennet et al. (2020) mention, "potential move from the NSR to the TSR will likely be gradual rather than sudden." This move is directly connected with climate change and melting the ice in the region.

For the improvement of the economic conditions of the NSR and the Arctic areas, according to maritime experts, more public and private funding is necessary in the region, as there are still some obstacles for development of the region – mainly the lack of infrastructure as the precondition for attracting other investments. Improvements are also necessary in ship navigation, charting, radio and satellite communication, and icebreaker capacities. All of that is necessary not only for economic development, but also for security of the shipping and international trade using Arctic and NSR area and facilities.

In this context, Gricius (2021) points out that "with its unpredictable seas, severe climate conditions, high costs and lack of developed infrastructure in the northern territories – the Arctic has many obstacles for socio-economic and maritime development."

There is still long way for the NSR to be real alternative for the Suez Canal and the Panama Canal. However, if there is cooperation between relevant players, this way can be shortened. Involved global and regional players must be aware that security guarantees are basic preconditions for further improvements of the area in terms of international trade exchange.

Finally, the possible success of the NSR will have global consequences, as it will mean a new real alternative for the transport of international trade goods. It will also have significant impact in global politics, strengthening the role of involved players. In terms of geopolitics, it will confirm the position of the Arctic as a region of current global importance.

It is in vital interest of Europe to solve all the disputes in the Arctic peacefully and with means of cooperation, predominantly with Russia. It is necessary for the political and economic security of the continent and for its prosperity.

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China's Role in the Northern Sea Route

Attila Fábián and Juraj Ondriaš

Contents

Abstract

The goal of this chapter is to present the attitude of the People's Republic of China towards the Northern Sea Route (NSR) initiative of Russia. After describing the benefits and drawbacks of the NSR, the text then presents the potential of the route in the extraction and transport of oil and natural gas. The chapter then focuses on the development of the route. The Chinese initiative of the Polar Silk Road, which is somewhat analogous to the NSR, will be mentioned. The chapter then turns to the opportunities that China sees in the NSR in the context of the presented benefits and drawbacks. The most important projects of mutual cooperation between Russia and China will briefly be described as well. The principal

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conclusion is that such cooperation is in the interest of both countries, despite any rivalry that may arise between them in the exploitation of the newfound opportunities in the Arctic.

Keywords

Arctic · Cargo shipping · Hydrocarbons · Infrastructure development · China–Russia relations · Northern Sea Route

Introduction

With the melting of the ice cap in the Arctic Ocean as a consequence of global warming, the Northern Sea Route (NSR) along the Russian Arctic Sea coast promises to become an important alternative trade route connecting the East and West portions of the Eurasian continent. More relevantly, the Arctic Ocean connects the continents of Europe, Asia, and North America, with these three continents accounting for 90% of international trade (Zoltai, 2018). However, to effectively harness the newly available potential of the increasingly ice-free Arctic Sea, Russia is in need of foreign investment, since it does not possess sufficient capital of its own to develop the necessary infrastructure to allow the NSR to reach its full potential. The People's Republic of China has emerged as the principal investor and partner of Russia in its Arctic endeavors, due to their relative closeness politically and due to the large amount of investment capital China possesses thanks to its meteoric economic rise over the past four decades. China is willing to allocate much of this capital to the NSR and its infrastructure projects, since these also benefit China, which is seeking alternative shipping routes and sources of commodities, especially hydrocarbons. The aim of this chapter is therefore to showcase China's role in the NSR.

After an overview of the main benefits and drawbacks of the Northern Sea Route, the chapter focuses on the crucial role of oil and natural gas in the development of the NSR. The exploitation and transport of these commodities provide much of the rationale behind the development of the NSR, as well as being one of the most important reasons behind China's great interest in the route. The text then turns to Chinese investment and cooperation with Russia on infrastructure projects along the route. Both the motivations and the most important specific projects will be discussed. The main method of study was the analysis of online sources from relevant internet portals that focus on issues of the Arctic, maritime transport, or China. The chapter will focus mainly on the economic aspect of the NSR and PSR, with others, such as the environmental or strategic aspects, only mentioned briefly when they touch upon economic reality. Also, although the principal economic actors are mentioned throughout, the text is influenced by the neorealist school of international relations, meaning that states will be considered as the principal and unitary actors. While such an approach does reduce the complexity of the issue, it is somewhat more merited than it would usually be due to the strong state involvement in the economy in both countries, especially when it comes to natural resources and regional development. The main conclusions are that it is in the interest of both countries to continue cooperation along the NSR because of the mutual benefits that accrue to both partners. For Russia, China is an indispensable source of capital, without which it could not properly develop the NSR. For China, by contrast, the NSR is a welcome opportunity to diversify both its shipping routes and its sources of commodities, especially hydrocarbons. Furthermore, China has an excess of capital, meaning that the investment opportunities along the NSR satisfy its needs in this area as the economy as well.

An Overview of the Northern Sea Route

The Northern Sea Route is a major development project of Russia, which intends to take advantage of the melting Arctic Sea ice to reroute a significant portion of global maritime traffic to the shores of Northern Russia. The route should also aid in developing the isolated areas along the Arctic coast and further inland (Guo & Wilson, 2020). This is to be accomplished by opening up the natural resource wealth of the region to exploitation and enable a more efficient transport of these commodities through the Arctic Sea. For these plans to succeed, it is necessary for Russia to present the benefits of the route within the context of the more favorable climatic conditions of the Arctic. The main benefits are the expected decrease in distance and thus in travel time between the major trading hubs of Western Europe and East Asia. For example, utilization of the NSR could shorten the delivery time of cargo ships travelling between the ports of Europe and East or Southeast Asia by 30–40% compared to the traditional route through the Suez Canal. For vessels surpassing the Suezmax limit – i.e., too large to use the Suez Canal and obliged to take the longer route around Africa via the Cape of Good Hope – travel time could be decreased by as much as 60% (Arcticbulk, 2021). This corresponds to a shortening of the distance between the major trading hubs of Eurasia. For example, the NSR is expected to

> reduce the distance between Shanghai and Rotterdam (Europe's largest commercial port in the Netherlands) by almost 2,800 nautical miles or by 22 percent. This route is also likely to reduce the transportation cost by 30 to 40 percent. Similarly, while a container ship from Tokyo to Hamburg (Germany's major port city) sails for about 48 days via the Suez Canal, it can cover the same distance by about 35 days via the NSR. (Nanda, 2021)

To take another set of estimates, as stated in another study carried out by the Copenhagen Business School,

> the Arctic Route has the potential to bypass the Panama Canal and cut the time of voyages between Asia and Europe by 40 per cent. According to searoutes.com, a ship traveling from South Korea to Germany via the Cape of Good Hope, South Africa, would take approximately 46 days. If it went via the Suez Canal, it would take 34 days. The same voyage along the NSR would take approximately 23 days. (Port Technology, 2018a)

Already in 2011, it was demonstrated that an oil tanker would take 22 days to travel the distance between Murmansk on the Kola Peninsula in Northwest Russia and the Chinese city of Ningbo, just south of the Yangtze River delta. The traditional Suez Route was estimated to take twice as long (China Briefing, 2011). Therefore, as shown in the above quote, the NSR could also have an impact on shipping routes between Asia and Europe through the Western Hemisphere, by avoiding the Panama Canal and thereby reducing shipping time by 4 days (Zoltai, 2018) – not as much of a significant saving of time as with the Suez Canal route, but within the context of contemporary just-in-time trade logistics, still an interesting proposition for businesses. In sum, the average distance between East Asia and Western Europe is estimated to be 12,800 km by the Northeast Passage (and 13,600 km by the Northwest Passage), as compared to 21,000 km by the Suez Canal Route and 24,000 by the Panama Canal Route, showing the reason for the economic potential and the attractiveness of the route through the Arctic (Abdul Rahman et al., 2014). Of course, this is provided that the issues regarding year-round transport on the NSR are resolved.

Russia can benefit strongly from the opening of the Arctic, since it borders the bulk of the Northeast Passage, and it has taken steps to develop the portion of this passage that falls under the scope of the NSR. Researchers from the Netherlands Bureau of Economic Analysis estimated that two-thirds of the traffic taking the Suez route could be redirected to the NSR, which means 10,000 more ships traversing the Arctic annually (Bekkers et al., 2015). To put this into a global context, the estimated of the proportion of world trade that passes through the Suez Canal ranges from 8% to 12%. An increased number of vessels means more money for Russian transport facilities, harbors, and icebreakers, which are currently obligatory for vessels passing through the NSR. The attractiveness of the NSR as an alternative passage has been given an additional boost by the blockage of the Suez Canal in late March 2021 (Nanda, 2021). This incident gave Russia the opportunity to tout the reliability and competitiveness of the NSR, which is free from such artificial bottlenecks (Reuters, 2021).

The viability of this route is not merely theoretical but is clear from the increased traffic from year to year. Over the past decade, the interest and utilization of the NSR by shipping companies has been rather spotty, but the trend has been positive (Barkham, 2017). In 2010, only four ships utilized the NSR, rising rapidly to 41 in 2011 (Arcticbulk, 2021). In the following year, 2012, 46 ships carrying 4 million tons of cargo traversed the NSR, with another rapid increase to 71 vessels in 2013 (Port Technology, 2018a), of which 40 crossed the entire route and 15 were international crossings (Saul, 2020). The international transits accounted for 1.356 million tons of cargo in 2013, which therefore excludes cargo transported within Russia. The year 2013 represented a peak in the transit through the NSR as shipping companies took advantage of the shorter distance to cut down on fuel costs. With the fall in oil prices in 2014, however, this became less prominent, until oil prices began to climb once again from 2016 (Port Technology, 2018a). Thus in 2015, there were only 18 international transits carrying 40,000 t of cargo, which rose to 19 international transits and 214,000 t of cargo in 2016 (as a portion of 1705 transits in total for the year, the vast majority of which were domestic) (Sun, 2018). Since then, the utilization of the NSR has also picked up pace, with 331 ships taking the route in 62 transits in the first 11 months of 2020, compared to 227 ships undertaking 37 transits in 2019 (Saul, 2020). As for the increase in the volume of trade, in 2020, the quantity of cargo shipped through the NSR was almost 33 million tons (of which 18 million tons was liquefied natural gas, or LNG) – an eightfold increase from 2012 (Reuters, 2021) and a fivefold increase since 2015 (Odynova, 2021). The Russian authorities expect trade volumes to continue growing rapidly, reaching 80 million tons by 2024 according to the energy ministry of Russia (Reuters, 2021). Trade could potentially reach 120 million tons by 2035 according to Maksim Kulikov, deputy director of the NSR development department of Rosatom (the Russian state corporation dealing with nuclear energy, which also has control over the nuclear icebreaker fleet through its Atomflot division) (Vorotnikov, 2019).

Despite the benefits of a shorter distance and lower expenditures on fuel, and the resulting rise in the use of the NSR over the past several years, there are still challenges that the NSR must resolve before becoming a full-fledged alternative trade route. Estimates claim that notwithstanding the advantages, the NSR is currently 30–40% more expensive than the Suez route (Vorotnikov, 2019). Part of this extra cost is due to higher insurance because of the risk posed by sea ice and inclement weather, as well as resulting difficulties for any potential search and rescue operations (Jacobsen, 2018). As expressed by the Port Technology portal, "*Such is the uncertainty around Arctic shipping, the International Union of Marine Insurers (IUMI) said in August 2018 that insurance for voyages may only be given on a case-by-case basis*" (Port Technology, 2018a). Another reason for the increased cost is the obligation to pay for Russian icebreakers. This cements Russian control over the waterway, but it can dissuade shipping companies, especially if they have invested in building their own ships with icebreaking capabilities. Then there is the limited reliability of the NSR as a route open year-round, with the NSR being currently navigable for most ships for only 3 months of the year on average (Port Technology, 2018a), give or take a month (TASS, 2017a). However, icebreakers can extend this interval, and ships with icebreaking capability may even attempt the crossing year-round (Barkham, 2017). This drawback is expected to diminish as the Arctic climate continues to get warmer.

Apart from these disadvantages, shipping companies have identified another drawback in the fact that the NSR is better suited to transport of commodities rather than container cargo. This is because container cargo ships need to make multiple deliveries along their route to be profitable (Port Technology, 2018a), and the Arctic coast of Russia is too sparsely populated to absorb the necessary amount of container trade. In addition, the area does not possess the necessary infrastructure to process and transport the cargo to population centers further inland. Furthermore, the shipping of cargo would essentially be one way, with limited opportunities to transport backway cargo. In this respect, the NSR has a disadvantage not only compared to other shipping routes, but compared to rail transport as well, which can cut straight across the continent (Vorotnikov, 2019). One analysis by the Russian University of Transport/Moscow Institute of Railway Engineering attempted to determine whether the NSR was viable for the transport of perishable goods in refrigerated containers (Baginova et al., 2019). The authors of the study concluded that while it was not suitable as a transport corridor, it showed promise as a supply route for the region or for the transport of regional goods, claiming that "*this route can be considered as an effective transport corridor for ensuring the implementation of seasonal targeted programs at the federal level, such as supply of goods to northern Russia or delivery of Far Eastern salmon to Central Russia*" (Baginova et al., 2019, p. 6). The transportation of automotive components and finished vehicles was similarly judged to be currently unfeasible without significant state subsidies. For this type of cargo transport, there would also have to be massive investment into the construction of vehicle-carrying ships capable of sailing through Arctic waters. Still, there is no appetite for this among automobile manufacturers and shipping companies, unless market conditions such as customer demand change significantly (Vorotnikov, 2019). Yet despite these analyses, there is interest in exploring the NSR as a container shipping route – in 2018, the Danish transport company A.P. Møller-Maersk sent the container vessel Venta Maersk on a 37-day West-to-East trial passage through the NSR from Vladivostok to St Petersburg (Port Technology, 2018b). The Venta Maersk, capable of carrying 3600 TEU, belonged to a new class of container ship, built with a reinforced hull to withstand polar conditions. Even so, it relied on a Russian icebreaker on the voyage. However, the company stressed that this was only a one-off expedition to test the NSR. Nevertheless, the mere fact that Maersk is considering the NSR is a good sign for Russian ambitions (Jacobsen, 2018).

Hydrocarbons in the Northern Sea Route

However, whether or not the NSR will be viable as a container route, it has undisputed importance in the transport of natural resources such as oil or natural gas (mainly in its liquefied form as LNG) and other commodities such as iron ore and other minerals (Saul, 2020). As mentioned above, over half the cargo transported along the NSR in 2020 (18 million out of 33 million metric tons) consisted of LNG (Odynova, 2021). This type of commodity cargo transport can serve single customer markets and thus does not rely on intermediate stops. A major aspect of the NSR, therefore, consists of the development of infrastructure (such as refineries and specialized port terminals for oil and LNG tanker ships) for the exploitation and processing of the region's natural resources and their transport to foreign markets.

One such project is the creation of the Yamal-LNG facility for the production of LNG near the village of Sabetta on the Northeastern tip of the Yamal Peninsula in the Russian Arctic. The facility is the world's largest LNG project (Chun, 2020). It will be accompanied by a seaport and an airport, and should have a production capacity of 16.5 million metric tons of LNG annually. Because of the high costs involved and the necessity for foreign capital and market demand, Russia entered into partnerships with foreign companies. While the major Russian gas company Novatek has a 50.1% stake in the project, other shareholders include the French gas company

Total with a 20% stake, and, more significantly for the future of the region, the China National Petroleum Corporation (CNPC) a Chinese state-owned enterprise (SOE) with 20% and the Silk Road Fund with 9.9%, which is also a Chinese state-owned investment fund (TASS, 2017a).

Although the development of Sabetta is linked to the transport of LNG, there are plans to take advantage of the NSR for the transport of other types of cargo. For example, already back in 2016, the route was used to ship two chemical reactors from South Korea which were destined for the chemical refinery in Pavlodar, Kazakhstan. The reactors were shipped via the NSR to the port at Sabetta, and from there transported up the Ob and Irtysh Rivers to Pavlodar (Staalesen, 2016). The same route via Sabetta port was used again the following year, for ten shipments to supply plant components to a new petrochemical plant in Tobolsk in the Southern Urals of Russia (Staalesen, 2017). The NSR can, though, facilitate the flow of cargo in both directions. In the opposite direction, the Russian region of Omsk reached an agreement in 2019 to export grain, with a first shipment of 5000 metric tons, to Japan via the Irtysh and Ob rivers, Sabetta, and the NSR. This route is expected to be less expensive (at a cost of ₽7000) to the traditional railway route, which costs ₽11,800. The success of the agreement is contingent on the ability of the port of Sabetta to establish a certified access point, since the legally required phytosanitary controls should take place on site at the port from which the grain is to be shipped (Staalesen, 2019a). This demonstrates that it could be economically viable to transport at least non-container cargo, such as bulk cargo (such as grain) or specialized items (such as chemical reactors), over the NSR. However, oil and natural gas are set to remain as the most important commodities underpinning shipping along the route.

The importance of the Arctic, however, is not only as a transport route of these commodities but also as a source of their extraction. The Arctic is estimated to be rich in metals and minerals such as gold, platinum, iron lead, zinc, manganese, or uranium (Zoltai, 2018). Yet the principal source of wealth in natural resources lies in energy commodities. For example, when it comes to proven reserves of oil and natural gas, an analysis from 2008 by the BP Statistical Review stated that the region was estimated to contain 65.6 billion barrels of oil, of which the share of Russia was 59.2 billion barrels. In the case of natural gas, the numbers were even more skewed in favor of Russia, which had 38.07 trillion cubic meters of gas out of 38.41 trillion cubic meters in the Arctic as a whole (Jørgensen-Dahl, 2010). In the case of potential reserves, the Russian territory may hold around 48 billion barrels of oil and 42 trillion cubic meters of natural gas (Sun, 2018). It is estimated that approximately 70% of Russia's oil and natural gas reserves are offshore, i.e., on the continental shelf around Russia's coast, especially in the Arctic (Guo & Wilson, 2020). As for unexplored reserves of energy commodities, a comprehensive large-scale assessment of the United States Geological Survey (USGS) also from the year 2008 named the Circum-Arctic Resource Appraisal, or CARA, estimated that

> the Arctic might contain 90 billion barrels of undiscovered oil, 1,669 trillion cubic feet of natural gas, and 44 billion barrels of undiscovered natural gas liquids. The Arctic is thus supposed to account for about 13 per cent of undiscovered oil, 30 per cent of undiscovered

> natural gas, and 20 per cent of undiscovered natural gas liquids in the world. This represents about 22 per cent of all undiscovered, technically recoverable oil and gas resources in the world and is slightly less than the year 2000 assessment which, however, included land territories south of the Arctic Circle. Expressed in oil-equivalency terms, undiscovered natural gas is thought to be three times more abundant than oil in the Arctic. (Jørgensen-Dahl, 2010)

The USGS analysis goes on to say that

> the area in the Arctic most accessible and presumably less costly from an exploration and recovery point of view may be the Barents Sea. According to the USGS the Russian and Norwegian Barents Sea shelf may contain about 11 billion barrels of undiscovered oil, 11 trillion cubic meters of undiscovered natural gas and 2 billion barrels of undiscovered natural gas liquids. (Jørgensen-Dahl, 2010)

The majority of these resources are expected to be located in the East Barents Sea basin, under the control of Russia – specifically 68% of the oil, 85% of the natural gas, and 65% of the natural gas liquids. According to the same source, the mentioned USGS estimate from the year 2000 claimed that the broader Arctic region (on both sides of the Arctic Circle) comprises 23.9% of all undiscovered reserves of oil and natural gas. These are all conservative estimates, as they only included deposits of at least 50 million barrels of oil or oil-equivalent natural gas, exploitable with current technology, and explicitly excluding nonconventional sources. Furthermore, it can be expected that the accelerated pace of the melting of the sea ice will make more deposits available for exploitation.

China in the Arctic

While the NSR is a Russian initiative, it is of interest to other powers as well, most notably the People's Republic of China. China is the second largest economy in the world by nominal GDP (and the first by purchasing power parity) (Statistics Times, 2021). It is also the largest trading nation in the world – being the largest exporter and second largest importer of goods (Global Edge, 2021) – and therefore reliant on efficient and safe trade and supply routes. As such, it is little wonder that China would take an interest in an alternative trade route that promises to dramatically cut back on the delivery times for Chinese manufactures exported to its crucial markets in Europe by container ships. Furthermore, for China, the NSR may in some instances still be a cheaper option of maritime cargo transport, especially in the case of energy commodities, than the Suez route, even when factoring in the extra cost of an icebreaker escort (China Briefing, 2011).

Apart from working together with Russia on the development of the Northern Sea Route, China has its own ambitions in the Arctic region. China's reliance on trade has led it to create the most ambitious trade and transportation initiative ever, termed the Belt and Road Initiative (BRI). The BRI is divided into two main prongs, the land-based Silk Road Economic Belt (SREB) and the sea-based Maritime Silk Road

(MSR). Even apart from these, other "silk roads" have been proposed, most relevantly the Polar Silk Road (PSR). The PSR is roughly analogous to the Northern Sea Route, apart from being more expansive, seeing as it extends from the coast of China to the ports of Northern Europe, and thereby recreating the Northeast Passage between the two opposite ends of Eurasia. Just like Russia and its NSR, China's PSR intends to take advantage of the melting Arctic sea ice to create an alternative to the established transport routes.

The PSR is seen as an alternative to the MSR, so it is necessary to study the drawbacks of the MSR to understand the value of the PSR. The principal drawback of the MSR is the existence of several chokepoints along the route, such as the Strait of Malacca, and the Bab-el-Mandeb and the Suez Canal on either end of the Red Sea. For traffic continuing to Northern Europe, the Strait of Gibraltar also counts. Should any of these chokepoints be sealed off to Chinese shipping by an adversarial power, it would strongly affect trade between China and its European partners, or cut China off from its major sources of energy and other commodities. Chinese ships would have to consider alternative and much longer routes, whether through the various straits through Indonesia or possibly around Australia, the Cape route around Africa, or even a route through the Western Hemisphere. Compared to these, the PSR would be much shorter, as seen above. Of such chokepoints, the Malacca strait is the most critical for China, as it is not only the gateway for Chinese exports throughout the Eurasia and Africa, but also the main route for imports of hydrocarbons from its major suppliers in the Middle East and Africa. The very existence of the MSR is vulnerable to adversaries, giving the alternatives – such as the SREB and the PSR – a strategic dimension by default. To avoid becoming over-reliant on this route, the PSR (as well as the SREB) was developed as a key function of the BRI. The cultivation of Russia as a supplier of hydrocarbons is important for the same reason, as developed above. The PSR, just as the NSR, promises to deliver these commodities while bypassing these vulnerable areas, as well as diversifying their source from China's traditional suppliers. The chokepoints – namely the Malacca strait and the Bab-el-Mandeb – are also vulnerable to attacks by pirates which flare up every few years. In comparison, the PSR and NSR have no such risks. Nonetheless, the PSR is not devoid of chokepoints – the Bering Strait lies off the coast of Alaska, and the route passes near Japan, putting it within reach of China's rivals.

Sino-Russian Cooperation Along the Northern Sea Route

However, as has been noted above, the potential of the NSR for shipping container cargo is limited because of a lack of substantial intermediate markets between the end points. This means that it is in the sector of energy that the NSR is especially significant for China. Because of China's rapid economic growth, the demand for and consumption of energy has outstripped domestic supply, meaning that China has become increasingly reliant on hydrocarbon imports. While the countries of the Middle East have been the principal suppliers of hydrocarbons, over the past decade China has also been looking at other potential partners, such as in Central Asia, Africa, or Latin America, to diversify its suppliers, and, equally importantly, its transport routes. Of these partners, Russia is rapidly gaining prominence as a crucial supplier of hydrocarbons to China. This partnership is beneficial for both countries, for two main reasons. Firstly, European countries have been Russia's primary export market, but over the previous decade, Russia's share in this market has declined. This is mainly because of increased geopolitical tensions with the West, represented by organizations like the EU and NATO which comprise many of these European buyers of Russian hydrocarbons. These European countries look for other suppliers and sources of energy to combat what is perceived as an overreliance on Russia. Russia has thus needed to look for alternative buyers in order to avoid economic problems, and China has become an attractive option due to its high demand for hydrocarbons, as well as its unified market (Zoltai, 2018). Indeed, the NSR has been considered as an alternative option for the transport of hydrocarbons to China as early as 2011, when a tanker loaded with gas condensate made the voyage between the Purovsky gas processing plant in the Russian Arctic to the port of Ningbo in China (Russia Briefing, 2011a). Only last year, Gazprom Neft, the oil division of Gazprom, shipped its first consignment of Arctic oil to China via the NSR. The 144,000 t of oil were transported between Murmansk and Yantai on the Bohai Sea on the Northeast coast of China, over a period of 47 days. The year before, in 2019, Russia's second largest oil producer, Lukoil, also made a deal with the Chinese to transport a cargo of crude oil through the Arctic (Reuters, 2020). In 2019, following a summit in Beijing, Russian President Vladimir Putin also proposed a plan to deliver natural gas from the Russian Arctic to China via a pipeline that would also run through Mongolia (Staalesen, 2019b). These actions by the largest oil producers of Russia show the pivotal role of hydrocarbons in the development of the NSR.

The second reason Russia stands to benefit from a partnership with China is that Russia's leaders realize that the development of infrastructure along the NSR, which is necessary to make the route viable, would be difficult if it relied solely on its own capital. China thus represents a welcome source of funding for the NSR development projects – especially since China itself is looking for opportunities to invest its substantial accumulated capital. China has been providing capital for infrastructure development in Siberia and the Russian Far East for a decade, sometimes investing more than the Russian government itself, in exchange for a steady supply of raw materials (Russia Briefing, 2011b). Expanding this mutually beneficial dynamic to the newly accessible deposits of natural resources in the Arctic is a natural evolution of this trend. Indeed, in 2015, the then-Deputy Prime Minister of Russia, Dmitry Rogozin, invited China to take part in development projects along the NSR, such as the construction of railways to service the ports along the route (Arctic Portal, 2015). For example, during a summit of the Shanghai Cooperation Organization (SCO) held in the Chinese port city of Qingdao in 2018, Russia's state development corporation Vnesheconombank (VEB) and the China Development Bank (CDB), which is also controlled by the Chinese government, signed a deal to finance jointly selected projects, notably those falling under the NSR, aimed to integrate the priorities of its Belt and Road Initiative (BRI, which will be developed in detail below) and the Russian-led Eurasian Economic Union (EAEU). Under this agreement, the CDB should transfer $9.5 billion (₽600 billion in 2018) to VEB (Staalesen, 2018).

As for specific projects of mutual cooperation, it has already been noted that Chinese state-owned entities – i.e., CNPC and the Silk Road Fund – own a 29.9% stake in the Yamal-LNG project in the Russian Arctic. This is the first such joint project between the two countries. The production of LNG at the facility started in December 2017, and the first shipment of LNG to China arrived at the port of Nantong in July of the following year. The transport of LNG to ports in China is carried out by Chinese shipping companies (Chun, 2020). It is expected that this project will supply China with 4 million metric tons of LNG a year (Reuters, 2018). Chinese investors are also interested in plans to connect Sabetta with the Eurasian rail network, which would entail an investment of $3.22 billion (Zoltai, 2018), as part of the Northern Latitudinal Passage or Railway. The new rail connection would be an extension of the railway to Bovanenkovo on the Yamal Peninsula, and it would be about 170 km long (Staalesen, 2021). Another opportunity for Russia to utilize Chinese investment could be the Murmansk Transport Hub, where regional authorities seek financing to make up for a lack of domestic funds (Staalesen, 2018).

The second venture bringing Russia and China together in the region will focus on the development of the Payakha oilfield near the mouth of the Yenisey river. The agreement on this project was signed in June 2019, between the Russian company Neftegazholding and the China National Chemic Engineering Group (CNCEG), a Chinese SOE. The project is expected to comprise "*the construction of six crude oil processing facilities, a crude oil port capable of handling 50 million tonnes a year, 410 kilometres of pressurized oil pipelines, a 750-megawatt power station and an oil storage facility*" (Chun, 2020).

One other project that has been proposed is the development of a deepwater port for the city of Archangelsk, at the mouth of the Northern Dvina River (TASS, 2017b). Specifically, the port should be located on the island of Mudyug in the river delta, 55 km from Archangelsk proper. Funding would be provided by yet another Chinese SOE, the China Poly Group (CPG). In 2016, the CPG signed an agreement on intent to earmark $79 million (¥550 million) for investment in the port. Further impetus for the project was given by the China Ocean Shipping Company (COSCO), which expressed interest in using the Arctic Ocean for commercial shipping to Archangelsk. Another Chinese enterprise which is expected to be involved in utilizing the port is the China Marine Fuel Service Corporation (TASS, 2017c). "*Linking up with Russia's railway network, the port will help develop a combined sea–land transportation system, and improve links to Siberia. The local government predicts the new port and associated railways will create 40,000 jobs in the region*" (Chun, 2020).

China's usage of the NSR is already transcending the cooperation between itself and Russia. For example, even 10 years ago, there were plans for the Tschudi Shipping Company of Norway to transport Norwegian iron ore to Qingdao port (China Briefing, 2011). It has also started investing in Norwegian oil and gas fields in the North Sea (Zoltai, 2018). Any such oil or gas destined for China would logically be shipped by the Northeast Passage. In 2019, the route was traversed from Helsinki in Finland to Qingdao in China by the Chinese vessel Tian Xi, which is owned by COSCO, transporting 30,000 metric tons of paper pulp (Port Technology, 2018c). As another example, in September and October 2020, the Belarusian Potash Company exported a shipment of potassium chloride to China via the NSR (and the Northeast Passage in general, since the cargo was shipped from the Lithuanian port of Klaipeda). As reported by BelTA, the national news agency of Belarus, "*The delivery time was reduced by 1.5 times in comparison with traditional routes. Charter costs were reduced considerably as well*" (BelTA, 2020). All these initiatives are part of China's own vision for the Arctic – the Polar Silk Road.

Conclusions

As can be seen from the chapter, the Northeast passage, comprising both the Northern Sea Route and the Polar Silk Road, could have significant potential for trade in the Eastern hemisphere in the future. According to the logic of today's just-in-time transport, the shortening of the route between both ends of Eurasia should be a substantial incentive for the utilization of the passage. Of course, the increased costs of insurance and paying for icebreaker escorts has to be taken into account, but these costs should diminish with time, as more Arctic sea ice melts and as more countries invest in expanding their fleets of icebreakers – or outright start constructing cargo vessels with icebreaking capabilities. Such a development may not be to Russia's liking, but it is most probably inevitable in the long term, with Russia preserving its dominant position in icebreaking capability for a long time to come, thanks to its head start in quantity of icebreakers and in know-how.

It would appear that the potential for container shipping is limited, considering that container vessels are expected to make multiple stops and turn a profit on each leg of their voyage. The Russian Arctic coast simply has neither the population size nor the density (i.e., large cities), nor are the regions wealthy enough to justify such stops. What is more, there is a lower opportunity to transport backway cargo on the return voyage. Even so, several shipping companies, both Western and Chinese, have shown interest in this route if circumstances should become more favorable. Still, the drawbacks in the domain of container cargo transportation are more than compensated for by the vast potential the NSR promises in the domain of extraction and transport of mineral commodities, but especially oil and natural gas. The Arctic is rich in these energy commodities, and the NSR can play an important role in their transport to energy-hungry markets across Eurasia.

All these reasons that make the Northeast Passage valuable for Russia within its North Sea Route project also make it a very attractive investment opportunity for China. China is seeking to diversify both the sources of commodity import and the shipping routes used to transport these commodities as well as Chinese exports of manufactured goods. Currently, China sources the vast majority of its oil and natural gas imports from the traditional producer areas of the Middle East and Africa. It imports these hydrocarbons via the busy shipping route through the Strait of Malacca, while a sizeable amount of Chinese manufacture exports goes in the opposite directions via the Suez Canal route, through the Strait of Malacca and the chokepoints on either end of the Red Sea to get to Europe. These straits and chokepoints are potentially vulnerable to closure by any power hostile to China, which could seriously endanger the Chinese economy. With a limited capability to project its own power over these shipping routes and chokepoints, China is looking for alternative routes. Its Belt and Road Initiative suggests several such options via land-based trade corridors within the Silk Road Economic Belt that would avoid the mentioned chokepoints and bypass the reach of adversarial powers. However, the NSR is also a particularly suitable opportunity for China. Of course, the NSR does not alleviate all the Chinese concerns – there are chokepoints on this route as well, such as the Bering Strait, and potentially within reach of the power projection capabilities of the USA, not to mention the substantial Chinese reliance on Russia. The abovementioned drawbacks of the NSR for container cargo transportation are also relevant. However, utilizing the NSR means that China can avoid putting all its eggs into one basket, namely the Maritime Silk Road which spans the traditional shipping routes with all their mentioned vulnerabilities. For this strategic reason, as well as for the aforementioned economic reasons, China would do well to continue its close partnership with Russia. Russia could thus be assured of continued investment from Russia, which would be to the benefit of the development of the NSR, and to the benefit of the Sino-Russian relationship in general.

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Chinese Polar Silk Road in the Russian Arctic

Mariia I. Ermilova and Juraj Ondriaš

Contents

Abstract

The aim of this chapter is to present the Chinese initiative of the Polar Silk Road (PSR) in relation to the Northern Sea Route (NSR) initiative of Russia. The complementarities and potential rivalry between both of these initiatives will be addressed. After defining the PSR within the broader Belt and Road Initiative, the chapter will focus on the reasons and motives for its development. It will also look at China's involvement in the Arctic in the broader context of Russian-Chinese cooperation. Some opportunities for and challenges to cooperation between Russia and China in the Arctic will be mentioned as well. While there is some potential for rivalry, in the present geopolitical circumstances, mutual cooperation on the Arctic routes would be much more beneficial for both countries.

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Introduction

Due to the melting of the Arctic ice cap as a consequence of global warming, the Northeast Passage that connects Western Europe and East Asia through the Arctic Ocean is becoming a more economically viable option of transporting cargo. Whether in the case of transporting goods between both ends of Eurasia, or in transporting Arctic commodities (especially hydrocarbons) to resource-hungry states, the passage is of growing interest to global shipping and therefore an increasingly important asset of the Arctic countries. Foremost among these is Russia, whose Northern Sea Route (NSR) project is already well underway. Yet while the NSR is a Russian initiative, it is of interest to other powers as well, most notably the People's Republic of China. China is the second largest economy in the world by nominal GDP, and the first by purchasing power parity (Statisticstimes, 2021). It is also the largest trading nation in the world – being the world's largest exporter and second largest importer of goods (Global Edge, 2021) – and therefore reliant on efficient and safe trade and supply routes. As such it is little wonder that China would take an interest in an alternative trade route that promises to dramatically cut back on the delivery times for Chinese manufactures exported to its crucial markets in Europe by container ships. Furthermore, for China, the NSR may in some instances still be a cheaper option of maritime cargo transport – especially in the case of energy commodities – than the Suez route, even when factoring in the extra cost of an icebreaker escort (China Briefing, 2011).

The cooperation between both countries is mutually beneficial. Russia does not have the large amounts of capital needed to develop the necessary infrastructure along the route. China, on the other hand, has an excess of capital it is looking to invest abroad. Conversely, China is looking to diversify its sources of commodities, especially hydrocarbons, and the Russian Arctic has a vast untapped wealth in these natural resources. As a result, both countries collaborate on many infrastructure development projects in the Arctic region of Russia, mainly in port infrastructure and hydrocarbon extraction, processing, and transport (Chun, 2020).

However, Chinese ambitions go further than cooperation with Russia on the NSR. China has its own vision for the Arctic, called the Polar Silk Road (PSR), a part of its wide-reaching Belt and Road Initiative (BRI). While the infrastructure projects along the Arctic coast of Russia fit rather well within the scope of both initiatives, there is also an element of competitiveness between the two countries, especially over the measure of control each country would have over the route. The goal of this chapter is therefore to present the Polar Silk Road in relation to the Northern Sea Route, namely, to ascertain to what extent they are compatible or to what extent the PSR poses a threat to Russia and its interests in the Arctic.

Before proceeding with the content, it is first necessary to define the most relevant terms used in the text. The text deals with three related but separate terms describing the shipping routes in the Arctic Sea – the Northeast Passage, the Northern Sea Route, and the Polar Silk Road. The broadest of these terms is the Northeast Passage, which can mean any of the maritime routes connecting Northern and Western Europe to East Asia through the Arctic Sea North of the Eurasian landmass. By contrast, the NSR and PSR are narrower terms. The Northern Sea Route is defined by Russia as the corridor linking Russian ports and other infrastructure (mainly to process and transport oil and natural gas) between the Barents Sea and the Bering Strait, i.e., a portion of the Northeast Passage bordering the Russian Arctic coast. The Polar Silk Road, on the other hand, is a Chinese project, describing the shipping routes, ports, and infrastructure projects on the route between the coast of China and the Atlantic coasts of European countries, including all the countries in between, most notably Russia. The PSR is, thus, even longer than the Northeast Passage, but unlike that term, it is not so much a geographical term as a name for the projects along the way.

After a brief overview of the BRI, the text focuses on China's rationale for the PSR. China's goals in the Arctic are presented, as well as the Russian reactions to having China not only as a major partner but also a potential rival. Several examples of Chinese efforts to pursue an Arctic policy which is independent of Russia are noted. The main method of study was the analysis of online sources from relevant internet portals that focus on issues of the Arctic, maritime transport, or China. The chapter will focus mainly on the economic aspect of the NSR and PSR, with others, such as the environmental or strategic aspects, only mentioned briefly when they touch upon economic reality. While, too, the principal economic actors are mentioned throughout, the text is influenced by the neorealist school of international relations, meaning that states will be considered as the principal and unitary actors. While such an approach does reduce the complexity of the issue, it is somewhat more merited than it would usually be due to the strong state involvement in the economy in both countries, especially when it comes to natural resources and regional development. The main takeaway is that while there is some potential for rivalry, in the present geopolitical circumstances mutual cooperation on the Arctic routes would be much more beneficial for both countries.

The Chinese Case for a Polar Silk Road

Apart from working together with Russia on the development of the Northern Sea Route in the Arctic, China has its own ambitions in this region. China's reliance on trade has led it to create the most ambitious trade and transportation initiative ever: the BRI. To understand the role and value of the Arctic as a trade corridor and source of commodities for China, it is first necessary to expand upon the BRI. The beginnings of this initiative date back to 2013. In September of that year, the new President and Paramount Leader of China, Xi Jinping, unveiled his vision of a "New Silk Road" on a visit to the Kazakhstani capital of Astana, now Nur-Sultan (Viehe et al., 2015). The land-based corridors of this initiative are called the Silk Road Economic Belt (SREB). Following on from that, President Xi proposed the creation of a Maritime Silk Road (MSR) on another foreign visit, this time to the Indonesian capital of Jakarta, in October 2013 (Wu & Zhang, 2013). The objective of this corridor was to increase trade and improve infrastructure along the route from the South China Sea through the Indian Ocean to Europe. The principal means of accomplishing this goal was by building or expanding harbor infrastructure. Just as the SREB, the MSR outgrew its original vision by continuously expanding the projects and number of countries involved, e.g., by including the East coast of Africa in the initiative. Indeed, it must be emphasized that one of the hallmarks of the BRI is its vagueness – the Chinese leadership has not released any definition of which countries or which projects are specifically included in the initiative. The reason for this may be to give China a free hand in determining which projects will be included under the umbrella of the BRI, depending on their profitability, propaganda value, and the status of political relations between China and the partner country.

Apart from the SREB and MSR, other "silk roads" have been proposed, most relevantly the Polar Silk Road (PSR). The PSR is roughly analogous to the Northern Sea Route, apart from being more expansive, seeing as it extends from the coast of China to the ports of Northern Europe, and thereby recreates the Northeast Passage between the two opposite ends of Eurasia. Just like Russia and its NSR, China's PSR intends to take advantage of the melting Arctic sea ice to create an alternative to the established transport routes. The PSR was first suggested in 2017 – not yet under this name – in a policy document titled *Vision for Maritime Cooperation under the Belt and Road Initiative* and jointly put out by the National Commission on Development and Reform and the State Oceanic Administration. This document suggested several maritime corridors, including one through the Arctic Ocean (Sun, 2018). The real introduction of the Polar Silk Road to a global audience was by a white paper named *China's Arctic Policy*, which was published in 2018 (State Council, 2018). This white paper enumerated three Arctic routes – the Northeast Passage (comprising the NSR), the Northwest Passage (which goes through the Arctic islands of Canada and Alaska), and the Central Passage, also called the Transpolar Sea Route, or TSR (which cuts across the Arctic, passing close to the North Pole). China sent expeditions to ascertain all three routes, the only country known to have officially done so (Business Standard, 2021). As with the other BRI corridors, China does not specify the route of the PSR. However, the TSR is still not reliably open to navigation due to sea ice. The Northwest Passage goes through waters controlled by the USA and Canada, neither of which currently have a good relationship with China, negating the Chinese requirements for a trade route that would be protected from possible interference by China's adversaries. That leaves the Northeast Passage, overlapping with the Northern Sea Route, as the only available route for the PSR for the foreseeable future. The connection is strengthened by the shared projects between Russia and China.

The PSR is seen as an alternative to the MSR, so it is necessary to study the drawbacks of the MSR to understand the value of the PSR. The principal drawback of the MSR is the existence of several chokepoints along the route, such as the Strait of Malacca, and the Bab-el-Mandeb and the Suez Canal on either end of the Red Sea. For traffic continuing to Northern Europe, the Strait of Gibraltar also counts. Should any of these chokepoints be sealed off to Chinese shipping by an adversarial power, it would strongly affect trade between China and its European partners or cut China off from its major sources of energy and other commodities. Chinese ships would have to consider alternative and much longer routes, whether through the various straits through Indonesia or possibly around Australia, the Cape route around Africa, or even a route through the Western Hemisphere. Compared to these, the PSR would be much shorter, as seen above. Of such chokepoints, the Malacca Strait is the most critical for China, as it is not only the gateway for Chinese exports throughout the Eurasia and Africa but also the main route for imports of hydrocarbons from its major suppliers in the Middle East and Africa. The very existence of the MSR is vulnerable to adversaries, giving the alternatives – such as the SREB and the PSR – a strategic dimension by default. To avoid becoming over-reliant on this route, the PSR (as well as the SREB) was developed as a key function of the BRI. The cultivation of Russia as a supplier of hydrocarbons is important for the same reason, as developed above. The PSR, just as the NSR, promises to deliver these commodities while bypassing these vulnerable areas, as well as diversifying their source from China's traditional suppliers. The chokepoints – namely, the Malacca Strait and the Bab-el-Mandeb – are also vulnerable to attacks by pirates which flare up every few years. In comparison, the PSR and NSR have no such risks. However, the PSR is not devoid of chokepoints – the Bering Strait lies off the coast of Alaska, and the route passes near Japan, putting it within reach of China's rivals.

Chinese Goals and Russian Reactions

The main objective of China in the Arctic is thus to ensure that the regional routes, to the extent that they are or will potentially be navigable, are available for use to shipping of the non-Arctic countries, namely, China itself. The same demand applies to access to the natural resource wealth of the region – most importantly oil and natural gas, but also other commodities and even fisheries. An auxiliary goal, which can also serve as a means to accomplish the main goals, is to maintain a scientific presence in the Arctic, which is developed below. The importance of the PSR for China's political leadership was showcased by the inclusion of the route in the draft of the Chinese 14th 5-year plan for 2021–2025, as well as being announced among the long-term objectives until 2035 (Business Standard, 2021). China's interest in the Arctic was shown in its bid to gain a seat on the Arctic Council, of which it became an observer in 2013. This Council, formed in 1996 by countries bordering the Arctic region (Canada, Denmark, Finland, Iceland, Norway, Russia, Sweden, the USA), is a platform for Arctic cooperation in science, environmental protection, and the economy.

China defines itself as a near-Arctic power (State Council, 2018), due to its interests in the Arctic as a transportation corridor and as a source of energy and other mineral commodities, but also due to its capabilities in fulfilling these interests

– through the allocation of capital, the development and utilization of icebreakers and icebreaking cargo ships, its ability to undertake scientific research in the region, and more. It would therefore like to be involved in managing regional affairs and in drawing up the rules that govern conduct in the region. China is somewhat at odds with the full members of the council, given they can assert certain sovereign rights and special privileges over parts of the region, such as jurisdictional and economic rights. By contrast, China sees the Arctic and its resources as a common heritage of all mankind – and China, as the most populous nation on the planet, represents a large enough portion of mankind that it should be represented, as stated by Chinese Rear Admiral Yin Zhuo in 2010 (Zoltai, 2018). This contributed to a suspicious attitude of Russia (and other Arctic powers) towards China at the start of the decade (Sun, 2018). Russia had to look past its suspicions after 2014, when its economic problems forced it to turn to China for investment capital, but the other Arctic powers remain cool to Chinese attempts to play a larger role in the governance of the Arctic, though they benefit economically from the Chinese presence. However, by becoming an observer in the Arctic Council, China had to recognize the interests of the full members. This is explicitly stated in the 2018 White Paper on Arctic policy, namely, that "China respects the sovereign rights of Arctic States over oil, gas and mineral resources in the areas subject to their jurisdiction in accordance with international law, and respects the interests and concerns of residents in the region" (State Council, 2018).

In any case, at least in the present time and circumstances, Chinese interests in the Arctic would be better served by not provoking the full members of the council on the issue of sovereignty due to its weak foothold in the region and the advisability of cultivating allies among the Arctic powers. Such a conciliatory stance is most relevant with regard to Russia, because of all the joint projects the two countries are undertaking, not only in the Arctic. China stands to benefit having Russia as an ally, not only for the reason of gaining access to Russia's natural resources, as developed above, but also to avail itself of Russia's experience and to benefit from the permanent Russian presence in the region as a country bordering the Arctic, such as in the case of using Russian ports and infrastructure, or rescue capabilities in case they are needed. Last but not least, having Russia as an ally in the region would be beneficial in any dispute with the USA, Canada, or the European Arctic powers with which China is often at odds in other areas of global policy. As in other areas of the world, China's economic rise has the Arctic powers worried. There are fears that economic expansion may be followed by a military presence in the Arctic (Reuters, 2018). China vehemently denies such plans, yet it would still be prudent for it to cultivate allies in the region to mitigate any actions by adversaries to limit or counter the Chinese presence in the Arctic, especially if the region becomes more important to global trade. It might well happen that the same strategic logic as faced by the Maritime Silk Road in the South China Sea, the Indian Ocean, and other seas to the south of Asia will begin to develop in the Arctic. In such a scenario, the PSR would be just as vulnerable as the MSR, a situation which could be avoided by a close partnership with Russia. In this regard, the two countries can build upon existing partnerships and institutions such as the Shanghai Cooperation Organization (SCO).

As for the stance of Russia towards China's attempts to place its investment projects in the Arctic within the scope of its BRI, this has been quite favorable so far. The Russian policymakers recognize that Russia on its own does not have the necessary amount of capital to develop the NSR to reach the potential that they have set for it (Goble, 2019a). Still, there is a fear that if China is holding the purse strings, it could become the dominant member of the partnership, allocating funds to serve its interests rather than those of Russia's development. A major sticking point between the two countries is the issue of sovereignty in the Arctic. As described above, Russia claims sovereignty of a sizeable portion of the Arctic beyond its coastline, while China insists that the Arctic belong to all of humanity and thus to all countries. This is a direct challenge to Russia's claims. At the moment, China must respect Russian claims to sovereignty, since the routes and deposits of commodities closely hug the Russian Arctic coast, but this leverage of Russia will weaken as more of the sea ice melts and more of the Arctic is exposed and made available for transport and commodity exploitation, beyond the claims of Russia. The most interesting question related to this issue is whether Russia could return to its pre-2014 unfriendly attitude towards Chinese efforts to become an Arctic power itself and make common cause with the other Arctic powers, most notably the USA and Canada, to counter Chinese efforts to internationalize the Arctic (Goble, 2019b). That seems unlikely, given the current state of the relationship between Russia and the Western powers, with Russia seeing China as a useful partner in the Arctic and on other issues of international relations and preferring a stronger Chinese presence in the Arctic to an American one (Goble, 2020). However, a continued rise in the power and assertiveness of China may result in a rethinking of positions by the various other great powers (Woody, 2020).

Apart from lacking the money, Russia also does not have the manpower for the crewing of the tanker ships it wants to utilize on the route to transport the extracted and processed hydrocarbons. As stated by Paul Goble for the Eurasian Daily Monitor, "there simply are not enough experienced Russian sailors and officers to man the ships Moscow wants to make use of. Under Russian law, the officers of ships sailing under the Russian flag must be Russian citizens, have experience in sailing in Arctic waters, and also be knowledgeable about ships carrying liquefied natural gas (LNG), an increasingly important cargo on the route" (Goble, 2018). This means that Russia will have to rely on foreign vessels and shipping companies for the transport of the region's commodities. This gives another edge to China, which is rapidly developing its Arctic commercial fleet. As noted by Zoltai (2018), "the Chinese state-owned shipping company COSCO plans to launch 6 cargo vessels on the Northern Sea Route for commercial transportation. China has become one of the leading Arctic shipping countries, and COSCO considers itself a leading shipping company on the Northern Sea Route." In 2019, companies from the two countries signed an accord in St. Petersburg which made "China an increasingly important supplier of liquefied natural gas (LGN) (sic) carriers and other transit ships for this route" (Goble, 2019a).

Yet this penetration by Chinese shipping is not limited to the transport of energy commodities. A similar situation may arise with icebreakers, as will be detailed in the following part of this chapter. There has also been talk in China of using its own vessels to sail up the Russian rivers that flow into the Arctic Sea to buy Russian grain. Though Russia could refuse permission, the question is whether Russian political leaders can afford to refuse China. According to Goble, the melting of the Arctic sea ice was more of a curse than a blessing for Russia, as it opened up the Arctic to countries (mainly China) which did not have Arctic capabilities on par with Russia (Goble, 2019b).

Official declarations of Russian political leaders have also been supportive, whether or not the support is genuine or pragmatic. The invitation by the former Deputy Prime Minister Rogozin has already been noted above. It must be mentioned that Russia is an integral part of two of the land-based corridors of the SREB, specifically the China-Mongolia-Russia Corridor and the New Eurasian Land Bridge. The various proposed infrastructure projects of the NSR were thought to be a good fit for mutual cooperation with China within the BRI, due to their role in increasing regional connectivity, facilitating the transport of natural resources to China, and the general good relations between the two countries. At a summit in Moscow in the same year, the presidents of Russia and China "signed a joint declaration, specifying the Polar Silk Road and the Northern Sea Route as the main venue of their cooperation" (Zoltai, 2018). Also, in May 2019, the First Deputy Prime Minister of Russia, Maksim Akimov, stated "that the NSR can become a second, water-based 'silk road' and would only bring the two countries closer together" (Goble, 2019a). He also suggested the merging of the Northern Sea Route with the Maritime Silk Road, which would create a shipping route enveloping the entire landmass of Eurasia and connecting Europe to both Northeast and Southeast Asia (Ankov, 2019).

China as an Independent Arctic Player

However, following the unveiling of the PSR, an element of rivalry has been injected into mutual relations concerning the region. The PSR represents China's own alternative vision for Arctic connectivity, in which China plays the main role instead of being reliant on the regional powers, notably Russia itself. One of the principal ways this ambition is demonstrated is by China's efforts to decrease its dependence on Russian icebreakers, specifically by constructing its own fleet of icebreaking vessels. China acquired its first research vessel with icebreaking capabilities – the Xue Long (Snow Dragon) – in 1993 from Ukraine (Nilsen, 2017); this was the ship that China used to traverse all three potential passages through the Arctic (Zoltai, 2018). The country constructed its second icebreaker – Xue Long 2–20 years later in 2019 (Staalesen, 2020). This time, however, it used its own shipbuilding capabilities, demonstrating its complete independence in building and utilizing icebreakers. This is in addition to a couple of lesser icebreakers intended for the Bohai and Yellow Seas surrounding China (Goldstein, 2020).

Russia's uneasiness over these icebreakers and the importance it attaches to its own icebreaking capabilities are well illustrated by the rhetoric surrounding the launching of Russia's newest nuclear icebreaker – the Arktika – in September 2020. This ship, planned as the first in a new class of such vessels, is heralded as the largest and most powerful icebreaker, and it is seen as a symbol of Russian sovereignty (or at least its control) over the NSR. The governor of St. Petersburg, Georgiy Poltavchenko, said that the new vessel will corroborate Russian sovereignty over the northern territories of the Arctic Ocean (Odynova, 2020). There are also plans for two more Arktika-class icebreakers and a new and even larger and more powerful class, the 22220 class (Goldstein, 2020). The nuclear icebreakers are a substantial leap forward from the previous diesel-powered icebreakers, such as Ilya Muromets, which entered service in 2017. The Ilya Muromets was the first icebreaker built in Russia in 40 years (TASS, 2018). This shows how Russia, like China, has recently invested greatly in its icebreaking capabilities. Therefore, the new icebreakers are not merely a symbol, but they are a practical tool of Russian control over the region – at least so long as Russia dominates the global icebreaker capability and can mandate and charge ship of other nations to use these vessels in their Arctic crossings. The Barents Observer portal elucidates that "Nuclear power has the advantage of long range and massive power, compared with diesel-electric or gas-powered engines that will have to either carry a lot of fuel or make many fuel stops during a voyage. Along the Northern Sea Route, or in the High Arctic, infrastructure and fuel deposits are rare" (Nilsen, 2019). This is why nuclear-powered icebreakers represent the pinnacle of icebreaker shipbuilding.

The question can be posed as to if – with the development of ports, fuel deposits, and other infrastructure in the Arctic – nuclear-powered vessels will lose this advantage. The downside of such vessels is the cost of their production and maintenance, as well as safety issues with the nuclear reactors and fuel. This is why in the past, the USA, Germany, and Japan abandoned their nuclear icebreaker programs. This means that Russia is currently the only country which possesses such vessels. However, this may change, as China is developing its own nuclear-powered icebreaker similar to the Arktika (Nilsen, 2019). A nuclear-powered icebreaker capable of long-term autonomous operation would be an important step for an independent Chinese Arctic policy. One might wonder whether it is worth it for China to enter into a sort of "icebreaker arms race" with Russia, considering the drawbacks of nuclear-powered vessels and of antagonizing its principal Arctic partner, but China has other reasons to do so. Zhang Lucking, an expert from the Science and Technology Commission of China National Nuclear Corporation, claims that the current diesel-powered generation of Chinese icebreakers is not sufficient for some polar areas under extreme weather conditions (Nilsen, 2016). Other reasons include the fact that the nuclear reactors could also be used for other types of vessels, whether civilian cargo ships (Zhong, 2016) or nuclear aircraft carriers or other military vessels (Nilsen, 2018). Building such icebreakers is also a prestigious technological achievement, bolstering China's soft power, and it is something that a powerful economy like China can afford.

Another way in which China is staking its own independent claim as a major player in the Arctic is through the development of its research bases and other scientific enterprises in the region. The country has sent out over 30 polar expeditions since 1984, and China's first Arctic research base – the Yellow River Station – was established already back in 2004. It must be said that China has legitimate scientific concerns in the Arctic, beyond merely propping up its claim as a near-Arctic power. The melting of the sea ice that promises to open the Arctic shipping passages also contribute to rising sea levels, which will also affect Chinese settlements and agriculture. Chinese researchers estimate that 20 million people will have to be relocated from low-lying coastal areas (Zoltai, 2018).

Another Chinese research and development project in the Arctic (with direct relevance to regional shipping) concerns the BeiDou satellite navigation system, China's analogue to the American GPS, the Russian Glonass, or the EU's Galileo. In 2016, 2017, and 2019, China's North Sea Navigation Support Center conducted a test to determine short-wave communication guarantee capabilities along the Northeast Passage. According to Zhao Fenglong, an official at the center, the purpose of the tests was to "study the BeiDou system's signal coverage, positioning accuracy and short message communication capability in the Arctic region, in a bid to provide data support for BeiDou to join the Global Maritime Distress and Safety System" (Si, 2019). The North Sea Navigation Support Center itself was only established in 2012, just as the NSR beginning to develop more rapidly because of rapidly melting Arctic sea ice.

That the Chinese vision for its PSR transcends cooperation with Russia in the NSR is seen in Chinese scientific collaboration projects with other countries apart from Russia. One of these is a joint plan with Finland to construct the China-Finland Monitoring and Research Center for the Arctic, inaugurated in October 2018. The center, located in Sodankylä in the North of Finland, "will collect, process and share satellite data, providing an open international platform to support climate research, environmental monitoring and Arctic navigation" (Chun, 2020). The center is part of the Digital Silk Road and China's Arctic policy within the BRI. China has also contracted Finnish shipbuilders to design reinforced cargo ships that would not need icebreaker escorts (Bennett, 2013). All this demonstrates the importance of Finland for China's Arctic ambitions, even though Finland does not have a coastline on the Arctic Sea.

Another project is located in the Northern Icelandic city of Karholl, where both countries set up the China-Iceland Arctic Science Observatory, also in October 2018. It tracks climate and environmental changes in the region, which, as with the Finnish project, could provide useful information for the PSR. This observatory is part of a broader collaboration between China and Iceland since 2012, when they signed a memorandum of understanding and a deal on cooperation in the Arctic (Chun, 2020). The relationship between them also encompasses shipping, with Iceland interested in building a transshipment port on its territory (Bennett, 2013). In general, China has stepped up its investment in all the Arctic countries. Finland became the recipient of the fifth largest foreign capital investment by China, at a level of $8.43 billion between the years of 2000 and 2016. Norway, where Chinese investment in its oil and gas deposits has already been noted, received 7 billion USD in Chinese investment over the same period. There is also increased Chinese foreign capital investment in Sweden, Iceland, Greenland (part of Denmark), and even

Alaska and Canada. The interest shown by China in all these Arctic countries demonstrates Chinese attempts to cultivate partners in the Arctic Council apart from Russia. Still, none of the members of the council (apart from Russia) are members of the BRI (Zoltai, 2018), and therefore they remain outside the scope of the formalization of the PSR.

While in practical terms this does not matter due to the vagueness of the PSR and BRI, it demonstrates that these countries want to keep their distance from China. This is partly due to the standard reasons that countries cite when expressing skepticism of the BRI and its corridors, such as China using its economic leverage to gain favorable conditions (contracts awarded to Chinese companies without a public tender, the imposition of Chinese workers on projects in partner countries, etc.) and the suspicion that China uses debt-trap diplomacy to obtain even more leverage over its partners, but partly also for political reasons, given that all these Arctic countries identify as free market capitalist countries and liberal democracies, and their elites are ideologically opposed to the brand of politics and economics espoused by China. That leaves Russia, which is politically and economically much closer to China, for the reasons explained previously.

In practice, most of the joint Russian-Chinese projects along the Arctic coast mentioned above fit into both initiatives. The NSR also fits into the goals of the BRI from the Chinese point of view – to diversify the transport routes for Chinese import and exports to construct and renovate the necessary transport infrastructure that would facilitate the development of these routes and to serve as an investment opportunity for Chinese capital in aid of these goals. To illustrate this complementarity between the two concepts, at the second BRI forum in April 2019, President Putin suggested that the NSR and the PSR could be merged into one unified route, to increase their competitiveness and global reach (ANI, 2019). This suggestion echoed a similar sentiment expressed 4 years earlier by Deputy Prime Minister Rogozin (Arctic Portal, 2015). Such a merger would be beneficial for both Russia and China. In the case of the NSR, it would become part of a larger network of routes connecting diverse foreign markets, which would make it more economically viable than if it remained merely a route for the export of Russian oil and natural gas. In the case of the PSR, China would be able to rely on Russian infrastructure and mitigate any possible rivalry with a major Arctic power. However, there is a question how both countries would share control of the route. Russia would probably have an interest to keep the focus of the route on the variant that would go through Russian coastal waters, to the detriment of variants using more open waters such as the Transpolar Sea Route, so as to make use of infrastructure on the Russian Arctic Sea coast. This would give Russia additional leverage, e.g., in mandating the use of icebreaker escorts even for vessels which ostensibly would have icebreaking capability. On the other hand, the increased possibility of traversing the NSR without the assistance of an icebreaker should increase the interest of other countries and shipping companies in this route which could be exploited by Russia as a selling point to divert shipping to the NSR (Nanda, 2021). While the question on which corridor to focus on is not currently an issue since the route along the Russian coast is the only feasible one at present, it is questionable whether China would see things the same way in a few years or decades if and when the Transpolar Sea Route becomes available for navigation.

Conclusions

China has a growing interest in the Arctic, because of the natural resource wealth of the region, and the potential to diversify its shipping routes. Despite this, the routes and natural resource deposits are still under the control of the Arctic states, meaning that China needs to cultivate good relations with them. The partnership between China and Russia on developing the Northern Sea Route is the most developed, due to the geopolitical situation and the needs and interests of both countries. Russia lacks the investment capital to finance all the projects along the NSR, which China can provide easily and willingly. For its part, China hopes to exploit the natural resource wealth of the Arctic, much of which is located on Russian territory. However, the vision of China for the Arctic goes beyond cooperation with Russia. The Chinese see their Arctic investment and plans to develop shipping in the region in the context of their Belt and Road Initiative, under the banner of the Polar Silk Road. In practice, the infrastructure projects of the NSR and PSR are largely complementary. Russian political leaders have even called for a merger of the two initiatives. Much of the positive reaction of Russian leaders is due to the fact that Russia is dependent on Chinese financing, meaning that they cannot easily afford to alienate their Chinese partner. However, this fact and several others make the Russians uneasy over this partnership and Chinese ambitions. The consensus is that Russia risks becoming a junior partner to China and will be forced to cede practical control over the Arctic routes to the Chinese. China is making Russia nervous with its investment in technology such as icebreakers and by its increased presence in the Arctic – so far mostly economic and scientific, but with a possibility to expand this into a more direct challenge to Russian interests and influence. This nervousness ties into broader fears of Chinese domination in the Russian Far East. The interests of both countries are often said to be too divergent to make future cooperation tenable.

The main issue between the two countries is whether the Arctic powers have sovereignty over the Arctic routes, as claimed by Russia (and the other Arctic states), or whether they should be internationalized, as supported by China (and several other countries interested in shipping across the Arctic). A broad international acceptance of Russian sovereignty would give Russia the power to enforce its rules over the NSR, such as the mandate to use Russian icebreakers, levying fees and tolls, or the interdiction of rivals from the route. China, by contrast, claims that the Arctic is a common heritage of all humankind, so no country can stake territorial claims over it. As noted above, China, which defines itself as a near-Arctic power because of its interests in the region, is developing Arctic technologies and would stand to lose out if it was blocked from exploiting the Arctic resources by the Arctic powers. Russia and China are therefore diametrically opposed on this question, and it is often cited as a reason why their mutual partnership is destined to fail, but this question may be resolved by the continued melting of the Arctic ice cap. This would mean that an increasingly larger part of the Arctic Ocean beyond the claim of the Arctic states would become available to international shipping. Countries would keep sovereignty over the infrastructure on their territory, over their territorial waters, and possibly beyond, whether extending to their Exclusive Economic Zones or any other agreed-upon boundary, but the Transpolar Sea Route and possibly other corridors should remain unclaimed by any country. In any case, divergent interests are nothing new in international partnerships. Furthermore, the Arctic is only one area of Russian-Chinese cooperation, and in the present constellation of international relations, both countries stand to gain much more than they lose from mutual cooperation. This is especially relevant in the Arctic, where both countries need each other to develop their initiatives in the region – Russia providing the territory, resources, and technological know-how and China providing the capital.

In the end, both countries will have to compromise. China will have to recognize that until the Transpolar Sea Route opens up, Russia is very much the dominant player along the Northeast Passage and all the initiatives it comprises. Russia's territory borders the Arctic, it is best able to project power in the region, and it has a head start in the necessary technology in extracting and transporting cargo through the regional routes. The situation will remain like this for as long as the maritime routes need to stay close to the Russian coast, use icebreakers on which Russia has a near monopoly, and rely on infrastructure which is located on sovereign Russian territory. Still, Russia needs to recognize that it cannot hold on to its privileged position with moves such as mandating the use of Russian icebreakers and preventing other countries from using the route of claiming sovereignty over waters far beyond the accepted limits. It will have to recognize that with the shrinking of the Arctic ice cap and the opening of new routes, it will no longer be able to dictate the conditions of transit for vessels, companies, and countries who choose to avoid the coastal waters and infrastructure of Russia. Russia will have to use its head start in technology and know-how to innovate and stay ahead of the competition. A close partnership with China and being able to count on Chinese investment could be the best way to accomplish this.

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Landline Rail Connectivity of Russia in the Arctic Zone

Development Under the Belt and Road Initiative

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Contents

Abstract

The chapter undertakes a landline rail infrastructural perspective on the development of transit potential of Russia given the Chinese Belt and Road Initiative. Being in the concept of transit economy, the authors introduce and empirically test the idea of bridging the Northern Sea Route with the Belt and Road Initiative under the umbrella of the Ice Silk Road.

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Introduction

Most of the current infrastructure and investment projects implemented in the Arctic are aimed at transport and logistics support for the development and export of raw materials of this mineral-rich region: foremost, new gas fields, the production of liquified natural gas (LNG), ensuring the export of nonferrous metals, and creating an infrastructure for developing circumpolar coal deposits. Thus, the raw material nature of the Russian economy is consolidated and strengthened.

The most important task is to diversify the national production structure to increase its technological level. An effective way to solve this problem is to create innovative and industrial zones of trade routes in the Arctic region both in the direction of “East-West,” and, more promisingly, “North-South.”

At the same time, the Chinese Belt and Road initiative, announced in 2013, should become an integral part of the Cold Silk Road in the Russian segment of the Arctic. However, it is worth saying that it is going to be only a part of both state projects and areas of activity of organizational and institutional entities operating on the principles of interstate-corporate partnership (ICP).

Interstate-corporate partnership (ICP) is a set of forms of medium- and long-term interaction between states and corporations (a large transnational corporation), as well as interstate and intercorporate cooperation in initiating, preparing, and implementing, firstly, global and macro-regional infrastructure and integration projects and forming innovative and industrial belts of trade routes to ensure sustainable economic development and income generation.

The transit significance of large innovative infrastructure projects in the Arctic provides for developing a transit economy in the regions of the Far North, using the following:

- Its favorable economic and geographical position
- Synergy with export-import flows and domestic cargo transportation, primarily within the framework of northern import
- The production, technological, organizational, and institutional competitive advantages of Russia, which has a centuries-old experience in developing the Far North, especially active during the Soviet years

The formation of an effective transport and transit system (TTS) in the Russian segment of the Arctic will allow not only to add revenues from transit cargo traffic to the ones from export raw materials operations using a synergetic effect, but also to increase the volume of added value created in the region through the formation of innovative and industrial belts of trade routes of the twenty-first century, as well as the development of a high-tech transit economy in the region.

The transit economy (TE) is a national economic and evolutionary-institutional system in which particular revenues constitute a significant part of income and provide one of the foundations of the well-being of authorities, economic entities, employees, the population, interstate entities, state entities, corporate entities, city-states, and nodal points of the world economy. These revenues (monetary and otherwise) from the passage through the territory of countries and controlled zones of cargo and passenger flows include vehicles, energy, water, information resources, and other types of export of transport; it also includes tourist services, the reexport of goods, the functioning of related industries, the provision of services to ensure transit, and the development of innovative-industrial belts of trade routes (Tsvetkov et al., 2014, 2019; Zoidov et al., 2017; Pak, 2018).

TE provides:

- Effective functioning of the TTS on the principles of the international production cooperation
- Transfer of advanced equipment, high technologies, and advanced competencies along with innovative and industrial belts of trade routes
- The transition from traditional and outdated production facilities to new production facilities of the future technological structure, an increase in added value
- Implementation of the political-economic, military-strategic, socio-cultural, scientific-educational, and environmental interests of the subjects of the fuel and energy complex, taking into account ensuring their economic, epidemiological, and climatic security (Zoidov & Medkov, 2021)

For Russia, the most promising idea is to establish close socioeconomic, industrial, technological, scientific, and technical relations along the “North-South” line, as well as to develop trade routes and their innovative and industrial belts.

Speaking about the transport and communication development of the Russian Arctic in the new reality, the main emphasis of innovative and industrial development should be placed on developing and scaling the technologies for using renewable energy sources (RES) and the large-scale decarbonization of individual transportation, production processes, and the world economy as a whole.

The decarbonization of the world economy consists not only in reducing the carbon intensity of the gross domestic product (GDP), but also in changing the entire global configuration of energy flows. The development of modern trade routes should contribute to the formation of a “green economy,” and there are all the necessary conditions for this.

The accelerated energy transition in Europe should change the configuration of coal transportation in favor of the states of the Asia-Pacific region (APAC). The ever-increasing export shipments of coal and wood, 75% of which are sent to the Far East, create obstacles to the development of transit cargo transportation in the East-West direction along the Trans-Siberian Railway (Transsib) (Pak, 2020, 2021).

Decarbonization of the world economy implies the formation and development of modern trade routes based on the principles of the IPC (international production cooperation), as an instrument of concerted efforts of states and corporations to increase the sustainability of economic development and ensure environmental safety.

We need a system of sustainable “green energy” or something close to it: nuclear (mobile nuclear power plants), LNG gas, tidal, geothermal. All these opportunities are embedded in the prospects for the development of the Russian Arctic.

A key role in the decarbonization of the world economy should be played by rail transport, which generates minimal carbon dioxide emissions compared to other types of transport; therefore, increasing its share in the structure of transport services can help to reduce the emission of harmful substances.

In the railway transport itself, the structure of traction is changing in favor of expanding the use of environmentally friendly engines: electric traction (with the production of electric energy from renewable energy sources), gas turbine, hydrogen, etc.

An important environmental activity of JSC “Russian Railways,” which uses the competitive advantages of Russia, is the transition from diesel fuel to natural gas. This involves the creation of mainline gas turbine locomotives (GT1h) and shunting gas-thermal locomotives (TEM19h) powered by LNG, used in a test mode in the north of the country.

Since the market efficiency of alternative types of traction is still low, one has to implement innovative projects within a large corporate structure and their state support on the principles of the ICP.

This is all the more relevant because the Arctic became the most militarized region in the world during the Cold War (Shirokorad, 2017); so, when it ended, this vast territory was largely deprived of military funding, which reduced the conditionally fixed costs of cargo transportation and supported the coastal infrastructure.

The institutional foundations of corporate construction and public-private partnership are considered in the works of Yyeskom (2015), North (1997), Kleyner (2016), etc.

The high-tech development of land transport is discussed in detail in the works of Lapidus (2020), who points to “the three main ‘pillars’ of transport of the future: magnetic levitation, vacuum levitation, and hydrogen transport elements. This is the future of the systematic development of railway transport and the consolidation of its leading positions in the transport market in conditions of harmonization with nature and public demand” (Lapidus, 2020).

The basics of decarbonization of the world economy are described in Rifkin Dzh (2014). As noted, “fossil fuels-coal, oil, and natural gas are an elite source of energy, for the simple reason that they are found only in certain places” (Rifkin Dzh, 2014). The refusal or a significant reduction in the consumption of fossil fuels, whose deposits are located in a limited number of places, should primarily reduce the volume of energy transportation and fuel consumption.

The chapter hypothesizes that, when forming the fuel and energy complex in the Russian segment of the Arctic, land transport communications should be developed within the framework of a particular organizational and institutional structure – the Eurasian Transport and Transit Company (ETTC) – for creating transport and transit systems and innovative and industrial belts of trade routes of the twenty-first century, acting on the principles of the ICP.

The research uses the methods of evolutionary and institutional theory, the theory of production and technological balance of the economy and technical and economic structures, the system paradigm, a world system analysis, and expert and analytical assessments.

Problems and Prospects of Sustainable Development of Transit Cargo Transportation Along the Northern Sea Route (NSR)

The difficulties of performing regular transit traffic along the Northern Sea Route (NSR) are associated with severe natural and climatic conditions, the lack of necessary swimming facilities and coastal infrastructure, difficulties in reloading reinforced ice-class vessels, etc.

According to the First Deputy General Director and Director of the Development and International Business Unit of Rosatom, who performs the functions of a single transport and logistics operator of the NSR, K. Komarov, the transit along the "Cold Silk Road" is minimal, but the NSR may well become one of the Eurasian transport corridors. The goal of the operator company is to start carrying out one-time trial transit traffic by 2025 and pass about 30 million tons of transit cargo by 2030.

The government of the Sakhalin Region, which expects to become one of the entry points of the NSR in the east of the country through the development of the port of Korsakov, believes that in the future the volume of all types of transportation along the Arctic route will reach 80–100 million tons per year, whereas in 2020 they amounted to 33 million tons. According to the forecasts of the Analytical Center under the Government of the Russian Federation, the potential volume of container transportation through the NSR will amount to 1.8 million TEU by 2030 (Belov, 2021b).

The need for expensive icebreaking. Transportation along the NSR is impossible without icebreaking escort and marine support vessels, even in the conditions of global warming. Icebreaking is, on average, needed from 76 days in the port of Vanino to 193 days in the port of Magadan. The effect of these and other factors causes the following: the "Cold Silk Road" is not excluded from the Russian TFC.

The use of nuclear icebreakers creates acceptable navigation in the western sector of the NSR all-year round, and up to 6–7 months in its eastern part. Today, the icebreaker fleet serving the movement of ships along the NSR consists of five units, while five more icebreakers are under construction.

It is believed that at least five powerful nuclear icebreakers should provide year-round piloting of vessels transporting hydrocarbon raw materials from the fields of the Yamal and Gydan peninsulas and the shelf of the Kara Sea to the markets of the European Union and the Asia-Pacific region. (The vice president of the International Academy of Transport V. Zbarashchenko points out that "we should use Arctic-class vessels in the Arctic, they are unprofitable on all other lines. They are distinguished by high fuel consumption, huge investments in construction. For example, a cargo ship without an ice cover costs $165 million, and a ship with the same deadweight, but of an ice-class, costs $365 million already. It turns out to be an economic absurdity: this 'monster' goes 600 miles along the Kara Sea, breaks two-meter ice, and then it goes 2 thousand miles to Rotterdam on clean water.")

The need for the development of port infrastructure. Arctic ports along the NSR, except for the port of Dudinka, need major repairs, reconstruction, and dredging to receive large-tonnage vessels.

Most ports need developing and improving facilities for receiving and disposing of household waste, eliminating emergency oil spills, and strengthening ship repair capacities.

The development of economic activity in the Arctic required creating new seaports and terminals on the Arctic coast (Varandey, Sabetta, Kharasaway), as well as reconstructing and expanding the Murmansk transport hub.

The task of ensuring the safety of passing the route. Ensuring the safety of navigation on the NSR requires the construction of a rescue and service fleet, the creation of rescue coordination centers in ports, and the bases of emergency rescue vessels in the ports of Tiksi, Pevek, Dixon, and Providence.

Regular depth measurements on the NSR route, cartographic survey, measures for navigation, and hydrographic support – ensuring reliable navigation and hydrographic equipment – are necessary.

Environmental risks and the need to implement environmental measures. The multiple increase in the transportation of hydrocarbon raw materials through the NSR determines the special urgency of the tasks of protecting the environment from pollution and possible accidents. At the same time, one should also take into account that the oil extracted on the Arctic shelf, as well as ship fuel, belong to heavy grades, the spill and leakage of which causes even more significant environmental damage.

Difficulties in obtaining income from transit cargo transportation. According to the Deputy Director of the Department of State Policy in the field of Sea and River Transport of the Russian Ministry of Transport V. Klyueva, "most of the NSR is an area where the navigation is free under international law, which means that the Russian Federation does not have exclusive rights to navigation on the NSR. In this sense, a direct comparison of the NSR with the Suez or Panama Canal does not seem quite correct. The Suez and Panama Canals charge a fee for passage, while one cannot introduce a fee for the passage of a vessel through the NSR" (Larionova, 2016b).

A merchant ship going from Europe to the countries of the Asia-Pacific region does not enter Russian ports and does not use this infrastructure. This contradicts the very nature of high-speed transit cargo transportation. Nevertheless, Russia has to fulfil its obligations to conduct emergency rescue operations, provide cartographic and hydrometeorological information, etc.

On the other hand, active shipping will increase the demand for navigation and hydrographic services. The services for transit vessels include bunkering ships, supplying them with fresh water, performing emergency and urgent repairs and diving inspections, and keeping crew change points.

The provision of these services assumes that the ports located on the NSR should be open for foreign ships to call. In this case, the NSR should compete with the Southern Sea Route.

Using the NSR as a transit artery requires solving the problem of reducing the cost of passage and icebreaking along this route, taking into account unfavorable natural and climatic conditions, as well as the need for construction, reconstruction, and resumption of the navigation infrastructure.

The key point is to minimize the conditionally fixed costs for each vessel's passage. It is necessary to achieve a synergistic effect in the form of:

- Wide use of the NSR to ensure the implementation of projects for the extraction of hydrocarbons and other minerals in the Arctic, on the shelves of the Arctic seas or in the basins of the largest Siberian rivers
- The involvement of the NSR in ensuring domestic transportation, primarily of northern import
- A multiple increase in the efficiency of transit cargo transportation

The organization of a global container sea service on the NSR is hindered by the need to transfer containers to ice-class vessels at the initial and final points of the "Cold Silk Road."

Global warming opens up new transport and communication opportunities and prospects for the integrated development of the northern territories permanently. At the same time, climate changes may reduce the transport and transit potential of the Russian Arctic, in particular, enabling higher-latitude routes across the Arctic Ocean that run outside the Russian territorial waters for transporting transit cargo.

The greenhouse effect causes the melting of permafrost, waterlogging of territories in the Far North, river flooding, and catastrophic flooding, which requires implementing costly water transport projects within the framework of creating the Global Eurasia.

The most promising in terms of decarbonizing export-import, transit, and local transportation is the use of gas-turbine gas carriers, oil tankers, container ships, and bulk carriers, as well as powerful nuclear icebreakers.

The formation and development of the innovation and industrial belt of the NSR as a trade route of the twenty-first century should include, primarily, the activities of Russian shipbuilding companies producing high-ice-class container ships using LNG, based on domestic developments and/or having a high degree of localization (at least 80%).

Decarbonization is an integral part of the most promising innovation and investment projects and development programs. For example, within the framework of cooperation between Norway, Russia, Finland, and Sweden in the Barents/the Euro-Arctic Transport Area (BEATA), a draft joint transport plan for the Barents region has been agreed upon, which includes:

- Getting knowledge about transport flows and transport needs in the Barents region
- Creating conditions for reducing greenhouse gas emissions
- Improving road and maritime safety and creating a more efficient transport system
- Reducing the number of obstacles when crossing the border

Problems of Implementing the Mechanism of Public-Private Partnership (PPP) when Implementing the Transport and Transit Potential of the Northern Sea Route (NSR) and Constructing the Northern Latitudinal Passage (NLP)

Investment projects based on PPP principles are, as a rule, implemented as a result of the lobbying activities of influential entrepreneurs and business groups. The Yamal LNG project and related projects aimed at developing NSR, the construction of the NLP, and the port of Sabetta were no exception.

The Sabetta port was constructed on the principles of PPP. The federal budget financed the creation of sea and approach channels, an operational water area, a navigation and traffic control system. Investors of Yamal LNG (the Russian company Novatek, the French Total, the Chinese National Oil Corporation, and the Silk Road Fund) built berths, warehouses, and engineering networks.

The USX project is considered as an alternative direction for the export of oil and gas complex products. The Ob-Korotchayevo railway (707 km) will connect the Sverdlovsk and Northern railways.

The Karskaya-Sabetta non-public railway is a continuation in the north of the Obskaya-Bovanenkovo line built by Gazprom and is part of the Yamal LNG project.

The construction of the NLP will also be financed on the principles of PPP at the expense of the federal and regional budgets, the investment program of JSC "Russian Railways," loans, and project participants' funds. The preliminary cost of the construction is estimated at ₽190 billion.

One of its advantages is the minimum currency risk: sand, crushed stone, rails, sleepers, locomotive traction, and other components are produced in Russia. The hardest part of the NLP is the bridge over the Ob River in the Salekhard area. The estimated cost of the construction is ₽70 billion. The expected payback period is 35 years. This money was invested in a federal target program, the financing of which can be postponed to a later date (RZD-Partner, 2015).

The transit value of the project is as follows:

1. The port of Sabetta can become one of the key elements of the NSR coastal infrastructure.
2. The export of Yamal LNG products using ice-class gas carriers and the delivery of materials and other cargo necessary for the construction and operation of production facilities extracting and liquefying natural gas and the operation of the port will reduce the conditionally fixed costs for the passage of one vessel, including transit traffic.
3. NLP can turn the port of Sabetta into an additional point of entry and exit of transit cargo to the NSR by using the Russian railway network, and can also ensure the reliability of the port's operation and stability in the adjacent territory.

A critical analysis of the mentioned "additional entry points" is required to evaluate the intensity of competition between different modes of transport. Besides, the difficulty of implementing the PPP mechanism in the implementation of large-scale infrastructure projects must be pointed out, as must the incomprehensibility and opacity of the guaranteed income institution.

For example, the new Karskaya-Sabetta railway should be constructed and maintained using PPP. The law adopted in the first reading by the Legislative Assembly of the Yamal-Nenets Autonomous Okrug assumes that the project should be implemented entirely at the expense of the investor's own and borrowed funds, and imposes obligations on the government of the Yamal-Nenets Autonomous Okrug to pay a minimum guaranteed income to a private investor until 2048.

At the same time, the income indicator is determined either by the tender documentation or by an agreement. The bill states that the district can issue tax benefits to the partner, as well as provide "funds from the district budget under the law."

According to the forecast of M. Ivanova, the head of the Railway Transport Department of the Yamal-Nenets Autonomous District Government, the new railway in the direction of the port of Sabetta should carry cargo traffic of such intensity that the region will not have to pay compensation to the investor for the minimum guaranteed income during its operation.

However, experts are accurate with their statements when predicting the size of the cargo base of the new transport communication, the prospects for its payback and, therefore, the supposition that the government should pay compensation to the investor for using the railway (Verevkina, 2015).

The revenues of the Yamal-Nenets Autonomous District allow the region to act as a co-investor of the project, and not as a guarantor of the income that the company implementing the project receives. Besides, the Karskaya-Sabetta railway is not included in the programs for the development of transport infrastructure in Russia, coordinated by the Russian Ministry of Transport and JSC "Russian Railways."

The construction of the Northern Latitudinal Passage can also be financed with an infrastructure loan. It is a large oil and gas field in the north of the Ural Federal District (Bovanenkovskoye, Novoportovskoye, Urengoyskoye, Yamburgskoye, Zapolyarnoye, Yuzhno-Russian, etc.) that can be the resource base for the existing or planned enterprises in the area of NLP.

According to the vice president of the Center for Strategic Research (CSR) Gorovaya (2021), the NLP project can become a framework for further development of industry and transport infrastructure. For example, the creation of the Ob-Bovanenkovo-Sabetta railway corridor (NLP-2) with access to the NSR routes should become an important element of the development of promising areas of Yamal, which will allow reducing logistics costs both for the import of development cargo and the export of liquid hydrocarbons (Gorovaya, 2021).

It should be emphasized that **the NLP would be a much greater transit value if it were a part of the Circumpolar Railway stretching to Chukotka and partially duplicating the NSR as a land transport artery**.

Current Projects for the Creation of Land Transport and Communication Infrastructure in the Regions of the Far North

In 2019, PJSC Gazprom Neft, LLC Gazpromtrans, LLC Gazprom Invest, and JSC Russian Railways signed a cooperation agreement on the railway transportation of liquid hydrocarbons from the Kharasaveysky and Bovanenkovsky fields. The agreement provides for the development of a logistics strategy for the transportation of gas condensate and liquefied hydrocarbons by the Ob-Bovanenkovo-Karskaya railway and further to the port of Ust-Luga on the Baltic Sea coast. JSC "Russian Railways" would provide cargo transportation from the Ob station of the Northern Road to the

Luzhskaya station of the Oktyabrskaya Road, and empty tanks would be transported in the opposite direction.

A project is being developed for the construction of a 420 km all-season highway in the Far North, which would provide communication between Chukotka and a new port under construction in the Arctic. The project is needed since the navigation period in Chukotka lasts no more than 3 months, and land communication is hampered by the melting of permafrost in the summer.

One cannot organize the rhythmic export of products from the Baim Mining and Processing Plant under construction in Chukotka with a capacity of 70 million tons of ore (containing significant reserves of copper, gold, silver, and molybdenum) per year without developing a powerful land infrastructure.

The year-round cargo transportation will help to reduce the dependence of some Arctic territories of the Russian Federation on northern deliveries carried out in winter. It is assumed that an all-season transport communication should be carried out on the principles of PPP with the participation of the Chukotka government (50% of the costs) and concessionaires. Besides, a floating nuclear power plant with a capacity of more than 400 MW (Solntsev, 2021) should be built jointly with Rosatom.

There is also a project of a separate Verkhnezeisk-Chumikan railway with a length of 486 km and a carrying capacity of 30 million tons, which does not converge with the Baikal-Amur Mainline. The project was initiated by the "A-Property" company, which counts on priority for passing cargo flows on the existing railways at the Eastern Landfill within 5 years. The project will be implemented at the expense of the operating flow, with funds coming from and attracted by the A-Property company. It is not expected to receive subsidies and other state support measures.

Today, the implementation of the infrastructure and industrial project "Ural Industrial-Ural Polar" has been stopped. It was initially planned to open traffic on the Polunochnoye-Ob railway (Sverdlovsk Region – Yamalo-Nenetsky Autonomous District, Labytnangi, respectively), with a length of 850 km in 2013, as well as to build new power plants.

The purpose of the NLP-1 project was to ensure the economic accessibility and feasibility of involving the mineral resources of the Circumpolar and Polar Urals in industrial production by creating a transport corridor along the eastern slope of the Ural Mountains.

The reasons for the failure of the project were the following:

1. The financial and economic crisis
2. Difficult natural and climatic conditions
3. Loss of competence in the implementation of significant infrastructure projects
4. Constantly increasing the cost of the project
5. Lack of sufficient budget funding: the amount of ₽6.5 billion was allocated only for the development of project documentation
6. The relatively low economic significance of the project

According to O. Vasilyeva, "the project, on the one hand, will allow developing the railway network of the Russian Federation and thereby increasing transport accessibility, unloading the existing infrastructure that operates at the limit of carrying capacity, as well as attracting an additional cargo base to railway transport. On the other hand, the construction of the Northern Latitudinal Passage will create new jobs and replenish the budgets of the federal and regional levels" (Aleshina, 2021). There is nothing new here.

JSC "Korporatsiya Razvitiya" became the successor of the "Ural Industrial-Ural Polar" investment project. However, there are no plans to make budget investments in the company's activities, and its funds do not allow it to implement ambitious projects such as the NLP, so in the near future, there will be a question of terminating its activities (Aleshina, 2021).

In general, when implementing projects of innovative and infrastructural support for Russian interests in the Arctic, nonstandard solutions, approaches, and schemes should be used, primarily in the organizational and institutional field.

Problems and Prospects of Forming the International Transport Corridor "North-South" in the East of Russia

The congestion problems of the Trans-Siberian Railway and the Baikal-Amur Mainline require the creation of alternative routes. The growing number of coal shipments, especially during the summer track repairs and construction works, can and does create congestion and traffic restrictions on the Trans-Siberian Railway, which increases the competitive advantages of alternative Euro-Asian routes, including those in the North-South direction.

These circumstances, as well as the need to implement huge costs, arise due to our skeptical attitude to the idea of building a new Trans-Siberian railway for organizing high-speed passenger traffic and the movement of accelerated container trains. The construction of the cargo-forming North Siberian Railway (Sevsib), which can be carried out with the broad involvement of private investors to divert the main cargo flows to it, is considered to be more promising.

Sevsib should be built in conjunction with the modernization of BAM and the construction of the White Sea-Komi Republic-Ural railway (Belkomur). At the same time, the released capacity of the Trans-Siberian Railway could be used to expand container transit (Pak, 2020; Pak & Sarkisov, 2014).

Considering the spatial development of Russia, the strategic task here is to combine the growth of production and export supplies of natural resources with an increase in the transit opportunities of Siberia, the Far East, and the Far North. This should replace raw material rent with transport and transit rent as the main source of income for the population and the budget.

Almost all major transport infrastructure development projects in Eastern Siberia and the Far East provide us with a unique opportunity to combine the growth of raw material production with the formation of a significant transport and transit potential of the territory which lays the basis of its sustainable development (Petrakova, 2011).

Thus, the construction of the Berkakit-Tommot-Yakutsk railway (802.6 km) within the framework of the "Integrated Development of Southern Yakutia" project should dramatically increase the transport and transit potential of Russia, if the mainline along the Yakutsk-Magadan-Anadyr-Uelen route is extended through the Bering Strait to Alaska.

The formation of the Europe-America railway corridor through the territory of Russia requires enormous costs, due to the significant distances, the need to build a double-track line, difficult natural and climatic conditions, and the high cost of laying a tunnel under the Bering Strait. Therefore, only a global multinational corporation operating on the principles of the ICP can implement this project.

The development of transit transportation should reduce the share of conditionally fixed costs in the cost of transport services, which is especially important as most Russian regions are remote from external borders.

On the other hand, the development of transit requires categorizing the existing railways by types of cargo and constructing the special lines for the transportation of bulk cargo and the high-speed transportation of passengers, containers, and light cargo.

The development of the railway and innovative segments of the Russian TTS in the Far North should have a synergistic effect and lead to effectively solving the following tasks.

Synergy with the provision of northern delivery to the regions of the Republic of Yakutia. A large-scale reconstruction of the transport and warehouse infrastructure of the northern delivery, created during the USSR, is urgent; this requires the modernization and maintenance of the coastal zone of the NSR and the rivers flowing into the Arctic seas (in particular, the organization of dredging operations in the deltas of the Lena, Yana, Indigirka, and Kolyma rivers), alongside the reconstruction of existing and construction of new distribution centers, oil depots, aviation sites used for the rapid delivery of fresh products, etc.

As noted by the Deputy Chairman of the State Assembly of Yakutia V. Gubarev, state funding for the northern import of food to the Arctic zone of the region is only 10% of what is needed. As a result, if in the 1990s 600 t of potatoes were imported to one district of the republic, today 500 t are imported to all 13 Arctic regions of the republic (Belov, 2021b).

At the same time, there is a lack of containers for storing vegetables and perishable products, and the depreciation of the existing warehouses of the main supplier enterprise of JSC "Yakutopttorg," built back in the 1960s, exceeds 50%, or 80% for individual objects.

The large debt burden does not allow the regional authorities to participate in financing and crediting the projects of modernization and creation of a modern transport and warehouse infrastructure of the northern delivery. Either the participation of the federal authorities (which we doubt) or the active involvement of an interstate corporate structure developing transit cargo transportation is required.

All 13 Arctic regions of Yakutia depend on the NSR, which includes not only marine waters but also points in the lower reaches of northern rivers, where ships are unloaded and loaded.

The projected cargo turnover of the sea terminal in Naib should be 18 million tons per year by 2032 under the basic scenario or 23 million tons under the intensive one. Every year, about 2.7 million tons of cargo are imported to the republic during the navigation period, while more than 300,000 t are transported using the NSR. The advantage of building a new port 112 km from Tiksi is that it is going to be protected from driving winds and deep water (Belov, 2021a).

After the Berkakit (Neryungri-cargo)-Tommot-Nizhny Bestyakh railway was completed, the connection between the Trans-Siberian Railway, BAM, and the NSR became more reliable and shorter, which, in connection with the modernization projects of the Arctic ports, goes far beyond the regional framework.

JSC "AK "Yakutian Railways"" provides passenger and cargo transportation to Yakutsk via a multimodal system including road, river, and rail transport within the framework of regional and corporate cooperation. Today, the Nizhny Bestyakh-Tynda passenger train runs daily, including cars of nonstop communication Nizhny Bestyakh-Vladivostok, Nizhny Bestyakh-Blagoveshchensk, and Nizhny Bestyakh-Irkutsk.

Development of "green energy." Implementing three projects of low-tonnage production for liquefying natural gas, with the participation of JSC "Sakhatrans-neftegaz," PJSC "Yakut Fuel and Energy Company," and JSC "Atomenergomash," is being considered in Yakutia.

The republic already has a gas liquefaction complex in the Megino-Kangalassky district, whose products are also supplied to the railways of Yakutia. The lack of stationary energy on the 364 km-long Tommot-Kerdem section made it necessary to build energy centers based on Capstone microturbine power plants with LNG storage complexes at several railway stations.

Ensuring the integrity of the Russian Federation. The importance of Yakutia for ensuring the integrity of the Russian Federation is due to the possible activation of pan-Turkist aspirations initiated by expansionist sentiments in Turkey.

One of the projects to increase the transit potential of the Republic of Sakha-Yakutia included in the "Strategy of socio-economic development of the Far East and the Baikal Region for the period up to 2025" is the Mohe (China)-Jalinda-Skovorodino-Tynda-Neryungri-Yakutsk-Northern Sea Route ports of the Russian North and Western Europe. This route is an example of the cargo flows along the North-South route in the east of Russia and the northern "transport corner" of global communications between Asia and Europe.

The key conditions for its successful functioning include:

1. The construction of the Berkakit-Tommot-Yakutsk railway (with a bridge over the Lena River)
2. The development of transport communication along the NSR

The total length of the Berkakit (Neryungri-cargo)-Tommot-Nizhny Bestyakh line is 802.6 km. In 2004, the Berkakit-Aldan-Tommot section was opened by JSC Yakutian Railways. In 2014, the Tommot-Nizhny Bestyakh section (the right bank of the Lena opposite Yakutsk) was built. Its length is 439 km.

The bridge across the Lena River should allow:

(a) The creation of a large transport hub in Yakutsk, including the railway, the Yakutsk River Port, the Kolyma, Vilyu, and Amga highways
(b) A connection between the Trans-Siberian, Baikal-Amur mainlines and the NSR

The advantages of the project include:

1. The availability of specialized contractors with experience in the construction of large bridges, who are free after they have completed the transport infrastructure facilities for the APEC summit in Vladivostok and the Crimean Bridge. However, their lobbying opportunities are aimed at implementing the project of a bridge (tunnel) connecting the Khabarovsk Kray with Sakhalin. This project may also have a transit value, but only in the case of connecting Sakhalin with the Japanese islands.
2. The potential increase in the workload of railways served by JSC "Yakutian Railways," which allows minimizing the conditionally fixed costs per unit of transit cargo. The shift of northern import to railway transport and the growth of mineral extraction in Southern and Central Yakutia should contribute to the growth of cargo turnover.

However, this project may be affected by the decision to build only a road bridge and then postponing the construction to a later date. Moreover, the railway delivering goods to the capital of the republic is idle due to the lack of a ferry (ice and ferry) in spring.

3. The work carried out by the railway to reduce operating costs by replacing outdated diesel locomotive engines with modernized General Electric engines. GE Transportation company produces diesel locomotives adapted to the conditions of the Far North, especially for the Yakutian Railways.
4. Wide distribution and development of water cargo transportation in the region. When the Berkakit-Tommot-Nizhny Bestyakh railway and the bridge crossing to Yakutsk are completed, the functioning of the river fleet will significantly change. As part of the northern delivery, the volume of traffic on the port of Osetrovo-port of Yakutsk route will fall due to the transfer of cargo to rail transport, and the number of empty flights up the Lena will decrease due to a reduced flight turnover by 4000 km.

On the other hand, the role of river transport in cargo transportation along the Lower Lena should increase, especially in the case of attracting transit cargo to the NSR.

The weak points of the route include:

1. The limited functionality of the bridge crossing over the Lena River in the Yakutsk region with a length of 3 km, which, as it was assumed, should be carried out only by road at the initial stage, and may be then supplemented by a railway tier.
2. The need to attract investments to the construction of the bridge on a concession basis due to a lack of state budget funds.
3. That the State may provide funding for the construction of even a road bridge later, due to the need to support the restoration and development of the Crimean transport infrastructure.

4. The independent status of JSC "SC 'Yakutian Railways'", the need for additional approvals and contracts.
5. Personnel problems of the company, which is experiencing an acute shortage in this regard, both when it comes to retaining old employees and attracting new specialists. The lack of a developed housing market in Yakutia is superimposed on personnel problems, which requires the company to implement its construction program.
6. Complex natural, climatic, and engineering-geological conditions of the highway, and the need to introduce an automatic geocryological monitoring system on the Berkakit-Tommot-Nizhny Bestyakh (Yakutsk) railway, which prevents possible deformations of the earth bed on permafrost soils.
7. The multimodal nature of the route, the need for numerous transshipment operations: when switching from the Chinese standard railway track to the Russian standard track, in the port of Yakutsk to river vessels, at the mouth of the Lena to sea vessels.
8. Limited navigation period on the Lena River and the NSR, the need for icebreaking and regular hydraulic engineering measures.

The main disadvantage is that the prospects for realizing the transport and transit potential of the Republic of Sakha-Yakutia have been postponed indefinitely.

The most promising project, both in terms of realizing the transport and transit potential of Russia in general and Yakutia in particular, and in terms of a comprehensive solution to the problems of developing the Arctic territories, is the project of extending the railway line to Chukotka and further through the Bering Strait to North America.

Thus, a "transport cross" (the intersection of the East-West and North-South directions) could appear in Eastern Siberia, connecting Europe, Asia, and America.

As part of the implementation of the Belt and Road Initiative, the Chinese authorities may consider participating in the construction of a high-speed railway connecting Asia with America through the territory of Russia. The railway will start in the north-eastern part of China, then pass through Russia to Chukotka and through the tunnel under the Bering Strait to Alaska, Canada, and the United States. The length of the mainline should be about 13,000 km, the length of the underwater tunnel 200 km, the average speed of the train 354 km/h (RT na russkom, 2014).

Organizing High-speed Communication Based on the Principles of Creating "Maglev," an Open Magnetic-Levitation Transport System

A prominent specialist in the field of transportation processes, Lapidus notes: "An important direction of the development of Russian railway transport as the basis of an efficient, environmentally friendly, sustainable land transport system is the development of high-speed Eurasian transport communication using modern innovative technologies of high-speed rail transport and the geographical advantages of the Eurasian continental space of Russia" (Lapidus, 2020).

New technologies for moving high-value goods should play a key role in the development of ultra-high-speed transportation. The safety requirements for cargo transportation makes it possible to use the potential high-speed capabilities to the full. The development of ultra-high-speed cargo transportation affects people to a lesser extent since city bypasses are built (Tsvetkov et al., 2020).

Russia lacks a domestic demand for intercity ultra-high-speed transportation of both passengers and cargo, which would pay for the creation of large magnetic levitation systems. One should go beyond the boundaries of the state borders and embed Maglev technologies in the TFC of Global Eurasia, primarily in the North-South direction.

At the same time, it should be taken into account that transit as such, the export of transport services is not much different from that of raw materials if the components of transit transport are imported. This is especially true for the China-Russia-Europe direction.

Maglev technologies of the transportation process make the infrastructure and rolling stock low maintenance (due to reduced wear and tear), which adds another argument in favor of concentrating income from transit transportation in a large corporate structure, and not in the form of paying for the services of track workers and service depot employees.

In Russia, there is a significant research reserve for the development, implementation, and dissemination of transportation technologies based on the principles of magnetic levitation in conditions of natural atmospheric pressure.

It seems that for the transport communication China-Russia, the tunnel under the Bering Strait-Alaska should be built in the form of an open magnetic levitation system. This will give it an exceptional competitive advantage compared to sea transport on the routes between East Asian countries and North American countries (China-USA).

China is interested in paying back the scientific and technical developments and expanding the sales of magnetic levitation transport products, including within the framework of implementing the Belt and Road Initiative. At the same time, the participation of the Silk Road Fund in the Yamal-LNG project only strengthens the raw material orientation of the Russian economy.

Organizational and Institutional Design of the Railway Component of the Transport and Transit System in the Arctic Region

The corporate organizational and institutional design of the North-South transport direction was outlined when discussing the proposals for the formation and functioning of a Single Transport and Logistics Operator of the Northern Sea Route (NSR) as a PPP company.

At that time, experts pointed out that the system of fleet operation on the NSR is fragmented – organized and managed by public and private companies following their current interests. Under these conditions, more than 300 economic entities conducting economic activities in the Arctic were interested in the effective functioning of the NSR management system by creating a special structure responsible for organizing cargo transportation along the highway (Larionova, 2016b).

According to the General Director of JSC "Korporatsiya Razvitiya Kamchatskogo Kraya" N. Pegin, "a single state body should deal with the development of the Northern Sea Route, and for managing the national Arctic transport line, it is necessary to determine a single operator whose competence would be all issues related to forming cargo traffic, organizing and implementing cargo transportation along this route. Moreover, this single operator should be considered as a joint comprehensive project of the state and business, where the state creates appropriate conditions and guarantees for carriers so that it is more profitable for them to carry not through the Suez or Panama Canals, but through the NSR" (Larionova, 2016b).

The unified state body or the Single Transport and Logistics Operator, which should be engaged in the management and development of the NSR, is designed to solve the following issues:

- Forming the cargo flow
- Organizing and implementing cargo transportation along this route
- Issuing permits for passage through the NSR
- Providing navigation services in the Arctic
- maintaining rescue, navigation, and communication equipment
- Organizing northern delivery, implementing cargo transportation under state orders, optimizing transport and logistics processes
- Increasing the competitive advantages of the NSR in comparison with the sea routes through the Suez or Panama Canals
- Improving the legal norms regulating navigation in the waters of the NSR
- Organizing public-private partnership

The Single Transport and Logistics Operator should be concerned and organize the construction and operation of container terminals in Murmansk and Petropavlovsk-Kamchatsky as transshipment hub ports at the points of entry and exit of the NSR in order to exclude using expensive ships of the reinforced ice class in warm seas (Vice-president of the International Academy of Transport).

When determining the status of this company, one should adjust the anti-monopoly legislation. It should be a naturally monopolistic quasi-state structure.

The Single Transport and Logistics Operator should be a single monopolist, because the separation of export transportation of hydrocarbon raw materials from that of other types of cargo (import, transit, northern delivery, military-strategic, etc.) will inevitably increase the conditionally fixed costs for the transportation of non-primary cargo units and, consequently, decrease the competitiveness of the NSR in the world market of transport services.

By itself, year-round cargo transportation should increase the market in the cargo base of the NSR.

However, in summer, there is no need for icebreaking. Besides, there are several routes of the NSR, passing both in the coastal zone (characterized by the absence of ice in the summer) and in the open ocean with a more complex situation all year round. The FSUE "Atomflot" (as the NSR Single Transport and Logistics Operator) should be interested in the longest possible use of icebreakers, which may be economically unjustified.

All other things being equal, though, a larger number of icebreakers increases the flexibility in terms of drawing up the routing grid following the requirements of shippers. The growth of the icebreaker fleet may allow it to make a year-round schedule of movement along the NSR, which will further increase the attractiveness of this route.

In the meantime, according to the former general director of FSUE "Atomflot" V. Ruksha, "in the conditions of employment of nuclear icebreakers on national hydrocarbon projects, FSUE Atomflot does not have free capacities for icebreaking support of transit flights if they are performed on the spot principle" (RZD-Partner, 2016).

In general, the experts proposed various options for the management system of the NSR in the form of creating a corporation, a holding company, or a transarctic information and logistics platform as an economic space in the Arctic region for network cooperation and interaction of companies, state and international organizations (Larionova, 2016a).

We suggest that Single Transport and Logistics Operator NSR should have the organizational form of a PPP company and solve three following main tasks:

1. State management of the NSR development, proposals for improving the institutional environment in the field of Arctic transit cargo transportation
2. Increasing the income from the export of transport services, by attracting, first of all, transit flows of high-yield goods to the NSR
3. Organizing navigation on the highway and providing the related services

Summing up the various proposals, we can conclude that a joint comprehensive project of the state and business of the Single Transport and Logistics Operator NSR should perform the following specific functions:

- Form and consolidate cargo flows, both at the points of entry to the NSR and along the entire Arctic route; organize cargo transportation for state needs
- Coordinate the interests and the activities of numerous public and private companies conducting economic activities in the Arctic
- Provide various services to ships during the Arctic navigation
- Coordinate icebreaking escort of vessels; interact with the Federal State Unitary Enterprise "Atomflot"
- Take part in the creation of an icebreaking flotilla, the number and total capacity of which would be critical to ensure year-round navigation throughout the NSR and attract transit cargo flows

- Take part in the construction and operation of nodal ports (hubs) at the points of entry and exit of the NSR, in particular, in the creation of a large hub in the east of the country – a place of concentration of LNG and container cargo, taking into account the fact that it is impractical to use ice-class vessels in warm seas when transporting hydrocarbon raw materials, import and transit cargo
- Introduce trunk-feeder transport systems, where shuttle ships that operate year-round on the NSR route, at the endpoints of the route, carry out cargo transshipment to larger vessels

In our opinion, the NSR Single Transport and Logistics Operator was supposed to manage not only shipping but also transportation on the railways suitable for ports on the NSR: the railway under construction to the port of Sabbeta, the entire Northern Latitudinal Passage (NLP), that can be built by Belkomur and the railway from Yakutsk to the Bering Strait.

The NSR Single Transport and Logistics Operator should be engaged in the development and inclusion of water transport routes along the largest Siberian rivers in the ITC. It is the Single Transport and Logistics Operator of the NSR that should become a source and an active participant in creating institutes, involving legal norms regulating navigation in the waters of the NSR and along adjacent transport communications.

When developing the transit economy in Russia, it should be taken into account that, by analogy with the Black Sea Straits, Russia does not charge for the passage of ships through the NSR. However, the Russian state governing bodies have the right to establish rules for the passage of ships to protect the environment: the collection of insurance fees that go directly to the budget, fees for icebreaking, the use of infrastructure, etc.

When developing transit traffic along the NSR, one should also listen to considerations of a military-strategic nature. In particular, the United States plans to increase its capabilities in the Arctic in order to ensure freedom of navigation and flight in this region. In turn, the Russian Federation can create zones where navigation will be limited for military and strategic reasons.

The organizational and institutional support for the creation of the railway component of the Russian TFC in the Arctic region can be most effectively and efficiently handled by the ETTC, operating on the principles of the ICP. The directions of interstate-corporate partnership in the development of the transit economy in the Russian Arctic are shown in Table 1.

Conclusions

In order to develop transit traffic on the territory of Russia and the EAEU countries, the authors put forward a new concept of attracting additional cargo traffic using a linking system. In this case, we are talking about the mutual linking of the companies from non-Arctic states (primarily Chinese) in the development of natural resources in the Arctic and on the shelf of the Arctic seas with the involvement of an additional

Table 1 Directions of interstate-corporate partnership in the development of the transit economy in the Russian Arctic

No	Directions of development of fuel and energy complex in the Russian Arctic	Organizational and managerial efforts of the ETTC within the framework of the ICP
1.	Development and maintenance of the NSR	Formation and increase of the cargo base of transit traffic along the NSR, organization of the work of nodal ports at the initial and final points of transport communication, navigation, hydrographic and emergency rescue support of navigation
2.	Development and production of innovative types of rolling stock	Financing and organization of production of the icebreaker fleet, ice-class container ships, specialized railway traction rolling stock for the regions of the Far North
3.	Construction of transport and communication systems based on the principles of magnetic levitation	Purchase and localization of rolling stock production for the open Maglev system, activation of domestic R&D in this area, use of accumulated potential, the energy supply of the system based on renewable energy sources.
4.	Optimization of transport and logistics processes in the Russian Arctic	Implementation of the synergistic effect of export-import, domestic (northern import) and transit cargo transportation in the Arctic. Avoiding excessive competition between modes of transport.
5.	Linking the development of the TTS of Russia in the Far North with the Initiative of the People's Republic of China "Belt and Road"	The development of the "Cold Silk Road," the realization of China's interest in laying the China-Russia-America transport communication
6.	Decarbonization of the world economy, ensuring the environmental safety of the functioning of the TTS in the Arctic	Increasing the role of the railway and magnetic levitation transport in Arctic transit transportation, introducing new types of traction on a non-carbon and low-carbon basis with a minimum amount of harmful emissions
7.	Resolving interstate contradictions	Activation of internal corporate mechanisms for solving international problems, the formation and development of supranational management structures

Source: Compiled by the authors

cargo base for transit traffic along the Northern Sea Route (NSR) and land communications along the routes Asia-Russia-Europe, Asia-Russia-America, and Europe-Russia-America.

Such a link is of exceptional importance for developing the North-South transport direction in the east of Russia: it will reduce the payback period for the new railway infrastructure in Yakutia and the future combined automobile and railway bridge over the Lena River.

The evolutionary prospects of the China-Russia (Yakutia)–Northern Sea Route–European ports route do not look very promising, primarily due to the multimodal nature of transportation, delays in financing and difficulties in building railway bridge crossings across the Lena River in the Yakutsk area, and the limited period of sea and river navigation.

The development of corporate mechanisms for overcoming interstate contradictions will allow implementing global infrastructure projects in the conditions of new normality. The first will be the long-cherished idea of connecting Asia and North America by rail through a tunnel under the Bering Strait. The importance of this innovative infrastructure project can hardly be overestimated: its impact will be multifaceted both for interstate trade relations and solving urgent domestic problems.

A large-scale program of decarbonization of transport work on global trade routes, implemented on the principles of the ICP, should be established. The development of land transport infrastructure in the Arctic should contribute to the decarbonization of the world economy. This will also be facilitated by the creation of innovative and industrial belts of land and sea trade routes in the Far North.

The Russian Arctic, as a source of LNG, is an ideal place for the use of mobile traction with a gas engine drive. LNG trains can be effectively used on the Ob-Karskaya section of the Northern Latitudinal Route for testing the technologies for the use of alternative fuels and forming the image of Gazprom and Russian Railways as environmentally responsible global companies (Pletnov, 2021).

The urgent task is to create an infrastructure for producing LNG, constructing specialized filling complexes, developing the schemes for the delivery of hydrogen to filling stations, and reducing the cost of hydrogen fuel.

The development of land communications in the Arctic requires efforts to combat waterlogging and the melting of permafrost as a result of global warming and river flooding.

All in all, a critical assessment of the NSR transit significance in modern conditions is required. The organizer and the main recipient of income from the transit cargo transportation through the NSR should be the ETTC, acting as a transport and logistics operator that has its own fleet of container ships of reinforced ice class and other types of vessels.

One should transfer the railway infrastructure in Yakutia, which has transit significance, to the ownership of the ETTC. Besides, the ETTC should become a company that would be engaged in determining the place and role of the NSR in the development of transit transportation, would act as a customer and buyer of ice-class container ships, and would be engaged in promoting this service on the global transportation services market.

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Gas Turbine Units as Development Drivers for the Northern Sea Route

Leyla E. Mamedova, Maria E. Gogolukhina, and Taras M. Grigorev

Contents

Abstract

The chapter concerns organizational and economic aspects of transferring energetic facilities of Northern Sea Route shore territories and marine technical objects to gas and turbine units. Gas and turbine units are traditionally used in the sphere of energetics, oil and gas extraction and pumping, and military shipbuilding. Nowadays there are suggested variants of conversion and applying the aforementioned technologies to the sphere of civil shipbuilding as well, which is especially interesting for the Northern Sea Route development. The increase in using gas and turbine units will lead to an increase of repair inquiries. The relevance and economic efficiency of applying additive technologies for renovating the blades of gas and turbine units were studied. The role of the mass application of gas and turbine units within the Northern Sea Route zone as of development driver of the territory was defined. This will definitely improve energy supply, infrastructure, and ecological situation in the region, as well as increasing the level of localization, the Russian presence, and the research potential of the Arctic zone at large.

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Keywords

Gas and turbine units · Development driver · Northern Sea Route · Additive technologies · Marine technics · Shipbuilding · Innovation · Energetics

Introduction

Mastering the Northern Sea Route (NSR) and the Arctic Zone of the Russian Federation as a whole is one of the priority areas for the development of the national economy. According to the "Strategy for the development of the Arctic zone of the Russian Federation and ensuring national security for the period up to 2035," approved by Presidential Decree No. 645 of 26.10.2020, the measures have been developed to ensure the socio-economic development of the Arctic zone, with an emphasis on creating new and expanding the existing infrastructure of the NSR (Decree of the President of the Russian Federation, 2020).

The following main problems associated with this special territory can be identified:

1. *Uneven development.* Even though, along the entire water area, there are more than 70 transshipment bases and ports in the NSR, there are not so many cities and settlements with a developed infrastructure due to the difficult climatic conditions. Less than half of the 14 major ports operate year-round. The population density in these territories is extremely low due to poor transport infrastructure, the lack of a state support system for northern delivery, high unemployment, lower life quality compared to the average in Russia, and a high proportion of emergency housing stock with a low rate of commissioning of new housing.
2. *Low investments in the environment.* Investors are interested only in increasing the extraction of minerals rather than maintaining the ecological balance of the developed territories. For example, the main energy carrier is environmentally harmful diesel fuel used both for generating electricity in coastal territories and ship power plants (SPP).
3. *The growing conflict potential of the Arctic.* Increasing the interest of the neighbors of the Russian Federation in the north in extracting minerals and marine biological resources in the Arctic region implies the constant development of the Russian Navy in these territories.

We propose using various socio-economic and technological tools to cope with the tasks formulated in the Strategy for the Development of the Arctic zone and to maintain the region's economic growth. From the technological point of view, we have to change the existing nature of investment towards the development of high-tech industries. One of the actual directions of technological development is the transfer of ships, marine equipment facilities, port and coast development, and the urban economy to the use of gas turbine unit (GTU).

Literature Review

The problems of NSR development have been widely discussed in scientific works of the last decade. The importance of the Arctic region for the Russian economy is emphasized in the works of Biryukov and Savostova (2021), Faykov and Faykova (2021), Ivanova (2021), Popova and Sizova (2020), Soun (2017), Voronina (2019), Smirnov (2021), Efremov and Palkina (2020), and Marchenko et al. (2021). All the authors note the high potential the region has for the Russian Federation from the points of view of resources, transport, and defense, which is associated with the increased interest of the state in the development of the infrastructure of the NSR.

One of the interesting solutions for increasing the region's energy supply is using gas turbine generators. The work of gas turbine engines is described by Chumakov (2012) and Uvarov (2012). Gas turbine generators meet the requirements of the Arctic region. Gas turbine generators will inevitably need repair. The issues of repairing engine parts using additive technologies are considered in detail in the works of Turichin et al. (2016) and Turichin et al. (2018). An important effect of the use of gas turbine generators will be the decarbonization of the region's economy. The works of Rakhimov (2019), Mayorova (2015), Selenchuk (2016), Glebova and Daneeva (2021), and others deal with this topic.

Problem Statement

Russia (especially the Arctic zone) is facing a shortage of energy, which indicates the demand for gas-fired turbine power plants. The Russian market is and will be determined by the orders of state structures and state-owned enterprises, as well as private enterprises that had problems participating in the formation of energy-generating capacities. The Russian Ministry of Defense and the Ministry of Emergency Situations are also potential consumers of gas turbine power plants. They can be easily moved and work in severe climatic conditions, so they can be used in deployment sites of military units, when eliminating the consequences of major accidents or natural and man-made disasters, for organizing temporary schemes for supplying electricity and heat, or for creating energy supply infrastructure when developing new territories.

Power plants can be installed in areas remote from sources of gas and other types of hydrocarbon fuels, where municipal facilities, energy-intensive enterprises, and large facilities under construction that require transport infrastructure (which is necessary for organizing LNG supply) will undoubtedly make up a large segment of consumers in the NSR zone.

Historically, gas turbine generators were developed for use in military and civil aircraft construction. Aviation gas turbine engines are characterized by extremely reduced overall dimensions and weight. Subsequently, the gas turbine generator technology was widely used in shipbuilding, energy production, and the oil and gas industry. Such gas turbine generators, on the contrary, are large-sized units, but they are lighter and simpler in comparison with diesel power plants.

The small-sized gas turbine generators used in the aircraft industry, including microturbine generators, allow us to apply this technology more widely in various industries (Neftegaz.RU, 2014). Such compact microturbine systems have several technical and environmental advantages that are relevant for use in the Arctic zone and which solve the problems of developing these territories identified above:

- The ability to work in low-temperature conditions.
- Combined power and heat generation (cogeneration).
- The absence of chimneys, which minimizes the volume of harmful emissions into the environment.
- The utilization of associated petroleum gas (APG), which is a side effect of oil production and generates a significant amount of harmful emissions. Power plants can use APG to generate electricity, which has a very high degree of efficiency.
- They are used for autonomous power supply.
- They can work on most of the industrial fuels, such as natural gas, propane, diesel fuel, kerosene, or associated petroleum gas; renewable fuels can also be used: E85, biodiesel, and biogas.

Today, the Russian aviation industry has released significant capacities for producing aircraft and marine turbojet engines, which can be used and converted into energy gas turbine generators. Taking into account these production prerequisites of a noninvestment nature and the identified technical and environmental advantages, the growth in the production and use of gas turbine generators in the Arctic zone will imply certain positive organizational and economic aspects:

- Low installation cost
- Small size, which in some cases allows them to be used in existing premises of power plants
- High maintainability
- Small weight, which greatly facilitates and accelerates the repair work (entire blocks or elements can be replaced)
- High acceleration – the start-up time does not exceed 2 minutes, which is especially important for peak operating modes
- Good adaptability for remote control.

Increasing the technological level of manufacturing and repair of power plants is possible due to the introduction of additive technologies for restoring their components. The development of additive technologies provides a unique opportunity to produce metal products of complex geometric shapes, which cannot be done by traditional methods. Additive technologies allow one to increase the material utilization rate to almost 99 percent and, thereby, reduce the production cost. Additive technologies should improve the functionality of gas turbine engine parts (GTE). This makes it possible to obtain parts not only with complex spatial geometry of the surface but also with the internal structure and organized geometry of cavities, which are extremely difficult to obtain by other methods. In this context, functionality is understood as a unique ratio of strength and weight characteristics, as well as the ability to obtain gradient properties for the mechanical and thermophysical characteristics of parts due to the directional effect of fusion energy and the topology of the fused layers.

Regarding the complex-profile parts, special attention is paid to the nozzle blades of the turbine of the gas turbine generators. The accuracy of manufacturing nozzle blades, determined by a variety of factors (the manufacturing technology used, the accuracy and rigidity of the technological equipment, the equipment fleet used, etc.), must be in the tolerance from −0.15 millimeters to +0.2 millimeters. At the same time, the requirements for the accuracy of manufacturing blades are constantly increasing. The manufacturing technology of turbine nozzle blades can be based on additive technology methods and is designed to solve import substitution issues in the manufacture and repair of complex gas turbine engine parts. This technology will allow piece and small-scale production of new and incoming gas turbine generator parts for repair, which should reduce the cost of repair, shorten the technological cycle, improve the quality of the final product, and avoid the need to supply imported analogues.

To test the repair technology with the use of additive methods, sections of the nozzle blades of the gas turbine engine that are subjected to significant damage in operation and require replacement or expensive restoration during repair are selected. The use of domestically made powder metal compositions should make it possible to choose the optimal technological modes and work out the technology of producing and repairing imported gas turbine generators and gas turbine power plants, using domestic materials, which will become very important in the conditions of import substitution and proactive import substitution.

Current State of Affairs

The main economic advantages of additive manufacturing and repair of gas turbine engine resource parts are manifested due to the organizational and technological flexibility of manufacturing and repairing small batches and single products due to low processing costs. This is relevant in the context of import substitution of power plants' resource parts (nozzle sections, turbine guide devices, burner devices). The components of imported power plants manufactured by additive technologies provide additional benefits to the end-user by reducing the cost, production, and delivery time.

Complex technology of additive manufacturing and repair of gas turbine engine parts is relevant for:

- Gas turbine power plants for civil and industrial purposes, mobile gas turbine power plants
- Gas pumping stations with a gas turbine drive
- Drive turbines for railway and shipping transport
- Turbine equipment

Gas turbines and gas turbine engines by almost all leading companies around the world (Siemens, General Electric, Ansaldo, Mitsubishi, Kawasaki, Solar, MAN, and others) are used in Russia. The number of gas turbine engines delivered is hundreds of units. Their maintenance and repair are carried out, as a rule, by foreign companies and are extremely expensive. The high dependence of the country's electric power industry on the supply of imported equipment and its maintenance threatens the industry's scientific and technological sovereignty.

The main element that requires repair as part of a gas turbine engine is the blade. To assess the effectiveness of the repair of gas turbine engines' blades using additive technologies, let us consider the average annual production program of one of the large Russian enterprises engaged in the repair of gas turbine engines of Russian and foreign production (see Table 1). The article considers gas turbine engines of the Taurus 60 type manufactured by the American company Solar Turbines, Inc. (a subsidiary of Caterpillar, Inc.); German gas turbine engines manufactured by the MAN Group of companies; as well as Russian gas turbine engines of the NK-12ST type manufactured by PJSC Kuznetsov, which is part of JSC UEC.

The input edge of the working blade of a steam turbine is restored using the Russian-developed robotic complex based on the LS-5 ytterbium fiber laser for laser growing. The parts are also fully produced using laser gas-powder surfacing in Russia.

As a single unit of measurement, one engine is accepted for repair, taking into account the average number of blades that fail (see Table 2). To calculate the cost of repairing the blades of one engine, current industry data on material consumption, labor intensity, and overhead costs are used (see Table 3).

To date, the repair of the GTD blades is carried out by replacing worn-out blades with new ones. Thus, to determine the economic effect of introducing a new surfacing technology, we compared the cost of restoring the blade with the cost of a new one (see Table 3). The maximum economic effect (88 percent) is achieved in the case of using foreign gas turbine engines if compared to the Russian ones, since, on the one hand, the number of blades that fail is significantly less, but on the other hand, the constant growth of the euro exchange rate also affects the cost (in ₽) of

Table 1 Planned annual production program for engine repair, units

	2022	2023	2024	2025	2026	**Total**
Taurus 60	3	3	3	3	3	**15**
MAN	1	1	1	1	1	**5**
NK-12ST	6	6	6	6	6	**30**

Source: Compiled by the authors based on the results of implemented projects

Table 2 The average number of GTU blades to be repaired, units

Engine type	Taurus 60	MAN	NK-12ST
Number of blades in the wheel, units	199	178	316
The number of blades in the wheel to be repaired, units	80	93	211
The number of blades in the wheel to be repaired, per cent	40 per cent	52 per cent	67 per cent

Source: Compiled by the authors based on the results of implemented projects

Table 3 Cost and repair of blades of one engine, ₽

Cost item	Taurus 60	MAN	NK-12ST
Pretreatment (cleaning/washing)	4025	4250	10,550
Troubleshooting (visual and measuring control, nondestructive testing)	8050	8500	21,100
Preheat treatment	161,000	170,000	422,000
Mechanical processing (preparation for repair)	8050	8500	21,100
Laser surface coating (salary fund, absorbing)	664,274	545,047	670,715
Final mechanical processing (stripping)	8050	8500	21,100
Troubleshooting (visual and measuring control, nondestructive testing)	241,500	255,000	633,000
Final heat treatment (heat treatment + applying heat-resistant coatings)	36,225	38,250	94,950
Final control (visual and measuring control, penetrant inspection)	8050	8500	21,100
Materials	259,125	262,000	224,700
Special equipment, the cost per piece of the product	99,418	104,975	42,200
Overhead costs	73,255	77,350	192,010
Depreciation	498,661	464,066	89,991
UNIT COST PRICE	2,069,683	1,954,938	2,464,516
Cost of a new blade, ₽	17,121,883	15,934,022	3,089,920
Economic effect, ₽	15,052,200	13,979,084	625,404
Economic effect, per cent	88 per cent	88 per cent	20 per cent

Source: Compiled by the authors based on the results of implemented projects

purchased blades. Repairing the blades of the Russian gas turbine generators using additive technologies also has a 20 percent economic effect, even though the average number of worn parts is significantly higher compared to foreign ones.

Discussion

When switching to the widespread use of gas turbine generators in the NSR zone, one should ensure appropriate operating and repair conditions for these units. The traditional method of repairing the main elements of the gas turbine generator (blades) is an expensive operation since it is associated with replacing them with new ones. The development of additive technologies in the field of restoring gas turbine generator blades should significantly reduce material and labor costs, as well as the speed of repair, significantly reducing the cost of repair and overall operation of gas turbine generators. Taking into account the advantages of using gas turbine generators in the Arctic region discussed in the section “Current State of Affairs,” as well as the increased economic attractiveness of repairs, a large-scale transition to gas turbine generators can become a driver for the development of the entire Arctic zone and, in particular, the North Sea Route.

When speaking at the session of the Russian Energy Week, President Vladimir Putin stressed that remote regions of Russia that are not included in the Unified Energy System (UES) of the Russian Federation are the main direction for the development of renewable energy sources (RES) (Ministry of Energy of the Russian Federation, 2018). The same principles are reflected in the Energy Strategy of the Russian Federation for the period up to 2035 (Resolution of the Government of the Russian Federation, 2020). These regions primarily include the territories of the NSR and remote areas of Yakutia and Chukotka. Today, environmentally harmful diesel installations with a high degree of wear, low efficiency, and difficulties of operation in low-temperature conditions are used in these regions. Diesel fuel is delivered within the framework of the "Northern delivery" during a limited navigation period. New power plants using gas turbine generators might be a good solution to the problems of the territories of the NSR.

Under the decree of the Government of the Russian Federation No. 949 of 22.07.2019, it is necessary to localize the production of gas turbines as much as possible, including producing key components and controlling turbine production technologies, rights to the technology, including methods, know-how and patents, and rights to design and technical documentation (Resolution of the Government of the Russian Federation No. 949, 2019). The share of Russian components should reach 90 percent by 2022. Another localization requirement is the availability of test equipment for the hot tract components (blades, gas distributor, and combustion chambers) and a service center for the turbine repair, after-sales, and warranty maintenance.

It should be noted that Russian and international energy companies focus on the exploration and development of alternative energy sources, primarily seeking to convert all heat engines to the mixture of gas and hydrogen according to Directive of the European Parliament and of the Council of the EU 2016/802/EC "On the reduction of the sulphur content of certain liquid fuels" article No. 6 "Maximum sulfur content in marine fuels used in territorial seas, exclusive economic zones and pollution control of the member states of the EU, including the control of emissions of SO and the passenger vessels carrying out regular flights to the ports of the EU or from ports of the EU" (Resolution of the European Parliament and the Council 2016/ 268 802/EC, 2016). The transfer of energy from the NSR regions to the use of gas turbine generators solves the task of decarbonizing the economy set by the European community.

The following positive aspects of the region's development can be identified in connection with the transition to gas turbine generators in the coastal territories of the NSR and marine equipment facilities operating in this region:

- Increasing the energy supply of the region and the availability of permanent energy sources used alongside renewable energy sources (which are not permanent), due to the increase in the number of energy-efficient and maintainable power plants at the gas turbine generator
- Improving infrastructure and the quality of life
- Increasing the number of year-round ports along the Northern Sea Route
- Reducing the problems associated with the "northern import"

- Creating new jobs
- Increasing the local manufacturing content
- Improving the environmental situation in the region, controlling emissions (including CO2 and sulfur), partial decarbonization, secondary use of the generated heat in the form of waste gases in the process of energy generation (recuperation)
- Increasing the Russian presence in the Arctic zone, reducing the subsequent conflict potential of the region
- Increasing the research potential of the region

Conclusions

The development of the Northern Sea Route and adjacent territories is an extremely important initiative for the Russian Federation today. The main problems faced by the state and business in the framework of this task include the uneven development of the territory, environmental problems, and the growth of the conflict potential of the Arctic. The authors have made an attempt to determine what could become the driver of the development of the Arctic zone, including the Northern Sea Route. Using gas turbine generators at both power plants of the coastal zone territories and marine equipment facilities has several significant advantages compared to traditional diesel generators. This includes the ability to work at extremely low temperatures, eco-friendliness, cogeneration, autonomous use, and high maintainability. The latter should ensure the long-term use of gas turbine generators in the Arctic zone. The main wear element of the gas turbine generator is the turbine blade, which should be repaired using additive technologies. This technology possesses many technical advantages, while also being economically advantageous compared to the standard replacement of the blade with a new one. All in all, using gas turbine generators with innovative additive technologies is not only possible, but also expedient, and should become one of the important drivers of developing energy supply and infrastructure and increasing the attractiveness of the NSR region for life and work.

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Northern Sea Route Infrastructure and Shipbuilding Development

Ecological Norms

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Contents

Abstract

The research analyzes problems of optimizing the Northern Sea Route (NSR) structure, including the Eastern sector of NSR and the Arctic zone development, acquiring cheap and ecological energy, and Arctic projects development. Energy intensity characteristics were studied and applied to different types of fuel and new ecological standards. The Paris Climate Agreement implies the decarbonization of economics through a decrease in carbon dioxide emissions. Technologies for decreasing harmful substances concentration in power plants exhaust were analyzed, such as selective catalytic reduction, recirculation of exhaust gas, scavenge air humidification, Miller cycle, using of low-pressure

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engines, and CSNOx. Ammonia was chosen as the most perspective and optimal fuel type; it meets the demands of energy effectiveness. The ways of its "green" production, including renewable energy sources, were analyzed. Potentially interesting for ammonia production could be the Arctic atom fleet of Russia, including low power floating mobile energy blocks, which have a definite surplus of electricity.

Keywords

Northern Sea Route · NSR · Shipbuilding · Innovations · Renewable energy · Oil-and-gas companies · Arctic · Offshore power plant · OPP

Introduction

The relevance of the topic comes from the extremely important and even vital role of the polar regions for the planet Earth.

In Soviet times, research and practical development of The Northern Sea Route were given national importance. On March 10, 1921, Lenin signed a decree on the creation of a Floating Marine Research Institute. This institute was researching the Arctic Ocean with its seas and estuaries, islands, and adjacent coasts of the Soviet Russia (Polar branch of FGBNU VNIRO, 2020).

Since 1923, 19 polar radio meteorological stations have been built on the coast and islands of the Arctic Ocean in just 10 years. The USSR soon became a leader in the development and research of the North Pole and the Arctic zone.

Today, the territorial waters and the shelf of the Arctic are most developed along the coast of the Russian Federation. The international ice base at the cape Baranov on the island of Bolshevik, Taimyr AANI JSC, carries out bilateral international cooperation with research and educational organizations from Germany, Norway, Finland, France, the Republic of Korea, and Japan. Clearly, there are almost no countries adjacent to the Arctic in the list. Of the Arctic countries, the Russian Federation, Denmark (Greenland), and Canada have the longest coastlines, and the USA (Alaska), Iceland, and Norway have the shortest. Finland is a former Arctic country that lost the Petsamo area in 1945, thereby losing access to the Barents Sea (State Scientific Center of the Russian Federation Arctic and Antarctic Research Institute, 2021).

At the same time, the tracks of the Northern Sea Route (NSR) are already beginning to play a significant role for the Siberia-Europe and Siberia-Asia transport corridors. However, the NSR routes are not so easy to take without using special vessels. The contribution to the world's raw material base is also impressive. The importance of the Arctic for the world economy is huge, yet the harsh climatic conditions require special approaches. The NSR is a tool for supporting the participants of Arctic projects. At the same time, shipbuilding and mechanical engineering are the main tools for creating special Arctic vessels. The participants engaged in the competent implementation of helping Arctic projects to develop the Russian

Table 1 The main indicators of pollution from engineering and maintenance division and the phased introduction of restrictions according to IMO Tier standards

IMO Tier	Date of construction	H-total weighted limit of emissions per cycle (g/kWh) n-rated engine speed (rpm)		
		N	$n = 130 - 1999$	$n \geq 2000$
I	01.01.2000	17.0	45*n(−0.2)	9.8
II	01.01.2011	14.4	44*n(−0.23)	7.7
III	01.01.2016	3.4	9*n(−0.2)	2.0

Source: Compiled by the authors according to www.svarka-info.com

economy and make a significant contribution to the world economy and the environment, contributing to its recovery from the crisis, while participating in activities to preserve the nature of the North regardless of the major global environmental organizations controlled and used by some international participants (Sea News of Russia, 2019).

Firstly, to reduce pollution of the world's oceans, IMO Tier environmental standards have been introduced in North America and Europe and continue to develop to increase the restrictions on emissions into the environment which are, in fact, the marine analogue of the Euro automotive environmental standards. All modern marine power plants have to be certified according to the IMO Tier standard if the vessels with which they are equipped run along the routes of Europe and North America. Table 1 shows the main indicators of pollution received from marine power plants and shows the stages of putting restrictions into effect according to the new standards (Svarka-info.com, 2021; Rentenergo, 2021; Excavator.ru, 2021).

Secondly, when the Paris Climate Agreement was signed in 2016 (BBC.com, 2017), the international community is faced with the task of decarbonizing the economy, which involves reducing carbon dioxide emissions into the atmosphere, and can be fulfilled only after a complete transformation and replacement of energy systems using high-carbon resources with systems with a low carbon content or its complete absence. One cannot completely and immediately abandon carbon-containing energy sources for obvious reasons. Still, we can reduce the concentration of carbon in emissions and systematically introduce low-carbon technologies in the energy sector, industry, and transport, all while maintaining an energy-intensive component comparable to that in diesel fuel.

Literature Review

The relevance of studying the Arctic zone, including its coastal and water territories, is emphasized in many scientific works, including those by Biryukov and Savostova (2021), Faykov and Faykova (2021), Ivanova (2021), Popova and Sizova (2020), Soun (2017), Voronina (2019), Smirnov (2021), Efremov and Palkina (2020), Marchenko et al. (2021). The developing infrastructure and the growing exploitation of the Northern Sea Route areas are inevitably associated with an increasing volume of harmful emissions, including those of various power plants. The works of Istomin et al. (2019), Turkin and Turkin (2015), and Epikhin et al. (2020) deal with the issues of exhaust gas purification. The use of "green" ammonia as an energy resource should significantly reduce the environmental burden on the region. The works of Sosna and Kasym (2017) and Aksenchik (2021) deal with the processes of ammonia production. According to Ushakov (2009) and Appolonova et al. (2016), a civil nuclear fleet including floating power units described in the books of Tupchienko and Imanova (2018), Korolev and Ugolnikov (2019), and Dyudyaev and Mayorova (2021) can be considered as a source for "green" ammonia.

Problem Statement

Various technologies are used to purify the exhaust gases of power plants using hydrocarbon fuel, which enables reducing the concentration of harmful substances by chemical and mechanical means. Some of these include:

Selective Catalytic Reduction (SCR)

This system injects urea or ammonia into the exhaust gas before it passes through the installation, including a special layer of catalyst, at a temperature of 300 to 400 °C. The chemical reaction between urea/ammonia and NOx in the exhaust gases reduces NOx emissions (NO and NO_2) to N2. This system requires a highly efficient turbocharger as the engine load must be 40% or higher since NOx is reduced to N2 within a certain temperature range (300–400 °C). If the temperature is above 400 °C, the ammonia burns and does not react with NOx, which can make the system inefficient. If the temperature is below 270 °C, the reaction rate is low, and the resulting ammonium sulfates will destroy the catalyst (Sea News of Russia, 2019; Svarka-info.com, 2021; Zureli.com, 2021).

- Some B & W (MAN) engines have DeNOx or SiNOx systems using the SCR technology.
- Some Wartsila engines also have a NOR (NOx Reduction) system that uses the SCR technology.

Emissions are reduced by more than 90% due to the use of SCR technology to meet Tier III standards.

Exhaust Gas Recirculation (EGR)

This technology enables recirculating a part of the exhaust gas after the turbocharger into the scavenge receiver after passing it through the scrubber unit (exhaust gas flushing). A decrease in NOx compared to level I of about 50–60% is stated, but there remains a discharge of purifying water that requires purification. Since some countries are against the discharge of this water, its reuse creates a corrosion problem (Svarka-info.com, 2021; Excavator.ru, 2021).

Scavenge Air Humidification

The air from the turbocharger is heated after passing through the compressor. Seawater is injected into this heated air for cooling and saturation. Distillation can use seawater instead of freshwater. Air humidification is controlled by maintaining the purge air temperature within 60–70 °C. Water reduces the peak temperature in saturated air, since water has a higher thermal conductivity than air. Using this method, NOx can be reduced to about 60%. By combining other technologies, such as EGR, with this technology, one can meet NOx Tier III standards (Svarka-info.com, 2021; Excavator.ru, 2021).

The Miller Cycle

The use of the Miller cycle in 4-stroke engines, together with a high-efficiency turbocharger (i.e., the early closing of the intake valves before the BDC), expands and cools the intake air, which reduces the amount of NOx produced. This NOx reduction method will require two turbochargers (2-stage turbocharging) (BBC.com, 2017). This method, together with the principle of direct water injection (DWI) and other methods such as fuel-water emulsion, can reduce NOx emissions to meet Level III standards (Belousov & Chernyavsky, 2013).

The Use of Low-Pressure Gas Engines

New marine engines that use low-pressure compressed natural gas (CNG) as a marine fuel should be more important for meeting Tier III standards. Wartsila has developed a two-stroke engine with DF technology that uses low-pressure CNG as fuel (Korabel.ru, 2021). It is based on the lean combustion principle (relatively high air/fuel ratio), in which a premixed air/fuel charge is ignited by the pilot fuel. One of the most important features of this engine is that the emission level is below the NOx limit, which is achieved without the use of an exhaust gas purification system.

CSNOx

Ecospec has developed a system known as CSNOx, in which freshwater or seawater is used to pass through an ultra-low-frequency electrolysis system. This purified water is additionally mixed with a reacting gas to reduce the NOx content. The system reduces CO2, SOx, and NOx emissions using one compact apparatus. This technology, along with other aforementioned NOx reduction methods, can be used to meet Tier III standards. CSNOx has the advantage of achieving high efficiency with low maintenance and energy consumption (Svarka-info.com, 2021).

Combination

A combination of technologies having one or more combinations – such as electronic engines with variable fuel delivery time, CNG as fuel, or a direct injection of water or fuel emulsion in water, etc., with other methods of reducing NOx emissions – can be used to meet Level III emission standards.

Of particular interest is the method of reducing emissions by switching to a physically different fuel, for example, methane or ammonia ("green" ammonia). Ammonia fuel fully meets the requirements for energy efficiency. However, the production of such ammonia should not be "dirty," otherwise such a solution does not make complete sense. This is usually obtained industrially at the enterprises using classical technologies. Its production is associated with environmental pollution, including carbon emissions. Therefore, ammonia is not enough in and of itself, but must be "green" ammonia (Argusmedia.com, 2020). When obtaining "green" ammonia, the following technology is used: Electricity from renewable sources (solar panels, wind, or water-electric generators) drives an electrolyzer to extract hydrogen from water. At the same time, nitrogen is obtained separately, at an air separation unit.

Ammonia Energy Intensity and Production

Looking at the ammonia itself (NH_3), only hydrogen is required as a fuel. As can be seen from the chemical formula, there are three hydrogen atoms per one nitrogen atom. Diesel fuel has 23 hydrogen atoms in the chemical formula ($C_{12}H_{23}$), but there is also an undesirable element – 12 carbon atoms. Carbon itself is safe, but it is released during combustion and immediately passes into a compound with oxygen (carbon dioxide). The ratio of carbon (or nitrogen for ammonia) to hydrogen is approximately ½, which is greater than that of methane ($CH_4 = 1/4$) and ammonia ($NH_3 = 1/3$). A comparison of the three fuels is shown in Table 2.

As can be seen from the table, the most energy-intensive (hydrogen-containing) fuel is methane, whose reserves will be depleted in 70 years. Ammonia is in second place, and here one cannot but mention the transition to a new S-shaped curve. A fuel revolution in global industry is coming. Ammonia acts as a carrier of hydrogen, since pure hydrogen is very volatile, and it is still hard to store it safely today.

Ammonia is produced industrially in two ways:

- From fossil hydrocarbons
- From water and air

Table 2 Comparison of diesel fuel, methane, and ammonia

Title	Diesel fuel	Methane (from CNG)	Ammonia
Chemical formula	C12H23	CH4	NH3
Energy carrier	Hydrogen	Hydrogen	Hydrogen
Binding	Carbon	Carbon	Nitrogen
The ratio of C(N)/H	1/2	1/4	1/3
Type of waste	CO, CO_2, soot. . .	CO, CO_2	NO
The degree of harmfulness	Very harmful	Harmful	Neutral
Placing by eco-friendliness	3	2	1
Placing by energy intensity	3	1	2

Source: Compiled by the authors based on the materials of LLC "Irkutsk Oil Company," the Japanese corporation JOGMEC. The data was obtained on the following websites: www.irkutskoil.ru; www.jogmec.go.jp

Today, the first source of ammonia production is most used, which is associated with the developed oil and gas industry of the main oil and gas producing and processing regions. However, even now, before hydrocarbons are exhausted, projects must be started using the second method, which cannot but meet the environmental agenda of the world community. It should be noted that producing ammonia from water and air demands much electricity, which makes the production of "green" hydrogen and "green" ammonia dependent on electricity sources. This circumstance is the main problem that must be solved before initiating large-scale production and distribution of "green" ammonia. Therefore, ammonia should be produced centrally in places where electricity is cheap. It would be even better to obtain ammonia as a secondary unnecessary product in some production processes, for example, at large factories.

Case of Green Hydrogen and Ammonia

It turns out that there is an ideal solution for obtaining clean fuel, but its production requires at least a huge amount of fuel, that is, the problem is looping on itself. At the same time, the Russian Federation has enormous nuclear energy capabilities, including in the Arctic. Table 3 shows the composition and characteristics of Russian nuclear-powered civil vessels.

Russia has owned and used nuclear icebreakers since the Soviet era. During this time, the country has accumulated enormous experience in all technological processes related to the life cycle of floating nuclear facilities in the Arctic. The world's only floating thermal nuclear power plant (Akademik Lomonosov) is located in the bay of the port of Pevek as a stationary vessel (Flot.com, 2020).

The fact is that during the operation of the reactor, the radiolytic decomposition of water into free hydrogen and oxygen occurs under the influence of neutron and gamma radiation. If nitrogen and oxygen are present in the water, ammonia and nitric acid are formed under the influence of radiation:

Table 3 The composition and main characteristics of Russian nuclear-powered vessels

Vessel name, sailing area	Draft, meters	Electric power, megawatts	Excess electric power, megawatts
50 Let Pobedy, track	11	2 × 27, 6	Not less than 1.2
Yamal, track	11	2 × 27, 6	Not less than 1.2
"Vaigach" the mouth of rivers, track	8.1	2 × 18.4	Not less than 0.8
"Taimyr," the mouth of rivers, highways	8.1	2 × 18.4	Not less than 0.8
Lighter truck Sevmorput	11.8	5.1	1.7
Floating APEC Akademik Lomonosov, Pevek	5.5	70 (total average power of two units)	22
Arktika, the mouth of rivers, tracks	10.5/ 8.55	7.2	1.2

Source: Compiled by the author based on the materials of the website www.flot.com

$ZN_2 + N_2 \rightarrow 2NH_3$;
$2N_2 + 5O_2 + 2H_2O \rightarrow 4HNO_3$.

At the same time, nitric acid is reduced under the influence of radiation and ammonia is formed:

$2HNO_3 + 5H_2 \rightarrow N_2 + 6H_2O$;
$ZN_2 + N_2 \rightarrow 2NH_3$.

Thus, ammonia and hydrogen are removed from the 1st loop of the nuclear steam generating plant through the main condenser and bubbling-the ventilation device, and the excess electricity allows one to use the "free" resource, which allows the Corporation "Rosatom" to start producing cheap "green" ammonia. Table 3 shows that a large excess of electricity is located in the Eastern Arctic, which, by the way, is the closest to the potential markets for ammonia fuel in East Asia. The Akademik Lomonosov NPP stands out among the potential cheap sources of electricity.

The floating power unit Akademik Lomonosov is the main project of a series of mobile transportable low-power energy units. It is designed to operate as part of a floating nuclear thermal power plant and is a new class of energy sources based on Russian nuclear shipbuilding technologies. Akademik Lomonosov, proposed for the energy supply of large industrial enterprises, port cities, complexes for gas and oil shelf extraction, and processing, is being created at a serial power plant of nuclear icebreakers, tested during their long-term operation in the Arctic. Akademik Lomonosov is equipped with two KLT-40S reactor units. Together, they are capable of providing to the coastal networks about 70 MW of electricity and up to 50 Gcal/h of thermal energy for heating water in the nominal mode. The electric power supplied to the coastal network without consuming thermal energy by the shore is about 76 MW. Taking the mode of maximum heat output of about 146 Gcal/h, the electric power output to the onshore network is about 44 MW. One of the two PES should provide electricity to a locality with a population of about 100,000 people. The project is designed for reliable year-round heat and electricity supply to remote areas of the Arctic and the Far East of Russia.

Discussion

Infrastructure development of the Arctic region cannot happen unsystematically. The Arctic infrastructure is a tool for solving certain tasks of the state in this region. It is built based on the needs of global consumers of natural resources and large cargo carriers who transfer goods between the regions of Europe and Asia. At the same time, the Russian state is to preserve the fragile nature of the North and respect the interests of the local population. For implementing such large-scale projects as the developing oil and gas supply to East Asian countries and ensuring the transit of merchant ships through the NSR, it is particularly hard for ships to overcome the Arctic regions adjacent to the coast of Eastern Siberia and Chukotka, especially in winter and spring. As for the supply of electricity to port facilities, they should be mobile. Commercial success should not be crucial when adopting a construction plan, since the state develops the Arctic through subordinate structures. Energy development projects significantly affect the entire economy of the regions. One of the most energy-saturated outposts of Eastern Siberia and the Far East is the bay of the port of Pevek. To develop the economy of this region, the preliminary design stage of an optimized floating power unit was completed in 2020. In comparison with the Akademik Lomonosov, the optimized floating power unit will have lower mass-dimensional characteristics and cost. The high price of Akademik Lomonosov is one of the main arguments of opponents of the floating power unit concept. According to the results of the preliminary design, it is clear that the optimized floating power unit can cost much less than Akademik Lomonosov. This should be achieved by using the new RITM-200 M reactor, which is smaller and weighs less while having a higher unit power compared to the KLT-40S. The energy compartment will be built only in Russia.

The intermediate transition project is a modernized floating power unit. This project was developed specifically for the Baimsky ore-dressing and processing enterprise in Chukotka using the Akademik Lomonosov. Its hull has similar characteristics to the project 20,870 (length: 144 m, width: 30 m, and draft: 5 m). The differences will be in the reactor plant (it will use the RITM-200 reactors instead of the KLT-40S), as well as a turbo-generator plant. The electric capacity of such a power unit will be about 100 MW. Rosatom offers to supply four of them, one of which will be used as a substitute. All this makes it possible to implement the "green" ammonia project.

Conclusions

This chapter analyzes the problems of developing the Eastern sector of the Northern Sea Route and the Arctic zone from the point of view of obtaining affordable and eco-friendly energy and developing Arctic projects. Energy-intensive characteristics were considered concerning different types of fuels and new environmental standards; technologies for reducing the concentration of harmful substances in the exhaust of power system were analyzed. The most promising and optimal type of fuel – ammonia – was selected and methods of its production were considered, with an emphasis on the use of renewable energy to produce it.

This decision should develop the economy of the Arctic, and all jobs will be created under the task of ensuring the activities of the main lessees of the Arctic and the Northern Sea Route, that is, environmentally friendly production processes, making a high value-added, innovative, high-tech, energy-intensive, environmentally friendly products and the most popular element in terms of the humankind development concept – hydrogen (ammonia) – as well as its export from the Arctic zone.

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Northern Sea Route Development

Sustainability Issues

Julia N. Solovjova and Maria E. Gogolukhina

Contents

Abstract

The prospects of the Northern Sea Route in the context of sustainable development are researched in the chapter. While shipping generally is acknowledged as an environmentally friendly transportation mode, sea transport contributes to the global environmental problems and climate change. The goal of this chapter is to find out the potential contribution of NSR to sustainable development and to understand the risks and limitations of the project arising from sustainability dimensions. The development projects in the Arctic are considered through the lens of the triple bottom line concept of sustainable development with additional factors: beyond economic feasibility, social and environmental opportunities and risks, and operational and institutional factors are shown. This approach connects sea transportation with the spatial development of the regional economy.

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Introduction

The development of the Northern Sea Route (NSR) stipulates the reconstruction of transport infrastructure on the vast territories, as well as changes in the complex processes of the socio-economic development of the Arctic zone. This project has a significant potential in contributing to global sustainable development by shortening transportation times, saving fuel, solving social problems through connecting distant regions, intensifying export-import operations, and developing and implementing innovations in polar technologies. However, it might also result in environmental problems, one-sided economic growth based solely on fossil fuels and other mineral resources extraction, and negative impacts on the subsistence economy of the indigenous peoples. The goal of this chapter is to find out the potential contribution of NSR to sustainable development and to understand the risks and limitations of the project arising from sustainability dimensions.

Literature Review: Sustainable Development of Sea Transportation

The term "sustainable development" was coined in 1987 by the World Commission on Environment and Development. The well-known definition from its report "Our Common Future" (1987) – ensuring that development (i.e., a process of change accompanied by the exploitation of resources, the direction of investments, the orientation of technological development, and institutional change) meets the needs of the present without compromising the ability of future generations to meet their own needs – is still relevant today. Sustainable development implies knowledge accumulation and technological advancement to decrease resource exploitation. It is important to diminish the risks of damaging the biosphere, despite the growing scope of human intervention. Sustainable development is unthinkable without the basic change in values and aspirations.

The focus of sustainable development initiatives has changed several times in the last decades. It started as a response to natural resource depletion, technological hazards, and environmental pollution (i.e., mainly in the sphere of environmental protection). However, it soon became clear that only affluent countries are able to ration environmental pressures and to deal with large-scale treatment of polluted rivers, harbors, and land. Thus, the focus of sustainable development shifted to fighting against poverty, improving education and medical care, and solving other pressing social issues. However, due to the growth of global carbon dioxide emissions and continuing climate change, environmental issues again gained prominence. In the Sustainable Development Goals (SDGs, 2016–2030) currently implemented, the triple bottom line concept is put into force: the balanced set of economic, environmental, and social considerations. The present SDGs, compared to the previous global development program, have become less anthropocentric and more ecocentric.

The same combination of goals is seen on the company level in ESG concept (Environmental, Social, and Corporate Governance). These are three central factors in evaluating corporate behavior and measuring the sustainability of company investments.

Companies of the transport and logistics sector exert a considerable impact on the environment (Oberhofer & Dieplinger, 2014). Transport plays a fundamental role in economy and social development: Transport infrastructure is a prerequisite for the interconnectedness of any territory. Demand for transport services is closely linked to economic growth. Effective transportation systems positively contribute to social development and economic growth, but at the same time also lead to negative impacts on the environment and human health. Thus, sustainability as part of the development of transport is gaining importance.

To track the trends and progress of sustainable transport systems over time, various indicators have been developed. It is worth mentioning the indicator set to assess transport sustainability performance developed by Dobranskyte-Niskota et al. (2007). This set of 55 transport sustainability indicators is grouped into 17 indicator themes and five dimensions: economic, environmental, social, technical/operational, and institutional sustainability. Thus, two additional dimensions were added to the three major sustainability pillars. Technical/operational dimension includes the themes of technology status and occupancy of transportation, while the institutional dimension is dedicated to measures to improve transport sustainability and institutional development.

Sustainability issues in maritime transport and the logistics industry have historically received less attention from researchers and the general public compared to air transportation, the overland freight sector, or urban mobility. However, maritime transport had developed significantly due to increasing vessel size, containerization, and intermodal freight transportation modes. The resulting growth of speed and reduction in shipping costs led to a rise in international trade carried by maritime traffic. It makes researchers to claim that “international trade and maritime trade are synonyms” (Blonigen & Wilson, 2013).

While shipping is acknowledged as an environmentally friendly transportation mode, nevertheless the numerous ships still emit greenhouse gas both at sea and within ports; gas emissions are also generated by container trucks on the road from the origin of the cargoes to the ports (Lee et al., 2019). Ports generate harmful effects on their adjacent population, increasing respiratory and cardiovascular diseases (Young-Tae et al., 2017). Lister et al. (2015) conclude that sea transport can be viewed as a major contributor to global climate change and that it is lagging in effective environmental governance versus onshore industries. Thus, it is important to reduce the environmental impacts of ship operations, to improve residents’ health in the areas close to seaports, and to minimize economic and social costs.

Regulations such as Emission Control Areas (ECA) and Reduced Speed Zone (RSZ) have been introduced in ports to diminish ship emissions and corresponding social costs. Companies attempt to develop speed optimization strategies which reduce fuel consumption and emissions through low-speed sailing without increasing the number of vessels (Norlund & Gribkovskaia, 2013). Container shipping liners and terminal operators publish sustainability reports. In the paper by Wang et al. (2020), content analysis of these sustainability reports is performed, and the concept of corporate social entrepreneurship is used to view the implementation of SDGs as an entrepreneurial endeavor that addresses economic, social, and environmental problems to create shared value.

Recent research has focused on sustainability in maritime supply chains, which is defined as the integration of ports and shipping companies along a supply chain and the coordination of cargoes, information, and financial flows in order to fulfill the customer needs, to improve profitability and competitiveness subject to compliance with regulations, and to control social and environmental impacts (Cheng et al., 2015). The following drivers of green maritime supply chain management were revealed: top management support, regulation pressure, green initiative adoption, and security pressure (Jasmi & Fernando, 2018).

The literature overview has shown that the topics of sustainable development of maritime shipping and supply chains have recently received more attention in research. However, the sustainability of maritime operations still remains less transparent than of onshore industries; the research focus is concentrated mostly on the environmental dimension; only initial attempts have been made to assess the sustainability of the complex multimodal supply chains.

Recent Advances in the Northern Sea Route Development

In the previous section, it was shown that sea transport contributes to global environmental problems and climate change. However, one can also observe the feedbacks of climate change on maritime shipping and seaport operations. Research shows that there has already been major disruption to port activities due to the growing intensity of tropical storms, which is associated with the current climate change (Becker et al., 2018). Parallel to that, the climate change influences on the environmental feasibility of Arctic shipping and, consequently, the economic feasibility of diverting ships from the conventional Southern shipping routes (Ng et al., 2018). The longer period of navigability influences the feasibility of the Northern Sea Route as a global transport corridor.

NSR goes along the northern shores of Russia in the seas of the Arctic Ocean connecting European and Far Eastern harbors of Russia as well as estuaries of navigable Siberian rivers in a single transport system. The length is 5600 km from the Kara Strait to the Providence Bay (The Water Area of the Northern Sea Route, 2021). NSR is the only navigable route connecting all Arctic and sub-Arctic regions of the Russian Federation. Together with numerous rivers that flow into the Arctic

Ocean, NSR is regarded as a part of a transport system connecting Russian territories in the dimension South-North (Zhuravel, 2019).

In 2020, almost 33 million tons were transported by NSR, including 18 million tons of liquefied natural gas and gas condensate from the project Yamal LNG. The dominating share of cargoes is intended for export. Cargo traffic grew nearly five times during the last five years (Tikhonov, 2021). In 2020, the transit flow of international cargo – supplies from Canada, Norway, and Russia to China – constituted just 1.2 million tons or 3.6% of the total freight traffic of NSR. This figure is about 1000 times less than the transit through Suez Canal (Gorokhova, 2021).

The new approach to the functioning of NSR stipulates a considerable increase in its cargo traffic, parallel with the development of the Russian Arctic territories. The increase in cargo traffic will be provided by the large projects of Russian companies of natural resource extraction and liquefied natural gas production, such as Arctic LNG 2 and Vostok Oil. The target is to raise the total freight traffic to 80 million tons in 2024.

Moreover, the far-reaching goal is to transform NSR into the global competitive transit corridor: the new connection between markets of Europe and South-East Asia and the conjugation of overland and maritime transportation routes. In certain cases, this shorter route from Korea, Northern China, or Japan might save up to 10–14 days of transportation time (Gorokhova, 2020). Global warming and technological advances increased the duration of navigation in the Eastern Arctic from the usual five (July–November) to nine months in 2020. A projected shipping line for multimodal and transit transportation will be utilizing NSR throughout the year, thus contributing to the higher quality of logistics on Eurasia and offering attractive conditions of movement of goods from Asia to Europe.

The disputes about the future of NSR as a means to exploit large mineral deposits in the Arctic zone and to export hydrocarbon and other types of raw materials, or as a globally competitive regular transport corridor for international cargo, are ongoing within industry, academic, and public circles (Zhuravleva, 2021). However, whatever the future set of shippers and cargoes transported through NSR is, there are several common challenges that need significant investments and efforts.

The following development directions are considered to be crucial to ensure the projected increase in the cargo traffic in NSR:

- Construction of several icebreakers that are able to ensure year-round navigation and commercially acceptable speed of icebreaking services for bigger vessels
- Reconstruction of two large transshipment hubs in the North-West and North-East to reload containerized cargo from feeder ships to ice-class ships
- Dredging, enlargement, and equipment of ports over the entire length of NSR and access routes to the ports
- Construction of new ice going vessels, namely, gas carriers
- Creation of positioning systems, emergency and rescue services, reliable communications, and satellite monitoring
- Modernization of means to eliminate accidental oil spills

- Organization of service for merchant shipping of international quality level, including ship repair, bunkering, logistical support, medical services, and waste management

All these tasks require considerable investments, as well as comprehensively addressing the challenges of spatial development of the Arctic and sub-Arctic territories. The decisions taken at the early stages of the NSR project development should be sustainable, taking into consideration social and environmental limitations and impacts of the activities.

Dimensions of Sustainability of the Northern Sea Route

The recent publications on the Northern Sea Route very rarely mention the issue of sustainability. Most often, they concern the prospects (Wan et al., 2021) and possible future operational models (Milaković et al., 2018) of the commercial use of the NSR, as well as its competition with other global routes (Abdul Rahman et al., 2014; Bennett et al., 2020). Sustainability is mostly addressed in a wider frame of the Arctic region, without a special focus on Northern maritime supply chains. The influence of NSR on indigenous peoples of the North – and specially protected natural areas – has been studied (Sharahmatova, 2018).

In the attempt to close this gap, we propose discussing the sustainability dimensions of the NSR and limitations to its development in the extended triple bottom line paradigm suggested by Dobranskyte-Niskota et al. (2007) (Table 1).

It is worth emphasizing the potential impact of the NSR on the social development of the Arctic territories. It will provide jobs by intensifying industrial development, helping to solve vital everyday issues of the population, and having positive effects on the social life of the region. This factor should be considered alongside the economic dimension.

Moreover, it should be pointed out that many of the abovementioned factors can be attributed to two or more dimensions. By considering their interdependencies, the complex influence of the project on the spatial sustainable development may be assessed.

Table 1 shows that NSR will require high investments but considerably improve the social conditions of the Arctic region as well as the economic conditions of the country and will also contribute to decreasing global carbon footprint. It also stipulates certain technical and operational challenges and requires institutional cooperation.

The possibility to fully utilize the potential of NSR depends on the interest and trust of various stakeholders. At present, the most interest is shown by the Russian resource-based companies and Far Eastern fishers. The attractiveness of the NSR will grow together with the development of infrastructure and the organization of line shipping with the established schedule of icebreaking services. Sustainability marketing, promoting lower carbon footprints and securing shorter delivery times, aims at diverting shippers from usual routes.

Table 1 Sustainability factors and limitations for the Northern Sea Route development

Sustainability dimension	NSR contribution to sustainable development	Limitations and risks
Economic	Growth of export from Russian polar regions Shorter transportation time between Asia and Europe Development of value adding sectors related to mineral resource extraction, that is, petrochemical production. Growth of order portfolio in numerous related branches, especially shipbuilding	Higher costs of transit transportation compared to the Southern routes due to charter costs for an icebreaker or ice-resistant vessel and high insurance rates Higher prices for ice-resistant vessels
Social	Reconstruction of social infrastructure and increasing the quality of life in polar regions "Northern delivery": provision of all necessary goods to the inhabitants of polar regions Creating new jobs that can prevent the exodus of the working age population Development of access roads to the ports, both railways and motor roads Improving access to Internet by fiber-optic cable line or satellite connection. Increasing food security: faster logistics to transport fish products from Far East to the western Russia; growth of sales of Russian agricultural products to densely populated Asia	Low population density Developed territories which are not spatially contiguous Distance from major industrial centers, high dependence of economic activities on supplies of fuel, food, and other essential goods from other regions of Russia Necessity to preserve traditional lifestyles and subsistence economy of indigenous minorities and their cultural heritage and languages
Environmental	Lower carbon footprint due to shorter route Growth of production of liquefied natural gas, which results in lower emissions than other types of fossil fuels	Extreme environmental conditions Vulnerability of Arctic nature even to minor human impact, low self-purification capacity Necessity to preserve the Arctic biodiversity Nuclear risks of icebreakers' engines Higher navigation risks in the ice
Technical and operational	Powerful icebreakers, which can move the route to higher latitudes, making the route shorter Long distance from Arctic to the sales market and corresponding necessity to develop transport	Exact travel time cannot be guaranteed in the unpredictable Arctic weather conditions. Large impact of seasonality factor Lack of ice-resistant vessels globally Lack of in-between ports on the route Aurora borealis causing connection disruptions
Institutional	Preservation of the Arctic as zone of peace and cooperation Research and development of polar	Considerable impact of geopolitical factors

(continued)

Table 1 (continued)

Sustainability dimension	NSR contribution to sustainable development	Limitations and risks
	technologies: innovative construction materials, life-support systems, fuel and lubricants, metals for machine building, and outfit Research of the Arctic as geographical object.	

Source: compiled by the authors

Conclusions

The analysis has shown that the Northern Sea Route has implications for economic, social, and environmental dimensions of sustainability. Two additional dimensions – technical/operational and institutional – have also been included in the analysis. This has been the first attempt to classify the risks and potential contributions of NSR to sustainable development. The further directions of research include the deeper differentiation and quantification of factors revealed.

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Optimization of Northern Delivery Economic Mechanisms

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Contents

Abstract

The chapter investigates technical and organizational peculiarities of the Northern delivery with Yakutia as a case study. Specifically, it looks into the nomenclature of transported goods, volumes of cargo flows, projects of ships of the sea and river fleet, needs of each point, and distances between them, infrastructure of ports and port points, audit of the technical and economic indicators of projects of ships of the operating fleet, and the calculated time of a round trip. Such analysis is rooted in mathematical methods applied to the planning of the work of mixed and river shipments. Quantitative modelling implies the task of distributing cargo flows between sea basins, the task of placing river vessels along the lines, and calculating the optimal plan for supplying tonnage for loading. The authors conclude by identifying the key problems and suggesting related solutions to sustain the Northern delivery broken down to technical characteristics of particular types of vessels to be used.

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Introduction

One of the key directions of developing the Northern Sea Route includes organizing the delivery of food, fuel, construction materials, and consumer goods by this method. The existing form of delivery is irregular, does not have a general established system, and is aimed at solving short-term tasks (TsNIIMF, 2016). The nomenclature of imported goods does not meet all the needs of the regions of the Far North. Delivery failures and insufficient quantities of goods have already provoked population outflow.

The Arctic provides more than 10% of Russia's national income and about 20% of exports. The extraction, processing, and further sale of such natural resources as oil, gas, hydrocarbons, nonferrous metals, and various minerals are the basis of the Russian economy.

More than 80% of combustible natural gas and 17% of oil and gas condensate are produced in the Arctic zone (Tsukerman & Goryachevskaya, 2018). According to experts, there are more than 85.1 trillion cubic meters of natural gas and 17.3 billion tons of oil equivalent (including gas condensate) on the Arctic shelf (Gritsevich, 2008).

The work is carried out on the example of data from the Republic of Sakha (Yakutia).

Problem Statement

The use of mathematical methods in planning the work of mixed and river transport has some specific features in many cases that require special economic and mathematical models specific only to this type of transport (Tarovik et al., 2017). On the one hand, river routes in most cases do not have closed contours, which greatly simplifies the optimal planning of transportation of homogeneous goods (it is enough to avoid oncoming flows), as well as solving other problems, such as the sequence of ships' delivery to loading points, etc. On the other hand, the difference in river transport types of rolling stock, which differ in their technical and economic characteristics (different capacity of ships, self-propelled and non-self-propelled fleet), and a variety of work performed within a single voyage with a different economic efficiency (e.g., in the laden and unladen direction) require the complicated formulation of transport problems, which must be taken into account: interchangeability of ships, types of cargo, scheme of cargo lines, types of traction service, etc. (Bakaev, 1966).

It should be noted that optimization methods have become the basis of algorithms for solving transport problems, which will be discussed below.

The Task of Distributing Cargo Flows Between Marine Basins

The solution of the problem implies distributing traffic between different modes of transport and the specialization of ports, taking into account the total transport costs for cargo transportation (Gritsan, 2004).

From the mathematical point of view, the problem is formulated as follows. The total costs of transportation and transshipment of goods should reach a minimum while taking into account the following:

- The amount of cargo going from the production area to the consumption area through the port
- The resources allocated for transportation in all directions for all cargo and following through all established ports
  - The amount of consumption in the *j* district
  - The resources of the *i* district
  - The bandwidth of the *k* port

When solving this problem, one can calculate transportation plans with a spread across the basins (Bakaev, 1966).

The obtained results can also be the initial data for solving planning problems within the basin, for example, for zoning cargo flows within the basin, taking into account the specialization of ports and linking with mixed modes of transport. The solution of the problem can be reduced to one of the methods for solving a transport problem with capacity constraints.

The Task of Placing River Vessels Along the Lines

One of the most important tasks of the organization of river transport vessels is to create the best plan for the distribution of the fleet by types of vessels and areas of work. The distribution of the fleet is the basis for drawing up schedules for the movement of river vessels, a plan for the supply of tonnage for loading, and planning economic indicators of the fleet.

An important step in solving this problem of fleet placement is to choose the optimal criterion. In different situations, different criteria should be used (Pashin & Polyakov, 1976). Such criteria can include:

- Minimum operating costs
- Maximum profitability
- High carrying capacity

As a result of solving the problem of distributing fleet types along the lines for the same source data according to different criteria, different variants of the plan are created.

We used the following methodology and algorithm for solving the problem of placing river vessels along the lines:

1. The matrices **D** and **K** of dimension $m \times n$ are given, as well as $A_i > 0$, $i = 1, 2, \ldots, m$, $B{>}_j > 0, j = 1, 2, \ldots, n$.
2. We should find a set of numbers x_{ij} satisfying the following conditions:

$$\sum x_{ij} \leq A_i;$$

$$\sum k_{ij}\, x_{ij} = B_j;$$

$$x_{ij} \geq 0,$$

and realizing the maximum of the linear form

$$\sum d_{ij}\, x_{ij}.$$

Concerning the problem of fleet distribution, we denote the following:

B_j is the cargo turnover on the j line;
And $_i$ is the number *of available type i vessels*;
k_{ij} is the carrying capacity of the vessel of the i type on the j line;
x_{ij} is an unknown number of ships of the i type used on the j line.

3. We prescribe an index of the profitability of using the fleet for each composition, assuming that $d_{ij} = S_{1j}k_{1j} - S_{ij}k_{ij}$ (S_{ij} − the cost of transportation of 1 thousand tons *of m* cargo on *the j* line by the i type of fleet).
4. As an initial plan, we take the distribution obtained by the maximum carrying capacity.
5. If an unused part remains during the initial distribution, an auxiliary line should be entered.
6. We build a closed circuit.
7. We check the implementation of plans for all lines.
8. We construct a system of potentials U_i and $V_{j.}$
9. Check for the condition $d_{ij} \leq 0$.
10. If so, then the plan is optimal (Bakaev, 1966).

Creating the Optimal Plan for the Supply of Tonnage for Loading

During navigation, there are periods when one has to send the maximum possible amount of cargo with different loading volumes with limited resources of empty tonnage. In this case, it is assumed that the amount of cargo available at the docks exceeds the loading capacity of the fleet. This task can also be set when ensuring the departure of the planned cargo with minimal use of tonnage.

Denoting by Q_{ik} the amount of tonnage of the i type, which is fixed for sending the k cargo, we get the condition for solving the problem as follows:

$$\sum Q_{ik} = Q_i \ (i = 1, 2, \ \ldots, n);$$

$$\sum P_{ik} \, Q_{ik} \leq G_k \ (k = 1, 2, \ \ldots, m),$$

where G_k is the number of cargo of the k kind to be shipped, per thousand tons.

If the above conditions are met, one has to determine Q_{ik} with the maximization of the plan's optimality criterion:

$$\sum \sum P_{ik} \, Q_{ik} = \max,$$

where P_{ik} is an indicator of the use of the load capacity of the i type of tonnage when loading k kind of cargo (Dorin et al., 1968; Mogilevsky, 2004).

This problem can be solved using the simplex method, as well as the method of potentials. When solving using the method of potentials, the equivalence coefficients of different types of tonnage are introduced when loading with different types of cargo concerning the tonnage of one type. The coefficients are calculated using the formula

$$d_{ik} = P_{ik} / PB_k.$$

In some cases, when the coefficients do not change monotonically, there may be nonoptimal solutions. In practice, the error in solving problems is insignificant and is justified by the simplicity of the solution by the method of potentials, as well as by the method of resolving multipliers.

Using linear programming, one can calculate tonnage delivery plans for loading 10–12% more cost-efficiently than in the usual way (Anischenko et al., 2003). The problem statement can be successfully applied both on river and sea transport.

Fleet Executing Northern Delivery: Evidence from the Field

We have studied 46 settlements on the territory of the Republic of Sakha (Yakutia) that participate in the delivery of goods, as well as the following projects of vessels providing Northern delivery:

- Project 21-88 – vessels of the "Kaliningrad" type, large dry cargo vessels and refrigerated vessels of the river-sea class, having four holds with hatch closures, with double sides and double bottom, with an engine room and a superstructure in the aft part;
- Project 292 – ships of the "Siberian" type, large dry cargo vessels of the river-sea class for Arctic navigation, having four holds with hatch closures, with double

sides and double bottom, with a reinforced ice hull, with an engine room and a superstructure in the aft part;
- Project R-77 and project 621 – vessels of the “Lenaneft” type, single-deck twin-screw self-loading motor ships with a forecastle, superstructure, wheelhouse, engine and pump rooms located in the aft part, with a bridge in the diametrical plane, river class;
- Project 1577 – vessels of the “Volgoneft” type, single-deck twin-screw bulk ships with a double bottom, double sides, tank and poop, superstructure and the engine room in the aft, a transition bridge in the transportation desk of the vessel, the “river” class;
- Project SK-2000 and SK-2000KN – dry-cargo ship-platform-pushers with a cargo awning on the main deck, with the engine room in the aft, the bow location of the superstructure and the wheelhouse, the “river” class;
- Project 1754MB – single-deck screw self-loading motor ships with a forecastle, superstructure, and engine room in the aft part, with a transition bridge in the diametrical plane of the vessel, “river” class;
- Project 866 – bulk motor ships designed for bunkering and transportation of diesel fuel and oil;
- Project 414B – single-deck twin-screw bulk-loading motor ships with a superstructure and an engine room in the aft part, “river” class;
- Project 15903 – type “Captain Sakharov,” sea container ships;
- Project 326 – type “Bakhtemir,” twin-screw dry cargo ships of mixed navigation “river-sea” with a carrying capacity of 1000 t, with a tank and an engine room located in the stern, with a superstructure and a wheelhouse in the middle part with a container deck, at the tank level and two cargo holds. As a result of the calculations carried out, it was found that the most cost-effective cargo delivery scheme is a direct delivery scheme.

As a result of calculations for all 46 points located in the Republic of Sakha (Yakutia), we found that the highest speed, both with cargo and empty, can be reached by project 21-88 (dry cargo vessels of the Kaliningrad type) and the lowest by project 326 (dry cargo vessels of the Kaliningrad type) (Fig. 1).

The calculated indicators obtained (averaged by projects) can be represented graphically in Fig. 2.

The resulting average duration of a round trip is shown in Fig. 3.

The navigation period on the sea section is 80 days; on the river section, it is 150 days (Fig. 4).

Calculations of operating costs for a round trip on the ship are shown in (Figs. 5, 6, and 7) (Fig. 8).

Besides, the following indicators were calculated:

- The time of the vessel’s course and its stops for a round trip
- The average duration of the circular voyage
- Operating costs for a round trip for a ship
- The carrying capacity of the vessel

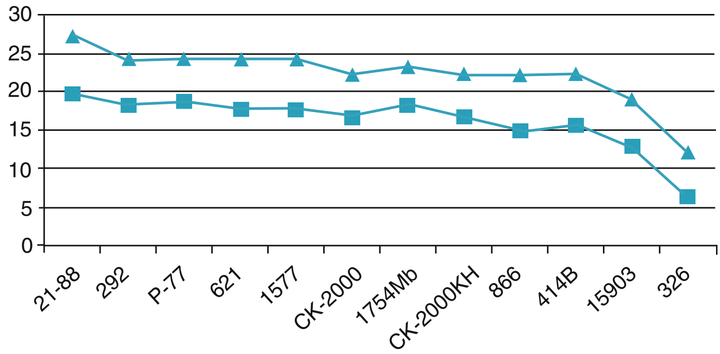

Fig. 1 Average speed indicators of vessels with cargo and empty, kilometer per hour. (Source: Compiled by the authors based on the results of research and statistical data)

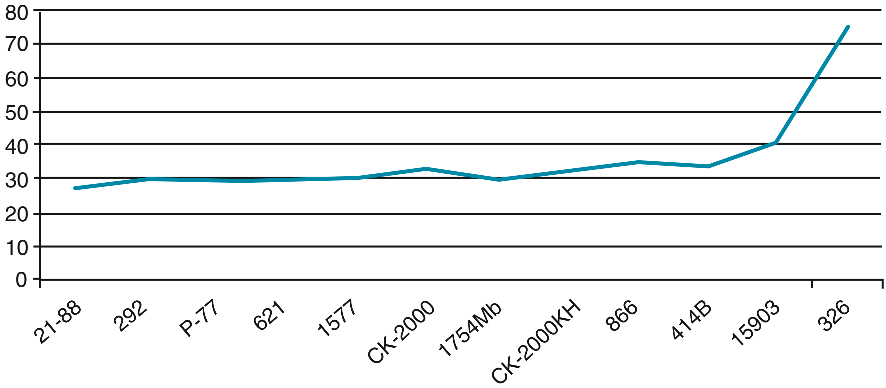

Fig. 2 Average indicators of the ship's running time, days. (Source: Compiled by the authors based on the results of research and statistical data)

Conclusions

The study of optimization of the economic mechanisms of Northern import consisted of three stages:

1. Collecting information about the needs of the settlements of the Republic of Sakha (Yakutia), about the distance between the points, about the fleet that currently provides Northern delivery
2. Structuring the collected information
3. Calculating the speed of ships with cargo and empty, the running time, the duration of the round trip, the needs for voyages/ships, taking into account the navigation area, operating costs per voyage, by ship (sea and river sections of navigation/in navigation), and the carrying capacity of the projects

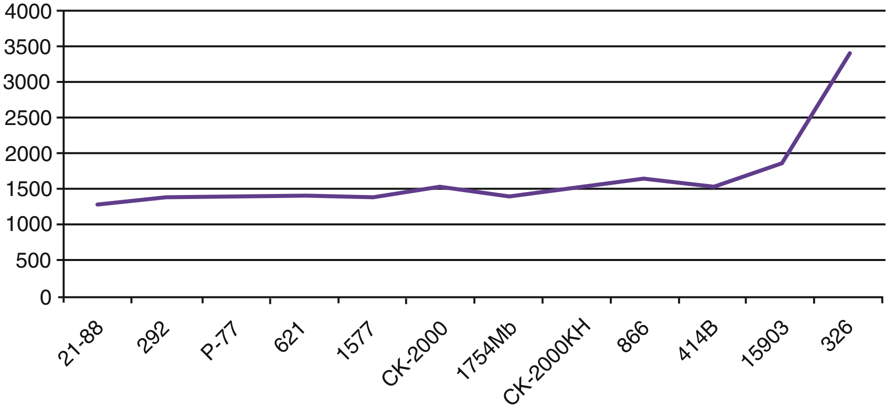

Fig. 3 Average duration of a round trip, day. (Source: Compiled by the authors based on the results of research and statistical data)

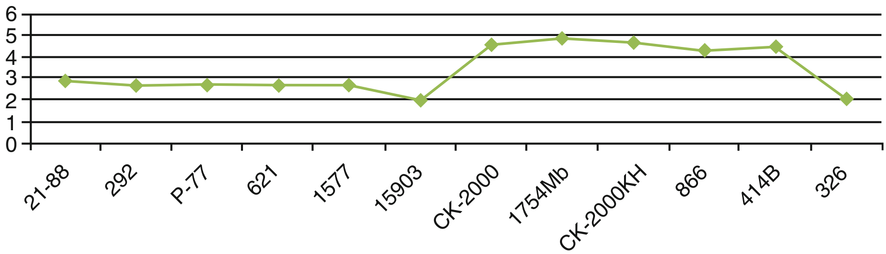

Fig. 4 The required number of voyages/vessels per the navigation period (on the sea section is 80 days, on the river section – 150 days. (Source: Compiled by the authors based on the results of research and statistical data)

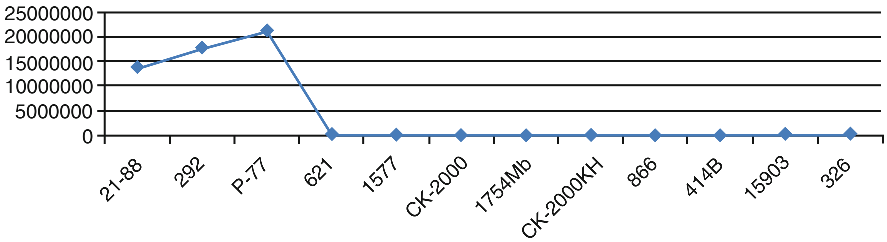

Fig. 5 Operating costs for a round trip according to ship projects, ₽ per day. (Source: Compiled by the authors based on the results of research and statistical data)

We came to the conclusions about the optimal characteristics of vessels to meet the needs of all residential settlements in the Republic of Sakha (Yakutia) in full per the navigation areas.

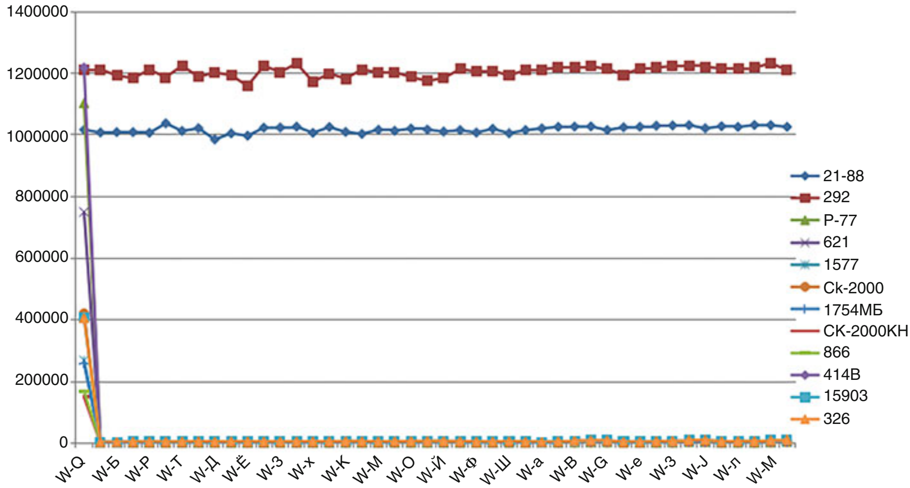

Fig. 6 Operating costs for the ship for navigation on the sea section. (Source: Compiled by the authors based on the results of research and statistical data)

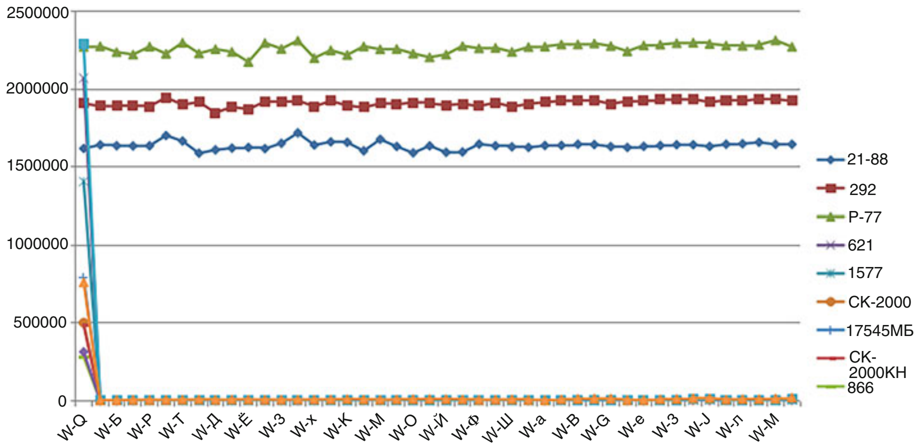

Fig. 7 Operating costs for the vessel for navigation on the river section. (Source: Compiled by the authors based on the results of research and statistical data)

The development of technical specifications for the design and further construction of a new optimal fleet to ensure Northern delivery should reduce financial costs and increase the efficiency of cargo delivery to the Far North.

Optimization of the economic mechanisms of Northern import is the beginning of a large and detailed study. Its goal is to develop a unified strategy for creating marine technology that can be used to develop the Arctic zone.

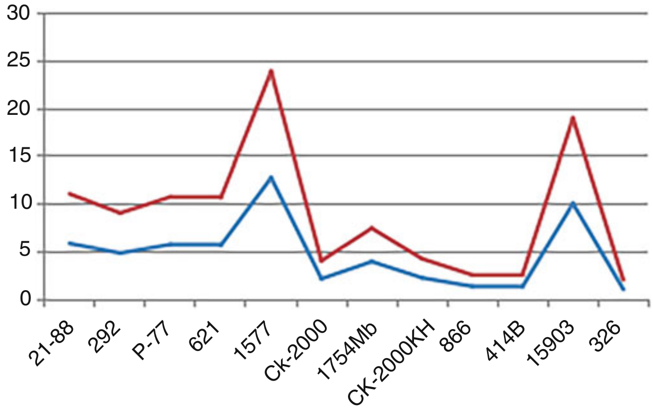

Fig. 8 Average indicators of carrying capacity, thousand tons. (Source: Compiled by the authors based on the results of research and statistical data)

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Revisiting the Logistics of the Arctic

Case of Chayanda Field

Andrei M. Golubchik and Tautginas Sankauskas

Contents

Abstract

Siberia and the Far North of Russia are very rich in minerals, but it is extremely difficult to develop such deposits due to harsh climatic conditions, small local population, and the almost complete lack of transport infrastructure. This situation has been thoroughly considered on the example of the logistics of cargo delivery to the Chayanda oil and gas field, located in a remote mountainous area of central Yakutia. The choice of this field is not accidental. It is an oil and gas condensate field and is the main source of oil for the Eastern Siberia-Pacific Ocean pipeline and of gas for the Power of Siberia gas pipeline. However, it is becoming obvious that the cargo fleet on the Lena River cannot meet both the urgent needs of the northern delivery to remote and hard-to-reach areas of the Republic of Sakha-Yakutia and shipments to Eastern Gas Program of PJSC Gazprom. Thus, holding significant field expertise, the authors justify a turn back to the experience and plans of the Soviet era for developing navigation on the great rivers of Siberia – the Lena, the Ob, and the Yenisei.

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Introduction

It is well known that Siberia and the Far North of Russia are incalculably rich in minerals. However, the harsh natural and climatic conditions make the development of such deposits technologically complex, time-consuming, and, for this reason, extremely expensive. Today, it is worth admitting that traditional methods and technologies of transport and supply logistics simply do not work in such conditions, because they become completely useless in places where roads can be used only for 5–6 months a year (in winter), and the rest of the time they are replaced by a boundless and bottomless swamp. The nearest railway station remains 1000 km to the south, and the airport does not yet exist, even in the most daring and ambitious plans.

The existing transport infrastructure facilities are extremely small, technologically weak, and seriously worn out, and there is no need to talk about logistics centers at all, as they simply do not exist. How can mining be developed in such conditions?

The authors of this study endeavor to understand the causes and problems that accompany transport logistics in the regions of Siberia and the Far North of Russia. First of all, we will be interested in organizing transport logistics in oil and gas fields.

Current State of Affairs

The old transport axiom says that uninterrupted transshipment of cargo from one type of transport to another is possible only with the coordinated work of all transport organizations at the points where railways, cars, and waterways meet – at transport hubs. Transport scientists have repeatedly been involved in solving problems related to the organization of uninterrupted transshipment of goods from one type of transport to another. Over the past 10–15 years, many theses have been devoted to the organization of rational cargo transshipment in sea and river transport hubs, including the works of V.P. Klepikov (2007), A.A. Lugovets (2008), A.S. Balalaev (2010), and N.A. Tushin (2012). However, the situation remains extremely difficult, and in some places, there is a dead end.

Let us consider these very painful issues using the example of building logistics schemes for cargo delivery for developing the Chayandinskoye field in Yakutia. The complexity and, at the same time, the uniqueness of the task is that two major oil and gas projects converge at one geographical point.

The Chayandinskoye field is an oil and gas condensate field (OGCF), which is why the following tasks were set for the performers:

- to build a transport infrastructure and equip complexes of oil treatment plants, which will later be transferred to a specialized operator. The extracted oil will be pumped into the Eastern Siberia–Pacific Ocean pipeline (ESPO);
- to build a transport infrastructure and equip the Chayandinskoye OGCF for gas drilling, the field being the starting point of the main gas pipeline “Power of Siberia.”

A single logistics center (SLC) has been created in the city of Ust-Kut (Irkutsk Region) for the overall coordination of transport logistics of all projects of OAO Gazprom. The SLC is designed to solve the most complex transport and logistics tasks for the delivery of materials and specialized equipment intended to create a paved highway with a length of 153 km to the construction site. The road runs from the Talakan field to the complex of oil treatment plants. (A paved road from the ports on the Lena River Vitim and Peledui to the Talakan field already exists. The owner of the road is OJSC "Surgutneftegaz," while the structures of OAO "Gazprom" have the opportunity to use this road on a compensatory basis.) Besides, one has to deliver the equipment for arranging and establishing the Installation Complex itself, as well as arranging the Chayandinskoye OGCF for gas drilling.

As part of the full development of the Chayandinskoye OGCF, it will be necessary to deliver at least 7–8 million tons of cargo, including more than 3 million tons of basic cargo (road slabs, pipe products in the assortment, road, construction, drilling and other special equipment, metal structures, cement, etc.), as well as at least 3–3.5 million tons of locally produced cargo (crushed stone, sand, lumber, and timber). Besides, approximately 1 million tons will be made up of cargo for ensuring the vital activity of workers (tools, workwear, residential modules, equipment for canteens and household premises, food). The mentioned volume of cargo received the conditional name "cargo of the Eastern gas program."

The entire volume of main cargo will go through the city of Ust-Kut, located in the north of the Irkutsk region, on the banks of the Lena River. Then, the bulk of the cargo will go along the Lena further, to the ports of Vitim and Peledui along the Lena River to the port of Verkhne Markovo (this is about 35–40% of the total volume) to be transshipped to motor vehicles and delivered through the winter road.

Ust-Kut has been chosen as the SLC for an extremely simple, even prosaic, reason: The Sturgeon river port is located in the city. The Osetrovsky River Port, in turn, is the only transport facility of the Lena River Basin today that communicates with the country's railway network through the Lena station (of the East Siberian Railway of Russian Railways), as a result of which the port is often called the "Gateway to the North."

At the end of 2020, the railway reached the station in the village of Nizhny Bestyakh located on the right bank of the Lena River, almost opposite Yakutsk, but there is no full-fledged cargo port in the village. (The operating organization is the Joint-Stock Company "Railways of Yakutia," a joint venture of the Government of the Republic of Sakha-Yakutia and JSC Russian Railways.) So far, everything remains as plans and projects. The distance from Nizhny Bestyakh to the ports of Lensk and Peledui is somewhat greater than from Ust-Kut, and the distance by rail (if viewed from the western part of the country) is much higher.

All these factors make this route look promising enough. The only positive aspect when using the port in Nizhny Bestyakh as a transshipment point will be the factor of using empty vessels returning to Ust-Kut for passing loading. So far, though, this is a project which is far from the clearest.

To return to the port of Osetrovo, there is some key technical information about it. The navigation period, due to the sharply continental climate of the region, is only

120–150 days (less than 6 months). The main amount of work is performed in summer, and the real weather outside is not taken into account.

The total length of cargo berths is 1872.4 m. The capacity of the enterprise allows transporting 1,500,000 t of cargo every time. In fact, the actual volume of cargo transportation does not reach even half of this amount. The capacities are distributed in two districts:

- Northern Cargo Area: the length of the quay embankment, consisting of 13 berths, is 1270 m. The number of covered warehouses is 11 pieces, the total area is 73,857.8 m^2; the open warehouse area is 281,862 m^2. The railway station Lena is in 5.35 km.
- Western transshipment complex: the length of the quay embankment, consisting of 6 berths, is 574.4 m. The total area of cargo platforms is 36,300 m^2. The railway station Lena is 3.45 km.

The port has over 9200 m of railway tracks with a front for the simultaneous delivery of 440 cars and a front for the simultaneous unloading of 80 cars. Osetrovsky Riverport carries out cargo securing on transport and develops and coordinates schemes for placing and securing cargo on mobile railway transport. Due to the well-developed infrastructure of intraportal and access railway tracks, loading and unloading operations are carried out almost completely excluding unproductive downtime of rolling stock. All modern berths are universal and can process various types of cargo.

The table below describes the technical capabilities of the local river fleet as of 2014. This year was chosen specifically, as it was the beginning of the active phase of work at the Chayandinskoye field (Table 1).

The total volume of cargo transported during the navigation of 2014 amounted to approximately 650,000 t, taking into account the cargo of the Eastern Gas Program. It is enough just to compare this figure with the need for the delivery of basic goods under the program, which will reveal a serious shortage of both transportation and technical capacities of the ports of the Lena River basin. Nonetheless, in addition to the cargo of the Eastern Gas program, it is necessary to ensure the northern delivery

Table 1 River fleet (including barge-towing structure) in the Lena River basin (2014)

	Fleet units	Total load capacity, thousand tons	Including the reserve for the Eastern Gas Program	
JSC Lenskoye ORP	88	142.3	35	54.5
LLC Shipping Company "Yakutsk"	26	87.5	10, including 5 tugs	12.5
JSC "Verkhoyansk River Shipping Company"	109	69.0	After receiving	Applications
TOTAL	223	327.8	≈ 63	≈ 75

Source: Golubchik (2016)

of goods to remote settlements of Yakutia and the delivery of goods to settlements along the river Lena, up to and including Yakutsk, at the same capacities.

The situation has only become more complicated. According to the results of navigation in 2020, the volume of traffic, at the cost of incredible efforts, managed to bring a little more than 760,000 t. However, this is not enough. As a result, the shortage of transport and logistics infrastructure capacities inevitably leads to mass manifestations of monopolism by local market players, which is why the rates for fleet and port infrastructure services are massively overestimated. In other words, prices for services have increased significantly.

Is It Worth Turning to the Old, Soviet Experience?

One of the ways to effectively solve the current problem in the Lensk-Osetrovsky transport hub could be to apply the experience of previous years. This means the need to bring Hub Transport Agreements back to life. Within this research, it is repeatedly called the Soviet experience.

The practice of transport hub meetings was widespread in the USSR in the 1960s to 1990s: Those who took part included representatives of the Ministry of Transport of the USSR (usually at the level of heads of freight departments of road departments and heads of stations serving the port), the port of transshipment, sea, or river carriers (at the level of deputy head of the shipping company (the head of the cargo department), and local car enterprises, both departmental and subordinate to the Ministry of Road Transport of the RSFSR. The result of such a meeting was the signing of a unique document – the *Hub Transport Agreement* – and the creation of hub offices of freight forwarding services. (They were renamed into Hub Freight Forwarding Enterprises in the 1980s. In Moscow, this structure was called Moscow Freight Forwarding Station.) Hub agreements were signed and successfully worked at the Moscow, Leningrad, Gorky, Osetrovsky, Vladivostok, and Nakhodka transport hubs.

At the same time, hub agreements do not regulate the relations of transport organizations with shippers and consignees who send and receive goods in direct mixed traffic. This circumstance is essential when comparing the hub agreement with the types of organizational contracts, which are long-term contracts for the organization of transportation, annual contracts concluded by road transport, and navigation contracts concluded by river and sea transport with shippers (Egiazarov, 2008, p. 138).

All in all, the hub agreement is based on a special organizational agreement. The main purpose of such a contract is to determine the procedure and conditions for performing the actions necessary to fulfill the obligations for the carriage of goods arising from the peculiarities of transportation on this type of transport and preceding the acceptance of the cargo for transportation.

The degree of application of these contracts and their role in individual modes of transport are somewhat different, but the conclusion of such contracts pursues one goal: to regulate when fulfilling obligations for transportation such relationships of shippers (consignees) and carriers, which, given the specifics of individual modes of transport, have not received sufficient regulatory development, i.e., organizational contracts regulate relations other than hub agreements (Kholopov & Golubchik, 2019).

Another distinctive feature of the hub agreement is that if organizational contracts regulate relations related to the transfer of goods by shippers to the carrier or vice versa, then the hub agreement regulates only relations related to the transshipment of goods from one mode of transport to another (Egiazarov, 2008, p. 139).

After the collapse of the USSR and the mass privatization of the transport industry, all hub agreements ceased to exist. However, serious problems arose at the points of docking of various types of transport, which not only significantly slowed down traffic flows, but also made them much more expensive. Today, the hub agreement does not work in any of the transport hubs of Russia. Internal documents are being adopted in some ports in order to "expand" the bottlenecks and not allow the port to be turned into a place for long-term cargo storage, as well as to establish operational interaction with other modes of transport.

Such documents, in their essence and meaning, are similar to a hub agreement. They are not a Soviet invention, but have long been well-known in maritime transport, where they are called "Port's Customs & Habits," and primarily meet the interests of the port. After the unified hub agreements were cancelled, the first such document among Russian river ports was created in the Osetrovsky river port. The document was called "Rules for handling vehicles and cargo in JSC Osetrovsky River Port" (Osetrovo, 2014). However, we recall that this was a document of the port, and it protected only its interests.

As it can be seen, the situation is extremely complex and very contradictory. Taken into account this difficult situation, one cannot do without the real help of the state. Assistance will be required in two main areas.

The first area is organizational. In the conditions of a serious shortage of carrying capacity on the Lena River, it is necessary to simultaneously provide the following aspects:

- northern delivery of goods to remote settlements of Yakutia;
- delivery of goods to settlements along the Lena River, up to and including Yakutsk;
- delivery of goods for arranging of the Chayandinskoye OGCF.

The demand for transport services is many times higher than the supply; following the laws of the market should provoke an unrestrained price increase on the part of a few river carriers. We cannot allow this. Therefore, on the one hand, one has to make a strong-willed decision on ranking priorities, and on the other, it is necessary to sign a hub agreement that will oblige all participants in the transport process to play by the same rules, without an explicit priority of their current benefits.

It is well-known that a hub agreement is a contract between all participants of multimodal transportation, and such a contract should be firmly based on a legal basis. The authors believe that the most successful solution would be to build such a contract on the provisions of the Federal Law "On Direct Mixed (Combined) Transportation." However, there is no such law in Russia, although there is a reference to it in the Civil Code (Article 788); there are only numerous draft laws that have been moving from department to department for about 25 years but never get to the completion stage.

The second area of assistance is economic or financial. The situation with the cargo fleet on the Siberian rivers of Russia is simply catastrophic. The entire fleet was built during the Soviet era, so by now it has grown very old. Today's shipowners operate what can still be repaired and operated, but ships keep retiring and the fleet is not renewed.

The increase in cargo turnover – i.e., the need for tonnage – imposed on the physical reduction of this tonnage leads to a shortage and an inevitable increase in transportation rates. As a result, all goods and materials delivered with the help of the river fleet become more expensive.

The authors got acquainted with the plans of the Soviet period to develop navigation on the rivers of Eastern Siberia to provide transport support for some oil and gas-bearing regions of the Far North. For example, the plans dated 1984 provided for the active construction of heavy-duty barge-towing trains with a lifting capacity of up to 16,000 t in the period from 1986 to 1991. Project documentation for nonself-propelled ship sections with a lifting capacity of 3750 t was actively developed. A whole line (modules) of barge platforms with a lifting capacity of 1300, 2000, and 2500 t was supposed to be built.

All these required tugboats, and the Soviet shipbuilding industry was quite able to handle the production, especially since the sections and modules were not very expensive and could well be performed far from the shipbuilding and ship repair plants, which were modern (even at that time) but numerous.

The authors are well aware that these plans are more than 35 years old and that it is not right to simply reapply these plans in modern conditions. However, some technical indicators are relevant today. The natural and climatic conditions of northern Siberia have not changed, the great Siberian rivers still carry their waters from the south of the country to the north, not all known deposits have been developed, and there are human, scientific, and industrial potentials.

As such, why isn't the fleet being updated? The question is almost rhetorical – navigation lasts a maximum of 4–5 months in the harsh northern climate, especially in the lower reaches of rivers that are located beyond the Arctic Circle. Shipowners have the opportunity to earn money only in these 4–5 months, while the rest of the time the fleet is idle in the winter sludge. Of course, the fleet not only does not earn money during this period, but it has to spend on protecting and maintaining ships in working condition.

Very simple calculations show that by borrowing funds at a standard bank interest, the cargo ship of the most recent project, with a lifting capacity of 3000 t, will only pay off in 28–30 years. This is a very long time, comparable to the life cycle of the ship itself, while ships are rarely used for more than 35–40 years.

Thus, according to the unwritten but very clearly observed rules of the maritime shipping business, large and respected insurance companies insure ships over 20 years old with a serious increasing coefficient, and they refuse to insure the ones over 25 years old at all. The ships and barges that have celebrated their half-century anniversary still operate on the Lena River.

It turns out that no one, even the most optimistic business, should invest in such a long and unreliable project. The authors see only one solution – they need financial assistance from the state, for example, in allocating a loan at a very low interest rate, or allocating a state subsidy for constructing river vessels for northern delivery.

Conclusions

It is quite obvious that the harshest natural and climatic conditions in the regions of the north of Siberia and the Far North of Russia turn the development of oil and gas fields into a labor-intensive, technologically complex, and extremely expensive business. Today, it is high time to admit that traditional logistics methods and technologies simply do not work in such conditions – the existing transport infrastructure facilities are extremely small and seriously worn out.

The cargo fleet on the great Siberian rivers (the Ob, Yenisei, and Lena) is worn out, most of the vessels have been in operation for 35–40 years or more, and the fleet renewal almost completely stopped in the early 1990s. Today, the fleet is coping with the current tasks of ensuring the delivery of goods to remote northern regions with great difficulty, and is not ready for a sharp increase in cargo traffic due to the development of oil and gas fields.

An unacceptable competition arises between socially significant cargo and cargo for the arrangement of facilities for oil and gas production in the conditions of an obvious shortage of freight and transshipment capacities. In such a difficult situation, the state's assistance is extremely necessary. Assistance is required in specific areas: organizational, legal, and financial support for the construction of the fleet.

To implement the first one, it is worth adopting the law "On Direct Multimodal Transport," in which it is crucial to lay the legal basis for the formation of a hub transport agreement. This, in turn, should provide a clear mechanism for organizing the interaction of companies, various forms of ownership in water-land transport, and logistics hubs.

To implement the second part, a mechanism for financial support for renewing the fleet on the Siberian rivers should be developed. In today's economic conditions, coupled with an extremely short navigation period, the payback period of a new vessel will be 28–30 years, which makes this type of business extremely unpopular.

At the same time, small- and medium-tonnage water transport for the delivery of LNG is a rapidly developing sector of the world economy. This can become an important area for the development of regional programs in the field of energy for Russia. LNG can act as an alternative type of fuel for remote northern settlements. Diesel fuel is usually delivered to these settlements. However, the sources of production of this fuel are very far from the place of its consumption, so the share of transport costs is up to 70% of the total cost of fuel. However, LNG is already being produced in the northern regions. The Yamal LNG plant with the Sabetta shipping terminal is already operating (Ivanov et al., 2020).

Besides, the Arctic LNG-2 plant, with a shipping terminal, is under construction. Both terminals are located in the water area of the Gulf of Ob. The LNG produced at these plants can be rationally used for autonomous gasification of northern settlements. The low cost of LNG and the shorter delivery of energy resources make it a good alternative to traditional diesel fuel.

Also, in the north-eastern part of Russia, settlements along the banks of the Ob and Taz Bay in the Yamal-Nenets Autonomous District, or settlements in the upper reaches of the Yenisei River to the city of Lesosibirsk in the Krasnoyarsk Territory, a group of districts located on the left bank of the Lena in the Republic of Sakha (Yakutia), can be gasified in a similar manner. With the development of coastal transportation, settlements along the Yana and Kolyma rivers can be gasified.

Of course, long navigation makes it hard to implement these plans. For example, when LNG is delivered along the Yenisei River from the LNG source (hub in Dudinka) to the most remote consumer (the city of Lesosibirsk), the distance is more than 1640 km. There is no combination of such working conditions and distances to consumers in any existing system of low-tonnage LNG delivery by inland water transport.

At the same time, there are some promising developments in Russia, so the vessel of the Lenaneft 621 project meets the necessary navigation parameters. It has the navigation category M-PR 3,5 of the Russian River Register, which allows operating throughout the entire river basin from the LNG source located at the mouth of the Lena, Ob, and Yenisei to the most remote consumer located on the banks of this river (Scherbanin, 2019).

The development of large-scale oil and gas projects in the Arctic zone of Siberia requires the active and urgent involvement of inland water transport. A scenario when oil and gas companies will have to create their river fleets cannot be ruled out. They should not be as powerful as the former Soviet giants Yenisei and Lena River Shipping Companies, but they should have the necessary transportation capabilities.

Such a fleet can be sold or leased when the main planned facilities are completed. It seems that the method will be very expensive, but this is the only real way to ensure the delivery of the necessary volumes of cargo. The existing shortage of ships will not be objectively eliminated soon; moreover, it will be intensified when the old fleet retires (it has not yet been replaced and no one knows when it will be).

It should be noted that at one time, Mexicans and Norwegians took the same path when developing offshore projects (Scherbanin & Golubchik, 2016). They had to, since they just had no other options.

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Part VIII

Ecology

Environmental Aspects of Arctic Development

Natalia S. Zagrebelnaya

Contents

Abstract

Large hydrocarbon reserves in the Arctic attract companies that begin to exploit them intensively. The specific ecosystem of the Arctic (special climatic and hydrological conditions) is exposed to significant environmental risks. In this context, it is important to identify the most acute environmental problems and propose on this connection that it is topical to identify the most acute ecological problems and to propose ways of their solution. As in the rest of the world, one of the most important problems is climate change. However, in the harsh conditions of the Arctic, these changes occur on average twice as fast as in the rest of the world. Rising temperatures cause the Arctic ice to melt, which leads to land subsidence and, consequently, to the collapse of industrial structures, which creates emergency situations leading to accidental spills. In addition, the development of the Arctic generates large amounts of greenhouse gases, and as the temperature rises and the ice melts in the region, their growth is even greater. The international community and the Arctic states are already implementing measures

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aimed at solving the main environmental problems of the development of Arctic resources. International environmental cooperation is being developed, and a national legal framework has also been formed which defines measures aimed at combating environmental pollution in the Arctic. At the same time, the author proposes possible new ways of solving the main environmental problems of the Arctic resource development, in particular the creation of an environmental cluster and the development of eco-tourism and green energy projects.

Keywords

Ecology · Arctic · Development of Arctic resources · Environmental problems · Climate change · Sustainable development

Introduction

Large-scale development of resources in the Arctic makes its ecosystem quite vulnerable, increasing the risk of accidents, leaks, and emissions of harmful substances into the atmosphere and the marine environment, which causes irreparable environmental damage. Under conditions of ongoing climatic changes, existing environmental problems in the Arctic become even more acute.

In order to solve environmental problems in the Arctic, relevant international agreements have been developed and international organizations dealing with issues of environmentally safe development of resources of the Arctic region have been established. The Arctic states have developed laws, programs, and strategies that define goals, directions, and tools to help minimize environmental damage.

The hypothesis of the study is that the obviously adopted measures to solve the environmental problems of the Arctic development are not enough, as evidenced by the aggravation of environmental problems in the region, so it is advisable to complement them with new measures. Thus, it is likely that the ecological cluster, eco-tourism, and "green" energy can become effective components of the environmental security system in the Arctic.

Literature Review

A large number of scientific papers, both Russian and foreign, are devoted to the issues of development of the Arctic resources and the environmental problems arising in this region.

A number of authors consider the environmental aspects of resource development in the Arctic in modern conditions (Brekhuntsov et al., 2020; Dudin et al., 2016; Kondratiev, 2020; Lipina et al., 2019; Przybylak & Wyszyński, 2020; Tolvanen et al., 2019; Sayedi et al., 2020; Sherstyukov, 2016; Shevchuk, 2015; Shulga et al., 2020).

The works of some Russian authors pay attention to certain ways and directions of solving the existing environmental problems in the Arctic region (Carayannis et al., 2017; Cherepovitsyn et al., 2018; Roslyakov & Ganyuschkina, 2021; Sedova & Kochemasova, 2018; Shevchuk & Shumikhin, 2019; Sheveleva, 2018).

The study of the above problems has been addressed by the works of foreign scholars (Nuttall, 2021; Pisaric & Smol, 2021; Koivurova & Liu, 2018; Birchall & MacDonald, 2019). The experience of the Arctic states in ensuring environmental security in the Arctic and achieving the indicators of sustainable development in accordance with the UN goals is considered separately (Gutenev, 2019; Dzyuban, 2019; Laruelle, 2020; Lipina et al., 2018; Rekets, 2020; Ryzhova, 2020; Sakharov & Andronova, 2020; Todorov, 2018).

At the same time, we would like to note that the above-mentioned works consider only individual environmental aspects of the development of the Arctic, either in the country context or in the legal context.

In this regard, the aim of the research is to identify the most acute environmental problems in the Arctic and at the same time to analyze the existing measures aimed at their solution, and to propose new possible measures to improve environmental safety in this region.

Arctic Resources and Conditions of Their Extraction

According to a study conducted by the U.S. Geological Survey, the Arctic has significant hydrocarbon reserves, in particular, about 13% of the world's undiscovered oil reserves and 30% of natural gas. Explored oil reserves are estimated at 90 billion barrels, which is about 6% of the world level, and natural gas almost 1670 trillion cubic meters, which is about 24% of the world level (Kondratiev, 2020).

Almost all of the Arctic's oil and gas resources are distributed among five countries: Russia, the United States, Denmark, Canada, and Norway (Fig. 1).

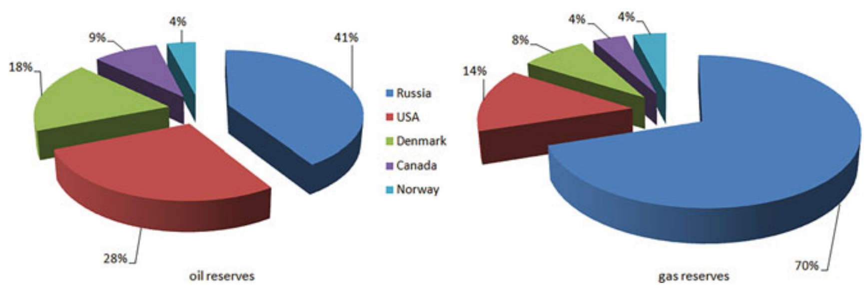

Fig. 1 Distribution of oil and gas reserves by country sector in the Arctic. (Source: Compiled by the author according to the Report of the Institute of Regional Problems (2015). *The Role of Arctic Oil and Gas Production in the Development of Russian Regions*. https://www.irpr.ru/wp-content/uploads/2015/01/irp_brochure_rus.pdf)

The presence of a significant amount of oil and gas reserves in the Arctic, the depletion of already developed fields in other regions, as well as the strategic task of ensuring the presence in the Arctic zone determine the possible growth of hydrocarbon production, especially on the Arctic shelf. Thus, according to a forecast made in 2015 by the World Petroleum Council (WPC), by 2030, oil production only on the Russian shelf of the Arctic will increase more than 3.6 times from 600,000 to 2.2 million barrels of oil equivalent per day. Other countries developing fields on the Arctic shelf are expected to increase 4.4 times in total: Norway may increase daily oil production from 100,000 to 700,000 barrels of oil equivalent per day, Canada – from 200,000 to 900,000 barrels of oil equivalent per day, the United States from 100,000 to 150,000 barrels of oil equivalent per day (Fig. 2).

At the same time, as Lipina et al. (2018) put it, the development of Arctic resources is carried out under rather difficult conditions:

- harsh climate, with negative air temperatures year-round, permafrost, and even the water surface covered with ice;
- the seasonal nature of operations and deliveries of material and technical resources and equipment, the short period of operation for production facilities and installations, and difficulties in maintaining them in winter;
- the low degree of geological exploration, which is complicated by eternal ice and significant depths of the Arctic seas;
- the need to constantly monitor weather conditions, track the condition of oil platforms, as they are exposed to wave loads, icing, encountering icebergs

All of the above require companies to make significant capital investments and apply unique, often untested technologies. Therefore, the intensified development of

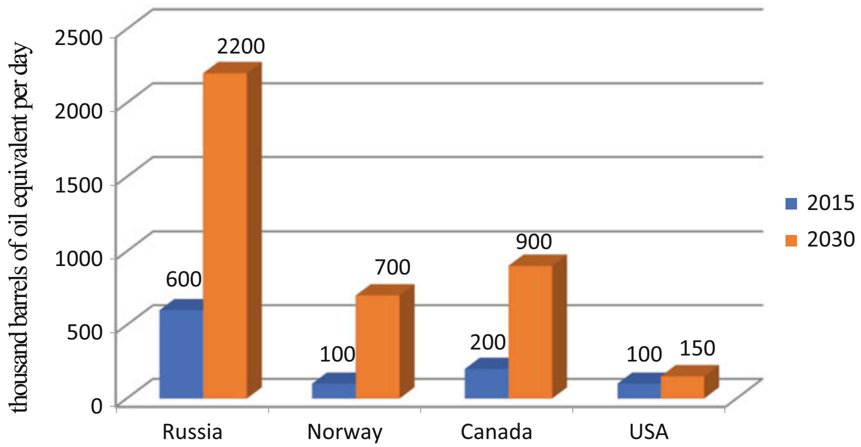

Fig. 2 Forecast of oil production growth in the Arctic shelf from 2015 to 2030, thousands of barrels of oil equivalent per day. (Source: Compiled by the author on the basis of the World Petroleum Council Yearbook (2015). Retrieved from: https://ineiran.ru/articles/WPC_Yearbook_2015.pdf)

oil and gas fields in such a complexly organized ecosystem of the planet as the Arctic strengthens and expands the already wide range of environmental problems in this region.

Environmental Problems of Developing Arctic Resources

Due to the intensification of economic activities in the Arctic, in particular the intensification of oil and gas prospecting, production and refining, as well as the construction and development of infrastructure for their transportation, a number of environmental problems arise.

According to the United Nations Environment Program (UNEP, 1972), the following environmental problems are manifesting themselves in the development of Arctic resources:

1. the climate is changing, Arctic ice is melting, and permafrost soils are thawing as global warming occurs;
2. Northern seas are polluted by wastewater containing pollutants such as petroleum hydrocarbons from production facilities and marine transportation;
3. littering and pollution of Arctic territories with industrial and municipal wastes;
4. precipitation of pollutants that fall into the environment from industrial facilities under development;
5. biodiversity and populations of various Arctic animals are decreasing as the human impact and climate change occur.

Almost all of the above-mentioned problems occur in different regions of the planet, but it is in the Arctic that they cause the greatest ecological damage. This situation is caused by the specific features of the Arctic ecosystem, in particular the special climatic and hydrological conditions (Sherstyukov, 2016).

First, climate formation in the Arctic occurs with a low influx of heat coming from the Sun.
Second, the extreme hydrological conditions are associated with significant sea level fluctuations and storms.
Third, the presence of permanent ice cover and drifting ice in the seas of the Arctic.
Fourth, the North Pole, located in the Arctic, is exposed to the geomagnetic pole, which contributes to the most favorable conditions for more polluted particles to accumulate in the atmosphere.

Thus, the Arctic climate is very sensitive to changes in the amount of greenhouse gases in the atmosphere, particularly carbon dioxide and methane. And the intensification of resource development in the Arctic is one of the main reasons for their increase.

These harsh conditions in the Arctic cause the most severe climate changes, which on average are twice as rapid as in the rest of the world. Over the past forty

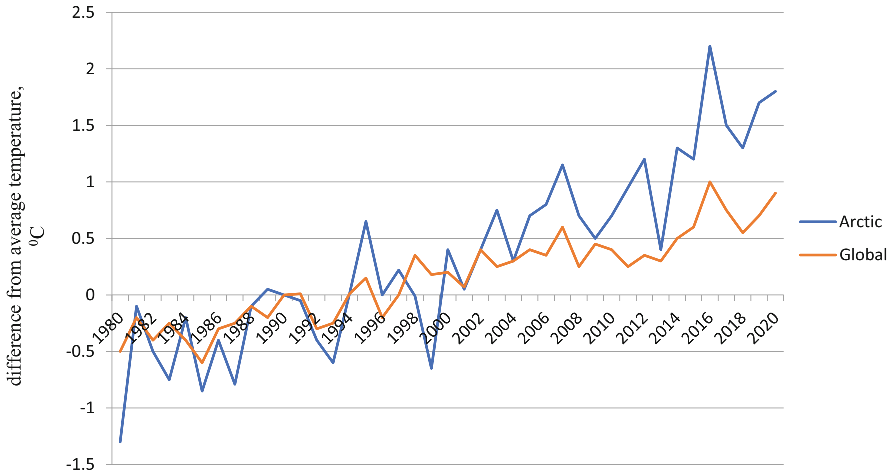

Fig. 3 Dynamics of deviations from the norm of average annual air temperature in the world and in the Arctic over the period 1980–2020, degrees Celsius. (Source: Compiled by the author on Scott, M. (2020). *2020 Arctic Air Temperatures Continue a Long-term Warming Streak*. Retrieved from: https://www.climate.gov/news-features/featured-images/2020-arctic-air-temperatures-continue-long-term-warming-streak)

years there has been a significant increase in temperature in the Arctic, with the deviation from the norm, since 2000, exceeding the global values and tending to increase (Fig. 3).

Rising temperatures in the Arctic generally cause ice to melt. Between 1980 and 2020, the area of sea ice in the Arctic region nearly halved from 7.67 to 3.92 million square kilometers (Fig. 4).

Climate warming in the Arctic and the melting of ice are causing such dangerous phenomena as soil movement and ground subsidence. They pose a threat to the development of resources in this region because most industrial structures, in particular buildings, sites of oil and gas production facilities, oil and gas pipelines, reservoirs, have pile foundations based on permafrost soils and are built with the expectation that they will be operated under certain temperature conditions. As a result, in the event of ground subsidence, such industrial facilities are severely damaged and fail. This is often the cause of accidents accompanied by oil spills and emissions of harmful substances into the atmosphere, which in the Arctic, compared to other regions, are much more difficult to eliminate due to insufficient natural lighting, poor weather conditions (e.g., ice drift, strong winds).

The offshore production of oil, gas as well as gas condensate also poses a threat to the Arctic ecosystem. In the process of launching wells, drilling, extraction, and transportation of resources through offshore parts of pipelines or by tankers, leaks or accidents may occur, as a result of which the marine environment will be polluted with hazardous substances, which decompose very slowly in low temperatures and harm the environment of the Arctic and nearby regions for quite a long period of time.

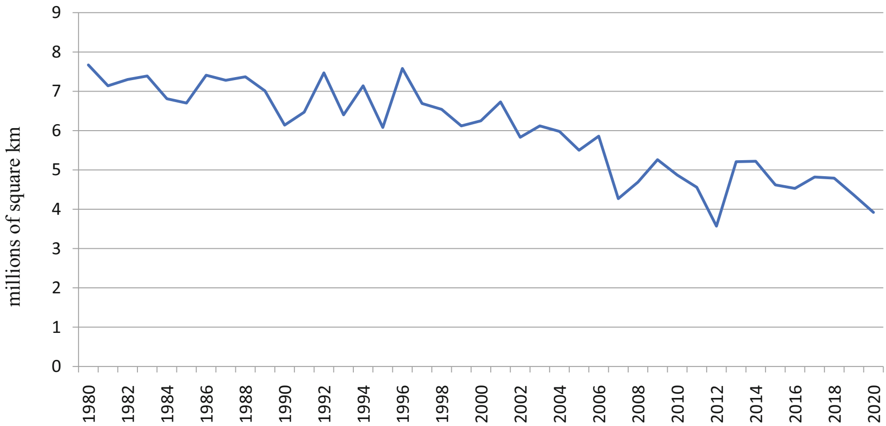

Fig. 4 Change in the area of sea ice in the Arctic over the period 1980–2020, million square kilometers. (Source: Compiled by the author on NASA (2021). *Arctic Sea Ice Minimum*. – https://climate.nasa.gov/vital-signs/arctic-sea-ice/)

In the process of drilling wells pollutants enter the atmosphere and the sea, and formation water is discharged. During burning of associated petroleum gases thin films are formed on the sea surface around oil and gas production platforms. During long-term exploitation of oil and gas fields the level of seismological hazard increases as subsidence of rocks occurs. During transportation by tankers, accidents and spills often occur when loading and unloading operations and bunkering operations are performed. Accidents on offshore oil and gas production platforms are also not uncommon, with contamination of the sea by hazardous substances.

Accidents in ice-covered areas pose the greatest danger, since so far there are no technologies and equipment allowing for the most effective elimination of oil spills from such surfaces.

Another threat to Arctic ecology is greenhouse gases, primarily CO_2 and methane. According to calculations by specialists of Brigham University, who study climate problems and their causes in the Arctic, it has been calculated that the permafrost at the bottom of the Arctic Ocean contains about 60 billion tons of methane and 560 billion tons of carbon-bearing compounds.

By conducting their own assessments and measurements of maritime permafrost deposits located in various regions of the Arctic, scientists have determined that from these deposits almost 5.3 million tons of methane and 140 million tons of carbon dioxide enter the atmosphere every year. In case the goal of sustainable development of keeping the average annual temperature growth on the Earth at the level of 2 °C is achieved, then until 2100 about 43 billion tons of carbon dioxide will be released from sea deposits of permafrost. But if rapid temperature growth which can be observed nowadays will continue, emission volumes will increase by more than 2.5 times and will amount to 110 billion tons over the same period. This figure is four times the average annual level of carbon dioxide emissions of mankind (Sayedi et al., 2020).

Melting ice in the Arctic also produces new sources of greenhouse gases that pollute the atmosphere:

- the organic matter preserved in the ice that existed in the preglacial period, thaws;
- microorganisms preserved in the ice are activated;
- previously formed greenhouse gases are released;
- microbial activity in the melted layers increases.

New sources of greenhouse gases in the Arctic region, in turn, further intensify climate warming, thus, creating a vicious circle.

The development of the Arctic, in particular the development of oil and gas fields, the construction of transport routes without taking into account the natural features of the region, the long period of decomposition of pollutants in difficult climatic conditions has led to the formation of so-called accumulated damage, which in addition to having a negative impact on the environment, also creates obstacles to further work in the region.

In order to minimize the negative impact of environmental problems from each group it is worth taking specific measures and to carry out a number of activities.

Implemented Measures to Solve the Main Environmental Problems of the Development of Arctic Resources

In order to solve the environmental problems of the development of Arctic resources, the international community and the Arctic states are already taking certain measures and carrying out relevant activities. Among the most actively used are the following.

First, international environmental cooperation is being developed, in particular, international agreements are being developed and international organizations are being established for the environmentally safe development of Arctic resources.

Second, national normative-legal regulation is being formed in order to combat pollution of the Arctic environment.

The most important documents for solving environmental problems in the Arctic are the following:

- The Rovaniemi Declaration on the Protection of the Arctic Environment along with the Arctic Environmental Protection Strategy (AEPS), 1991;
- The Nuuk Declaration, 1993;
- Agreement on Cooperation on Marine Oil Pollution Preparedness and Response in the Arctic, 2013;
- The International Code for Ships Operating in Polar Waters (IMO), 2014.

According to the provisions of the 1991 Declaration on the Protection of the Arctic Environment (the Rovaniemi Declaration), representatives of the governments of several countries (the United States, Canada, the USSR, Finland, Sweden, Norway, Denmark, and Iceland) made a commitment to implement a joint strategy for environmental protection in the Arctic, create a system of environmental monitoring and assessment of pollution by harmful substances in the Arctic region, and prevent situations that could lead to accidents that destroy the ecosystem of the Arctic.

The Nuuk Declaration on Arctic Environment and Development of 1993, signed by ministers of the Arctic states (the United States, Canada, Russia, Norway, and Denmark), recognizes the need to carefully exploit Arctic resources and apply special protective measures aimed to preserve the unique Arctic ecosystem. It also stresses the importance of observing the provisions of the UN Convention on Environmental Impact Assessment in a Transboundary Context, which emphasizes that the environmental impact of potentially dangerous projects must be assessed not only in the place where the project is implemented, but also in neighboring countries that may also be adversely affected by the project. This applies in particular to preventing pollution of the Arctic's water space.

The 2013 Arctic Marine Oil Pollution Preparedness Cooperation Agreement, signed by representatives of the governments of the United States, Canada, Russia, Finland, Sweden, Norway, Denmark and Iceland, is one of the tools to protect the Arctic environment from pollution as the development of Arctic resources intensifies. The purpose of this agreement is to strengthen cooperation among the Arctic states, to ensure coordination and mutual assistance in preparedness, timely response and protection against possible oil pollution of the Arctic marine environment. To this end, the countries must monitor the environmental situation in the Arctic region and establish national systems to ensure preparedness to respond to situations causing oil pollution. They must also cooperate with each other, exchange information, and conduct joint exercises and training in pollution response operations.

The provisions of the International Code for Ships Operating in Polar Waters (the Polar Code), adopted in 2014, which came into force in 2017, establish requirements to improve the safety of ship operations in remote, harsh polar waters, particularly in the Arctic, and prohibit the discharge of oil and oily water, harmful liquid compounds, waste water and garbage into polar waters, including the Arctic seas.

However, there are no provisions in the Polar Code that address atmospheric pollution. In this regard, the Arctic states have to be guided in this matter by Annex VI to the International Convention for the Prevention of Pollution from Ships (MARPOL), adopted by the International Maritime Organization. The provisions of this convention are aimed at establishing mandatory measures of a technical nature that contribute to the reduction of emissions arising from the use of fuel for ships. In this way, the Arctic states combat atmospheric pollution.

As a result of the implementation of the main provisions of the above-mentioned international agreements and documents in the Arctic, treatment facilities are being installed at industrial facilities, the design of tankers and the parameters of drilling and extraction equipment are being changed.

In order to solve environmental problems in the Arctic, a large number of international organizations have been established, among which the Arctic Council (2021) is of particular importance.

The Arctic Council is the leading intergovernmental forum promoting cooperation and interaction between the United States, Canada, Russia, Finland, Norway, Sweden, Denmark and Iceland on sustainable development and environmental protection in the Arctic region.

The Arctic Council's objectives are implemented by six working groups:

- Arctic Contaminants Action Program (ACAP);
- Arctic Monitoring and Assessment Program (AMAP);
- Conservation of Arctic Flora and Fauna (CAFF);
- Emergency Prevention, Preparedness and Response (EPPR);
- Protection of the Arctic Marine Environment (PAME);
- Sustainable Development Working Group (SDWG).

The Arctic Contaminants Action Program aims to ensure that the governments of the Arctic states organize and implement activities aimed at cleaning up and preventing pollution and emissions from resource development in the region.

Arctic Monitoring and Assessment Program is responsible for measuring and assessing the effects of harmful substances on the Arctic environment and preparing reports on the state of the Arctic ecosystem.

Conservation of Arctic Flora and Fauna works to preserve biological diversity in the Arctic.

Emergency Prevention, Preparedness and Response trains and exercises to deal with emergencies.

Protection of the Arctic Marine Environment prepares proposals on issues of recommendations aimed at protecting the Arctic marine environment and preventing and controlling its pollution.

Sustainable Development Working Group implements measures to protect and improve the Arctic environment.

In May 2021, the Arctic Council adopted the Strategic Plan for 2021–2030, which reflects the values and aspirations of the Arctic states to advance the goals of sustainable development and environmental protection in the Arctic region. According to this strategic plan, the Arctic Council intends to achieve seven key goals over the next ten years, three of which are directly related to addressing the major environmental challenges of developing Arctic resources.

The *first goal* concerns the Arctic climate. The Arctic Council will monitor, assess and report on the impacts of climate change in the region to determine whether or not the provisions of the Paris Agreement to reduce greenhouse gases in the atmosphere, as well as other harmful emissions that pollute the Arctic environment, are being met. The Arctic Council will also facilitate the sharing of knowledge and innovative technologies developed by various countries that address the above-mentioned challenges of minimizing the negative impacts of climate change in the Arctic region.

The *second goal* is related to the health and vitality of Arctic ecosystems. To achieve this, the Arctic Council plans to help prevent possible contamination of these ecosystems, monitor and assess their condition, and protect them using existing and emerging sustainable development approaches.

The *third goal* is to improve the health of the Arctic marine environment. In this regard, the Arctic Council will undertake efforts to prevent pollution in the Arctic seas, monitor and assess current and future impacts on the Arctic marine environment, and promote environmental safety at sea.

An important role in solving the main environmental problems of Arctic resource development is played by national legal and regulatory frameworks developed by the Arctic states (the United States, Canada, Norway, Denmark, and Russia).

In the United States, the environmental factor underlying Arctic strategies is one of the ways to ensure the political influence of U.S. leaders, both at home and abroad.

President B. Obama sought to protect the sensitive and unique ecosystem of the Arctic when, despite the fact that there are already stringent standards for the safety of hydrocarbon production, there remains a high probability of oil spills, which are very difficult to eliminate in the Arctic conditions. To achieve his goal, he invited Canadian Prime Minister J. Trudeau to negotiate solutions to environmental problems in the Arctic and they jointly signed a ban on offshore oil and gas extraction in Arctic waters in December 2016.

President D. Trump, upon coming to power, signed an executive order in April 2017 aimed at developing the U.S. energy industry, according to which restrictions on oil drilling in the Arctic were lifted. Also, at the very end of his presidential term, Trump issued licenses for oil and gas production in the Arctic National Wildlife Refuge.

In early 2021, the administration of U.S. President Biden suspended these licenses and requested an environmental review to investigate the effects of oil and gas production on the Arctic ecosystem and determine the possibility of environmentally safe development of resources in the region.

In Canada, in order to prevent pollution of the Canadian Arctic islands and Arctic waters adjacent to the mainland, the Arctic Waters Pollution Prevention Act was passed back in 1970, which provided for administrative and civil liability, as well as large material penalties for entities that pollute the marine environment.

In order to protect the environment in the Arctic, in September 2019, Canada developed a strategy for comprehensive socioeconomic development in Canada, the Arctic and Northern Policy.

Also in 2019, the Canadian government passed a resolution that imposed a ban on any activity related to hydrocarbon extraction on the Canadian Arctic shelf until 2021. To date, this ban is still in force.

In Norway, the main activities related to environmental issues of resource development in the Arctic are reflected in the strategic document published by the

Ministry of Foreign Affairs of Norway in November 2020, entitled “People, opportunities and interests of Norway in the Arctic. This document emphasizes the need to establish a center that would ensure preparedness and prompt response to possible oil spills.

It should be noted that in contrast to the regulatory framework of the United States and Canada, which is dominated by imperative norms and requirements aimed at taking specific measures to address environmental problems of the development of resources in the Arctic, in the legislation of Norway the main burden of responsibility for the safe conduct of works related to the exploration and extraction of resources lies mainly on the oil and gas companies. Thus, companies have certain flexibility in choosing the means of fulfilling the requirements related to environmental protection in the Arctic, achieving the set environmental goals and ensuring environmental safety in this region.

In Denmark the measures related to solving environmental problems of resource development in the Arctic by 2020 were spelled out in the “Strategy of the Kingdom of Denmark for the Arctic 2011-2020.” In September 2020, a new document Arctic Strategy 2021–2030 was adopted, whose main objective is to preserve the stable environmental situation in the region.

Denmark adheres to the principle of sustainable development in the development of offshore fields in the Arctic, for the implementation of which a lot of research and development works are carried out, aimed at reducing the risk of oil spills and environmental pressure in the Arctic.

In Russia, a number of documents have been adopted to address the major environmental problems of the development of Arctic resources, the most important of which are the Foundations of State Policy of the Russian Federation in the Arctic until 2035, approved by Presidential Decree No. 164 of March 5, 2020, and the Strategy for Development of the Arctic Zone of the Russian Federation and National Security for the Period to 2035, approved by Presidential Decree No. 645 of October 26, 2020.

In the Foundations of the state policy of the Russian Federation in the Arctic for the period up to 2035, one of the national interests of the Russian Federation is environmental protection in the Arctic.

This document notes that during the implementation of the state policy of the Russian Federation in the Arctic as of 2020 the application of special regimes of nature use and environmental protection in the Arctic zone of the Russian Federation has been expanded. However, it remains that the environmental monitoring system available in the Arctic zone of the Russian Federation is not prepared for environmental challenges.

An important goal of the state policy of the Russian Federation in the Arctic is environmental protection. And among the main directions of implementation of the state policy of the Russian Federation in the Arctic is ensuring environmental safety, as well as the protection of territories of the Arctic zone of the Russian Federation from emergencies of natural and man-made nature.

Russia’s main tasks in the sphere of environmental protection and environmental safety in the Arctic are related to:

- development, on a scientific basis, of a network of specially protected natural areas and water areas in the Arctic in order to preserve ecological systems and adapt them to the ongoing climate change;
- continuation of work aimed at the elimination of accumulated damage to the Arctic environment;
- improving the environmental monitoring system, using modern information and communication technologies and communication systems for measurements from satellites, offshore and ice platforms, research vessels, ground stations and observatories;
- introduction of the best available technologies, minimization of emissions into the atmospheric air, discharges of pollutants into water bodies and reduction of other types of negative impact on the environment during economic and other activities in the region;
- ensuring rational use of natural resources;
- developing an integrated system for handling all hazard class wastes, building modern environmentally friendly waste processing complexes;
- implementation of a set of measures to prevent various toxic and radioactive substances from entering the Arctic Zone of the Russian Federation.

The main tasks of Russia in the field of protection of the territories of the Arctic zone of the Russian Federation from emergencies of natural and man-made origin are related to:

- implementation of scientific, technical, regulatory and methodological support of activities to protect Arctic territories from natural and man-made emergencies, fire safety and safety on water bodies in Arctic conditions;
- development of Arctic complex rescue centers and firefighting and rescue units for liquidation of accidents and emergencies on water and continental shelf, improvement of their structure, composition, logistics and basing infrastructure, providing with new equipment, equipment and outfit, taking into account the tasks to be fulfilled in the Arctic environment;
- aviation support of measures to protect Arctic territories from natural and man-made emergencies in Arctic conditions.

The main indicator characterizing the effectiveness of the state policy of the - Russian Federation in the Arctic, aimed at solving environmental problems, is the share of investments in fixed capital in the total investments in fixed capital in the territory of the Arctic zone of the Russian Federation, carried out for the purpose of protection and rational use of natural resources.

The value of the indicator is defined in the Strategy for Development of the Arctic Zone of the Russian Federation and National Security for the period up to 2035.

Thus, according to the Strategy, the base value of the share of investments in fixed capital for the protection and rational use of natural resources in the total investments in fixed capital carried out in the Arctic zone (as a percentage) in 2019 was 2.6%, the target values for 2024 – 4.5%, 2030 – 6%, 2035 – 10%.

The Strategy for the Development of the Arctic Zone of the Russian Federation and National Security for the period up to 2035, in order to meet the main objectives related to environmental protection and environmental safety in the region, it is proposed to implement the following measures:

- create specially protected natural territories, ensure compliance with their special protection regime, including entering information about these territories in the Unified State Register of Real Estate;
- to adapt the economy and infrastructure of the Arctic zone to the ongoing climate change;
- identify, assess and record objects of accumulated environmental damage and organize work aimed at the elimination of accumulated environmental damage in the Arctic;
- develop a unified system of state environmental monitoring (state environmental monitoring), including the use of modern information and communication technologies and communication systems;
- conduct work in the field of hydrometeorology, in particular related to increasing the density of the observation network and technical equipment of environmental observation systems, taking into account the recommendations developed by the World Meteorological Organization;
- minimize emissions into the air, discharges into water bodies of pollutants arising in the course of economic and other activities in the Arctic zone, as well as to establish measures of state support aimed at the introduction of the best available technologies in the processes of economic and other activities in the Arctic zone;
- to prevent negative environmental consequences in the development of natural resources;
- develop a unified state system of emergency prevention and response, allowing the implementation of measures aimed at eliminating oil and petroleum product spills, including in the waters of the Northern Sea Route and other maritime transport corridors;
- prevent highly toxic and radioactive substances and dangerous microorganisms from entering the Arctic zone from abroad;
- conduct regular assessments of the environmental and socioeconomic consequences of anthropogenic impacts on the Arctic zone environment, including those caused by the transfer of pollutants from North American, European and Asian states;
- conduct regular assessments of the impact of nuclear power facilities located in the Arctic zone on the environment and the population;
- Ensure the rational use of associated petroleum gas in order to minimize flaring;
- provide state support for waste management activities in the Arctic Zone, improve the system of hazardous waste management in the Arctic Zone;
- create a system for promptly informing public authorities and the population in case of emergence or increase in risks of harmful impact of the most dangerous pollutants and microorganisms in connection with emergency situations caused by climate change.

The expected results of the Strategy for the Development of the Arctic Zone of the Russian Federation and National Security for the period up to 2035 include the following:

- it is planned to create a state system for monitoring and preventing the negative consequences of permafrost degradation;
- the efficiency of the unified state system for emergency prevention and response in the Arctic zone is to be improved;
- the process of replacing, in isolated and hard-to-reach areas, inefficient and polluting diesel power generation with generation based on liquefied natural gas and renewable energy sources will be completed;
- the negative impact of economic activity on the Arctic environment must be reduced and prevented.

In order to implement the above-mentioned activities, in September 2020, the Arctic Zone Public Council was formed under the Ministry of the Russian Federation for the Development of the Far East and the Arctic for a period of 2 years. One of the most important tasks of the Arctic Zone Public Council is to take part in the development of environmental protection measures in the Arctic zone.

In July 2021, the Public Chamber of Russia created a special fund "Clean Arctic," which aims to finance the environmental project of the same name, aimed at solving the problem of cleaning up the accumulated environmental damage of the Arctic territories.

In general, the ongoing activities to address the main environmental problems of the development of the Arctic resources at the international and national level are reduced to the development and adoption of international agreements and national legal and regulatory documents and strategies, the provisions of which are aimed at creating a system of environmental monitoring in the Arctic, structures for rapid response to environmental disasters, as well as reducing emissions of greenhouse gases and other pollutants into the Arctic marine environment, creating conditions to ensure the environmentally safe development of Arctic resources.

Possible New Ways of Solving the Main Environmental Problems of Arctic Resource Development

Despite the large number of measures already being implemented to solve the main environmental problems of the development of Arctic resources, these problems persist, and some of them are even more acute. In this regard, in addition to the already implemented measures, it is possible to propose possible new ways of solving environmental problems in the Arctic.

First, the implementation of a cluster approach in the Arctic region. Second, the development of ecological tourism in the Arctic. Third, the development of green energy projects.

At the present stage, new forms of organization of economic activities, which include ecological clusters, act as an effective response to the growing environmental challenges and threats. Therefore, it is proposed to create an environmental cluster in the Arctic, which would unite already existing international organizations and national authorities dealing with environmental problems in the Arctic; oil and gas companies, which are among the main polluters of the Arctic region ecosystem; scientific organizations and design institutes searching for the most effective ways to minimize the negative impact on the Arctic environment and technologies to prevent new environmental threats; investors. Thus, an approximate scheme of an environmental cluster in the Arctic may look as follows (Fig. 5).

The synergistic effect of the joint interaction of the above-mentioned participants of the environmental cluster will allow to solve the problem of accumulated environmental damage in the region, restore the polluted environment, as well as to develop and use environmental-friendly technologies in the development of resources in the region.

As another possible way of solving environmental problems in the Arctic, we can offer the development of ecological tourism. According to the definition of the International Union for Conservation of Nature, ecological tourism is understood as travel of people which contributes to protection of the environment. The feature of ecological tourism is the prevention of negative impact on nature, encouraging tour operators and tourists to protect it. Also, ecological tourism is one of the sources of

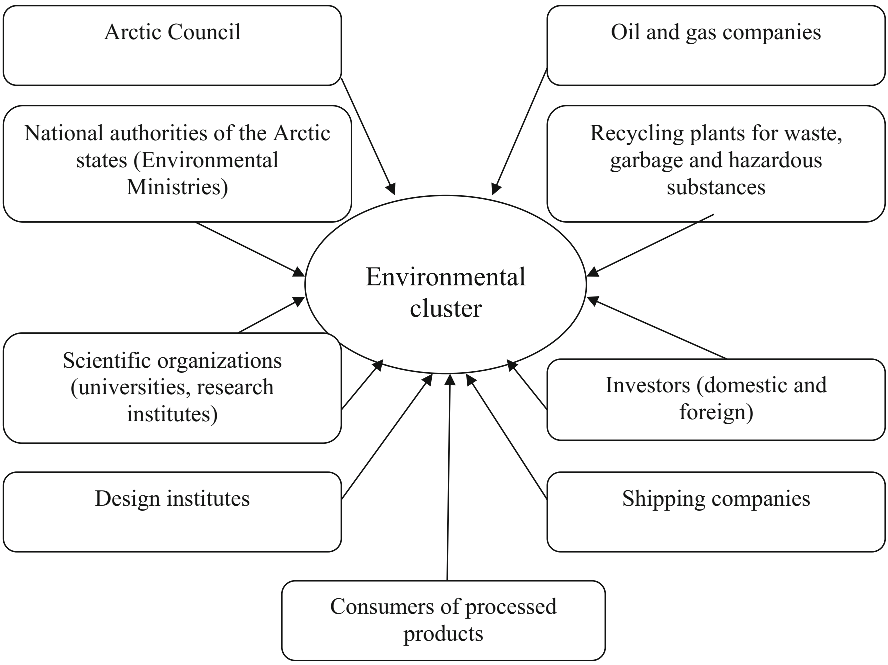

Fig. 5 Design of an ecological cluster in the Arctic. (Source: Compiled by the author)

income that can be directed to finance the implementation of environmental protection measures. For the Arctic, it is of particular importance. Eco-tourists can take part in the elimination of accumulated damage in the region by cleaning up garbage and waste, as well as in other environmental activities.

A possible solution to environmental problems in the Arctic could also be the development of green energy projects in this region. The energy supply of the Arctic is provided by diesel power plants, which require fuel that has to be transported from other regions. In this regard, the development of renewable energy sources in the Arctic would reduce the pollution caused by diesel and its transportation. Carbon dioxide, which is abundant in the Arctic region and is very harmful to the environment, can be used to produce alternative energy. Scientists from South Korea's National Institute of Science and Technology Ulsan (UNIST), together with specialists from the Georgia Institute of Technology (USA) have developed a new filtration system that absorbs CO_2 and produces electricity and usable hydrogen fuel. This installation, called Hybrid Na-CO_2 System, can be used in the Arctic to reduce the amount of CO_2 in the atmosphere and solve the problem of global warming.

Conclusions

The presence of large hydrocarbon reserves in the Arctic attracts oil and gas companies. However, the development of resources in this region is complicated by harsh conditions (permafrost, negative temperatures most of the time of the year), industrial facilities are exposed to the negative impact of the natural environment (icing, collisions with icebergs). This increases the risk of accidents accompanied by oil spills and emissions of harmful substances into the atmosphere and marine environment.

In addition, ongoing climatic changes, causing an increase in temperature, lead to melting of the ice, resulting in even more acute environmental problems in the Arctic.

At the same time, due to climatic conditions, self-purification processes in the Arctic ecosystem are much slower than in other regions.

All environmental problems of developing Arctic resources can be divided into two main groups: problems of a natural character and problems of a technological character.

The first group includes problems of global climate change, which causes increasing temperatures and melting of Arctic ice, causing, in turn, an increase in methane and carbon dioxide emissions, pollution of the Arctic environment with carbon-containing organic compounds.

The second group includes problems associated with the operation of various industrial facilities, which cause accumulated environmental damage, accidents accompanied by oil spills, emissions of environmental pollutants and greenhouse gases.

In order to solve the first group of problems, international agreements are being developed, international organizations are being established, national legislation and strategies of the Arctic states are being developed whose provisions and activities are aimed at protecting the Arctic environment, reducing greenhouse gas emissions, improving the marine environment, and preserving the unique Arctic ecosystem.

To solve the second group of problems, treatment facilities are being installed at industrial facilities, and companies are changing the design of equipment and ships.

However, the undertaken measures on solving environmental problems of the development of Arctic resources might be strengthened by the following.

First, to create an environmental cluster, which would solve the problem of accumulated environmental damage and restore the polluted environment due to the synergistic effect of interaction between international organizations, national bodies of the Arctic states, oil and gas companies, waste processing plants, consumers of waste products, scientific organizations, design institutes, transport companies, and investors.

Second, to develop eco-tourism in the Arctic, which would encourage tour operators and tourists to protect the environment and generate income that would finance the measures taken to solve environmental problems in the region.

Third, to develop "green" energy projects in the Arctic, which would reduce pollution from diesel used in industrial facilities, as well as solve the problem of recycling carbon dioxide, which can be converted into electricity.

All the above-mentioned activities will probably fulfill the objectives of sustainable development of the Arctic region and solve the problem of global warming in general.

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Wicked Problem of Waste Management in the Arctic Region

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Contents

Abstract

The accumulation of waste in the Arctic due to long-term anthropogenic load leads to irreversible degradation of the environment. Alongside modern economic activity, global warming and the release of plastic previously trapped by ice are threats to the further accumulation of waste in the Arctic. It is also shown that climate change increases the availability of marine and oceanic waters for

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navigation and tourism, which further exacerbates the accumulation of rubbish. It is revealed that the unsolvable problem of the accumulation of plastic and microplastics in the Arctic is its permanent intake due to the movement of the waters of the world ocean. It is noted that the migration of microplastics through trophic chains harms all participants in the chains and ultimately human health. It is established that the Arctic Zone of the Russian Federation, due to the significance of the territory and the movement of rubbish with the current and wind, is the "destination" of plastic and requires special efforts to minimize it. Global programs and Russian projects for cleaning the Arctic from plastic are presented in this chapter. A model of the movement of rubbish is proposed, which allows analyzing the deposition of its movement and predicting the accumulation areas. Using this model, mechanisms for allocating costs for cleaning the Arctic are proposed. Regulatory opportunities and limitations for cooperative interaction between the Arctic and other countries are shown, both in terms of financing waste management projects, and in the interests of intensifying the physical elimination of rubbish flows and preventing an environmental catastrophe in the Arctic.

Keywords

Wicked problem · Waste management · Arctic · Plastic · Microplastics · Garbage movement in Arctic waters

Introduction

The introduction of the principles of circular economy, which involve reducing the environmental burden simultaneously with economic growth and achieving the Sustainable Development Goals, requires modern approaches to managing the accumulated and generated waste (Ocean North, 2021). The Arctic region is largely affected by climate changes, which simultaneously underlie the formation of the climate, which requires close attention to the state of the environment in the region. The long-term anthropogenic impact on the territory of the Arctic without due attention to the environmental component of economic decisions has provoked the degradation of the natural environment due to pollution and the growth of waste volumes (Gorlysheva & Berdnikova, 2018).

The further socioeconomic development of the Arctic is associated with the combined influence of infrastructural and institutional factors, human resources, the industrial sector, with mandatory consideration of the ecological heritage (Didenko et al., 2015), environmental challenges, and management decisions for its restoration. In the last decade, research on Arctic pollution focused on persistent highly toxic organic pollutants, methane emissions, radioactive waste, hazardous industrial substances, and municipal waste (Arctic Regions, 2010).

Indeed, oil and gas, metallurgical, and mining projects are often implemented taking into account only economic efficiency, violating the environment of the

Arctic zone. The problem remains the spill of hydrocarbon substances, and the need to minimize them in Arctic waters requires international cooperation, which is partially ensured by the Polar Code introduced in 2017. It was aimed at preventing pollution with petroleum products, harmful substances, bulk, waste, and rubbish from ships (Deggim, 2017).

There is still a need to dispose of industrial waste and waste from the military garrisons (equipment, containers, metal structures, equipment, spent wells, etc.), which was accumulated, for example, on the territory of the Russian Arctic during the long Soviet period. It requires an inventory of both accumulated and generated waste from modern management, and the adoption of balanced alternative solutions for removal, burial, incineration (Mizin, 2014), waste processing, taking into account the economic and environmental consequences for each locality (Zhuravel, 2017).

An acute problem of recent years is the accumulation of nondegradable plastic waste in the world as a whole and the Arctic in particular. The increase in the volume of plastic rubbish In the Arctic is associated with the intensification of modern economic activities (Napper & Thompson, 2020; Tošić et al., 2020): shipping, tourism, the accumulation of solid household waste (SHW) as a result of the activities of the indigenous population and invited specialists; the movement of plastic rubbish with the flow of water masses (Murtaza et al., 2016) from other continents to the Arctic; with the ice melting and the release of plastic rubbish previously captured by ice into the Arctic waters. A special problem of our time is the pollution of water and land with microplastics, due to the ease of its movement both by current and wind (Strand et al., 2021) and along trophic chains, food chains, through birds and animals with a direct threat to human health.

It should be borne in mind that each country bordering the Arctic has internal state programs for environmental protection and waste management in its Arctic zones; however, global solutions to the problem of pollution of the Arctic, and especially its coastal waters, involve linking the interests of key Arctic powers, international organizations and councils. First of all, these are the interests of the coastal states – Norway, the United States, Russia, Canada, Denmark, (Arctic-5); then the subarctic countries-Finland, Sweden, Spain (Arctic-8); then the non-Arctic states of East Asia (China, Japan and South Korea); as well as the UN, the Arctic Council, the Barents Euro-Arctic Region Council, the institutions of the Nordic countries, the EU, and NATO (Sergunin & Konyshev, 2018).

The freedom of navigation, tourism, fishing, and research in the open international maritime space near the Arctic in some sense erodes the responsibility of countries for the migration of pollutants in the waters and on the coasts of the northern seas under climate change (Ivanova et al., 2018). The issues of the struggle for the resources and influence of countries in the Arctic, the expansion of the borders of the continental shelves of individual countries, the preservation of the sovereignty of the offshore zone (Boguslavskaya, 2019), the responsibility of countries in terms of waste management, both previously accumulated and generated due to the movement of the waters of the world ocean and modern management, remain debatable.

All things considered, the management of waste, in particular plastic, in the Arctic is an urgent problem of our time. The most important tasks include: identifying the causes and consequences of the accumulation and movement of plastic in the Arctic and the Arctic zone of the Russian Federation (AZRF), as well as projects to eliminate it; to model the movement of rubbish to understand the threats of its accumulation in specific territories (water areas); to establish restrictions and opportunities for regulatory consolidation of the responsibility of Arctic countries for accumulating plastic waste in the Arctic, in particular on the territory of the AZRF.

Materials and Methods

The research methods included the theoretical methods of analysis, generalization, identification of contradictions and analogies based on available scientific publications on the research topic. Important scientific works of the authors were used for the study:

– on the accumulation and movement of plastic rubbish in the Arctic as a whole – Murtaza et al. (2016), Halsband and Herzke (2019), Eisted and Christensen (2013), Eriksen et al. (2020), Strand et al. (2021), etc.;

- on the problems of plastic waste formation in the Arctic zone of the Russian Federation – Lima et al. (2021), Saprykina (2015), Tošić et al. (2020), Ivanova et al. (2018);
- on the migration of plastic and microplastics in food chains – Katare et al. (2021), Linnebjerg et al. (2021), Collard and Ask (2021), Ross (2021), Diepens and Koelmans (2018);
- UN reports, international conventions, state programs and regulatory documents of individual countries were studied to find information about the projects and activities that contribute to the management of plastic waste and minimization of pollution.

Wicked Problem of Waste Management: Analysis and Discussion

Problems of Plastic Waste Formation and Management in the Arctic

Accumulation and Movement of Plastic Waste in the Arctic Region

The amount of marine plastic waste has increased significantly over the past 60 years, with the largest amount recorded in the Northern Hemisphere (Andrade et al., 2021; Ostle et al., 2019). Borrelle et al. (2020) noted that at least 18.6 to 26 megatons, or 11% of the macroplastic waste generated in the world in 2019, ended up in the oceans. Plastic waste in the marine environment can travel long distances (Murtaza et al., 2016) and, depending on the size, composition, density and shape, plastic particles can accumulate in various Arctic ecological environments on land and in the sea, in soil or vegetation, in the water column, in bottom sediments, as well as in coastal zones (Halsband & Herzke, 2019).

Like other regions, the entire range of sizes of plastic debris can be found in the Arctic: from macroplastics (>5 mm) to microplastics and fibers (<5 mm). The polymer composition of plastic waste observed in remote regions mainly includes four polymers: polyethene (PE), polypropylene (PP), polystyrene (PS), and polyethene terephthalate (PET) (Andrade et al., 2021). Tire wear particles (TWP) are an additional category of contaminants and consist mainly of synthetic styrene-butadiene rubber (SBR).

Plastic can be released into the Arctic environment during industrial activities (for example, fishing, shipping), from the port pier and shipyard, as well as from domestic sources (Napper & Thompson, 2020; Tošić et al., 2020). Population changes along the Arctic coasts (Eisted & Christensen, 2013), as well as the growth of tourism, are the local factors causing plastic pollution in the Arctic (Eriksen et al., 2020). In many cases, there is a lack of infrastructure in remote areas of the Arctic to manage the growing plastic waste (for example, in Greenland and Svalbard).

If we take the marine environment, microplastics are mainly formed as a result of weathering and fragmentation of plastic debris on beaches under the influence of UV radiation, temperature changes and physical movements, as well as carried by wind, waves and currents (Strand et al., 2021). The speed of macro- and microplastics' horizontal movement differs, large floating particles are exposed to wind, and microplastics are completely submerged in water. A large amount of Atlantic water enters the Arctic Ocean through the Fram Strait and contains various amounts of plastic objects and microplastics (Bergmann et al., 2016). Current reports also demonstrate the role of air and precipitation in the transport of microplastic particles explaining the presence of microplastic in Arctic snow and ice samples (Collard & Ask, 2021).

Studies have revealed that currents can transport significant amounts of plastic to the polar regions (Wichmann et al., 2019). Thermohaline circulation in the North Atlantic (Cózar et al., 2017), Stokes wave-like drift (Delpeche-Ellmann et al., 2021), movement along riverbeds and tributaries, and the capture of plastics by sea ice contribute to the accumulation and movement of practically nondecomposable plastic pollutants in the Arctic.

Surface circulation models and field data have shown that the pole-directed branch of the Thermohaline circulation carries floating debris from the North Atlantic to the Greenland and Barents Seas, which could become a dead-end for plastic. Taking into account the limited surface transport of plastic that already exists and continues to accumulate in these Arctic regions, as well as based on mechanisms operating for downward transport, it is assumed that the seabed under this Arctic sector is an important sink of plastic debris (Cózar et al., 2017).

Microplastics are potentially captured by sea ice during the formation and drift of sea ice. Sea ice from the Beaufort, Chukchi, and East Siberian Seas can be included in the Beaufort cycle. Mobile sea ice floes in the Arctic Ocean can capture pollutants on the way of their drift and play a role in their redistribution due to possible release during ice melting (La Daana et al., 2020). These changing conditions inevitably affect the dynamics of plastic and microplastic transport in the Arctic Ocean.

The studied concentration of microplastics in sea ice cores from the Central Arctic basin varied from 2 to 17 particles per l^{-1} with a particle size from 0.10 to 4.99 mm (La Daana et al., 2020). Most of the microplastics found in the ice cores were fibers (79%), and the remaining part (21%) was fragmented. The distribution of microplastics in ice cores by size classes was as follows: 0.1–0.5 mm (32%), 0.5–1 mm (20%), 1–2 mm (23%), 2–3 mm (13%), 3–4 mm (7%), 4–5 mm (4%). As for the color, the majority of microplastics registered in ice cores have shades of blue (53%).

Scientific research on the origin of microplastics in surface waters or sea ice does not allow us to talk about precisely defined patterns of its appearance. However, potential sources of these pollutants may include (1) river runoff from the rivers of Siberia and Canada, (2) inflow of polluted waters of the Pacific Ocean and the Atlantic Ocean, (3) discharge of graywater from ships operating in the Arctic, and (4) atmospheric drifts (La Daana et al., 2020).

Understanding the presence, sources, transport routes and the fate of plastic waste in the Arctic is crucial for determining the potential threats posed by such pollutants to marine organisms, the Arctic ecosystem and indigenous populations.

The Threat of Absorption of Plastic Waste in Food Chains

More than 80% of the adverse impacts of rubbish in the marine environment are associated with plastic waste since they can have physical and biochemical effects on this environment (Andrade et al., 2021). Degraded plastics accumulate in various water systems, pollute them and enter the food chain (Katare et al., 2021). Plastic waste has been found in the biota of various trophic levels, such as marine invertebrates, fish, marine mammals, seabirds, green turtles and penguins (Ross et al., 2021). Microplastics have been detected in amphipods (*Gammarus setosus*), blue mussels (*Mytilus edulis*), red *Kamchatka* crabs (*Paralithodes camtschaticus*), and fish, and plastics have been detected in Arctic seabirds since the 1960s (Linnebjerg et al., 2021).

Seabirds have been used as pollution biomonitors for many years, and many colonies of Arctic seabirds are studied well enough. As a result, there are several reports of plastic ingestion by birds, which in this case serve as a source of information on the duration, volume and types of pollutants, including in some Arctic regions of Canada, northern Iceland, the Faroe Islands and Svalbard (Collard & Ask, 2021).

All living organisms are embedded in interaction networks: people interact within and between populations, and these interactions play an important role in shaping the structure and dynamics of ecosystems. Scientific research on the content of plastic in seafood raises concerns due to their subsequent ingestion into the human body and threats to health (Ross et al., 2021). Such concerns underscore the need for a more holistic understanding of the distribution and penetration of plastic waste into ecosystems for the indigenous peoples of the circumpolar region who rely heavily on food from the ocean.

The structure and complex composition of natural food chains allow us to build theoretical models for studying plastic waste transfer, especially the processes that ultimately affect the health of individuals (Diepens & Koelmans, 2018). These authors implemented a model of plastic transport through the Arctic trophic network which includes Atlantic cod and polar bear as the main predators. For example, cod has a high ecological and economic value and is a central part of the Arctic food network; it is a key species for maintaining populations of, for example, sharks, seabirds, mammals such as seals, and polar bears, and is an important component of the human diet.

In addition to drifting sea ice, the Arctic is also known for its numerous glaciers. Indeed, glacier fronts are a feeding ground for many seabirds and mammals (Collard & Ask, 2021). Glacial fronts can potentially pose a great threat to Arctic organisms since they can be a source of pollutants and plastics individually, as well as plastics with other sorbed pollutants. Many scientists note the need to study synthetic fibers in the food chain, for example, their level in biota, as well as how they affect organisms. To a greater extent, anthropogenic fibers can be extracted from biota samples using extraction protocols aimed at plastic particles (Murtaza et al., 2016).

We have only started studying the plastic contamination of the food chains of terrestrial mammals, birds and invertebrates in the Arctic. The effectiveness of the research, which makes it possible to assess the movement of plastic in the waters and on the shores of the Arctic by modeling natural food chains and their movement, requires the cooperation of coastal states with each other and with indigenous peoples and local hunters.

Cleaning Projects, Measures to Eliminate Rubbish in the Arctic

Preventing plastic pollution from entering the marine environment is a priority topic worldwide. Indeed, the goal of the UN General Assembly's Agenda for Sustainable Development for the period up to 2030 is "the conservation and rational use of oceans, seas and marine resources" and calls for actions that prevent and significantly reduce marine pollution of all types by 2025 (UN, 2017). In recent years, methods for measuring plastic emissions have been brought to a single registration system for making the results comparable (provide the unity of protocols, units of measurement).

Greenland, the Faroe Islands, Finland, Iceland, Norway, and Sweden have signed the Convention for the Protection of the Marine Environment of the North-East Atlantic OSPAR. This convention uses an extensive monitoring program in the Arctic waters of Greenland, Norway, and the Barents Sea to assess the pollution of beaches and the seabed (PAME, 2019).

At the regional level, the OSPAR Convention is the only policy measure (as of March 2020) that specifically concerns marine animals and birds: Plastic consumption is tracked and used as an indicator of the marine environment. Besides, the development of a common database (for example, the database of the International Council for the Exploration of the Marine Environment, used by OSPAR, HELCOM, and other expert groups) to provide long-term monitoring data with appropriate control and quality assurance procedures should improve pan-Arctic assessments.

Urbanek et al. (2017) carried out the screening of Arctic microorganisms capable of destroying bioplastics. A total of 313 microorganisms were isolated from 52 soil samples from the Arctic region (Svalbard). One hundred twenty-one (38.66%) of isolated microorganisms showed biodegradation activity. The ability to form transparent zones on emulsified poly (butylene succinate-co-adipate) (PBSA) was observed for 116 microorganisms (95.87%). A particularly high biodegradation ability was observed in the *C. rosea* strain, which showed 100% degradation of starch films. The data indicate that *C. rosea* can be used in natural and laboratory conditions for decomposing plastic waste.

Plastic waste management can be difficult for developing countries; for developed countries, it is good practice to help with the disposal of marine plastic. For example, Canada provides 100 million Canadian dollars to help developing countries reduce the amount of plastic waste in the oceans and coastal areas (Government of Canada, 2020).

Norway has also allocated about $200 million to the Norwegian Program for the Development of the Fight against Marine Debris and Microparticles of Plastics to help reduce the volume of marine debris from large sources in developing countries in 2019–2022 (Government of Norway, 2018). In 2018, Inatsisartut (the Parliament of Greenland) established the Environmental Fund (Miljøfonden) to improve plastic recycling and fisheries waste management programs, for which 1 million Danish kroner was allocated in 2019 (Government of Greenland, 2019).

Problems of Plastic Waste Management in the Arctic Zone of the Russian Federation

Transfer of Plastic Waste to the Arctic Zone of the Russian Federation

The Arctic is usually defined by its political and geographical boundaries and is considered to cover all areas north of the Arctic Circle. The Arctic zone of the Russian Federation includes the territories of the Murmansk Region, Chukotka, Yamalo-Nenets Autonomous District, some municipalities of the Republic of Karelia, the Republic of Komi, the Republic of Sakha (Yakutia), the Krasnoyarsk Territory, and the Arkhangelsk Region. In addition to the vast territory of the Russian Arctic, it includes the three largest rivers of the Arctic: the Ob, Yenisei, and Lena, which are also among the ten largest rivers on Earth by basin size (Collard & Ask, 2021).

The model described by Lima et al. (2021) predicted a high density of plastic pollution in point zones of the Arctic Ocean, including several seas bordering Russia (the Chukchi, Bering, Kara and Laptev Seas). The Arctic Ocean accounts for about 11% of the world's river flow.

The paper (Saprykina, 2015) provides a large amount of actual data on the ecological state of the Arctic zone of the Russian Federation, in particular, plastic and microplastic pollution. It was established that the main source of anthropogenic impact in the Arctic zone of the Russian Federation is industrial and economic activity related to the development of minerals, especially hydrocarbons. The potential environmental risks associated with the increasing load on ecosystems when using the Northern Sea Route and with the emergence of new industrial facilities are characterized. There is an annual increase in the rate of deliveries of oil and petroleum products to transshipment and port terminals; therefore, tankers and onshore transshipment complexes are considered to be the main potential sources of pollution.

The article by Tošić et al. (2020) focuses on the problem of wastewater since the Barents and Kara Seas are directly connected by water exchange with polluted bays and bays. There is a significant anthropogenic impact of atmospheric transport of pollutants since the Arctic is a zone of unloading of air flows accumulated in mid-latitude areas.

The article by Ivanova et al. (2018) presents an analysis of plastic pollution of the waters and coasts of the Barents Sea and adjacent waters. The authors consider the influence of various factors, including climate change in the Arctic, on the plastic pollution of the marine ecosystem. The focus is on the existing and potential damage to industrial fishing in the Barents Sea and adjacent waters. Special attention is paid to controlling and monitoring the collection of plastic garbage on board and the efficiency of its disposal.

Bolsunovskaya and Bolsunovskaya (2015) note that the decrease in the area of sea ice in the Arctic zone of the Russian Federation opens up new transportation routes and access to resources, which, in turn, can create additional environmental threats of pollution, including plastic waste. Therefore, the natural conditions of the Arctic should be considered as a complex system of interrelated factors.

If we take the marginal shelves of the Arctic, freshwater flows from Siberian rivers, such as the Dvina and Pechora (Barents Sea), the Ob and Yenisei (Kara Sea), the Lena (Laptev Sea), and the Kolyma (East Siberian Sea), can be potential participants in the loading of microplastic waste in the Arctic sea ice of the Arctic zone of the Russian Federation (La Daana et al., 2020). The influx of Pacific waters into the Arctic Ocean through the Bering Strait is also a potential source of pollution, and the water of the Pacific Ocean is influenced by anthropogenic activities that occur in North America and eastern Russia.

The work of Ershova et al. (2021) describes the most extensive spatial coverage of research in the Arctic and Pacific sectors of the Russian Federation within the framework of the scientific expedition of the fourth stage of the TRANSARCTICA-2019 program. The surveys were conducted to obtain an assessment of the pollution of the marine environment with microplastic particles of the entire Arctic zone of the Russian Federation and the seas of the Far East along the Northern Sea Route from Vladivostok to Murmansk and back. The main tasks are to develop a sampling technique for the content of microplastic particles in the surface water layer in the Arctic and Far Eastern seas, as well as to obtain preliminary estimates of marine pollution to determine the zones of the greatest accumulation of microplastics during the expedition route.

Sampling was carried out in the Okhotsk, Bering, Chukchi, East Siberian Seas, Laptev Sea, Kara and Barents Seas. According to the results of quantitative and qualitative assessment of the content of microplastic particles in the subsurface layer, it was found that their average content was 143 pcs/^{m3} for the Pacific sector of the northern sea route and 11.3 pcs/^{m3} for the seas of the Russian Arctic. The largest concentration of microparticles, 357 pcs/^{m3}, was found in the Sea of Okhotsk, the smallest, 1 pc/^{m3}, in the East Siberian Sea. Microparticles of various shapes, sizes, and colors were found in the collected samples. Among them, we can distinguish the most common filamentous transparent synthetic fibers that were present in each of the samples. The greatest variety of colors and shapes of particles is found in the seas with a strong transport load – the Barents, Kara, and Okhotsk. The particle size varied from 100 to 3500 microns (Nova, 2021).

Environmental Control of Plastic Uptake in Food Chains in the Arctic Zone of the Russian Federation

The levels of plastic pollution of biota are almost completely unknown in the Russian Arctic. The work (Collard & Ask, 2021) describes the study of samples of benthic invertebrates in the Arctic zone of the Russian Federation – the Bering and Chukchi Seas, including starfish, shrimp, crabs, fragile asterisks and bivalves. The level of microplastics in all benthic organisms ranged from 0.02 units/g of wet weight (ww) to 0.46 units/g of wet weight, which is lower than that of bottom organisms in coastal areas and the open ocean worldwide. Fibers were dominant among the types of plastic. The most common size class is 0.10 to 1.50 mm (66%).

It was recorded that between the 1960s and 2015, at least 331 marine species of living organisms ingested plastic, of which 92 were fish species (Kühn et al., 2015). Several fish species were studied in the Arctic zone of the Russian Federation: polar cod (*Boreogadus saida*), Atlantic cod (*Gadus morhua)*, big-eyed goby (*Triglops nybelini*), Atlantic salmon (*Salmo salar*), and capelin (*Mallotus villosus*). The frequency of finding plastic in the stomach of fish ranges from 0% to 34%. Atlantic cod was the most studied species, and plastic was recorded in 0% of fish from the Norwegian coast and in 2.7% of Atlantic cod from the Baltic Sea (Kühn et al., 2015). In general, all studies have shown a low level of pollution of Atlantic cod.

Today, there are no long-term monitoring programs for plastic ingestion by seabirds in Russia. However, the studies on the uptake of plastic pollution by seabirds in the Russian Arctic are expanding (Golovnyuk et al., 2019; Zelenskaya, 2019; Solovieva et al., 2020). In November 2019, the seminar “Plastic pollution and seabirds in the Russian Arctic: the level of knowledge, information exchange, opportunities for cooperation,” organized within the framework of CAFF and AMBI, became the first one dedicated to the impact of marine plastic on seabirds.

The environmental consequences of ingesting plastic are currently largely unknown. Large objects can get stuck in animals and block the intestines, as well as cause injuries or a false sense of satiety; very small particles can move and pass to organs or cells with unknown consequences. The recent discovery of various persistent organic pollutants adsorbed on passive polyethene samplers deployed west of Svalbard highlights the possibility of toxin transmission when ingested in Arctic organisms, which suggests subsequent toxicological effects on the human body (Collard & Ask, 2021).

Further research is needed in the Arctic zone of the Russian Federation to model the processes of accumulation and migration of plastic waste both in connection with the movement caused by the movement of water layers and along trophic chains.

Cleaning Projects, Measures to Eliminate Garbage in the Arctic Zone of the Russian Federation

Russia considers the problem of plastic pollution of the marine environment in federal policy and legislation. For example, the main federal legislation regulating waste management is the law "On Waste Production and Consumption" (Federal Law, 1998), which primarily concerns land-based waste sources. In addition, since Russia is a party to the MARPOL Convention, its provisions have been implemented as a law (MNR, 2019). Following MARPOL, the Instructions for the Fishing Fleet on the Prevention of Pollution from Ships and the Mandatory Rules for Seaports (2007) concerning the prevention of pollution from ships, including plastic pollution, were adopted.

The consequences of plastic pollution of the marine environment have also been added to the agenda of the Ministry of Natural Resources and Ecology within the framework of the working program of the Joint Russian-Norwegian Commission on the Environment, so it is expected that the policy on plastic pollution of the marine environment in Russia will be strengthened.

At the regional level, Russia is a party to such conventions as HELCOM (Baltic Sea) (HELCOM, 2015). In addition, the National Environmental Project (NEP, 2018), led by the Ministry of Natural Resources and Ecology (MPRE), is going to implement waste management programs to reduce waste production and consumption in Russia. The Ministry of Natural Resources of the Russian Federation is working on improving waste management in 15 specially protected natural areas (protected areas; one of them is located in the Russian Arctic), where solid waste collection systems (including those dealing with plastic) will be implemented (MNR, 2019).

To date, there are several long-term monitoring programs for plastic pollution of the Russian Arctic marine environment. For example, the pollution of the marine environment by plastic waste in the Baltic Sea is being investigated within the framework of the HELCOM Regional Action Plan on Combating Marine Plastic (HELCOM, 2015). A database on marine debris has been created and a database on microplastics is being developed, and cooperation has expanded to the Arctic region (Blinovskaya et al., 2020).

The article (Larionova & Pyankova, 2020) raises the problem of ecological consciousness of the urban population on the example of the residents of Arkhangelsk. A brief description of the importance of solving environmental problems in the Arctic is given. The article describes the rubbish reform in Russia and the reasons for its implementation. The Arkhangelsk region is considered one of the Arctic regions of Russia. The author also analyzes the reasons for the acute public discussion about rubbish in the Arkhangelsk region. A bilateral initiative to change the attitude to natural resources is described. The results of a sociological study of the Arkhangelsk population's readiness for separate garbage collection are presented.

In addition to the activities of the "State Program for the Socio-economic development of the Arctic zone of the Russian Federation" and state programs in the socioeconomic sphere of the Arctic development, it is proposed to include various types of plastic in the list of dangerous pollutants of the waters and coasts of the Russian Arctic and to build plastic waste recycling facilities.

Many Governments have developed national strategies to support economic development in these Arctic coastal regions. The Russian Federation was at the forefront with a Strategic Development Plan until 2035: “The Northern Sea Route.” The project is justified by ensuring a sustainable social development program in the field of waste management.

Today, territorial schemes have been developed for all the Arctic regions of the Russian Federation for the disposal of waste, including plastic. The weakest points of waste management in the Arctic region are the accumulation of solid waste and transportation, the construction of new landfills that meet modern requirements (Agakhaniants et al., 2019). The northern conditions should be taken into account in these interrelated stages of waste management. For example, Murmansk is going to build a plant and a waste sorting complex for incineration and disposal of waste.

If we take the Nenets Autonomous Okrug, it is proposed to transport solid waste directly to sorting stations or their primary accumulation in 40 zones with subsequent transportation to the burial ground in Naryan-Mar or to waste processing enterprises in the neighboring region: the city of Arkhangelsk, the city of Mezen (Arkhangelsk region), the city of Usinsk (city of The Komi Republic). Waste should be exported by barges, all-terrain vehicles and cars. There are plans to build four small-sized waste sorting stations with a capacity from 80 tons/year to 12,000 tons/year in the future.

To increase the efficiency and focus of waste management efforts in the Arctic zone of the Russian Federation, one has to create a map of the rubbish flows, use mathematical modeling of movement and develop the mechanisms for allocating costs for cleaning up the Arctic from rubbish.

Modeling the Movement and Accumulating Rubbish in the Arctic Zone of the Russian Federation, Mechanisms for Allocating Cleaning Costs

Since we are talking about microplastics and elements of the remnants of human life activity of relatively small size, as well as due to the ease of the packaging materials used, which forms the main part of the rubbish, one has to apply a well-known method for predicting the movement of this rubbish following the Arctic water currents.

The proposed model of rubbish movement, which contributes to understanding and foreseeing the areas with threats of its accumulation, is based on studies of water flows in the Arctic, which carry rubbish throughout the territory of the macroregion. As can be seen in Fig. 1, which was borrowed by the authors from a free resource (indicated in the link), the flow of waters has two main directions. The first direction is circular. The ingress of rubbish into this current in the long term can lead to the formation of an artificial rubbish island like the Large Pacific Garbage Spot that has already been formed in the same manner. The development of human activity and the

Fig. 1 Arctic Ocean Arctic Circle map. (Source: Free resource with non-commercial use. Retrieved from: https://www.pngwing.com/en/free-png-twril)

accumulation of garbage near this current may soon lead to the formation of an Arctic garbage patch. It is important to note that the Great Pacific Garbage Patch is relatively closer to civilization, but a solution to its problem has not yet been found. The problem is in the access to public goods. All countries strive to get rid of their rubbish and use the public good of the Pacific region for rubbish disposal. Unlimited access makes charging impossible. Nevertheless, the solution to the problem of the Great Pacific Rubbish Patch has long been overdue and there is only one way out – we should distribute quotas for financing the removal of rubbish spots, including the processing of this garbage, between coastal countries. Quotas can take into account the population of coastal countries and the average level of rubbish formation per person. In this case, there is a need to create a supranational body responsible for implementing this large-scale project with the appropriate powers and funding. A similar model could be used in the Arctic.

Current 2 is much more complex in its structure (Fig. 1). Here, you can see the flow of waters from the shores of the Russian Federation toward Denmark (Greenland) and Canada, around Greenland, around the islands belonging to the Russian Federation, as well as several less significant currents. We need to apply a different method of collecting and processing rubbish here. First, one has to take into account the population and the volume of rubbish formation per 1 person, and second, take into account the population ratios of coastal territories washed by the waters of the Current 2. The mechanism of financing the work can be the same as in the first case – through the distribution of quotas, but taking into account the specified additional parameters.

The ability of a supranational body to conduct inspections of waste generation and provide a mechanism for proving guilt in illegal dumping of rubbish and imposing responsibility on the guilty party could be of great importance. Such a system would ensure the distribution of cleaning costs according to the emerging threats.

It is also important to take into account that the activities of the Arctic Council, the ongoing programs and projects of the Arctic and other countries and intercountry associations require further strengthening, especially in terms of joint efforts to finance and physically eliminate rubbish in the waters of the Arctic. The problems of regulatory consolidation of the responsibility of the Arctic and other countries for the accumulation of plastic waste in the Arctic, in particular on the territory of the Arctic zone of the Russian Federation, were stated.

Conclusions

The complexity of solving the problem of waste management is due to its duality. On the one hand, retrospective projects for the development of the Arctic and the deployment of military bases and garrisons have contributed to the accumulation of rubbish, which is gradually being eliminated within the framework of programs and activities of the Arctic states. On the other hand, the modern economic activities of both indigenous peoples and organizations for the exploration of the Arctic and mining lead to an additional accumulation of garbage.

It is noted that introducing the principles of the circular economy requires special attention to minimizing nondecomposable plastic waste. In terms of plastic, the threat is not so much its accumulation in the composition of solid waste from management on land in the Arctic, but also its displacement from other continents through the system of communicating water spaces of the planet which is difficult to predict. The possibilities of moving plastic and, with its gradual degradation, microplastics to the Arctic zone due to the peculiarities of the flow of water masses and wind movement are presented. An additional threat is posed by plastics previously captured by ice and released due to climate change. Besides, microplastics, migrating through the system of trophic chains, directly threaten human health.

Financing programs and projects for sorting, minimizing and recycling waste from Arctic countries in the Arctic region were presented. It is noted that a significant area of the Arctic zone of the Russian Federation, the expansion of Russia's resource interests in the Arctic, and the movement of significant amounts of rubbish along waterways to the Russian northern seas require forecasting possible directions of waste accumulation. A model of rubbish movement was proposed. It contributes to understanding and anticipating areas with threats of its accumulation and allows distributing the costs of cleaning according to emerging threats.

It was shown that the environmental degradation of the Arctic region, in turn, affects global climate changes and affects the interests of the whole world. The activities of the Arctic Council, the programs and projects implemented by the Arctic and other countries and intercountry associations require further strengthening, especially in terms of joint efforts to finance and physically eliminate rubbish from the Arctic waters. The problems of regulatory consolidation of the responsibility of the Arctic and other countries for the accumulation of plastic waste in the Arctic, in particular on the territory of the Arctic zone of the Russian Federation, were stated.

The results obtained are of interest to research organizations dealing with the problems of the Arctic; the research teams studying the issues of circular economy, ecology, and climate change; and the state institutions responsible for the development of waste management programs.

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Global Arctic Issues in Bilateral Cooperation for Environmental Management Protection

Russian-Chinese Case

Nadezhda K. Kharlampieva, Marina A. Ermolina, and Anna S. Matveevskaya

Contents

Abstract

The issues of environmental protection in the Arctic region as an interdisciplinary area, including research in the field of climate change and water resources protection and imbalance and changes in the environment associated with anthropogenic impact, are included in the list of urgent problems of our time. The formation of a space of knowledge and the search for directions of scientific research in the Arctic in bilateral and multilateral interstate relations are aimed at creating interstate institutions of interaction in monitoring the state of the natural environment in the Eurasian Arctic. In this fragile natural ecosystem, there are two sea powers – Russia and China. The chapter presents four stages of modern bilateral Russian-Chinese relations, which are given as an example of the evolution of the normative theory of international relations: 1992–2001, the development of the foundations of modern relations; 2001–2014, the formation of interstate institutions and the achievement of agreements on strategic partnership; 2014–2019, the development of the main directions of social and economic

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development; and autumn 2019 to the present, the formation of bilateral relations in the context of the implementation of the conceptual model of sustainable development in line with balanced socioeconomic and environmental development. In this study, much attention is paid to multilateral international treaties and regional bilateral agreements between Russia and the People's Republic of China in the field of creating a space for natural resource use and environmental protection, as well as a national strategy in the field of environmental protection regulation in the implementation of economic and other activities in the Russian Arctic. The chapter analyzes the main problems of legal regulation of environmental protection in the Arctic Zone of the Russian Federation and examines the prospects for international cooperation between Russia and China in this area.

Keywords

Normative theory of international relations · Russian-Chinese relations · Polar Regions · The Arctic · The Antarctic · Arctic Eurasia

Introduction

The formation of international policy on the Arctic issues took place thanks to Russian plans to restore the former might of the USSR in its northern territories. The emergence of a discussion about the impact of climate change on the North and the Arctic is associated with the institutionalization of international interaction in the Polar Regions – the Arctic and Antarctic. The International Council for Science and the Interdisciplinary Division of the International Council for Science, called the "Scientific Committee for Antarctic Research" (1958), and the International Arctic Science Committee (1990), which is a member of this authoritative international association since 2005, help to define two directions of scientific planning and implementation of polar research in two areas: marine scientific research and the formation of interdisciplinary scientific knowledge.

Foundations for the creation of international cooperation in the field of scientific research and education. UNESCO activities include work to humanize the process of globalization and the implementation of Chap. 35 (Science) and Chap. 36 (Education, public conscience, and learning) of "Agenda XXI" (Agenda XXI and other documents of the conference in Rio de Janeiro (1993), holding the Decade of "Education for Sustainable Development" (UNGA) Resolution 57/254, December (2002)). The International Bureau of Education, headquartered in Geneva, has become a center for the dissemination of not only universal knowledge and education policy. The UNESCO and the International Council for Science unite the principle of universality and trust (Art. 5. Statutes and Rules of Procedure/as modified by decisions taken at the 30th Session of the General Assembly of ICSU Rome, Italy, September (2011)) in the practice of improving the well-being of mankind, ensuring a healthy environment, and creating conditions for the internationalization of knowledge and skills in the world. Internationalization is becoming a keyword in the ongoing reforms of higher education and planning of academic work – bridging the gap in education and general development between rich and poor countries – and preparation and discussion of the principles of ethical relations on climate change issues.

China's involvement in the global economic system of the twenty-first century with 18% of the world's population in Arctic relations is becoming a fact. Thus, the chapter presents a part of the promising direction of the international political situation around the Arctic. The authors posed the research question if it is possible to globalize the Arctic theme in the social sciences, not only through the dissemination of knowledge within physical and geographical boundaries but also in the international political and international legal space. How can we preserve and save the fragile surrounding ecosystem of the Arctic through international cooperation?

The main considerations are knowledge about the Arctic and the relationship of people within this knowledge. First of all, we must determine the genesis of environmental problems arising in the Arctic region. Knowledge about the Arctic includes the dissemination of ecosystem knowledge about the areas adjacent to the watershed of the Arctic Ocean and about the inhabitants of the Arctic, their culture and life, the state of their rights, and their environment. First of all, the attitude of the inhabitants of the Arctic to each other, to the authorities, to the formation of communities; secondly, relations between states, groups of states, groups of communities. Therefore, the globalization aspects of the Arctic theme in this chapter are considered on the example of bilateral relations between Russia (as having large geographic areas of the Arctic) and China (having a large population).

The value and regulatory mechanisms of relations between the indigenous population of the Arctic and states that have maritime borders in the Arctic Ocean play a crucial role in the development of not only the normative theory of international relations but also world politics with the participation of China and other states. In the context of the emergence of the concepts of "Eurasian security arc," "Arctic relations," etc., bilateral relations between Russia and China and their role and place in the Russian Arctic fall into our field of vision. As leading Russian legal scholars note, the preservation of the Arctic environment in the face of political and economic claims on the part of various powers is a promising area of cooperation (Bogolyubov & Krasnova, 2018). It is this aspect of international relations that dominates the development of Russian-Chinese cooperation in the Arctic at the present stage.

Literature Review

Prospects for interaction in the field of research in the Polar Regions concern the evolution of normative theory in international relations (Brown, 1992, 2012, 2017; Cochran, 1999), history and theory of political and legal sciences (Risse, 1998), as well as many areas of combining knowledge of social and natural sciences (Kharlampieva et al., 2017; Rednikova & Kudelkin, 2018; Kharlampieva, 2011, 2017; Slaughter et al., 1998; Adžić, 2021).

The active development of science has led to the emergence of several interdisciplinary fields that relate to both humanitarian and natural science research. The problem of environmental protection refers to such problems in the first place. This problem gradually turned into an important philosophical and even psychological problem of our time, arising as a result of solving the life tasks of a social agent (Vernadsky, 1989, 1991). At the same time, one of the most important aspects of the research topic is the clarification of the terminology used in international and national documents, as well as the unification of conceptual categories necessary for the study of problems related to the environment.

Environmental and legal studies in relation to the Arctic Zone of the Russian Federation are presented in numerous works of famous Russian scientists (Bogolyubov & Krasnova, 2018; Emelyantsev & Valentey, 2020, Zhavoronkova & Agafonov, 2018; Agafonov & Ignatiev, 2018).

The contribution to the evolution of the foundations of the normative theory of international relations, world politics, economics and ecology through the development of international interaction between the two countries in the Russian Arctic is conceptually substantiated (Kharlampieva, 2011, 2016; Gusevskaya, 2018).

Lawmaking initiatives from the standpoint of strengthening interaction between Russia and China in the environmental field, according to Russian authors (Rednikova & Kudelkin, 2018), are recognized to become the basis of the Arctic Eurasian interregional environmental policy. The authors used methods of scientific knowledge that allow a comprehensive study of the significant aspects of agreements between countries on cooperation on the application of the best available technologies (Konakhina et al., 2019), as well as regulatory regulation in this area (Demidov et al., 2019; Kudel'kin, 2020; Mokhorov et al., 2019; Snetkov et al., 2020).

The problem of the development of ecological tourism for economic and educational purposes is presented in sufficient detail in the works of specialists representing social sciences, i.e. Vasilyeva (2020), Ermolina et al. (2019), Korostelev and Gavrilov (2019), and Matveevskaya et al. (2020).

Methodology for Studying Bilateral Russian-Chinese Relations

The study of the foundations of bilateral and multilateral interaction in international relations and, in particular, the prospects for cooperation in the field of research in the Polar Regions concerns the evolution of normative theory in international relations (Brown, 1992, 2012, 2017; Cochran, 1999) and history and theory of political and legal sciences (Risse, 2012; Slaughter et al., 1998), as well as many areas of social and natural sciences. Analysis will allow comparing and identifying points of contact of interests of both states and the foundations of bilateral Russian-Chinese relations in combination with consideration of structural and functional aspects of scientific research strategic planning in the Polar Regions – the Arctic and the Antarctic.

Despite the short period of modern Russian-Chinese relations, the discussion of promising areas of Arctic environmental protection is a contribution to the sphere of scientific and technical cooperation in the Polar Regions, as well. The structural-functional method allows you to study research and cultural, information, and communication projects and programs associated with the Russian Arctic and to strengthen the Arctic Eurasian component in its natural-spatial scientific interaction at the international level.

As the experience of Russian-Chinese cooperation shows, considering the development and implementation of strategic planning documents for the development of the Far East and the Russian Arctic, bilateral relations can be divided into four stages: from 1992 to 2001, from 2001 to 2014, from 2014 to 2019, and from 2019 to the present. Based on this political-chronological approach, we will consider promising issues of interstate cooperation and strategies in the field of environmental protection.

The First Steps: Contribution to a Multipolar World (1992–2001)

The first stage includes the signing in 1992 of "the Joint Declaration on the Foundations of Relations between the Russian Federation and the People's Republic of China" (Joint Declaration, 1992). Paragraph 11 of this Declaration states that "the parties will take the necessary measures to expand exchanges between the central and local bodies of legislative, judicial and executive power, public organizations." One of the first documents of that time is related to the environmental project on the creation of the "Khanka Lake" reserve, included in the list of the "Khankaisky" state natural reserve with protected zones in the Primorsky Territory (territory of the Russian Federation) and a reserve with protected zones in Heilongjiang Province (PRC territory).

"The Russian-Chinese joint declaration on a multipolar world and the formation of a new international order" was adopted 5 years later. The document reads: "based on the development of relations of equal and trusting partnership, aimed at strategic interaction in the XXI century, from their responsibility to the world community, which they bear as permanent members of the UN Security Council." Paragraph 3 of this declaration, the role of the "Commonwealth Independent States as an important factor of stability and development in Eurasia," and paragraph 6 denote "responsibility for peace and development throughout the world and the future of mankind, strengthening coordination and cooperation in international affairs . . . and the joint progress of mankind." Commissions for the preparation of regular meetings of heads of government Russia and China was formed in the same year (On the Russian Part of the Commission for the Preparation of Regular Meetings of the Heads of the Governments of Russia and China, 1997). The Commission adopted a "Regulation on the preparation of regular meetings," creating the first two subcommittees on trade, economic, scientific, and technical cooperation (On amendments to the Resolution of the Government of the Russian Federation, 1997). In 1998, the Commission decided to create subcommissions for cooperation in the field of energy, transport, and nuclear issues (On Amendments to the Decree of the Russian Federation, 1998). The agreement on the establishment of the Russian-Chinese consortium “Center for Science and High Technologies” (On the Approval of the International Scientific and Technical Project, 1995) was signed in accordance with the “Memorandum of Understanding between the Ministry of Science and Technical Policy of the Russian Federation, the State Committee of the Russian Federation for Higher education and the State Committee for Science and Technology of the People’s Republic of China” in Beijing.

Thus, from the point of view of environmental issues and development, we will allow ourselves to note the current stage of Russian-Chinese relations as a continuation of the early agreements between the PRC and the USSR, updated in 1992, and the creation of agreements on the creation of a transboundary nature conservation Khanka cooperation zone (1993). At the same time, the Declaration on the creation of the foundations for building a new world order in the Eurasian space in a multipolar world showed the serious intentions of the parties in the globalizing world. The first interdepartmental documents reflect not only the coincidence of interests in the world of scientific and technological development but also the strengthening of institutional and functional ties in the space of knowledge, science and technology.

The Second Phase: Fundamentals of Research and Educational Interaction (2001–2014)

The second stage begins with the signing of the “Treaty on Good Neighborliness, Friendship and Cooperation between the Russian Federation and the People’s Republic of China” (Agreement on Good Neighborliness, Friendship and Cooperation between the Russian Federation and the People’s Republic of China, 2001) in Moscow on July 16, 2001, and reaching agreements on the creation in 2004 of subcommissions in the field of education and culture (On the Russian part of the Russian-Chinese commission for cooperation in education, culture, health care and sports, 2004).

The “Concept of the state policy of the Russian Federation in the field of international scientific and technical cooperation for 2000–2005” (2000) outlined plans for Russian-Chinese state relations in the field of international scientific and technical cooperation. The plan for the implementation of this concept stated the instruction to carry out “work to improve the legal framework of bilateral and multilateral international scientific and technical cooperation and its harmonization with world practice in this area.” The documents on the creation of two subcommissions were an important step in 2004. These were subcommissions on communications and information technology, as well as in the field of space (On Amendments to the Resolution of the Government of the Russian Federation, 1997). Partnership based on the principle of mutual trust, equality, and mutually beneficial cooperation between the two countries was achieved in 2005 on the eve of joint military exercises (On the Submission to the President of the Russian, 2005). These principles were enshrined in the field of long-term cooperation and economic development of countries within the framework of the signing of the “Agreement on cooperation in the oil sector,” in 2009 (On the Signing of the Agreement, 2009).

The dialogue between the twin cities of St. Petersburg and Shanghai (1988) is developing during this period. The adopted Declaration updated the interstate relations of the two countries (Declaration on Friendly Cooperation Between the Government of St. Petersburg of the Russian Federation and the People’s Government of Shanghai of the People’s Republic of China, 2005). The document outlined agreements on “encouraging cooperation and exchange of information in the field of architecture and urban planning, ecology of large cities, social development of cities, including the construction of social facilities.” These agreements were continued in the development of cooperation “in the field of tourism and hotel industry, increasing tourist exchange, promoting the development and improvement of excursion and tourist services.”

Cooperation on environmental protection and environmental safety is further developed. Agreement on Cooperation Between the Administration of St. Petersburg of the Russian Federation and the People’s Government of Shanghai of the People’s Republic of China for 2003–2008 (2003) and the Decree of the Government of St. Petersburg (2013) demonstrate interstate support for “environmental technologies” and “ecology of big cities.”

The Government of St. Petersburg adopted a document: “On the draft agreement on friendship and cooperation between the Government of St. Petersburg of the - Russian Federation and the People’s Government of Guangdong Province of the People’s Republic of China” (signed in St. Petersburg on September 17, 2003). The document stipulates that “The parties cooperate, exchange information and work experience in the field of environmental protection and environmental safety on the principles of energy efficiency and resource conservation, interact on the use of natural resources and environmental monitoring.” The Decree of the Government of St. Petersburg of September 19, 2017, N 793 “On Approval of the Draft Agreement on Cooperation Between the Government of St. Petersburg (Russian Federation) and the People’s Government of the City of Xi’an (People’s Republic of China)” states that “The parties cooperate, exchange information and experience work in the field of environmental protection and environmental safety on the principles of energy efficiency and resource conservation, interact on logistics, territorial planning and transport infrastructure development.” “Agreement on Cooperation Between the Administration of St. Petersburg of the Russian Federation and the People’s Government of Shanghai of the People’s Republic of China for 2003–2008” (concluded in St. Petersburg on September 17, 2003) stipulates that “The Parties shall promote the development of business ties between organizations of St. Petersburg and Shanghai, working in the field of tourism, excursion and exhibition and fair activities.”

This stage of interaction between China and Russia outlined the structures of political and legal interdepartmental relations in the field of humanitarian interaction – education, culture, health care, and sports. These interactions are collectively referred to as “soft power tools” in international relations research. The tools of the Russian-Chinese “soft power” showed the features of the Eurasian space of knowledge (Kharlampieva, 2017) within the specific political boundaries of the Council of States of Independent States (1991) mentioned in the Russian-Chinese Declaration of 1997, as well as the newly created multilateral institutions of the Eurasian Economic Community (EurAsEC), Shanghai Cooperation Organization (SCO).

In light of the formation of the Eurasian integration policy, in the land space of the Arctic Zone of the Russian Federation (hereinafter the AZ of the Russian Federation) under the Decree of the President of the Russian Federation (2014), within the boundaries of the strategic resource base of Russia, ensuring the solution of the tasks of its socioeconomic development (Fundamentals of State Policy, 2008). The Eurasian Economic Commission, within the framework of treaties, forms a model of interaction between countries in a single economic space. Regulation on multilateral economic issues in the Russian Federation affects, among other things, the AZ of the Russian Federation.

Within the framework of this strategy, the constituent entities of the Russian Federation, united in the AZ of the Russian Federation, are called upon to become the most successful regions of socioeconomic development with the participation of state, private, and public structures. New forms of regional social relations are formed at the level of local, regional, and municipal governments. One of the pressing problems of our time is the search for decent work and social justice. This problem turned into a general movement of people, changing the consciousness of people, scientific and political understanding, considering the historical and practical components, which provide an opportunity to provide modern legal support.

The successful experience of the economic activity of modern associations shows some positive examples and trends in lawmaking with the aim of the conditions for interaction of the current generation. For almost 30 years of practice in the Arctic region, the formation of marine environmental policy (paragraphs 13 and 14 of the 21st Millennium Goals) continues in the framework of sustainable balanced development. In this regard, through the efforts of the member states of the CIS Interparliamentary Assembly, the Concept of Environmental Security is being formed. The Treaty on the Eurasian Economic Union, which creates conditions for interaction in a single economic space, also provides for the active inclusion of the Arctic in world economic relations.

The international “organized space of society” and the synergetic factor (Pilyasov, 2012) formed the basis for the formation of strategic plans for the involvement of the Russian Federation in world economic relations, in order to create an organized space for development. This includes information and communication technologies; highly qualified human potential; effective interaction of the state with business structures, scientific communities, domestic regions, and NGOs in the global scientific and technical sphere; expanding international scientific and technical cooperation; and internationalization of research activities. The practice of forming the political and legal basis of the international educational and research space is presented in examples of the legislative activities of international associations, such as associations of countries such as the CIS Interparliamentary Assembly

(Model Environmental some law of the CIS countries), the Eurasian Economic Union, and the Arctic Council ("Agreement of the Arctic Council on Strengthening International Cooperation").

China's openness policy is in line with Russian humanitarian foreign policy, the ideology of the Greater Eurasian Partnership. These are projects such as: the Eurasian movement of the Russian Federation (St. Petersburg State University hosted a round table on Eurasian integration in 2016), a single educational space, multicultural educational space (Guruleva, 2015), the role of Slavic universities (Matvienko, 2016), the creation of a rating scale for the EAEU universities, and dialogue between representatives of different cultures as the key to the successful functioning of common commodity markets, services, and capital. At the same time, the role of Russian regions is increasing. Projects of the regions are presented: "Educational cooperation in the Altai-Asia space" in the Siberian Federal District (Resolution of the III International Educational Forum "Altai-Asia", 2016) and Eurasian Association of Universities: SCO Network University, CIS, BRICS, International Association of Transport Universities of the Asia-Pacific Region, Russian-Kyrgyz Consortium of Technical Universities, "Association of universities of Siberia and the Far East and North-Eastern regions of China," "Association of universities of the Russian Federation and the People's Republic of China," and "Association of Asian universities." Problems of bilingualism, implementation of joint educational programs, nostrification of educational documents, and obtaining a work visa when inviting foreign teachers to work in Russian universities require solutions.

The authors suggest that a single intercultural humanitarian space can become one of the essential areas of research and educational mobility within the framework of the common labor market policy and the common labor market of the EAEU association. The New Silk Road project is one of the large-scale integration regional initiatives of our time. China's geopolitical priority in this project is aimed at enhancing its presence in Eurasia and Central Asia. The New Silk Road project enjoys active support from Russia and the countries of Central Asia. The New Silk Road project promotes research and educational integration in the Central Asian region. The example demonstrates a significantly increased educational migration from Kazakhstan, which ranked 9th in China in terms of the number of foreign students studying there after South Korea, the USA, Thailand, Russia, Japan, Indonesia, India, and Pakistan. The number of Kazakhstani students in China over the past 10 years has grown 14 times and amounted to 11,764 people in 2014. And this trend continues to grow (Sadovskaya, 2014). Another example demonstrates the emergence of centers for the study of Kazakhstan at Dalian, Shanghai, and Beijing University of Foreign Languages in 2013.

In the process of Eurasian integration (in connection with the promotion of the concept of open policy on the part of China), the role and place of international research and educational cooperation is increasing. The use of a world-political approach in research in this area in modern conditions makes it possible to identify and assess the impact of individual interdependent elements of international interaction; the formation of a political and legal space creates a legal condition and provides a guaranteed environment for the conduct of humanitarian interaction. The "New Silk Road" project helps China to promote the idea of China's openness in the Eurasian region, mainly in Central Asian countries, with which China's economic and cultural interests are linked.

The renewed dialogue between the twin cities of St. Petersburg-Shanghai has become an example of the successful implementation of commercial programs and projects in the field of construction, tourism, and other areas of cultural and educational ties. The Arctic direction of Russian-Chinese relations begins from this time. The annual Russian-Chinese meetings begin during this period. One of the first events was a meeting of the Oceanological University of China and St. Petersburg State University on the Arctic in 2012. The results of the Tenth Russian-Chinese academic meeting "Bilateral and multilateral interregional cooperation in the Arctic" (held in 2021) showed the prospect of international cooperation in the environmental sphere.

The Far Eastern direction of Russian-Chinese relations, which is of particular importance in the history of the Arctic, is being strengthened by the creation of the Ministry of the Far East and the Arctic. Thus, the second stage, which laid the foundation for research and educational interaction from 2001 to 2014, continued through the renewal of agreements between the twin cities, interregional relations in the Far East of the Russian Federation, the creation of a federal ministry for the Far East, and improvement of the content of the adopted bilateral documents.

Stage Three: Turning to the East (2014–2019)

The third stage begins in 2014, when the Governments of Russia and the PRC signed another bilateral "Agreement on cooperation in the supply of natural gas from Russia to the PRC via the 'eastern' route" (Agreement Between the Government of the Russian Federation and the Government of the PRC on Cooperation in the Field of Natural Gas Supplies, 2014). This Agreement opened an international discussion on the "pivot of Russia to the East" and laid the foundation for the development of many business projects and programs.

The next step was taken after the instruction of the President of Russia to study gas reserves in the Irkutsk Region, Krasnoyarsk Territory, and Yamal with the aim of supplying it to China via Mongolia via the "western" route (TASS, 2019). This stage was marked by a new page in Russian-Chinese relations with the participation of third parties – the Mongolian People's Republic.

The principle of the collective decision-making process worked in this case. This principle is enshrined in the provisions of the Treaty of the Eurasian Economic Union "international treaties of the Union with a third party." The practice of interactions within the framework of international treaties of the Union with a third party through the Eurasian Economic Commission is working out the schemes of integrative processes with the Republic of Armenia and the Kyrgyz Republic. In addition, on November 27, 2015, a Memorandum of Cooperation between the Eurasian Economic Commission and the Ministry of Industry, Trade and Energy of the Republic of Korea was signed in Seoul. These examples show the relevance of this practice in the implementation of large-scale Arctic projects. The development of new trilateral and multilateral agreements at the interstate and commercial levels, the creation of a new format of socioeconomic relations (Resolution of the Government of St. Petersburg, 2017), and the scientific and technical cooperation within the boundaries of the North-Western Shipping Company are expanding due to the activities of coastal twin cities: St. Petersburg, Qingdao, and Guangdong. This form of regional relations is also maintained with other port cities.

The powers of the Ministry of the Far East and the Arctic and the activities of the emerging North-Eastern Shipping Company make it possible to continue clarifying the legal regulation in the development of the Arctic Zone of the Russian Federation and the boundaries of its administrative-territorial units. The subject of discussion is focused on the issues of Russian-Chinese scientific and technical cooperation in the study of the Polar Regions (Kudel'kin, 2020).

The authors consider it expedient to continue the discussion about the water-basin principle and its international research component in the study of the Polar Regions – the Arctic and the Antarctic. It is obvious that Russia and China have the opportunity to contribute to the basis of the normative theory of international relations, which will have global significance in the future. The water-basin principle of international scientific cooperation has three levels: global (oceanic), the Arctic Ocean; regional (marine), the seas of the Arctic Ocean; and national, large water bodies of Arctic Eurasia (straits, bays, estuaries, rivers, lakes).

The "International Arctic Environmental Assessment Program" (AMAP), the Arctic Research Scientific Committee (IASC), and the Arctic Council are promoting an integrated science and technology "system of systems" – the Sustaining Arctic Observing Network. This system was approved and adopted by representatives of ministers of science and education in 24 countries and the EU in Washington and further on in Berlin in 2018. These international initiatives could be carried out partially within the framework of the Federal Law on the territories of advanced development and their water areas of a water body located at the level of federal subjects (municipal legislative acts of the Russian Federation). The authors propose the creation of a Regional Innovation System "Sustaining Arctic Observation Network" in the Russian Federation (Kharlampieva et al., 2017), which will be the result of the Russian Federation's chairmanship of the Arctic Council in 2021–2023.

The research potential of the Russian floating platform "North Pole," the prospects for interdepartmental cooperation of ministries in science and higher education, natural resources, and ecology of China and Russia have the potential to create Russian-Chinese laboratories for the study of Polar Regions. Similar laboratories have already proved their effectiveness: the Russian-German Laboratory of Otto Schmidt and the Russian-German master's program of St. Petersburg State University in polar and marine research "Pomor." The proposed laboratories will supplement the content of the Agreement on Cooperation in the Field of Protection and Rational Use of Transboundary Waters (Agreement between the Government of the Russian Federation and the Government of the People's Republic of China on Cooperation in the Field of Protection and Rational Use of Transboundary Waters)

(Order of the Government of the Russian Federation of December 20, 2007 No. 1873-r.), including the regions of the Arctic zone of the Russian Federation. Some authors consider it "advisable to develop and sign a separate regional bilateral agreement on environmental issues in the Arctic" (Rednikova & Kudelkin, 2018), based on an analysis of the formation of state policy between Russia and China in the field of environmental protection (without.) would become the backbone of the Arctic Eurasian interregional environmental policy based on the water-basin principle.

Stage Four: Socio-Ecological Monitoring in the Arctic (2019–present)

Under the Antarctic Treaty, scientific and technical cooperation can be carried out with the participation of the Scientific Committee on Antarctic Research in the framework of the implementation of the Strategy for Activities in the Field of Hydrometeorology and Related Areas for the Period up to 2030 (considering aspects of climate change) (Strategy for Activities in the Field of Hydrometeorology and Related Areas for the Period up to 2030 (considering the aspects of climate change)) (Order of the Government of the Russian Federation of September 3, 2010 N 1458-r.) The international systems for monitoring the environment, its pollution, cover a wide range of socially oriented (Demidov et al., 2019; Ermolina et al., 2019; Konakhina et al., 2019; Snetkov et al., 2020) and scientific and technological areas of science.

Ecological tourism is singled out as an independent type of tourism (Matveevskaya, 2017) and is spelled out in the Concept of the Federal Target Program "Development of Domestic and Inbound Tourism in the Russian Federation (2019–2025)" (2019). "The concept of long-term socio-economic development of the Russian Federation for the period up to 2020" (approved by the Order of the Government of the Russian Federation of November 17, 2008 N 1662-r) proceeds from the fact that the task of capitalizing its environmental benefits is urgent for Russia, which should find expression, in particular, in the development of ecological tourism. The development of ecological tourism is spelled out in the Strategy for the Socio-Economic Development of Federal Districts and a number of other documents. "The concept of sustainable development of the indigenous peoples of the North, Siberia and the Far East of the Russian Federation" (approved by the Order of the Government of the Russian Federation of 04.02.2009 N 132-r) set the task of developing ecological tourism with the participation of representatives of the indigenous peoples of the North in places of their traditional residence and traditional economic activities, creating necessary conditions for the employment of representatives of small peoples in ecological tourism. The Strategy for the Development of Tourism in the Russian Federation for the Period up to 2035 (approved by the Order of the Government of the Russian Federation of September 20, 2019, N2129-r) involves the development of a separate concept for the development of ecological tourism in the Russian Federation for the period up to 2035. In a short time, the

Federal Agency of the Russian Federation, as of 2020, signed cooperation with 10 international associations and 56 intergovernmental and 10 interdepartmental agreements based on 2 federal laws and 1 state standard.

Let us consider the state of compliance of legislative acts regarding the development of ecological tourism, including Arctic tourism, in the Russian Federation (Lukin & Kharlampieva, 2016) and their compliance with international standards, without considering the organization of expeditions in the sea, oceanic part of the Russian Arctic using a world-political approach (Kharlampieva, 2016) in its opposite position (national-regional-international).

The Table 1 shows legislative acts and international standards for organizing the development of polar/ecological tourism in the estuarine regions of the Russian Arctic, which have regional features of organizing ecological tourism. At the same time, the Federal Law "On the Basics of Tourism Activities in the Russian Federation" (1996) fits into the international environmental management system in the European North, having experience of interaction with northern neighbors – with Finnish and Norwegian tourism companies (ISO 9001, EN 45000). At the same time, the Federal Law "On Specially Protected Natural Areas" (1995) is being improved in accordance with the requirements of the environmental management system, environmental protection from harmful influences, and health and safety systems.

The contribution of tourism to mutual understanding and respect between peoples and societies is spelled out in the "Ethical Code of Tourism" adopted by the World Tourism Organization in 1999, demonstrating the potential of Russian-Chinese interaction. Thus, the adaptation of the system of requirements of international,

Table 1 Legislative acts and international standards for organizing the development of polar/ecological tourism in the estuarine regions of the Russian Arctic

	Federal laws of the Russian Federation and GOST	Barents/Euro-Arctic Region (BEAR) (Republic of Karelia, Arkhangelsk and Murmansk regions)	International standards
1	Federal Law "On the Basics of Tourist Activity in the Russian Federation" of November 24, 1996 N 132-FZ (last edition)	Finnish and Norwegian tourism companies have an environmental management system – ISO 9001, EN 45000 ISO14001 GOST P ISO 14001-98; Environmental protection from harmful influences "GOST R 52104-2003"	ISO 9001 quality management system ISO 14001 environmental management system ISO 45001: 2018 Occupational Health and Safety System Article 1. Contribution of tourism to mutual understanding and respect between peoples and societies. Global Organization (1999) Ethical Code of Tourism, adopted by the World Tourism Organization
	GOST R 56642-2015 Tourist services. Ecological tourism. General requirements		
2	Federal Law "On Specially Protected Natural Areas" dated March 14, 1995 N 33-FZ (as amended and supplemented)		

Source: Compiled by the authors

national, and bilateral environmental standards and the norms of organizing ecological tourism between the Russian Federation and the PRC (Qin & Qi, 2021), considering the interests of the polar territories/Arctic ecosystem, is becoming an urgent topic of Russian-Chinese relations.

Conclusions

The authors have posed the research question whether the "mediating role" of Russia can be performed between the European, American, and other national systems in the research and educational environment, in which institutions of higher education and science adapt to globalization, considering local realities.

At the same time, the results of a formalized analysis and application of the structural-functional method for studying the state of the foundations for the formation of bilateral and multilateral relations between Russia and China, strategic planning for the development of the Far East and the Russian Arctic, showed that the key aspects are (a) contribution to the evolution of the foundations of the normative theory of international relations, world politics, and economics (Kharlampieva, 2011, 2016); (b) Russian-Chinese relations in the study of the Polar Regions – the Arctic and the Antarctic, developing international scientific cooperation within the geophysical boundaries of Arctic Eurasia and within the framework of the Antarctic Treaty; and (c) environmental protection and tourism as promising areas of Russian-Chinese relations.

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Part IX

Sustainable Development

Sustainable Development in the Arctic

Case of Alaska

Inna V. Andronova and Andrei G. Sakharov

Contents

Abstract

Alaska, the northernmost territory of the United States, offers a unique mix of a carbon-based economy and strong self-government, coupled with critical reliance on federal funding for a large part of its employment and economic activity. The chapter provides a brief overview of Alaska's experience in promoting sustainable development by analyzing strategic priorities, policies, and the implementation thereof, while tracking sustainable development indicators' dynamics in the past decade to draw conclusions on the United States Arctic region's potential to effectively transition to sustainable development path. The United States of America is currently in the process of formulating a sustainable development policy for the Arctic region. The existing documents do not address the main challenges facing Alaska – the state's high dependence on the natural resource

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sector and the lack of infrastructure. Changes in the region's economic well-being reflect natural market processes, geographic location, and climate conditions in Alaska, rather than deliberate sustainable development policy by the government. Despite persistent natural population growth in the state and the Arctic zone, the demographic situation and, consequently, the region's employment and future economic growth prospects do not look sustainable. Existing trends toward declining natural population growth, as well as the interdependence of migration flows and hydrocarbon energy prices, do not create a solid foundation for increasing the self-sufficiency of Alaska's socio-economic sphere. Under the existing conditions, volatility in commodity markets inevitably leads to a systemic employment crisis, particularly impacting the most vulnerable Arctic regions, as manifested in the 2013–2018 recession. This trend is only likely to worsen as the state's resource-based economic growth weakens.

Keywords

Sustainable development · Arctic · United States' Arctic policy · Alaska · United States of America

Introduction

The Arctic Research and Policy Act of 1984 defines the United States Arctic Zone as all of the United States territory North and West of the boundary formed by the Arctic Circle and the Porcupine, Yukon, and Kuskokwim rivers; all adjacent waters, including the Arctic Ocean and the Beaufort, Bering, and Chukchi Seas; and the Aleutian Archipelago (United States Congress, 1984). Today, less than 48,000 people out of Alaska's 731,000 total population inhabit this vast area (Table 1) (Alaskan Department of Labor and Workforce Development, 2020).

At the federal level, the key areas of regulation with regard to the Arctic region are: sovereignty and security (geopolitics), scientific research, navigation, natural resource extraction, and combating climate change. Socio-economic development issues are barely touched upon and with minimal tangible reference to sustainability or resilience. Nevertheless, some elements of the concept of sustainable development still can be traced in the existing national strategic documents. This chapter attempts to examine how these elements have translated into real changes in the key sustainability indicators in the United States Arctic Zone over the past few years and to assess if the basic conditions for sustainable development were created.

Table 1 Key characteristics of the state of Alaska in 2019

Territory (kilometers squared)	Population (people)	GRP ($ billion)	GRP per capita ($)
570,641	731,545	54.44	74,343

Source: compiled by the authors based on the data from the United States Census Bureau (2021). Retrieved from: https://www.census.gov/quickfacts/fact/table/AK/PST040219#PST040219

The National Strategy for the Arctic Region, adopted in May 2013, remains the main conceptual document outlining the United States priorities in the sphere of comprehensive socio-economic development of the Arctic (United States President, 2013). The strategy complements the provisions of the 2009 Arctic Directive, which focuses primarily on foreign policy and security issues (United States President, 2009). One of the activities outlined in the Strategy was to ensure “responsible Arctic region stewardship,” including by protecting the environment and conserving the natural resources of the Arctic, as well as “using an integrated management system” to ensure a balance between economic development, environmental protection, and cultural values of the region (United States President, 2013).

In January 2014, the National Strategy Implementation Plan for the Arctic region was adopted, outlining 36 specific initiatives of the federal government to be implemented in the Arctic (United States President, 2014). Among them, in addition to environmental measures, there were actions directly aimed at improving the socio-economic sustainability of the region, in particular: development of transportation and communication infrastructure of the region, development of renewable energy sources and increasing the efficiency of traditional energy sources, and modernization of the management system in the field of resource extraction and consumption.

Nevertheless, despite the goals stated in the strategic planning documents, the state of Alaska is not trending upward on most key sustainability indicators, largely due to the fact that the basic preconditions for resilient state economy, capable of sustaining itself, do not yet exist.

Socioeconomic Development

Since the middle of the last decade, even before the COVID-19 pandemic, Alaska saw a protracted period of economic recession. The state’s GRP declined from \$64.8 billion in 2012 to \$54.4 billion in 2019. The state’s share in the US economy correspondingly shrank from 0.39 percent to 0.28 percent, respectively (Table 2). The main reason for this was the downturn in world prices for the state’s main export product – oil. This was followed by a decrease in employment in the extractive industry, which was exacerbated by the already present downward trend in the number of jobs in the government sector (Erickson & Barker, 2015).

The key unsustainability factors of the state’s economy in this case were the dependence on hydrocarbon exports and insufficient economic diversification. Although extractive companies employed about 3 percent of Alaskas jobs in 2013, more than 16 percent of the jobs were related to supporting their operations. Thus, the oil price crisis has led to an overall decline in employment, particularly in the state’s Arctic region. In particular, the North Slope Borough, home to the state’s largest hydrocarbon fields, has suffered the most from the extractive industry volatility and the subsequent employment crisis, which led to significant fluctuations in the number of service sector jobs. For example, this northernmost region of Alaska lost 17.4 percent of jobs in 2019–2020, compared to a 7.7 percent reduction in the state on average (Alaska Department of Labor and Workforce Development, 2021a).

Table 2 Alaska's gross regional product in 2009–2019

	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Alaska ($ billion)	58.67	61.85	64.45	64.80	62.47	60.39	54.43	52.84	53.93	55.26	54.39
United States ($ billion)	15,209	15,599	15,841	16,197	16,495	16,912	17,432	17,731	18,144	18,688	19,092
Share (per cent)	0.39	0.40	0.41	0.40	0.38	0.36	0.31	0.30	0.30	0.30	0.28

Source: compiled by the authors based on the data from the United States Department of Commerce. Retrieved from: https://www.bea.gov/data/gdp/gdp-state

The trend in employment data from 2013 to 2020 by sector shows an overall decline of more than 10 percent in the number of jobs in the state. Notable there has been a 45 percent decline in oil and gas employment and a 32.5 percent decline in mining sector employment (Table 3).

The state's unemployment rate during the recession also exceeded the United States average (Table 4). Among the few areas that gained employment during the recession were education and health care.

Table 3 Alaska's employed population by sector (excluding agriculture) in 2013–2020 (people)

Sector	2013	2020
Total nonfarm	336,500	302,600
Goods producing	48,300	38,900
Service-providing	288,200	263,600
Mining and logging	16,700	11,300
Mining	16,400	N/A
Oil and gas	14,100	7800
Construction	17,200	15,800
Manufacturing	14,400	11,900
Seafood processing	10,500	N/A
Trade/transportation/utilities	63,900	58,900
Wholesale trade	6500	6200
Retail trade	35,900	33,400
Food and beverage stores	5800	N/A
General merchandise stores	10,200	N/A
Trans/warehouse/utilities	21,500	19,300
Air transportation	5800	N/A
Information	6200	4900
Telecommunications	4100	N/A
Financial activities	12,200	10,800
Professional and business services	30,300	26,100
Educational and health services	47,900	49,400
Health care	33,200	38,200
Leisure and hospitality	33,700	26,600
Accommodation	8200	N/A
Food services and drinking places	20,700	N/A
Other services	11,300	10,100
Government	82,700	76,800
Federal government	15,500	15,400
State government	26,300	22,400
State education	7800	N/A
Local government	40,900	39,000
Local education	22,900	N/A
Tribal government	3600	N/A

Source: compiled by the authors based on the data from the Alaska Department of Labor and Workforce Development. Retrieved from: https://live.laborstats.alaska.gov/ces/ces.cfm

Table 4 Unemployment in the state of Alaska in 2009–2019 (percent)

	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Alaska	7.7	7.9	7.6	7.1	7.0	6.9	6.5	6.9	6.9	6.5	6.1
The United States	9.9	9.3	8.5	7.9	6.7	5.6	5.0	4.7	4.1	3.9	3.5

Source: compiled by the authors based on the data from the Alaska Department of Labor and Workforce Development and the United States Bureau of Labor Statistics. Retrieved from: https://live.laborstats.alaska.gov/labforce/labdataall.cfm?s=2&a=0, https://www.bls.gov/charts/employment-situation/civilian-unemployment-rate.htm

A significant share (25.4 percent in 2020) of jobs in the state is in public sector administrative positions. Alaska as a whole shows a high level of dependence on federal government – 61.79 percent of the state's territory is administered by various federal agencies, 33.93 percent of this land is managed by the US Fish and Wildlife Service, 32.3 percent by the U.S. Bureau of Land Management (including the National Petroleum Reserve at North Slope), 23.3 percent by the US National Park Service, 9.72 percent by the US Forest Service, and 0.75 percent by the US Department of Defense. As of June 2021, the number of people employed by federal agencies in the state of Alaska was around 15,200 (about 5 percent of the total employed population) (Federal Reserve Bank of St. Louis, 2021). Despite the fact that the United States government does not provide direct grants to pay off state budget deficits, federal funding is allocated annually to federally owned facilities within the state. The resulting influx of money into the state economy has a stabilizing effect on the socio-economic situation in the Arctic region and served to ameliorate the crises during both the 2014–2019 recession and the COVID-19 pandemic (Alaska Department of Labor and Workforce Development, 2021b). As oil revenues will inevitably decline in the coming decades, both with the depletion of existing oil fields and technological refinement of alternative energy sources, as well as under constant pressure from the proponents of climate agenda, federal assistance is bound to play an ever-increasing role.

The recession also affected the demographic potential of the state as a whole and the Arctic region in particular. The beginning of the decade was marked by steady population growth, both through natural increase and balanced migration flows. However, since 2013, the de-intensification of labor migration flows to the state led first to slower growth and then to a decline in population. For the first time in history, Alaska experienced such a long period of net migration outflow (Alaska Department of Labor and Workforce Development, 2021a) (Table 5).

However, despite the decline, the region is still experiencing significant natural population growth. In 2019–2020, this figure amounted to 5042 people. It is also noteworthy that Arctic region's predominantly indigenous population has remained stable and even shown slight growth during the decade (Alaska Department of Labor and Workforce Development, 2021c). Life expectancy at birth has also increased during the past decade (Table 6).

At the same time, the aging of the population (the average age increased from 33.8 years in 2010 to 35.7 years in 2020), as well as the aforementioned migration outflow, is gradually reducing the share of the economically active population

Table 5 Population of Alaska in 2009–2020 (people)

1 July–30 June	Population	Population change	Growth rate (percent)	Births	Deaths	Natural increase	Net migration
2009–2010	713,984	16,156	2.29	11,218	3631	7587	8569
2010–2011	722,473	8489	1.18	11,694	3844	7850	639
2011–2012	731,005	8532	1.17	11,100	3853	7247	1285
2012–2013	736,552	5547	0.76	11,312	3980	7332	−1785
2013–2014	737,053	501	0.07	11,432	3968	7464	−6963
2014–2015	737,786	733	0.10	11,323	4294	7029	−6296
2015–2016	740,637	2851	0.39	11,272	4451	6821	−3970
2016–2017	738,920	−1717	−0.23	10,751	4425	6326	−8043
2017–2018	735,367	−3553	−0.48	10,369	4413	5956	−9509
2018–2019	732,734	−2633	−0.36	9897	4642	5255	−7888
2019–2020	728,903	−3831	−0.52	9634	4592	5042	−8873

Source: compiled by the authors based on the data from the Alaska Department of Labor and Workforce Development. Retrieved from: https://live.laborstats.alaska.gov/pop/estimates/data/ComponentsOfChangeAK.xls

Table 6 Life expectancy at birth in the state of Alaska in 2009–2016 (years)

2009–2011	2010–2012	2011–2013	2012–2014	2013–2105	2014–2016	2016–2018
76.4	76.6	76.6	76.7	76.5	76.2	78

Source: compiled by the authors based on the data from Alaska Department of Health and Social Services and the National Center for Health Statistics. Retrieved from: http://web.archive.org/web/20210502205906/http://dhss.alaska.gov/dph/VitalStats/Documents/PDFs/VitalStatistics_AnnualReport_2016.pdf; https://www.cdc.gov/nchs/pressroom/states/alaska/ak.htm

Table 7 State of Alaska labor force participation rate in 2009–2019 (percent)

	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Alaska	70.1	69.6	68.9	68.1	67.8	67.4	66.7	66.1	65.2	64.1	63.7
United States	64.6	64.3	64	63.7	62.9	62.8	62.7	62.7	62.7	63	63.2

Source: compiled by the authors based on the data from United States Bureau of Labor Statistics. Retrieved from: https://data.bls.gov/pdq/SurveyOutputServlet

(Table 7). The working-age population in the state of Alaska as of December 2019 was estimated at 346,800 (United States Bureau of Labor Statistics (2020).

One of Alaska's most important nonextractive industries is tourism, with its related hospitality infrastructure – before the pandemic, the state hosted about 2.25 million tourists annually. The industry employs about 10 percent of the state's workforce (Table 3). It is also an important source of fiscal revenue – tourism brought in \$126 million to the state and \$88 million to municipalities, with an estimated total economic impact of \$4.5 billion. The state government's investment has been a major factor in promoting Alaska's image as an attractive tourist destination. However, the economic recession has not spared the industry. From 2012 to

2017, the state Legislature cut the funding by 79 percent (Johnson, 2020). Additional blow was dealt by the COVID-19 pandemic in 2020–2021.

The main tourism destination in Alaska is the state's national park system, which includes 23 sites run by the US National Park Service, that is, the federal government (United States National Park Service, 2021). National Parks are also an important part of the region's environmental sustainability, preserving biodiversity, the absorptive capacity of the forests, and natural landscapes. The tourism potential of these and other natural sites in Alaska, however, is severely limited by a lack of infrastructure, primarily transportation, relatively high cost of living in the region, as well as growing, yet still underdeveloped winter tourism capacities (AP News, 2018).

The economic well-being of the state's population varies by geographic location. While the cost of living in big cities like Anchorage and Fairbanks has been declining for the past decade and is now generally in line with the largest cities in the continental United States, inhabitants of the remote parts of the state, including the Arctic Zone, still face high costs to meet most of their daily requirements. By comparison, as of early 2021, a gallon of gasoline cost \$2.75 in Fairbanks and \$2.88 in Juneau, while its price reached as high as USD8 in the Arctic Village settlement and \$8.35 in Atka (Aleutian Islands). Similarly, the cost of healthcare in the state is also well above the national average (ranging from 50 percent to 62 percent) (Alaska Department of Labor and Workforce Development, 2021d). High prices in remote areas and small communities in the Arctic zone are largely attributed to the lack of transportation infrastructure and the high costs of shipping goods by water and air.

State household incomes during the recession grew slower than the US average (Table 8), which, combined with the high cost of living, puts additional strain on consumer demand and reduces the potential for economic growth and diversification in the region.

Since 2014, Alaska has adjusted the minimum wage each year according to the rate of inflation (Table 9). Thus, minimum wage in the state has been on the rise in 2009–2021 and has reached \$10.34 in 2021, around a quarter higher than the federal

Table 8 Average household income in the state of Alaska in 2013–2018 (\$)

	2013	2014	2015	2016	2017	2018	2019
Alaska	72,237	71,583	73,355	76,440	73,181	74,346	75,463
The United States	52,250	53,657	55,775	57,617	60,336	61,937	65,712

Source: compiled by the authors based on the data from the Data USA. Retrieved from: https://datausa.io/profile/geo/alaska#economy

Table 9 Alaska state minimum wage in 2009–2021 (\$ per hour)

	2009	2010	2015	2016	2017	2018	2019	2020	2021
Alaska	7.25	7.75	8.75	9.75	9.80	9.84	9.89	10.19	10.34
The United States	7.25	7.25	7.25	7.25	7.25	7.25	7.25	7.25	7.25

Source: compiled by the authors based on the data from the Alaska Department of Labor and Workforce Development. Retrieved from: https://labor.alaska.gov/lss/whact.htm minimum of $7.25 (Alaska Department of Labor and Workforce Development, 2014).

The Alaska Permanent Fund is another tool serving to improve the welfare of the state's population. It was created to provide an investment base from oil revenues as a source of future budget revenue. At least 25 percent of the state's royalty income from oil and other mineral extraction as well as federal payments is allocated to the Permanent Fund. The Fund serves as an auxiliary source of funds in case of budget deficits. Legislation sets an annual limit on the amount of money that can be drawn from the fund, but the limit can be changed if necessary, depending on oil prices. Funds transferred to the budget by the fund are counted towards state debt and must be reimbursed to the fund in surplus years. As of June 2021, the Permanent Fund's capital was estimated at $81.1 billion (Alaska Permanent Fund Corporation, 2021).

The Fund is also entitled to pay dividends to the state's population. Between 2009 and 2019, Alaskans received an average of about $1300 annually. Since 2015, the size of the payment has been set by the state legislature (Alaska Permanent Fund Corporation, 2021). It should also be noted that Alaska has no income or sales taxes. The main sources of state revenues are: corporate taxes, license fees, federal funds, and profits from investment activities (Alaska Office of Management and Budget, 2021). Since the recession hit the state in 2014, the budget has been in deficit, plunging to $3.17 billion in 2017 (Table 10).

Infrastructure

As mentioned above, infrastructure represents one of the key bottlenecks for the region, a factor that negatively affects living standards and significantly diminishes the Alaska's economy long-term growth prospects. This is particularly true for the region's transportation infrastructure. About 80 percent of the state's communities are not connected by a network of highways. Alaska's largest existing transportation infrastructure is designed primarily to meet the needs of the oil, gas, and mining industries. For example, the Dalton Highway is the only surface transportation artery connecting the oil fields of northern Alaska (North Slope) to the rest of the state. The total length of the highway is 666 kilometers, with only about 175 kilometers paved. The Trans-Alaska pipeline runs in parallel to the road, pumping oil from Prudhoe Bay to the south of the state (United States Bureau of Land Management 2021). The rest of the Arctic Region North Slope, Northwest Arctic, Nome, Kusilvak, Aleutans West, Aleutans East, and parts of the Yukon-Koyukuk do not have any arterial automobile roads connecting settlements and communities, who have to rely on water and air transportation. Alaska Department of Transportation and Public Facilities, in charge of road maintenance and construction in the state, has in the recent years been primarily preoccupied with maintaining the existing roads, without any significant efforts to expand the network in the Arctic region. Total road network length fluctuated over the decade, peaking at 28,535 kilometers in 2019 (Table 11).

In the context of the lack of ground transportation infrastructure, air transport plays a vital role for Alaskan economy and people's livelihood. The American

Table 10 Alaska state budget in 2009–2019 ($ billion)

	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Expenditures	11.43	8.41	9.82	11.37	12.07	11.33	10.64	9.81	9.73	10.21	11.22
Revenue	12.62	7.28	10.06	11.79	12.59	10.66	9.26	7.06	6.55	7.758	10.58
Balance (incl. Contributions to the Permanent Fund)	1.30	−1.05	1.53	0.42	0.51	−0.67	−1.38	−2.75	−3.178	−2.455	−0.69

Source: compiled by the authors based on the data from the Alaska Office of Management and Budget. Retrieved from: https://omb.alaska.gov/category/budget-reports

Table 11 Length of road network in Alaska in 2011–2020 (kilometers)

2020	28448.73
2019	28535.62
2018	27433.45
2017	24995.82
2016	24986.16
2015	25953.17
2014	25306.35
2013	25227.51
2012	26228.31
2011	26828.47

Source: compiled by the authors based on the data from the Alaska Department of Transportation and Public Facilities. Retrieved from: https://dot.alaska.gov/stwdplng/transdata/cprm.shtml

Society of Civil Engineers estimates that the economic impact of the aviation industry in the state amounts to $3.5 billion annually. There are about 400 airfields of various types and another 300 runways in the state. However, the quality and technical condition of airfields varies greatly, from state-of-the-art international airports in Anchorage and Juneau to local and community small facilities in remote regions. Funding to support the technical condition of aviation infrastructure comes primarily from federal programs. For example, the Alaska Department of Transportation and Public Facilities allocates $34 million annually for this purpose, while the Federal Aviation Administration's Airport Improvement Program amounts to around $200 million (American Society of Civil Engineers, 2017).

The Essential Air Service Program is among the most important federal civil aviation initiatives for Alaska. Under this Program, the United States Department of Transportation provides small, remote communities with access to the National Air Transportation System by subsidizing two flights a day with 30- to 50-seat or, if necessary, 9-seat or smaller aircraft, to large or medium-sized hub airports. The Department currently subsidizes air travel for about 60 locations in Alaska and further 115 in the mainland United States (United States Department of Transportation, 2021). Clearly, this program plays an integral role in ensuring the viability and resilience of local communities in the Arctic region. However, regularly transporting small amounts of people and cargo can have negative side effects, both in terms of economic efficiency and environmental sustainability, as small-scale flights are characterized by high rates of air pollutant emissions per passenger.

Energy and Climate

Similarly to transport infrastructure, the Arctic region of Alaska, with over 125 villages, has almost no electric grid connections. Residents in these communities have to rely on local microgrids for power.

Climate issues are at the core of the concept of sustainability in public and political discourse and are often associated with the whole concept. In this regard, it was the energy-climate nexus, along with the geopolitical issues, that formed the basis of the US strategic documents on the development of the Arctic.

One of the most important initiatives proposed in the National Arctic Strategy Implementation Plan was the development of renewable energy in the region (United States President, 2014). Specifically, it included:

- Encouraging wind, tidal, and solar energy development through collaboration with local and regional stakeholders, while leveraging private investments, including from foreign sources.
- Mobilizing federal and state resources to support regional renewable energy development and collaboratively developing a ten-year action plan in collaboration with private sector stakeholders.
- Developing public-private partnership mechanisms to finance and promote research in renewable energy.
- Deployment of small-scale renewable energy systems in remote communities.

The Ten-Year Renewable Energy Plan, published in April 2015, focuses on maximizing the efficiency of microgrids as the backbone infrastructure for subsequent connection of renewable generation capacity, improving energy efficiency of production and consumption of renewable energy sources (United States Department of Energy, 2015).

However, despite the priorities and goals outlined by the federal government, there are currently no facilities in the Arctic zone of Alaska that generate electricity for the local microgrid based on renewable sources (Fig. 1).

Most of the power plants in the Arctic region are gasoline-powered, with a small minority being gas-power. Overall, natural gas dominates the state in power generation (43 percent). Hydropower accounts for a significant portion (26 percent) (Table 12). However, all hydropower plants are located in the south and southeast of the state, in regions not formally part of the Arctic zone (United States Energy Information Administration, 2021).

Greenhouse gas emissions in the state, according to the latest available data, have been declining along with the overall United States indicator, reflecting both a gradual transition to cleaner technologies in manufacturing and transportation, as well as reduced production due to lower hydrocarbon prices and Alaska's economic downturn in mid-2010s (Table 13). More than half of the emissions in the state come from the extractive industry, with transportation accounting for a significant share.

Thus, given the state's continued reliance on hydrocarbon revenue and lack of progress in terms of installing new renewable capacities, Alaska is as far from achieving environmental equilibrium, as it is from reaching socioeconomic sustainability within a foreseeable future.

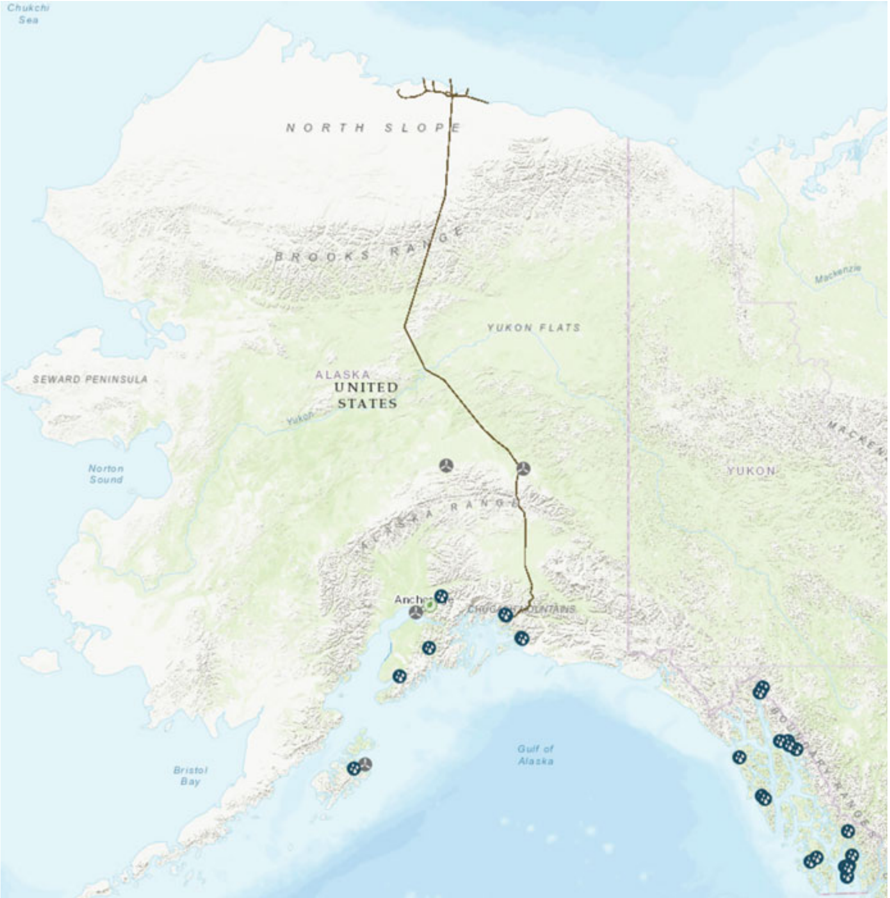

Fig. 1 Renewable energy generating capacity in the State of Alaska in 2021. Source: adapted by the authors from U.S. Energy Information Administration (2021). *Alaska*. Retrieved from: https://www.eia.gov/state/?sid=AK

Table 12 Power generation in the State of Alaska by Energy Source in 2021

Energy source	Output (megawatt per hour)	Share (percent)
Petrol	68	16
Natural gas	180	43
Coal	41	10
Hydro	108	26
Other renewables	18	4
Total	415	100

Source: compiled by the authors based on the data from the United States Energy Information Administration. Retrieved from: https://www.eia.gov/state/?sid=AK#tabs-4

Table 13 Greenhouse gas emissions in Alaska in 2005–2015 (mertic tons CO_2 equivalent)

	2005	2015
Alaska	54.64	41.3
The United States	6131.9	5412.4

Source: compiled by the authors based on the data from the Alaska Department of Environmental Conservation and the United States Environmental Protection Agency. Retrieved from: https://dec.alaska.gov/air/anpms/projects-reports/greenhouse-gas-inventory, https://cfpub.epa.gov/ghgdata/inventoryexplorer/#allsectors/allgas/gas/all

Conclusions

The United States of America is currently in the process of formulating a sustainable development policy for the Arctic region. The existing documents do not reflect the full range of federal government's activities to ensure the functioning of the socio-economic sphere of the state of Alaska in general and the Arctic zone in particular. The needs of the region are not fully taken into account in the concept documents. For example, the emphasis on addressing environmental issues does not address the main challenges facing Alaska – the state's high dependence on the natural resource sector and the lack of infrastructure. Changes in the region's economic well-being are not the result of a deliberate Arctic sustainable development policy, but reflect natural market processes, geographic location, and climate conditions in Alaska.

Despite persistent natural population growth in the state and the Arctic zone, the demographic situation and, consequently, the region's employment and future economic growth prospects do not look sustainable. Existing trends toward declining natural population growth, as well as the interdependence of migration flows and hydrocarbon energy prices, do not create a solid foundation for increasing the self-sufficiency of Alaska's socio-economic sphere. Under the existing conditions, volatility in commodity markets inevitably leads to a systemic employment crisis, particularly impacting the most vulnerable Arctic regions, as manifested in the 2013–2018 recession. The sustainability of Alaska's economy is additionally challenged by its continued heavy reliance on federal inflows in all key economic areas. This trend is only likely to worsen as the state's resource-based economic growth weakens.

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Sustainable Development of the Arctic Zone of the Russian Federation

Opportunities and Challenges

Mikhail E. Kuznetsov and Natalia A. Samsonova

Contents

Abstract

The Arctic Zone of the Russian Federation (AZRF) has a significant economic potential. Today, it is being developed mainly through the use of the mineral resources available in the region. The chapter analyzes opportunities and limitations in implementation of large projects for the extraction and processing of natural resources in the AZRF and assesses the versatile impact of those projects on sustainable development of the territories in the Arctic zone of the Russian Federation. It provides a general assessment of the economic potential of the region and the prospects of its development, evaluation of the potential volume of the added value, tax revenues from the projects, and

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considers infrastructure restrictions (transport, communication, and port infrastructure). Active economic development of the Arctic zone and growth of the cargo base of the Northern Sea Route make especially relevant the issues of sustainable development of the Arctic zone territory, including the need for development of the social infrastructure, intensification of maritime navigation, and careful attitude to the environment. The analysis, estimates, and forecasts in this chapter were made by the authors on the basis of open data and public strategic documents.

Keywords

Arctic zone of the Russian Federation · Northern Sea Route · Sustainable development · Economic potential · Added value · Tax revenues · Maritime navigation

Introduction

Key priorities in management and development of the Arctic zone of the Russian Federation are defined in Principles of State Policy of the Russian Federation in the Arctic till 2035 (Decree of the President of the Russian Federation dated 05.03.2020 N 164) and in the development strategy of the Arctic zone of the Russian Federation and national security protection till 2035 (Decree of the President of the Russian Federation dated 26.10.2020 N 645). Analysis of those documents makes it possible to claim that the purposes and basic approaches to management and development of the region are clearly stated in the key strategic declarations – the principles of national policy and the development strategy of the Arctic zone of the Russian Federation. The comparison given in Table 1 makes it possible to state that the principles and approaches declared by Russia totally correspond to the international principles of sustainable development and global purposes of the UN in the field of sustainable development (Resolution adopted by the General Assembly on 25 September, 2015).

As it is seen from the declaration of national interests, the problems of rational development of the resource base, complex social and economic management, and development of the major traffic artery – the Northern Sea Route – are balanced by problems of social development and environmental protection, as well as the rights and the lifestyle of indigenous ethnic groups.

The development strategy of the Arctic zone of the Russian Federation and national security protection till 2035 established main mechanisms, ways, and means to achieving the strategic objectives and priorities of sustainable development of the Arctic zone of the Russian Federation and national security protection. At the same time, the strategy clearly states both the opportunities connected with management and development of the Arctic zone of the Russian Federation and risks and threats (challenges). In this chapter, we are going to make general quantitative and qualitative assessment of those possibilities and challenges.

Table 1 The analysis of compliance of the stated national interests of the Russian Federation in the territory of the Arctic zone

Global purposes of the UN in the field of sustainable development (Quoted according to the Resolution accepted by the General Assembly on September 25, 2015, 70/1. Transformation of our world: the Agenda in the field of sustainable development till 2030)	National priorities of Russia's activities in the Arctic zone (Quoted according to the Development Strategy of the Arctic zone of the Russian Federation and national security protection till 2035 (approved by Decree of the President of the Russian Federation dated 26.10.2020 645), Decree of the President of the Russian Federation dated 05.03.2020 164 "On the Principles of the State Policy of the Russian Federation in the Arctic till 2035")
People We are full of determination to put an end to poverty and hunger, in all their forms and manifestations, and to ensure that all people could realize their potential with dignity and equality and in healthy ̆environment	• Ensuring the high quality of life and welfare of the population of the Arctic zone of the Russian Federation
Planet We are full of determination to save the planet from degradation, including by means of implementation of the rational models of consumption and production, rational use of its natural resources, and adoption of urgent measures in connection with climate change so that the planet could satisfy the requirements of the present and future generations	• Environment protection in the Arctic, protection of the native habitat, and the traditional way of life of the indigenous ethnic groups living in the territory of the Arctic zone of the Russian Federation • Ensuring the ecological safety
Prosperity We are full of determination to ensure that all people could live in the conditions of prosperity and well-being so that economic, social, and technical progress continued in harmony with the Nature	• Development of the Arctic zone of the Russian Federation as a strategic resource base and its rational use for acceleration of the economic growth of the Russian Federation • Development of the Northern Sea Route as a globally competitive national transport communication line of the Russian Federation • Complex social and economic development of the Arctic zone of the Russian Federation • Development of science and technologies • Creation of modern information and telecommunication infrastructure
World We are full of determination to promote creation of peaceful, fair, and free from social barriers society, in which there is no place for fear and violence. Sustainable development is impossible without peace and peace is impossible without sustainable development	• Ensuring sovereignty and territorial integrity of the Russian Federation • Ensuring military safety, protection and border security of the Russian Federation in the Arctic
Partnership We are full of determination to mobilize all means necessary for implementation of the present Agenda in the framework of the updated Global Partnership in the interests of sustainable development based on the spirit of resurgent	• International cooperation in the Arctic • Preservation of the Arctic as a territory of peace and stable and mutually advantageous partnership

(continued)

Table 1 (continued)

Global purposes of the UN in the field of sustainable development (Quoted according to the Resolution accepted by the General Assembly on September 25, 2015, 70/1. Transformation of our world: the Agenda in the field of sustainable development till 2030)	National priorities of Russia's activities in the Arctic zone (Quoted according to the Development Strategy of the Arctic zone of the Russian Federation and national security protection till 2035 (approved by Decree of the President of the Russian Federation dated 26.10.2020 645), Decree of the President of the Russian Federation dated 05.03.2020 164 "On the Principles of the State Policy of the Russian Federation in the Arctic till 2035")
global˘solidarity focused first of all on the needs of the poorest and the most vulnerable groups of population and assuming participation of all countries, all interested parties and all people	

Source: Compiled by the authors on the basis of contents of the UN Resolution (dated 25.09.2015, N 70/1) and documents planning strategic development of the territory of the Arctic zone of the Russian Federation

Literature Review

One of the main advantages of economic development of the Arctic territories are sea transport arteries – the Northern Sea Route and its expanded version the Northern Sea Transit Corridor. This is why our approaches to assessment of sustainable development have to include the transport component and the associated conditions: climatic, geopolitical, infrastructure, and others. Economic feasibility of using the Arctic transport arteries as an alternative route between Asia and Europe for various scenario parameters (such as fuel prices, climatic conditions, and the length of navigation period) is evaluated in many studies (Aksenov et al., 2017; Khon et al., 2010; Lasserre, 2014; Lasserre & Pelletier, 2011; Liu & Kronbak, 2010; Schøyen & Bråthen, 2011). In addition to the factors influencing direct transportation costs (transportation distance, fuel consumption, remuneration for the crew, payments for using the route), researchers also note the importance of effective vessels loading and sufficient capacity of transport infrastructure.

Methods for assessment of the social and economic effects of the investment projects implemented in the Arctic were examined by many authors, such as (Somanathan et al., 2006; Lu et al., 2014; Novoselov et al., 2017; Afonichkina & Afonichkin, 2018; Tishkov et al., 2020; Zhukov, 2020) and others.

The methodology used in this chapter to estimate the effects of projects implementation will be described below.

Assessment of Opportunities

Key opportunities of management and development of the Arctic zone of Russia are undoubtedly connected with the development of mineral resources of the region and the development of the Northern Sea Route as a competitive national transport artery.

Development of Mineral Resources

Economic capacity of the Arctic zone of the Russian Federation is realized mainly through development and use of mineral resources. The main types of minerals of the Arctic zone of the Russian Federation as of January 1, 2020 are shown in Table 2 (in decreasing order of the share of reserves in total reserves of the Russian Federation).

Oil production volume in land territories of the Arctic zone of the Russian Federation (hereinafter – the RF Arctic zone) in 2019 was 10% of the total amount of oil production in the Russian Federation, the volume of gas condensate production was 84%, the volume of oil (associated) gas extraction was 31%, and the volume of natural gas production was 91% (Federal State Statistics Service, 2020).

Volumes of crude oil, oil (associated) gas, and natural gas production by organizations located in the territory of the Arctic Zone of the Russian Federation for 2017–2019 are shown in Table 3.

During 2017–2019, there was a decrease in oil production volumes – in 2019 the production volume was just 71% of the production volume in 2017. At the same time, the all-Russian volumes of oil production kept growing. The volumes of gas and gas condensate extraction in the period were also growing. The greatest growth rate is noted in oil (associated) gas extraction – in 2019, the production volume was 124% of the production volume in 2017.

Development of the Northern Sea Route

At first sight, the benefits from use of the Northern Sea Route (hereinafter – NSR) are obvious. They include shorter transit time, and consequently, economy on fuel and labor costs and charter of the sea vessel. Thus, an approximate length of the route along the NSR from Yokohama to Rotterdam is 7300 nautical miles and the transit time is about 20 days. The same route through the Indian Ocean and the Suez Canal is one and a half times longer – (12,500 nautical miles and 33 days, respectively).

However, it should be noted that the main obstacle on the way to large-scale development of the Northern Sea Route as a global transport artery is the absence of stable year-round navigation, severe weather and ice conditions, and the lack of navigation and emergency rescue infrastructure. With its creation and also with the formation of a powerful fleet of icebreakers ensuring year-round navigation, the interest to the development of NSR as a transit artery will keep growing.

The volumes of traffic through that transport artery are already several times exceeding the record levels of the Soviet Union. In 1986 record for the USSR 6.7 million tons of cargo was transported along the Northern Sea Route. In 2019, the figure exceeded 31.5 million tons. According to the target value in the Decree of the President of the Russian Federation dated May 7, 2018 N 204 “On the national goals and strategic objectives of the development of the Russian Federation for the period up to 2024” it is expected that the volume of traffic through the Northern Sea Route

Table 2 Main types of minerals of the Arctic zone of the Russian Federation as of January 1, 2020

Type of mineral	Share of the reserves in total reserves of the Russian Federation (%)	Extracted in the previous year	Extraction share in total extraction volumes of the Russian Federation (%)
Impact diamonds	100	0	0
Scandium	90.1	0	0
Platinoids	78.6	141.1 t	96.1
Combustible gases (free gas)	76.3	607.5 billion m^3	87.4
Gallium	71.8	727.6 t	88
Rare-earth metals	71.4	111.6 thousand tons	100
Apatite ores	67.6	5, 8 million tons	99.2
Condensate	58	25.05 million tons	79
Rubidium	57	2.62 million tons	97.9
Tin	50.5	0	0
Copper	41.1	441.4 thousand tons	46.2
Titan	30.3	446 thousand tons	100
Diamonds	29.3	18.3 million carat	39.8
Antimony	27.1	0	0
Silver	25.3	119.2 t	5.2
Combustible gases (dissolved gas)	25.2	9.2 billion m^3	1.3
Oil	20.8	68.74 million tons	13.2
Zirconium	16.9	18.5 thousand tons	100
Gold	12.6	32.8 t	7.4
Molybdenum	12.6	0	0
Tungsten	6.4	0	0
Lead	5.7	0	0
Coal	3.6	8.1 million tons	2.0
Zinc	3.2	0	0
Iron ores, cesium, bauxites, selenium	Less than 3	–	–

Source: Compiled by the authors according to open data from the Federal State Budgetary Institution VSEGEI (Russian Geological Research Institute named after A.P.Karpinsky) and the FSSS (Federal State Statistics Service). Retrieved from: https://vsegei.ru/ru/, https://rosstat.gov.ru/

will reach 80 million tons a year by 2024, 90 million tons by 2030, and 130 million tons by 2035 according to the target values in the "Development Strategy of the Arctic zone of the Russian Federation and national security protection for the period up to 2035" (Decree of the President of the Russian Federation dated 26.10.2020 N 645).

It should be noted that shorter transit time and use of modern, ecologically safer transport solutions will allow the Northern Sea Route to make its contribution to the fight against climate change. Thus, according to our calculations, the reduction of

Table 3 Indicators of the volumes of crude oil, oil (associated) gas, and natural gas production in the Arctic zone of the Russian Federation

Indicator	Land territories of the Arctic zone of the Russian Federation			Russian Federation (for reference)		
	2017	2018	2019	2017	2018	2019
Oil production, million tons	71.38	68.74	50.86	511.73	520.96	524.35
Oil production share in total Russian volume, per cent	14	13	10	100	100	100
Growth rate of the oil production volume	1.00	0.96	0.74	1.00	1.02	1.01
Gas condensate extraction, million tons	23.65	25.05	26.16	30.63	31.75	31.00
Gas condensate extraction share in total Russian volume, per cent	77	79	84	100	100	100
Growth rate of gas condensate extraction volume	1.00	1.06	1.04	1.00	1.04	0.98
Extraction of oil (associated) gas, million cubic meters	21,584.36	21,547.39	26,743.13	77,565.67	79482.04	86015.88
Share of oil (associated) gas extraction in total Russian volume, per cent	28	27	31	100	100	100
Growth rate of oil (associated) gas extraction volume	1.00	1.00	1.24	1.00	1.02	1.08
Natural gas extraction, million cubic meters	540,742.61	571,982.57	585,418.76	598,576.72	629,659.64	642,676.08
Share of natural gas extraction in total Russian volume, per cent	90	91	91	100	100	100
Growth rate of oil (associated) gas extraction volume, per cent	1.00	1.06	1.02	1.00	1.05	1.02

Source: Calculated by the authors based on data from Federal State Statistics Service of Russia. Retrieved from: https://www.gks.ru/free_doc/new_site/region_stat/arc_zona.html

CO_2 emissions in cargo transportation through the NSR instead of the Suez Canal can exceed €200 million equivalent by 2030 (Fig. 1).

Reduction of CO_2 emissions during cargo transportation by water will be facilitated by gradual transition from oil fuel to LNG. The forecast of CO_2 emissions during cargo transportation by the types of fuel used is shown in Fig. 2.

The projected growth in the use of LNG as ship fuel in 2023 will lead to a decrease in the specific emissions of CO_2. Prevalence of LNG over oil fuel is expected by 2030, which will result in decrease in the specific emissions of CO_2 down to 3 g per 1 ton-mile.

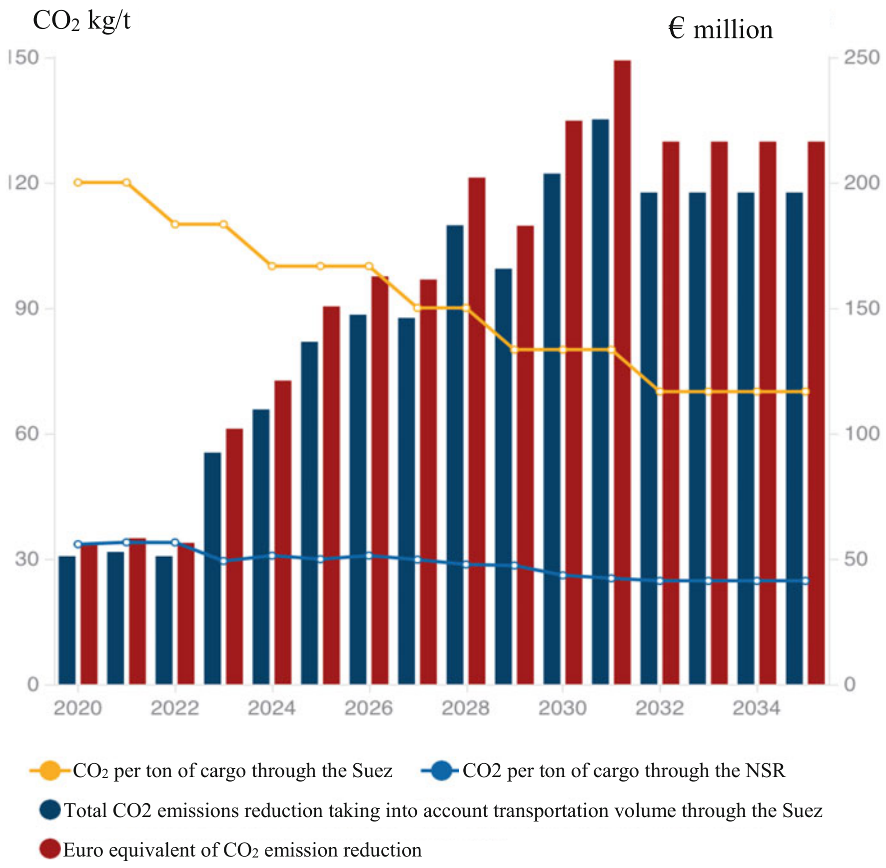

Fig. 1 Reduction of CO_2 emissions when using the NSR for cargo transportation. (Source: Calculations of the authors according to public statements of the companies providing cargo transportation along the NSR. Retrieved from: https://yamal.gazprom-neft.ru/, https://www.rosneft.ru/, https://www.novatek.ru/, https://www.nornickel.ru/, https://www.kazminerals.com/, https://threearc.ru/, http://www.pgrk.armz.ru/ru/, https://www.polymetalinternational.com/ru/, https://arctic-energy.com/, http://www.aeoncorp.ru/)

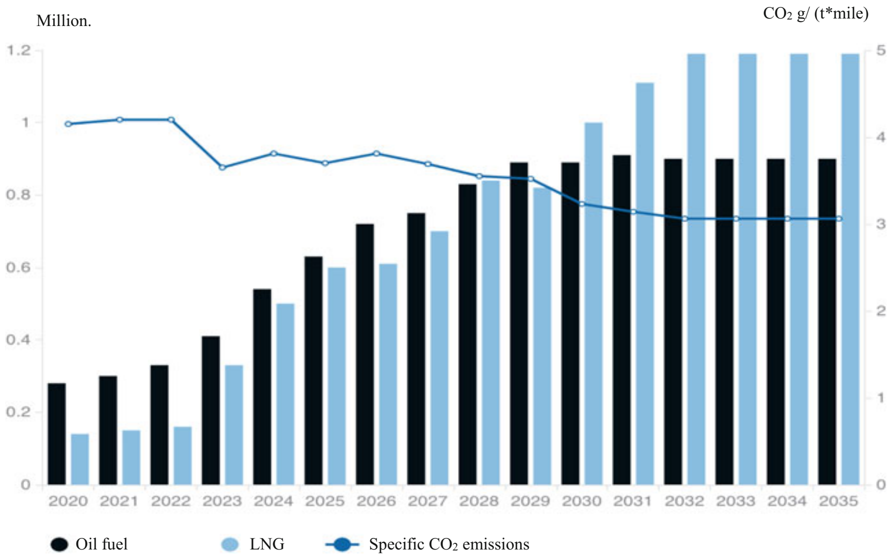

Fig. 2 Forecast of CO_2 emissions by the transport industry. (Source: Calculations of the authors according to public statements of the carrier companies and the companies providing cargo transportation along the NSR. Retrieved from: https://yamal.gazprom-neft.ru/, https://www.rosneft.ru/, https://www.novatek.ru/, https://www.nornickel.ru/, https://www.kazminerals.com/, https://threearc.ru/, http://www.pgrk.armz.ru/ru/, https://www.polymetalinternational.com/ru/, https://arctic-energy.com/, http://www.aeoncorp.ru/)

Assessment of the Impact of Investment Projects on Sustainable Development of the AZRF Territory

Methodology

The Federal Autonomous Scientific Institution "Eastern State Planning Center" planning complex development of various areas of the Arctic zone is creating an information and analytical system ArcticLabs (hereinafter – IAS "ArcticLabs"). The project is implemented according to the decree of the President of the Russian Federation dated 05.03.2020 N 164 "On the Principles of State Policy of the Russian Federation in the Arctic till 2035" confirming the necessity to create a unified statistical, information, and analytical system for monitoring and management of social and economic development of the Arctic zone of the Russian Federation. The main objective of the system is to become an additional expert instrument of planning of the development of the Arctic territories in interrelation of three main aspects: economic, social, and ecological. One of the features of the service is an ability to make synchronous complex forecasts for different scenarios.

The heart of the system is a dynamic mathematical model with simulation of effects at the international, federal, regional, and corporate levels, uniting all means of transport, urban economics, demography, climate, and ecology and performing calculation of different scenarios for the development of the Arctic depending on the speed and the scale of economic, social, and climate changes.

In IAS "ArcticLabs," one can set the parameters of projects whose realization is connected with increasing the cargo traffic along the Northern Sea Route or development of the territories of the Arctic zone of the Russian Federation.

The impact of the projects on sustainable development of the territories of the Arctic zone of the Russian Federation consists in social and economic and ecological effects arising as a consequence of their realization.

Assessment of social and economic effects of implementation of the projects is carried out on the basis of assessment of the following factors:

- Gross added value created by direct participants of a project and related types of economic activities ensuring implementation of the projects
- Number of new jobs created in the territory of implementation of a project
- Tax revenues from direct participants of a project

Further in the chapter the methodology and results of calculations of socioeconomic effects from projects on extraction and processing of minerals in the Arctic zone of the Russian Federation used in IAS "ArcticLabs" are presented.

Assessment of the Gross Value Added Created in the Course of Implementation of Large Projects

Approach to Gross Value Added Calculation

The gross added value (hereinafter – GVA) generated by a project is assessment of its contribution to the gross regional product. GVA within a project is created by its direct participants and the related types of economic activities ensuring implementation of the projects. In our case, the related activities are those rendering services in cargo transportation by the sea transport and cargo processing in the sea ports of the Arctic basin.

We will determine the gross added value using the following formula:

$$GVA_i^t = O_i^t \times GVA\_S_i^t,$$

where:

GVA_i^t is the gross added value created in t year in the course of production of the i-th type of product/rendering of the i-th type of service.
O_i^t is output of the i-th type of products/services in t year.
$GVA\_S_i^t$ is the share of gross added value in production of the i-th type of products/services in t year.

Output of goods and services is the total cost of the goods and services being the result of production activities of the resident units of the national economy in the reporting period (Federal State Statistics Service, 2015). The described methodology takes into account output of the i-th type of products being a result of production activities of the participants of a project. Output of the i-th type of products/services in t year is determined by the formula:

$$O_i^t = V_i^t \times C\text{т}_i^t,$$

where:

V_i^t is the volume of produced and shipped products/rendered services of the i-th type in t year (in respective units of measurement).

$C\text{т}_i^t$ is the cost of a unit of products/services of the i-th type in t year.

Since gross added value is determined as the cost of output of goods and services minus the cost of intermediate consumption, the share of GVA in output of the i-th type of products/services in t year is determined by the formula:

$$GVA\_S_i^t = 1 - IC\_S_i^t$$

where:

$IC - S_i^t$ is the share of expenses on intermediate consumption in output of the i-th type of products/service in t year.

Intermediate consumption is the total cost of the goods and services consumed as expenses in the process of production except for fixed assets whose consumption is reflected as fixed capital consumption. According to paragraph 37 of the methodical recommendations for development, adjustment, monitoring of a medium-term forecast of social and economic development of the Russian Federation (Order of the Ministry of Economic Development of the Russian Federation dated June 30, 2016), it is recommended to assess GVA in the current prices of the forecast period years as the difference between the output in the current basis prices of the forecast period and expenses on intermediate consumption in the current prices for the buyers taking into account the expected deflator indexes of output and deflator indexes of expenses on intermediate consumption. Then, the share of expenses on intermediate consumption on output of the i-th type of product/services in t year should be determined by the following formula:

$$IC\_S_i^t = \frac{\sum_{k=1}^{n} K_{ki}^t \times D_k^t}{PI_i^t},$$

where:

K_{ki}^t is the amount of expenses (in ₽) on intermediate consumption of products/services of the k-th type of activity per ₽ of output of products/services of the i-th type of activity (a coefficient of the direct costs matrix).

D_k^t is a deflator accumulated by t year relative to the basic period on products/services of the k-th type of activity. The basic period in IAS "ArcticLabs" is a year for which direct costs matrix coefficients (year of formation of the basic tables "input/output expenses") are calculated.

n is the number of products/services by types of activities, net taxes, and other components of intermediate consumption. Products/services in IAS "ArcticLabs" are grouped by types of economic activities according to OKVED-2 (for A–T sections). The amount of taxes with the deduction of subsidies is not considered due to the lack of data for the forecast and due to the relatively small share of this component in expenses on intermediate consumption.

PI_i^t is the price index for products/services of the i-th type of activity accumulated relative to the basic period by t year.

Expenses on intermediate consumption of goods and services should be determined by the matrix of direct production costs for a specific project. In the absence of such data, the coefficients of the matrix of direct costs are calculated according to the basic tables "expenses/output" (a symmetric "expenses/output" table) published by Rosstat. By the time of our evaluation of the effects, Rosstat calculated and published basic "expense/output" tables for 2016.

Values of the deflators on products/services by types of activity (for A–T sections) for the forecast period are taken from the medium-term and long-term forecasts of social and economic development of the Russian Federation prepared by the Ministry of Economic Development of the Russian Federation (Ministry of Economic Development of the Russian Federation) for A–F sections and for transport (Section H). For other economy sections, the values of the deflators are determined similar to the approach accepted in the procedure of application of price indexes and deflator indexes by types of economic activities and other indicators as a part of the forecast of social and economic development of the Russian Federation in determination of prices for the products delivered under the State defense order (Order of the Ministry of Economic Development of the Russian Federation dated 01.04.2020 No.190) (the deflator is equal to ½ of the PI value and the industry deflator) and by deflators of products and services presenting similar results of activities by economy sectors (industries).

The price index for products (PI_i^t) accumulated relative to the basic period is calculated on the basis of forecast values of the prices for respective products. Forecast values till 2035 are taken from the forecasts of social and economic development of the Russian Federation and open forecasts of international financial and analytical systems.

Gross Value Added Created by Direct Participants of the Project

In the framework of perspective forecasting, we will consider production plans of development according to the basic (target) scenario for the following projects/deposits located in the territory of the Arctic zone of the Russian Federation (Table 4)

On the basis of the public statements made by companies participating in the projects, the authors made a forecast of the production volumes that can be used to

Table 4 The list of the projects/deposits used for their impact assessment on the development of the Arctic zone of the Russian Federation

Name	Products	Region	Carrier companies/affiliation with AZRF	Port of shipment	Unloading port/affiliation of the unloading port with the Arctic basin
Novy port	Oil	The Yamalo-Nenets Autonomous Okrug (hereinafter – YNAO)	Gazpromneft Shipping/No Roswell Arctic/No Sovcomflot/No	Sabetta (terminal Cape Kamenny)	Murmansk port/Yes
Vostok Oil	Oil	Krasnoyarsk Krai (Turukhansky district)	Rosnefteflot/No	the Sever Bay	Murmansk port/Yes
					Petropavlovsk-Kamchatsky port/No
Arctic LNG-1	LNG, gas condensate	YNAO	Modern Arctic Marine Transport LNG/No Arctic LNG-1/Yes	Sabetta	Murmansk port/Yes
					Petropavlovsk-Kamchatsky port/No
					ROTTERDAM MAASVLAKTE/No
Arctic LNG-2	LNG, gas condensate	YNAO	Modern Arctic Marine Transport LNG/No Arctic LNG-2/Yes	Sabetta	Murmansk port/Yes
					Petropavlovsk-Kamchatsky port/No
					ROTTERDAM MAASVLAKTE/No
					ZEEBRUGGE/No
Yamal LNG	LNG, gas condensate	YNAO	Sovcomflot/No TEEKAY/No Dynagas/No Mitsui O.S.K. Lines/No Dynacom/No	Sabetta	Murmansk port/Yes
					Petropavlovsk-Kamchatsky port/No
					ROTTERDAM MAASVLAKTE/No
					ZEEBRUGGE/No
					SHANGHAI/No
					YANGKOU/No
					MONTOIR/No
					ISLE OF GRAIN/No
					TIANJIN/No
					BILBAO/No
Ob LNG	LNG, gas condensate	YNAO	Modern Arctic Marine Transport LNG/No NOVATEK/No	Sabetta	Petropavlovsk-Kamchatsky port/No
					ROTTERDAM MAASVLAKTE/No

(continued)

Table 4 (continued)

Name	Products	Region	Carrier companies/affiliation with AZRF	Port of shipment	Unloading port/affiliation of the unloading port with the Arctic basin
Norilsk Nickel	Metals (except gold), sulfur	Krasnoyarsk Krai (Taimyr Dolgan-Nenets municipal district)	Polar Transport Branch of PJSC MMC NORILSK Nickel (Dudinka)/Yes	Dudinka	Murmansk port/Yes
					ANTWERPEN/No
Baimskaya deposit	Metals (except gold)	Chukotka Autonomous Okrug	GDK BAIMSKAYA/Yes	Pevek (Nagleynyn terminal)	TIANJIN/No
Tomtor deposit	Metals (except gold)	Sakha (Yakutia) Republic (Oleneksky Evenki national area)	Vostok Engineering/Yes	Khatanga	Krasnoyarsk port/No
Pavlovskoye deposit	Metals (except gold)	Arkhangelsk region (urban district Novaya Zemlya)	First Ore Mining Company/Yes	Yuzhny Island terminal	Arkhangelsk port[a]/Yes
					Murmansk port/Yes
Mayskoye deposit	Gold concentrate	Chukotka Autonomous Okrug	Far East Shipping Company (FESCO)/No	Pevek	Nakhodka port/No
Severnaya Zvezda	Coal	Krasnoyarsk Krai (Taimyr Dolgan-Nenets municipal district)	Sovcomflot/No	Yenisei	Murmansk port/Yes
					Indiga port/Yes
VostokUgol-Dikson	Coal	Krasnoyarsk Krai (Taimyr Dolgan-Nenets municipal district)	VostokUgol-Dikson/Yes	Dikson (Chaika terminal)	Murmansk port/Yes
					Indiga port/Yes

Source: Compiled by the authors on the basis of public statements of the companies participating in the projects. Retrieved from: https://yamal.gazprom-neft.ru/, https://www.rosneft.ru/, https://www.novatek.ru/, https://www.nornickel.ru/, https://www.kazminerals.com/, https://threearc.ru/, http://www.pgrk.armz.ru/ru/, https://www.polymetalinternational.com/ru/, https://arctic-energy.com/, http://www.aeoncorp.ru/

[a]Where the loading port coincides with the unloading port, the transportation is between different terminals within the same port

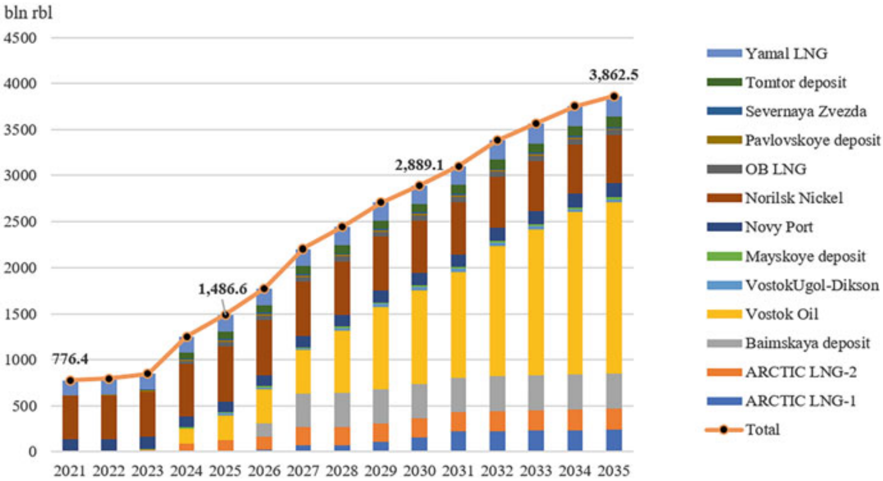

Fig. 3 The forecast of the GVA structure by projects according to the basic scenario for the period up to 2035, billion ₽. (Source: Calculated by the authors in IAS "ArcticLabs")

evaluate the GVA created in the course of production. The forecast of the VGA structure by projects according to the basic scenario for the period up to 2035 is shown in Fig. 3.

In the projected GVA structure, the most significant contribution to the total GVA volume throughout the entire period will be made by the projects of Norilsk Nickel company, starting from 62% in 2021 and gradually decreasing down to 14% in 2035. At the same time, the maximum share of Norilsk Nickel in the total production volume is estimated as slightly more than 5% of the production volume for all projects. A large volume of the GVA is provided by the diverse structure of Norilsk Nickel production including expensive and scarce metals. Starting from 2027, the leadership in the share in the total volume of products will belong to Vostok Oil project with the projected GVA value at the level of ₽1.9 trillion by 2035 (in current prices).

The Gross Value Added Created by Related Types of Economic Activity Ensuring Implementation of the Projects

In the framework of our assessment, the related types of activity are water transport services and auxiliary transport services (cargo handling and transshipment). For assessment of the contribution of the projects to the Gross Regional Product (GRP) of the Arctic zone of the Russian Federation from the GVA created in the course of cargo transportation by the sea transport by each project and type of cargo (the information was obtained from public sources of the companies and during interviews), we determined carrier companies and their belonging to the Arctic zone of the Russian Federation (Table 4).

The amount of created GVA was estimated by the volumes of cargo transportation of the companies working in the Arctic zone of the Russian Federation. The forecast

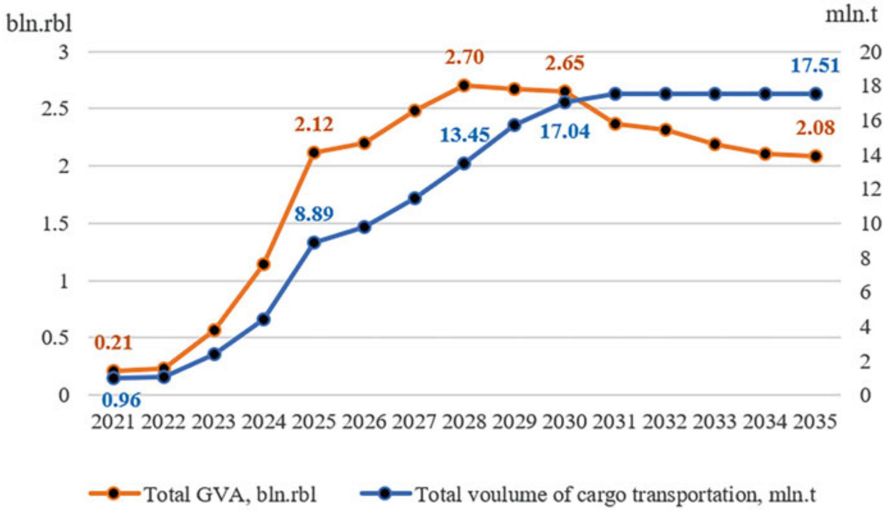

Fig. 4 Forecast of volume of cargo transportation and amount GVA for the basic (target) scenario till 2035. (Source: Calculated by the authors in IAS "ArcticLabs")

of the volume of cargo transportation and the amount of GVA for the basic (target) scenario till 2035 is shown in Fig. 4.

Till 2028, the amount of GVA from cargo transportation will keep growing with the growth of the volume of cargo transportation. The maximum value of GVA is expected in 2028 – ₽2.7 billion. Then, despite the continuing growth of the volume of cargo transportation, there will be gradual decrease in the amount of GVA connected with a predicted decrease in the share of GVA in the output (due to a more rapid growth of the prices for intermediate consumption relative to the prices for the services).

In order to assess the contribution of the projects to the Gross Regional Product of the Arctic zone of the Russian Federation according to the GVA created by means of services involving liquid and solid bulk cargos and break-bulk cargos transportation in the Arctic zone of the Russian Federation, we determined the loading/unloading ports of the products from the projects and their affiliation with the Arctic basin (Table 4).

In assessment of the GVA created by means of services on cargo processing in ports, we take into account the fact that each loading/unloading port carries out transshipment operation of the respective cargos (liquid, solid, and break-bulk ones). The forecast of the total revenue and the amount of the GVA created in the ports of the Arctic basin from transshipment of the projects' cargoes according to the basic (target) scenario till 2035 is shown in Fig. 5.

The predicted size GVA created from services in processing of cargoes by ports of the Arctic basin by 2035 will reach ₽154.5 billion. GVA share to release (in our case to revenue) will remain for the entire period of forecasting at the level of about 40%.

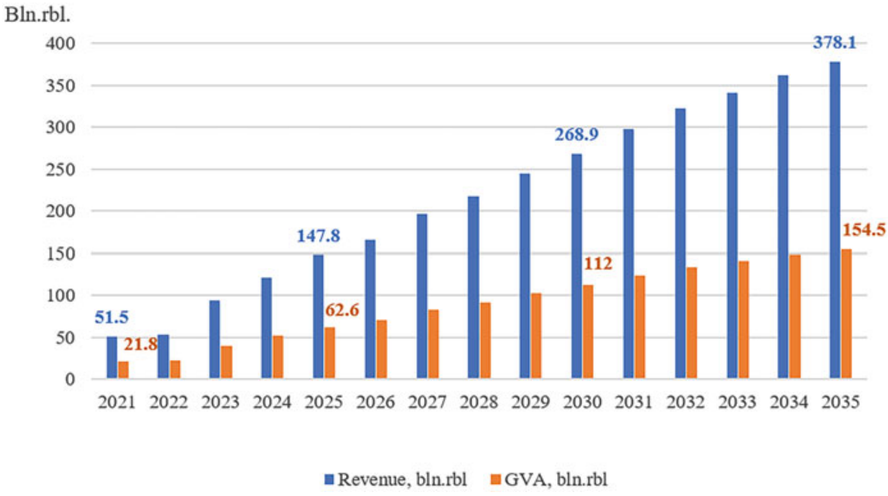

Fig. 5 The forecast of the total revenue and the amount of the GVA created in the ports of the Arctic basin from transshipment of projects' cargoes according to the basic (target) scenario till 2035. (Source: Calculated by the authors in IAS "ArcticLabs")

Assessment of the Contribution of the Projects to the Gross Regional Product (GRP) of the Arctic Zone of the Russian Federation

The contribution of the projects to the GRP of the Arctic zone of the Russian Federation can be estimated by the total GVA created in the course of production by direct participants of the project, in the course of products transportation using the sea transport by the resident companies of the Arctic zone of the Russian Federation and in the course of products transshipment in the ports of the Arctic basin. The projected structure of the GVA created by different territories in the Arctic zone of the Russian Federation till 2035 is shown in Fig. 6.

Different shares of the territories in 2021 and 2035 are explained by different commissioning times of the projects and different periods they require to reach their maximum production capacity. The Taymyr Dolgan-Nenets municipal district of Krasnoyarsk Krai and the Yamalo-Nenets Autonomous district will keep making a stable contribution to the GRP of the Arctic zone of the Russian Federation during the whole forecasting period. After 2029, the prevailing share in the total amount of GVA will belong to Turukhansky district of Krasnoyarsk Krai.

To estimate the scale of the contribution of the projects to the GRP of the Arctic zone of the Russian Federation, one could compare the total GVA with the GRP level of the Arctic territory for 2019 projected till 2035 in the current prices (using a GDP deflator index according to the scenario conditions of the forecast of social and economic development of the Russian Federation for 2022–2024 and according to the long-term forecast). The projected share of the GVA created by the projects in the amount of GRP of the Arctic zone of the Russian Federation is shown in Fig. 7.

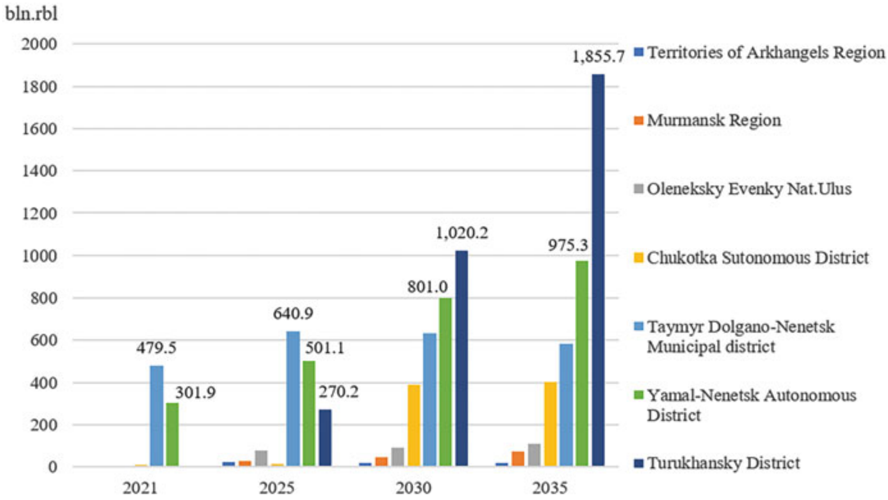

Fig. 6 Projected GVA created by different territories in the Arctic zone of the Russian Federation till 2035. (Source: Calculated by the authors in IAS "ArcticLabs")

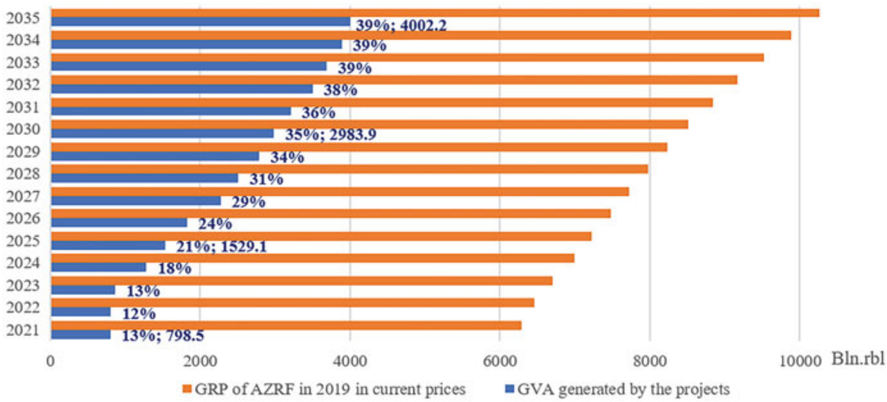

Fig. 7 The projected share of the GVA created by the projects in the amount GRP of the Arctic zone of the Russian Federation. (Source: Calculated by the authors in IAS "ArcticLabs" according to the data of the FSSS and the Ministry of Economic Development of the Russian Federation. Retrieved from: https://www.gks.ru/free_doc/new_site/region_stat/arc_zona.html, https://www.economy.gov.ru/material/directions/makroec/prognozy_socialno_ekonomicheskogo_razvitiya/)

The projected GVA from the projects in 2021 is 13% of the GRP level of the Arctic zone of the Russian Federation for 2019 in the prices of 2021. By 2035, the total GVA from the projects is expected at the level of ₽4 trillion, which will make 39% of the GRP of the Arctic zone of the Russian Federation from the level of 2019 in the prices of 2035.

Evaluation of the Number of New Jobs Created in the Territory of Project Implementation

In addition to the GVA created in the course of production and other related economic activities, project implementation also changes the structure of jobs on the territory keeping the current jobs, opening new ones or reducing their number. Different stages of project development require different amount and quality of labor: the investment stage (construction or reconstruction) of large projects usually requires a large number of workers and construction specialists for a short term who can be hired not from the local labor market; the operational stage requires a certain number of workers and specialists to provide implementation of the production plan for a relatively longer term. The number of jobs at the operational stage of large projects has a significant influence on the structure of the regional labor market.

The number of jobs at the operational stage of the projects can be estimated for the existing projects by indicators of actual labor costs for production and production plans; for new projects – according to the open data on the number of created jobs and production plans.

The considered projects in total at the operational stage will provide 32 thousand jobs in 2021; 60 thousand jobs in 2025; 108 thousand jobs in 2030, and 147 thousand jobs in 2035. For better visualization of the scale of contribution of those projects to the number of workers, let us compare the total number of jobs at the operational stage of the projects and the average number of workers in organizations which are carrying out their activities in the Arctic zone of the Russian Federation, where the level of 2020 is 950 thousand people (FSSS publications of the official statistical information on social and economic development of the Arctic zone of the Russian Federation in 2020. The statistical indicator “Average number of employees in organizations carrying out activities in the Arctic zone of the Russian Federation (without small businesses)”) (Fig. 8).

By 2035, the number of the jobs created by the projects will reach 16% of the average number of employees (without small businesses) in the Arctic zone of the Russian Federation in 2020.

The forecast of the structure of jobs by the projects is shown in Fig. 9.

Till 2025, the prevailing share in the total number of jobs created by the projects will belong to the projects of Norilsk Nickel Company – 21.3 thousand jobs. Starting from 2024, according to the basic (target) scenario, Vostok Oil will enter its operational stage creating 12 thousand jobs and gradually increasing their number up to 104 thousand jobs in 2035.

The projected annual change of the number of jobs for all projects being considered is shown in Fig. 10.

Except for a small reduction (by 154 jobs) in 2021, an increase of the total number of jobs is expected throughout the whole forecast period, which will affect the indicators of the local labor markets and the parameters of internal and external migration in the Arctic Zone of the Russian Federation.

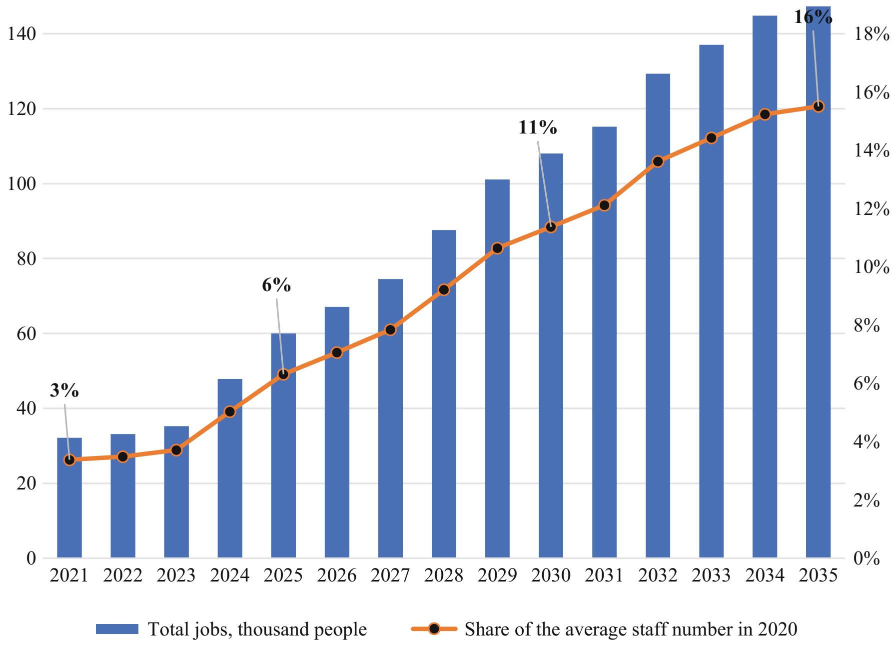

Fig. 8 The number of the jobs created by the projects and their share from the level of average staff number in AZRF in 2020. (Source: Calculated by authors in IAS "ArcticLabs")

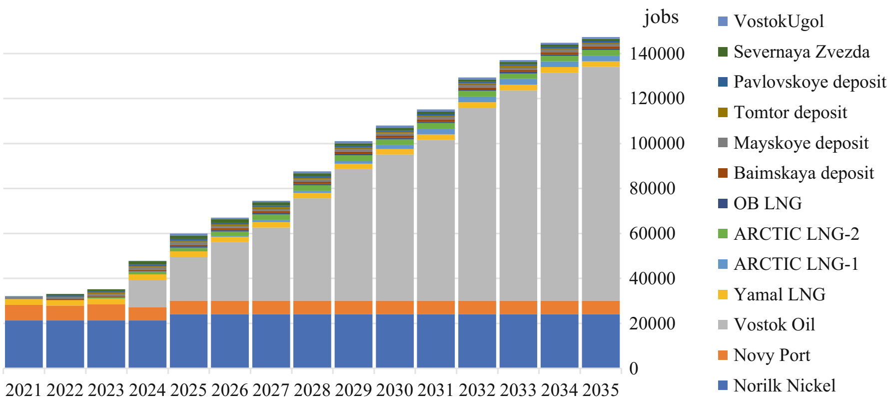

Fig. 9 Forecast of the structure of created jobs by the projects. (Source: Calculated by authors in IAS "ArcticLabs")

Assessment of Tax Revenues from Direct Participants of the Projects

For assessment of tax revenues from the projects, we determined the rates of federal and regional taxes taking into account preferential treatment and changes of the tax legislation.

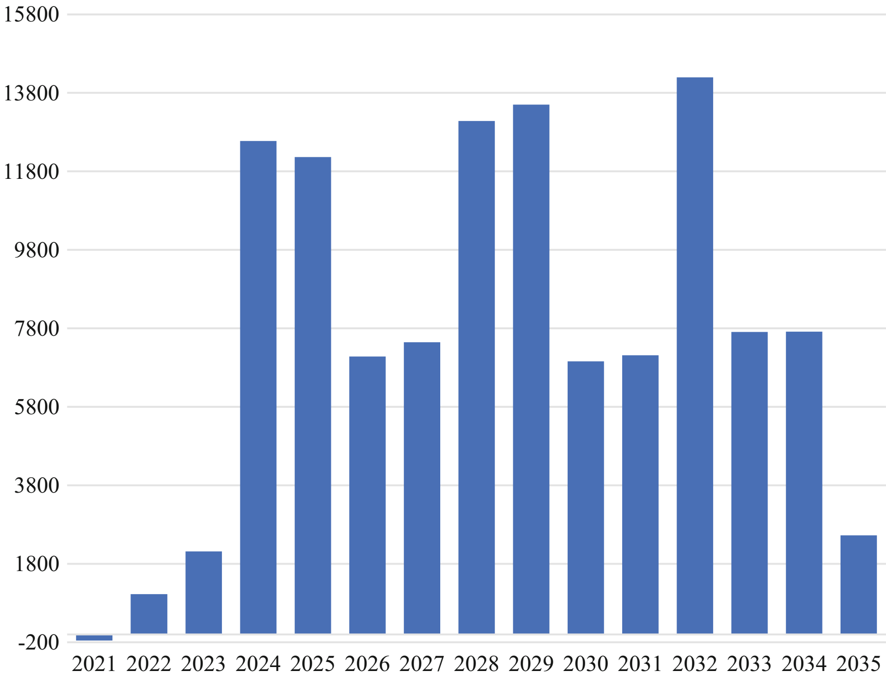

Fig. 10 Projected annual change of the number of jobs by the projects. (Source: Calculated by authors in IAS "ArcticLabs")

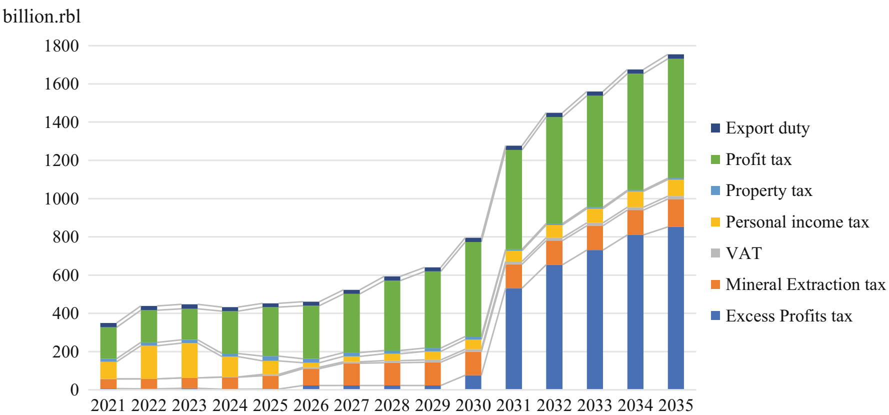

Fig. 11 Volume and structure of tax revenues from the projects. (Source: Calculated by the authors in IAS "ArcticLabs")

Tax revenues from the projects to budgets of different levels were estimated on the basis of the forecast of taxation bases and tax rates. The forecast of the volume and the structure of tax revenues from the projects are shown in Fig. 11.

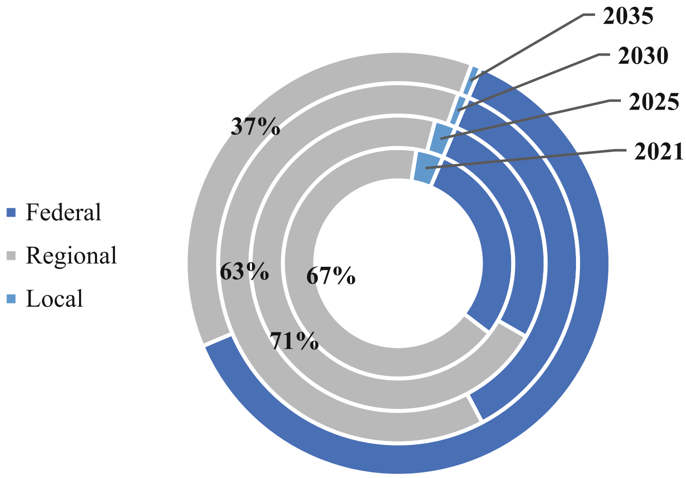

Fig. 12 Forecast of the structure of tax revenues by levels of the budgetary system of the Russian Federation for 2021, 2025, 2030, and 2035. (Source: Calculated by the authors in IAS "ArcticLabs")

Starting from 2031, an important role in the structure of tax revenues will belong to the revenue added tax, increasing from 39% to 45% in last five-year period of the forecast as compared to 9% in 2030. Growth of the share of this tax is connected with a predicted growth of the taxation base created by Vostok Oil project – starting from 2031 the forecast for this project shows a decrease in the volume of capital investments and growth of profit.

The forecast of the structure of tax revenues by levels of the budgetary system of the Russian Federation for 2021, 2025, 2030, and 2035 is shown in Fig. 12.

Growth of receipts from a tax on additional income changes structure of receipts on budget levels towards federal. The share of regional tax revenues to 2030 is predicted at the level of higher than 60%.

Assessment of Challenges

The Strategy for the Development of the Arctic zone of the Russian Federation underlines the risks and threats influencing social and economic development of the region. The strategy pinpoints the following factors (Decree of the President of the Russian Federation dated 26.10.2020 N 645) which can interfere with the development:

- Extreme climatic and natural conditions, including low air temperatures, strong winds and ice cover on water areas of the Arctic seas
- Patchy character of the industrial and economic development of the territories and low population density

- Remoteness from the main industrial centers, high resource intensity, and dependence of the economic activity and life support of the population on supplies of fuel, food, and essential commodities from other regions of Russia
- Low stability of the ecological systems determining the biological balance and the climate of Earth, and their dependence on insignificant anthropogenic influences

Risks and threats to the social and economic development highlighted in the strategy are also confirmed by current negative trends.

Risks in the social sphere (Decree of the President of the Russian Federation dated 26.10.2020 N 645):

- Negative demographic processes in most subarctic territorial subjects of the Russian Federation, outflow of human resources (especially highly skilled) to the southern regions of Russia and abroad. The territories of the Arctic zone of the Russian Federation have been changing (in 2017, three municipal units of the Republic of Karelia; in 2019, eight municipal Units of the Sakha (Yakutia) Republic were added); therefore, the analysis of the demographic dynamics is possible only on the basis of relative indicators of natural and migration movement of the population (Fig. 13).
- Starting from 2015, a stable decrease in the natural growth of the population – from 3.9 to 0.7 people per 1000 people – is observed in the territory of the Arctic zone of the Russian Federation. Even though the positive migration balance was

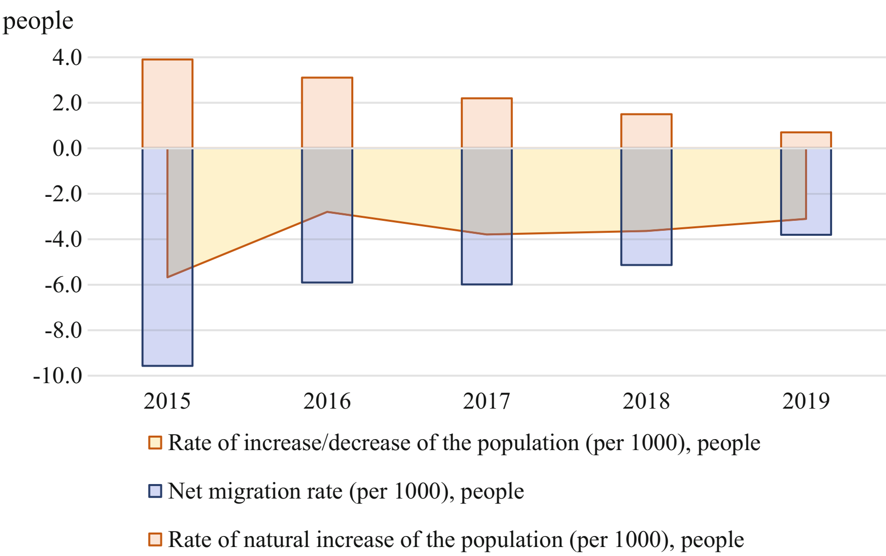

Fig. 13 Components of population movement of the Arctic zone of the Russian Federation. (Source: Calculated by the authors based on data from Federal State Statistics Service of Russia. Retrieved from: https://www.gks.ru/free_doc/new_site/region_stat/arc_zona.html)

gradually decreasing from 9.8 to 3.8 per 1000 people, but still it was a component outweighing the decline in the population.

- Discrepancies between social service infrastructure and the character and the dynamics of population dispersion, including those in education, health care, physical culture, and sport. The most important problem in education is availability of preschool education. From 2016 till 2019, the number of pupils in preschool organizations in the Arctic zone of the Russian Federation was growing at a more rapid rate than the number of preschool organizations themselves. In 2016, there were on average 185 pupils per organization offering preschool educational programs (in the Russian Federation – 148 pupils). By 2019, the number was reduced to 181 pupils (but it still exceeded the average number for Russia – 161 pupils per organization) (Calculated by the authors according to the data from the Federal State Statistics Service of Russia (Rosstat)).

The dynamics of commissioning of the basic social facilities and services in the land territories of the Arctic zone of the Russian Federation for 2016–2020 is shown in Table 5.

- As it can be seen from the table, new facilities are commissioned and existing ones are systematically renovated in education and physical education. But there is no such constancy in culture and health care. Very few new cultural institutions, concert halls, and movie theaters are being opened. Only 80 seats in theaters were built in the territory of the Arctic zone of the Russian Federation in the last 5 years. Commissioning of new medical and obstetrical centers and medical outpatient clinics in sparsely populated districts started only in 2020.
- Critical condition of housing facilities, insufficient availability of clear drinking water for the population. The quality of drinking water according to the Complex Observation of the Living Conditions of the Population in 2016 and 2020 improved: in 2020, only 10.1% of the respondents mention poor quality of drinking water in comparison to 19.4% in 2016; high quality of water is noted by 32.4% instead of 26.4%. However, more than a half of the respondents (57.5% in 2020 and 54.0% in 2016) still note that water quality is satisfactory.
- Lack of an effective system of staff training, imbalance between territorial and professional supply and demand of human resources (shortage of workers and engineers and a surplus of unemployed specialists and people without professional education).
- Poor quality of life of indigenous ethnic groups of the North, Siberia. and the Far East of the Russian Federation living in the territory of the Arctic zone of the Russian Federation.

Risks in the economic sphere:

- Lack of modern domestic technical means and technologies for prospecting, exploration, and development of sea fields of hydrocarbons in the Arctic.
- Depreciation of fixed assets, especially transport, industrial and energy infrastructure.

Table 5 Commissioning of social facilities and services in the land territories of the Arctic zone of the Russian Federation

Infrastructure facility	Unit of measure	In total due to construction and reconstruction				
		2016	2017	2018	2019	2020
Hotels	Beds	25	73	410	105	141
Hospitals	Beds		24	240		7
Outpatient clinics	Visits per shift		300	88	75	242
Medical centers	Meters squared			474.0		1499.0
Swimming pools (with lanes 25 and 50 m long)	Pieces	3		1	3	1
Water surface of the swimming pools (with lanes 25 and 50 m long)	Meters squared	1485.0		367.5	340.0	492.0
Sports facilities with artificial ice	Pieces	1	1		2	1
Area of sports facilities with artificial ice	Meters squared	1800.0	2827.0		3473.0	1800.0
Gyms	Meters squared	580.0	1111.0	1300.6	8988.0	6901
Health and fitness centers	Pieces	3	6	1	8	3
Flat sports facilities (football fields, playgrounds, etc.)	Meters squared		18,102.4	2528.2	1244.0	2349.0
Tourist centers	Places	12	87	30	32	12
Professional educational organizations	Total area of educational and laboratory buildings m^2		1330.0	3150.0		8388.0
General education organizations	Student places	1003	510	720	865	1540
Preschool educational organizations	Pupils	1200	1828	1200	1330	4920
Clubs	Seats		60	260		350
Concert halls and movie theaters	Seats			330		400
Places of worship	Pieces	8	9	5	6	1
Bathhouses	Seats	60	43	6	31	49
Shopping and recreation centers	Total area meters squared	56,843.0		43,268.0	588.0	
Trade and office centers	Total area meters squared	338.0		4189.0		
Theaters	Seats			80		

Source: Calculated by the authors based on data from Federal State Statistics Service of Russia. Retrieved from: https://www.gks.ru/free_doc/new_site/region_stat/arc_zona.html

- Underdevelopment of the basic transport infrastructure, its sea and continental components, aging of the icebreaker fleet, lack of small aircrafts.
- High power consumption and low efficiency of natural resources extraction, high production costs in the absence of effective compensation mechanisms, and low

labor productivity. The utilization rate of oil well operating fund in 2019 decreased in comparison to 2017 by 3% and was 79% (in general for the Russian Federation the utilization rate is 84%). The utilization rate of new oil wells in land territories of the Arctic zone was 85% (An indicator “Balance of calendar time, utilization rate of oil wells operational fund (for all wells and including new oil wells that were put into operation)”) (Federal State Statistics Service, 2020). The utilization rate of gas wells operational fund in the Arctic in 2019 was 85%, including 65% for new wells (in general for Russia the rate was 81% and 61%, respectively) (An indicator “Balance of calendar time, utilization rate of oil wells operational fund (for all wells and including new oil wells that were put into operation)”) (Federal State Statistics Service, 2020).

- Imbalance in economic development between certain subarctic territories and regions, a significant gap in the level of development between the leading and depressive areas.
- Insufficient development of navigation and hydrographic and hydrometeorological support for navigation.
- Lack of the means of continuous complex space monitoring of the Arctic territories and water areas, dependence on foreign means and sources of information support for all types of activities in the Arctic (including interaction with aircrafts and sea vessels).
- Lack of the modern information and telecommunication infrastructure allowing rendering of communication services to the population and economic entities throughout the Arctic zone of the Russian Federation.
- Underdevelopment of the energy system and irrational structure of power generating plants, high cost of energy generation and transportation. In addition to the aforesaid there is also considerable differentiation in the electricity generation costs across the territories. Figure 14 shows a comparison of electricity generation costs in the regions of the Arctic zone of the Russian Federation and the Far Eastern Federal District.

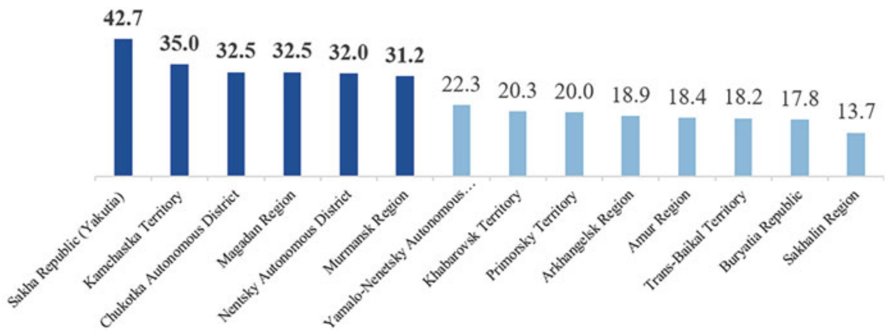

Fig. 14 Energy generation costs, ₽ per kilowatt per hour. (Source: Compiled by the authors according to the data of the Analytical Center for Government of the Russian Federation, analysis of OJSC KRDV)

In science and technologies:

- Shortage of technical means and technological capabilities for exploration, development, and use of the Arctic spaces and resources, insufficient readiness for transition to an innovative way of development of the Arctic zone of the Russian Federation. Innovative development is slowed down by the structure of internal costs of the organizations for research and development existing in the territory: during the period from 2017 to 2019, the share of capital expenditures (including costs of equipment) on average did not exceed 3% whereas in the Russian Federation the share of capital expenditures was on average 6.8% of the costs of research and development (Calculated by the authors according to the data from the Federal State Statistics Service of Russia (Rosstat). Indicators "Internal expenses on research and development" and "Internal current expenses on research and development").

In environmental protection and management:

- In environmental protection and management, one can note an increase of human-induced load on the environment with increase in probability of achievement of its maximum values in some water areas of the Arctic Ocean adjacent to the Russian Federation and in certain territories of the Arctic zone of the Russian Federation characterized by the existence of particularly adverse areas, potential sources of radioactive pollution, and a high level of accumulated ecological damage. At the same time, the share of investments into fixed capital used for environmental protection in the total amount of investments into fixed capital remains quite small: during 2017–2020, the maximum reached value was 2.6%; however, in 2020, the share of investments dropped to 1.5% (Calculated by the authors according to the data from the Federal State Statistics Service of Russia (Rosstat). Indicator "Investments into fixed capital used for environmental protection and rational use of natural resources in the territory of the Arctic Zone of the Russian Federation."). One should also note the low utilization efficiency of investments used for environmental protection (Fig. 15).

- Investments into fixed capital used for environmental protection are on average 80% of the volume of current expenses on environmental protection. However, the volume of current expenses does not decrease from year to year, which may indicate low efficiency of the added new capacities for environmental protection (water resources, open air, etc.).
- The list of risks highlighted in the strategy may be supplemented with the risks connected with climate change.

In terms of environmental risks, it seems to be of utmost importance to create a complex system monitoring ecological impact of economic activities in the Arctic zone. Such system is particularly relevant in the framework of amendments to Appendix VI of the International Convention for the Prevention of Pollution from

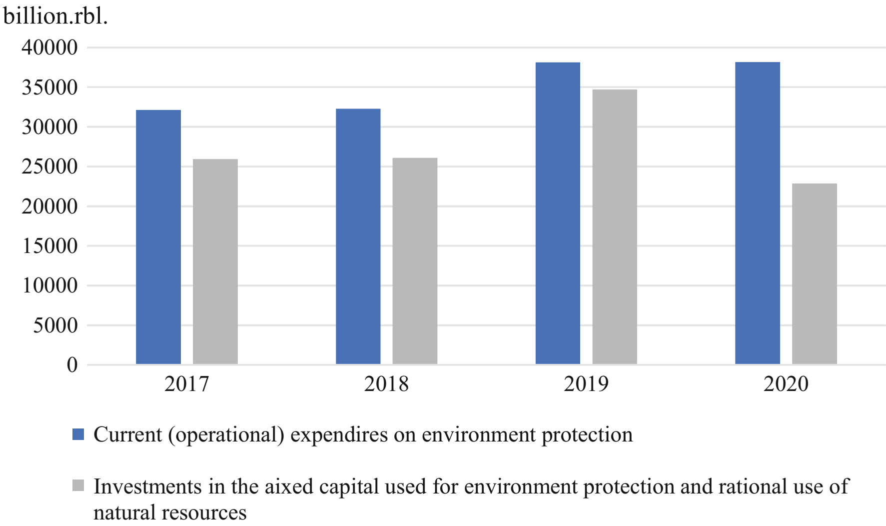

Fig. 15 Correlation between the current (operational) expenses and investments in environmental protection in the Arctic zone of the Russian Federation. (Source: Compiled by the authors according to the data from the FSSS. Retrieved from: https://www.gks.ru/free_doc/new_site/region_stat/arc_zona.html)

ships made by the International Maritime Organization imposing new requirements for reduction of carbon footprint from maritime navigation (Ministry of Transport of the Russian Federation, 2021).

Conclusions

According to the results of the conducted research, we can draw the following conclusions.

1. The principles and approaches stated by Russia completely correspond to the international principles of sustainable development and the global purposes of the UN in the field of sustainable development. The objectives of rational development of the resource potential, complex social and economic development and development of the major transport artery – the Northern Sea Route – are balanced in terms of national priorities by the goals of social development and environmental protection and the rights and the lifestyle of indigenous ethnic groups.
2. The Arctic zone of Russia really has the considerable resource potential providing at the moment nearly 100% extraction of rare-earth metals, apatite ores, titanium, zirconium, rubidium, and platinoids. Almost one third of Russian diamonds and silver reserves, one fifth of the oil fields, one tenth of gold reserves are located in the territory of the Arctic. Besides, the Arctic is the leader in natural gas reserves and natural gas production.

3. Consistent implementation of investment projects in the Arctic zone of the Russian Federation will allow the country to receive about ₽1.8 trillion of tax revenues to all budgets of the budgetary system of the Russian Federation and to create approximately ₽4 trillion of added value in the region in 2035, which is comparable to 40% of the total amount of GRP of the Arctic zone in 2019.
4. Development of the Northern Sea Route as a strategic transit corridor will make it possible not only to lower the load on the "bottlenecks" of world transport arteries (such as the Suez Canal), but will also contribute to the reduction of the "carbon footprint" of the transport industry.
5. Key challenges in the development of the Arctic zone of the Russian Federation are connected with negative demographic processes, staff shortage, critical condition of the housing sector in some areas, poor quality of life of the indigenous people of the AZRF, absence or poor quality of the infrastructure (energy, communication) and its considerable depreciation level as well as fragility of the Arctic ecosystems with a high level of the accumulated ecological damage.
6. Overcoming those challenges, in our opinion, is possible on the basis of the principles of sustainable development – stimulation of the growth of economic activities and balancing it with availability of social, power, and communication infrastructure, human capital, and the quality of life of the population, as well as ecological responsibility. In order to coordinate the efforts of all participants of the process of sustainable development according to the principles of the state policy, it is planned to create a specialized information system (IAS "ArcticLabs") capable to provide answers to an extensive range of issues. First of all, the system is used to evaluate the success of implementation of the development strategy of the Arctic zone for various scenarios, to determine the risks and the weaknesses of the program, and to estimate a contribution of any particular project to the development of the territory (growth of GRP, infrastructure development, new jobs, and taxes) and to evaluate potential efficiency of different incentives (benefits, subsidies). Moreover, the mathematical model being the cornerstone of the system helps to determine technical, transport, and infrastructure needs of the region, to keep track of the dynamics in the key industries of regional economy, to calculate cumulative efficiency of the implemented projects, revealing key risks, analyzing sensitivity of the projects, and the need to attract investments and external financing. It uses a big array of data on production chains, supply networks, infrastructure, transport, and demand, and calculates the costs of production, transportation, proceeds from sales, social effect, and environmental risks.

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Sustainable Development and Corporate Social Responsibility in the Arctic Zone

Elena B. Zavyalova and Anastasia I. Kuzmenkova

Contents

Abstract

The chapter analyzes approaches to defining "corporate social responsibility" and "sustainable development" along with the evolution of and the link between these terms. The chapter is particularly focused on analyzing sustainable development through the prism of strategies employed by the Russian, Norwegian, and American oil and gas companies in their activities in the Arctic. The authors have identified common arrangements for ensuring sustainable development in the Arctic which are implemented in three main areas: environmental protection and production safety, cooperation with and support for indigenous Northern ethnic minorities, and technological development. Moreover, a disparity between priorities and focus of the strategies employed may be observed due to differences in

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the companies' forms of presence in the region. The authors conclude that the role of ensuring the sustainable development goals promotion is growing. Besides, establishing long-term sustainable development targets is a sign of corporate social responsibility becoming a necessary element in the companies' competitive market battle and even survival, in the future, albeit today the environmental element is clearly in the forefront.

Keywords

Sustainable development concept · Corporate social responsibility · Social responsibility · Environmental responsibility · Economic responsibility · Arctic sustainable development

Introduction: Theoretical Prerequisites of ESG-activities of the Companies Functioning in the Arctic Zone

From the moment the UN Global compact was signed to the present day, the business community has experienced a real revolution. In the year 2000, when the first Millennium Development Goals were adopted, introducing social and environmental factors into economic policy was the exclusive prerogative of states and governments, whereas in the course of the issue's development more and more stakeholders have become involved in the process. Since the adoption of the Sustainable Development Goals (SDG) by the global community in 2015, businesses have become key figures in and investors into the global concept of sustainable development. ESG strategies have in fact become an essential element of the companies' management activities; it has become impossible to enter large stock markets, attract investors, and retain shareholders without nonfinancial statements and notable positions in sustainable development ratings.

One of the commonly accepted approaches to sustainable development is the "triple bottom line concept" (3BL, TPL) introduced by an American economist and entrepreneur John Elkington in 1994 (Elkington, 1997). This approach is based on the link between three main aspects of sustainable development: the environmental, the social, and the economic ones. Thus, based on this concept, not only financial indicators should be taken into account, but environmental and social consequences of the company's activity as well (Pylypiv et al., 2017). Moreover, the practicability of this approach is noted to apply both on the macro- and microlevels. Applied to companies, three core criteria of corporate sustainability may be identified – the so-called "3P" (People, Planet, Profit). The concept also expands on the "triple-win strategy" proposed by John Elkington, under which all three interested parties are the beneficiaries: businesses, clients of a sustainable company, and all remaining members of society receive profits. Notably enough, at present the concept is defined in a broader way to include the fourth, management aspect (Starikova, 2017).

At the same time, the terms sometimes become mixed up. In particular, this concerns the terms "corporate social responsibility" (CSR) and "sustainable development." A number of researchers believe CSR to be a part of sustainable development, whereas others view it as a separate phenomenon. In this study, we will be sticking to CSR basically having become a part of sustainable development, albeit the two terms cannot, by any means, be used interchangeably. The problem experienced within the global community is the apparent shift from the proclaimed 3BL to environmental constituent. However, the authors of this study are of the opinion that an appropriate balance between environmental and social measures of sustainable development must be maintained. Which is exactly why the nowadays somewhat forgotten CSR concept may prove useful for revitalizing companies' socially directed activities.

By way of following the chronologically logical order of events, let us begin the analysis by studying the concept of corporate social responsibility. Academic interest in companies' social responsibility took root back in the mid-twentieth century, as various methods of defining this phenomenon were formulated; however, the definition given in the International standard ISO 26000 "Guidance on social responsibility" published in 2010 is the most complete and accurate one according to the majority of experts (Dmitriev, 2011). Under this definition, social responsibility means the responsibility of an organization for the impacts of its decisions and activities on society and environment, through transparent and ethical behavior that contributes to sustainable development, including health and the welfare of society; takes into account the expectations of stakeholders; is in compliance with applicable law and consistent with international norms of behavior; and is integrated throughout the organization and practiced in its relationships (ISO 26000).

According to the representatives of the World business Council for Sustainable Development (WBCSD), CSR is the continuing commitment by business to contribute to sustainable economic development while improving the quality of life of the workforce and their families as well as of the local community and society at large.

Therefore, one of the main purposes of CSR is securing the goals of sustainable development, meeting the needs of the present without compromising the ability of future generations to meet their own needs. This definition of sustainable development is presently the most widespread and encompasses the "corporate sustainability theory" contemplated in G.H. Brundtland's report in 1987. Later it found its way into the UN "Millennium Development Goals" program in 2000 and the "2030 Agenda for Sustainable Development" of 2015.

Securing sustainable development and furthering of the CSR principles is, first and foremost, directed at large corporations in light of their operational capacity and the scale of their activities being incomparable to those of governments and international organizations; moreover, violations of human rights and environmental and other social requirements are most common in large corporations (MGIMO, 2008).

One way or the other, the social aspect is touched upon in terms of a company's employees experiencing adverse working conditions in the course of production activity or in terms of indigenous ethnic minorities having business activity close to or directly in areas of their habitation. Moreover, companies encounter growing risk of human rights violations, namely:

- Health damage due to adverse environmental conditions
- Unsafe labor conditions
- Racial, gender, and other types of discrimination
- Involuntary relocation of locals
- Use of involuntary child labor (King et al., 2016)

In particular, project implementation in the Arctic raises an especially interesting topic of relationship models with indigenous ethnic minorities. Three relationship models have become the most widespread (Funk et al., 2019).

1. **Regional model.** This model contemplates close cooperation and long-term joint venture prospects between extracting companies and the region's indigenous population. It also includes public hearings, public annual company reports, environmental monitoring with assistance from the region's population, implementing educational programs promoting, inter alia, employment for the locals, and support for socio-cultural projects. This model is the most efficient and open for interested parties, albeit it remains complex and expensive.
2. **Local model.** This model pertains to relationships between companies and the indigenous population of a specific region where production sites are located. The model operates by use of sponsorship and charity. As opposed to the previous model, no long-term cooperation is contemplated. Companies usually enter into cooperation agreements with a municipality under which the former provides assistance with or funding for a particular project (e.g., establishment of a specially protected natural area).
3. **Single-point model.** This model is used before establishing full-scale production (the stage of geological survey or preparing production infrastructure) and is characterized through the interaction of the company, local population, and community organizations, merely announcing and declaring the suggested cooperation options. This model is the most closed off from society, as it excludes the aforementioned interaction tools, which provokes conflicts and lack of understanding from the locals.

A lack of proper open dialogue with the local population causes various socio-economic problems incurring losses for both parties. For instance, EP Petroecuador, an Ecuadorian oil and gas company, was forced to turn to the military for assistance because of blocking the oilfield by the local population (Valencia et al., 2021). Another example would be the launch of the Point-Thompson field operating by ExxonMobil, which was challenged by local protests.

The most wide-scale corporate initiative in the field of sustainable development is the UN Global Compact comprising ten key principles of business responsibility which are to become the basis for the companies' strategy and activities. Currently more than 9500 companies and 3000 nonprofit organizations from over 160 countries are members of the UN Global Compact. This Agreement consists of 10 principles and has two main purposes:

- Support and application of the principles by the companies (in the area of human rights, labor relations, the environment, and anticorruption laws)
- Promoting companies' activities in realizing sustainable development goals (SDG)

As per the main purposes of the Agreement, the UN considers the Global Compact as a key intrasectoral platform for efficient involvement of the global business community into achieving sustainable development goals. Seventeen sustainable development goals for 2030 (SDG) adopted by UN member-states in 2015 are the guiding principles with an aim to unite governments, nonprofit organizations, and businesses in solving the topical issues of sustainable development and include both qualitative and quantitative targets.

As opposed to millennium development goals which were used as a basis for sustainable development strategies from 2000 to 2015, SDG propose an active participation of businesses in achieving said goals and also include specific tasks and indicators used for performance of these tasks. Thus, large companies from different economic sectors have supported the SDG and are working towards integrating relevant goals to the strategy (Fig. 1).

Based on data in pic. 1, a growth trend may be observed in the number of companies that decided to increase sustainable development responsibility and to publish the relevant GRI-standardized reports. Among such companies are the largest foreign and Russian oil and gas producing companies, including: Equinor (2000), Suncor Energy Inc. (2001), BP (2000), Royal Dutch Shell plc (2000), NK Rosneft PJSC (from 2010), Lukoil PJSC (from 2008), Tatneft PJSC (from 2019), and other companies.

The above is evidence to the fact that the concept of corporate social responsibility is an inherent part of sustainable development. CSR is a regular dialogue with

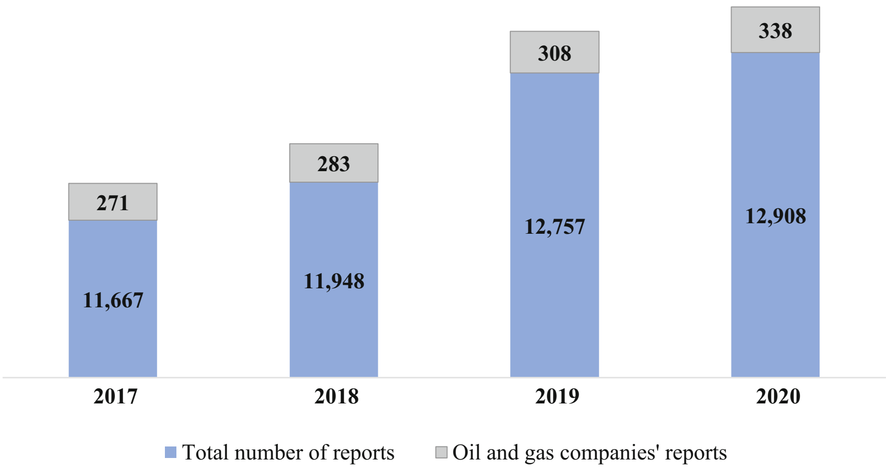

Fig. 1 Oil and gas companies' sustainability development reports. Source: compiled by the author based on segment data. Retrieved from: https://www.corporateregister.com/livecharts/

society and is reflected in the system of economic, environmental, and social indicators of a company's sustainable development. Therefore, any production and economic decisions are made on every interconnected level of corporate governance taking into account the consequences for the company and for society (Kostin, 2013). Despite the common trend of voluntarily decision to increase sustainable development levels among companies, this issue remains especially pressing for the oil and gas sector. Moreover, the provisions of the UN Global Compact have in fact become form and direction requirements of specific companies' CSR programs.

Prerequisites for Expanding ESG Activities in the Arctic

Apart from the global trend of businesses becoming involved in implementing sustainable development principles for companies operating on the Arctic offshore, at least three factors may be identified that served to speed up introduction of ESG factors into the corporate governance system. This refers to a series of large accidents and scandals surrounding business ethics violations as well as connected to climatic and socio-economic features of the region.

The most widely known and obvious example of noncompliance with ethical principles in contradiction to the logic of sustainable development and CSR is the 2001 bankruptcy of Enron that had become one of the largest energy companies in the USA during its 15 years of existence. From the beginning of the 1990s to 1998, the company's share price rose by 311%. By the end of the year 2000, Enron's market capitalization was in excess of $60 billion, which was 70 times more than its revenue and 6 times more than its book value. Moreover, Enron was recognized by the Fortune magazine as the most innovative among America's large companies. Enron's collapse was the result of financial statement fraud: by using unethical accounting methods, the company concealed multibillion debts and inflated its profits which caused steep increases in share prices. At the same time, company management sold their shares at peak prices and cashed in bonuses for efficient work.

Enron's auditor, Arthur Andersen, was found guilty of unlawful destruction of postaudit documents relevant to the investigation by the USA Securities and Exchange Commission, as well as of neglecting audit standards due to a conflict of interest – the audit company additionally provided advisory services.

As a result of this case, 20 thousand employees lost their jobs and $1.2 billion worth of retirement savings. Investors lost more than 60 billion USD. As a result of this incident, the Sarbanes – Oxley Act – was passed imposing stricter liability for the quality and accuracy of financial records. After the Enron investigation, focus shifted to Arthur Andersen's remaining clients who also subsequently declared themselves bankrupt, with the largest case being the bankruptcy of a TMT company WorldCom.

As for the second group of reasons – environmental disasters – it is worth looking into damage caused to the Arctic's fragile ecosystem – the Exxon Valdez tanker oil spill that took place close to the shores of Alaska in 1989. Prior to the 2008

Deepwater Horizon drilling platform accident, the aforementioned disaster was the most wide-scale in terms of environmental damage caused. A heavy-tonnage oil tanker ran ashore in the Prince William sound, with more than 250,000 barrels of oil spilling into the sea over a short period of time as a result. The accident was caused by human error, however, according to the investigation report of the US National transportation safety board, the ship's crew were also forced to work overtime which affected their performance. Besides, the issue of the nonfunctioning collision prevention radar system was not resolved, which could have prevented the disaster.

The crash site was difficult to access resulted in challenges to secure a swift reaction to the emergency. Three years after the accident, in 1992 the US Coast guard declared the area clear of waste; however, the long-term consequences of the spill can be observed even nowadays.

Soil pollution and a decline in marine biodiversity had a negative effect on the fishing-based economies of nearby towns. Liquidation costs totaled $4.3 billion. However, $5 billion worth of punitive damages initially fined to the company were reduced to $500 million as a result of countless court hearings. Measures to strengthen environmental security, to prevent oil spills, to ensure the safety of employees and business communities, as well as the Oil spill Act of 1990 may all be considered as positive outcomes of the incident.

2020 saw the most wide-scale accident in the Russian Arctic to-date, which is often compared to the Exxon Valdez oil spill in terms of environmental damage – the disaster nearby Norilsk occurring as a result of the spill of 21,000 tons of oil on the territory of TPP-3 owned by a subsidiary of "MMC Norilsk Nikel" PJSC, with 6,000 tons having been absorbed into the ground and the rest spilling into rivers and lakes running into the Kara Sea. After the accident, another sustainable development priority for the Arctic region was set out – ensuring production safety in the presently melting and shifting permafrost.

It should be noted that the Arctic is in an especially dire need of socio-economic and environmental welfare due to special life and labor conditions, a unique nature and climate, unique underlying resources and ethnography that requires careful handling in order to ensure its preservation and sustainable development.

According to one of the more reliable estimates of oil and gas potential – the US Geological service – 30% of the world's unexplored gas reserves (around 47 trillion cubic meters of natural gas) and 13% of oil reserves (90 billion barrels) are concentrated in the Arctic, with 84% located in marine areas and with a mere 16% located on land (USGS, 2008).

Eight Arctic states own territories in the Arctic located beyond the Northern polar circle with a latitude extending beyond the $66°33'44''$ parallel – those are the permanent members of the Arctic council: Denmark (Greenland), Iceland, Canada, Norway, Russia, the USA, Finland, and Sweden. However, the region can be distinguished by the fact that out of the countries with access to the Arctic shelf, only three have reached the stage of industrial fossil fuel production: the USA (oil extraction), Norway (gas extraction), and Russia (oil extraction, reserves are mostly comprised of gas). Moreover, on average the period between the discovery of a deposit in the Arctic and the start of development lasts 15–20 years (Sochneva, 2016). This is caused by a number of risks associated with the development of oil and gas fields in the Arctic which can be divided into four main categories:

- **Natural and climatic risks:** permafrost, winds with velocity of more than 15 meters per second, old shifting glaciers
- **Technological:** designing and construction of platforms, vessels, equipment, taking into account the need to ensure accident-free operations in the Arctic; lack of certified technology and solutions; difficulties with decommissioning infrastructure
- **Environmental:** vulnerability of the environment towards pollution, existence of endangered sea flora and fauna
- **Logistical:** limited access, undeveloped infrastructure for uninterrupted delivery, and consignment of hydrocarbons; the need to establish a complex system of managing the ice conditions, etc.

Solving the outlined issues will provide an opportunity for sustainable development of the Arctic shelf and transpolar territories. The most pressing tasks are establishment of infrastructure and procuring year-round navigation while preserving the fragile environment and biodiversity. Thus, in order to study international practice, it would be reasonable to analyze the approaches of oil and gas companies active in the Arctic zone towards ensuring the region's sustainable development.

Practical Implementation of Sustainable Development Among Russian Companies Active in the Arctic Zone

In analyzing the concept of sustainable development in the Russian Arctic, it should be noted that active work on developing the Arctic shelf began back in early 1980. Extending the Timan-Pechora and the Western Siberian oil and gas provinces into the Pechora and Kara seas was seen as a priority. Construction of a number of drilling ships was ordered for the region's development, with the ships having soon been sold out in the 90th. Geological exploration of the Arctic was basically suspended after 1991. The total explored area of the Arctic waters remains extremely small: 20% of the Barents Sea, 15% of the Kara Sea, and 0% of the Eastern Siberian, Laptev, and Chukchi seas.

Moreover, according to the Russian Ministry of Environment, 80% of gas and 60% of oil are extracted in the Russian Arctic with ABC_1 reserves estimated at 3.87 billion tons and 3.7 trillion cubic meters. In that respect, it is in this region where discovery of unique and large deposits is expected (Mordushenko, 2021).

According to section three of article 9 of the Law of the Russian Federation No. 2395-1 dated 21.02.1992 "On subsoil," access to subsurface sites on the continental shelf is provided to companies with over 50% state participation in the share capital and possessing over five years of experience in developing the subsurface sites of the Russian continental shelf. Currently only two companies meet these requirements – "NK Rosneft" PJSC and "Gazprom" PJSC, both owning more than 80% of licenses on the shelf.

Meanwhile, at the Saint-Petersburg World Economic Forum 2021, a precedent was set for a private Russian company receiving access to the Russian Arctic shelf. "Gazprom" PJSC and "Novatek" PJSC have announced a joint venture with a view to developing the Northern Wrangel licensed site (Eastern-Siberian and Chukchi seas) (Novatek, 2021).

Being large public corporations, the aforementioned companies publish annual sustainable development reports under the GRI standard and are part of global ESG ratings. Every year the companies become more and more open, presenting their stance, disclosing measures being taken and the effects thereof. For instance, in 2020, "NK Rosneft" PJSC published its updated public stance: "Rosneft: contribution to implementing UN sustainable development goals" as well as its human rights stance, a declaration of observance of human rights in relations with suppliers of goods and services and a carbon management plan up to 2035.

In 2020, "Gazprom Neft" joined the UN Global Compact. Moreover, the company became one of the leaders in the international CDP rating and also scored the highest among Russian oil companies.

"Novatek" PJSC set priority targets for achieving UN SDGs and approved 2030 environmental and climatic goals. Moreover, in 2020 the company became the first and only player in the Russian oil and gas market to have received an A rating according to a reputable agency MSCI ESG Ratings (Novatek, 2021). One cannot fail to note the company's joining one of the most significant global "green" initiatives in the oil and gas sector – the "Methane Guiding Principles."

The companies have approved long-term sustainable development goals for 2030–2035 and are in the process of establishing separate divisions for coordinating the achievement thereof.

Further on, the activities of these companies will be analyzed in order to identify the similarities and differences in their approaches to a responsible development of the Arctic region.

"Gazprom Neft" PJSC

"Gazprom Neft" PJSC is the first and currently the only Russian company to be working on extracting oil on the Arctic shelf in freezing sea conditions. The company began oil extraction at the Prirazlomnoye oil field in the Pechora Sea in December 2013, with the first shipment of arctic oil having been consigned to European consumers in April 2014 (Gazprom Neft, 2021a). Notably enough, around 30% of all "Gazprom Neft" PJSC oil is extracted at "Prirazlomnoye," "New Port," and the Eastern-Messoyakha fields developed together with "NK Rosneft" PJSC (Gazprom Neft, 2020b). The company also considers the Arctic a region with the potential for further development and expansion of operations.

Ensuring safety at the "Prirazlomnaya" sea platform. Taking into account the unique oil extraction project on the Arctic shelf, the company aims to ensure maximum production safety and to minimize potential environmental risks. For example, during construction of the “Prirazlomnaya” platform, special technological solutions, special corrosion- and wear-resistant materials, and coating were used, capable of withstanding maximum ice loads, waves measuring up to 10 m in height, and shielding the platform from washing away. The “zero discharge” principle has also found its application, pumping the drill fluid and other waste into a special absorption well or transporting them to the shore for disposal. Moreover, all of the wells in place are inside the platform and its foundation serves as a buffer between the well and the open sea. A caisson oil depot calls for a “wet” technique of oil storage excluding exposure to oxygen and the formation of an explosive environment (Gazprom Neft, 2021a).

Unloading is performed from the platform to the tankers by a complex direct oil unloading device (CDOUD), equipped with an emergency stop and shut-down system.

Marine production sites are hard to access and generally pose higher danger levels. To preserve the “Prirazlomnaya” platform’s safety, the company has implemented an automated control and security system that allows to remotely and automatically manage oil extraction, preparation, storage, and unloading, as well as to control electricity outputs, fire safety, emergency equipment, and technology shutdown. Eighty sensors track changes in the platform’s work and a lot of focus has been given to the evacuation system.

Due to the field being located in the freezing part of the sea, safe year-round unloading is secured through an ice management system, the key element of which is the Ice Conditions Control Center. Thanks to the use of self-learning mathematical models, it has become possible to produce more accurate meteorological and ice forecasts. “Gazprom Neft” PJSC has also developed and implemented a marine operations safety control system along with a smart digital arctic logistics control system “KAPITAN.” The system is in place to provide 24/7 tracking of the company’s field and depots access parameters and to calculate optimal transportation routes, taking into account weather forecasts, including ice conditions.

Environmental safety is secured through specialized ice-breakers with cutting-edge oil-gathering equipment on board, regularly conducting emergency patrol. An emergency oil spill response plan is in place, and since 2020 the company has developed in association with the Engineering center of the Moscow Physics and Technology Institute an innovational dispersion medium for cleaning-up oil spills in ice conditions with an efficiency rate of up to 80%.

Application of digital and innovational technology. For the purposes of raising efficiency of shelf projects, the company has implemented the “Poseidon” program that employs digital technology. The system includes an Extraction Optimization Center creating models of the entire oil asset chain of production (Digital alter ego) and an Emergency Control Center (Alexeev, 2018).

“Gazprom Neft” PJSC is developing a number of innovational technologies that increase safety levels for use in the Arctic, with one of them being the application of unmanned flying devices. The scope of application for this solution is quite wide: from geological exploration and transportation of cargo to the fields, to control over construction and the state of the infrastructure. Despite the technology being new, according to the company's representatives, by 2020 it had matured enough to warrant its mass industrial implementation of its use in extreme conditions. For example, Russian-produced unmanned aircraft was first used in the South-Priob oil field in the Khanty-Mansi Autonomous Okrug in low temperatures for delivery of oil samples from wells to laboratories. Quadcopters are also used at the company's oil fields for magnetic surveys, aerial laser forest scanning, creation of a digital model of the landscape, cadastral works, construction monitoring, etc.

Unmanned trucks have been successfully tested together with "KAMAZ" at the Eastern-Messoyakha field. Compared to piloted counterparts, unmanned "KAMAZ" trucks are 50% safer and allow to cut transportation costs by 10–15% (Gazprom Neft, 2020c).

It should be noted that "Gazprom Neft" PJSC owns around 40 patents in the field of environmental and production safety.

Cooperation in the field of sustainable development. One of the glaring examples of successful cooperation in the field of sustainable development is assistance provided by companies with high success rates of cleaning up oil spills and those experienced in postaccident clean-up nearby Norilsk, which Gazprom Neft took active part in.

In 2020, together with Shell, the company established a joint venture for developing hydrocarbons on the Gyda peninsula. An agreement was reached on cooperation in reducing greenhouse emissions, forest regeneration, increasing energy efficiency, implementing renewable energy, as well as managing flight safety for the air traffic (Gazprom Neft, 2020a).

Social investment program. "Gazprom Neft" PJSC employs a social investment program called "Hometowns" with a view to improving quality of life in regions of activity. Projects are developed in partnership with regional governments, not-for-profit organizations, locals, and the company's employees. The program covers different areas: sports, science, education, culture and arts, urban transformation, and volunteering (Gazprom Neft, 2021b).

"NK "Rosneft" PJSC

"NK "Rosneft" PJSC is currently the largest license-owner on the continental shelf, and it owns 28 licenses in the waters of the Western (19 projects in the Barents, Pechora and Kara seas) and Eastern Arctic (9 projects in the Laptev, Eastern-Siberian and Chukchi seas) (Rosneft, 2021b). The company's portfolio lacks arctic shelf projects that have reached the extraction stage; however, "NK "Rosneft" PJSC is implementing a complex long-term program that includes geological, oceanological, meteorological, and environmental research. Apart from continuing to study the arctic sea shelf, 2020 saw the launch of the "Vostok Oil" project: an arctic cluster combining a unique reserve potential of over 6 billion tons of oil of the Vankor cluster, the Payakha field group, the Western-Irkin site, and the Eastern-Taimyr field group.

Notably enough, "NK "Rosneft" PJSC, having had prior experience of successfully developing shelf sites of the Okhotsk Sea together with foreign companies, also began the development of the Arctic shelf in association with ExxonMobil and Eni pursuant to appropriate cooperation agreements signed beforehand. However, after the introduction of sectoral sanctions in 2014, work on the projects was suspended for an indefinite period.

Localization of technology and imports phase-out. In order to localize technology and to develop marine production facilities for the Arctic's sustainable development, the company is actively constructing a shipbuilding cluster in the Far East of Russia – "Zvezda" shipbuilding complex (SC "Zvezda") which has become more relevant than ever in light of restrictions on the use of foreign technologies. The complex is being constructed by a consortium of investors "Rosneftegaz" JSC, "NK "Rosneft" PJSC, and "Gazprombank" JSC. The ship lineup includes large-capacity vessels, including reinforced ice class vessels, special vessels, sea platform elements, and other types of marine machinery. Such market leaders as Hyundai Heavy Industries Co., Ltd., Samsung Heavy Industries Co., Ltd., the Dutch Damen, the French GTT, and others have become technological partners for the shipbuilding process. The wharf has already received orders from leading Russian energy sector companies: Orders have been made for the construction of the unique, biggest in the world atomic icebreaker for the Leader "Rossiya" project, gas-carrying vessels of ice class Arc7 for the "Arctic SPG 2" project, and large-capacity shuttle tankers of a high ice class for the "Vostok Oil" project and for other vessels. After the completion of all of the wharf's construction stages, more than 7,500 jobs will be created.

Geological exploration on the arctic shelf. The company's strategic development is intrinsically linked to the future development of both the land and the shelf of the arctic region. From 2012 to 2020, the company has conducted an unprecedented amount of seismic testing and has discovered unique oil and gas fields such as "Pobeda" and the "Marshall Zhukov" oil field in the Kara Sea. A number of studies of the environment, the ice cap, the weather, and the flora and fauna are performed before the start of marine geological exploration.

Research and development and expeditions. The company has a functioning corporate R&D project complex (RDPC) which includes 32 R&D and project institutions whose task it is to develop, test, and implement modern technologies. For example, in order to preserve the marine environment, the RDPC has developed a dispersion medium for cleaning up emergency oil spills and tests have begun for a unique microbe-based compound for disposing of hydrocarbon pollutions in a marine environment and a cold climate. The company owns 64 patents, and 72 technologies have either been implemented or are in the process thereof.

"Arctic Research Center" LLC (part of "NK "Rosneft" PJSC's RDPC) employs a complex long-term scientific program in the Arctic which includes geological, meteorological, oceanographic, ice, and biological research. ARC experts install autonomous sensors and track the movements of the icebergs and ice fields and any changes in their trajectory. This work is performed together with leading Russian scientific and project organization. Collection of geological and meteorological data is performed in the waters of the Kara Sea and the eastern arctic seas. The data are used, inter alia, for planning of geological exploration.

Implementing the "Vostok Oil" project with a minimal carbon footprint. Renewable energy is expected to be used for the "Vostok Oil" project, including wind energy. Moreover, a number of ships including 10 high ice class tankers powered by gas-based motor fuel will be required for the transportation of the hydrocarbons extracted. The project also contributes to the development of the Northern Sea Route (NSR): for example, the expected cargo traffic may rise up to 30 million tons by 2024 and by 100 million tons by 2030. The company notes that the project will have a minimal carbon footprint – 12 kilograms per barrel, taking into account that this number usually averages to 50 kilograms per barrel in new oil fields (Rosneft, 2021a).

"Novatek" PJSC

"Novatek" PJSC is an independent natural gas producer in Russia with its main production sites located on the arctic land. The company's strategic goals are based on a broad resource potential with low extraction costs, serving as the groundwork for gas liquefication and processing projects – "Yamal SPG," "Arctic SPG 2." The projects serve to further the development of the North Sea route thanks to transportation of the products in both the western and the eastern directions. It should be noted that the projects are implemented with help from foreign partners: "Yamal SPG" shareholders include the French Total, Chinese CNPC, and the Silk Road Fund. The project has received external funding from Russia, China, Italy, France, Japan, Germany, Sweden, and Austria totaling up to 19 billion USD (Novatek, 2017).

Development of imports phase-out. Currently SPG projects involve the use of primarily foreign technologies; however, the company is actively involved in imports phase-out, employing a significant share of Russian contractors and utilizing Russian technology. The construction of "Yamal SPG's" fourth line makes use of Russian technology and the new project – the "Obskiy SPG" production site – will be fully equipped with Russian machinery. Moreover, another one of the company's larger projects – "Arctic SPG 2" – will be equipped with 15 gas-carrying vessels of ice class Arc7 constructed at the Russian wharf "Zvezda" SK (Far Eastern Shipbuilding and Ship repair Center, 2021).

The company is developing its own base for the production of gravity-based foundations (GBF) (large-capacity marine structures construction center) for setting up SPG facilities that possess a number of advantages and ensure reduced negative impact on the environment, including zero risks of compromising structural integrity in cases of rising ground temperatures.

"Novatek" PJSC has patented its own gas liquefication technology – "Arctic cascade" which serves as the basis for "Yamal SPG's" fourth line and the future "Obskiy SPG" project. The technology is aimed at reducing energy usage by using the Arctic's own natural cold climate. As such, the first three lines of "Yamal SPG" were designed and developed by a French-Japanese consortium of Technip, JGC, and Chiyoda with the use of the Air Products liquefication technology (Davydov, 2021).

Thirty percent localization levels have been achieved in the “Yamal SPG” project in terms of Russian components, “Arctic SPG 2” is projected to reach 50%, and the projects to follow are aimed to reach no less than 70% (Vedomosti.ru 2021). Such large-scale projects undoubtedly stimulate breakthrough Russian development – for example, in the “Yamal SPG” project, the first large-capacity cryogenic pump constructed by “OKBM Afrikantov” (Atomenergomash) has been successfully tested, as well as a heat transfer device for the SPG-production site (Kazankompressormash) and a cryogenic heat transfer device (Cryogenmash). However, the company is still questioning the quality of the Russian equipment (Nilsen, 2021).

Reduction of the carbon footprint. The use of SPG production cycle gases for heating the heat transfer agent of the heating systems (cogeneration) and saving fuel has allowed “Novatek” PJSC to significantly reduce greenhouse emissions. “Yamal SPG” is also utilizing a methane recuperation technology – returning the gas to the technological process for repeated liquefication or for use as fuel – for flash gas disposal (methane vapor produced as a result of gas liquefication). Notably enough, transportation of products by sea is also a contributing factor to reducing the carbon footprint, especially considering that gas-carriers operate on a low-carbon flash gas produced from the transported SPG. Moreover, taking into account that the company specializes in SPG production, it is participating in solving the government’s task of transitioning to natural gas-based motor fuel-powered vehicles.

In the context of the global trend of transitioning towards low-carbon energy sources, “Novatek” PJSC, being a producer of natural gas and SPG, is one of the main potential beneficiaries. Moreover, for “Novatek” PJSC, it is especially important to develop in the field of hydrogen: production of “blue” and “green” hydrogen and shipping it to Europe, as well as “blue” ammonia with carbon dioxide entrapment and disposal.

Considering that the Russian Government is actively working on the “North Sea route” Federal Project with a view to reaching cargo traffic targets of 80 million tons by 2024, the company aims to develop year-round navigation for transporting cargo in both the western and the eastern directions, including transportation with the use of eco-friendly natural gas-based motor fuel. Besides, the use of the “North Sea route” can by itself help reduce the effect on the environment, as it reduces the Asian route by 40%.

Cooperation with the North’s indigenous ethnic minorities. Apart from the arrangements common among all companies, “Novatek” PJSC is conducting target training of people from indigenous ethnic minorities for TEK production sites and for the needs of the Yamal region municipality.

Moreover, the company’s collective employment agreement guarantees that the minimum salary rates for the employees are to be higher than the minimum salary rates in regions where the personnel are employed. As of December 31, 2020, the minimum salary of employees stationed in the Yamal-Nenetsk Autonomous Okrug was 75% higher than the region's minimum salary, while in Moscow the minimum salary was twice as high as the minimum salary.

After analyzing sustainable development reports of the aforementioned companies, we have been able to identify similar approaches to Arctic projects (Table 1). However, due to different goals and forms of presence in the region, a disparity in priorities and focal points of their policies may be observed.

For convenience, let us present common trends and differences in the form of tables (Table 2).

International CSR Practices and Other ESG Programs in the Arctic Region

Norway

Currently Norway's technological and economic superiority in the development of the continental shelf is the basis for the country's economic welfare. Therefore, it is extremely surprising that fishing, sailing, nonferrous industry, and hydraulic power industry were Norway's primary sources of income until mid-twentieth century, with the first oil extraction attempts having ended in failure: around 33 wells turned out by dried out. Moreover, initially the Norwegian shelf was dominated by foreign companies undertaking geological exploration and oil field extractions.

The Norwegian shelf development model may be distinguished by the fact that already at the onset of the oil and gas industry, the country's government had already prioritized national institutions in the overall project roadmap. For this purpose, in 1972 a state-owned oil company Statoil (currently Equinor) and an authority overseeing the industry – the Norwegian Petroleum Directorate – were established.

In December 1972, a decree was passed on geological exploration and extraction on the shelf, stressing the need for allowing Norwegian companies to take part in tenders for the supply of oil and gas equipment and technologies provided that the products meet the employer's requirements. In distributing licenses, the government also showed preference for those companies that maximized use of Norwegian products and services. As a result, the Norwegian participation share in the development of oil fields at times reached 90% (Kadysheva, 2007). However, in the meantime, competition was preserved between national and foreign suppliers with the main criterion still being the quality of goods and services.

In order to adopt the necessary expertise and skills from foreign companies and develop the country's own industry, the authorities decided to establish the 50-percent state participation principle for each license. It would later be decided that the participation percentage in each license would be set either higher or lower than this threshold and would be determined on an individual basis.

Currently Norway's and Scandinavia's largest company is Equinor, being the biggest oil supplier and second-biggest natural gas exporter to the European market. Moreover, the company is a supplier of clean electricity produced by wind energy to the British market. The company is also the largest project operator on the

Table 1 The companies' common arrangements for the sustainable development of the Arctic

Environment protection and production safety
Rational use of oil-associated gas (OAG)
CO_2 emission prevention by means of gas entrapment and storage
Increased energy efficiency thanks to reducing the volume of resources consumed, implementing renewable energy sources
Emission reduction by producing and utilizing hydrogen with CO_2 entrapment and disposal
Reduction of methane emission intensity by implementing innovational technologies: unmanned aircraft, laser and thermal vision devices, scanning, ultrasound sensors
Production of and transition to, eco-friendly fueled transport
Regulation of the environmental impact on permafrost, permafrost conservation of buildings and structures' foundations
Reduction of negative impact on bodies of water by implementing a sewerage system, purification facilities, reverse pumping of reservoir waters, clean-up of shorelines, and sewage waters
Waste reduction, separate waste collection, and disposal with subsequent recycling
Preservation of biodiversity at production sites, including biological compensation arrangements, R&D expeditions, monitoring the state and outlining the indicators of the Arctic's ecosystem sustainability
Partnerships with leading international companies in the field of decarbonization
Implementing environmental management and monitoring systems
Implementing unmanned transport technologies
Use of equipment and environment monitoring systems with the help of various sensors that allow to collect live data and build digital assets models
Minimizing human presence in performing dangerous works on production sites by implementing automated unmanned technologies
Cooperation with and support of the North's indigenous ethnic minorities
Corporate policies are in place regulating priorities in interacting with the North's indigenous ethnic minorities.
Educational, cultural, sport and social programs, charity.
Furthering economic and social development by creating new jobs, improving infrastructure and introducing quality of life improvement programs under cooperation agreements with the regions of activity.
Support for the indigenous ethnic minorities in terms of preserving their cultural traditions and traditional way of life (support for deer herding and the population's traditional nomadic way of life) as well as provision of targeted assistance.
Holding of public hearings.
Target worker training, including employees from indigenous ethnic minorities, for jobs required.
Integration of the North's indigenous ethnic minorities into the modern economic landscape without loss of cultural patterns.
Holding of grant competitions and support for local initiatives.
Technology and innovation development
Imports phase-out and technology localization.
Development of internal expertise in corporate innovation centers.
Development of own technology for solving specific narrow tasks.
Implementing digital technologies into all stages of productions: from seismic testing to sale of products.

Source: compiled by the authors based on analysis of the companies' sustainable development reports for 2020. Retrieved from: https://www.rosneft.com/upload/site2/document_file/a_report_2020_eng.pdf, https://www.novatek.ru/common/upload/doc/NOVATEK_SR_2020_ENG.pdf, https://www.gazprom-neft.com/annual-reports/2020/csr_en_annual-report_pages_gazprom-neft_2020.pdf

Table 2 Differences in the Russian companies' approaches to sustainable development in the Arctic

No.	Sustainable development initiative (used for Arctic projects)	Approaches and tools utilized in the Arctic		
		"NK Rosneft" PJSC	"Gazprom Neft" PJSC	"Novatek" PJSC
Distinctive features of activity in the Arctic		Lack of extraction projects, active geological exploration on the arctic shelf (around 80% of licenses owned on the arctic shelf). A unique oil extraction project "Vostok Oil" has been launched on the mainland; active extraction projects on land. Localization of shipbuilding and marine machinery construction technology for the purposes of developing the North Sea Route and the arctic resources. Holding annual R&D expeditions.	Work on the only arctic shelf oil extraction project in Russia in freezing waters – "Prirazlomnoye." Active extraction projects on the arctic mainland. Optimization and efficiency increase at functioning production sites by implementing digital and energy efficient technology, search, and implementation of innovational environmental solutions. Active innovational activity thanks to internal R&D.	Primary gas and SPG production assets are located in the arctic region. The key project – "Yamal SPG" based at the South-Tambeskoye gas field. The "Arctic SPG 2" project has been launched based at the Utrenneye field. Construction of the SPG gravity-based foundation line production site. SMP development and use of natural gas-based motor fuel.
1.	Environment protection and production safety	Natural carbon absoprtion Increased oil spill control efficiency Annual R&D expeditions and environmental protection measures aimed at preserving and replenishing natural resources, protecting endangered animal species, studying of marine mammals Vehicle operation safety control system Establishment of a corporate ice	Energy audits, transition from diesel power stations to gas-turbine power stations Strategic priority of no harm to the people, the environment, and property, "Target-zero" Safety control system based on a risk-oriented and barrier approach Digital platform for managing operational risks Use of digital	Development of hydrogen and methane-hydrogen mixtures, ammonia, and other low-carbon gas recycling products Use of cogeneration Use of flash gases as fuel for SPG transportation Use of natural gas-based motor fuel

(continued)

Table 2 (continued)

No.	Sustainable development initiative (used for Arctic projects)	Approaches and tools utilized in the Arctic		
		"NK Rosneft" PJSC	"Gazprom Neft" PJSC	"Novatek" PJSC
		conditions monitoring system; Use of digital predictive analytics technology for predicting failures, asset modeling, computer vision Cybersecurity	probability forecast technology and incident modeling, equipment failure modeling technology assessing the state of the barriers for failure prevention Implementation of unmanned vehicles (aircraft and cars)	
2.	Development of technology and innovations	Localization and imports phase-out, more specifically the construction of the "Zvezda" shipbuilding complex in the Russian Far East for production of ships and marine machinery for the development of the Arctic, as well as development of the machine-building cluster Development of technology for the mass production of dispersion mediums and microbe-based compound for cleaning-up emergency oil spills, as well as safe drilling fluids Implementation of digital technology into the entire production process Use of seismic data registration systems Development of a corporate scientific	Digitalization of key operational processes; creation and functioning of the company's technological centers covering each stage of the company's work Systematic control through innovation centers Increased oil extraction rate at mature oil fields Active imports phase-out Use of digital twin assets and centralized oil extraction project management A functioning "Digital Arctic" competence center for securing year-round uninterrupted oil transportation from arctic oil fields	Use of alternative energy, hydrogen, renewable energy sources Own SPG production technology – "Arctic cascade" Own production base – large-capacity structure construction center for the production of gravity-based foundations Ensuring the use of Russian equipment with a step-by-step localization increase from project to project

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No.	Sustainable development initiative (used for Arctic projects)	Approaches and tools utilized in the Arctic		
		"NK Rosneft" PJSC	"Gazprom Neft" PJSC	"Novatek" PJSC
		and project complex (largest European corporate system for solving practical fundamental tasks; more than 800 pieces of technology developed)		
3.	Ensuring the welfare of the local community	Promotion of the socio-economic development of the region of activity: infrastructure development, sport, cultural events, scientific and educational programs, environmental projects Providing access to modern digital technology Internal training resource for strategic investment projects	"Hometowns" social investment program Employment of local contractors Corporate volunteering	Support for indigenous ethnic minorities according to the Indigenous population sustainable development assistance plan Charity programs in the field of healthcare, education (from indigenous ethnic minorities, including for TEK facilities), culture and sports Ensuring equal pay for equal labor (minimum salary for employees in the Yamal-Nenetsk autonomous Okrug is 75% higher than the region's minimum salary)

Source: compiled by the authors based on analysis of the companies' sustainable development reports for 2020. Retrieved from: https://www.rosneft.com/upload/site2/document_file/a_report_2020_eng.pdf, https://www.novatek.ru/common/upload/doc/NOVATEK_SR_2020_ENG.pdf, https://www.gazprom-neft.com/annual-reports/2020/csr_en_annual-report_pages_gazprom-neft_2020.pdf

Norwegian shelf (Equinor, 2021). The company covers around 60% of carbon extraction on the shelf, including the arctic shelf in the Barents Sea.

Thus, Norway has been developing the Arctic continental shelf since 2007, with the first project having been the Snøhvit gas field in the Barents Sea. The project involved the construction of a production site consisting of a submarine extraction complex, CO_2 pumping wells, a submarine pipeline extending 143 kilometers and leading to the SPG complex Hammerfest LNG.

It should be stressed that the work on this project completely changed the socio-economic situation in the city of Hammerfest. Before the construction of the SPG production site, fishing had been the primary specialty of the town, the population dwindled due to unemployment and low quality of life. In the course of field development, despite participation of foreign auxiliary plants, the then Statoil company employed local suppliers and contractors for the project. This stimulated the establishment of the Petro Arctic supplier association, created with the goal of increasing localization levels. Besides, for the purposes of funding local budgets, a realty tax was introduced which amounted to 90% of all budget revenues. Budget revenues allowed to increase the town's economic activity and to revitalize the labor market (Belyakova, 2016).

Taking into consideration the emergence of new projects including discoveries of fields and future geological exploration plan, the Petro Arctic supplier association predicts a rise in job numbers by 3000 for work in the northern part of Norway.

Not everyone supports the company's strives, however. Activists of the Sami community have expressed their discontent for the negative impact of the company's activities on the people's traditional way of life. The reason for this was Equinor's announcement of increased investments and development of renewable energy sources subject to oil extraction growth over the course of the next five years.

In terms of support for the local population, apart from the common arrangements, the company uses fishing vessels to create a regional oil spill clean-up infrastructure, in order to support fishermen.

Having changed its name from Statoil to Equinor in 2018, the company is one of the best examples in the field of sustainable development. Even the change of the company's name is aimed at implementing a development strategy, becoming a multiprofile business: Diversification and development of "green" energy have become its priorities (Equinor, 2021).

In 2016, extraction began at the oil field Goliath in association with Eni. The launch of the project had been postponed on countless occasions due to delays in construction at the wharf; the project was also criticized by environmentalists. A unique cylindrical floating complex equipped with a submarine extraction complex was constructed at the South Korean Hyundai Heavy Industries wharf. Moreover, in order to reduce CO_2 emissions, the plant is powered not from the mainland, but by gas turbines and generators installed on the platform itself. Meanwhile, the platform has already seen a number of extraction shutdowns due to various complications in the course of operation.

In 2020, the company set new environment protection goals:

- Reduction of greenhouse gas emissions by 40% by 2030, by 70% by 2040, and reaching zero emission levels by 2050 on marine fields and coastline production sites in Norway.
- 0 methane emissions by 2050.
- 0 routine oil-associated gas burning by 2030 (Norway).

- Renewable energy facilities – 4–6 gigawatts by 2026 and 12–16 gigawatts by 2035; the goal is to become the largest wind energy-powered business.
- In general, carbon neutrality is set to be achieved by 2050.

Considering that the government plays a key role in regulating the oil and gas sector, these target waymarks are in line with the government's priorities.

In light of the carbon neutrality goal, the "Northern lights" project has been launched in association with Shell and Total for entrapment, transportation, and storage of CO_2 on the floor of the North Sea in empty oil field. The government has allocated $ 1.7 billion worth of targeted financial aid. Apart from a positive impact on the environment, the project will also allow to create jobs for Norwegian businesses – around 57% of investments will be allocated to local contractors.

Equinor is installing the first ever floating wind generators in the North Sea created for providing electricity to marine oil and gas platforms. The company intends to take the lead in this segment and aims to spread the floating wind generator technology in various regions of the world. For example, the Hywind Tampen project has already been completed, possessing an 88 megawatt capacity and powering the Snorre and Gullfaks fields (around 35% of the energy required). Many experts predict that the use of a wind park at such old fields may be a sign of a future transformation of these assets into a new energy project, achieved by using the communication and technical support infrastructure already in place for transporting the energy generated to the shore. Moreover, the "shelf transformation strategy" involves Equinor's plans to deconstruct every fourth gas turbine from marine platforms.

The ambitious emission reductions goals are set to be achieved by synergizing such areas as electrifications, increased energy efficiency, development of new production and sale chains, CO_2 entrapment and storage, and hydrogen production (Equinor, 2021).

The company is a pioneer in terms of using CO_2 entrapment, use, and storage technology and is working on creating a European production chain based on the use of this technology on other platforms. A facility has been constructed under the "Shohvit" gas project, separating the well streams before the gas is cooled down for SPG production. Afterwards CO_2 is transported back via pipeline and is pumped into submarine storage reservoirs.

Having strong positions in the natural gas and carbon emission segment, the company will be aiming to take on a special role on the growing hydrogen market. At the same time, this Norwegian company does not intend to discard the traditional oil and gas business, as it simply rebalances its asset portfolio between oil, gas, and renewable energy sources.

USA

The US Arctic oil and gas fields are concentrated on Alaska's Northern slope. Commercialization of the shelf began in 1987. Only oil is extracted on the US arctic continental shelf in the Beaufort Sea. In the majority of cases, extraction is performed from artificial island or by means of horizontal drilling from the land. Sea platforms are not used. The primary marine projects include Nikaitchuq, Point Mclntyre, Endicott, Oooguruk (Panichkin, 2021).

Each oil barrel produced by BP at the Alaskan Northern slope doubles the company's average emission rates. Having set a goal of reaching zero emissions, the company decided to take the "divestments" approach (optimizing the asset portfolio) – one of the easiest ways to reduce the carbon footprint. For example, in 2019 BP, having worked in Alaska since 1959, announced the sale of assets in the region. Equinor (previously Statoil) did the same earlier in 2015, and in 2017 Royal Dutch Shell and Total all exited their oil-sand development projects.

Operating companies in Alaska sold their share to a smaller player – Hilcorp Energy Co. – with a business model aimed at acquisition of mature assets. As the same time, the industry's carbon footprint is not reduced. Notably enough, according to Bloomberg studies, Hilcorp have been the cause of three times the number of violations and incidents (including 30% more oil spills due to human error) than BP have had from the middle of the previous century to 2015. Hilcorp, however, denies these matters in their statements (Adams-Heard, 2021). Currently Hilcorp is the largest Alaskan operator. The company does not publish sustainability reports.

One of the three main players in the Alaskan land oil and gas development sector is ExxonMobil. The company's portfolio concentrates the most available gas reserves on the Alaskan Northern slope. For instance, since 2016 the company has been working on the Point-Thompson project. Remoteness and development difficulties were obstacles to the development of this field discovered in 1975. Local protests also slowed the project down.

The company is taking the following measures to protect the environment:

- Directional drilling for oil extraction on the shelf (half of the resources are concentrated on the shelf)
- Monitoring and preserving biodiversity
- Preserving the natural landscape, designing platforms, and infrastructure in a special manner
- Use of lifting pipelines for reduced impact on movements of wild animals
- Radars and subterranean surveillance cameras
- 70% of suppliers and contractors are local Alaskan contractors; ExxonMobil's investments totaled $ 4 billion with 70% thereof being directly into the Alaskan economy
- Educational programs

However, it must be said that the US' largest oil and gas companies are reluctant to join GRI. Under the UN Global Compact, the country is represented by only three companies – Kosmos Energy, Hess Corporation, and Pioneer Natural Resources. The remaining companies focus exclusively on their own development strategies. Therefore, companies active in Alaska have chosen the simple option of compliance with ESG criteria – sale of their shares in the relevant projects. That being said, it should be noted that oil and gas companies limit disclosure of information on sustainable development commitments in the American Arctic. The largest operator does not publish nonfinancial reports at all.

Conclusions

The analysis of the sustainable development arrangements in the Arctic has shown that despite the numerous similarities in the measures being taken, companies set different priorities based on the asset portfolio and form of presence in the region. Moreover, the selected development strategy of the business itself plays a key role. For example, the Norwegian Equinor has completely shifted towards a “green” future evidenced by a change in branding and the creation of a new business model founded on wind generation, CO2 entrapment and storage technology, and hydrogen production, with traditional oil and gas business ways in mind.

American companies have selected the simple option of complying with ESG criteria – they have sold their shares in the relevant projects. It should be noted that oil and gas companies limit disclosure of information on sustainable development commitments in the American Arctic. The largest operator does not publish nonfinancial reports at all.

In 2020, Russian companies began assessing prospects and formulating alternative energy development and hydrogen production strategies. The companies set ambitious carbon footprint reduction goals. The companies’ main competitive advantages may be identified upon analysis of the arrangements in place: localization of technology, monitoring and studying the environment, development and application of cutting-edge digital technologies, and development of the gas segment and SPG technologies.

The analysis allows us to claim that Russian and Norwegian companies have overtaken their American counterparts in terms of putting sustainable development to practice. Common trends for these countries include the growing role of R&D, digital technologies for monitoring, predicting, and managing socio-economic consequences of the companies’ activities in the Arctic. Another trend common both for Russian and Norwegian companies is the increased focus on localization and purchase of equipment from national producers.

In realizing the socially oriented goals, one may see an almost complete overlap of methods and means. In particular, this concerns training programs for local inhabitants, social investments, higher pay guarantees, and charity events.

With that being said, upon analyzing the overall number of projects and the cost thereof, it becomes obvious that Norway prioritizes social matters, especially creating jobs. Meanwhile Russia focuses more on the environment by, for example, ensuring security of assets functioning in permafrost, as well as on monitoring the environment and biodiversity.

The facts outlined above are evidence of the growing prevalence of ESG agendas for companies’ development strategies and activity roadmaps. Despite the companies having now voluntarily undertaken to ensure sustainable development, everything points towards ESG arrangements becoming mandatory in the future and serving as one of the main criteria for the competitive selection and "survival" on the market.

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Energy Development of the Russian Arctic and Sustainable Development

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Contents

Abstract

Economic development of ecologically fragile and strategically important regions traditionally draws special attention to the activities of energy companies. The chapter examines the strategies of Russian and foreign energy companies operating in the Arctic in the areas of environmental protection, social support, and economic incentives for the local population. The authors analyze the influence of the political and economic context (including Russia's Arctic Development

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Strategy to 2035 and Russia's chairmanship of the Arctic Council in 2021–2023) on the evolution of "sustainable" company strategies.

Keywords

Arctic · Energy · Sustainable development · Oil and gas companies · Russia · Arctic Council

Introduction

The Arctic region represents a complex area with geopolitical, environmental, social, economic, and technical issues intertwined. According to an assessment of oil and gas resources in the Arctic conducted by the U.S. Geological Survey (USGS, 2009), the Arctic contains considerable energy reserves, namely, about 90 billion barrels of oil, 50 trillion cubic meters of gas reserves, and 44 billion barrels of gas condensate, which constitutes roughly 16%, 30%, and 26% of the world's undiscovered hydrocarbon resources. The majority of these reserves is attributed to the Arctic offshore.

Russia as an Arctic state pays a particular attention to the region – as a source of political, economic, and strategic power (Carayannis et al., 2021; McCauley et al., 2015). Strong national interests are to be in line with international cooperation via interstate communication and interactions with other corporate actors. Indisputably the Arctic is a region of great attention from the environmental organizations and demands highly focused ecological strategies both from states and operating companies. Since the oil and gas development is to be realized by a number of energy companies, in the foreseeable future the companies have to adapt its policies to provide additional evidence of their environmental impact and to strengthen its position as responsible actor to the possible extent.

The current chapter includes several sections. The first one provides an overview of the current academic literature dedicated to the analysis of sustainability strategies of the oil and gas companies in the Russian Arctic, of their role in sustainable development of the region, and of the recently elaborated tools and analytical mechanisms to assess environmental and social impacts of Arctic energy projects with insights related to its improvement. The main part gives an understanding of the regulatory and strategic approach toward Arctic governance in Russia at the national level and in the Arctic Council in accordance with the Russian Chairmanship for 2021–2023. Moreover, the main part offers an insight into the current projects of the Russian and foreign energy companies and their approaches to tackle environmental and social issues in the region. In conclusion, summing up and assessment remarks are given.

Literature Review

Academic literature related to the sustainable development and the activities of the oil and gas companies in the Russian Arctic explores a range of research questions.

A number of researchers have explored the historical background and the nature of the corporate social responsibility of the energy companies in Russia, their approach to tackling environmental issues. Ecologically and socially responsible behavior of the Russian energy companies is often regarded as a paternalistic heritage from soviet regime where energy exploration activity was exercised by the state as the main contributor and caretaker of the people and the nature (Crotty, 2016; Henry et al. 2016; Petrov 2016). Since the 1990s, Russian oil and gas companies influenced to a large extent by the state have started a transition from state lead to corporate lead approach (Tulaeva & Tysiachniouk, 2017; Remington et al. 2013). More and more the companies' approach to tackling social and environmental issues surmounted "paternalistic" version and became more complex engaging new actors and stakeholders, both international and local (Ljubownikow et al., 2013; Benyaminova et al., 2019).

As a result, on the one hand, the extractive industry "inherited" the paternalistic role for the location of its activities. On the other hand, the international cooperation of corporate actors, influence of nongovernmental organizations (NGOs) and local communities especially in such technically difficult to explore region accelerated creation and incorporation of additional standards and corporate norms in the sphere of sustainable development. The concept of benefit sharing understood as a mutual gain of financial and nonfinancial benefits between extractive industries and local communities (Wynberg et al., 2009; Prno & Socombe, 2012) drives the development of sustainability approaches of the corporate sector working in the Arctic.

Novikova (2016, 2020) explores the role of state and energy companies' interactions in relation to indigenous people. The scholar advocates a cooperative approach for the Arctic resource governance which combines state protection measures active cooperation with strong legislative base (Ryabova & McCauley, 2017) and structured proactive position of oil and gas companies.

Smits et al. (2016) explore the concept of Social License to Operate understood as the acceptance of an industry activity by local communities and other stakeholders. The authors underline the role of human capital development in fostering the legitimacy of Arctic energy development. Loea and Kelman (2016) in the research based on the interviews with local communities come to conclusion that local population has clear expectations about oil and gas companies and provide support for their activities given the additional job opportunities and positive economic effects necessary for the community development.

Another block of literature assesses the interactions between oil and gas potential of the Arctic and UN sustainable development goals (SDGs). SDGs represent 17 goals of the world's development the achievement of which should accelerate the harmonious sustainable development of the nations (UN, 2020). Dmitrieva and Romasheva (2020) in order to evaluate how oil and gas companies may contribute to sustainable development create innovation policy roadmap based on SDGs. Despite strong anti-extractive position of environmental NGOs (WWF, 2021; Greenpeace, 2015), a number of researchers presume that natural resources including oil and gas are critical for the development of the society (Calas, 2017; Dobra et al., 2018), that it is crucial to direct investments from extractive industries development in human and physical capital to drive sustainable development. Innovation policy road map including key drivers, policies, resources, sectoral developments, key enablers with main tools for innovative changes in such spheres as prospecting and exploration, drilling oil and gas wells, development of hydrocarbon deposits, transportation and storage, environmental and social innovations are considered to contribute to sustainability-based economic activity in the Arctic (Dmitrieva & Romasheva, 2020). SDGs framework is suggested in order to develop more detailed and locally relevant indicators (Nilson & Larsen, 2020). According to some researchers (Larsen & Huskey, 2020; Kofinas et al., 2013), SDGs may provide additional solutions to develop Arctic economies and to strengthen its social capital.

In order to understand the viability of an energy project in the Arctic and to assess the pro and contra arguments, a number of assessment models have been recently elaborated. Thus, Carayannis et al. (2020) suggest TESCIMP methodology to assess the prospects of the Arctic oil and gas offshore projects. The methodology is based around the so-called TESCIMP factors, namely, technologies (T), infrastructure (I), environmental safety (ES), climatic and geological factors (C), macroeconomic factors (M), and political factors (P). As for the environmental safety issues, the authors suggest the following management options: improvement of the environmental regulation system, increase in the number of eco services and enhanced monitoring, investments in eco technologies, and orientation on international standards and cooperation. The climatic and geological group of factors is suggested to be tackled by development of new technologies designed specifically for harsh climate conditions and additional financing of the offshore geological exploration. The TESCIMP methodology may be used as a part of a comprehensive assessment approach.

Another assessment model for the energy projects in the Russian Arctic on offshore zone is Quintuple Innovation Helix Model which is focused on university-industry-government relations, public and civil society, and the environment (Carayannis et al., 2017). The Quintuple Innovation Helix Model is claimed by the authors to be a decent basis for the assessment of the Arctic offshore projects since it provides a win-win solution between economy and society based on ecology, knowledge, and innovation. The authors attribute to the oil and gas businesses in the Arctic the role of the creators of the centers for economic developments where the interests of all the actors involved are taken into consideration. The active participation of every party would create a favorable investment, enhance the environmental policies, coordinate the interests, create a basis for risk sharing between the government, investors, and business, etc.

Nazarova (2016) explores the risk management approaches of the oil and gas companies in the Arctic. Based on a case study of a Russian energy company, the research suggests the duality of the risk management exercised by a company – as seen by risk-emplaced and risk-displaced departments. HSE, insurance, and finance practices (risk-emplaced) provide all the necessary documentation including Risk Register, Risk Matrix, etc. but do not deal in practice with the risks. While transportation, supply, maintenance division welcome the necessary documentation, they state that it may not be that necessary for them since they have been exercising those practices for a while. In any case given the complex nature of Arctic environment and specific factors, companies are to imply structurally complex organizations (Badri, 1999) and to combine different methods to develop indicators (Øien, 2013).

Russian Strategy for the Arctic Development. National and International Perspective as a Part of the Russian Chairmanship in the Arctic Council in 2021–2023

As of today, the institutional framework of Russia's approach to developing the Arctic could conceptualized at two layers – national (broken down to the Strategy of Development of the Arctic Zone of the Russian Federation and the Provision of National Security for the Period to 2035) and international (broken down to Russia's chairing the Arctic Council in 2021–2023).

Strategy of Development of the Arctic Zone of the Russian Federation and the Provision of National Security for the Period to 2035

In October 2020, the Strategy of Development of the Arctic Zone of the Russia Federation and the provision of national security for the period to 2035 was adopted (Kremlin, 2020). The Strategy places a special impetus on the social and economic development of the Arctic underlying the role of natural resources.

According to the 2035 Arctic Strategy (Kremlin, 2020), there are a number of characteristics which define the socioeconomic development of the region and the national security in the Arctic:

– Extreme climate conditions, low levels of population density and transport, and social infrastructure
– High sensitivity level of ecosystems to external effects, especially where indigenous people of the Russian Federation live
– Climate change that contributes to new economic opportunities as well as new risks for economic activity and environment
– Sustainable geographic, historical, and economic connection with Northern Sea Route (NSR)
– Uneven industrial and economic development of certain Arctic territories, economic orientation on natural resources extraction, its transportation to Russian territories with high level of industry development and export
– High resource intensity of economic activity and life sustainment, dependence on fuel, food, and other life necessities delivery from different Russian regions
– Rise of conflict potential in the region

The Strategy underlines the role of the region for the development of the whole country and its national security. Such role is backed by a number of factors. First of all, the Arctic natural resources: onshore the region provides over 80% of natural gas and 17% of oil and offshore – 85.1 trillion cubic meters of gas and 17.3 billion tons of oil. Moreover, the Arctic through its technologically complicated projects drives additional investments, technological and economic development. NSR creates new economic opportunities as well given the changing climate conditions. However, the Strategy emphasizes high risks of climate change in the region for the country and the whole world. In addition, the role of indigenous people and their historical cultural heritage for the Arctic development is underlined. At last, the Strategy mentions that Russia has strategic deterrence forces in the Arctic against potential hostile actions from other countries.

As a novel of the Strategy, a regionally differentiated approach has been adopted (NATO, 2021). For each of nine Arctic regions, a set of development priorities and projects is established. Such carcass-clustered approach continues the logic adopted in the 2014 State Program according to which a group of development zones (clusters) is to be created to receive a tailored government attention and treatment.˙

The strategy specifies several steps to achieve goals in the following spheres:

– Social development
– Economic development
– Infrastructure developmentScience, education, technology
– Environmental protection and ecological security
– International cooperation
– Population protection from emergencies (natural or industrial)
– Military security, protection of national borders

The 2035 Strategy suggests an interactive tool, namely, a digital platform (www.arctic2035.ru) where every citizen is entitled to introduce a proposition or a project related to the Arctic development. The platform represents an innovative mechanism to engage numerous nongovernmental and local communities and to provide support for the projects aimed at the economic, social, environmental, and cultural development of the region.

Russian Chairmanship in the Arctic Council

The Arctic Council created in 1996 (Arctic Council, 1996) as a "high level forum" to "provide cooperation, coordination, and interaction among the Arctic states" remains an important platform in the architecture for Arctic governance where the Arctic Council plays a role of intergovernmental fora (Barry et al., 2020). Providing a platform for interstate and interorganization exchange, the Arctic Council helps to identify knowledge gaps and intensify as a consequence of initiative creation and problem-solving in an area required. Despite some organizational drawbacks such as lack of an overall strategy or absence of obligated reporting (Barry et al., 2020), the Arctic Council have demonstrated good performance results and contributed to development of common grounds between Arctic states (Young, 2019).

Geopolitical shifts, climate change, energy resources transform the Arctic into a region with a growing complex of arrangements (Young, 2019). The Arctic Council despite its informal status succeeded in adopting legally binding agreements. Such agreements relate to search and rescue (2011), oil preparedness and response (2013), and the enhancement of scientific cooperation (2017).

Russia views the Arctic Council as the leading regional organization which coordinates the international cooperation in the region (Arctic Council, 2021). The chairmanship in the Council is seen first of all as a platform to stimulate economic development, investments, international projects, on the one hand, and to coordinate the activities of the Arctic states in order to promote sustainable development of the region, environmental security and preservation of the cultural and historical heritage, on the other.

According to the Russian chairmanship program, a large number of events is planned including scientific conferences, discussions, expeditions, student summits and forums. The majority of the events will take place in the Arctic regions – Yakutsk, Salekhard, Murmansk, Arkhangelsk, Syktyvkar, and the North of Norway.

The program (Arctic Council, 2021) prioritizes four key spheres of cooperation within the Arctic Council.

1. Arctic people including indigenous people. Underlining the importance of issues related to indigenous people on the national level, Russia plans to further promote social projects, namely, the preservation of historical and cultural heritage, educational and professional initiatives, joint projects dedicated to the digitalization, creative industries, ecology, and youth. Three thematic clusters are identified – Development of Human Capital in the Arctic, Indigenous peoples of the Arctic, and Arctic Youth.
2. Environmental protection including climate change. A special attention is to be paid to preventing and reducing anthropogenic pollution in the Arctic, cooperation in the field of hydrometeorology, preserving and restoring the diversity of Arctic flora and fauna. Russia suggests two main clusters in the area – Climate Change and Ecology of the Arctic, and Prevention of emergencies.
3. Socioeconomic development in the region. For the cluster of economic development, Russia sets the following goal of its chairmanship of the Arctic Council's Sustainable Development Working Group – "advanced environmentally friendly technologies in the Arctic region's transport sector, industry, housing, energy, including the increased use of renewable energy sources to improve the living standards of the Arctic population" (Arctic Council, 2021). In the cluster "Development of Infrastructure and Sustainable Shipping," a special focus is placed at sustainable safe shipping, NSR, and digitalization. The other thematic clusters are Arctic Tourism, Cultural Program.
4. Strengthening of the Arctic Council. The following thematic clusters are targeted in the block – International Arctic Cooperation and International Scientific Cooperation. Russia aims to continue the development path of the organization at the same time promoting "greater synergies with other regional platforms, such as the Arctic Economic Council, the Arctic Coast Guard Forum, the University of

the Arctic, the Barents Euro-Arctic Council, the Northern Dimension" and increasing "participation in the process of formation and analysis of global and national environmental databases" (Arctic Council, 2021).

According to the Russian program at the Arctic Council, no radical institutional reforms are going to take place. Russia is likely to continue the logic of the previous chairmanships and place special impetus on sustainable development of the region based on the advanced environmentally responsible technologies (Sergunin, 2021).

Sustainability Strategies of the Oil and Gas Companies Operating in the Russian Arctic

Energy grants of Russia and foreign companies have shown general commitment to sustainable development when developing oil and gas fields in the Arctic. Each of them has adopted related strategies with ranging level of cooperation with the state and by-pass research programs, including social and ecological dimensions (Table 1).

Rosneft

Rosneft holds the leading positions in the Russian oil industry. Its major activities cover hydrocarbon prospecting and exploration, production of oil, gas, and gas condensate, offshore field development projects, refining, sales of oil, gas, and refined products in Russia and worldwide (Rosneft, 2021a).

Rosneft sees its contribution to sustainable development as the country's development, enhanced quality of life and living conditions as a result of the company's performance. The company as a part of its Rosneft 2022 strategy asserts its commitment to the UN Sustainable Development Goals such as "sound health and well-being," "low cost and emission-free energy," "decent work and economic growth," "combating climate change," and "partnership for sustainable development" (Rosneft, 2019).

The company contributes to the achievement of these goals through a number of steps and programs such as carbon management governance, energy transition through increase in its natural gas production, reduction of CO_2 emissions and improvement in energy efficiency, reduction of methane emissions, enhanced partnerships on carbon management approaches.

The 2022 Rosneft strategy defines a number of priorities in its environmental agenda:

– Reduction in associated petroleum gas (APG) flaring and specific absolute air emissions
– Increased use of recycled water and improved treatment of produced water from oil production

Table 1 Comparison of energy companies in the Russian Arctic

Criterion	Rosneft	Gazprom Neft	Novatek	TotalEnergies	Shell
Sustainability strategy	Strengthening of environmental and social obligations in Rosneft 2022 Strategy	Strengthening of environmental and social obligations in Gazprom Neft 2030 Strategy	Strengthening of environmental and social obligations in Novatek 2030 Strategy	Changing business priorities to develop low carbon energy sources	Changing business priorities to develop low carbon energy sources
Commitment to UN SDG	+	+	+	+	+
Cooperation with state	Strong ties with the state government, agreements with local governments	Strong ties with the state government, Agreements with local governments	Strong ties with the state government, agreements with local governments	Ties with the state government defined by the project requirements	Ties with the state government defined by the project requirements
Projects in the Arctic	28 projects in the Russian offshore Arctic and 12 projects in the Yamal Nenets region	Projects are driven by Prirazlomnoye, Novoportovskoe, and Vostochno-Messoyakhskoe fields	Yamal LNG and Arctic 2 LNG	LNG projects with Novatek	Development of 2 blocks on Gydan peninsula in cooperation with Gazprom Neft
Research programs (ecology and social) in the Arctic	+	+	+	–	–

Source: Compiled by the authors

– Reduction in oil-contaminated areas and accumulated waste
– Delivery of environmental obligations and requirements arising from the current projects and activities of the company

As a state company, Rosneft participates in a number of working groups and state committees such as The Interdepartmental Working Group on the Economic Aspects of Environmental Protection and Regulation of GreenhouseGas Emissions under the Ministry of Economic Development, The Working Group on Energy and Environment of the Interdepartmental Commission to Support Russia's G20 Participation under the Ministry of Energy, The Working Group on Energy Efficiency and Greenhouse Gases of the Committee on the Energy Strategy and Fuel and Energy Development under Russia's Chamber of Commerce and Industry.

Overall, the company engages in the majority of state environmental programs and pays special attention to reforestation, improving biodiversity, reducing environmental footprint (Rosneft, 2019).

In the last 5 years (Skolkovo, 2020), Rosneft invested 100 billion in the development of the Arctic shelf, and it remains one of the companies' business priorities.

Since 2012, Rosneft regularly studies hydrometeorological, ice, engineering, geological, and environmental conditions at the Arctic. In order to carry out a complex and extensive research activity in the region, the Arctic Scientific Center (the company's entity) arranges regular scientific expeditions to the Arctic and conducts specialized studies in the Arctic seas (the Kara, the Laptev, the Chukchi seas). In 2018, a large-scale 2-year scientific work was accomplished in the area of Rosneft responsibility in the Kara Sea where the polar bears' population and their locations were registered (Rosneft, 2021b). In addition, the Arctic Scientific Center specialists elaborated a methodology for Arctic geo-cryology mapping and implemented digital geo-cryology zoning maps of the Kara Sea and the Laptev Sea.

The company conducts the Arctic offshore climate parameters database and maintains it on regular basis (Rosneft, 2021b).

Gazprom Neft

Gazprom Neft represents one of three largest oil and natural gas producers in Russia.

In 2018, Gazprom Neft established a new development strategy till 2030. The main goal of the strategy is to become a company of new generation (Gazprom Neft, 2020a).

In order to reach this goal, the company pays a special attention to its projects in the Russian Arctic as a long-term priority. Yamal region and its resources have a key role to play.

The company stated its key security aim as "zero aim" which implies no negative effect on people, nature, and facilities during operational activities (Gazprom Neft, 2020a).

As far as it is possible for the oil and gas industry, the principles of sustainable development are integrated in the company's business strategy and are in line with the UN SDGs. In 2020, Gazprom Neft joined the UN Global Compact, participated for the first time in CDP rating and was rated “B” showing the best result among Russian oil and gas companies.

Gazprom Neft investments in the environmental protection arose to ₽8 billion. The company’s climate priorities are reduction of CO_2 emissions and gas flaring, increase in the number of low carbon projects, renewable energy.

As for the moment, Gazprom Neft strives to imply renewables where it is ecologically and economically viable. Thus, at the Omsk refinery, a solar station was installed with 1 MW capacity. The project is to be developed and its capacity should be increased till 20 MW. In Yaroslavl region, a fuel-filling station based on solar energy was launched last year.

As for the Arctic region, Gazprom Neft established a corporate biodiversity Arctic program which implies special conservation measures based on species-indicators of the sustainable development of the region. The program targets the company’s operations and its hydrocarbon transportation routes near the Prirazlomnoye field and the company’s projects in Yamal region.

The company continues to realize a large-scale research project on narwhal (*Monodon monoceros*) and walrus.

The technological solutions of the platform suggest the maximum protection of the environment. For example, “zero emissions” technology integrated in the platform assures no discharge of production or drilling waste in the sea. By contrast all the waste is injected directly to the strata or transported onshore to be recycled.

In order to protect birds and to reduce noise impacts, helicopters delivering personnel to the platform fly over the sea at a safe height and a special birdlife protection facility covers a range of 3000 m.

Since 2012, the company conducts regular research on the habitats and breeding grounds of Atlantic walruses around the Prirazlomnaya platform, particular attention being paid to the Dolgy, Matveev, Golets, Vaigach, and Bolshoi, and Maly Zelenets islands. Walruses represent an indicator of a sustainable state of the region, and since the oil production began, no changes have been noticed in walruses’ behavior or activities.

In the Arctic, Gazprom Neft used the technology of modeling the transport system of the field for the project management. The technology considers the movement of ships, filling storage facilities, and freezing of the ice channel and represent an integrated digital solution to minimize transportation costs and reduce the risks associated with production and logistics in the Arctic. Within the framework of the project, the “Kapitan” system was developed, which provides effective year-round transportation of the entire volume of oil produced from the Arctic fields – Novoportovskoye and Prirazlomnoye and reduces transportation costs at the same time (Morgunova & Kovalenko, 2021).

Novatek

Novatek is the largest independent producer of natural gas in Russia. The company’s activities are development, production, refinery, and realization of natural gas and hydrocarbons (Novatek, 2021).

In 2019, the company chose five main UN SDGs to prioritize in its activity. These are the following SDGs: “good health and well-being,” “quality education,” “affordable and clean energy,” “decent work and economic growth,” and “climate action.”

According to Novatek’s sustainable development strategy (Novatek, 2020), the following environmental and climate change targets till 2030 were established:

– Reduce methane emissions per unit of production in the Production, Processing, and LNG segments by 4%
– Reduce air pollutant emissions per unit of production by 20%
– Reduce greenhouse gas emissions per unit of production in the Upstream segment by 6%
– Reduce greenhouse gas emissions per ton of LNG produced by 5%
– Increase the associated petroleum gas utilization rate to 99%
– Increase the share of waste directed to utilization and disposal to 90%

Novatek is an active player in the sustainability development of the region. In 2020, the amount of responsible investments as well as compensatory payments for cultural and educational programs in the Russian Arctic consisted ₽4.1 billion.

Novatek has a number of agreements of socioeconomic cooperation with Arctic regions including Yamal-Nenets Autonomous and Murmansk Regions. The agreements target the strengthening of socially oriented facilities and organizations, sports institutions, educational programs, and a number of technical solutions including repairs of a sewage pumping station in Tarko-Sale, purchase of incinerators to burn wastes, solar panels including portable solar panels, adaptation of residential space and public property in apartment blocks for people with limited mobility to develop accessible environment in Yamal-Nenets Autonomous Region (Novatek, 2020). A special attention received people from low-income families, people with disabilities, the elderly, veterans, critically ill and disabled children, as well as people who faced hardships.

Another block of investments relates to educational programs. Since 2020, the Company in cooperation with the Government of the Yamal-Nenets Autonomous Region implements a program “Teacher for Russia.” The main goal of the program is to engage leading universities graduates to teaching in small regional schools which as a rule experience lack of teachers. Novatek invested in the renovation of Murmansk state technical university facilities.

A special program “Talented children” is realized at schools in Yamal-Nenets Autonomous Region. A resource center of field-specific education – “Centre of natural sciences” created by the company successfully functions in Tarko Sale of Purovsky district. The center provides special educational modules for natural sciences classes.

In 2020, the Yamal for Descendants Association of indigenous peoples received support from the company. Novatek assisted in purchasing of snowmobiles, gas-fired boilers, and technical facilities and aids for clans, equipment, and materials required for the work of fishermen and reindeer herders (Novatek, 2020). A special attention is paid to organizing and staging ethnic festivals of indigenous peoples, supporting cultural heritage (financing of the Limbya Nomad Camp), performing emergency prevention archaeological activities at the Taz Metal-Casting Workshop cultural heritage site as well as funding environmental campaigns.

Novatek is a constant participant of the Public Program of Indigenous Minorities of the North in Yamal-Nenets Autonomous Region. The program includes medical support, building of specialized hospitals, and telehealth solutions for remote areas.

TotalEnergies

TotalEnergies represents an integrated oil and gas company with a full range of services at downstream, upstream sectors, transportation, trading, marketing, refinery.

In 2020, the company states about its strong adherence to energy transition principles and its commitment to diversify its energy mix including more carbon neutral solutions. These changes found its reflection in the new company's title – TotalEnergies (Total 2020).

The company underlines growing energy demand and its need to profitably increase its energy projection; as a result, TotalEnergies prioritizes liquified natural gas and electricity as the two fastest growing energy markets which are enable to satisfy the energy demand and diminish carbon intensity of the energy sector.

In the next decade, the company plans to lower the share of oil products by 30% while the sales mix will consist of 30% oil products, 5% biofuels, 50% natural gas, and 15% electrons, primarily of renewable origin.

In order to lower its emissions, the company prioritizes the following solutions – natural carbon sinks (e.g., forests), regenerative agriculture and wetlands, and carbon capture and storage (CCS).

In 2020, the company invested $2 billion in renewable energy and electricity projects. The organizational structure of the company included a new segment – Integrated Gas, Renewables & Power. Among the new energies projects, a number may be noticed in the wind and sun energy (Total Quadran, Total Eren, Total Solar International, SunPower), energy distribution (Total Solar Distributed Generation).

Moreover, the company has its own venture foundation – Total Carbon Neutrality Venture which accumulates and supports startups and small and medium companies in the sphere of renewable energy and advanced energy solutions.

Being the second largest global LNG producer, TotalEnergies places a special impetus on its LNG projects.

In addition to its 10% acquisition deal of Arctic Transshipment LLC, TotalEnergies and Novatek signed Memorandum of Understanding to work together on emissions reduction resulting from the production of LNG, the use of renewable power. Two companies expressed their willingness to develop large-scale carbon capture and storage solutions CCS and to explore new opportunities for decarbonized hydrogen and ammonia.

Shell

Shell represents an intergrated energy company and provides services for a large range of activities including exploring for oil and natural gas; developing new oil and gas fields; producing LNG and GTL; supplying, marketing, and trading oil, gas, and other energy-related products; producing refined energy products, lubricants, aviation fuels; developing CCS projects; and investing in nature-based solutions.

In February 2021, Shell launched a new development strategy "powering progress" which aims to "accelerate the transition to net-zero emissions, purposefully and profitably" (Shell, 2020). The strategy supports four main pillars – generating shareholder value, respecting nature, achieving net zero emissions, and powering lives.

The main goal of the strategy is to achieve net-zero emissions by 2050 while generating shareholder value. At the same time, Shell establishes medium and long-term targets – 20% by 2030, 45% by 2035, and 100% by 2050. As a strategy to achieve such targets, Shell places special impetus on necessary behavioral and mindset changes. Thus, the company states to apply so-called learner mindset which contributes to openness, curiosity, and humility to make better decisions.

The performance is to be maximized while increasing the trust within the company and maintaining diverse and inclusive culture.

Shell defines a number of indicators which correspond to the progress of its sustainability strategy. Among such indicators are number of incidents during operations, leaks and spills, gas flaring, emissions intensity at upstream, integrated gas sectors, and refinery facilities.

In order to enhance its activities in the sphere of energy transition, the company has formed a separate entity – Integrated Gas and New Energies. In 2019, Shell invested $907 million (Statista, 2020) in research and development and participated in a number of new energy projects in the form of investment or acquisition. Such projects relate to a number of areas including transport (Greenlots, Ravin.ai, Revel), wind energy (EOLFI, CoensHexicon), electricity (Rheinland Hydrogen Electrolyser Limejump, Hudson), solar energy (ESCO Pacific, Cleantech Solar), etc.

The remuneration politics of the governance is linked to achievement of sustainability goals and constitutes 10% linked to security and 10% linked to environmental indicators.

In 2015, Shell stopped its drilling operations in the Arctic offshore; however, the company participates in a number of onshore Arctic projects the USA, Norway, the Canadian Arctic, and Russia (Shell, 2020).

In 2020, Shell Exploration and Gazprom Neft formed a joint venture to develop the onshore Leskinsky and Pukhutsyayakhsky license blocks in the Russian Arctic zone on the Gydan Peninsula (Gazprom Neft, 2020b). The two parties signed two Memorandums of Understanding related to cooperation in emissions-reduction projects, collaboration in developing nature-based solutions, and ensuring air transport safety. As a part of the joint venture, the two companies confirmed its willingness to develop reforestation and forest conservation projects, energy-efficiency enhancement, and renewable energy projects.

Conclusions

This chapter has accumulated the latest academic analysis dedicated to the energy development of the Russian Arctic and the corresponding corporate approaches, brief updates on the national regulatory approach in Russia and its aspirations for the chairmanship in the Arctic Council, as well as an overview of the Arctic oil and gas projects in light of its environmental and social policies.

It can be seen that the Arctic region represents a unique territory where a mixed approach to CSR and environmental management is applied. Russian oil and gas companies with its strong historical paternalistic background adopt enhanced sustainability strategies in the region and aspire to combine a number of positions.

First of all, a paternalistic position where a Russian oil and gas company plays a role of strong entity ensuring environmental, social, and local rights through agreements with local governments and organizations. In this light, the companies adhere in their activities to the national strategy in the Arctic and operated in line with the state priorities.

However, working in cooperation with western partners, Russian oil and gas companies adapt to foreign practices and introduce in their sustainability strategies more standardized frameworks, focused on climate and environmental indicators. As it can be seen from the companies' description, the energy companies relate their activities to SDGs that might contribute to goal-oriented activities and tighter adherence to sustainability principles. In addition, both Russian and foreign countries apply strict environmental and social policies for their Arctic projects; however, Russian companies design region-specific programs and introduce tailor-made sustainability approach for their activities in the region. As a result of the analysis in the chapter it can be stated that Russian companies develop their own environmental, biodiversity, and social programs designed specifically for the region's environmental and social needs, thus contributing to their new role as a research-inducing center.

It can be concluded that while preserving numerous controversies the energy development of the Russian Arctic will represent both state and corporate priorities in the near future. The economic development of the region is interlinked with the natural resource development, and it is crucial to enhance the sustainability approaches of the operating oil and gas companies to increase mutual cooperation between state, corporation, and local communities. As the overview presented in the chapter shows, state and corporate actors strengthen their environmental positions in the region while academia develops more and more analysis and analytical tools to improve the environmental and social indication of the energy development of the Arctic.

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Transport Planning and Sustainable Development in the Arctic Region

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Contents

Abstract

The concept of sustainable development (SD) created by the UN is an internationally recognized development vector of society and the economy, which provides for a harmonized solution to a set of problems in the interests of present and future generations. The implementation of the SD provisions should take into account local characteristics and traditions. In this regard, the Arctic region is characterized by the following significant features: economic concerns; the predominant development of extractive industries; the underdevelopment of transport and logistics infrastructure and the increased level of costs for its operation; technological problems caused by severe natural problems. In this chapter we also discuss prognosis methods which should be used as part of transportation planning procedures. These methods are: forecasting the operation period of temporary winter roads, and predicting the duration of the navigation period of the northern rivers.

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Arctic region · Sustainable development · Transport problems in northern regions · Road transport · Prognosis · Temporary roads

Introduction

International cooperation in the Arctic is aimed at addressing issues of natural heritage preservation (Veldhuis et al., 2019), including the marine environment (Beyer et al., 2020; Yaraghi et al., 2020) and the dignity of indigenous peoples of the North (IPN), oil spill prevention (Bambulyak & Ehlers, 2020; De Vries et al., 2021; Johannsdottir & Cook, 2019; Oliveira et al., 2020; Shapovalova-Krout, 2019), and the regulation of fisheries (Bryndum-Buchholz et al., 2020); it also addresses mining and the regional economy (Larsen et al., 2019), the preservation of human health (Junkka et al., 2021; Ratelle et al., 2020; Vorontsova & Vorontsov, 2019), the social and economic development of territories (Arruda & Krutkowski, 2017), energy supply, legal regulation (Bankes, 2020; Inozemtsev, 2021), interdisciplinary research, and the improvement of educational activities.

Sustainable development (SD) is the conceptual framework for the activities in the Arctic region, which provides for the achievement of 17 economic, environmental, and social goals for the benefit of present and future generations (Blair & Lovecraft, 2020; Guterres, 2021).

To implement SD, it is necessary to attract funds and forces. Among the various means of development in the Arctic, the provision of the population and the economy with transport is considered the most problematic one (Filippova et al., 2017). People are the only force carrying out anthropogenic activities and knowledge workers are the leading social class (Dun et al., 2020). Our goal was to ensure the operational integrity of the motor transport in the Arctic and personnel training, taking into account the specifics of labor activity in the Arctic region.

Currently, the Government of the Russian Federation pays particular attention to the areas of the Far North and the Arctic. One of the state-level tasks is to ensure the efficient and safe activities of the specialists and population working and living in these regions. The ongoing research and development made it possible to establish that among the various tasks associated with the development of the Far North and the Arctic, the most problematic are the tasks of providing transportation services to the population and economy (*Northern Delivery* (*Severny Zavoz* in Russian) – delivery of goods to the northern territories). Northern Delivery should be understood as a whole complex of measures carried out at the state level. Its purpose is to provide the territories of the Far North and the Arctic Zone of Russia with food, fuel, medicines, and other vital products. The need for delivery to the northern territories is due to the lack of developed agriculture, manufacturing, or transport network in the Far North and the Arctic. Besides, transport connects the Arctic regions that are significantly distant from each other into a single whole and ensures the movement of all consumed and extracted resources.

Transport is the basis of the infrastructure for all anthropogenic activities in the Arctic. Road transport (wheeled and tracked vehicles, etc.) in the Arctic provides door-to-door transportation over long distances along unstable and technically unprepared routes and operates in harsh weather and climatic conditions. Therefore, the improvement of technology and traffic management in the regions of the Far North and the Arctic is one of the topical areas in applied science and practice.

Specific Challenges of Sustainable Development of Transport in the Arctic Zone

We have conducted a poll of 43 experts in the field of sustainable development, transport, and challenges in the Arctic region, according to the Report of the Open Working Group of the General Assembly on Sustainable Development Goals (UN, 2014).

This approach allowed us to divide the SD goals into groups based on the main functional focus.

Humanity goals: 1, 2, 3, 4, 5 (hereinafter the numbers indicate the goal number). Road transport provides food security and medical care to the population, as well as transport communication with places far from the terminals of the main types of transport. Educational activities in the Arctic are aimed at eliminating difficulties related to access to education.

Economic goals: 8, 9, 12. In the Arctic, road transport needs an inclusive approach due to the specifics of transport routes and operating conditions, as well as the isolated location of transportation origins and destinations. Transport in the Arctic ensures the delivery of goods to the northern territories (Northern Delivery) and 15–20 percent of jobs.

Social and political goals: 11, 16, 17. The social SD of transport in the Arctic should consider the necessity to take special care of the preservation of the vulnerable environment and utilize government support to compensate for increased transportation costs, taking into account the final external results of transportation. In a political sense, transport in the Arctic region connects settlements, cattle camps, and industrial facilities that are remote from cities into a single community.

Environmental goals: 6, 7, 13, 14, 15. The process of disposal of waste from transport activities is quite problematic. The traditional way of life of IPN is characterized by a careful attitude to the environment. Therefore, in the Arctic, ethnic-and-educational and environmental-and-educational approaches should be used with account for local specifics and ethno-cultural significance.

Forecasting the Operation Period of Temporary Winter Roads a Factor of Sustainable Transportation Process in the Arctic Zone

The accuracy of forecasting the operation period of temporary winter roads has a significant impact on the planning and volume of cargo transportation. A method was developed for forecasting the start and end dates for the delivery of the most essential goods to the northern territories by road (using temporary transport routes), with account for the cyclic nature and frequency of changes in natural and climatic phenomena.

Considering the risk analysis, another method was developed for determining the maximum capacity of individual road network elements in the northern regions. The use of this method makes it possible to minimize the damage associated with the impact of risks and increase the reliability of transportation through its rational planning and dispatching traffic management. Using the method for forecasting the possible timelines of goods delivery to the northern territories and the results of the risk analysis, typical scenarios of the transport and technological process in a multimodal transport system were proposed.

Recommendations were developed for the creation of transport and logistics centers in the northern regions, operating based on integrated automation of the basic functions of dispatching traffic management and the use of telematics, navigation, and other information technologies, which improves manageability, the efficiency of regulation, and the reliability of transportation (Filippova, 2019b; Filippova et al., 2017). Modern innovative information technologies and planning optimization provide information support for transport in the Arctic (Cetrulo et al., 2020), including with the use of information from the GLONASS/GPS network (Bogumil & Vlasov, 2016; Filippova et al., 2019a).

The chapter discusses a method of forecasting the operation time of temporary transport routes (winter roads) used for transportation most of the year. The volume of transported goods and transportation safety largely depends on the accuracy of such forecasting. Changes in weather conditions, deterioration of visibility, and a sharp drop in temperature also have a significant impact on transportation safety and reliability, which makes it urgent to inform the participants of the transportation process about the current situation on the transport route. At the present stage, the main direction of road transport development is the expansion of the use of intelligent transport systems. The development of satellite navigation, on the one hand, and equipping vehicles with on-board systems to inform drivers about weather conditions along the route, on the other, have created the basis for the use of intelligent transport systems – in particular, meteorological monitoring and information subsystems. The data received from the meteorological monitoring subsystem using external means of information should be sent to the driver for making a prompt decision on how to operate the vehicle. In this regard, it is required to design highly automated vehicles (HAVs), when data are processed from all vehicle subsystems in aggregate, and not from each separate subsystem. HAVs, or so-called unmanned transport systems, are a necessary link in the development of northern territories and in solving one of the global problems of the Strategy of Scientific and Technological Development of the Russian Federation – “territorial connectivity.”

Algorithm for Forecasting the Start and End Dates for the Operation of Winter Roads

Modern innovative IT, including satellite navigation, remote monitoring, Internet of Things (IoT), and planning optimization based on computer models, provides effective information support for transport in the Arctic (Cetrulo et al., 2020). At the Department of Transport Telematics of the Moscow Automobile and Road Construction State Technical University (MADI), research and development activities related to the use of these technologies were performed based on navigation information generated by signals from GLONASS/GPS systems.

This chapter presents methods of forecasting the start and end dates for the operation of temporary transport routes (winter roads) in the winter. The method is based on statistical data on the average monthly day and night air temperatures in various cities of the world, which are represented by sinusoidal approximations of the annual temperature trend. It was found that in the overwhelming majority of cases, the sine curve amplitude is smaller, and the value of the phase characterizing the lag of temperature cycle dynamics from daylight duration cycle dynamics is higher for night temperature than for day temperature. In addition, the average annual night temperature is lower than the average annual day temperature, and night temperature dynamics appear to be similar to day temperature dynamics in a region with a cooler, but less continental, climate. Differences were given for three pairs of values for the characteristics of the annual temperature cycle (average annual temperature, sine curve amplitude and phase), calculated based on night and day temperatures (Bhoopalam et al., 2018; Prikhodko & Zhankaziev, 2016).

Currently, automatic monitoring of road transport operation in the Arctic is being successfully carried out. However, the use of navigation monitoring of vehicles is not enough to improve the safety and efficiency of transportation. The reason for this is that transportation by road in the Arctic is associated with risks such as threat to life and health of workers and passengers (especially on long-distance routes), damage or loss of goods and vehicles, and the disruption of the delivery to northern territories (Severny Zavoz). These risks, which affect the success of cargo transportation, largely depend on weather and climatic conditions. The operating conditions in the winter, which in the Arctic takes most of the calendar year, differ significantly from the operating conditions in the summer. In the winter, cargo and passengers are transported along temporary transport routes – winter roads. Therefore, the accuracy of forecasting the operation period of winter roads has a significant impact on the planning and volumes of goods and passengers' transportation. In this regard, studies on the climatic features of the northern regions of Russia and the Arctic should be continued. Analysis of day and night temperatures and the factors of their changes will facilitate prompt decision-making and prevention of emergencies. Based on these studies, it is possible to make recommendations on the timing and movement of vehicles on the route.

To approximate the annual temperature dispersion variation, a trigonometric model (Latonin et al., 2020; Rohli & Vega, 2018; Wooten et al., 2020) will be used:

$$Y = a + b_1 \, sin \ \alpha + b_2 \, cos \ \alpha$$

We assume that monthly air temperatures are known for a specific location. Therefore, we will introduce the following designations: y_1 is the average temperature in January, y_2 is the average temperature in February, and so on. The approximate value of the ith average monthly day temperature for a given location will be denoted by ŷi.

$$\widehat{y}_i = a + b_1 \sin a_i + b_2 \cos a_i \tag{1}$$

where αi = i · 30°. The value αi corresponds to the middle of the ith month, i = 1, 2, ..., 11, α 12 = 0, i.e., coordinate 0 corresponds to the middle of December.

$$\alpha = \bar{y} = \frac{1}{12}\sum\nolimits_{j=1}^{12} y_j, b_1 = \frac{1}{6}\sum\nolimits_{j=1}^{12} y_j sin\alpha_j, b_2 = \frac{1}{6}\sum\nolimits_{j=1}^{12} y_j cos\alpha_j \tag{2}$$

The value a is the average annual temperature.

For any location under consideration, the coldest (on average) day is no later than 6 months after the winter solstice on the timeline. The value α corresponding to the minimum value (1) is equal to the following:

$$\alpha = \alpha_{min} = arctan\frac{b_1}{b_2}$$

for locations in the Northern Hemisphere, and

$$\alpha = \alpha_{\min} = 180^\circ + \arctan\frac{b_1}{b_2}$$

for locations in the Southern Hemisphere. Let us assume that:

$$\beta = \alpha_{\min} = \arctan\frac{b_1}{b_2} \tag{3}$$

for locations in the Northern Hemisphere, and

$$\beta = \alpha_{min} - 180^\circ = arctan\frac{b_1}{b_2} \tag{4}$$

for locations in the Southern Hemisphere. The sine curve amplitude can be calculated as follows:

$$A = \sqrt{b_1^2 + b_2^2} \tag{5}$$

The $\alpha'_{\min}, \beta', A'$ parameters are analogs of the αmin, β, A characteristics. The $\alpha'_{\min}, \beta', A'$ values are calculated based on night temperature fluctuations.

$y'_1, y'_2, \ldots, y'_{12}$ denotes the average monthly night temperatures. We assume that:

$$a' = \bar{y}' = \frac{1}{12}\sum\nolimits_{j=1}^{12} y'_j, b'_1 = \frac{1}{6}\sum\nolimits_{j=1}^{12} y'_j\ sin\ \alpha_j, b'_2 = \frac{1}{6}\sum\nolimits_{j=1}^{12} y'_j\ cos\ \alpha_j \tag{6}$$

$$\beta' = \arctan\frac{b'_1}{b'_2} \tag{7}$$

$$A' = \sqrt{(b'_1)^2 + (b'_2)^2} \tag{8}$$

The approximate values of the ith monthly average night temperature are calculated as follows:

$$\widehat{y}_i' = a + b_i' \sin \alpha_i + b_2' \cos \alpha_i \tag{9}$$

Equations (1) and (9) can be represented in the following form, respectively:

$$\widehat{y}_i = A \sin(\alpha_i + \beta - 90^\circ),\ \ \widehat{y}_i' = A' \sin(\alpha_i + \beta' - 90^\circ) \tag{10}$$

for locations in the Northern Hemisphere, and

$$\widehat{y}_i = A \sin(\alpha_i + \beta + 90^\circ),\ \ \widehat{y}_i' = A' \sin(\alpha_i + \beta' + 90^\circ) \tag{11}$$

for locations in the Southern Hemisphere, i = 1, 2, ..., 12.

The root-mean-square errors δ, δ' to approximate day and night temperature deviations are calculated as follows:

$$\delta = \sqrt{\frac{1}{12}\sum_{i=1}^{12}(y_i - \widehat{y}_i)^2},\ \ \delta' = \sqrt{\frac{1}{12}\sum_{i=1}^{12}\left(y_i' - \widehat{y}_i'\right)^2} \tag{12}$$

The average absolute error is calculated as follows:

$$\Delta = \frac{1}{12}\sum_{i=1}^{12}|y_i - \widehat{y}_i|,\ \ \Delta' = \frac{1}{12}\sum_{i=1}^{12}\left|y_i' - \widehat{y}_i'\right| \tag{13}$$

In this chapter, we use a trigonometric model to approximate the annual dispersion variation of annual day and night air temperatures. Previously, in the sinusoidal approximation, only the average annual air temperature on the date of the study was used. The results obtained show that the annual dispersion variation of night air temperature is similar to the annual dispersion of day air temperature for locations with a less continental and less warm climate. The amplitude of night temperature is smaller than the amplitude of day temperature. The sine phase characterizes the lag of the night temperature cycle in relation to the daylight duration cycle, which is greater than the lag of the day temperature cycle. The results can be interpreted as follows. The lowest average night air temperature corresponds to the point in time that is farther from the winter solstice than the lowest average day air temperature. Likewise, the lowest highest average night air temperature corresponds to the point in time that is farther from the summer solstice than the lowest highest average day air temperature. The amplitude of the annual dispersion of day temperature is greater than that of the annual dispersion of night temperature. The third parameter is the average value. It is obvious that the average annual night temperature is lower than the average annual day temperature (Bilbao et al., 2019; Stephenson et al., 2012; Waheed et al., 2020).

Method of Predicting the Duration of Ice Phenomena

A method of predicting the duration of ice phenomena in the navigable waters of the northern rivers of Russia was developed based on the use of the mathematical apparatus of Markov chains (Filippova, 2019b; Kim et al., 2017). Using this method, it is possible to predict the beginning and end of navigation on the northern rivers of the region, which can be used in transport planning of deliveries to the northern territories. In the general case, the Markov process has n possible states, the number of which, in our case, depends on the number of dates for the beginning of navigation along a navigable river. Since the analysis shows that the transition probabilities do not depend on the step number, the Markov process under consideration is homogeneous (Poler et al., 2014) and the dimension of the following matrix will be n x n (Filippova et al., 2019b).

$$P = \left[p_{ij}\right] = \begin{vmatrix} p_{11} & p_{12} & \cdots & p_{1n} \\ p_{21} & p_{22} & \cdots & p_{2n} \\ p_{31} & p_{32} & \cdots & p_{3n} \\ p_{n1} & p_{n2} & \cdots & p_{nn} \end{vmatrix} \tag{14}$$

On the main diagonal of the matrix, there are probabilities for the system to remain in its current state. The relevance of the method is determined by the fact that the duration of navigation along the northern rivers can vary in a significant range from 110 to 160 days. In these conditions, the accuracy of predicting the beginning and end of navigation plays a very important role, since it makes it possible to determine when it is reasonable to start using road transport for the bulk of the cargo.

The matrix of transition probabilities makes it possible to determine the date and probability of optimistic and pessimistic scenarios. For spring ice phenomena, the optimistic scenario corresponds to the minimum number of the day (date) of their beginning in the corresponding row of transition probabilities and the probability of this event. The pessimistic scenario corresponds to the maximum number of the day (date) of their beginning in the corresponding row of transition probabilities and the probability of this event. For autumn ice phenomena, the optimistic scenario corresponds to the maximum number of the day (date) of their beginning in the corresponding row of transition probabilities and the probability of this event. The pessimistic scenario corresponds to the minimum number of the day (date) of their beginning in the corresponding row of transition probabilities and the probability of this event. Method testing on real data showed that it can be used for effective planning, organization, and performance of preparatory works before the beginning of summer navigation on a northern navigable river.

Conclusions

The main features of Arctic logistics in the northern regions of Russia and the factors affecting the reliability of transport accessibility were identified, investigated, and classified. Taking into account the harsh operating conditions, an approach to improving the reliability of road transport operation in the North of Russia was developed. It takes into account special operating conditions, the use of intelligent transport system technologies, and the use of the results of forecasting the influence of internal and external factors that are essential for improving the efficiency of transportation in the Arctic. The practical use of the developments discussed in this chapter in the northern regions of Russia allowed us to evaluate the expected results: the cost of material resources for transportation by road decreases by 8–10 percent, the reliability of cargo delivery increases, and the demand for personnel for the dispatching service (previously decentralized) is reduced by half.

The conducted studies, aimed at solving the theoretical and applied problem of increasing the reliability of road transport operation and its interaction with other modes of transport in the Arctic, provide a solution to the important problem of sustainable transport development in the North of Russia.

The results show that the annual cycle of night temperature in relation to the annual cycle of day temperature corresponds to a less continental and, obviously, cooler climate. If the climate is characterized by night temperature, and not by day temperature, then the average annual temperature is lower, the temperature amplitude is smaller, and the phase of the lag of the annual temperature cycle from the daylight duration cycle increases.

An innovative approach was developed to improve the reliability of road transport operation in the North of Russia, which is distinguished by the use of the forecast results describing the influence of internal and external factors that are significant for improving transportation efficiency in Arctic operating conditions.

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Part X

Social Issues

Human Security in the Arctic

Alexander A. Sergunin, Valery N. Konyshev, and Maria L. Lagutina

Contents

Abstract

In the Arctic region, a central challenge is that inhabitants are exposed to multiple nontraditional and nonmilitary threats resulting from environmental, economic, and societal changes, which can be understood as threats to human security broken down to its seven components: economic security, food security, health security, environmental security, personal security, community security, and political security. The authors argue that a comprehensive approach to human security overlaps with the concept of societal security and must, therefore, consider threats to collective identity and the essential conditions necessary for the maintenance and preservation of a distinct society.

Keywords

Human security · Societal security · Arctic · Sustainable development · Resilience

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Introduction

Traditionally, the emergence of the "*human security*" concept is associated with the UN activities in the mid-1990s; in fact, the idea itself was not new then, with many researchers pointing to the fact that it appeared back in the 1940s (Inglehart & Norris, 2012). However, the term of "human security" was first proposed in 1994 in the "Human Development Report" of the United Nations Human Development Program (UNDP), where the phenomenon was defined as "safety from such chronic threats as hunger, disease and repression" and "protection from sudden and hurtful disruptions in the patterns of daily life-whether in homes, in jobs or in communities" (UNDP, 1994, p. 23). Besides that, the main components of "human security" were identified in the text of the Report, including: economic security, food security, health security, environmental security, personal security, community security, and political security.

Among the threats were the consequences of climate change and environmental pollution, its degradation and depletion of resources, problems of food security and health, socioeconomic development, various forms of violence, conflicts, suicide, and drug use as a form of individual violence against oneself, problems preserving cultural heritage and traditional ways of life, etc. A feature of this group of problems is that their solution requires the attention of not only individual governments, but the entirety of society, including local residents and local communities.

At the same time, within the framework of the concept of "human security," there has been an obvious shift in emphasis from the security of the state to security of individuals and their communities, which became a reflection of a number of world political transformations after the end of World War II. It should be also noted that the "human security" concept in the UN interpretation is interconnected with the concepts of sustainable development and human rights.

However, the UN's definition has a rather broad and abstract character, so therefore serves only as a kind of general framework; in practice, instead, there is a fairly wide variety of approaches to the definition of "human security," both at the level of international organizations and states (Konyshev, 2014, pp. 44–45). It is because of the very broad interpretation of the term, as well as because of its "Western" origin (Gjørv et al., 2009, p. 6), that many researchers assess the concept of "human security" very critically (Chandler, 2008; Paris, 2001).

As far as the Arctic is concerned, it has always been imagined as a territory fraught with danger to humans: harsh climatic conditions, polar nights, remoteness from developed territories and their inaccessibility, dietary habits, predatory animals, etc. From the very beginning, the population of the northern territories was engaged in adaptation to these harsh living conditions. Despite the active role of states in the development of the Arctic territories, individuals and communities have always played a leading role in the Arctic, possessing a unique experience of survival in difficult climate conditions.

Currently, Arctic residents face diverse challenges at various levels. These challenges result considerably more from environmental, economic, and societal changes than from military threats and are attributed to the human rather than national/state security sphere. In light of this, examining the Arctic region illustrates the importance of utilizing a more comprehensive understanding of security. State sovereignty is not widely contested in the High North, and there are few regional threats to the survival of Arctic states, if any; instead, common challenges such as climate change, or shared interests such as in developing the region's abundant natural resources, have led to extensive international cooperation among the Arctic states.

It should be noted that in the Arctic, the human security concept is intertwined with the societal security one. According to the definition provided by the Copenhagen School of Security Studies, societal security refers to the "sustainability, within acceptable conditions for evolution, of traditional patters of language, culture and religious and national identity and custom" of a society (Buzan et al., 1998, p. 8). In other words, it is about "the ability of a society to persist in its essential character under changing conditions and possible or actual threats" (Wæver et al., 1993, p. 23).

Human security is linked to numerous issues that influence societal security. In fact, a society cannot be secured if individuals and communities forming them are not secured or safe. If human security refers to the security of individuals and their communities, the concept of societal security refers to how societies at large are capable of preserving and reproducing their essential characteristics in the face of variable phenomena that threaten the essence of such societies.

In the Arctic, human and societal security overlap and interlink with each other, and human security "can support the promotion of societal security and the development and implementation of policies that address the wants and fears of Arctic peoples" (Hossain et al., 2017, p. 64). Human security is an excellent analytical tool to identify and address the multiple vulnerabilities that the inhabitants of the Arctic face, and that threaten not only their security at an individual level, but also security at large in a societal context. It should be noted that addressing threats to human and societal security eventually enhances the security at the national level – the security of the states themselves.

Taking into account the ongoing shift from the hard (military) and state-centric to soft (nonmilitary) and human/societal security problematique in the Arctic, it is important to examine (1) how different theoretical schools apply the human security concept to the situation in the High North; (2) which human security threats and challenges can be identified in the region; and (3) whether the human security concept is embedded in national strategies of the eight Arctic countries or not.

Theoretical Approaches to Human Security in the Arctic

There are four major International Relations (IR) paradigms: political realism/neorealism, liberalism/neoliberalism, globalism, and postpositivism. Each paradigm has its own interpretation of the human security concept.

The neorealist school considers human security to be secondary compared to national security, which, in their opinion, is crucial for the wellbeing of both the nation as a whole and an individual. The neorealists believe that focusing security policy on individual problems can lead society away from solving fundamental problems and undermine the entire national security system. This school tends to interpret human security as a component or lowest level of national security (individual, societal, national), equating human security to individual security (Konyshev, 2014; Tsygankov, 2010). Furthermore, individual security is seen as personal safety. Personal safety is viewed by the neorealists as protection of people from physical violence, whether from the state or external states, from violent individuals and substate actors, or from domestic abuse. For many people, the greatest source of insecurity is crime, particularly violent crime. This understanding of human security is reflected, for example, in Russia's national security doctrines, including the most recent one (Putin, 2021).

Another IR school, *neoliberalism,* shares the UN interpretation of the human security concept. This approach is based on the assumption that human security is indebted to the human rights tradition (the ideas of natural law and natural rights). This approach uses the individual as the main reference and argues that a wide range of issues (e.g., civil rights, cultural identity, access to education and healthcare) are fundamental to human dignity. The liberals argue that the goal of human security should be to build upon and strengthen the existing global human rights legal framework (Hossain & Petrétei, 2016; Hossain et al., 2018). In the case of the Arctic, they focus on indigenous peoples' rights. The neoliberals welcome Arctic nations' efforts to solve indigenous peoples' problems and protect their traditional economies and cultures. At the same time, the neoliberals heavily criticize those Arctic governments which are unable to implement their indigenous peoples' policies effectively (Rohr, 2014).

The *globalist school* challenges the "narrow" understanding of human security as individual security suggested by both the neorealist and the neoliberal legalist approach (Heininen, 2016). The globalists tend to interpret human security as an analogy to the sustainable development concept (Dodin, 2005; Selin & Vasiliev, 2010). They argue that economic growth is insufficient to expand people's choice or capabilities, and areas such as health, education, technology, the environment, and employment should not be neglected. On the other hand, the lack of human security has adverse consequences to economic growth and, therefore, development. The globalists underline that imbalanced development that involves horizontal inequalities is an important source of conflict. Therefore, vicious cycles can readily emerge where a lack of development leads to conflict and then to further lack of development (Graham & Poku, 2000; Larsen & Fondahl, 2015). Likewise, virtuous cycles are possible, with high levels of security leading to development, which further promotes security in return.

The most radical globalist version believes that the Arctic (particularly, its natural resources and sea routes) is a common heritage/asset for humanity that should be interacted with together with other countries and in a very careful way. Moreover, these sorts of globalists point out that an international legal regime similar to the Antarctic Treaty should be established and a comprehensive agreement should be concluded on the Arctic to make it a "region of peace and cooperation" (Dodin, 2005, p. 23; Sivakov, 2009; Watson, 2009). Similar to the Antarctic legal system, a proposed new Arctic regime should prohibit any economic and military activities in the region. Only subsistence economies of indigenous peoples of the North and research activities should be allowed in the High North. Some globalists suggest establishing a UN-based governance regime in the Arctic which should replace the existing national sovereignty-oriented model (Kharlampieva & Lagutina, 2011).

This globalist subschool tends to ignore the fact that, for many Arctic countries, this region is of growing economic importance and a home for many industrial centers. For example, the Arctic Zone of the Russian Federation (AZRF) produces more than 10% of the entire Russian GDP and 20% of its export – even if only about 1.6% of the country's population lives there (Ministry of Foreign Affairs of the Russian Federation, 2021; Arctic-info.ru, 2016).

Alaska, America's only Arctic state, is the second largest producer of gold (after Nevada) and provides 8% of the national silver output. The Red Dog mine in northern Alaska boasts the world's largest zinc reserves, producing 5% of the global output and 79% of the total US output. That mine also produces lead – 3% of the global total and 33% of American lead. Alaska is also America's second largest oil producer, at 20% of the total extracted volume (Ekonomika shtata Alyaska, 2021).

In this situation, the globalists' proposals to stop economic activities in the Arctic seem simply naïve and utopian.

The postpositivist school does not suggest a unified approach to human security. For example, postmodernism, the most radical subschool of postpositivism, heavily criticized "positivist" security concepts but did not develop any security concept of its own (Kapustin, 1996).

Social constructivism, another postpositivist subschool, prefers to interpret human security through the identity concept. According to this subschool, human security, which is socially constructed, can be ensured only if actors' identities are formed in a nonconfrontational way (Vasilieva & Chensin, 2011). Otherwise, multiple identities clash with one another and do not favor a desirable level of human security.

The constructivists are satisfied with the paradigmatic change of the Arctic countries' discourse: Instead of perceiving the North as something remote and hostile that should be "conquered," now the Arctic nations treat the High North as a natural and integral part of their countries that should be taken care of (Dregalo & Ulyanovsky, 2011; Nazukina, 2013). The North has developed a more positive and attractive image, and now it is associated with the ideas of growth, prosperity, and innovation. Moreover, now many northern countries tend to perceive the Arctic as a region of peace and stability, where different identities can be reconciled and harmonized. At the same time, the constructivists continue to monitor some negative processes and factors that continue to generate nationalistic sentiments within Arctic societies and elites and impede international cooperation in the Arctic region (Medvedev, 2013; Morgunova, 2014).

The so-called postcolonial subschool views the Arctic territories as former "internal" colonies of northern countries that were exploited for many decades in a predatory manner (Kukulin, 2013; Etkind, 2014; Huggan & Jensen, 2016; Silis, 2014). The situation now is slowly changing for the better, but there is still a long way to go to make the Arctic a "normal" territory where human security standards are observed. Along with the radical globalists, the postcolonialists believe that the best way to ensure human security in the region is to deindustrialize it and make it a sort of a natural reserve where the indigenous peoples' rights and proper living standards are secured (Medvedev, 2013).

Human Security: Threats and Challenges

Before designing an effective human security strategy, the Arctic countries should have a clear understanding of the nature of threats and challenges in this sphere. These threats and challenges can be considered according to the seven main parameters of human security.

Economic security. The 1994 UNDP report defines economic security as an "assured basic income," either from one's own labor activities or from a social, public safety net (UNDP, 1994, p. 25). In other words, the assurance that individuals will be able to find a remunerated job that will allow them to earn a decent income. In this case, it is essential to differentiate between the human-centric and state-centric economic security. While the latter focuses on the economy as it affects the state (e.g., in macroeconomic terms), the former is an element of human security and focuses on the steady income of individuals. Human economic security, being a part of the nontraditional or rights-based approach to security, focuses on individuals and communities rather than on the state or macroeconomic data (Martin, 2018, p. 27).

In the case of the Arctic, it is also important that local communities could benefit from the exploitation of the region's national resources, partaking in decision-making on the potential use of ancestral lands or areas used for traditional economic activities such as reindeer husbandry or fishing.

The situation in the Arctic region, however, is far from ideal. For example, the unemployment rate among Russia's indigenous people has been estimated at between 30% and 60%, which is three to four times higher than that of other residents of the Arctic Zone of the Russian Federation (AZRF) (Rohr, 2014, p. 34).

About half of American Indian and Alaska Native (AIAN) people – the official term for the North American indigenous population – live in urbanized areas and are mostly integrated into the modern economy characteristic of high-income nations. About half of AIAN people, however, remain in isolated small communities in rural areas of Alaska that are not connected by road to larger population centers. Economic opportunities in this region are limited. Most of the available jobs are in public administration or in scattered resource extraction enclaves staffed with shift workers. Few AIAN residents possess the skills for these jobs, and many continue to practice mixed cash and subsistence fishing and hunting livelihoods. Persistent economic and social disadvantages for rural AIAN people are manifest across a broad range of economic and social indicators. Barely half of working-age adults are employed, per capita income was only 52% of the national average, and the cost of living is much higher (Berman, 2019, p. 162).

Official poverty rates for all Alaska Natives, based on income as recorded by the Census Bureau, are about 2.5 times the poverty rate for non-Native Alaskans, and twice the rate for the Alaska population as a whole. The Native/non-Native disparity has persisted as poverty rates drifted upward after 2000. Reported poverty rates for Indigenous Alaskans living in rural areas are even higher: 25% in 2011–2015, up from 20.5% in 2000 (Berman, 2018, pp. 106, 165–166).

Although Canada is one of the wealthiest nations in the world, socioeconomic disproportions between the indigenous and nonindigenous peoples still exist. For example, figures from December 2019 to February 2020 show the indigenous unemployment rate at 10%, while it was just 5.5% for nonindigenous people. The COVID-19 pandemic hit indigenous peoples stronger than nonindigenous ones. Indigenous unemployment shot up to 16.6%, while nonindigenous sat at 11.7% in May 2020 (Benning, 2020).

Occupational structure is an important aspect of the indigenous peoples' economic security in the Arctic. The more flexible indigenous peoples are in choosing their professions, the more opportunities they have for getting high-paying jobs. Conversely, the lack of flexibility in the choice of profession can affect the level of employment in the region and wages of indigenous peoples.

For example, in Russia, there is a trend common for many indigenous communities across the AZRF in terms of occupational preferences: Many young indigenous men, unlike women, appear to have been socialized into a path dependency and consequently have difficulties accepting alternative paths and changes. They tend to narrow their choices (sometimes on their own, sometimes as a part of a family decision) in favor of "traditional male professions" (mechanics, snowmobile drivers, etc.) (Rozanova, 2019, p. 66) that are complimentary to indigenous ideas of traditional "masculine" professions and help them with reindeer herding and hunting (Ventsel, 2018). According to some accounts, about 41.2% of the total population of the Nenets Autonomous Area (NAA) – predominantly men – work in the traditional economy (reindeer husbandry, hunting, gathering, and fishing/fish farming) on a permanent basis. As of 2018, this traditional branch employed about 1000 people (predominantly Nenets men), mostly in reindeer husbandry (Rozanova & Mikheev, 2020).

Among the main reasons for the indigenous men's decision to remain in traditional Nenets professions are: (1) protection against unemployment (a lack of good education aggravated by a lack of jobs in remote villages of this Arctic region pushes them to engage in reindeer husbandry); (2) the possibility of preserving the ethnocultural identity of the Nenets as indigenous people of the north (reindeer husbandry remains the only branch of the traditional economy capable of ensuring cultural reproduction); and (3) governmental support for traditional economic occupations in the NAA (indigenous peoples pursuing the traditional way of life and obtaining traditional occupations are protected by state and eligible for getting social guarantees and monetary payments).

Similar trends can be found among the Canadian aboriginal people. Among those who have taken some training to develop job skills, 81.9% were employed and 8.0% were unemployed, while among those who have not taken any training to improve their job skills, only 60.6% were employed and 14.4% were unemployed (Statistics Canada, 2021).

Food security is another important element of human security. According to the UNDP definition, food security implies the constant "physical and economic access to basic food" (UNDP, 1994, p. 27): more specifically, this means both the availability of food as well as the possibility to acquire it. In the Arctic context, the food security concept acquires a deeper meaning because access to food supplies in such an isolated and remote area is not simple and represents a real challenge. Distances to market centers are long, distribution networks are not as developed as in other regions, and food imports have become essential to ensuring the availability and variety of products.

For example, in the Russian Arctic, many remote coastal communities have a stable connection to the "mainland" only via maritime transport on the seasonal basis. The so-called "northern supply" – which includes foodstuff, other consumer goods, fuel, and construction materials – takes place every summer season and lasts about 4 months. The rest of the year, these remote settlements are almost cut off the central part of the country.

It should be also noted that the Arctic indigenous peoples have already experienced negative consequences related to the import of foods that have replaced traditional staples. In this case, food security intersects with health security. Climate change also threatens food security in the Arctic because seasonal patterns are altered, animal cycles are changed, fish migrate, and the conditions for the growing of plants are modified. Last but not least, microplastic pollution has become a global problem. Microplastics are now found in Arctic fish and animals that have become unsafe to eat.

Health security is defined by the UNDP (1994, pp. 27–28) as the availability and access to adequate health systems, together with the elimination of threats to the health of individuals.

Unfortunately, the Arctic region is replete with health security problems. For example, the fertility rates in nearly all Arctic countries and regions have been declining over the past few decades, and most have fertility rates at or below the replacement level. Arctic regions with high shares of indigenous populations tend to have higher fertility rates, including Nunavut (Canada), Greenland, and Russia's Nenets and Chukotka autonomous areas. The Arctic regions of Norway, Lappi, and several regions of Russia have extremely low fertility rates. Part of the "demographic crisis" during the 1990s in Russia, including in the north, was a steep decline in childbearing, when the fertility rate declined from 1.89 in 1990 to 1.16 in 1999 before increasing to 1.79 in 2016 (Coates & Holroyd, 2020, pp. 48–49).

The indigenous peoples of Russia have extremely high adult mortality rates. Just over one-third of indigenous men (37.8%) and less than two-thirds of indigenous women (62.2%) in Russia reach the age of 60 (Rohr, 2014, p. 32). At the national level, the figures are 54% for men and 83% for women. This has led Russian demographers to describe the state of the indigenous peoples as a demographic crisis.

Besides, 36% of AZRF indigenous people die prematurely from nonnatural causes, which is more than double the national average of 15%. Infectious diseases, such as tuberculosis, a typical indicator of extreme poverty, cause 60 deaths per 100,000, which is almost three times the national average of 23 per 100,000. Furthermore, maternal deaths and child mortality are significantly above the national average.

Alcoholism is a major factor in the indigenous peoples' acute health crisis (including women). The Russian Federation Council's Committee on Northern and Indigenous Affairs has established that, over the course of the 2000s, alcoholism has increased 20-fold, mostly due to increased alcohol consumption among women and children. This increase is, among other things, attributed to an uncontrolled flow of alcohol into the regions inhabited by indigenous peoples (Rohr, 2014, pp. 32–33).

The AZRF population demonstrates a higher suicide rate than average in the entire country. Between 1998 and 2002, the incidence of suicide among northern indigenous peoples came to over 100 per 100,000 – more than double the national average of 38 per 100,000. In the Koryak district in northern Kamchatka, this figure has been established as 133.6 per 100,000.

As some studies based on the Nenets Autonomous Area data show, there were higher suicide rates in the indigenous Nenets population compared with the non-indigenous population. Suicides among Nenets and nonindigenous populations in the NAA are associated with different sociodemographic characteristics. The strongest positive associations with the suicidal risk in the Nenets population were observed for particular characteristics: 20–29-year-old, male, urban residence, a high education level for both sexes, and being divorced or a widower for males or being married for females. These characteristics may have connections to a lack of a "sense of indigenous belonging," lack of cultural identity, and problems of resilience.

In the nonindigenous population, higher risks of suicide were observed for males, rural residence, having secondary school education, being an employer or employee, and being single. The highest suicides rates in this group were seen in males aged 20–29 years, and females aged 30–39 and 70 years and above.

As the result of the above negative processes, life expectancy at birth in Nordic countries is higher by 13.6 years for males and 7.6 years for females than in the Russian Arctic regions (Coates & Holroyd, 2020, p. 48). In the Russian northern regions, life expectancy at birth is 65 years for males and 76 for females, although it has a tendency to increase at a higher rate than in the Nordic countries.

The indigenous population in the Nordic countries shares many health security problems with its Russian counterparts. Greenland has the highest suicide rate in the world per capita, with a yearly rate around 80 deaths per 100,000 over the last decade (The Arctic Council Sustainable Development Working Group, 2021, p. 205).

In Sweden, Finland, and Norway, the statistics are not divided by ethnicity, but studies have indicated that suicide rates are significantly higher in Arctic regions, with the highest rates in reindeer-herding Sámi populations (Jacobsson et al., 2020). Although the health status of Sámi is generally similar to that of nonindigenous residents, suicides are an exception; suicide rates among Sámi men are significantly higher than among non-Sámi, especially in Northern Finland (Pollock et al., 2018; Young et al., 2015).

According to some accounts, half of Sámi adults in Sweden suffer from anxiety and depression. One in three young indigenous reindeer herders has seriously contemplated or attempted suicide – more than double the rate among their Swedish peers. Other studies have found rates of suicidal ideation to be nearly four times higher among Sámi than among other Swedes (Schreiber, 2016). For many Sámi, suicide offers an escape on their terms from the inexorable force of climate change, which is eroding the traditional way of life in the Arctic.

In Iceland, which has no indigenous population, the suicide rate in 2018 was 9.7 deaths per 100,000 (Organization for Economic Cooperation and Development, 2019), and in the Faroe Islands, also with no indigenous population, the rate was 4.8 deaths per 100,000 (The Arctic Council Sustainable Development Working Group, 2021, p. 205).

In 2019, the suicide rate in Alaska was 28.7 per 100,000, with indications of especially high rates in the northern and southwestern part of the state (Farr et al., 2019, p. 42), where the indigenous populations range from 50% to 75% of the whole population (Wang & Roto, 2019).

Mortality rates for Alaska Natives statewide are 40% higher than the state and national averages, driven by injury death rates three to four times the national average. Suicide rates for rural Alaska Native young males are particularly high (Berman, 2018, p. 162).

In Canada, Inuit regions suffer from a much higher rate of suicide than the rest of the country. While the national average is 11.3 suicides per 100,000 inhabitants, Inuvialuit is 60.4, Nunavik is 113.5, Nunavut is 116.7, and Nunatsiavut is a shocking 275.3 suicides per 100,000 inhabitants (Dobes, 2019). Specialists identified the key reasons behind suicidal behavior among the Inuit as depression and substance use (alcohol and cannabis). They traced these pathologies to the colonization era. During those times, indigenous peoples were forced to leave their lands, abandon their traditional way of life, and stay in permanent settlements. The Inuit had to send their children to infamous residential schools, where they were subjected to harsh treatment in a foreign environment, with the ultimate goal of assimilating them into the mainstream society and annihilating their Inuit identity.

Health security challenges in the Arctic can be grouped into four main categories: development of an adequate health care infrastructure; prevention policies; external environmental factors; and securing sufficient resources for coping with health security problems.

The creation of a good health system (clinics staffed with high level professionals and equipped with modern medical equipment) might be a difficult task for many Arctic regions. Establishing health centers might be limited to bigger towns and cities. People might be forced to travel long distances to visit a clinic or a hospital. A main challenge is thus to increase the means to provide proper health services. Such health care systems need to include the development of health care infrastructure, adequate funding for these institutions, or the provision of services such as transportation.

Prevention schemes are a second main challenge. Prevention activities reduce the need for medical care and help to increase the wellbeing and health of individuals and their communities. Some basic prevention activities can include measures to overcome low nutrition, or sport and other community and group-based activities. Prevention policies should also address existing social problems such as alcoholism, drug addiction, sedentary lifestyles, and gender inequality. In addition, access to telemedicine or e-health services can vastly contribute to prevention as well as early detection while saving costly travels.

As for external environmental factors, pollution represents the main threat to health security in the Arctic. Many pollutants from all over the world are present in Arctic lands and waters. The elements such as persistent organic pollutants or other contaminants are issues of particular relevance when it comes to health security in the High North. Curbing and reducing pollution may have direct positive effects on human health in the region.

Finally, securing sufficient funding and adequate resources for establishing proper health systems in the Arctic is another major challenge. Due to the low population density of the region, the vast distances, and the harsh environment, investments to tackle health issues are, in per capita terms, higher than in other areas. But as mentioned above, modern electronic services can help reduce the funding needed to provide good and adequate health services to the inhabitants of the Arctic, and in particular to those living in more remote areas.

Environmental security. According to the 1994 UNDP report, environmental security is a "healthy physical environment" (UNDP, 1994, p. 28). The healthiness of the environment can be threatened by economic, industrial, and military activities, pollution, degradation of ecosystems, or climate change. These threats can be local or the result of transborder and global activities. Generally, the Arctic environment is still pristine, particularly if compared to many other regions in the world. However, it is not free from stressors such as climate change, increased human activity, and long-range transportation of pollution.

The ecological situation in each Arctic region is very different from each other. On the one hand, for example, in the Canadian Arctic, there is practically no industrial activity, and the transport infrastructure is poorly developed, so the state of the environment is quite satisfactory; on the other, in the western part of the Russian Arctic, where large centers of extractive and heavy industries are located, the environmental situation is unfavorable.

Continued neglect of ecological aspects of the AZRF industrial activities resulted in heavy pollution of many Russian Arctic urban areas. Russian environmentalists pointed out 27 impact zones in the AZRF, which are polluted to the extent that serious threats both to local ecosystems and population's health emerged there (Fig. 1). The most problematic impact zones include the Norilsk industrial conurbation (more than 30% of total pollutants), the West Siberian region where oil and gas production is concentrated (30%), the Murmansk Region (10%), and the Arkhangelsk Region (5%) (Dushkova & Evseev, 2011; Sokolov, 2013). According to some experts, around 15% of the Russian Arctic is heavily polluted (Kochemasov et al., 2009).

To address the numerous environmental problems in the AZRF, in 2011, the Russian Government launched a program worth ₽2.3 billion to clean the area,

Fig. 1 The AZRF impact zones. (Source: compiled by the authors)

including the Franz Joseph Land and Novaya Zemlya Archipelagos. By the end of 2016, some 42,000 t of waste had been removed from these archipelagos, and 349 hectares of insular land had been cleaned. In 2015, another AZRF cleaning program was launched – this time with a ₽21-billion funding envelope. By the end of the following year, the cleaning of Wrangel Island – including the removal by the Russian military of 36,477 barrels and 264 t of scrap metal – was nearly complete (Neftegas.ru, 2016).

Nuclear safety in the High North is also a matter that encourages Russia and other Arctic states to cooperate. Notably, more than 200 decommissioned nuclear reactors from submarines and icebreakers from the Soviet period are stored on the Kola Peninsula – a Soviet "legacy" that is especially problematic for neighboring countries such as Norway, Finland, and Sweden. It should be noted that the US-Russian Cooperative Threat Reduction Program (Nunn-Lugar) of 1991–2012 (Nikitin & Woolf, 2015) and the Multilateral Nuclear Environmental Program in the Russian Federation (Government of the Russian Federation, 2003) played a significant role in nuclear waste treatment.

The Russian Government program on nuclear and radiological safety for 2008–2015 succeeded in dismantling 195 retired nuclear submarines (97% of the total quantum), removing 98.8% of radioisotope thermoelectric generators from service, and dismantling 86% of these generators. Centralized long-term storage facilities for spent nuclear fuel were constructed. Moreover, 53 hazardous nuclear facilities were decommissioned, 270 hectares of contaminated land was remediated, and open water storage of radioactive waste was ended (Rosatom, 2017).

The Russian northern regions and urban centers now try to prevent and reduce pollution in the AZRF rather than to focus on the elimination of accumulated ecological damage (Tianming et al., 2021). They believe that reduction of air pollution will help to mitigate climate change and suggest a number of specific measures to reduce dangerous emissions. These policies are viewed as more adequate and efficient than eliminating the environmental damage mostly created by the Soviet economic and defense activities in the north. On the other hand, this is a good example how climate change adaptation and mitigation strategies can complement and reinforce each other.

Russia has supported and vigorously participated in developing all the UN-related environmental initiatives, ranging from the Intergovernmental Panel on Climate Change's recent reports (2014, 2021) to the International Maritime Organization's Polar Code (2014–2015) and the Paris Agreement on climate change (2015). Moscow has also actively participated in the Arctic Council working and expert groups involved in environmental research and assessment.

It is not only Russia that has environmental problems in the Arctic. For example, in Northern Norway, there are similar problems in Kirkenes, where mining, processing, and ship repair enterprises are located. In Northern Sweden, the concern of the "greens" and the Sámi people is caused by the activities of an iron ore mine and a processing plant in Kiruna. In Alaska, the sources of environmental problems are oil and gas pipelines, the mentioned Red Dog mine, and military activities.

Personal security refers to the absence of sudden and unpredictable physical violence (UNDP, 1994, p. 30). Such physical violence could be either caused by states, loose or organized groups of individuals; or be targeted at specific groups (such as women or children). Threats to personal security might arise from outside the community, from specific individuals in one community, or from the community as a whole. It can arise from circumstantial factors (being in the wrong place at the wrong time), or be rooted in the pillars of a society (such as domestic violence). In the first case, randomness is the main element to be considered. In the second, vulnerability of individuals or collectivities within the community are far more relevant factors (Peterbauer & Martin, 2018).

As the Arctic region opens up to the world, new threats to personal security might emerge. Those could include organized crime or trafficking in drugs and people.

For example, the Russian "fish, crab, and caviar mafias" not only aim to expand their commercial activities and sideline their foreign rivals, but also to establish control over the regional governments and federal agencies in the Russian Far North and East.

The Arctic states are concerned about smuggling, not only from outside the region (a threat that remains hypothetical for the time being), but also between the Arctic nations themselves, which is already a reality. For example, in 2012, a narwhal smuggling ring was disclosed by the Canadian and US law enforcement agencies. Between 2000 and 2010, an American family purchased the tusks legally in northern Canada and then used the Internet to find buyers in the United States. This family is estimated to have sold between $400,000 and $1 million worth of tusks to as many as 150 buyers (McGwin, 2015). It should be noted that narwhals are protected under various national and international treaties. The Convention in International Trade in Endangered Species of Wild Fauna and Flora bans their hunting in Canada and Greenland by anyone other than the Inuit. Canadian tusks may be sold domestically or shipped abroad to countries where their sale is legal. Imports of tusks to the United States are banned under the federal Marine Mammal Protection Act.

Illegal migration is one more security challenge for the Arctic states. Over the last decade, Canada registered several cases of illegal migration. For example, Romanian citizens traveled from Greenland to Canada's Ellesmere Island by motor boat before trying to fly to Toronto. Several Turkish sailors have illegally left their ship in the Canadian port of Churchill in attempt to travel by train to Winnipeg (Gudev, 2014).

The case of Arab refugees traveling to the Nordic countries via the polar routes is a much more serious security threat. Since the beginning of 2015, at least 29,000 people, mostly from Syria, have used various routes to seek asylum in Norway. The number of asylum seekers arriving plummeted by 95% in 2016 (Osborne, 2016). The refugees being bussed to Russia had taken the so-called "Arctic Route" through Russia, crossing the Norwegian border by bicycle as Russia does not allow anyone to cross by foot. In November 2015, Oslo announced it would deport people who had arrived from a safe country. The Norwegian government considers Russia safe, but has not given the refugees opportunity to appeal the decision. The Norwegian authorities have started sending the first of approximately 5500 mainly Syrian refugees, who have been housed in a transit camp in the north of the country, back to the Russian border they crossed in 2015 (Norway sends 2016). Critics of the government have said the attempts to return refugees to Russia put them at risk and contravene European human rights. Although Norway is not an EU member, it is in the border-free Schengen zone. In addition to deportation, in 2016 Norway started to build a steel fence at its border with Russia to prevent a further influx of refugees.

As far as Finland is concerned, approximately 32,500 refugees, mostly natives of Iraq, came to the country in 2015 (TASS, 2016). Most of them arrived through the Swedish-Finnish border in the north of the country, but many others chose other routes, such as traveling by ferry from Germany and across the border with Russia in northern Lapland. The Russian-Finish border has become one of the main routes that refugees use to get to Finland. The influx of refugees from Russia to Finland increased after Norway tightened security measures on its borders and made the procedure of asylum application more difficult in late 2015, prompting migrants to seek alternative paths to enter the EU's borderless Schengen area and to get asylum there. In January 2016, Finland registered 500 asylum seekers arrivals from Russia against 700 border crossings throughout 2015 (Sputnik, 2016b).

In March 2016, Russia and Finland agreed to introduce temporary restrictions at two checkpoints on their border, Salla and Raja-Jooseppi, for citizens of third countries. Similar to Norway, the asylum seekers were sent back to Russia, where they have valid residence permits. The Finnish Ministry of Interior said that the measures have aimed to curb undocumented migration and related threats and enhance the effectiveness of measures taken by both Helsinki and Moscow to combat illegal migration.

Some Arctic nations (especially Russia) are seriously concerned about the threat of nuclear terrorism. Moscow is afraid that not only the industrial infrastructure or oil platforms, but also nuclear power plants and nuclear waste storages, could be potential targets for terrorists. There are two nuclear plants – Kola and Bilibin – in the AZRF. Recently, a floating nuclear power plant was stationed in the port of Pevek. Most notably, more than 200 decommissioned nuclear reactors from submarines and icebreakers from the Soviet period are stored on the Kola Peninsula from the Soviet period. In 2016, Russia launched a large-scale program for removing nuclear waste from the former Soviet submarine base in Andreev Bay in the Murmansk region. A total of 22,000 containers of spent fuel from nuclear submarines and icebreakers were stored in three storage tanks. There were also approximately 18,000 m^3 of solid waste and 3400 m^3 of liquid radioactive waste, which, according to Norwegian sources, are collectively as radioactive as 5000 Hiroshima bombs (Sputnik, 2016a). These nuclear facilities must be reliably protected to prevent potential terrorist attacks.

Although today crime is not a major concern in the Arctic, existing cooperation networks and expertise should be strengthened as to avoid potential new threats. Unfortunately, personal security is hardly covered in the national policies and strategies and mostly left for municipalities and local communities themselves.

Community security. According to the 1994 UNDP report, individuals often "derive security from their membership in a group – a family, a community, an organization, a racial or ethnic group that can provide a cultural identity and a reassuring set of values" (UNDP, 1994, p. 31). Ensuring community security means that the language, culture, or – more generally – integrity of those groups is preserved. In other words, this means that the community endures and persists beyond its current individuals. At the same time, it means that vulnerable subgroups within such communities are also recognized and valued by the community; that is, that the community at large is not a source of threats to individuals.

Within the Arctic context, it is widely assumed that threats to security can affect the more vulnerable communities such as indigenous peoples, women, children, and old generation. They are particularly vulnerable to the effects of rapid modernization, industrialization, socioeconomic structural changes as well as environmental threats such as climate change.

It should be noted that ensuring the continuation of Arctic indigenous communities requires that the different cultural and community-based culture is protected, so it can be handed over to the next generation. The formal protection of indigenous languages, culture, traditional economies and way of life, particularly after centuries of neglect if not open repression, is already formally included in all Arctic nations' policy and strategy documents. The Arctic states also work on establishing knowledge centers where traditional knowledge can be gathered and transmitted following both traditional and modern, scientific ways. Such institutions contribute to the enhancement and transmission of traditional culture and language, and thus reduce community insecurity.

In Finland, Norway, Sweden, and Russia, Sámi people created some representative institutions to protect their ethnic identity, culture, and rights. For example, Sámi parliaments were established in Finland (1973), Norway (1989), Sweden (1993), and Russia (2008). In Russia, however, both the Murmansk regional government and some local Sámi organizations have challenged the legitimacy of the Kola Peninsula Sámi Assembly (the official name of the Sámi parliament), and it was dismissed in 2018. Instead, the Russian Sámi preferred to organize regular Sámi conventions to discuss common problems and address them to the local and regional governments.

Except for the indigenous peoples, an often-neglected community security problem is gender empowerment and the promotion of gender equality measures, both at the economic as well as the community and political levels. Women are roughly 50% of the Arctic population, and a gender perspective needs to be taken into consideration when addressing human security challenges ranging from men's violence against women, sexual harassment and abuse, guest hetaerism, girls' early marriages, and women's access to health care, education, and well-paid jobs.

For example, according to some accounts, in the Canadian Arctic, indigenous women are 12 times more likely to go missing or be murdered than their nonindigenous counterparts (Ágústsson, 2021, p. 87). Additionally, in remote locations and situations, women tend to become more financially dependent on their spouses, and therefore more vulnerable. Job opportunities in the extractive economy see lower rates of female employment, reflecting significantly greater barriers to women working in the extractive sector, and further isolating of women who live in camps and extractive industry communities.

It should also be noted that, much like in the rest of the eight Arctic states, women in the Arctic (particularly indigenous women) are politically underrepresented and suffer from unequal social and economic structures. Even if there are no formal restrictions barring indigenous peoples from assuming public office, the reality on the ground is that they are factually underrepresented and that, in this case, it is insufficient not to actively violate the rights of indigenous peoples; the state is duty-bound to take special measures to fulfill this right. Even in predominantly indigenous villages, the local mayor and their aides are usually nonindigenous males. International experts believe that this is indicative of a reality of structural discrimination against which the state has to intervene actively.

According to the Gender Equality in the Arctic Report-3, except for the Chukotka Region in Russia and Nordic regions of Västerbotten, Norrbotten (Sweden), and Nordland (Norway), women remain less likely to participate in the political sphere than men across the Arctic regions (Fig. 2).

With an average level of 26.3% of female representatives in the Arctic elective bodies, the gender gap varies significantly across Arctic countries and across the regions/subnational entities. Today, there is just one region with full gender parity achieved – the Chukotka Autonomous Area in Russia. A great difference in gender composition is observed in elective bodies not only across the entire Arctic but also across the country's regions, from the highest proportion of women's representation

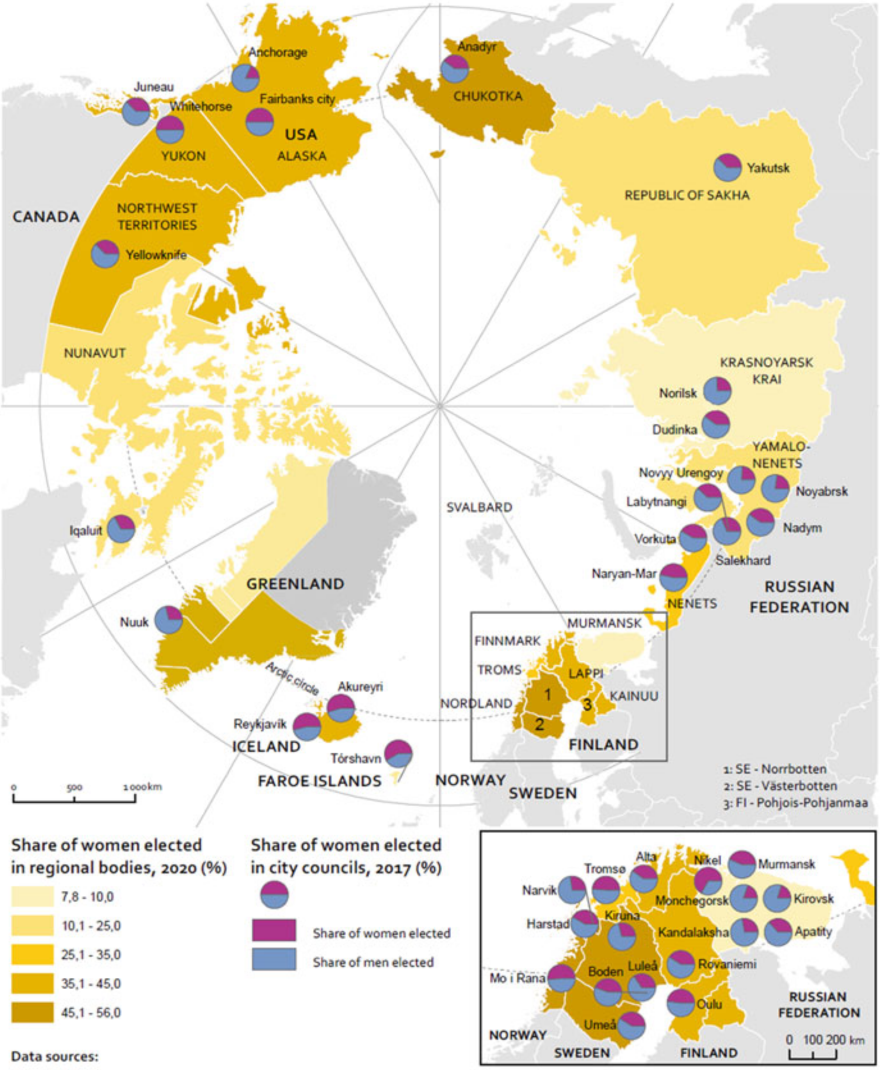

Fig. 2 Women's representation in elected regional, (sub)national elective bodies, and city councils (per cent). (Source: adapted from Ágústsson (2021))

(50% elected deputies of both genders in Chukotka) to the lowest one (7.8% of female legislators in Krasnoyarsk Province) (Fig. 3).

Iceland became a world leader in closing most gender gaps as a result of both women's NGO activism and the country's special programs aimed at improving gender equality in such critical areas as education, political participation, and women's participation in the labor force. However, as far as women's representation in the Icelandic parliament is concerned, the trend toward narrowing the gender gap

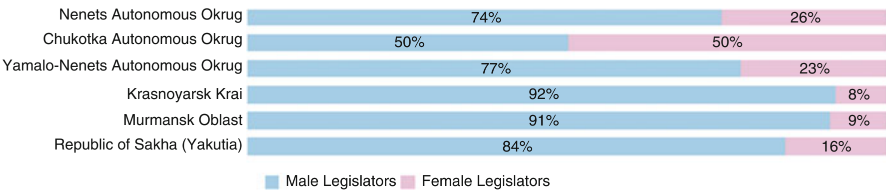

Fig. 3 Share of male and female legislators in regional elective bodies in the Russian Arctic in 2020. (Source: adapted from Ágústsson (2021))

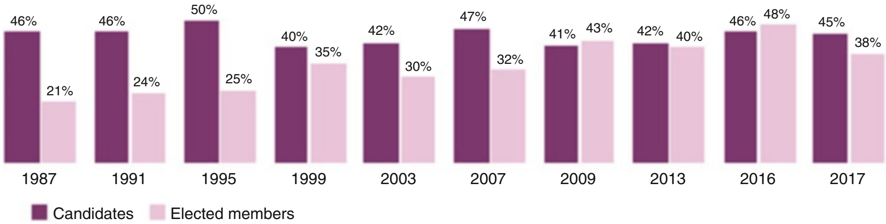

Fig. 4 Women as percentage of candidates and elected members in Icelandic parliamentary elections in 1987–2017. (Source: adapted from Ágústsson (2021))

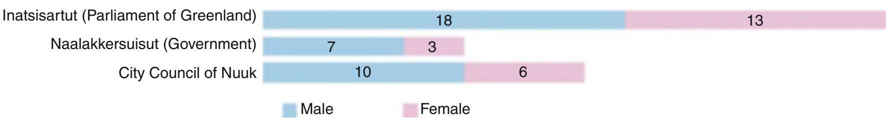

Fig. 5 Gender political representation in Greenland. (Source: adapted from Ágústsson (2021))

in legislative institutions is not sustainable. The first setback took place in the first decade of the twenty-first century, when the proportion of men in two parliamentary elections of 2003 and 2007 increased despite female candidates' active participation: women won slightly over 30% of parliamentary seats. The 2017 elections demonstrated another decrease in the number of female legislators from 47.6% to 38% (see Fig. 4).

In Greenland, although the political norms are gradually changing toward more gender-equal representation in institutions of political power (Fig. 5), elements of patriarchal structures are still dominant in the public domain. The current political system does not fully guarantee equal access to all levels of power, across different sectors, or meaningful participation in political discussions to all genders.

Despite achieving approximate parity in numbers in the Greenlandic parliament, gender gaps still exist at political leadership positions. For example, the female President leads the parliament, but all the political parties' leaders are men, and male parliamentarians lead 8 out of 13 committees.

At the city level, where the political stakes are not that high, the general pattern shows greater gender equality across city councils in all Arctic countries than in regional legislative bodies. Although the top leadership positions of city mayors remain mainly male dominated in the Arctic region, in the United States and Canada, three out of six major cities – Juneau, Yellowknife, and Whitehorse – are led by female mayors.

With an average level of 37.8% of elected female seat holders in city councils, women's representation in most regions is higher than in regional legislative bodies (26.3%) (see Fig. 2). This is especially true in Russia, where women are typically much better represented in city governance. However, the share of elected female council members varies considerably not only from country to country and region to region, but also from city to city within administrative-political territories (Fig. 6). For instance, in the Murmansk Region of Russia, women occupy 20% of city council seats in Monchegorsk and 43% in Murmansk to 66% in Nikel. In Alaska, women hold 18% of city council seats in Anchorage, 38% in Juneau, and 50% in Fairbanks. The causes of cross-regional and intraregional disparities leading to existing imbalances are different in each case and can be explained by the local political peculiarities.

At the local level, despite different and, in some cases, opposite patterns observed in gender composition in local elective bodies, the gender gap in political empowerment is less profound throughout Arctic communities. In Iceland, for instance, there is a sustainable trend toward achieving full gender parity. In 2018, this has almost been achieved at the municipal level (Fig. 7). It should be noted that the number of elected women was proportionally higher in larger municipalities than in smaller ones.

Despite numerical parity, the presented numbers do not say everything about women's level of influence at the local government level. Studies have repeatedly shown a worrisome trend: Men are more likely to get re-elected than women, and the last local elections are no exception. About half of the male deputies were re-elected, compared to 32% of women.

A relatively new emerging phenomenon of reversed gender disparity related to male underrepresentation is also indicated in the North, especially in predominantly indigenous communities. For instance, in the Russian Arctic, the local political and civic empowerment of women is particularly visible in remote communities where women play a substantial role and have an overwhelming majority in local governance institutions.

For example, in the Nenets Autonomous Area, the recent local elections of 2016–2018 brought women majorities into power in eight out of nine predominantly indigenous municipalities (Fig. 8), revealing a significant gender gap in favor of female elected representatives. Overall, women got 48 seats (71%) and men only 20 (29%).

There are three major factors that significantly contribute to the political trend toward women's empowerment in these local AZRF settlements: (1) the Soviet doctrine of gender equality that was implemented in the Arctic as a form of women's liberation (partly through the depatriarchization of traditional family institutions); (2) the Soviet system of compulsory education for all children; and (3) women's personal goal-setting and career strategizing.

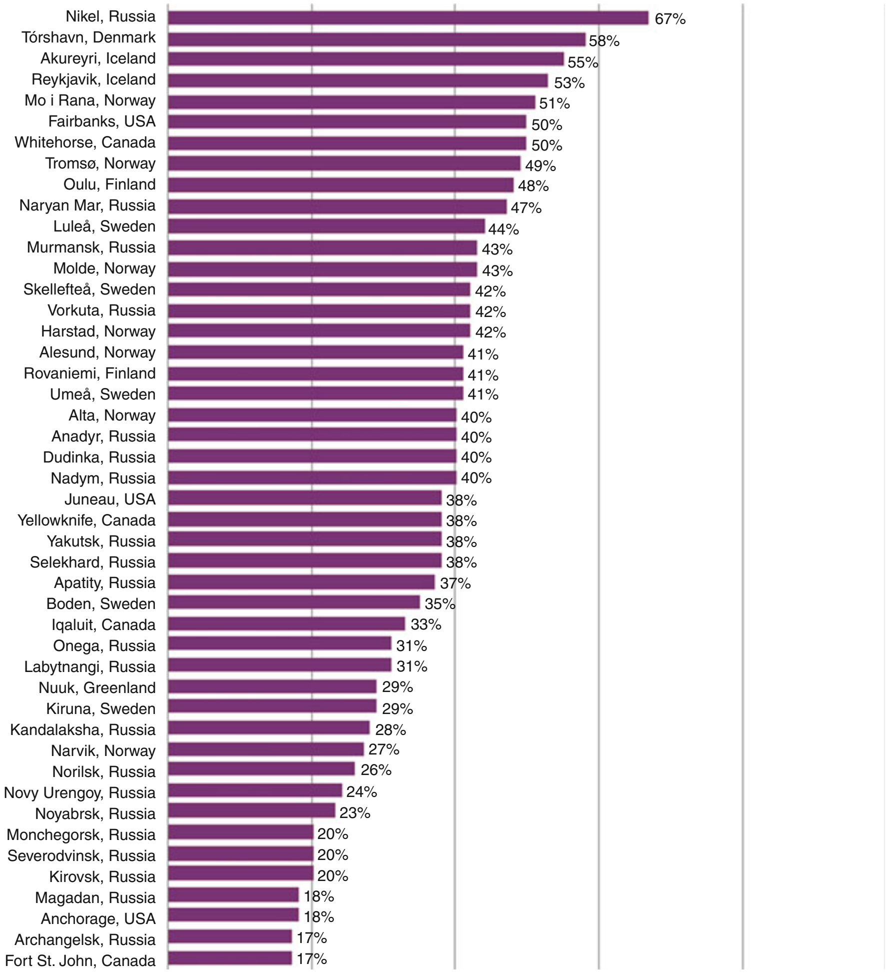

Fig. 6 Share of women elected to city councils. (Source: adapted from Ágústsson (2021)

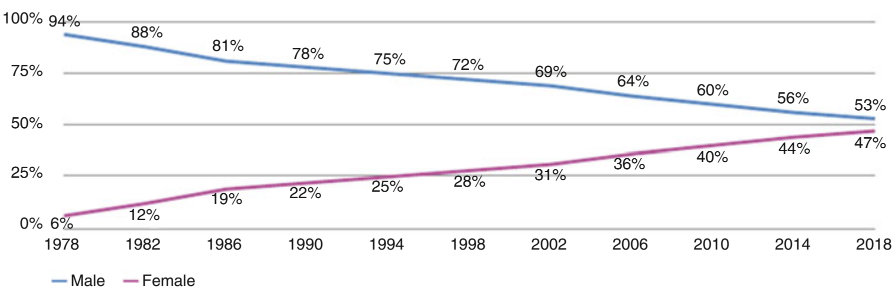

Fig. 7 Share of elected male and female deputies at municipal elections in Iceland in 1978–2018. (Source: adapted from Ágústsson (2021))

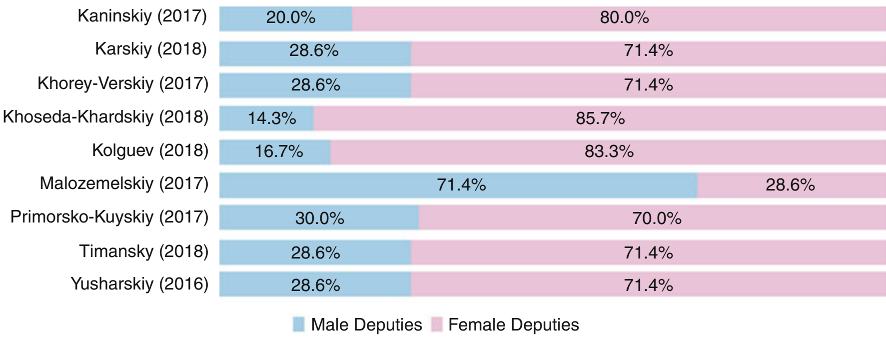

Fig. 8 Gender disparity in selected Nenets municipal councils (Russia): elected female and male deputies, by percentage (elections of 2016–2018). (Source: adapted from Ágústsson (2021)

This phenomenon can be observed in many communities across the Arctic. For example, in Greenland, men's identities are strongly attached to defined notions and visual representations of hunting and fishing. Males are socialized into maintaining traditional work activities that no longer enable them to secure success in the current political system. Despite holding formal political leadership by having an overwhelming majority in municipal councils, men often feel disempowered (Ágústsson, 2021, p. 241).

However, generally, the problem of reaching a gender balance in the representative bodies of the Arctic regions, cities, and municipalities is still an important priority on the human security agenda of the Circumpolar North.

It should be noted that in the case of community security, human security is particularly closely intertwined with societal security, since it reflects problems that relate to specific communities, which, in fact, make up society.

Political security. The UNDP report (1994, p. 32) attributes political security to a society "that honors their basic human rights." As Martin (2018, p. 40) notes, within the Arctic context, enhancing political security for the wellbeing of the local populations might refer: to the enhancement of self-government and local governance structures to deal with phenomena at the local level; to ensuring that local and indigenous communities are part of the different decision-making processes regarding issues that affect them; or to ensuring that local communities have certain (direct or indirect) control over the revenues generated by the exploitation of the natural resources located in the region. Some level of integration of indigenous, local, and nonstate actors has been partially achieved through regional governance fora and different arrangements at the national levels. Several Arctic states stress the need to strengthen and deepen current levels of self-government (for example, in the cases of Greenland and the Faroe Islands), and that the prospects of economic development are not to diminish but to increase the current self-governing structures. Further development of such political instruments is essential to achieve a lasting and far-reaching political security.

According to the Human Freedom Index 2020, at least seven out of the eight Arctic states could arguably present a good record of respect and promotion of basic human rights (in particular the Nordic countries, who are also deemed champions in this field). Nordic countries have the following freedom ranks: Denmark – 4, Sweden – 9, Finland – 11, Norway – 15, and Iceland – 20 (Vásquez & McMahon, 2020, p. 48). North American countries were ranked sixth (Canada) and seventeenth (US) (Vásquez & McMahon, 2020, p. 43). Russia is the only problematic country in the region, criticized for the lack of political freedoms, tolerance to political opposition, and free mass media. For these reasons, it has the lowest rank – 115 (Vásquez & McMahon, 2020, p. 38). However, in the case of Russia's Arctic zone, such criticism might be not entirely relevant because Moscow tries to actively involve its Arctic regions, cities, municipalities, and indigenous communities to strategic planning and decision-making.

It should be noted that promoting political cooperation and collaboration between the Arctic governments (at the state or regional levels) in order to address various transboundary challenges means promoting political – and thus human – security. In this context, all Arctic states promote the use of multilateral institutions such as the Arctic Council or Barents Euro-Arctic Council, as well as stronger partnerships among the Arctic states.

A Brief Review of the Arctic States' Strategies in the High North

Some Arctic countries – such as Canada, Norway, and Sweden – are among those countries that, since the 1990s, have actively promoted the human and societal security concepts in their foreign policies. Among these countries, Canada played a key role in including "human security issues on the circumpolar agenda" (Exner-Pirot, 2008), including on the agenda of the Arctic Council. However, has this concept been reflected in the national Arctic strategies?

It is known that today all the Arctic countries have published their Arctic strategies, some of which have already been republished taking into account new trends in the development of international cooperation in the Arctic. It is in the texts of the strategies of the Arctic countries that one can find the goals, objectives, and main priorities of the Arctic countries in the implementation of their Arctic policy. However, none of the strategies of the Arctic countries (with exception of Canada) explicitly mentions the human security concept. The 2019 Canadian Arctic and Northern Policy Framework notes: "Canada has an opportunity to bolster its international leadership to ensure that the evolving international order in the Arctic is shaped in a manner that protects and promotes Canadian interests and values, such as human and environmental security, gender equality and meaningful engagement of Northerners, especially Indigenous peoples" (Government of Canada, 2019).

At the same time, some elements of this concept (in the UN definition) are simply noted in strategic documents: "The policies and strategies cover not only economic or geopolitical strategic topics, but also social, environmental and human aspects of sustainable development in the region" (Exner-Pirot, 2008). Based on the analysis of these documents (Danish Ministry of Foreign Affairs, 2011; Government of Canada, 2019; Government of Finland, 2013; Government of Norway, 2021; Government of Sweden, 2020; Parliament of Iceland, 2011; President of the United States of America, 2013; Putin, 2020), it can be stated that the priority of most Arctic countries is economic security (sustainable use of natural resources, economic development, business interests in the Arctic, etc.), environmental security (climate changes, balance between environmental protection and economic development, protection of the Arctic ecosystem and biodiversity, etc.), community security (tackle societal and community-based problems, gender equality, promotion women and youth empowerment, create jobs, foster innovation, etc.), and political security (increasing participation of local inhabitants in decision-making processes, promoting the wellbeing of indigenous people, etc.). The rest of the components of human security are found only in certain countries. For example, references to food security issues can only be found in Canada's and Russia's Arctic strategies, personal security only in Canada's and Finland's, and health security only in Canada's, Denmark's, Russia's, and Sweden's.

Obviously, attention is paid to various aspects of human security in national Arctic strategies to varying degrees, while in all cases, there is no comprehensive approach to human security. As Martin (2018, p. 26) notes, this is largely due to the fact that Arctic strategies are mainly focused on determining the national interests of countries in the Arctic, they have a truly state-centric character and "economic and environmental security, as elements of human security, can be better connected with the national priorities of the Arctic states." Thus, the strategic documents of the Arctic countries are mainly focused on the interests of the state, and the interests of the inhabitants of the Arctic take the second place. However, tracing the evolution of the Arctic strategies of the countries that republished them, it can be noted that the "human dimension" appears more and more in their content.

For example, in the 2013 Russian Arctic strategy (Putin, 2013), only threats and challenges related to economic, environmental, and health security were identified. In the Russian Arctic strategy designed up to 2035 (Putin, 2020), some new human security challenges are addressed – the food, demographic, personal, communal, societal, nuclear, and information ones.

Conclusions

Several conclusions emerge from the above analysis.

The "human security" concept was accepted by all IR paradigms in one way or another, although the neoliberal and globalist paradigms are most receptive to this concept. These two paradigms have developed the most detailed human security agenda in the Arctic, although they have not been able to fully influence the Arctic states' policies in this area.

All eight Arctic countries have familiarized themselves with the human security concept. To some extent, this concept is embedded in their Arctic strategies, although only the Canadian one directly refers to the human security problematique. The Arctic states' strategies link human security issues with societal security and a sustainable development agenda.

At the same time, in the Arctic states' strategic documents, quite often economic, ecological, food, health, personal, communal, and political dimensions of human security are not properly harmonized with one another. Priority is given to economic and environmental aspects of human security strategies, while other dimensions are often ignored or given less attention.

The strategies analyzed in this chapter are still highly state-centered. This means that these documents focus first on the state, and then on the inhabitants of the Arctic. Despite the human security elements found in the above documents, the overall state-centric approach is still in place.

At the same time, the Arctic countries try to address the human security problematique as a part of their sustainable development strategies in the Arctic. They created proper legal and institutional settings for the development and implementation of such strategies. The Arctic states have made great strides in implementing some human security-related projects (mostly economic and environmental) over the last 10–15 years. There was a clear shift from survival or reactive strategies to capacity-building, proactive human security, or sustainable development strategies.

However, there is still a long way to go, in terms of both the development of adequate policies and their effective implementation. The main problem is how to solve the “words and deeds” problem, since many of the human security-oriented projects in the Arctic countries still remain on paper and have never been implemented.

To conclude, despite the above problems and shortcomings, the total “balance sheet” of the Arctic states’ human security strategies and general dynamics in this sphere is rather positive. The Arctic countries are serious about solving numerous socioeconomic, environmental, and other human security-related problems and making their Arctic regions and cities better and more comfortable places to live in.

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Demographic Development and High North Communities in Eight Arctic States

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Contents

Abstract

The chapter tries to draw a demographic portrait of the modern Arctic region, discovering its main demographic trends and features. The population of the global Arctic is about 4 million people; however, this figure hides significant area differences in the demographic dynamics of the Arctic territories. We reveal that in the Arctic territories, life expectancy indicators are, as a rule, particularly low among indigenous peoples (from Alaska and Canadian Nunavut to Russian Chukotka). In many parts of the Arctic region, life expectancy has increased over the past 10–15 years (including in the Russian regions lagging behind in this indicator). However, the (sometimes very large) gap in life expectancy between the Arctic territories and non-Arctic territories remains in many Arctic states. This shows that even in the oil- and gas-producing Arctic territories, revenues from

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hydrocarbon production (of course, taking into account the peculiarities of their redistribution throughout the country) are not enough to “block” the negative impact of other factors on the life expectancy of the local population, and this problem requires a more detailed study.

Keywords

Arctic region · Arctic territories · Arctic population · Arctic demography · Arctic life expectancy · Arctic fertility

Introduction: What Is the Arctic?

A true “Arctic age” in global research started in the 1980s, to which Arctic ice melting and changing landscape of the region contributed. In 1996, the Arctic Council was created, the leading intergovernmental forum on a variety Arctic issues. In its reports, the Arctic Council includes the following districts and provinces of eight states into the Arctic region: Alaska (the USA); Yukon, the Northwest Territories, and Nunavut (Canada); Greenland (Denmark); Iceland; Finnmark, Troms (these two counties were merged on January 1, 2020), and Norrland (Norway); Norrbotten, Västerbotten (Sweden); Lapland, North Ostrobothnia, and Kainuu (Finland); and many Russian districts and provinces, including the Murmansk Region, the Republic of Karelia, the Arkhangelsk Region, the Republic of Komi, the Yamalo-Nenets Autonomous Okrug, the Khanty-Mansi Autonomous Okrug, the Taimyr Peninsula and Evenki District (now parts of the Krasnoyarsk Kray), the Republic of Sakha (Yakutia), Magadan Region, Koryak District (now part of Kamchatka Kray), and Chukotka Autonomous Okrug (Larsen & Fondahl, 2014, p. 153).

A system and institutional analysis were used in the research. Also, statistical methods of analysis were the important instruments to describe the socioeconomic situation in the Arctic region. The main base of statistical data for the research is the Bulletin of the Federal State Statistics Service of Russia, which details the regions of Russia and socioeconomic indicators as of 2018.

Changes in the institutional and economic conditions for the development of the Arctic region were considered in the works of Baklanov et al. (2021), Degai and Petrov (2021), Dmitrieva and Romasheva (2020), Ilinova et al. (2020), Lasserre (2021), Liu et al. (2021), Stepanov et al. (2021), Voronina (2021), and Waage et al. (2020). Institutional problems of digitalization as direction for public administration and corporate governance were in the focus of Osipov (2020) and Popova (2020).

Demographic Dynamics of the Arctic Regions

In 2013, 4.05 million people lived in the Arctic region (as defined by the Arctic Council), which is 56 thousand (or 1.4%) less than the population recorded in 2000 (Larsen & Fondahl, 2014, p. 53). However, this relative stability of the population numbers masks significant regional differences in demographic changes in particular Arctic regions and even individual settlements.

Thus, the population of Alaska grew by 3.3 times in 1950–2017 (from 135 to almost 740 thousand people), while the general US population grew by 1.8 times during the same years (US Census Bureau, 2019). This was largely due to the discovery of Prudhoe Bay oil and the start of its production, which created lots of new high-paid jobs, attracting internal migrants from all over the country. The total fertility rate here is higher than the national average, at about 2.3 children per woman (and more than 3 children per woman among the indigenous population). Life expectancy, on the contrary, was somewhat lower in Alaska than the national average – 76.4 versus 78.7 in 2015. However, the most problematic issue was the low life expectancy of the Alaskan indigenous population, which at that time only reached 69.7 compared with 78.1 for non-indigenous population, which means that more than 8 years of gap still have to be caught up (McLaughlin & Castrodale, 2017).

Arctic lands of Canada – namely, Yukon, the Northwest Territories, and Nunavut – occupy more than one-third of Canadian territory but hold only about 0.5% of its population (about 120 thousand) (Newfoundland & Labrador Statistics Agency, 2017). Even this number results from a considerable increase in the population of these territories in the late twentieth and the early twenty-first century (the population numbers doubled from 55.4 thousand in 1971 to 121 thousand in 2017, which greatly outpaced the population increase in the whole Canada) (World Bank, 2018). Fertility rates are higher than the national average (1.54 children per woman), but both in Yukon (1.62) and the Northwest Territories (1.8), they are still below the reproduction level. Nunavut stands out here with its three children per woman (Statistics Canada, 2020). As for the life expectancy, which is approaching 82 in Canada, it was lower than the national average in all three Arctic provinces; the gap was particularly dramatic for Yukon, which fell almost 10 years behind the national average (OECD, 2019a).

Greenland, the Arctic region of Denmark, hosts about 58 thousand people (near 1% of the country's population). In 1960–1990 the population of Greenland grew markedly (by almost 70%), but then this growth practically stopped (World Bank, 2018). The fertility rate in Greenland exceeds that of Denmark (slightly more than 2 children per woman vs. 1.7), but life expectancy is markedly falling behind (80.7 in Denmark in 2016 vs. 71.8 in Greenland in 2013).

Iceland is situated somewhat to the south of the Arctic Circle but is still listed among the Arctic states. Its population has been growing stably from 175.6 thousand in 1960 to 281.2 in 2000 and 341.2 in 2017 (World Bank, 2018). The near doubling of the population was made possible by both relatively high fertility (stably around 2 children per woman after the end of the fertility transition) and advancing life expectancy, which exceeded 73 already in 1960 and gained almost 10 years after that, reaching 82.5 in 2015 (World Bank, 2018).

Of the three Arctic provinces of Norway, Nordland is the most populated one, with 243.3 thousand people in 2018; Troms ranks second with 166.5 thousand, and Finnmark, which has the largest territory out of the three (48.6 thousand square kilometers), has only 76.2 thousand (Statistics Norway, 2018c). Thus, the Arctic population of Norway is about 9% of the total population of the country (around 5.3 million). During the last two decades, the population of Norway was generally increasing, but the population dynamics of the Arctic provinces was mixed, as Nordland and Finnmark were losing their population at the beginning of the third millennium, but then the trend changed, and they experienced an increase (not a large one, though) (OECD, 2019b).

Population dynamics in the Arctic provinces of Norway seem to be under the noticeable influence of migration processes. At first glance, migration balance in all three provinces is very modest (440 in Nordland, 528 in Troms, and −42 in Finnmark in 2017). However, these figures conceal the very significant inflow and outflow of the population in these provinces. Thus, in 2017, 7.3 thousand people came to Nordland Province (of which 2.7 thousand were from abroad); in the same year, 6.9 thousand people left the province. Troms had 6.3 thousand in-migrants and 5.8 thousand out-migrants, while Finnmark had 3.0 thousand in-migrants and 3.0 thousand out-migrants (figures rounded to thousands) (Statistics Norway, 2018b). This suggests that migration processes in the Norwegian Arctic are very active; however, a steady population outflow from the northern territories to the more southern regions of the country is not observed.

However, in the medium term, the Arctic regions of Norway may face a decrease in population due to the natural decline associated with a significant drop in fertility. In Norway, overall, the total fertility rate fell from 1.98 in 2009 to 1.62 in 2017; a similar decrease was observed in all three Arctic provinces; the fertility rate drop was especially strong in Troms (from 1.98 to 1.53 children per woman) (Statistics Norway, 2018a).

Sweden's Arctic territories include the Upper Norrland region, located in the far north of the state and crossed by the Arctic Circle. The region includes two counties: Norrbotten (Sweden's northernmost and largest county) and the adjacent Västerbotten. Strictly speaking, only Norrbotten is a part of the Arctic territory per se; however, since most of the demographic statistics of Sweden are presented not by counties but by larger administrative-territorial units (regions), we consider in this part of the study the demographic characteristics of the Upper Norrland region as a whole and of both its constituent counties in particular.

The Upper Norrland region, which occupies 37.4% of Sweden, is one of the most sparsely populated European territories with a population of just over half a million people. The population of Upper Norrland reached a historic maximum (527.4 thousand people) in 1994, after which it decreased until the beginning of the 2000s; then, there was a period of stagnation, and only from the beginning of the 2010s that the population of the region began to grow again (Statistics Sweden, 2018).

To a large extent, the decline in population in the region is due to its decline in the northernmost county of Sweden: Norrbotten. First of all, the sharp drop in the Norrbotten population (most likely due to migration) from the mid-1990s to the beginning of the 2010s is noteworthy: from 267.6 thousand in 1994 to 248.5 thousand people in 2011. This means that over slightly more than a 15-year period, the county lost more than 20 thousand of its population, all while the general population dynamics of Sweden at that time was the opposite, steadily increasing, with growth accelerating since the mid-2000s. Overall, from the mid-1990s to the early 2010s, the population of Sweden went up from 8.8 to 9.5 million people (Statistics Sweden, 2018).

In terms of fertility rates and their dynamics, Norrbotten differs slightly from the average situation in Sweden. In the early 2000s, the total fertility rate in Norrbotten was less than 1.7 children per woman. However, since the mid-2000s, fertility rates started growing both in the country as a whole and in its Arctic part. In 2016, TFR was around 1.8–1.9 children per woman (sometimes even a little higher) in Norrbotten and around 1.7–1.8 in Westerbotten.

As for the life expectancy, here, as in the case of Iceland, there was a relatively slow but steady increase in the last decades of the twentieth century and the start of the twenty-first. However, Sweden's life expectancy was already extremely high in the 1960s by world standards of the time. The life expectancy in Norrbotten and Westerbotten is slightly inferior to the national indicators (both for men and women), but the gap here is by no means as wide as, for example, between life expectancy in Nunavut and Canada average (see above). Indeed, the life expectancy of women in Sweden increased from 76.83 in 1966–1970 to 83.99 in 2013–2017, while the life expectancy of men went up from 71.93 to 80.41, respectively. In Norrbotten County, the dynamics of life expectancy for both sexes was generally consistent with the national one. The life expectancy of women increased from 76.47 to 83.26, while the life expectancy of men grew from 71.46 to 78.94. In Westerbotten County, the dynamics of life expectancy for both sexes was also generally consistent with the national level. The life expectancy of women increased from 76.52 to 83.54, while the life expectancy of men went up from 72.37 to 80.21 (Statistics Sweden, 2018).

Among the 19 regions of Finland, 3 regions belong to the Arctic territories – namely, Lapland (the northernmost region), North Ostrobothnia, and Kainuu. Of the three regions, the largest in area is Lapland, with a territory of 92.66 thousand km^2, more than the two other Arctic regions combined. Lapland is marked by an extremely low population density (2 people per 1 km^2), the lowest not only among the Arctic regions of Finland but also among all Finnish regions as a whole. Currently, the population of the three Arctic regions of Finland is just over 12% of the total Finnish population, while the total area of the Arctic regions (149,667 km^2) is slightly more than 44% of all Finnish territories.

In the Arctic regions of Finland, compared with the population dynamics of the country as a whole, between 2001 and 2017, Finland's population steadily increased from 5.2 to 5.5 million, but in the three Arctic regions combined, there was a fairly significant population growth over most of that period as well; indeed, from 2003 to 2017, the population living in the Arctic regions of Finland has increased from 648 to 666 thousand people (though in the last 2–3 years the growth has slowed down) (OECD, 2019b).

However, when instead considering the demographic dynamics of each Arctic region of Finland separately, more heterogeneity is revealed. Of all three regions, a steady and significant population growth during the indicated period was only observed in North Ostrobothnia (from 369 to 408 thousand people in 2001–2017). This means that the population of this region grew by more than 10% since 2001, i.e., population growth rates here were higher than in Finland as a whole. However, in the two other Arctic regions of Finland, an opposite situation was observed – the population here steadily declined throughout the entire period under consideration. The number of residents of Lapland fell from 192 to 180 thousand people and the number of residents of Kainuu from 90 to 78 thousand people (OECD, 2019b). In both cases, the absolute value of population decline was 12 thousand people over a 17-year period. However, in relative terms, this decline was more "palpable" for Kainuu, as this sparsely populated region lost about 10% of its population. Unfortunately, there is no data on in- and out-migration at this level; however, it seems quite logical to assume that migration was largely "responsible" for the loss of population by Lapland and Kainuu.

The demographic trends observed in recent years indicate that the population decline may exacerbate – indeed, throughout the 2010s, fertility rates fell sharply in Finland, from 1.87 children per woman in 2010 to 1.49 in 2017. This drop was also visible in the Arctic regions, where the total fertility rate for the same period fell from 2.01 to 1.52 in Lapland and from 2.04 to 1.79 in Kainuu. The "luckiest" one here was North Ostrobothnia, where the fall was also noticeable, but the number of children remained high, as the original number of children was significantly higher: here the decrease was from 2.4 to 1.91 children per woman (Official Statistics of Finland, 2018a).

As for life expectancy (Finland being one of the world leaders in this indicator), in all three Arctic regions, this indicator has slightly lower values than in the country as a whole; however, there is not such a dramatic gap as, for example, between Canada as a whole and Nunavut. In 2014–2016, life expectancy was 81.24 in Finland as a whole, 80.57 in Lapland, 81.57 in North Ostrobothnia, and 80.29 in Kainuu (Official Statistics of Finland, 2018b).

Russia presents the trickiest case in terms of demographic analysis of its Arctic territories. Firstly, even though we listed Russian Arctic territories according to the Arctic Council report in the beginning of this chapter, this is not the list Russia officially uses. Indeed, Russia approved its own list of Arctic territories in 2014, with some additions made to it in 2017 and 2019. Russian Presidential Decree No. 296 of May 2, 2014, approved of the following list of Russian Arctic territories: the Murmansk Region, the Nenets Autonomous Okrug, Chukotka Autonomous Okrug, the Yamalo-Nenets Autonomous Okrug, the city of Vorkuta (in the Komi Republic), parts of the Republic of Sakha (Yakutia), the city of Norilsk, two parts of the Krasnoyarsk Kray, the city of Arkhangelsk and other municipalities in the Arkhangelsk Region, and a number of lands and islands in the Arctic Ocean. Later on, three municipalities of the Republic of Karelia and some more territories of the Republic of Sakha (Yakutia) were added to the list.

Demographic Dynamics of the Russian Arctic

Developing and legally defining the territories comprising the Russian Arctic Zone was a necessary step, as this Zone is a special object of state policy and regulation. However, analysis of the demographic dynamics of the Arctic territories of the Russian Federation is complicated by the fact that the Arctic Zone includes very different units, such as whole regions, cities, and municipalities or some individual areas within a region. Thus, it becomes methodologically incorrect to compare, for example, the migration balance of a single city (even a large one) and a whole region, since different factors influence the dynamics of migration flows at different levels. Moreover, in those constituent entities of the Russian Federation that only partially enter the Arctic Zone, there may be migration between the Arctic and non-Arctic territories within the subject (which, obviously, cannot be the case in the subjects that have entered the Arctic Zone as a whole). For a number of reasons, it is incorrect to compare the birth and death rates in the regions and individual municipalities (due to the peculiarities of birth and death registration).

It should also be taken into account that data on the Arctic Zone of the Russian Federation as a single region has been provided only since 2014, and therefore the long-term dynamics of the population in the entire Russian Arctic cannot be tracked (although it is known that it experienced a significant decline in the 1990s and the subsequent period of slow recovery). However, it can be seen that at present, the population of the Arctic Zone of the Russian Federation continues to decline, from 2.4 million people as of January 1, 2014, to 2.37 million by January 1, 2017. In 2018, the level of 2.4 million was regained, but this happened due to the inclusion of the Republic of Karelia into the Arctic territories. (Federal State Statistics Service. Calendar of publication of official statistical information on the socioeconomic development of the Arctic Zone of the Russian Federation in 2018. Item No. 84. Estimation of the resident population as of January 1 of the current year and on average for the previous year. 02.07.2018. URL: http://www.gks.ru/free_doc/new_site/region_stat/calendar1-2017.htm.)

In this situation, it seems reasonable to trace the population dynamics of the regions of Russia which, wholly or partially, enter the Arctic Zone (Table 1).

The most visible trend is that, despite economic growth and social improvements achieved in Russia in the 2000s and the 2010s, population loss never stopped (and is currently continuing) in four out of nine regions of Russia which enter the Arctic Zone (wholly or partially), including in the second-largest such region, the Arkhangelsk Region (which can even be called the largest one, given that the formal definition of the Arctic Zone does not include the Krasnoyarsk Kray as a whole, but only some of its parts). In order to understand whether catastrophic mortality continues to contribute to this population loss (as was the case in the 1990s), let us view the dynamics of life expectancy situation in these regions (Table 2).

First of all, all the regions in Table 2 made remarkable gains in life expectancy in 2000–2017: in many cases close to 9–10 years. Taking the average Russian life expectancy as a reference figure, only one Arctic region – the Yamalo-Nenets Autonomous Okrug – exceeds the average Russian life expectancy at any given time point in the table. The rest of the regions are generally lagging behind the Russian level, but the gap is not catastrophic, usually 1–2 years. The only region which can be still called a true demographic catastrophe is Chukotka Autonomous

Table 1 Population (thousands) of the regions of Russia which, wholly or partially, enter the Arctic Zone, various years

	2005	2010	2015	2017
Komi Republic	963	899	857	841
Arkhangelsk Region (without the Nenets Autonomous Okrug)	1240	1183	1130	1111
Murmansk Region	839	794	762	754
Krasnoyarsk Kray	2869	2829	2866	2876
Yamalo-Nenets Autonomous Okrug	517	525	534	538
Nenets Autonomous Okrug	42	42	44	44
Chukotka Autonomous Okrug	52	51	50	50
Republic of Karelia	676	643	630	622
Republic of Sakha (Yakutia)	954	958	960	964

Source: Calculated by authors on the basis of the Bulletin of Federal State Statistics Service of Russia. 2018. Regions of Russia. Socio-Economic Indicators. Moscow: Rosstat, 2018 (In Russian)

Table 2 Total life expectancy (years) of the regions of Russia which, wholly or partially, enter the Arctic Zone, various years. Russian level presented for comparison

	2005	2010	2015	2017
Russian Federation	65.37	68.94	71.39	72.70
Komi Republic	62.12	66.87	69.40	71.05
Arkhangelsk Region (without the Nenets Autonomous Okrug)	62.97	67.99	70.70	71.96
Murmansk Region	63.83	68.43	70.24	71.67
Krasnoyarsk Kray	63.02	67.57	69.69	70.61
Yamalo-Nenets Autonomous Okrug	67.58	70.05	71.70	73.53
Nenets Autonomous Okrug	62.97	64.92	71.00	71.52
Chukotka Autonomous Okrug	58.48	57.49	64.16	66.10
Republic of Karelia	61.84	66.42	69.16	70.65
Republic of Sakha (Yakutia)	64.68	66.75	70.29	71.66

Source: Calculated by authors on the basis of the Bulletin of Federal State Statistics Service of Russia. 2018. Regions of Russia. Socio-Economic Indicators. Moscow: Rosstat, 2018 (in Russian)

Okrug, which at the beginning of the 2000s had a total life expectancy comparable with some least developed countries experiencing violent internal conflicts. In the 2000–2017 period, it made remarkable success, gaining almost 7 years. Still, it is visibly lagging behind both Russia in general and its Arctic counterparts (metaphorically saying, Chukotka is now living in the rest of the Russian Arctic's year 2010) and should be a focus of immediate policy attention.

Finally, let us regard the fertility situation in Russian Arctic (see Table 3).

Two notable features should be mentioned when describing the fertility situation in the Russian Arctic. First, almost all regions (except for Murmansk Region and the Republic of Karelia) have total fertility rates higher (not infrequently, significantly higher) than the Russian average. Second, the dynamics of their TFRs generally runs parallel to the dynamics of the Russian TFR.

Table 3 Total fertility rate (children per woman) of the regions of Russia which, wholly or partially, enter the Arctic Zone, various years. Russian level presented for comparison

	2005	2010	2015	2017
Russian Federation	1.294	1.567	1.777	1.621
Komi Republic	1.364	1.625	2.002	1.779
Arkhangelsk Region (without the Nenets Autonomous Okrug)	1.342	1.614	1.818	1.651
Murmansk Region	1.253	1.486	1.714	1.565
Krasnoyarsk Kray	1.303	1.614	1.837	1.666
Yamalo-Nenets Autonomous Okrug	1.571	1.785	2.188	1.948
Nenets Autonomous Okrug	1.809	2.109	2.584	2.350
Chukotka Autonomous Okrug	1.910	1.888	2.097	2.079
Republic of Karelia	1.304	1.577	1.766	1.561
Republic of Sakha (Yakutia)	1.732	1.998	2.191	1.927

Source: Calculated by authors on the basis of the Bulletin of Federal State Statistic Service of Russia. 2018. Regions of Russia. Socio-Economic Indicators. Moscow: Rosstat, 2018 (in Russian)

Conclusions

When talking about the Arctic region, one should remember that it is not an integrated region united through a complex network of intensive social, demographic, economic, and other interrelations (trade, finance, investment, etc.); rather, from an economic point of view, the Arctic is singled out as a particular region due to the similarity of various important characteristics of its constituent parts. However, since the Arctic territories cross the borders of various countries, specific national conditions also have a strong influence on the development of particular Arctic territories.

The population of the global Arctic is about 4 million people. However, this figure hides significant regional differences in the demographic dynamics of the Arctic territories. Some territories (say, Alaska in the times of the Prudhoe Bay discovery) managed to attract quite a lot of new population. However, a more typical situation for Arctic territories is to retain a rather stable population or experience a slow decline. Again, another well-known extremity here is the colossal population loss of the Russian Arctic in the 1990s. However, we have shown that the two recent decades saw either a near-stagnation of the population in the regions of Russia which enter (wholly or partially) the Arctic Zone or (in four out of nine cases) continued decline but not of a catastrophic scale (certain Arctic areas of some Scandinavian countries have lost up to 10% of their respective populations in quite a short time, as well). This poses a question worthy of separate research – how many people does each Arctic state "need" in its Arctic territories in order to keep the economy, governance, and other spheres of development going? This same question, from the people's point of view, would require investigating: what conditions and stimuli are needed to make living in the Arctic attractive to people?

The quality of life is well approximated by the indicators of life expectancy. In the Arctic territories, life expectancy indicators are, as a rule, slightly lower than their respective national averages. The figures are particularly low among indigenous peoples (from Alaska and Canadian Nunavut to Russian Chukotka). In general, within the Arctic, there is a significant differentiation in terms of life expectancy, from more than 82 in Iceland to slightly more than 66 in the Chukotka Autonomous Region of Russia. In general, it can be noted that in many parts of the Arctic region, life expectancy has increased over the past 10–15 years (including in the Russian regions lagging behind in this indicator). However, the gap in the indicator of life expectancy between the Arctic territories and non-Arctic territories remains in many Arctic states and in some cases has a very significant scale. This shows that even in the oil- and gas-producing Arctic territories, revenues from hydrocarbon production (of course, taking into account the peculiarities of their redistribution throughout the country) are not enough to "block" the negative impact of other factors on the life expectancy of the local population, a problem which requires a more detailed study. Migration processes in the Arctic territories also deserve a separate study – the outflow of population from the northern territories is considered a "traditional" problem, which is also relevant for many territories in the Arctic Zone of the Russian Federation; however, in the Norwegian Arctic, for example, although migration processes are very active, there is no steady outflow of population from the northern territories to the more southern regions of the country. This case, like the entire Arctic migration picture as a whole, certainly deserves a closer look.

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Housing Infrastructure Development in the Arctic

"Smart House" Systems

Natalia G. Sidorova, Anastasiia R. Druzhinina, and Maksim A. Nedostup

Contents

Abstract

The potential of the Arctic is great, and its forecast resources are huge. In the future, these reserves will become the basis of economic development not only in Russia, but also in the whole world, as traditional sources of raw materials are gradually being depleted. The Arctic is a great source of oil, gas, and other minerals and a potential place to live. However, harsh climate, lack of infrastructure, and logistics problems turn life into a daily struggle. It is a great challenge to create an infrastructure there: The average winter temperature in some areas reaches −70 degrees Celsius, instead of the soil there are frozen silt and swamps, and strong snowstorms and earthquakes prevent the territory from settling in. However, Arctic is a best testing ground for alternative energy. Cold climate turned out to be an unexpected advantage for the IT infrastructure and smart technologies, especially for alternative solutions for residential infrastructure.

Keywords

Arctic · Smart house · Internet of Things · Ecology · Project · Innovation

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Introduction

Currently, the Arctic region is a great strategic priority for the world economy. It has huge amounts of natural resources, especially gas and oil. According to the forecast of the Ministry of Natural Resources and Ecology of the Russian Federation, about 20% of the world's hydrocarbon reserves are concentrated in this territory (Chvileva, 2020). The region is also rich in other minerals, in particular containing significant reserves of coal, gold, nickel, platinum, and diamonds.

One of the most important reasons for the development of Arctic, Antarctic, subarctic, and subantarctic climatic zones of the Earth is the Northern Sea Route, which is one of the key transport routes for the Nordic countries. It has sufficient potential to become a leading international transport artery, competing with the Suez Canal for the title of the main transport route for sea cargo transportation between Europe and Asia. For much of 2019, the cargo transportation indicator along the Northern Sea Route amounted to 26 million, and according to experts' calculations, by 2026 the cargo turnover of the route will be approximately 80 million tons.

The growing interest in the development of the sea route and minerals of the region is caused by global warming, due to which the area of icy marine territories is gradually decreasing. This opens up new prospects for the settlement of territories located beyond the Arctic circle, as well as the placement of permanent bases of the largest mining companies. At the moment, polar stations are being actively restored in the Arctic, seaports are being built, land plots are being built up, and tourist routes are being developed (Detter et al., 2021).

However, the development of the region is hindered by the difficult climate and the unsatisfactory condition of housing and communal facilities, which makes it quite difficult to attract people to work in the Arctic. The development of residential infrastructure in the Arctic should be the key to increasing the human resources potential of the region (Osipov et al., 2018; Osipov, 2019; Yankovskaya et al., 2021). Good housing conditions will help attract more people, which will help the economic development of the region. Moreover, it is necessary that the conditions created at the bases of companies, polar stations, and other residential premises are much better than in ordinary houses. The best housing conditions compensate for the harsh climatic situation.

The construction of new residential areas and major repairs of old ones should be accompanied by a complete update of all engineering systems. There is the low efficiency of using energy resources associated with outdated power grids and significant heat losses that occur against the background of a cold climate in the region. Because of this, more energy resources are consumed to maintain a comfortable temperature. This has the most negative effect on the regions of the Far North and polar stations, where there are no centralized energy supply and heating systems (Zakharov et al., 2020). The efficiency of thermal networks in isolated areas of the Arctic is extremely low, although the amount of energy produced is excessive. Also, there are high prices for energy resources and low provision of households with fuel and heat consumption accounting systems in these areas. It indicates the need to optimize the energy supply systems of residential buildings or to find other solutions that can reduce energy losses (Didenko et al., 2021).

Main Focus

The following research is an overview of housing infrastructure and a proposal of a "Smart house" project system adapted to functioning in severe climatic conditions and capable of significantly improving the energy efficiency of residential buildings at polar stations and in the regions of the Arctic, Antarctic, subarctic, and subantarctic climatic zones of the Earth. This study, focusing on these regions, addresses the objectives of assessing the effectiveness of the innovation in terms of:

1. Enhancing living standards.
2. Maintaining living conditions in terms of sustainability and closed loop economy.
3. Security of private information and property.

To address these three objectives, the following procedures were conducted: a SWOT analysis and calculations of economic indicators – NVP, IRR, etc.

The chapter presents the analysis of international experience in the field of IoT and Smart Houses, currently implemented solutions, and an overview for the next decades in the regions with severe climatic conditions. The study provides information on the project, which is recommended for implementation at polar stations and Arctic, Antarctic, subarctic, and subantarctic climatic zones of the Earth.

Smart Houses as a Viable Solution for Arctic Housing Development

The problem of harsh living conditions in remote areas of the Arctic is universally recognized. Every country that has regions beyond the Arctic circle is working on a solution to create convenient conditions for living there with low energy use, which will attract more people and help to boost development of the region (Lundqvist et al., 2020).

Smart houses are not the only option available for tackling this problem; for example, Russian scientists are actively proposing house building solutions based on prefabricated wooden structures and other materials with high thermal inertia.

In Denmark, a unique administrative building was created. Its architectural and design solutions proved to save around 75% of energy resources. The core of its effectiveness is a geothermal heat generated by innovative heat pump (Homius, 2021).

In many European countries, the Triple Zero concept is gaining popularity (Slimak et al., 2018). It is based on alternative energy sources, such as solar and wind energy, and aims at zeroing out energy consumption by usage of renewables. The analysis of these and other popular existing solutions of huge energy costs poor quality of living conditions is given in Table 1.

Table 1 Analysis of technological solutions applicable in Arctic

Option of Arctic housing development	Advantages	Disadvantages
Houses built from prefabricated wooden structures	Simplicity of construction achieved by usage of prefabricated wooden structures, high thermal inertia which preserves warmth and durability. The latter is attributes to wood's frost resistance that helps withstand northern sharply continental climate better than ferroconcrete	Difficult construction of technical building system; need to construct new building and create new ways of urban planning in small Arctic municipalities
Smart heating boilers	Ecological safety and simple installation, house temperature control, and significant energy economy that varies from 15% to 30%	Boiler malfunction will likely result in the crash of the whole electricity and heating system of the house, which is difficult to fix by unqualified person
Autonomic residential complexes	Residential complex made as a stilt house decreases technical building system heat loss and solves the problem of occasional snowdrifts that can occur after long blizzards and block the exit door. Concentration of facilities that provide basic necessities, such as shops, agricultural plantations, kitchens, and even social institutions (e.g., schools, medical post) provides high autonomy	Expensive construction that requires accurate urban planning and particular human resource
Solar batteries and energy-saving glass	Significantly less negative impact on the environment, lower heating and electricity costs, a positive impact on health due to increased glass coverage which results in better supply of vitamin D received by residents	Small energy effectiveness, especially in northernmost areas, where such the phenomenon of polar nights usually delays sun from shining for days
Triple Zero	Drop of the following indicators: energy consumption, emissions, and waste. Complex solution optimized to maximize the benefits of natural conditions	Energy effectiveness depends on climate conditions (daylight, wind, etc.), which are poor in the northernmost areas
Smart houses	Complex solution with simple installation and repair, energy effectiveness achieved by economy, small price compared with other solutions, individual solutions which can be easily customized for the needs of every household	Absence of special for Arctic solutions on the market, regular spending on batteries, difficult integration of products (sensors, actuators, etc.) made by different brands, sophisticated controls, which might be hard to understand by new users, possible overheating of microcontroller that can failure the entire system

Source: compiled by the authors

According to the table, there are several reasons why smart house technologies are the best option to tackle the problem of hosing infrastructure in the Arctic region:

1. The solution is complex: A smart house will not only save a lot of energy, but it will also greatly improve comfort of the house, performing both difficult (temperature management) and simple (lightning and power socket control) tasks for its residents.
2. The approach has a great efficiency and a relatively small price.
3. Smart houses can be used alongside another solution. A smart house is flexible and can be used as a complimentary technology with any option given in the table above and dramatically boost its overall efficiency.
4. Houses are likely to be eco-friendly, eschewing CO_2-heavy manufacturing processes.

This chapter proposes a complex artificial intelligence (AI)-based smart house solution capable of automatic control of every household technological system. Sensors, crafted specifically for Arctic conditions, will withstand frost and humidity, and microcontroller will be protected from overheating by special design and AI technologies that will predict a possible dangerous situation and automatically manage temperature, humidity, and electricity.

The proposed technological solution consists of:

- Connectivity modules to provide stable connection to the Internet required to set up remote control of the system
- Digital temperature sensors to automatically manage temperature in the building
- Motion sensors to track the movement of house residents which will significantly increase the energy efficiency
- Humidity sensors and fire sensors to manage and predict dangerous situations
- A microcontroller with AI module: a special algorithm that will control every aspect of the house using the information from the sensors and translating commands to the actuators
- Smart power sockets and smart lamps
- A control panel to manually control the system
- Actuators to perform actions (turn off the lights, increase temperature, etc.)
- Smart locks

Another feature of this smart house system is a mobile application, which will help residents monitor the current situation in the house. This application will send push notification in case of dangerous situations and give customers advice for house management with the help of the AI module.

All components of the system should be designed for the harsh Arctic climate and be frost resistant and durable. Any failures would be very hard to fix, especially in remote Arctic areas where it could take days for a qualified specialist to arrive and help. So, the system should be very stable.

There are two types of smart house systems: wired and wireless. In the first case, a microcontroller, sensors, actuators, and other parts of the system are connected by wires. Its advantage is the high accuracy of the command execution. However, it is difficult to install or repair, because multiple wires should be hidden inside the special constructions in order to maintain house aesthetics and protect wires from damage.

Wireless option is easier to install and maintain, because it uses radio waves to transfer information from one element of the smart house to another. If one of the sensors is out of order, it could be simply replaced with another. Thus, the wireless option is more suitable for remote houses.

Different studies say that usage of smart house technologies can decrease energy consumption of any building by 20–40% (Kumar et al., 2021). In the northern regions of the Arctic, this number will definitely be higher, because of the enormous heat loss that local houses have now. Energy is quite expensive in these areas, so smart technologies powered with AI will surely save money for the house owner and pay off in long term.

SWOT Analysis

To roughly assess the risks of this project, we conducted a SWOT analysis. The planning horizon is the Present.

Notation: S-strengths, W-weaknesses, O-opportunities, T-threats.

Scores: Z-score, P-importance for us, V-significance (calculated as Z*P).

Each indicator is evaluated considering its significance (V) – an assessment of its importance for doing business, considering the certainty of this assessment.

The introduction of these estimates makes it possible, among other things, to display the significance of strengths, weaknesses, opportunities, and threats on diagrams, compare them with each other, and visually assess the attractiveness of the starting position of a new business (Fig. 1).

Strengths and Opportunities – The project is investment attractive, due to the use of Russian technologies and unique complex solution for current problems in the regions with severe climate conditions, especially the Arctic.

Strengths and Threats – The first stages of the project would not be affected by an unstable economic situation and investments. Both threats could be covered with bootstrapping for start-stages of 3D modeling, experimental model, etc. In case government would not support projects in the Arctic, the project would implement solutions in other regions.

Weaknesses and Opportunities – With the support from Association of Green Universities, the project could find and employ specialists in the field of construction in the Arctic among students and teachers in universities. According to a representative of the Federal Agency for Maritime and River Transport (Rosmorrechflot), the infrastructure is currently developing, and by 2026 there will be the Internet in Arctic (RBC, 2021).

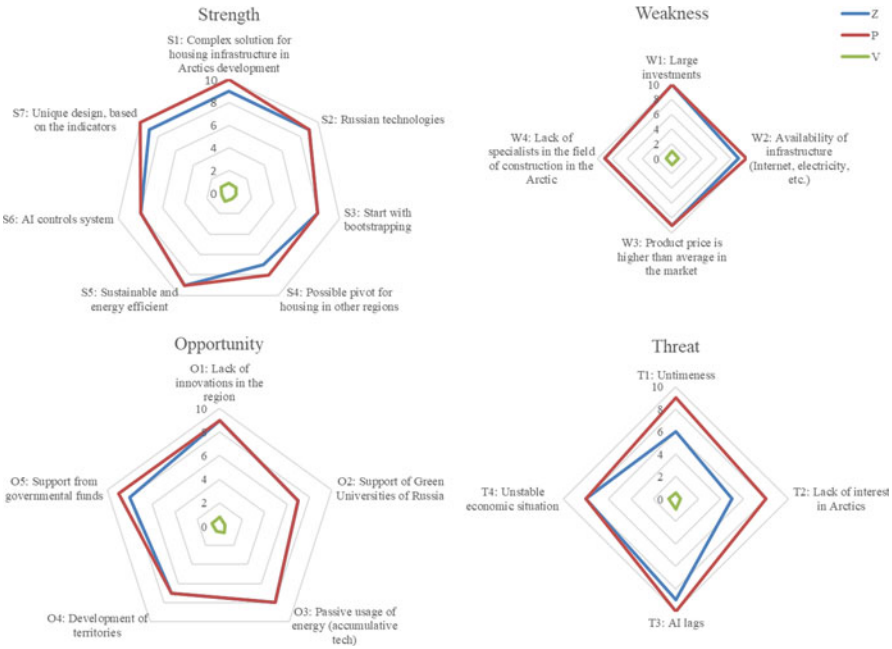

Fig. 1 SWOT-analysis of the project smart house in Arctic. Source: compiled by the authors

Weaknesses and Threats – The project needs appropriate marketing, with a financial plan, in order to be ready for any issue, and to attract investors, especially on the final stages.

To apply this solution on the market, we suggest creating a project and attracting venture investments. Thus, it is necessary to analyze its costs, which can be split into three types:

1. Fixed costs:
   - Tools
   - Depreciation
   - Salary and insurance contributions
   - Rental payments for office and workshop
2. Variable costs:
   - Raw materials to create sensors
   - Travel expenses
3. Initial costs:
   - Computers
   - Hardware for sensor and controller assemblance

In order to accurately estimate salary expenses, a project team should be described. Assemblage of system parts and programming does not require many

Table 2 Structure of annual costs

Name	Costs (₽ million)
Salary	6360
Tools	100,000
Insurance contributions	1908,000
Travel expenses	1272,000
Depreciation	600,000
Rental payments	1,200,000
Materials	4,500,000
Total	**15,940,000**

Source: compiled and calculated by the authors

people, so the project team will be relatively small. The project is based in Russia, so average salaries on Russian labor market were analyzed. Insurance contributions in Russia are 30% from salary (Kontur, 2021). Total salary and insurance expenses for the first two years of project are estimated at 1908 thousand rubles.

Travel expenses is money spent in installation trips when part of the project team goes to the customer and sets up the smart house. It can be approximately counted as 20% of the salary budget, which equals ₽1272 thousand.

Other costs involved in the project are rental payments and depreciation. Average rental cost of small manufacturing building with office and warehouse is around ₽1.2 million annually.

Depreciation can be counted by dividing initial costs on the depreciation norm, which include equipment and machines needed to assemble sensors and micro-controllers as well as computers needed to program the whole system. Estimated initial costs are ₽3 million; divided by depreciation norm of 5 years this will result in ₽0.6 million of annual depreciation.

Total annual costs of project in 2021 prices are ₽15,940 thousand, detailed in Table 2.

Profit tax is not included in costs due to the possibility of becoming a special economic zone resident, which grants 5 years of 0% profit tax.

The proposed project has a relatively small number of external threats and clearly outmatches any other solution in the Artic segment. Judging by that and strong interest from the Russian government in complex Russian IT-solutions, it has a major chance of attracting investors and securing the significant share of internal market.

Discussion

The key task of the project is to create a product that would make the lives of people who live in severe climatic conditions more convenient, as well as to solve the problem of the enormous energy costs there. It is necessary to find investments to implement such a project. In order to do this, the authors analyzed its investment effectiveness.

Key investment effectiveness indicators:

- Initial investments – ₽16,000 thousand
- NPV – ₽8997 thousand
- IRR – 33
- DPP – 3 years
- PI – 1.56

The discount rate used for the analysis was 15%. It was calculated by summation of Russian Central Bank refinance rate, which equals 5.5%, the current inflation ratio in Russia – 4.5%, and risk premium that was set at 5% (CBR, 2021). Estimated indicators show that the project has potential and high chances of attracting investors. Its Initial Rate of Return is 33%, which is quite high and shows a large safety margin. Even if the project encounters moderate risks or requires more resources, it will still be profitable.

User Effectiveness

In order to make assumptions about potential demand in the product, it is necessary to analyze its user effectiveness. The average price of electrical energy in Russian Arctic is around ₽100 for 1 kilowatt per hour which is 30 times more than average price in other Russian regions. This is caused by the usage of isolated electro stations with low efficiency powered by diesel fuel. The average price of the proposed solution for the customer is ₽600 thousand. Monthly energy consumption for one person in country house is 220 kilowatt per hour (Oschetchike, 2021). For the sake of this research, an average family of three people will be considered the project's target customer. The estimated energy economy of the proposed smart house system is 40%. Payback period (PP) for this family is calculated in the formula 1.

$$PP = \frac{(220 * 3 * 12 * 100) * 0,4}{600000} = 1.89 \tag{1}$$

Therefore, with payback period less than two years, the proposed system is effective for people who live in remote northern regions. It will give people a major boost in the quality of life, taking care of daily energy management routine and saving them a huge amount of energy, which will help to balance the enormous energy costs of these areas.

Conclusions

The proposed smart house project in severe climatic conditions at polar stations and in the regions of the Arctic, Antarctic, subarctic, and subantarctic climatic zones of the Earth is an effective, socially necessary, and multifunctional complex that might be implemented under the national goals and the Ecology national project of the Russian Federation. It is capable of significantly improving the energy efficiency of residential buildings and being helpful in terms of continuation of the settlement in these regions.

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Construction Risk Management in the Northern Climatic Zone

Vadim O. Evseev

Contents

Abstract

The construction process in the northern latitudes, in the far north, is accompanied by many risks that increase the time and cost of construction, which reduce the reliability characteristics of machines and workers. The main factors that create risks are weather conditions, insufficient information, and the lack of necessary professional competencies. The proposed work investigates the influence of climatic conditions on the performance of the construction process and the characteristics of the elements of the construction process: construction machines, workers, estimated cost of construction, and reliability of construction terms. The risks from weather conditions are calculated as an indicator of the severity of the weather, which takes into account the outdoor temperature and wind speed. The study of the influence of factors of insufficient information and insufficient professional

This chapter is a continuation and generalization of the author's previously published works "Modeling the reliability of the schedule of construction work" (Evseev 2020) and "Modeling the influence of weather and climatic conditions on the safety characteristics of the construction process" (Evseev et al. 2019).

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competence on the characteristics of the construction process was studied using the method of simulation modeling. The purpose of the study is to identify regression–correlation relationships between the indicators of weather hardness and the corresponding indicators of the elements of the construction process: the fund of workers' working hours, the coefficient of technical readiness of construction equipment, an increase in the estimated cost of construction, an increase in labor costs for the restoration of construction equipment, and the determination of additional costs by type of work. Also, the purpose of the study was to determine the acceptable level of professional competence of personnel and the acceptable level of incompleteness of primary information required for construction work. The use of the simulation model makes it possible to optimize management decisions, reduce construction risks, and reduce the estimated cost of construction. The model showed the possibility of managing construction risks, which made it possible to minimize deviations from the standard indicators of construction.

Keywords

Northern construction zones · Weather severity · Personnel competence · Information quality · Reliability of construction · Regression dependencies · Simulation modeling

Problem Statement

The Strategy for the Development of the Arctic Zone of the Russian Federation and Ensuring National Security for the Period up to 2035, approved by Decree of the President of the Russian Federation No. 645 of October 26, 2020, notes the features of its development: 1) extreme natural and climatic conditions that contribute to the emergence of risks for economic activity and the environment, 2) possible growth of conflict potential, 3) the probabilistic nature of the occurrence of events, 4) a high level of professional risk, and 5) a low level of development of information and communication infrastructure.

In the Decree of the President of the Russian Federation, the number of priority measures is: identification and analysis of the risks of natural and man-made emergencies and development of ways to prevent such situations.

Taking into account the peculiarities of the impact of climatic zones during the construction of infrastructure facilities is implemented in the form of a regulatory document "Set of rules. Construction climatology (Construction climatology). Updated edition. SNIP 23-01-99." The set of rules was compiled in order to increase the level of safety of people in buildings and structures and the safety of material assets in accordance with Federal Law No. 384-FZ of December 30, 2009 (Federal Law), "Technical Regulations on the Safety of Buildings and structures," to increase the level of harmonization of regulatory requirements with European and international regulatory documents and the use of uniform methods for determining operational characteristics and assessment methods.

The territory of Russia is divided into seven climatic zones (in which economic activity is carried out and in which new infrastructure facilities in the industrial and social spheres are being built).

Figure 1 shows the schedule of construction works that are carried out throughout the year, that is, in different weather and climatic conditions. As can be seen from Fig. 1, construction works are carried out throughout the year with various indicators of the severity of the weather, which complicates the work and increases the cost of the work.

According to formula 1, for the northern regions of Tyumen and Surgut, the indicators of weather severity are calculated, which have critical values in winter and affect the characteristics of those works that are carried out during this period.

Each construction work presented in Fig. 1 is described by certain characteristics: the duration of the work; the level of information uncertainty, which depends on the quality of design and estimate documentation; and the level of competence of personnel, which is determined by their qualifications and professionalism and the quality of decisions made.

Any construction process is a complex managerial, organizational, and technological system and is located in the following coordinate system: normative indicators of construction and stochastic/probabilistic indicators of construction. This coordinate system includes both the information contour of the management of

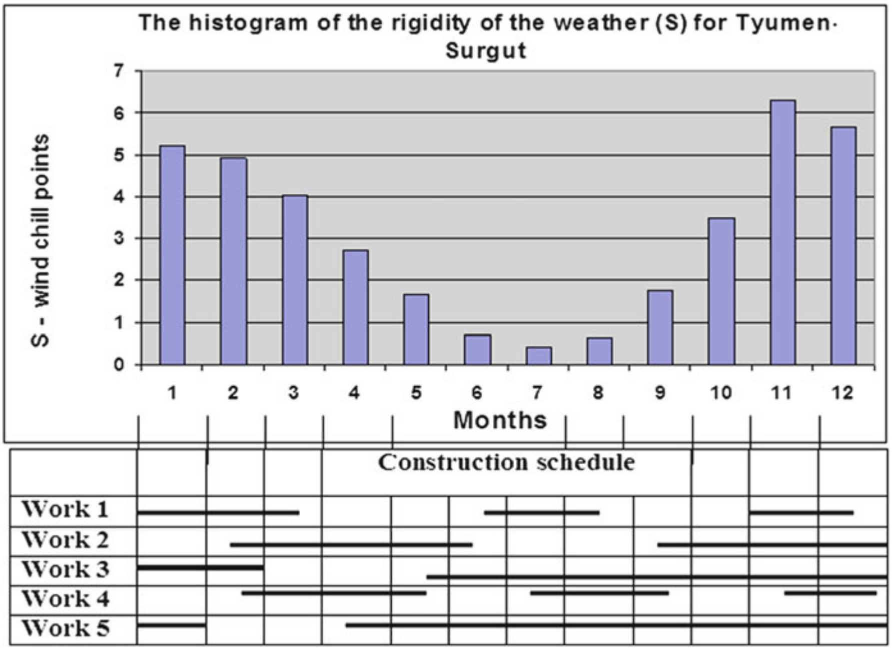

Fig. 1 Construction schedule and weather severity histogram. Source: adapted from Evseev et al. 2019

construction processes and the competence of the staff (Evseev and Skryl 2018; Borkovskaya 2014).

The contour of the construction process management system consists of a complex set of tasks of accounting, analysis, forecasting, decision-making, delegation of authority, control over the implementation of decisions, control over the effectiveness/efficiency of management decisions, and selection of corrective and control actions (Kotelnikov et al. 2012). Of course, everyone understands that the information in the project documentation may be incomplete, inaccurate, and unreliable, the methods of analysis may not be adequate and not systematic, and when planning it is impossible to take into account all the risks and nuances associated with the elements of the construction process. All this suggests that the scheme of the management system contains elements of uncertainty from climatic conditions, the level of competence, and the quality of information, and therefore, all management decisions made in the construction sector are classified as "decisions in the field of risk and with a certain level of risk" (Evseev 2017; Barkhi et al. 2018; Evseev and Seleznev 2021).

Personnel competencies are also located in the normative and stochastic/probabilistic coordinate system, since the qualitative and practical characteristics of personnel always have a discrepancy with a plus or minus sign, and the competence of construction departments is also a function of the quantitative and qualitative characteristics of the totality of employees in these departments (staffing and staff turnover, illness and absenteeism, downtime caused by lack of proper experience, combining professions, motivation, emotional state, constructive or destructive attitude to work, etc.).

Thanks to the acquired practical experience and acquired knowledge, sets of professional competencies of personnel are formed, which are characterized by new certain quantitative and qualitative indicators.

By definition, if the parameters of the elements of a complex system include probabilistic characteristics, then the output function of the entire system also has probabilistic characteristics. It is possible to find probabilistic characteristics (mathematical expectation, variance, and distribution law) of output parameters of a complex system (construction process) only by the method of simulation modeling, which is widely used not only in construction, but also in other spheres of life.

It is also necessary to recall the content of the concepts of reliability and safety in construction:

1. Organizational and technological reliability of construction means the ability of technological, organizational, managerial, and other decisions to ensure the fulfillment of the main indicators of construction: planned deadlines, cost, and regulatory quality of the construction of an object under the influence of disturbing factors inherent in construction as a complex dynamic system (Borkovskaya 2013; Osipov et al. 2016; Skryl et al. 2017).
2. The safety of a construction object is a condition in which there is no unacceptable risk (Bardenwerper et al. 2018; Polyakova et al. 2018) associated with harm to the life or health of citizens, property of individuals or legal entities, state or

municipal property, the environment, life or health of animals and plants as a result of destruction, damage to the construction object, and violation of safety requirements during the construction of such an object (Osipov et al. 2016).

Literature Review

The analysis of the scientific literature has shown the importance of studying the influence of the factor of climatic conditions both in construction and production and on people, economic indicators, and reliability indicators. Let us list some research works in the listed areas.

Sokolov (2015) considered the climate risks of Russia in his article. Makosko (2021) considered climate risks and the economic complex of Russia in the XXI century in his work. Boyarshinov et al. (2019) studied the influence of weather and climatic conditions of the Republic of Sakha (Yakutia) on road accidents. Savin (2013) in his scientific work studied the influence of weather and climatic conditions in Russia on the economic safety of industrial organizations. Avdotyin et al. (2012) conducted a study on the assessment of damage from natural and man-made emergencies. Komogorova (2014) examined the features of the influence of weather and climatic conditions on human health. Sergeeva (2020) has done a lot of work on the statistical analysis of the influence of climatic conditions on the economic development of Russian regions.

Risks introduce temporary and economic uncertainty in the construction schedule, in the estimated cost of construction, especially in the northern and Arctic construction zones. Risks, as a rule, are caused by insufficient competence of specialists and poor information; therefore, they are the subject of close study.

Bogachev et al. (2015) studied construction risks and the possibilities of their minimization.

Nekrasova and Kaloshina (2016) considered the risks of construction participants in the economic crisis. Sall (2014) studied weather and climate risks as an object of management. Perevozova and Vozilova (2015) in their research examined the sources and causes of risks of managerial incompetence.

Research Methods

Currently, economic and mathematical methods are widely used to optimize management, organization, planning, and forecasting of construction processes, regression dependencies, linear programming models, inventory management models, game theory models, dynamic programming models, graphical models and network models, simulation models, and some others, which were considered in the works of Ivanova (2012), Borkovskaya and Passmore (2018), and Evseev (2020). In our work, we investigate the influence of weather and climatic conditions on the features of the construction process using the method of regression and correlation analysis and the method of simulation modeling. The choice of the modeling method is largely due not only to the probabilistic characteristics of weather and climatic conditions, but also to the totality of the probabilistic characteristics of the elements of the construction process (Barkhi et al. 2019).

The simulation model uses an algorithm that allows to obtain the probabilistic characteristics of the output parameters. This is achieved by:

3.1. The presence in the simulation model of sensors/generators of random numbers with certain distribution laws: equal, normal, Weibull, exponential, etc.

3.2. A certain number of runs/simulations of the functioning of the constructed model of the system under study, which allows you to create an array of statistical data.

3.3. As a result of N number of simulations, we get N numbers of output values, which are statistics of final results and which are processed by methods of mathematical statistics.

The developed model used a sensor/generator of uniform random numbers; the number of simulation runs was equal to 30 iterations.

Input parameters of the simulation model:

1. Analytical relationship between the level of information uncertainty and the timing of the increase in construction.
2. Analytical relationship between the level of competence of the personnel and the duration of construction.
3. Four types of work, each of which was characterized by: a) its duration, b) the level of information uncertainty, and c) the level of competence of the personnel performing this work.
4. The sensor is a uniform random number.
5. The number of simulation runs of the construction process model.
6. Construction.

The output parameters of the simulation model include:

1. The value of the severity of the weather by months of construction.
2. Indicators of the loss of the working time fund.
3. Indicators of changes in the reliability characteristics of construction machines.
4. Indicators of influence on the working staff.
5. Indicators of the increase in the cost of construction.
6. The time by which the duration of construction increases.

Determination of Weather Hardness

The severity of the weather according to formula 1 calculates the relationship between wind strength and air temperature and their influence on how a person perceives this weather. The air hardness index is very important for protecting the health of people working outdoors, especially in northern latitudes. The severity of the weather is measured in a conditional temperature equivalent, that is, degrees Celsius.

The severity of the weather is a term that refers to the sensations of a person under the simultaneous influence of frost and wind and is calculated according to the Bodman formula:

$$S = (1 - 0.04\ T)(1 + 0.272\ V), \tag{1}$$

where:

S - weather hardness (points).

T - air temperature (degrees).

V - wind speed (m/s).

Graduation S: (S < 1) - nonlevel, soft; S = (1-2) - little severe, S = (2-3) - moderately severe; S = (3-4) - severe; S = (4-5) - very severe; S = (5-6) - severely severe; S = (more than 6) - extremely severe.

Since in the climate directory data on the temperature and wind speeds are given in the form of average values with intervals of deviations, for the realization of these values, a random number sensor with a normal distribution law is used in the model, which has possible values of temperature and wind during the days of each month. The weather severity index is calculated for each month (see Fig. 1). Also included in the simulation model are regression equations showing the relationship between indicators of weather severity and readiness for work of construction machinery, indicators of the complexity of repair of construction machinery, increase in the cost of repairs, injuries, accidents, possible economic losses, and losses of the working time fund.

Weather and climatic conditions in our work are considered and calculated as the concept of "weather severity."

Results and Discussion

The interface of the simulation model allows you to immediately obtain the results of the influence of weather and climatic conditions on the indicators of the construction process in the form of graphs and tables.

Figure 2 shows the obtained regression dependence of the possible values of injuries to builders due to the severity of the weather. The high correlation coefficient (coefficient of correlation = 0.95) confirms the importance of the obtained dependence, since injuries reduce the pace of construction and increase the cost of treatment. It should be noted that not taking into account these dependencies as construction risks in the construction schedule can lead to disruption of construction deadlines, as well as to an increase in the cost of construction. These dependencies are related to safety because they take into account a set of construction risks.

Let's consider some dependences of the influence of weather and climatic conditions on the characteristics of employees and the features of the working time fund. As an example, let's consider Fig. 3, where the number of working days per month of

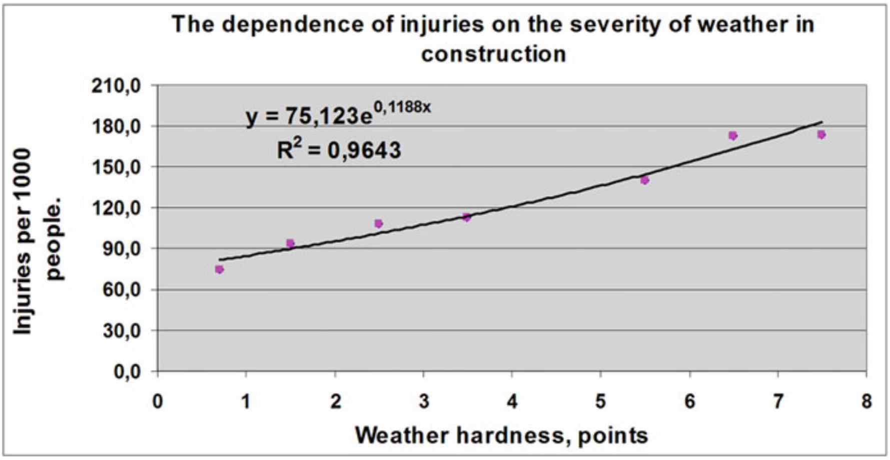

Fig. 2 Regression dependence. The relationship between the injuries of builders and the severity of the weather. Source: adapted from Evseev et al. (2019)

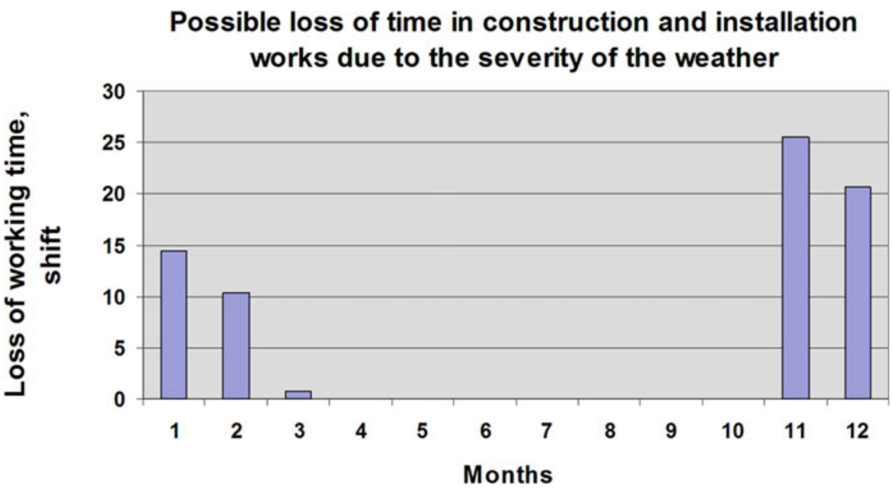

Fig. 3 The number of days when special working conditions are required for employees. Source: adapted from Evseev et al. 2019

construction is calculated, where workers require special working conditions, that is, additional 15 and 20 min breaks to restore the temperature due to extreme weather severity values and create an appropriate rehabilitation procedure. As can be seen from Fig. 3, for five winter and cold months, there are more than 70 working days with critical indicators of weather severity. The model also calculates the probability of absenteeism due to diseases associated with severe weather (Pleshivtsev et al. 2018).

Let's consider some of the effects of weather and climatic conditions on the characteristics of construction machines, which are associated with their reliability indicators. Figure 4 shows an example of the relationship between the indicators of weather rigidity and the coefficient of technical readiness of construction machines, which decreases as the indicator of weather rigidity increases. This dependence makes it possible to determine the number of working bulldozers and excavators that will be in active working condition. Figure 5 shows the dependence of the increase in the complexity of repairing the machine as the severity of the weather

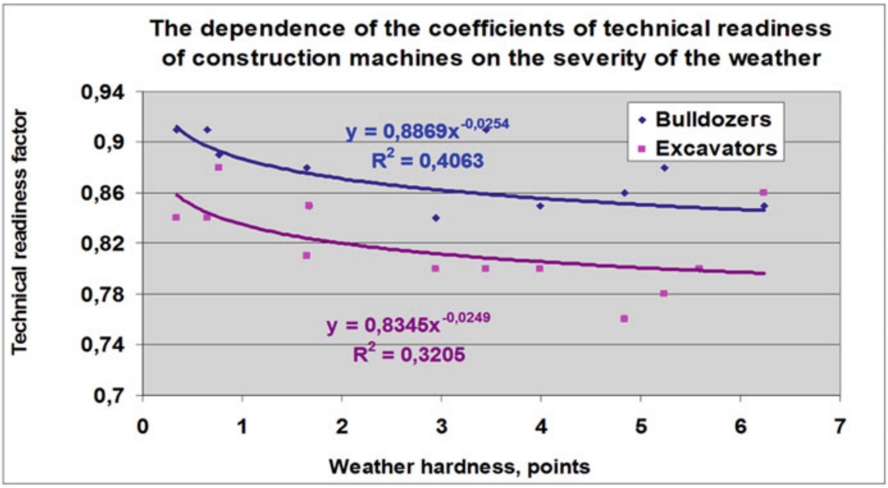

Fig. 4 Regression dependence. The effect of weather severity on the readiness of construction machines to work. Source: adapted from Evseev et al. 2019

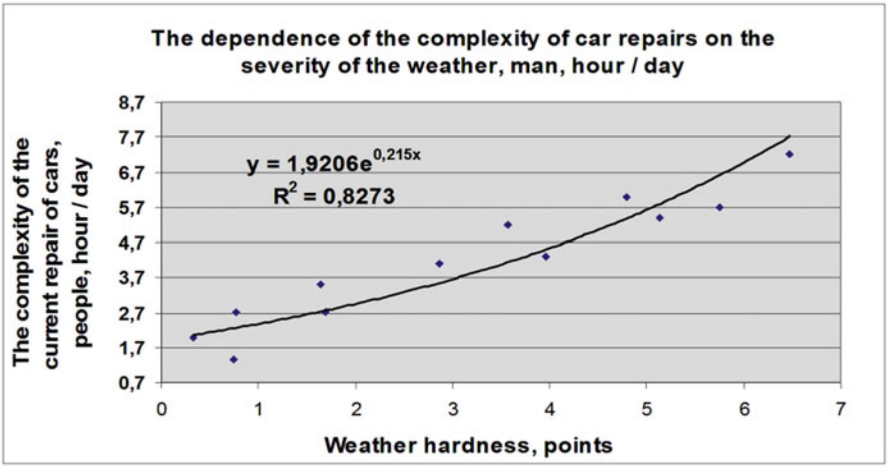

Fig. 5 Regression dependence. The influence of the severity of the weather on the complexity of the repair of equipment. Source: adapted from Evseev et al. 2019

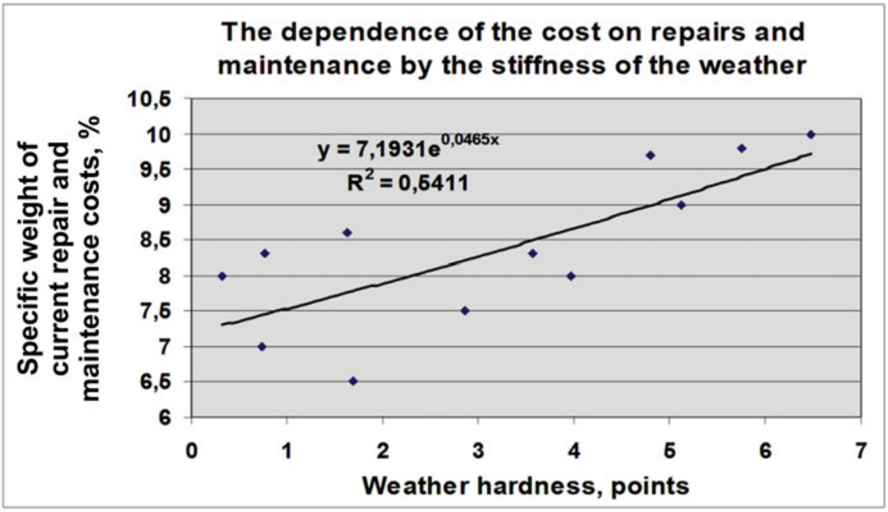

Fig. 6 Regression dependence – the effect of weather severity on the cost of repairing equipment. Source: adapted from Evseev et al. 2019

increases. As can be seen from the figure, the complexity of repairs can increase by 10%.

Weather and climatic conditions affect the economic characteristics of Passmore (2018) construction. Figure 6 shows the dependence of the increase in the cost of repairs depending on the severity of the weather, that is, these dependencies lead us to an increase in economic indicators of construction and a possible increase in construction time.

Figure 7 shows the dependence of the influence of the severity of the weather on the increase in the estimated rates of additional costs for the type of work, in our example, the development of excavators in an underground landfill.

The apotheosis of the insufficient reliability of the construction process is accidents on construction sites and their dependence on the severity of the weather (coef. Corr.=0.67) (see Fig. 8). The model allows you to change the initial dates of construction stages by type of work in online mode and immediately receive the information interface that interests us, in graphical and tabular form.

3.2. The output parameters of the model are:

1. Indicators of the histogram of possible construction periods at different values of the level of information uncertainty and competence of personnel (Figs. 9 and 10).
2. Plots the deviation of actual construction time from the planned construction time at various values of the level of uncertainty and competence of staff (Figs. 11 and 12).
3. The relationship of possible terms-structure of the levels of uncertainty (x) and competencies of employees (y)(x/y) (Fig. 13).
4. The Probabilistic characteristics of building terms depending on levels of uncertainty (x) and the competence of personnel (y) (x/y) (Fig. 14).

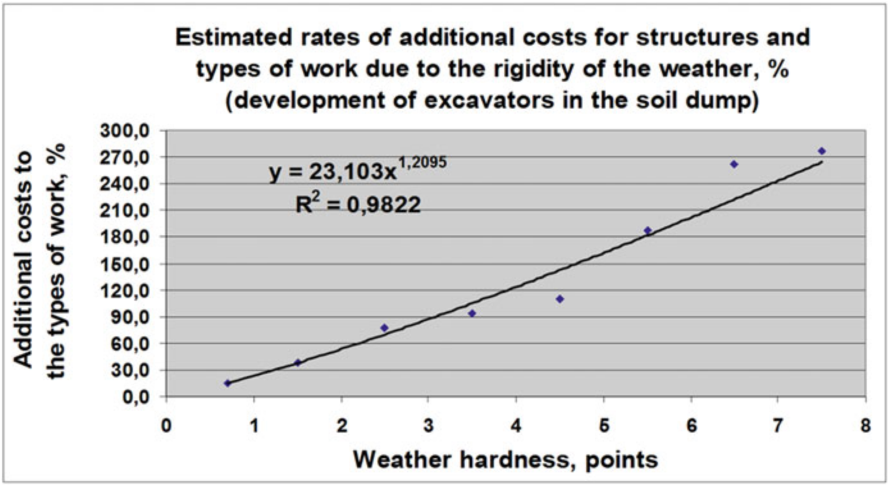

Fig. 7 Regression dependence. The impact of weather severity on additional costs. Source: adapted from Evseev et al. 2019

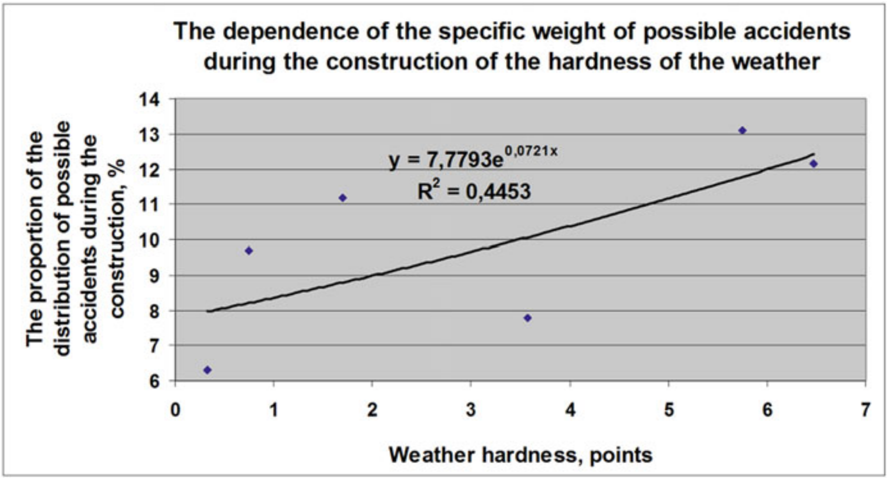

Fig. 8 Regression dependence. The effect of the severity of the weather on a possible accident. Source: adapted from Evseev et al. 2019

5. Indicators of expectation and standard deviation, both by type of work and by construction in general.

As can be seen from Fig. 9, the level of uncertainty = 0.55 and staff competence = 0.65: The probability of completion for 51 periods is 0.1 (P = 0.1); the probability of completion for 39 periods is 0.37 (P = 0.37); the probability of completion for the planned 19 periods = 0.0 (P = 0.0).

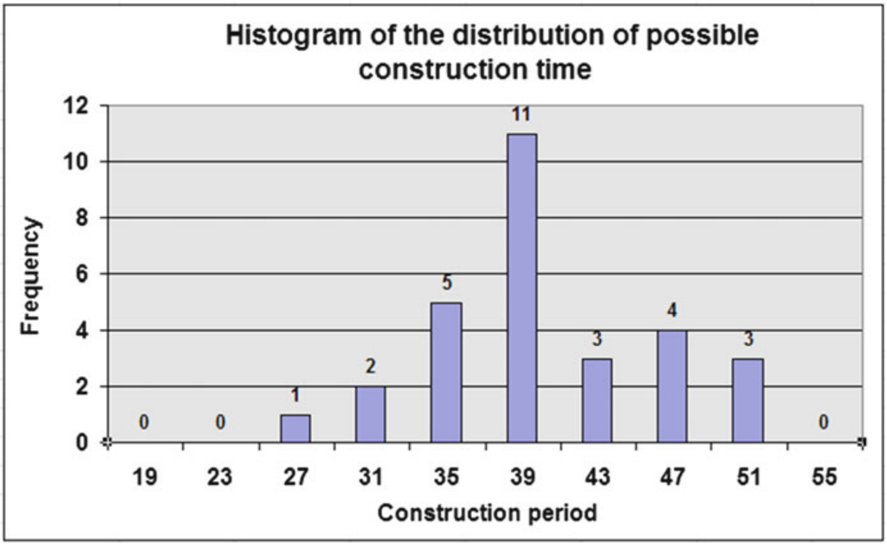

Fig. 9 Option 1. Histogram of possible dates of completion of construction (level of information uncertainty = 0.55 and staff competence = 0.65). Source: adapted from Evseev et al. 2019

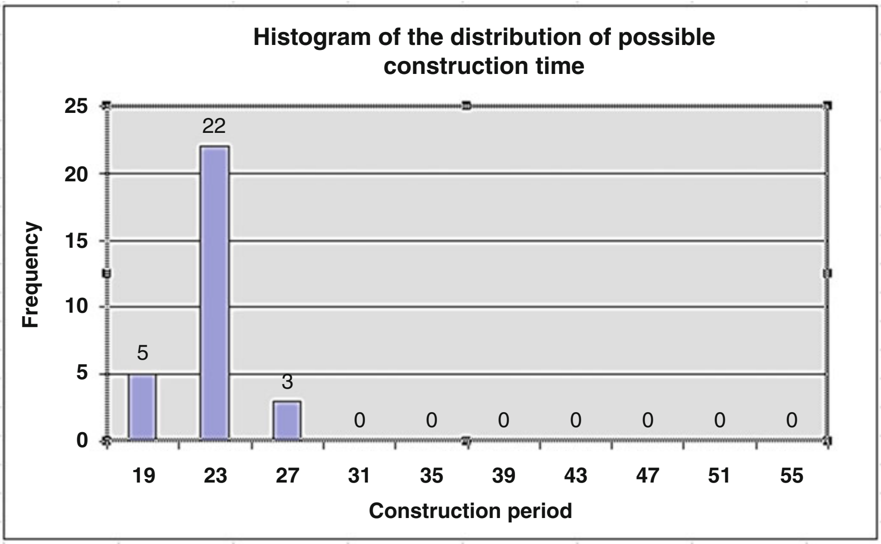

Fig. 10 Option 2. Histogram of possible construction dates (the level of information uncertainty = 0.2 and staff competence = 0.8). Source: adapted from Evseev et al. 2019

Figure 10 (option 2) shows the results at the level of information uncertainty = 0.2 and staff competence = 0.8; the probability of completion of construction in 23 periods is 0.73 (P = 0.73); the probability of completion in the planned 19 periods is 0.17 (P = 0.17), which is clearly insufficient.

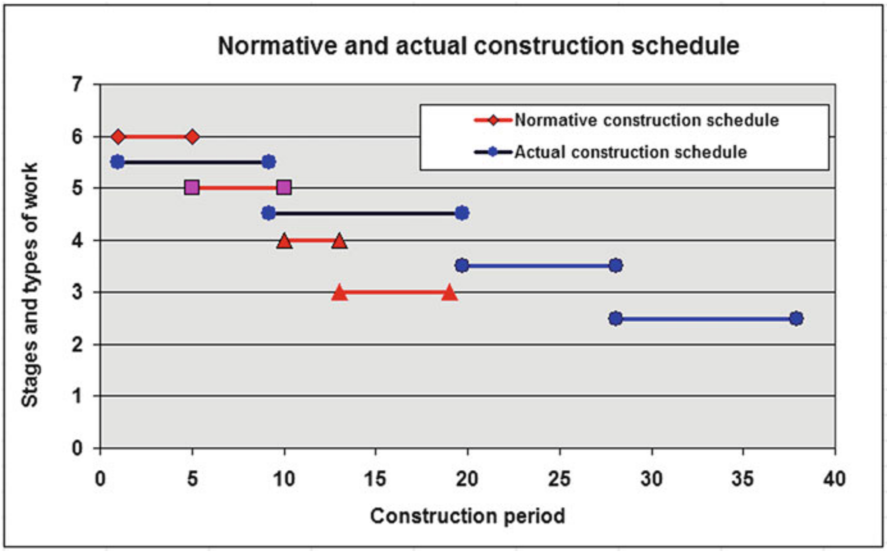

Fig. 11 Option 1. Regulatory/planned and actual construction schedule (when information uncertainty = 0.55 and staff competence = 0.65). Source: adapted from Evseev et al. 2019

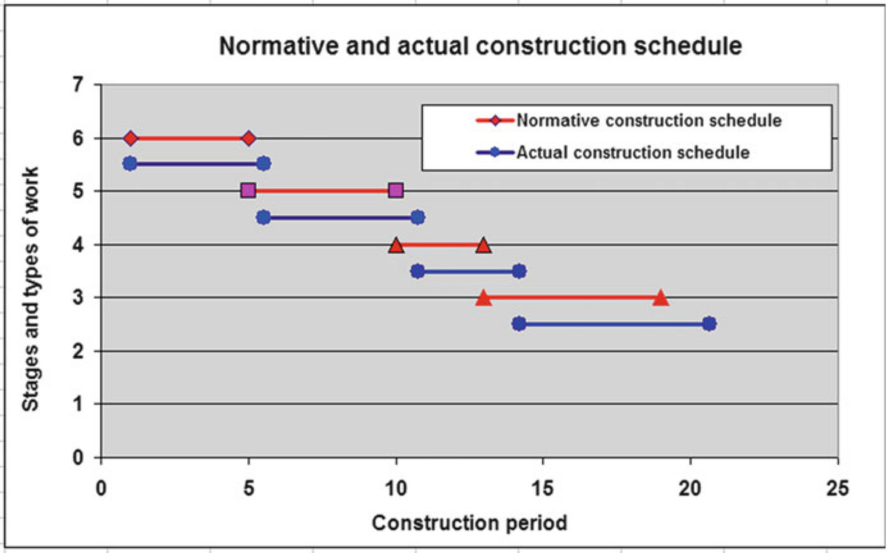

Fig. 12 Option 2. Regulatory/planned and actual construction schedule (with information uncertainty = 0.2 and staff competence = 0.8). Source: adapted from Evseev et al. 2019

Figures 11 and 12 (option 1 and option 2) show graphs of the construction process implementation with different input values of information uncertainty and personnel competence. When changing the input values, the graphs automatically (like

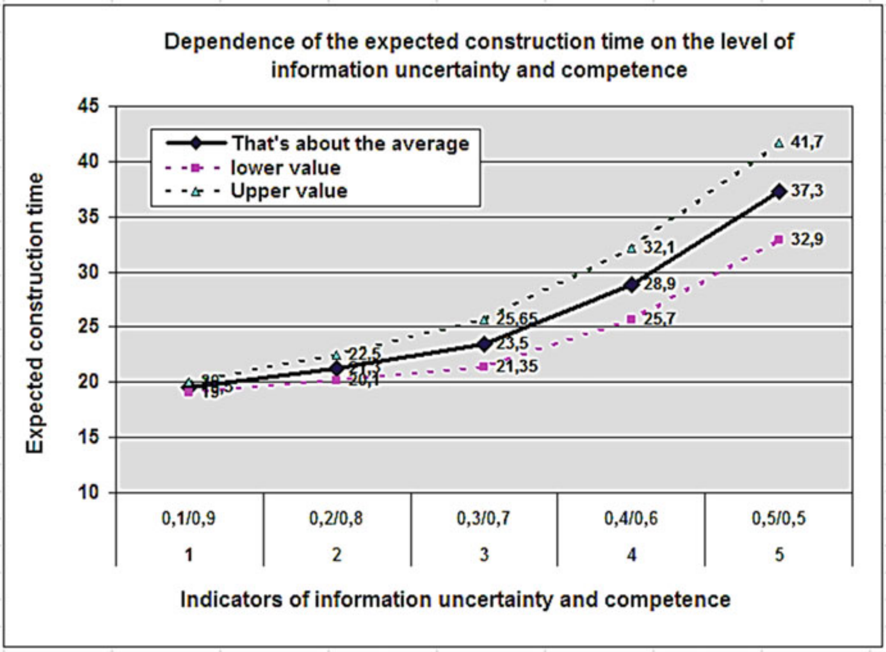

Fig. 13 Dynamics of deviations of possible construction dates depending on the levels of information uncertainty (x) and personnel competence (y) (x/y). Source: adapted from Evseev et al. 2019

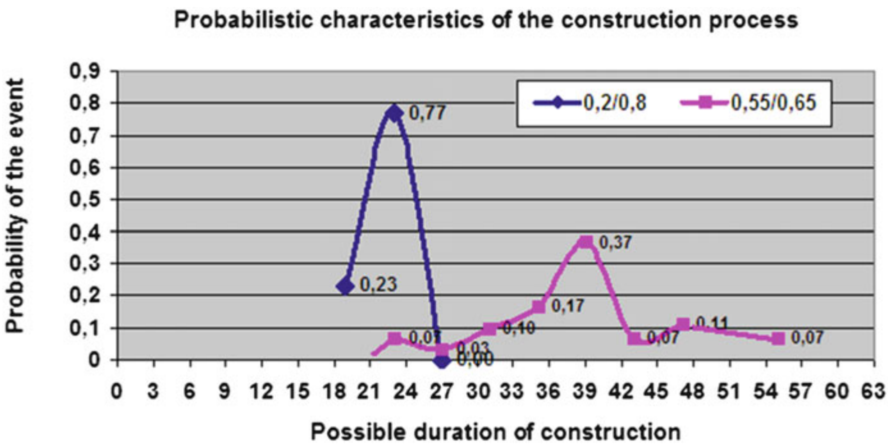

Fig. 14 Two variants of probabilistic characteristics and the end of the construction period, depending on the levels of information uncertainty (x) and the competence of personnel (y) (x/y). Source: adapted from Evseev et al. 2019

Table 1 Three main characteristics of the types of construction work

1	Types of construction works	Work 1	Work 2	Work 3	Work 4
2	Duration (T)	T1	T2	T3	T4
3	Level of information uncertainty (IN = 0-1)	IN 1	IN 2	IN 3	IN 4
4	The competence of the staff (CP = 0-1)	CP 1	CP 2	CP 3	CP 4

Source: adapted from Evseev et al. (2019)

histograms) change their configuration, which allows us to immediately visualize the simulation results.

Figure 13 shows the analytical relationship between the levels of information uncertainty and the competence of personnel, on the one hand, and possible construction deadlines, on the other hand. As can be seen from Fig. 13, an increase in uncertainty and a decrease in the competence of personnel lead to an increase in the interval of permissible deviations of construction deadlines.

Figure 14 shows the probability of completion of construction in a certain period of time, obtained as a result of modeling, with certain values of the level of information uncertainty and competence of personnel. So, the completion date for 22 periods corresponds to a probability of $P = 0.77$, and the probability of meeting the planned deadlines is $P = 0.23$. In other conditions of information uncertainty and personnel competence, the highest probability ($P = 0.37$) of completion of construction is 39 periods, instead of 19 planned periods.

A simulation model of the construction process has been constructed, the main characteristics of which are presented in Table 1. The result is evaluated by the indicator of the effectiveness of the decisions taken: The deviation of the actual construction dates from the planned deadlines.

Conclusions

1. As can be seen from the graphs, weather and climatic conditions affect all elements of the construction process: workers, construction machines, technology, logistics, materials used, etc., that is, they affect the safety and reliability of construction.
2. Weather and climatic conditions increase the construction risks, which are taken into account, increases the estimated cost of construction, both due to the introduction of additional available reserves and due to a possible increase in the construction time.
3. Regression dependencies (with a high level of correlation coefficient) between the indicators of weather severity and a certain set of characteristics of the elements of the construction process, which must be taken into account when assessing construction risks in the conditions of the northern and Arctic climatic zone.
4. The concepts of “information uncertainty” and “level of professional competence” used in the proposed model are integral indicators, that is, the proposed

simulation model is based on the concept of deduction (i.e., "general to particular"), which makes it even more complicated by including new conceptual categories in the simulation model.

5. The dynamics of deviations in the conditions of the construction process increases faster than the dynamics of changes in the level of information uncertainty and the level of competence (see Fig. 5); this indicates that the lack of competencies leads to an accelerated loss of controllability of the construction process.
6. The simulation results confirmed the need for high-quality design documentation and a high level of competence in construction in the northern and Arctic climatic zones, which significantly reduces the risks of deviations from the construction schedule.
7. Modeling allows you to quickly and fairly inexpensively obtain statistically significant information about all elements of the construction process. After statistical processing of the output information, it is possible to make significant management decisions to stabilize the construction process.
8. The use of simulation models in construction allows us to develop decision-making options, allows us to find optimal and rational solutions that contribute to the timely delivery of construction projects, reduces construction risks, and increases the reliability and safety of the construction process.

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Methods of Product Quality Assessment for the Arctic Population

Svetlana A. Shchegoleva and Pavel L. Titov

Contents

Abstract

The research is centered around the tree-graph model of technological processes. The interpretation of such a model is most convenient in terms of neural networks. The basic equation has been formulated for calculating the probability of the good-quality product yield. The probability of the good-quality product being obtained at the final stage is dependent on the number and distribution of factors, as well as on the length of technological graph; this dependence has been examined. The proposed technique makes it possible to identify and correct the neck stages in the technological processes. This technique will lead to improve efficiency of quality product manufacture for people of the northern regions.

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Introduction

At present, regions of the Far North and equated localities include 27 constituent territories of the Russian Federation with area over 11 million square kilometers; this is more than 60% of the territory of Russia (Mitina, 2020). On the one hand, this region is rich in subsoil resources and bioresources. The Arctic zone of the Russian Federation makes 12–15 of country's GDP and provides about one fourth of the Russian export. This region produces 95% of gas, 75% of oil, 90% of tin, and the main part of gold and diamonds. Eight percent of Russians, residing at the territories of the Far North and equated localities, produce one fifth of national income and provide nearly two thirds of inflow of foreign currency (Grigorishchin et al., 2020). On the other hand, the Arctic regions are distinguished by harsh climatic conditions for comfortable living; that in turn imposes the series of restrictions (Zvorykina & Zvorykina, 2018; Osipov et al., 2020). Due to this, the Russian Government regularly develops and implements measures to support people of the northern regions (Program of State Support, 2021). Among the tasks and objectives of the Support Program, the special emphasis is laid on the arrangement of conditions for quality improvement and competitiveness of the goods, works, and services provided by the nationalities of the North. In the long run, this shall promote preservation of existing jobs and creating new vacancies in the regions, decreasing out-migration and accelerating socioeconomic development (Yankovskaya et al., 2020; Osipov et al., 2021). People residing in the Arctic are also starved of supply of quality goods, because manufacture of the great majority of types of the goods directly within the regions of the Far North is hampered and economically unviable due to the peculiarities of the infrastructures. Furthermore, the quality of the goods supposed to be used in arctic conditions shall meet high requirements. Thus, the interest to improvement of well-known approaches and development of alternative approaches to the goods quality evaluation is acquired. This chapter is dedicated to the development and description of one of the alternative approaches to quality evaluation by means of tree-graph technique (Zikov, 2004; Harary, 2018).

One of the most important factors of the rise in the efficiency of production is an improvement in quality of output products (Efimov, 2016; Shatskih, 2014; Eremeev, 2016), which is treated at the present time as a crucial condition of its competitive strength on the domestic and foreign markets. In the advanced industrial countries, the quality systems successfully provide the high quality of the manufactured products. For control and management of the products' quality, many methods are used (Ishikava, 1988; Feigenbaum, 1986; ISO, 2013; Oakland, 2018). One of the crucial tasks is predicting the level of defective products. We devised a method allowing us to assess the quality of final products.

Tree-Graph Model of the Technological Process

This chapter presents the modification of the Ishikawa-Pareto method (Ishikava, 1988; Feigenbaum, 1986); it is based on the presentation of the technological process in the form of the appropriate tree graph which refers to the general graphs of Bethe type (Zikov, 2004; Harary, 2018; Bondy & Murty, 2008). The approach in terms of neuronets is the most relevant interpretation (Wosserman, 1992; Lawrence, 1993). The presentation of the technological process in the form of a complex tree graph assumes an application of the graph decomposition procedure. The decomposition methods in an analysis of complex systems – in particular, technological processes – are the essence of the systems analysis. Among the decomposition methods, we will consider the class of simplicial ones; only these allow us to present the complex process as a sum of modules, and, from the topological standpoint, each module is identical to the whole super-graph. The tree graphs proposed in this chapter satisfy the simpliciality principle.

Any technological process can be presented as a complex system, and, therefore, one can carry out the system analysis. As is known, the system analysis consists, mainly, in a certain decomposition procedure to which the technological process under consideration is subjected. This decomposition is not simple partition or separation (identification) of elementary components of the process; it should satisfy some symmetry requirements and a number of fundamental principles (Zikov, 2004; Harary, 2018; Bondy & Murty, 2008).

1. The technological process represents a chain of separate stages, T_i-modules. Here, just the chainlike, catching character of the successive modules is of significance. The chainlike type of dependence is well known in the theory of random processes as the Markovian processes (Ebeling et al., 2001; Shiryev, 1980; Karlin, 1971).
2. Generally, the technological chain is well ordered and represents the strict sequence of the T_i-stages.
3. Generally, the technological process is directed from the entry conditions which are presented by initial by-products, factors, or technical specifications to the output where the final – preferably, top-quality – product is provided.
4. Each technological module represents a certain, relatively independent subsystem. Formally, this can be presented as $\widehat{L}$ (T_i), technological operator of the appropriate stage.
5. T_i is the technological module of the process; it is, generally, characterized by many inputs, but has one output. Among the input signals (actions), there are the main and secondary ones. The secondary factors are technical specifications, basic stores, and materials. The module of i-stage is given by the operator L_i, while the input and output by-products are designated as π_{i-1}, π_i. $\{\varphi_i\}$ is a set of factors acting on operator L_i. The equation of motion for the technological module T_i is a typical operator one:

$$\pi_i = \widehat{L_i}(\pi_{i-1}|\{\phi_i\}) \tag{1}$$

6. The presence of any scaling principle (Kasti, 1982) is necessary for the decomposition of complex systems. If the technological process is represented as the hierarchical graph, one can see that it possesses a topological similarity, scaling. Generally, the general chain of the technological process will be represented by a super-graph.

For each stage of the technological process, the Eq. (2) can be written. The linear, ordered, and oriented graph can be presented algebraically, in the form of a chain of the partial equations (Ishikava, 1988):

$$\pi_1 = \widehat{L}_0(\pi_0|\{\phi_0\}); \quad \pi_2 = \widehat{L}_1(\pi_1|\{\phi_1\}) \to \pi_k = \widehat{L}_{k-1}(\pi_{k-1}|\{\phi_{k-1}\}). \tag{2}$$

This multistage chain is actually similar to the Markovian logic (Ebeling et al., 2001) and can be represented by the convolution iterative equation for the whole technological chain:

$$\pi_k = \widehat{L}_{\phi_{k-1}} \ldots \left(\widehat{L}_{\phi_2}\left(\widehat{L}_{\phi_1}\left(\widehat{L}_{\phi_0}\pi_0\right)\right)\right). \tag{3}$$

For this equation of the technological process, one can propose the most compact form using the chronological operator:

$$\pi_k = \overset{k}{\underset{i=0}{T}}(\pi_i|\{\phi_i\}), \qquad \text{where } \overset{k}{\underset{i=0}{T}} \sim \overleftarrow{\hat{L}_{k-1} \cdot \hat{L}_{k-2} \ldots \hat{L}_i \ldots \hat{L}_0} \tag{4}$$

π_k is generally the chronological operator of the whole technological process. It reflects the conditions of the chainlike nature, regularity, and orientation.

It is convenient to interpret the tree-graph representation of the technological process in terms of neuro-systems (Wosserman, 1992). In particular, operator L_i is a neuron action operator. It is convenient to describe $\{\varphi_i\}$ as the dendritic inputs and main inputs-outputs of by-products as axons. L_i are operators of i-th modules of the technological process. Actually, this is a set of instructions or algorithm of this technological stage.

The further consideration of the tree-graph representation of technological process will be performed using the assignment of probability measures to the dendritic inputs and axon inputs-outputs.

In that case, $\pi_{i-1} \Rightarrow P_{i-1}$ is the probability of the high-quality product yielded from (i − 1)-th module and entered i-th module. $\pi_i \Rightarrow P_i$ is the output probability of the high-quality product after processing in i-th module. $\{\varphi_i\} \to \{q_l^i\}$ is a set of the rejected probabilities attributable to the dendritic branches of i-th module. The letters P_i denote the probabilities of manufacturing the high-quality object or by-product, while q_l^i will denote the probabilities of the reject emergence by ϕ_l^i factor. For a module, the following operator equation in terms of the probabilistic characteristics can be also written:

$$P_i = \widehat{L}_i\left\{P_{i-1}\middle|\left\{q_l^i\right\}\right\} \tag{5}$$

In Fig. 1, the technological super-graph is presented. To the branches, the probabilistic measures are assigned. In the branches-axons, the threshold element u is introduced (Wosserman, 1992).

The threshold elements are determined by the Heaviside functions at the relevant values of the critical threshold probabilities. This is a rule of selection with which the

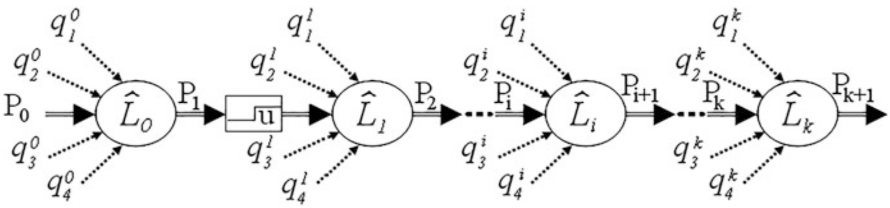

Fig. 1 Technological process diagram presented in the form of the tree graph. Probability measures q in dendrite branches and P in the axon ones. On each transition from one level to the other, the threshold element s is situated. (Source: Adapted by the author from Wosserman, F. (1992)

motion Eq. (5) should comply (Ebeling et al., 2001). q-factors are independent random variables which function jointly at every stage. Knowing the input probability P_i and values of q-factors at each stage, one can arrive at the final P_k using the iterative procedure of calculation. In so doing, the operator of comparison with a certain threshold probability is built into each module. Just the "above-threshold" probability travels into the next module. In the contrary case, the whole technological chain is violated. This can happen in any of the links. If the goal is set to project the generalized technological process resistant to the axon interruptions, it needs to proceed to the tree graphs of parallel types. At that case, the axon "noise" cannot affect all the branches at a time. The parallel technologies will exhibit such essential characteristic as redundancy (Ebeling et al., 2001), which, in turn, will result in the survivability of the technological process as a whole.

The probabilistic logic of the functioning i-th module will allow us to write the corresponding expression for probability P_i if P_{i-1} and $\{q_l^i\}$ are known. Let us assume that the probability P_i was determined with regard to the input probabilities using the multiplicative theorems (Shiryev, 1980). At the output, we will expect the emergence of the high-quality by-products with a certain probability. The complex input event precedes the output one. The recovery of the high-quality output product is possible if all the effects (along the dendritic inputs and axon) will be error-free with a certain probability. At that, all the input values should be synchronously characterized by the preset quality level. As a result, we have come to the multiplicative logic (Shiryev, 1980).

$$\mathrm{P}_i = \mathrm{P}_{i-1} \prod_{l=1}^{m} \left(1 - q_l^i\right) \quad \Rightarrow \quad \mathrm{P}_i / \mathrm{P}_{i-1} = \prod_{l=1}^{m} \left(1 - q_l^i\right). \tag{6}$$

By way of taking logarithms, let's turn from multiplication to additively:

$$\ln \frac{P_{i-1}}{P_i} = -\sum_{l=1}^{m} \ln\left(1 - q_l^i\right) = \mathrm{H_m}\left(1 - q_l^i\right) \geq 0. \tag{7}$$

The right side of (7) is an entropy for m independent compatible events. The value of $1 - q_l^i$ is the probability of correct functioning of φ-factor (Shiryev, 1980; Karlin, 1971).

In (7), the entropy of the correct (free of error, free from defects) functioning of dendritic factors is not the probability-distribution entropy. However, if the renormalization of factors φ is performed, then the entropy will be expressed as the standard Shannon entropy. Because the technological tree functioning logic on all modules assumes the independent and joint action of φ-factors (Shiryev, 1980; Karlin, 1971), then the entropy will be the additive value. The Eq. (7) can be reconstructed to the form convenient for the iterative stepwise calculation of the output probabilities:

$$\mathrm{P}_i = \mathrm{P}_{i-1} \exp\left(-\mathrm{Hm}\left(1 - q_l^i\right)\right). \tag{8}$$

From (8), the constructive conclusion follows that $\mathrm{P}_{i-1} \geq \mathrm{P}_i$ for any $i \leq m$ by reason of the damped exponential curve. This means that the probability of the intermediate product output (yield) from axon is not greater than the same probability obtained at the previous stage. Therefore, as a result of applying the cascade technological process with the successive topology, a probability of recovery of the high-quality output product will not increase.

Applying the recursive algorithm, one can calculate the probability of manufacturing the defect-free final product. In this case, all the threshold elements should be passed. These elements are equivalent to the by-product quality control at every stage. In the cascade of threshold elements with their critical decision level (these levels can be different for different stages), the evolutionary properties are conjectured (Ebeling et al., 2001). The expression (8) is the original one when describing any technological processes with analogous topology. The main point in (8) is estimating the entropy of the probability of the error-free functioning of dendritic factors. This probability is formed in accordance with the additivity principle from m φ-factors. It is also evident from (8) that, when estimating Pi, not only a set q_l^i but also a power of m-assembly of φ-factors will act as the parameters. Let's write the equation as follows:

$$P_i = \widehat{L}\left[H_m\left(1 - q_l^i\right)\right] P_{i-1}, \text{ where } \widehat{L_m}\left(\left\{q_l^i\right\}\right) = \exp\left(-H_m\left(1 - q_l^i\right)\right) \tag{9}$$

is the propagator where m is the number of factors acting at every level of the technological chain, $l = 1,2,\ldots m$, and the levels, stages of the process, are designated by index $i = 0,1,2,\ldots k$; k is the length of the technological chain.

Influence of Process Parameters to the Quality of the Final Product

There are several numerical experiments which are parameterized by choice of particular values of q_l^i and m. For example, let us assume that the number of φ_i-factors is $m = 3, 5, 7, 10$. As an additional requirement for a set of q_l^i- factors, let us assume that the defectiveness of all $\overline{q}_i$ factors is equal to the same value. We have specified $\overline{q}_i$ equal to 0.001 to 0.3, which is equivalent to the correctness levels of dendritic links of 99.9% to 70%. For the experiment in which all the dendritic factors have the same probability of errors, the expression for entropy (7) is simplified:

$$H_m\left(1 - q_l^i\right) = m \ln\left(1 - \overline{q}_i\right). \tag{10}$$

The diagram of propagator dependence on is damped (descending) when m changes from 3 to 10 and $\overline{q}_i$ from 0.001 to 0.3 (Fig. 2). In Fig. 2, the dependence of the propagator values is shown, i.e., to what extent the probability P_i (output axon) decreased with respect to the probability P_{i-1} (input axon) for i-th module of the technological tree.

As follows from Fig. 2, the probability of the high-quality product yield decreases with increase in the average level of discrepancies of factors q_i of the technological process. If the diagrams (Fig. 2) obtained for different m are considered, it can be observed that, with increase in the number of levels (length of the technological chain), the probability of obtaining the high-quality product at the output decreases too.

In the experiment when the one dendritic harmful factor will exist at every level of technological process, the first step includes a calculation of entropy of dendritic factors while the second one a calculation of the propagator. The propagator defines the ratio of the input and output probabilities by axons. In Fig. 3, a dynamic of entropy and propagator is presented.

It is evident from Fig. 3 that the entropy grows with increase in the defectiveness of the dendritic branch and, accordingly, propagator decreases. This leads into a comparison of the results of Figs. 2 and 3. There is no doubt that the assemblage of several "harmful" factors will influence more than one factor. In that case, the quantitative estimation and the nature of this influence are of significance. It is evident from Fig. 3 that, in the case of effect of single harmful factor, the probability of manufacturing a defect-free product decreases in a linear fashion, while, when influencing the assembly of harmful factors, the drop of diagram is fundamentally nonlinear and ever greater (Fig. 2). This manifests, particularly, at large values of q. The results presented in Figs. 2 and 3 allow us to estimate numerically the power effect of the assembly of harmful characteristics and probabilities of factors failures.

An example is the manufacture of a real product, such as sausage goods. As was said earlier, practically any production scheme – in particular, a scheme of food production – can be presented in the tree-graph form. Such graphs will differ only in

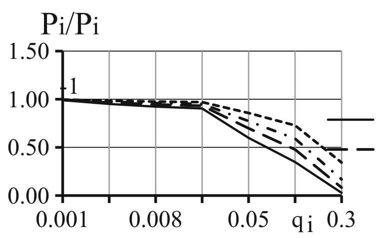

Fig. 2 Dynamics of P_i/P_{i-1} depending on the values of q_i and m. (Source: Compiled by the authors based on modelling)

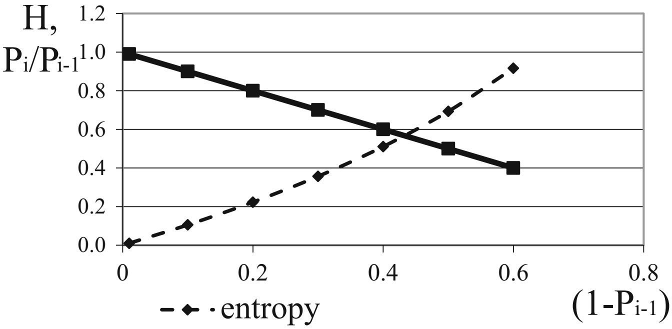

Fig. 3 Dependence of entropy and propagator for the case of the only defective factor on the probability of its failure (malfunctioning). (Source: Compiled by the authors based on modelling)

the number of hierarchy levels (k in our notation) and the quantity of the dendritic branches at every level (mi). To every of the dendrites, one can also assign the probability to be good quality $(1 - q_l^i)$.

We have presented the scheme of the semi-smoked sausage production which was represented by us in the form of the tree graph similar to Fig. 1. The scheme consisted of 13 stages every of which includes 3–5 factors. Further, we have calculated the estimated percentage of nonconforming products. In this regard, the probabilities of manufacturing the good-quality by-product were determined at every level.

For the simplicity of the calculations, we will use the same probabilities of the factors' malfunctions. For example, let $q_l^i = 0.0001$. The probability of yielding the good-quality final product at every subsequent level can be calculated with the use of (9), and, applying (10) for every level of the technological process, we obtain the following expression:

$$P_k = P_0 \prod_{i=1}^{k} \exp\left(\sum_{l=1}^{m_i} \ln\left(1 - q_l^i\right)\right), \tag{11}$$

where k is the number of levels of the technological process; mi is the number of factors affecting the quality of products at every i-th level; P_0 is the input probability of the good-quality product (quality of raw materials); and q_l^i is the malfunction probability at every of the stages. In case of equivalent (equal) probabilities of malfunctions q_l^i, the formula (11) is rewritten as

$$P_k = P_0 \prod_{i=1}^{k} \exp\left(m_i \ln\left(1 - q_l^i\right)\right), \tag{12}$$

where m_i is the number of factors at every i-th level. In Table 1, the numbers of partial factors acting at every stage are given.

Table 1 The number of factors at every level of the process

Serial number of the technological process level, *i*	1	2	3	4	5	6	7	8	9	10	11	12	13
Number of factors on given level, m_i	3	4	4	2	5	3	5	4	2	4	4	3	4

Source: Compiled by the authors based on modelling

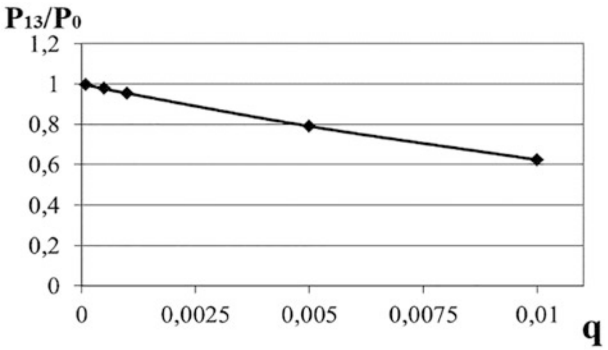

Fig. 4 Dependence of the good-quality product yield probability with regard to quality of input product (raw material) on the defect level of every factor (q_i = 0.0001; 0.0005; 0.001; 0.005; 0.01). (Source: Compiled by the authors based on modelling)

Substituting data from Table 1 into (12) and specifying $\overline{q}_l^i$ =0.0001, the same probability of malfunction for all factors, we obtain $P_{13} = P_0 \times 0.995$. The probability of manufacturing the good-quality product complying with the imposed requirements is 0.995 or 99.5%. Such value is obtained provided that the probability of malfunction at every stage of the technological line is kept at a minimum (0.0001%). Using the formula (12), we will find out the dependence of ratio P_{13}/P_0 on q.

The result of calculations is shown in Fig. 4.

Using (12), one can define what values of zero-failure of q-factors will allow us to reach the specified probability of high-quality output product. One can copper a tip and specify the values of zero-defect quality of q factors and calculate the possible probability of the output complying with imposed requirements of product. In our case, the total number of factors along the whole technological chain is 45, while the length of the technological graph itself is sufficiently large (k = 13). The resulting dependence is almost linear, with little to suggest it could be initially predicted. It is evident that such dependences can be determined for any technological process with similar topology. Endowing the tree graph with the statistical-probabilistic structure, one can set and take the tasks on optimization of the technological graph itself. It is natural to select the length of the technological graph k and the number m of factors in every module with their specified distribution q_l^i.

Conclusions

The proposed technique offers the opportunity to obtain the evaluation of the output product quality using the particular probability-theoretical topology of the tree graph of technological process. This will make it possible to identify and correct the neck stages in the technological processes, as well as to make an assessment of the irregularity level. This is particularly significant for use in technological processes with the quasi-linear architecture. The use of this technique makes it possible to improve the efficiency of quality product manufacture for people of the northern regions.

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Part XI

Research and Development

China's Soft Power Policy in Finland, Sweden, and Norway

A Cross-Country Analysis

Ekaterina V. Serova and Ivan R. Skripka

Contents

Abstract

This chapter discusses China's soft power policy tools, domains, and priorities in Finland, Norway, and Sweden. The authors identify four policy domains: firstly, education and learning, putting special emphasis on academic mobility dynamics and educational program development; secondly, research activities, including joint project development, R&D cooperation, academic centers, and network collaboration; thirdly, language and culture, with an aim to get better understanding of Chinese cultural power as part of the overall power of a state; and finally, media, since China invests in global media as part of its soft power policy facing at the same time a flurry of criticism from leading Nordic media on human rights policy, Chinese institution functioning abroad, etc. The study concludes that China's soft power policy in Northern European countries is diverse, but still

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incoherent and dependent on specifics of China's perception at national level, as well as evolving geopolitical crisis and tensions.

Keywords

Northern Europe · China · Soft power · Sino-Finnish · Sino-Norwegian · Sino-Swedish cooperation

Introduction

Soft power has long been a pillar in China's foreign policy in attempts to advance the country's interests in the international arena. Soft power meets the PRC's policy goals and objectives in terms of exercising nonmilitary influence, as well as influence in economic affairs. Nowadays, in addition to being the second largest economy, China has overtaken the EU on R&D spending as a percentage of GDP though it is still behind the United States; it possesses the second-largest stock of scientific papers in the world, and by 2050 China aspires to become a leader in the field of higher education and research, turning its 42 universities into world-class leading educational institutions. According to the Global Soft Power Index, in 2021, China is placed eighth among countries implementing soft power policies, slightly behind the United States, France, Canada, and the United Kingdom. To this end, facilitating and maintaining international cooperation remains important for China's government in attempts to shape foreign perceptions that influence China's international reputation.

Nowadays, the lack of comparative research on China's activities across Northern European countries makes it difficult to identify the main trends and degree to which soft power determines perceptions of China in a particular society. It also hampers the debates around the implications of soft aspects of specific activities by China in the context of international cooperation (Lukin & Torkunov, 2020; Guterres, 2021). To provide insight into these issues, this chapter answers a research question: what are China's tools and strategic priorities in pursuing soft power policy in Finland, Sweden, and Norway? These cases shed light on how the observed soft power and China's strategy desired effects are intertwined and what approaches towards China's policy are more favorable in Nordic societies.

As will be indicated later, China seeks to impact the Northern European states in various domains through a combination of tools. The toolbox includes the implementation of joint educational programs, academic mobility, joint research, the promotion of Chinese culture and language, and media and political messaging.

Literature Review

The notion of "soft power" was initially conceptualized within the American political theory at the end of the twentieth century, but the origins of this phenomenon as it applies to modern China should be derived from Thirty-Six Chinese stratagems described in Sun Tzu's *The Art of War*. Both stratagems and soft power put nonviolent methods, pragmatism, flexibility, and successiveness at the forefront. Furthermore, with reference to China's famous military strategists, soft power is often viewed by experts as an integral part of China's security strategy (Kalimuddin & Anderson, 2018). Sun Tzu's principle that "... supreme excellence consists in breaking the enemy's resistance without fighting" (Tzu, 2009, p. 11) appears to remain relevant in certain respects for understanding the modern China security strategy.

The Chinese version of the concept of soft power, unlike the Western one confining soft power to the ability to obtain preferred outcomes through persuasion and eliciting positive attraction, suggests a kind of behavioral model that comprises many tools through which the nation's cultural resources support state's economic and military clout (Hunter, 2009; Nye, 1990, 2004; Sparks, 2015). It is worth noting that soft power in China's case is considered in conjunction with economic power and economic diplomacy, because, as of yet, Chinese culture itself has limited appeal, its values fail to reflect the country's reputation abroad and its foreign policy is often perceived with skepticism.

Nye (2012), in *China and Soft Power*, also argues that "military power and economic prowess often have secondary soft-power effects." To proceed with this argument, in their report *China's Soft Power in Europe Falling on Hard Times*, Dams et al. (2021) stress that Chinese investment flow in a European country may be accompanied by image-boosting policies, but an investment per se is not a sign of soft power.

This chapter builds on and expands the findings of the aforementioned report. It is expected to fill a gap in literature by elaborating on Chinese ongoing interests and priorities in Finland, Sweden, and Norway in view of China's soft power strategy. The reference base is made up of official documents (i.e., Ministry of Foreign Affairs of Finland, 2021; Elmer, 2019; Norwegian Ministry of Education and Research, 2021; etc.), official statistics, partnership agreements of Finnish, Swedish, and Norwegian universities and research institutions, official websites, and national media output. References and research literature covering China's soft power policy in Northern Europe include 45 positions in Finnish, Swedish, Norwegian, and English.

Academic Mobility and Educational Programs

The development of higher and vocational education at the international level is one of China's pragmatic targets set in education modernization plan until 2035, which will undoubtedly contribute to the entry of Chinese universities into the world educational rankings (Torkunov, 2019a, b; Antyukhova & Kasatkin, 2020). This plan was preceded by a five-year project by the China's Ministry of Education (MoE), launched in 2012 and intended to upgrade the qualifications of 1000 university leaders from central and western regions of China overseas. The project by MoE was aimed at strengthening the capacity of leaders of Chinese universities, borrowing the best foreign practices, modernizing higher education in less developed regions of China, and building an innovative and egalitarian society in the long term (Liu et al., 2019, p. 52). Australia, Canada, Finland, Germany, Ireland, the Netherlands, the United Kingdom, and the United States were represented as the host countries. Finland was selected as a priority destination for the export of education.

Why do Chinese people choose Finland? Survey results of Chinese students enrolled in 2015–2016 in Bachelor's, Master's, and PhD programs at the universities of Tampere (50% of respondents), Helsinki, Espoo, Turku, Joensuu, and Oulu showed that Finland offers significantly more English-language HE programs than other European countries (respondents compared Finnish universities with universities in Germany and France). According to Chinese students, Finland is opening the door for employment in the EU market. The direct and relatively simplified study visa application procedure was another asset that determined the choice of Chinese students. Finally, it was noted that 99% of applicants apply to recruiting agencies which have extensive experience in cooperation with Finnish universities, and therefore there are a lot of students in Finland – representatives of the middle class of China who paid for agencies' services to find more appropriate university abroad and in return received free (until 2015) education at a prestigious Finnish university.

It is also important to take into account that many Chinese families introduce their children to the Finnish education system long before entering higher education institutions: in China (and Hong Kong), educational tourism (fin. *koulutusmatkailu*) is popular among teachers, students, and schoolchildren. Since 2017, Finland has implemented a project on educational tourism, aiming at development of ready service packages and programs, which include a detailed acquaintance with Finnish system of education. For example, there are educational packages for Chinese schoolchildren (fin. *Leirikoulupaketti kiinalaisnuorille*) in Oulu (fin. *Oulun leirikoulu*) and Rokuan (fin. *Rokuan leirikoulu*), designed for 9 days.

These educational packages are offered to foreign tour operators around the world, although we remember that Chinese schoolchildren had come to Finland earlier as part of short-term educational programs of twin schools (fin. *ystävyyskouluvierailu*). Interest is usually attracted by school camp programs that include the study of mathematics and natural sciences, an integrated approach to the study of a specific phenomenon, and the use of nature as a learning environment. In addition, the independence of Finnish children is highly valued in China. Over the years, when the policy *one family-one child* was implemented (1979–2015), children in Chinese families had become accustomed to an *easy and safe life* – they had not been conscious of the need to gain practical skills in everyday life, and, therefore, had not become independent (Visit Finland, 2018, p. 29).

The target markets for Finnish education exports are China, Southeast Asia, Latin America, and the Gulf region. Africa is seen as a potential new market, which has grown in attractiveness in recent years. In 2019, the turnover of educational exports amounted to €385 million (an increase of 7%, compared to 2018). The educational export roadmap for 2020–2023 aims to increase the value of educational exports in the Finnish economy to €1 billion in the long term.

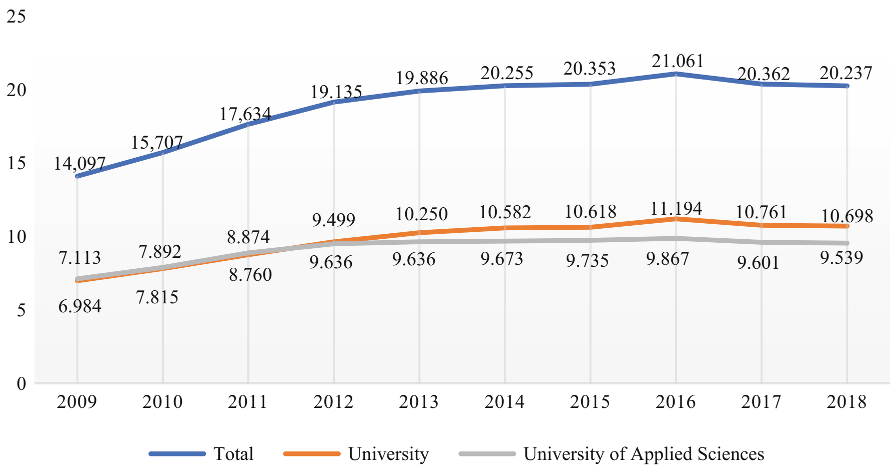

Fig. 1 Foreign students enrolled in Finnish universities in 2009–2018 (number of students). (Source: Compiled by the authors based on *Finnish National Agency for Education*. Retrieved from: https://www.oph.fi/sites/default/files/documents/kokonaismaarat-2009-2018.pdf)

In the context of the internationalization of education as a consequence of the export of educational services, we have identified several forms of Sino-Finnish cooperation in providing education and training: the development of academic mobility, allocating grants (funding) to support Chinese students, the implementation of joint educational and training programs, the creation of international organizations, and the creation of educational institutions abroad (Confucius Institutes).

In 2018–2019, the share of foreign students in universities in OECD countries averaged 6–7%, while in universities in Finland, Sweden, and Denmark it was above the average (8, 7, and 11%, respectively), whereas Norway was below the average (4%) (OECD, 2020).

According to the Finnish National Agency for Education for 2018 (the latest available statistics), in 2017–2018, 20,200 foreign students trained in short-term and long-term educational programs in the country's universities, which is 4% less than in 2015–2016 when the number of students in higher education programs reached a peak (21,061 people) for the period 2009–2018 (Fig. 1).

In 2015–2018, students from China constituted the third largest group of foreign students (8%), behind Russian students (11%), and students from Vietnam (12%). In 2018, the number of foreign students from Asian countries studying in Finnish universities amounted to 9,224,000 people (including 1644 people from China), or 45% of the total number of students from foreign countries (Finnish National Agency for Education, 2018d).

In 2020, the number of students from Asia who enrolled in educational programs of up to 3 months or more amounted to 718 people (including 242 people from China), or 11% of the total number of students who first arrived to study at Finnish universities from foreign countries. This is half as much as in 2019, and the mobility of Chinese students to Finland has decreased by three times (see Table 1).

Table 1 Incoming first-time students by mobility programs with a duration of up to 3 months or more, including internships and exchanges (number of students)

Year	2019/2020			2020/2021		
Region/country	Finland	Sweden	Norway	Finland	Sweden	Norway
World	12,848	24,395	6945	6156	16,949	3,02
Asia	2097	6267	1043	718	3238	768
China	800	1572	133	242	878	69

Source: Complied by the Education Management Information Service of Finland. Retrieved from: https://vipunen.fi; Swedish Higher Education Authority. Retrieved from: https://www.uka.se; Norwegian Directorate for Higher Education and Skills. Retrieved from: https://dbh.hkdir.no/

According to the Swedish Higher Education Authority (Ukä 2021), in 2019–2020 (the latest available statistics), Chinese students enrolled in short-term programs at Swedish universities made up the third largest group of international students, behind students from Germany and France. In 2020, the number of incoming students from Asia on educational programs with a duration of up to 3 months or more amounted to 3238 people (including 878 Chinese students) or 19% of the total number of foreign students studying for the first time in Swedish universities. Compared to 2019, the mobility of Chinese students to Sweden has almost halved.

According to the latest available statistics from the Norwegian Higher Education Statistics Database, 3436 international students were enrolled in universities of the country in 2020. It was the worst rate of mobility since 2010 (3735 students). A similar drop in the number of students from other countries is due to the tough pandemic regime in Norway, when it was difficult for foreign students to obtain a visa and get into the country.

The number of Chinese students in Norway has not changed significantly since 2010, when 97 people were studying. At the same time, there has been a drop in the overall share of Chinese students in Norway, especially since 2018.

Statistics from the Norwegian Higher Education Statistics Database show that in 2019–2020, Asian students enrolled in short-term programs at universities in Norway accounted for 15% of the total number of foreign students, and the continent's largest representation was from China: 133 people (1.9%), ranking tenth in terms of the number of foreign students in Norway. In 2020, the number of incoming students has more than halved. Seven hundred and sixty-eight people (including 69 Chinese students) came from Asia for educational programs lasting up to 3 months or more. Despite the decline in the number of Asian students at Norwegian universities, the percentage of all international students increased by 10% (25.4%).

According to the statistics of applications for English-language programs from applicants from Asian countries in 2016–2019, the number of applicants wishing to enroll in Finnish universities of applied sciences (fin. *AMK*) is less than those wishing to study at universities (fin. *Yliopisto*) focused on theoretical research. Thus, despite the general trend of an increase in the number of applications submitted to Finnish universities for the period 2016–2019, there are fewer applicants from China to AMK than to Finnish yliopisto (41 and 67%, respectively). Note that Chinese applicants predominantly prefer the latter: in 2019, 831 applications were

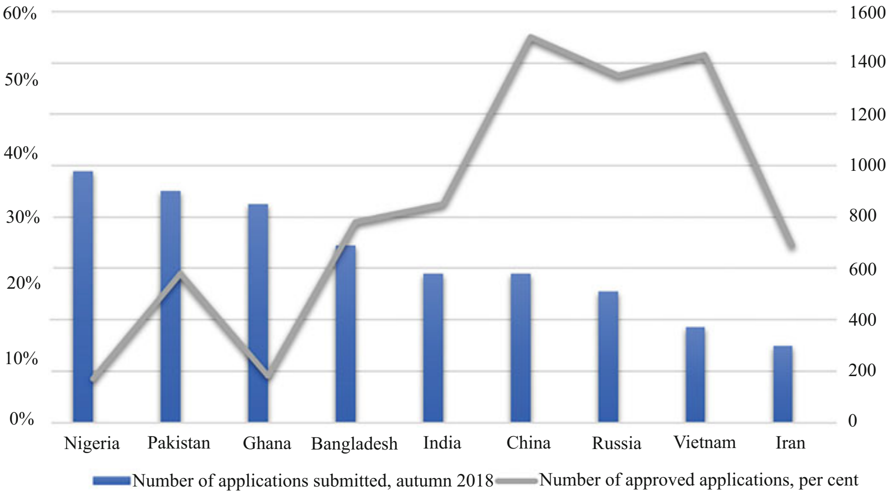

Fig. 2 Successfully submitted applications to Finnish universities (by total number) in 2018. (Source: Compiled by the authors based on Government of Finland (2019). Retrieved from: https://julkaisut.valtioneuvosto.fi/bitstream/handle/10024/161788/OKM_2019_31_Korkeakouluopiskelijoiden_maahantulo_ja_integroituminen.pdf)

submitted, with the share of those enrolled in Finnish universities being 46%. This is a fairly high percentage of successfully submitted applications, along with those coming from Russia (48%) and Vietnam (51%) (Government of Finland, 2019). In 2018, Chinese applicants became the record holders in the number of successfully submitted applications: the share of applicants was 55%, while 51% passed from Vietnam, and 49% from Russia (Fig. 2).

Finnish AMKs are less popular with Chinese students due to China's stalled education reform, which aims to create 300 universities of applied sciences from existing universities and other educational institutions. Taking into account that there are more than 2000 higher education institutions in China, only the names of three institutions contain the name "University of Applied Sciences." At the Sino-Finnish Forum of Rectors of Universities of Applied Sciences in 2019, representatives of the Häme UAS (HAMK, Finland) and the National Academy of Education Administration (NAEA, China) came to the conclusion that today universities and professional educational institutions in China cannot adequately meet the increased demand for qualified specialists. The participants noted the importance of the development of the Chinese system of universities of applied sciences following the example of the Finnish AMKs, created in the 1990s on the basis of previous educational institutions.

The experience of implementing joint Bachelor's and Master's degree programs illustrates the commitment of the Chinese and northern European partners to cooperation in several areas: high technologies and innovations (mainly Finland and Norway), bioengineering (Finland), energy (Norway), nursing (Finland), international relations (Denmark), global governance (Sweden), case studies, and social work (Sweden). In 2016, an international seminar was held at the Nordic Center at Fudan University, where the best practices for implementing joint educational programs were discussed, in particular:

- Master's double degree programs at the University of Gothenburg and Fudan University (Master's Program in European Studies, Master's Program in International Administration and Global Governance) (starting 2017).
- Master's double degree programs at Lund University and Fudan University (Lund University: Master of Science in Global Studies, Development Studies or Social Studies of Gender Studies; Fudan University: Master in Sociology, Social Anthropology or Social Work, with specialization in Chinese Society) (starting 2011).
- Joint Master's double degree program in sustainable energy of the Norwegian University of Science and Technology (NTNU) and Shanghai Jiao Tong University.
- Joint MBA program of the Norwegian Business School and Fudan University (starting 1996).
- Joint Master's program in Sinology (multiple Master's degree in China Studies) is being implemented, within the framework of cooperation between Zhejiang University (Hangzhou, China) and the central Northern European universities, including the University of Stockholm, the University of Oslo, the University of Copenhagen, and the Aarhus University (starting 2012).
- Joint Master's program of Aalborg University and the University of International Relations in Beijing on the study of China in the system of IR (China and International Relations).

  Educational programs in the context of Sino-Finnish cooperation include the following:
- Master's degree in Research and Innovation in HE program (Tampere University and Beijing Normal University) (starting 2012);Nursing Bachelor's double degree program (Satakunta University of Applied Sciences and Changzhou University)
- Joint Bachelor's degree program in Nursing (Jyväskylä University of Applied Sciences and Beihua University) (starting 2013)
- FuTuRE: Double Master's degree in information and communication technology (the University of Turku and Fudan University) (starting 2013)
- Master's program in food development, at the University of Turku and Jiangnan University – the key national university of *Project 211*, which operates under the direct supervision of the China's Ministry of Education – where the graduates obtain a double MSc-Tech degree (starting 2014)

  Educational programs in the context of Sino-Norwegian cooperation:
- In partnership with Fudan University, the University of Oslo implements joint undergraduate and graduate programs at the Faculty of Economics, Faculty of Theology, and Faculty of Law.
- UiT The Arctic University of Norway has bilateral agreements with six Chinese universities (Beijing Institute of Petrochemical Technology, Beijing Institute of

Technology, Shandong Jianzhu University, Shanghai Ocean University, Zhejiang University of Science and Technology, Zhejiang University of Technology); joint programs cover engineering education, as well as the study of ecology and climate change.

Almost all Finnish universities have partnership agreements with Chinese universities. It is worth saying that Finnish universities (as well as all eight Danish universities and one Norwegian university) endeavor to establish educational organizations in partnership with Chinese universities, including new type of university centers – the Sino-Finnish Center (SFC) in Shanghai (founded in 2010 by the Aalto University and Tongji University) and the Sino-Danish Center (SDC) in Beijing (founded in 2010 in partnership between Danish universities, the Chinese Academy of Sciences, and the University of the Chinese Academy of Sciences). The teaching staff in the centers convenes specialists from the countries of Northern Europe and China, and despite 10 years of experience in functioning, the issues of students' and teachers' sociocultural adaptation remain poorly studied. In the fall of 2019, the China-Norwegian Center for the Study of Society and the Environment was founded under joint initiative of the University of Oslo and Zhejiang University in Hangzhou.

To sum up, bilateral and multilateral cooperation of Finland, Sweden, and Norway with Chinese partners in the field of HE and training enjoys moderately positive dynamics that can be identified by virtue of academic mobility development, training programs implementation, and grants allocated for project implementation jointly with universities in Asia (joint courses, double degree programs, cooperation in employment relations, academic and staff exchanges). Cooperation between the two countries to move on a new stage when China begins to provide assistance in the construction of educational institutions (such tied loans, when China both invests and builds various facilities).

Despite being sufficiently represented in the educational domain, China's engagement in research is still limited, at least in Finland. According to Manninen (2020), China-related issues are explored at the Center for East Asian Studies of the University of Turku (Itä-Aasian tutkimuskeskus, CEAS), as well as by two sinologists at the University of Helsinki and the University of Lapland (they are teachers of Sinology, not researchers specializing in China). The University of Helsinki also has a small China Law Center, which is headed by a professor of labor and private international law. To provide a more consistent view, Sino-Nordic research activities should be analyzed in their entirety.

Joint Research Activities

Since 2012, Finland has been implementing the Asia Program: China is the leader among grant recipient partners, according to the reports of the Finnish National Agency for Education for 2012–2020. In 2019–2020, the target countries of the program were China, India, Indonesia, Malaysia, Singapore, Thailand, and Vietnam; in 2017–2018, they were Japan and South Korea; in 2015–2016, they were China and India; and in 2012–2014 only China was represented (Finnish National Agency for Education, 2020a). Information on the areas of cooperation, the number of funded projects, and their main content is presented in Table 2.

Another cooperation support program – Team Finland Knowledge, implemented by the Finnish National Agency for Education in 2021–2023 – allocates funding mainly for virtual internationalization projects in the field of sustainable development. The program enables virtual internationalization in sustainable development, working life cooperation, and technology cooperation areas. It is argued that areas related to technology are fields where Finnish HE institutions have opportunities to learn from their Chinese partners.

However, in social sciences and humanities, China operates very differently; these fields are thus more challenging for cooperation depending on the topic (Finnish National Agency for Education, 2021a, b, c, d). The number of approved project proposals submitted to the competition from Chinese higher education institutions was 6 (22%), behind only 11 Russian projects (41%). Sino-Finnish projects include designing a meta-network of PhD program in Nursing Science (Finnish National Agency for Education, 2021c), developing and testing a digital climate change curriculum in architecture education (Finnish National Agency for Education, 2021d), and contributing to the sustainability agendas of urban transport systems and services (Finnish National Agency for Education, 2021a). The project financing varies from €31.2 thousand to €72.0 thousand.

In Sweden, the largest agencies for funding for research and educational projects are the Swedish Institute (SI), the Swedish Research Council (VR), and the Swedish Foundation for International Cooperation in Research and Higher Education (STINT). Swedish Institute Management Program (SIMP) Asia provides support to leaders within trade, industry, and the public sector from China. Not only business representatives but also researchers receive funding from the Swedish Research Council and the National Natural Science Foundation of China (NSFC) for interdisciplinary collaboration projects during a grant period 2021–2023; the last one was devoted to corona and virus research (KI News, 2020). The Swedish Research Council and STINT SEK invested 15 million under Joint China-Sweden Mobility program for the period 2021–2024.

Sweden has two international centers specializing in Chinese studies – the Swedish Center for China Studies established in early 2020 with support from the Swedish industry (Swedish Center for China Studies, 2021), and the Swedish National China Center, established at the Swedish Institute of International Affairs in January 2021 and funded by the Swedish government (Swedish National China Centre, 2021). UI also has the Stockholm Observatory for Global China, the research network dedicated to questions arising in relation to China's growing global footprint (Stockholm Observatory for Global China, 2021).

The most influential agency for funding research and educational projects in Norway is the Research Council of Norway, which was established in 1993. In 2019 (latest available data), the Council invested NKr11.4 million in research and innovation. For example, the RCN actively funds research by the Norwegian Institute of International Affairs (NUPI), including research on China. Thus, NUPI

Table 2 Educational projects on China that received funding under the Asia program (by year) [fin. *Aasia-ohjelman rahoitetut Kiina-hankkeet*]

Year	Number of project proposals (in total)	Number of approved projects (in total)	Activities to be implemented under project	Topics, focal points	Funding (€)
2020	33	16 (including 7 Chinese)	Designing and development of joint educational courses Joint doctoral programs (Sino-Nordic doctoral training) Joint research activities	Sustainable urban development Robotizing service sector Development of a smart educational environment Clinical practice in patient care Aging and care services for the elderly Leadership training in nursing Digital education and digital research	€722,900 (€318,800 allocated to China)
2019	36	12 (including 4 Chinese)	Student and staff exchange Designing double degree programs Intensive courses (summer or winter schools) Joint events (conferences, seminars, workshops) Joint research activities	**China:** Artificial Intelligence in Electronic Business; biomedicine, sustainable mining and processing of minerals, education in industrial innovation (industrial design and management)	€510,380 (€176,500 allocated to China)
2018	19 (China is not involved)	8	–	–	–
2017	26 (China is not involved)	11	–	–	–
2016	26	12 (including 8 Chinese)	Designing double degree programs, joint Master's programs, training courses, e-learning modules	Interdisciplinary Research, Business Pedagogy, Software Engineering, Forestry, Gerontological nursing, Chronic Disease Management	€475,167
2015	18 (China) 10 (India)	13 (China) 5 (India)	Projects include various forms of cooperation	**China:** Digitalization, entrepreneurship in the gaming industry, European and China's intellectual property legislation, sustainable development of society, social work, nursing	€575,000 allocated to China €250,000 allocated to India

(continued)

Table 2 (continued)

Year	Number of project proposals (in total)	Number of approved projects (in total)	Activities to be implemented under project	Topics, focal points	Funding (€)
2014	30	10	Designing and development of joint educational courses Designing double-degree programs Student mobility Almost half of all projects involve cooperation in employment relations	Food safety, air quality, joint programs on renewable energy sources, as well as in the development of Sino-Finnish business relations	€422,000
2013	25	8	Designing and development of joint educational courses, schools Joint research Most projects involve short-term student exchanges	Green economy, innovation and entrepreneurship, Chinese and European political theory, social work and nursing, development of social media	€300,000

Source: Compiled by the authors based on the data from Finnish National Agency for Education. Retrieved from: https://www.oph.fi/fi/ohjelmat/aasia-ohjelma

received funding for the study "Chinese Anger Diplomacy" for the period from 2021 to 2024 (Norwegian Institute of International Affairs 2020). The aim is to study the criticism of liberal democratic states from China, and to assess how it can affect the role of China in world politics. The project involves five employees of the Norwegian Institute of International Affairs, as well as four scientists from the United States, England, Scotland, and the Netherlands.

The Fudan European Center for Chinese Studies (FECCS 2021) moved to Oslo in 2021 after the University of Copenhagen stepped down a year earlier. The center was founded in 2013 as a joint initiative of Fudan University and the University of Copenhagen and was initially housed at the Northern Institute for Asian Studies (NIAS) in Copenhagen. In May 2021, the University of Oslo and Fudan University began a new partnership and the center moved to the Department of Cultural Studies and Oriental Languages (IKOS) at UiO.

The main goal of the center is to become a bridge and platform for the development of academic cooperation in the field of Sinology between China and Europe. The centers facilitate cooperation between Fudan University and European universities. "Chinese Studies" in this context means academic activities involving Chinese researchers and/or topics related to China. The center promotes new and existing joint research projects, academic networks, and Sino-European cooperation with a focus on research, dissemination of research results, and exchange of graduate students and young researchers.

For the University of Oslo, this collaboration was an important step in striving to be considered the leading institution in Norway for academic collaboration with China. The agreement was signed in February 2021. It contains a statement that says academic freedom should be applied as a basic principle of collaboration. The director of the University of Oslo also says the Chinese partners are "very positive" about academic freedom.

FECCS is co-financed under a model in which Fudan University covers the salary of the general manager of the center and his activities, and the University of Oslo's contribution is administrative support and the provision of office space. The director of the center is appointed by the Norwegian side. The executive vice director, Chunrong Liu, was appointed on the initiative of Fudan University.

Also at the University of Oslo is the Sino-Norwegian Center for the Study of Society and the Environment (SINORSE), which coordinates and initiates research and teaching about society and the environment in collaboration between scientists, teachers, and students from the University of Oslo (UiO), Zhejiang University (ZJU), and the Max Planck Institute for the History of Science in Berlin. The center has 31 researchers, of which more than half (17) are from Zhejiang University. There are also three Chinese specialists on the board of directors.

In addition, there is a NUPI Center for Asia Research in Norway. The center is engaged in research in the Asian region and China, often receiving funding from the Norwegian Ministry of Foreign Affairs and other government agencies. The center has been in operation since 2015 and was intended to reflect the growing role of the countries of the Pacific region. The main objects of research are India and China. Since 2018, the center, together with the Chinese Academy of Social Sciences (CASS), has hosted the annual Norwegian-Chinese Symposium on Research in Social Sciences, Humanities, and Law.

According to one Finnish expert (Manninen, 2020), Stockholm will become a center for large-scale research of the Chinese society (a total of 7 research institutes, about 40 researchers). This, in particular, is facilitated by the trend associated with the high demand for PhD programs in Sweden among Chinese researchers. So, in 2020, the number of first-year postgraduates totaled 3100 people, while the share of foreign postgraduates was 40%. According to the Swedish Higher Education Authority (Ukä), the majority of foreign graduate students (450 people) came to Sweden from Asian countries, mainly China (35%), India (22%), and Iran (20%) (Ukä, 2021, p. 7).

It should be noted that the pandemic had practically no effect on the dynamics of the mobility of Chinese researchers to Sweden (in contrast to student mobility) (Fig. 3). In addition, the Swedish Foundation for International Cooperation in Research and Higher Education (STINT) and other institutions contribute to strengthening the activities and networks of Swedish higher education institutions with regard to China. In 2021, 30 projects in research cooperation with Chinese universities are granted SEK 15 million under Joint China-Sweden Mobility program for the period 2021–2024. In total, 165 projects have been funded since 2015 (STINT, 2021). According to the Swedish strategy on China, the government conducts long-term and strategic promotion of Swedish innovation, research, and higher education.

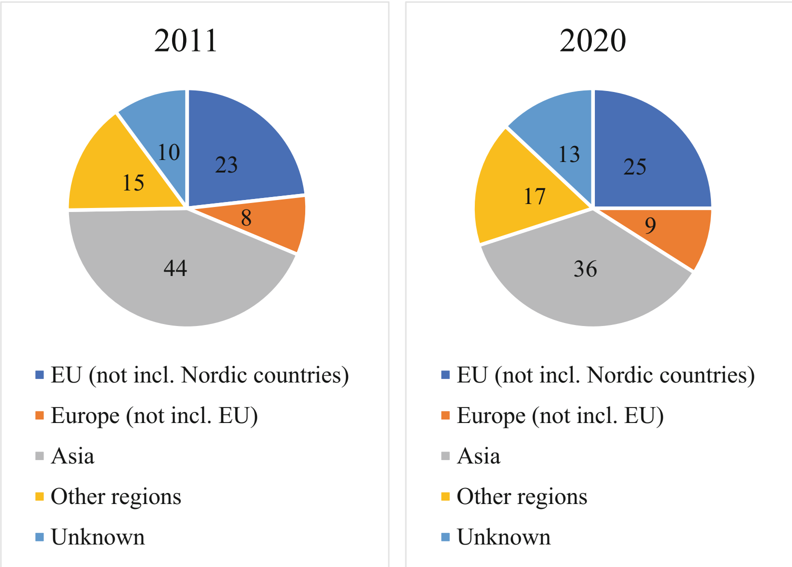

Fig. 3 Researcher mobility to Sweden in 2011 and 2020 (per cent by regions). (Source: Compiled by the authors based on *Swedish Higher Education Authority* (Ukä). Retrieved from: https://www.uka.se/download/18.6fdc950317c74b736705b9/1634130104126/Analys-211013-Flest%20utlandska%20doktorandnyb%C3%B6rjare%20fr%C3%A5n%20Asien.pdf)

Sino-Finnish R&D Cooperation

It is noteworthy that in the early 2010s Finland and Sweden displayed the highest levels of R&D intensity in Europe. R&D intensity is an indicator of the general ability to master and apply new technologies. Figure 4 depicts 12 countries with the highest R&D intensity. It also shows the dynamics of gross domestic spending on R&D in China, across the EU, and in OECD countries in 2007–2018. Just more than a decade after, the R&D intensity has declined only in Finland and Japan. For example, in 2007, Finland ranked second in the world in terms of investment in research, but in 10 years dropped to 11th place.

The latest official statistics for R&D indicate that in terms of absolute expenditures, China is the world's second biggest R&D player, with $514 billion, versus the United States' investment of $612 billion in 2019 (Fig. 4). According to Finland's Governmental Action Plan on China (2021), China's technological advances, funding of collaborative research, and markets make collaborations attractive. It is stated that RDI cooperation must ensure reciprocity and fairness to the mutual benefit of both Finland and China. In addition, Finland continues to participate in EU-China Science, Technology, and Innovation Roadmap negotiations under the leadership of the European Commission.

Sino-Finnish R&D cooperation includes the projects supported by the Academy of Finland (e.g., the Arctic Space Centre of Finnish Meteorological Institute in

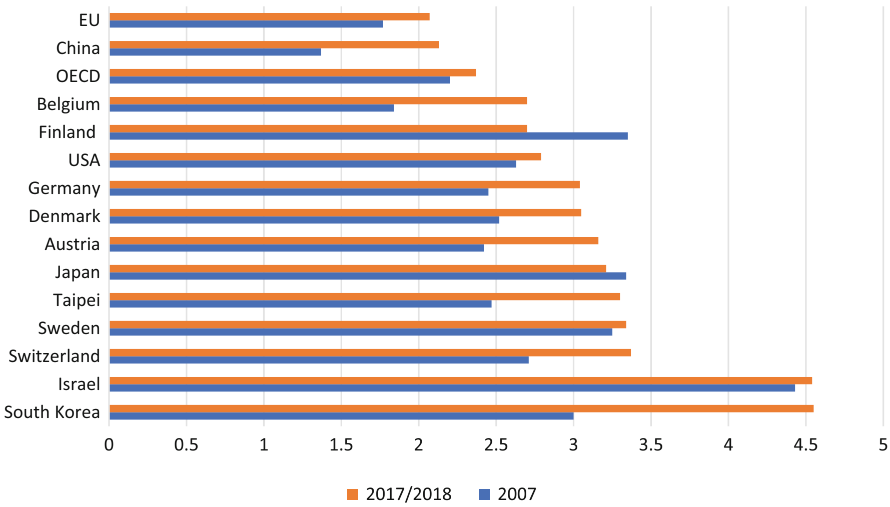

Fig. 4 World's highest R&D intensity in 2007 and 2017/2018 (per cent of GDP by country). (Source: Compiled by the authors based on *Elinkeinopoliittinen tilannekuva* (2020). Retrieved from: https://julkaisut.valtioneuvosto.fi/bitstream/handle/10024/162084/TEM_2020_09.pdf)

Sodankylä), and Chinese partners maintain cooperation in the meteorological data exchange; since 2014, the Arctic Centre of the University of Lapland in partnership with Wuhan University carried out a project on the comparison of legal positions by Finland, China, and the EU with regard to different Arctic topics such as fisheries, shipping, activities in the Arctic Council, and Indigenous Peoples' rights.

In 2017, Sino-Finnish Research Centre for Science, Technology, and Innovation (Sino-Finnish STI Centre) was cofounded by the University of Vaasa and the Chinese Academy of Sciences and supported by the European Regional Development Fund (ERDF). The Centre operates at the University of Vaasa, which provides educational and training services, as well as consultations for business representatives of China and Finland. The most important area of Finnish-Chinese cooperation within the center is the development of innovative solutions in the field of digitalization and energy sector.

Chinese Language and Culture Promotion

Finland's and Sweden's Responses to China's Cultural Influence

Today, in Finland, Chinese language as a main discipline is included into curriculum only at the University of Helsinki. However, on a national scale, the teaching of Chinese is very modest. In 2019–2020, a student studying Chinese as the main discipline of the Bachelor's degree program at the University of Helsinki earned 50 credits.

In 2006, an agreement on twin-city relations was signed between Helsinki and Beijing. The publications of the Finnish National Agency of Education on relations with China emphasize the importance of bilateral relations and the need to promote the internationalization of education at different levels (preschool, school, vocational, and higher education). At the conference on educational technologies, organized for the first time in 2018 in Hangzhou (Zhejiang province), it was noted that during the period of the agreement in Helsinki, the teaching of Chinese in primary schools has doubled (Finnish National Agency for Education, 2018e).

According to experts, the language training of Chinese language specialists in Finland is significantly inferior to the level of training in other European countries. As consequence, the absence of national (domestic) vision (fin. *Kotimainen näkemys Kiinasta*) and understanding of China, which is mainly limited to the interpretation of foreign experience and media output (Mustonen, 2020).

In Sweden, there are more opportunities to study Chinese: Lund University offers a Master's program as well as a large number of courses in Chinese, whilst Uppsala University offers a Master's program in Chinese. At the University of Copenhagen (Denmark), the Bachelor's degree program in Sinology involves teaching in English and Chinese. As for Finland, it is likely that new opportunities for training specialists in China studies appear in the fall of 2021, when the University of Turku, with the support of the Center for East Asian Studies and the Center for Language and Communication Studies (fin. *Kieli- ja viestintäopintojen keskus*) launches a new training program in Chinese at School of Languages and Translation Studies (Mustonen, 2020).

The popularization of the Chinese language and culture is carried out at the Confucius Institutes – a global network of specialized training centers, usually functioning at universities outside of China. In these institutions, cultural and educational activities are often associated with the political goals of the Chinese Communist Party. In 2018–2019, there were 548 Confucius Institutes in 142 countries of the world, including the countries of Northern Europe (Juhola, 2019).

In 2007, the University of Helsinki and the State Chancellery for the Spread of the Chinese Language Abroad (Hanban) and the People's University of China signed an agreement to jointly establish the Confucius Institute in Helsinki. Despite the agreement until 2023, Xi Jinping's rise to the post of leader of China and, later, the outbreak of a trade war between China and the United States increasingly fueled discussions about China's influence through various associations, companies, and individuals, which became a wakeful signal for the national security of states being the parties to agreements on Chinese language and culture promotion. For example, one of the targets of the Finnish SUPO (Finnish Security and Intelligence Service) is the Chinese Association of Science and Technology in Finland (CASTF), registered in Helsinki in 2014, which, according to Juhola, has close ties with China Zhi Gong Party (China Public Interest Party).

According to Juha Janhunen, Professor Emeritus at the University of Helsinki, the Confucius Institute has significantly changed its form of work over several years, so the time has come to revise the terms of cooperation (Koskinen & Parkkari, 2020). Janhunen noted that the resources allocated for functioning of the Institute (the annual budget being about €250 thousand, 50% comes from China and other 50 from the University of Helsinki) could be used in a more efficient way. In addition, it was emphasized that it is useless to maintain an institution that restricts freedom of discussion. For example, the topic of Sino-Tibetan relations is undesirable for discussion. One researcher at the University of Helsinki told Koskinen & Parkkari (2020) how a Confucius Institute employee criticized his presentation on Tibet. Janhunen and Lahtinen, chairs of the board of directors in 2012–2016, admitted that the Confucius Institute as an actor in the educational market does not have sufficient competencies, so its activities should be moved outside the university (Koskinen & Parkkari, 2020).

Another staff member at the University of Helsinki, who closely followed up on the activities by Confucius Institute, discussed the problems referring to the primary responsibilities of the Deputy Director of the Institute, appointed by the Chinese Hanban (Koskinen & Parkkari, 2020). In particular, it was noted that he was given a title of professor in China, but his responsibilities and competencies do not include teaching. Instead, he is engaged in drawing up reports at the China's request. At the same time, the Hanna Snellman, Vice-Rector at the University of Helsinki, emphasized that the position of the Deputy Director of the Confucius Institute is administrative rather than academic.

According to Milla Meretniemi, SUPO Communications Manager, allocation of funds for training or research is one of the ways a foreign state can influence teaching content and degrees (Koskinen & Parkkari, 2020). In 2015, the work of the Confucius Institute at Stockholm University was suspended. Its former director, Professor Emeritus Torbjörn Lodén reported how Stockholm University developed a set of rules to be included in the Confucius Institute's Charter, but China, for its part, insisted on new rules in their Charter (Koskinen & Parkkari, 2020). Among other things, the Beijing headquarters of Hanban proposed that the operations of the Stockholm division comply with Chinese law. Lodén said that the Swedes have never agreed with China's proposals (Koskinen & Parkkari, 2020). In addition, in 2017, the Copenhagen School of Economics stopped cooperation with the Confucius Institute, and in the summer of 2019 with Aalborg University.

Norway's Response to China's Cultural Influence

The Confucius Institute in Bergen began its existence in 2007 in cooperation with the University of Bergen (UiB) and the Western Norway University of Applied Sciences (HVL). The University of Bergen is the only institution in Norway to have a cooperation agreement with the Confucius Institute.

The criticism of the project was mainly related to the fact that the institutes are under the jurisdiction of the Chinese Ministry of Education, which is directly under the control of the Communist Party. In this regard, many experts talked about tough censorship in these institutions.

In 2018, the Confucius Institute in Bergen came into the spotlight after the report of the Norwegian Embassy in Beijing on the activities of Confucius institutions was disseminated via the Norwegian online media Khrono. The report highlighted institutions as an instrument of China's soft power, and noted that "the form of work was in conflict with the fundamental values of institutions such as academic freedom." In the fall of 2020, the two institutions behind the Confucius collaboration in Bergen – the Western Norway University of Applied Sciences (HVL) and the University of Bergen (UiB) – decided to close the Confucius Institute starting in the spring semester of 2021.

Nowadays, the study of the Chinese language is most common at the University of Bergen and the University of Oslo. UiB has a Bachelor's program in Chinese, which admits 20 students. Also, many programs for studying the Chinese language can be observed at the University of Oslo, which has partnerships with most of the leading universities in China. There is an Asian and Middle East Studies undergraduate curriculum as well as Chinese language courses for teachers and students.

Since 2019, the Norwegian University of Oslo (UiO) has begun to conduct the test in Chinese as a second/foreign language (TOCFL) jointly with the Ministry of Education. At that time, among the Nordic countries, only Sweden conducted such tests on knowledge of the Chinese language. This initiative came about with the assistance of the Department of Cultural Studies and Oriental Languages, which is also implementing a joint project with Taiwan.

University of Oslo researchers Heidi Haugen and Rune Svarverud believe that "learning Chinese is valuable, whether it's an elective in school, an exchange semester, or an evening course" (Haugen & Svarverud, 2021). However, they note that fluency in written and oral skills requires full-time study over several years.

Previously, the curriculum allowed students to take a five-year Chinese language course with a mandatory one-year preliminary language course. Today's Bachelor's degree lasts only three years. According to Norwegian Sinologists, this is not enough for learning Chinese (Haugen & Svarverud, 2021). In other Scandinavian and European countries, there is a four-year undergraduate course in Chinese, while in Norway, students have to pay for additional Chinese courses in order to fully master them.

Another important component of promoting China's soft power in Norway is the holding of events dedicated to Chinese culture. Cultural interaction between countries continued even during the coronavirus pandemic. In this regard, on January 5, 2020, a musical concert "Cultural China. Chinese-Norwegian Spring 2020 Festival, Gala Concert" took place. The event was organized by the Norwegian-Chinese Foundation for Cultural Tourism, in cooperation with the Norsen Group, the Norwegian Zhejiang Chamber of Commerce, and the Hunan Radio and Television International Media Holding, with official support from the Embassy of the People's Republic of China in Norway. According to the Chinese Ambassador to Norway Yi Xianliang, "the annual Chinese New Year concert for overseas Chinese has always been a big event in the overseas Chinese community in Norway" (Yi & Yixin, 2020). This festival has been held in Oslo since 2016 and, in addition to supporting the Chinese diaspora in Norway, aims to interest Norwegians in learning Chinese culture and language in the future. This festival has been held in Oslo since 2016 and, in addition to supporting the Chinese diaspora in Norway, aims to interest Norwegians in learning Chinese culture and language in the future.

In addition, there is cooperation between countries in the field of music education. The Norwegian Academy of Music and the Shanghai Conservatory of Music entered into a partnership agreement in 2018, covering multiple disciplines in both institutions. Following this initiative, the Center for Chinese Musical Culture opened on October 9 at the Norwegian Academy of Music to foster closer collaboration between students and teachers from both institutions. On September 9, 2021, a joint concert of traditional music of China and Norway took place. Interestingly, in 2001, an agreement was signed between Oslo and Shanghai on the establishment of twin-city relations.

Summing up, we argue that the China's policy in the promotion of language and culture in Northern Europe is somewhat incoherent, since the government does not make allowances for national specifics of Nordic societies; on the one hand, Nordic society tends to copy Western responses towards China, but on the other, the Nordic government authorities are making continuous commitments to legitimize cultural, educational, and research activities, as well as engaging business representatives as sponsors of various activities, whilst furthermore, finally, ordinary people consider knowledge about the Celestial Empire to be rather a service aiming to provide better understanding of what is China per se and what are the benefits from collaborations for the people.

Media Use and Political Messaging

Political relations with the PRC at the level of the Nordic governments (excluding Iceland) are inconsistent and unbalanced due to the existing requirements of the European Union to the national policies of Finland, Sweden, and Denmark, the allied commitments of Denmark, Norway, and Iceland to NATO (these countries are especially susceptible to pressure taken by the United States on security-related issues, which forces governments to pursue a more cautious policy with China), and existing bilateral agreements with Russia and the United States.

The EU's vision of relations with China is based on economic competition in the latter's quest for technological leadership. The EU also views China as a "systemic rival" lobbying for alternative governance models. Therefore, the Nordic countries of the EU should expect tougher measures from Brussels to regulate cooperation with China (which, for example, is already observed in the field of FDI). Likewise, Brussels is likely to impede cooperation within the *5 + 1 format* (Sino-Nordic cooperation), a Chinese initiative presented to the Nordic Council of Ministers in 2016. This is likely given the fact that the *16 + 1* format (cooperation between China and 16 countries of Eastern and Southeastern Europe), which has existed since 2012, is often portrayed as an example of the Chinese strategy of "divide and rule" in Europe.

By 2019, the approximate number of intergovernmental memorandums of understanding of *5 + 1* countries reached 165 (Denmark had 58, Finland 35, Iceland

28, Sweden 27, and Norway 17), but only two countries in the region have developed partnerships with China: Denmark (Comprehensive Strategic Partnership, since 2008) and Finland (Future-oriented new type of cooperative partnership, since 2017). Iceland, since 2013, has had a free trade agreement with China; currently, the kingdom of Norway is negotiating to sign such an agreement. The number of high-level visits to Denmark, Finland, Norway, and Sweden in 2016–2019 on average ranged from 7 to 9, as well as 3 in Iceland.

Nevertheless, the political relations of the *5 + 1* countries can hardly be called stable. The conflict of political values often led to the severance of relations between the PRC and individual countries of Northern Europe: as examples, the six-year crisis in Sino-Norwegian relations (2010–2016), the six-month crisis of Sino-Danish relations (2009), or the lawsuit of Gui Minghai, a Swedish citizen, complicating Sino-Swedish relations.

China's soft policy has received a lot of criticism in the northern European media (especially in Sweden). These include the field of human rights; environmental policy; and the activities of Confucius institutions and other Chinese associations abroad to drown out criticism of China. Examples of this include the Finnish Association for the Promotion of the Peaceful Reunification of China (FAPPRC), which has about 200 departments in more than 90 countries (Koskinen & Skön, 2020), and the Chinese Students and Scholars Association (CSSA), which has over 150 departments around the world, including at universities in Finland and Sweden (Expressen, 2018). There are fears that Chinese investments in strategic facilities such as airports and seaports will become an economic force: in Finland, Supo warns of increased Chinese interest in strategic infrastructure projects. According to Elina Sinkkonen, a Senior Research Fellow at the Finnish Institute of International Affairs (FIIA), every year China is making more bold attempts to stifle discussions in Europe that distort China's attractiveness (Koivurova, 2020).

Chinese overseas media activities are part of China's soft power policy. In 2007, the Chinese Communist Party called "soft influence" one of the main ways to influence the world community. Two years later, China invested €5.7 billion in the world media, and with the coming to power of Xi Jinping, according to Western experts, the role of the media as an instrument of party propaganda has strengthened (Uutiset, 2020).

In 2019, the influence of the Chinese media was also experienced in Finland (until 2019, the Finnish media remained, perhaps, the most loyal to China). An advertisement was posted in Helsingin Sanomat that announced Hong Kong's refusal to act violently against the extradition bill. The announcement sparked outrage in Finland: one HS columnist resigned in protest; Finns called HS "a platform for hybrid influence" (Uutiset, 2019).

This story, which, according to HS editor-in-chief Kaius Niemi, has thundered under the guise of social advertising (Uutiset, 2019), is notable for the fact that it entailed a number of publications in regional media (*Satakunnankansa*, *Suomenuutiset*, *Karjalainen*, etc.) that draw a line under the long-brewing conflict between the camp of supporters and the camp of opponents of the Chinese regime and China in general.

In addition, a key issue on the agenda was the discussion of the right to freedom of expression: the extent to which the media are free to write about the CCP's activities. It is known, in particular, that the owner of Sanoma Oyj, the leading media group in the Nordic countries, is also the chairman of the board of directors of KONE Oyj, a company with a significant share in the Chinese market.

Finland continues to perceive China as "a partner, economic competitor, and rival at the systemic level" (Government of Finland, 2020), which completely corresponds with the EU strategy on China mentioned above. In 2021, Finland has approved the Action Plan on China where the government is still concerned about Chinese human rights policy and seeks to encourage China to play a responsible role internationally. At the same time, it claims the China is one of the most important target countries for Finland's nation branding work.

Previously, in 2019, the Swedish government formulated the "Approach to matters relating to China" that also reflected increasing concerns about China across Europe. It was also a logical response to growing accusations that policymakers had been far too "naïve" dealing with Chinese counterparts. Furthermore, Swedish political journalist Björn Elmbrant pointed out that Swedish industry representatives had "naïvely" assumed that trade would contribute in the long run to Chinese transparency and respect for human rights (Elmbrant, 2019); thus, Elmbrant urges business leaders to stop being naïve, concluding that "...the more companies become dependent on the Chinese, the greater the risk that they will be forced to turn a blind eye to the abuses that take place" (Elmbrant, 2019).

In July 2021, a joint statement by the four leading Nordic media outlets in support of colleagues at *Apple Daily* and other Hong Kong media outlets was widely publicized. The protest appeal was published by *Aftenposten*, *Dagens Nyheter*, *Politiken*, and *Helsingin Sanomat* (Aftenposten, 2021). In a letter, the editors-in-chief of these media outlets protested against Chinese press censorship. The authors stated that freedom of speech is one of the main ingredients of democracy and human rights.

The open letter reached the Chinese government, which responded the same day. In a statement, China said it was shocked by the content and categorically refuses to accuse the northern media. It was also said in the response that the Hong Kong media were not punished for criticizing the government, but for actions coordinated with external actors. This incident was one of the few times that the media openly condemned Chinese policies.

Conclusions

This chapter argues that contemporary toolbox of China's soft power policy in cultural, educational, and research domains is still not adequately examined, which stresses the need for qualitative and quantitative research on China's efforts in implementing its soft power strategy across countries in Northern Europe. We recognize that other factors – including lobbying from other countries (such as the United States), economic exposure alongside benefits from multilateral cooperation, the advancement of Chinese military technology, etc. – could explain the existing national views and attitude towards China's policy in Northern Europe.

The soft policy priorities and strategic goals of Chinese government are as follows. Firstly, it seeks to make China a preferable and respected partner for the Northern European counterparts. Secondly, China strives to develop global networks with participation of promising scholars and experts, providing China with a platform with a means by which to grow its own cadre of researchers and academic experts to bolster its institutional capacity to inform the intellectual discourse. Thirdly, China's soft power will in the long run makes country's word heard, thus, increasing its sway over Europe by influencing related discourse. Finally, as a narrower goal, it seeks to tackle domestic issues related to the relative lack of high-skilled workers and low level of immigration.

The degree of China's influence upon the regional and global discourse on a wide range of issues is expected to increase correspondingly in future. Since China provides young academics with opportunities to pursue a PhD abroad (see Swedish doctoral program in demand), new individuals will take on positions of influence in institutions around the world and even establish their own institutions.

Today, China's soft power policy is not explicitly assessed in academia and media in Northern Europe. Overly negative and pessimistic assessments of China's soft power prevail in Sweden, while Finland and Norway share more cautious reasonable views, although not invariably. In that sense, China is sometimes regarded as "stain on the brand" (fin. *bränditahra*) of the democratic values of the Nordic societies.

By understanding China's soft power, Finnish, Norwegian, and Swedish policymakers can comprehensively assess their decisions. Soft power analysis facilitates identifying China's strategy in its entirety, including actions directed at various groups of society in any domain, areas of shared interest in education and research, and image-boosting policy activities. The prospects for further research are likely to identify the linkages between low politics and high politics in Chinese-Nordic relations through the analysis of soft aspects of business cooperation, investment flows, and company acquisitions. We do believe that under certain circumstances soft power may be employed to achieve aims that hard power simply cannot.

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Research Policy and Cultural Specifics in the Arctic Region

Case of Canada

Petr I. Kasatkin and Marina D. Krynzhina

Contents

Abstract

Specific unresolved problems remain in the scientific study of Canada, rooted in the historical and cultural identity of the inhabitants of this Arctic country. This chapter examines in detail Canada's science policy from the viewpoint of how the bilingual aspect has influenced this country's culture. The authors look into the scientific field of Quebec in the context of the cultural crisis, and the struggle for the recognition of the rights of two national communities linked by the unity of language and symbols. The chapter investigates the features of the Quebec scientific field and analyzes the reasons for its "peripheral" position. Despite the obvious progress in science policy in Canada, associated with the victory of the Liberal Party in 2015 and the decision to allow scientists to freely exchange information with journalists, unresolved problems still remain in this field, relating to the roots and identities of the country's inhabitants. Taking into account those contradictions that characterize Canadian culture and significantly influence it, the authors analyze whether and to what extent the linguo-cultural

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characteristics of Canada are reflected in the research activities of scientists themselves.

Keywords

Science policy · Science culture · Bilingual culture · Scientific community · Scientific research in Canada

Introduction

The 1999 UNESCO declaration notes the existence of a single scientific community serving a single purpose: "All cultures can contribute to scientific knowledge of universal value" (UNESCO, 1999).

However, the existence of value pluralism in science suggests that the scientific communities of different countries form different sets of values under the influence of their national cultures. In turn, these specific sets of values can serve as the basis for the emergence of national research cultures.

At the same time, in modern natural science research, most large-scale experiments, as a rule, go beyond the framework of one national laboratory, are tested and rechecked in other research centers, before they become an established fact of scientific knowledge. This is due to the fact that scientists need an appropriate material and material and technical base (Schwartz, 2007). Consequently, the course of the research process is internationalized. Its results today, as a rule, are the fruit of joint efforts at different stages of time of groups and systems of groups of researchers composed of representatives of different cultures.

In addition to the material and technical base, an important condition for the effective work of a researcher is knowledge for what purposes, in what conditions, and in what way the derivation of one or another formula and another formalized unit of knowledge was obtained. Sometimes this knowledge creates unexpected barriers to cooperation between representatives of different national scientific schools, since the values of national culture are associated with certain ethical preferences that have deep cultural, historical, and cultural and religious roots (Medvedeva, 2015).

There is no doubt that scientific information is one of the universal symbols, that scientific information is universal. Therefore, based on this logic, which implies that scientific information is international and adapted to any culture, it seems quite obvious that there is only one model for the development of science and all national scientific communities are usually similar in terms of their structures and functions. However, it is precisely because of this logic that contradiction is born.

The organization of research activities in the Arctic is just a vivid example of such a contradiction. On the one hand, the leading role of research activities in the region is openly recognized at the highest level. The development of the Arctic regions and the preservation of their cultural and social heritage is a very important task that cannot be accomplished within the framework of one national research team. On the other hand, representatives of different peoples participating in the development and study of the region rely on different sets of values, and the foreign policy of states in the Arctic is based primarily on national interests.

Canada's Arctic policy has undergone dramatic changes since the liberal government came to power. A significant political event took place in 2015: the Liberal Party of Canada won the general election, gaining an absolute majority of seats in parliament. Justin Trudeau became the Prime Minister of Canada, following his predecessor Stephen Harper, who had held the office for almost 10 years. Canada's nationally oriented The Arctic and Northern Policy Framework (Kikkert & Lackenbauer, 2019), published in 2019, confirmed the rejection of the aggressive conservative "hard security" policy in the region, expressed in the slogan "use it or lose it" (Bartenstein, 2010) and support for socio-cultural and environmental issues in Arctic policy.

Canada's Arctic policy is a kind of mirror of those internal contradictions that determine the characteristics of the research culture and scientific policy of Canada as a whole. Opinion polls (Roussel & Payette, 2011) have shown that French- and English-speaking Canadians see differently the goals and vector of development of the Arctic policy.

Conservative discourse has proven to be less attractive to French-speaking Canadians, who are mostly concentrated in Quebec. The results of the study confirmed the hypothesis that the inhabitants of Quebec are less concerned about security issues in the north and more about the environment and the fate of the indigenous population, and also tend to have less trust in federal institutions in general. Quebecans, unlike other Canadians, tend to have alternative political beliefs, and the federal conservative agenda only exacerbated these differences (Roussel & Payette, 2011).

Stephen Harper's resignation was considered by the public one of the most important steps toward improving science policy in Canada. According to official statements in a radio advertisement by the Professional Institute of Public Service of Canada (Ottawa), which has more than 57000 state scientists and professionals, for many years the Harper government had cut funding for scientists and ignored the interests of researchers if they did not correspond to government policy.

In addition, according to the Institute (Marketwired, 2016), the number of jobs for scientists was significantly reduced during the reign of the Conservative Party. Since 2006, about 2500 researchers have been dismissed.

In addition, in 2006 Canada ranked 16th in terms of public funding for scientific research in a list consisting of 41 countries, before descending to 23rd place in 2011 (Romanova, 2017). The data for 2011 posted on the government's website is the latest available for review.

The decision of the Conservative leader to restrict scientists' access to mass media was the most greatly criticized aspect among scientists (CCA, 2016). Even though most researchers were dissatisfied, Stephen Harper never cancelled the decree. Canadian scientists were forbidden to report the results of research to journalists for a long time. In turn, both the press itself and the topics that scientific journalists touched on in the media were controlled by the Canadian government.

One of the most famous cases of Canadian government interference in the process of reporting scientific achievements is the incident that occurred with Dr. Christy Miller, head of the Molecular Genetics Section of the Fisheries and Oceans Department (Pelletier, 2016).

Dr. Miller's study explaining why the salmon population was rapidly declining in the western part of Canada was published in 2011 in "Science," one of the most influential scientific journals. The researcher concluded that the fish may be infected with a virus associated with cancer. This assumption raised many questions, including whether the virus could have been introduced by the local processing companies.

The editors of "Science" considered the results of the study extremely important and prepared a press release that was sent to thousands of journalists around the world. Dr. Miller was mentioned as the main contact in the press release. Despite this, the Canadian Government refused all requests from journalists to interview Christy Miller, justifying its decision by the fact that the researcher refused to give an interview without the Department's permission.

Nevertheless, much later, Miller admitted that the management forbade making comments, as the decrease in the salmon population is not a piece of positive news (Pallab, 2015).

In addition, a large-scale study was conducted in 2013: 25% of the surveyed scientists in public service admitted that the government had given them instructions to exclude or change objectionable information for reasons unrelated to science. Seventy-one percent of respondents said that government intervention jeopardized the further development of science policy, since officials are not guided by scientific data, but act within the framework of their interests. Almost half of the scientists who took part in the survey were aware of cases when their department or agency deliberately withheld information.

That study was commissioned by the Professional Institute of the Public Service of Canada. More than 4000 scientists in the public service took part in the online survey.

Perhaps it was thanks to this ongoing policy toward scientific activity, which was constantly attacked and caused general dissatisfaction of scientists, that Justin Trudeau managed to win the election in 2015. Already in 2017, keeping his electoral promise, the Prime Minister re-established the position of Canada's Chief Science Advisor, which was abolished in 2008. The tasks of the advisor, which is Dr. Mona Nemer, Professor and Vice-President of Research at the University of Ottawa and Director of the school's Molecular Genetics and Cardiac Regeneration Laboratory, is to provide scientific advice to the government, the prime minister, the minister of science, and members of the cabinet of ministers; monitor political decision-making processes; verify that actual research results are taken into account when making policy decisions; and help the public understand the scientific foundations of public policy and major social issues. In one of the first interviews after taking office, answering a journalist's question about the lack of relevant experience, Mona Nemer noted: "Fortunately, several countries and jurisdictions have their main scientists on whom I can rely, in particular, Rémi Quirion from Quebec ... This collegiality is good for the planet and for Canada because we can go a long way in our bilateral and multilateral relations through science diplomacy" (Marleau & Girling, 2017). It is noteworthy that Rémi Quirion, Quebec's Chief Scientist, representing primarily French-speaking scientists in Canada, has held a similar position since 2011.

Literature Review

The study of secondary scientific communities may be considered a privileged object of analysis of the sociology of science, involving as it does the study of ideas about the scientific community and its development (Merton, 1973).

It is generally accepted that the scientific community, since its creation in the seventeenth century, has been international, consisting of many areas of scientific research, within which groups of scientists studying similar problems emerge. These scientists or groups exchange information across national borders. Subsequently, as a rule, an evolutionary-diffuse approach is used to analyze relations between the centers and the periphery, according to which the peripheral scientific communities not only exchange and adopt information from the centers but also reproduce it. That is, the central scientific communities are decisive and dominate provincial science. This idea of the structure of the international scientific community and the translation of scientific knowledge correlates with the concept of scientific revolutions of Kuhn.

There is no doubt that scientific data is one of the "transferable" symbolic goods; scientific data is universal (Haas, 1992). Therefore, based on this logic, which implies that scientific information is international and may be adapted to any culture, it seems quite obvious that there is only one model of the development of science, and that as a rule all national scientific communities are similar in terms of their structures and functions. To put an end to ethnocentric sociology, which follows the evolutionary philosophy (measured by such indicators as the number of publications, spending on research and development in percent of GNP, etc.), one should study the specific logic of each scientific field and analyze the relationship with other fields (religious, economic, political).

The scientific field's structure and activity do not depend on historically formed traditions but are subject to social relations, referring to the actions of certain people and social classes who somehow influence the scientific field for their benefit. Analyses of the social functions of science often derive simple and simplified conclusions: for example, if scientific research is used for military purposes, researchers can be condemned accordingly and considered "lackeys of capitalism and imperialism." One should also consider various mediation mechanisms through which scientists respond to various (sometimes contradictory) external requests while analyzing the degree of autonomy in the field of science.

It is tacitly assumed that modern science is independent of religion, politics, and economics. This suggests that the scientific community is becoming increasingly isolated from laypeople and everyday needs; scientists are dealing with those particular issues that seem most important to them or that they can solve (Romanova, 2018). Scientists have the right to report their findings only to a restricted number of colleagues, whose main task is to assess the quality of the work done.

Along with scientists gaining more and more independence, their status is also increasing. Scientists have the right not to have any extra competencies used in everyday life; they may occupy a position in the field of non-scientific activities, such as publishing in non-scientific journals, but at the same time to occupy various social positions in administrative, economic, political, and religious spheres. At the same time, the institutionalization of scientific activity – scientists who are increasingly working in the context of specific institutions (universities, research centers, etc.), which are grouped into scientific communities – are beginning to be distinguished from intellectuals, whose main role is to develop, present, and sometimes create the fundamental values of society (Fournier et al., 1975). Some American studies (Krige, 2008) do show that the scientists who cannot but have their own political opinion (being citizens of their country) are not actually interested in politics and very few of them are part of the American intellectual elite, i.e., they are published in large intellectual popular journals and participate in large intellectual and political debates (Cairns, 1975).

There has been a gradual increase in the role of science since the seventeenth century, and today, as clearly evidenced by the study of Ben-David, the definition of what this "role" means in contrast to other "roles" is much stricter (Ben-David, 1971). However, this does not mean that the production and dissemination of new knowledge is the only meaning of scientific activity today. According to the "Social Stratification in Science"by Cole & Cole (1974), the authors believe that one of the shortcomings within the history of science was neglecting the importance that the contribution of "administrators from science" has when promoting the results of research activities. The researchers distinguish two main scientific roles: the researcher, and the administrator.

Nevertheless, even this list of scientists' "roles" remains incomplete. Merton accepts both roles but also adds that a scientist is also a researcher, teacher, and keeper of knowledge (Merton, 1993). Despite this important fact, the list of such "roles" is still incomplete, since neither the importance of spreading knowledge nor the scientist's political activity is taken into account. All this suggests that there is only one "role" for the scientist, or at least no scientists correspond to the dominant ideas about the figure of the researcher. This is also one of the conclusions reached by Barnes and Dolby, who call on sociologists of science to study the conditions (financial support, organizational framework, technology development, etc.) that inflict changes in the regulatory structures of the scientific community (Barnes & Dolby, 1970).

Science Policy

In 2015, a young liberal politician coming to power marked an important stage for Canadian scientists. The first step toward a new science policy in Canada, which was received extremely positively by researchers, was the new Prime Minister's official permission to let scientists engage in dialogue with the media and openly talk about the latest results and achievements of Canadian scientists.

However, scientists' attempts to change the current situation in the field of science policy had been made even before the new Prime Minister took office. For example, the national initiative "Integrity in Science Project"was created in Canada as a response to the growing concern in society that many government policy decisions made in Canada – in its cities, provinces, and territories – are neither consistent nor based on reliable information obtained as a result of relevant scientific research (Pelletier, 2016).

The purpose of this Project is to draw attention to the role of scientifically proven facts in making decisions in the field of science policy. Seventy-five scientists and politicians from all over the country participated in the initiative. The main document of the Project was a Statement on the principles of informed decision-making in Canada. The document stated that the decision-making process should be based on evidence, which, in turn, should be the highest priority for the government at all levels.

There was a time when facts and science played an important role for science policy actors in Canada; however, a lot has changed over the past 20 years, according to Paul Dufort, visiting professor at the Institute of Science, Society and Politics at the University of Ottawa, and also co-chairman of the Project's executive committee.

Over the past 2 years, the creators of the initiative have conducted 30 in-depth interviews with experienced leaders in the field of science policy (Marketwired, 2016). Also, a national forum was held under the auspices of the Project in February 2015, which was attended by past and current representatives of governmental and nongovernmental organizations, professionals representing various fields of science, and many other leading minds from all over the country.

As a result of their long work, four principles were formulated at the forum. Officials and other scientists can be guided by these principles to improve and increase the effectiveness of Canada's science policy in various fields.

Principle No. 1: The decision-making process in the field of science policy should be based on proven facts that have been obtained by transparent, rigorous, and holistic methods.

Principle No. 2: There should be an open exchange of information between researchers, knowledge holders, decision-makers, and the public.

Principle No. 3: The results of research should be protected, preserved, interpreted, and submitted to the general public in an accessible and understandable form.

Principle No. 4: The decision-making process should be transparent and regularly evaluated by experts. As Paul Dufort noted, the same principles had been successfully applied all over the world.

In addition to the Statement of Principles, the Integrity of Science Project developed several illustrative examples of applying these principles, held a closed conference on the relationship between science and politics in Canada, and presented an analysis of in-depth expert interviews. These other materials are publicly available on the Project's website in full in French and English.

Despite the obvious progress of science policy in Canada, associated with the inauguration of a new prime minister and the decision to allow scientists to freely exchange information with journalists, other unresolved problems are rooted not in the current management system, but in the historical and cultural identity of the Canadian people.

In this regard, back in the twentieth century, the royal commission of 1965, investigating the relationship between English- and French-speaking Canadians, warned that the country was undergoing the strongest cultural crisis in its history (Shestopal & Silant'eva, 2012). Today, despite numerous institutional and political changes, the relations between French-speaking and English-speaking Canadians still provoke many conflicts.

The main unresolved problem is the desire Quebec has to secede from the country and gain independence (de Solla Price & Beaver, 1966). Formed in 1960, the Quebec separatist movement has repeatedly come close to achieving its goal. The most critical and dangerous internal political situation for the country's sovereignty arose in the 1980–1990s.

This situation emerged from the failure of the "Meech Lake Accord,"named after a small lake near Ottawa where the negotiations took place. The need for adopting the Paris Agreement arose after Quebec refused to sign the Constitution of 1982. The Quebec province was the only one not to ratify the new Constitution. As a result of the negotiations, five amendments to the act were discussed. They were to be unanimously approved by all the federal and provincial parliaments.

The amendments were aimed at recognizing the special rights Quebec has as a separate society. One of its points also suggested that the provinces would play a more important role in the Supreme Court of Canada and the Senate. However, the opponents of the agreement did not allow it to be implemented. It was ignoring the interests of French-speaking Quebec residents that increased discontent and the number of people wishing to secede.

It is noteworthy that such sentiments are not related to the actual status of the province in the domestic political arena. Each province, including Quebec, has its own government and governor. The standard of living in Quebec is high. The Federal Government's policy toward the province is not considered unfair or infringing. National institutions are required by law to provide services in French and English. An unprecedented pedagogical experiment was also conducted: almost a quarter of a million English-speaking schoolchildren are participating in training programs in which all disciplines (except English) are taught in French (Pelletier, 2016). However, it is participating in management at the federal level that causes most disputes.

Science Culture

Consequently, the Quebec crisis is associated with deeper roots: a cultural crisis, a struggle for the recognition of the rights of two national communities connected by the unity of language and symbols. Given these contradictions that characterize the

Canadian culture and significantly affect it, it is interesting to see whether and to what extent the linguistic and cultural features of Canada are reflected in the research activities of scientists themselves.

Recognizing the important role that science plays in the lives of Canadians, the Canadian Association of Science Centres and Natural Resources Canada sent a request to the Council of Canadian Academies (CCA) to conduct an independent in-depth study to find out what the current state of scientific culture in Canada is (CCA, 2016). It should also be added that scientific culture in this context is understood as the engagement of society and the government in the scientific field – namely, the recognition and support of the results of scientific activity. Scientific culture implies promoting education, training highly qualified personnel, and applying scientific knowledge in decision-making at the highest level, as well as implementing public policy.

The report prepared by the Council presents the results of a public opinion poll. The authors of the study came to the following conclusions: Canadians are characterized by a high involvement in national science compared to citizens of other countries, the level of scientific literacy is equal to or exceeds the level of literacy of citizens of other countries, and Canadians have a positive attitude to scientific activity in the country.

The main characteristic feature of Canadian scientific culture is that papers are mainly published in English and, as a result, research is conducted in English-speaking institutions (Romanova, 2017). They are of great interest to sociologists, who have managed to identify their specific structural characteristics, in contrast to the so-called "peripheral" scientific communities, which receive much less attention. Sociologists usually deal with the ongoing scientific research in Ontario and Quebec – the English-speaking and French-speaking provinces of Canada.

This supposed neglect of ideas is since these side communities are not believed to produce outstanding results; however, the true underlying reason is the language of publications. Since 85% of the population of Quebec is French-speaking, scientific activities in the province are partially carried out and covered in French. The use of French instead of English naturally raises several concerns, since all international scientific activity is carried out in English; this policy directly affects the recognition and dissemination of scientific results, including the citation level and the impact factor of scientific journals as a whole (Romanova, 2015a).

However, there are many Canadians who advocate the promotion of academic papers in French. For example, the physicist Pierre Demers, who had been advocating for "science in French" all his life, has condemned the lack of interest in this struggle among universities in Quebec (Pelletier, 2016). This is especially true for the researchers associated with natural science, who consistently follow the standards of scientific publications in English adopted in their field.

For example, in 2014, only 0.5% of scientific publications by Quebec researchers published in international journals in the field of natural and medical sciences were written in French, and 9.4% in the field of social sciences were, according to Vincent Larivière, a researcher at the Department of Research on the Transformation of Scientific Communication (Romanova, 2015a). These indicators show a decrease in the number of publications compared to 1980: a 14.3% decrease in natural science articles, and a 25.6% decrease in humanitarian research (Romanova, 2015b).

The scientific community in Quebec can and should be considered as a separate scientific field. For example, a study was conducted to find out to what extent and under what circumstances a scientist gives up one role and starts to play another, as well as under what conditions a scientist or a group of scientists is not afraid of being disqualified and rejected because they refused to take a certain role or other positions outside or inside the scientific field (Larivière, 2018).

The use of the term "scientific field"is not arbitrary: it indicates a change in the subject and method. The study of Canadian scientists does not affect the interaction and exchange between scientists but aims to study all the social positions they occupy and the factors that scientists must meet to succeed. The study aimed to determine the degree of interaction between the main scientific field and its subtypes, as well as between the scientific and the economic, religious, and political fields.

According to the universalist ideas about the role of a scientist (Merton, 1993), one can hold various high positions only under certain natural conditions. The first condition is the age of the scientist. Elderly scientists are increasingly "more susceptible to taking up other roles, for example, to lead the organization of research, to be an intermediary between science and other institutional spheres, or to accidentally leave the scientific field to take higher positions in university administration or serve in the field of international diplomacy" (Berkman, 2014). At the same time, it is believed that age not only increases interest in other types of activities but also indicates a decreased interest in the scientific field itself due to a natural decrease in productivity.

However, the tendency to take several positions outside the scientific field can discredit a scientist and prove that they have failed to achieve worthwhile results within the framework of their main vocation and that their scientific contribution is extremely low. That is why scientists themselves resort to a kind of self-censorship: they avoid interviews and publications in any mass media (Willis, 2005).

The second condition is high-quality scientific products. A scientist's recognition should not be based on their age or the degree of influence of the scientific field, but on the quality, novelty, and value of their work. Nevertheless, the organization in which the degree was obtained and under the auspices of which the main scientific research was carried out is also important for forging a career (Grossetti et al., 2014). However, the place and scientific institute where the degree was awarded is also important in a researcher's career. This is evidenced by the Matthew Effect, formulated by Merton (1993). The works of famous scientists, the significance of the results of their work, and the degree of citation by other researchers are perceived in isolation from their true value (Romanova, 2015b).

However, there is another point of view. It is not enough for a scientist to perform only one role, as a researcher, and exchange information with other scientists to implement the internal functions of the scientific field. They should occupy and separate many administrative positions (Petrovskij et al., 2010).

For example, the peripheral scientific field of Quebec French-speaking scientists is not weak, according to universalist criteria. This society is characterized by scientific works, integration with other scientific communities, and international interaction and the continuous exchange of information. However, this community remains somewhat ignored, due to the limited number of scientific positions and the impediments for Quebec scientists to occupy leading positions in the hierarchy of the Canadian scientific field at the federal level.

The ethnic division of scientific work cannot be reduced to a simple distinction between ethnic groups or areas of research (Fournier et al., 1975): this concerns the geographical location of administrative positions (National Council of Scientific Journals, editorial offices, publishing houses, the Royal Society of Canada, etc.), the availability of funds, and their distribution. Therefore, it can be described as a "peripheral" scientific direction, which not only borrows "paradigms" or sends its young scientists to specialize abroad but also occupies relatively few lower hierarchical positions in the international scientific field.

French-speaking scientists from Quebec are marked out from other Canadian scientists (as well as Canadian scientists from American scientists) not by the low quality of scientific works and their originality, but by the low number of scientific associations, journals, publishing houses, and scientific awards, as well as their lesser importance in international terms (those same associations, journals, etc.) (Blinov & Konnov, 2017).

If we argue that the functioning of the Quebec scientific field is less organized and less dependent on other scientific fields, then it is interesting how this affects the tendency of this community to take any positions outside of this field. Since it seems impossible to receive prestigious awards and recognition from the international scientific community due to the low rating of the field under consideration, there is a need for sponsorship and remuneration from political and intellectual groups outside of the scientific field.

From this point of view, the desire of scientists to occupy positions in the political field seems justified. Besides, the desire to get involved in an external management system may also be related to the subject of the discipline itself. Therefore, the scientists who study social problems (for example, the problem of poverty) cannot ignore the political structure. In this regard, it is much more important to study the stratification within the discipline itself and its difference from other areas (Konnov & Balyshev, 2012). Consequently, the norms established within the discipline make it possible to regulate the preferences of a scientist regarding the positions they hold both in the field and outside it, without taking into account their morphological characteristics (age, degree, etc.).

Conclusions

The economic situation in Quebec offers only weak incentives for the development of scientific activities limited to industrial production and research of technological innovations of an economic nature. Besides, a French-speaking university in Quebec produces much fewer scientists and engineers in comparison with an English-speaking one. The gap has been increasing over the years.

Besides, an English-speaking university in Quebec invests much more in areas of science such as applied sciences, exact sciences, and engineering (Larivière, 2018). Therefore, it is no wonder that scientists are becoming less interested in research and prematurely move to governing bodies.

A systematic analysis can show that in a dependent society, the development of scientific institutions and the creation of a scientific field can serve the goals of the so-called modernization of the country. Oppressed classes that seek consolidation and governance often join nationalist political movements and create new ideologies, as a result of which such policies affect the scientific sphere (CCA, 2016).

In addition, when groups of scientists resort to nationalist measures, using such tools for producing, managing, distributing, and repayment, and demand a proportional regional distribution of budgets, their opinions are taken into account only because these requirements correspond to the nationalist political strategies of other groups or social classes.

It should also be noted that in most countries involved in globalization processes, multinational research teams have a certain hierarchy. So, in the biomolecular laboratories of some universities in North Carolina in the USA, the experimental part, divided into sections and links, is performed in accordance with strict preliminary instructions by scientists seeking a green card, that is, a permanent residence permit (Cole & Cole, 1967). The head of the laboratory is by all means a US citizen, it is with him that the higher management of the research program discusses and instructs him.

A similar picture of the organization of scientific research exists in other countries and, of course, it is guided by the motivation of urgent, extra-urgent, long-term national interests (Lhérété, 2011). In accordance with this hierarchy, the state policy of financing priority scientific works, scientific immigration, granting citizenship, payment for work, representation at international conferences, etc. is being built.

However, we can hope that the Liberal Party of Canada – which is still in power and, judging by the latest 2021 polls, enjoys the support of voters – will avoid such manipulations.

All in all, the science policy of Canada and in particularly Canadian Arctic policy are characterized not only by the peculiarities of the scientific field, primarily due to the linguistic and cultural situation, but also by the influence of external factors: the dominant social groups, as well as the interests of religious, political, and economic leaders. The question remains open about the future of science policy in the context of establishing a new vector of public policy in Canada.

At the same time, the future of French-speaking research in Canada and the influence of French-speaking researchers and the government's Arctic science policy in connection with recent events look quite optimistic and promising. In 2021, Quebec Chief Scientist Rémy Quirion was named President of the International Network for Government Science Advise (INGSA), whose main mission is to enhance the role of science in decision-making in administrations and enterprises at all levels, striving for sustainable growth.

On the occasion of the celebration of the Francophone Day during the 4th International Conference on Science Advice to Government – The INGSA 2021 -

Rémy Quirion announced the launch of a French-language network of scientific advice, which will be an international analysis of the relationship between the science-speaking community of politics in their cultural and linguistic context. As the new President of INGSA, Quebec Chief Scientist Rémy Quirion has decided to prioritize this issue. He announced the creation of a governance committee at INGSA composed of representatives from the cultural communities.

The language influences the way relationships are built, and there is no doubt that the lingo-cultural dimension greatly influences the course of scientific discussion. The new president noticed that he can't wait to see how French-speaking people will perceive the relationship between science and politics. "I hope that these changes will lead to innovative and amazing models that will strengthen the links between science, politics and society," Dr. Quirion added.

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Personnel Training for Sustainable Development in the Arctic

Project-Based Approach in Formal, Non-Formal, and Informal Russian Education

Natalya Ye. Ryazanova

Contents

Abstract

Russia has no special guiding documents, specific requirements, or established rules governing sustainable development personnel training. This makes an educator’s efforts more interesting as well as provides opportunities for creativity and diverse achievements. The study presents 6 years of experience of working with young people under 35, and technologies and practices of education implementation based on the eight key competencies formulated by UNESCO in its Education 2030 Agenda. The study comes at a time when the Russian education

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system is undergoing a significant transformation back toward interactive and project-based learning. We consider certain elements and principles of Agile technologies appropriate in the VUCA world and present technologies used to introduce different project platforms in different learning modalities. All cited research and development is based on introducing the ideology and principles of sustainable development into the mental world of young people and their learning environment. The academic contribution and novelty of the study consist in disseminating and shaping the national agenda for the Arctic in universities, updating national development goals and objectives, and linking them to the global agenda. The study also considers the major types of projects and their results. In addition, we present a teaching-related elaboration of certain works aimed at sustainable development in the Russian Arctic.

Keywords

Education for sustainable development · Agile ideology in education · VUCA world · Project-based learning · Youth modeling of international processes · Youth project labs for the Arctic

Introduction

A clear and seamless interaction between employers and educational organizations is important for the education and personnel training system in any country. Such a system allows for seamless training, where a graduate is almost immediately ready to join a private or public organization with minimum time spent on retraining. This is important for the economy as it minimizes economic costs and, in most cases, solves school-to-work transition with just on-the-job mentoring. In this context, it is especially pertinent to ask what is wrong with the volatility-uncertainty-complexity-ambiguity (VUCA) world and if agile can help universities. The transformation of modern education has revealed a host of issues including somewhat misplaced career expectations, an inability to properly plan future graduate activities, and difficulties in determining what and how to teach the workforce of the future, which will soon engage with professions that the current generation of academic staff know either nothing or little about. In the current context several factors can be distinguished:

i. Societal demands are being transformed toward a more dynamic and somewhat less-expected nature as people expect the payback from university education as well as real knowledge and skills, i.e., relevant competencies, not just a broad professional outlook.
ii. The preferences and demands of employers are being transformed toward an expectation of real skills and practical experience in a recently graduated person; a solid CV with research topics and a set of internships and work placements is of great importance.

iii. The university applicant and student demand are transforming as millennials prove unready to spend hours listening to and writing down monotonous lectures and bookish wisdom, since in most cases that knowledge has already been gulped down using any possible source of information.
iv. Universities themselves have to transform and must be responsive to the demand of the real economy, the changing economic and political environment, and, together with industry experts, prepare in advance to present new types, forms, and content of education.

Present-day frontier universities' practice shows that they can provide for and form a higher knowledge economy. It also depends on the ability of academic staff to learn a lot, to pose challenging and competent questions that make one think continuously rather than once in a while, and rather than look for answers, start new debates where students would have multiple answers for different scenario options. It can also be triggered by the emergence of bright, out-of-the-box thinking professors who can disregard "established authorities" and put in independent research. It also happens that discoveries are made by those who simply did not know that it had already been discovered and formulated. Whoever can master these tricks will be the leader of the future.

In addition, technologies are now of particular importance to translate the global sustainable development goals (SDGs) agenda into personnel training for the Arctic, a region that is complex on many levels differs from others, and requires fundamentally new thinking, different strategies, different management, and decision-making technologies. Training requires simulations of these as part of the study or at the beginning of a career. The experience of the youth model of a major international event (the Arctic Council Working Groups) has forced a revision of educational and innovative activities, the integration of informal work into some segments of formal education of students in different fields of study (economic, social, and environmental); it promoted self-education of teachers in a professional environment and changed the content of some professional courses in local colleges and universities. These results have significantly changed the social climate and the significance of the youth agenda in Russia. A new youth cooperation agenda emerged at the level of the Ministry of Foreign Affairs of the Russian Federation, the Federal Agency Rosmolodezh, and through cooperation with the Arctic Council.

Literature Review

The *steady-predictable-ordinary-definite* (SPOD world) is transitioning to the *volatility-uncertainty-complexity-ambiguity* (VUCA world).

On the one hand, students already live in a new reality, mastering fast and individual learning: they are used to acquiring knowledge by themselves while picking what piques their interest (Dicker et al., 2018; D'Souza & Rodrigues, 2015); this acquisition of new competencies is extremely fast (Capella, 2009) and the existing methods that are more familiar for the teachers are no longer suited to the current educational process (Chirkov, 2015; Inozemtsev et al., 2020; Belogurov et al., 2020). New technologies, approaches, and methods are needed (Lujan & DiCarlo, 2006; Kamat & Sardessia, 2012).

This necessitated the creation of visionary programs that can look at the issues of educational development strategies in a completely different way. The Russian Academy of Education, for example, proved to be insufficient and was not able to quickly present the latest strategies for educational development, much less predict the fundamentally new formats of education. Employers also expect new professionals to be better than those already employed, which means that the university has to train people for professions that do not yet exist (Kamat & Sardessia, 2012).

In Russia, projects can be implemented in different forms and teaching methods (Dzyatkovskaya & Zakhlebny, 2014, 2016; Zakhlebny & Dzyatkovskaya, 2015; Dzyatkovskaya, 2012, 2014; Kasatkin et al., 2021).

An interdisciplinary approach through the integration of economic, social, and environmental data and the information on the research object, such as the Arctic zone of the Russian Federation, is now being applied (Ermakov, 2016; Abdurakhmanov et al., 2017; Grishaeva et al., 2018; Ivanova, 2017; Khaludorova, 2017).

Most developed countries have engaged in ESD using UNESCO recommendations to build competencies for sustainable development (Ignatov et al., 2019; Sakharov & Kolmar, 2019). Russia came on board as early as the 1980s and continues to support the trend. The main competencies to be developed in ESD are systemic thinking, legal thinking, teamwork, critical thinking, self-awareness, integrated problem solving, and predictive strategic vision.

Technical Aspects and Methods for Implementing Agile Ideology in Education in the Context of the VUCA World

It has now become clear that from a state of the SPOD (*stable, predictable, with consistent developments*), the world, along with the education and training system for the economy, has moved to a state of VUCA world. Now a new approach to the formation of the future education ideology, which can be built on new grounds, depending on employers' requirements, is needed on several levels in order for a future specialist to develop a picture of the new reality and the world to come:

Level 1: *Identifying* the current situation in education, understanding and articulating the causes of instability and employers' dissatisfaction with the graduate training.
Level 2: *Fixing the disequilibrium state and its polarization*, it is difficult to respond to employers' demands, especially in the Arctic zone, with the current methods and the current training ideology.
Level 3: *Context*: examining the cause and necessary changes, determining the level and scale of change needed.
Level 4: *Compatibility and constitution of new educational approaches, systems, technologies, and practices*. It turns out that combining the past and the future will not succeed; new foundations for the future must be built.

Level 5: *Consolidation* of the education system at the level of frontier universities, which is extremely difficult for mid-level universities to achieve.

Level 6: *Reflection*: independent evaluation by the professional community of the real economy of the transformation process similar to the experience of professional standards development; development of new modern educational practices and obtaining the expected result. This is extremely difficult to achieve, as systematic changes are required in the structural organization of higher education institutions, retraining or providing for completely different conditions for the formation of human resources capacity and the inextricable connection and constant involvement of the sectoral expert community. Only this kind of ongoing transformation can produce results in the VUCA world.

By way of example, we present a mental analysis experiment to understand the feasibility of implementing Agile principles in university practice (Table 1).

Implementing Agile Approaches in Education to Overcome Instability in the Future

The abovementioned Agile approaches can today be applied with varying degrees of success worldwide (Carnie, 1997; Da Graaf & Kolmos, 2003) and in all universities in the Arctic regions of the Russian Federation in three types of modern educational environments:

A. *Basic learning environment:* combining offline classes on online platforms and active transformation processes in frontier universities, analyzing vectors of impending change, and flexibly adapting minor and major courses into university curricula.
B. *Practitioner communities*: experts from the real economy or academia, expert councils to create breakthrough core curricula, horizontal learning (peer learning and validation), collaborations, forums, etc.
C. *Personal educational trajectory*: under the tutor's guidance, a student personally formulates motivation and expected educational result, constructs his/her educational trajectory, and actively implements it by using different methods within formal, non-formal, and informal learning.

The combination of these three components makes it possible to implement the Agile approach in modern education. This approach transforms the roles of university staff and students themselves, professional skills of future education teachers, making it necessary to master such skills as project work skills; ability to create original and relevant online courses; involvement of experts from the real economy, building a community of practice, building partnerships; conducting classes in a discussion and creative form, simulation of real events and situations, live-action games.

Overall, the educational model is changing toward a more student-centered one. Teachers are already able to offer new educational synthesis courses promptly, and

Table 1 Implementing Agile principles in transforming universities

Agile principles	Stakeholders	The situation in the SPOD world (what it used to be)	The situation in the VUCA world and agile principles implementation (what it is like now)
1. Individuals and interactions over processes and tools	*Comment (user story): before the 2010s, the most important thing for the university was to report to the Ministry that was the main evaluator of their performance*		
	1) Employers' needs	Partly accounted for, yet not adjusted every year. The feedback from the trainees had hardly any impact on the departments	**Challenge**: employees are willing to offer internships to only motivated students subject to motivational essays **Agile**: it is necessary to work out the internship places in advance, to motivate students, and to understand that the university's work on staff training will be evaluated by the employer ad hoc: next year they may refuse to take on interns at all due to their poor training **Unstable**: if priorities or management change, the organization may refuse to provide an internship without explanation **Agile**: urgently seek alternative organizations, ideas, and methods of organizing internships **Ambiguity**: employers are not willing to explain their position on selecting only the best students, and suggest universities should take it for granted **Agile**: teaching students to look for their interest in the profession and to write motivation letters to the employer as well as to compose a portfolio competently, etc. **Uncertainty**: employers are theoretically willing to cooperate with the university and create new training courses, and improve existing ones, but do not know how to get in

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Table 1 (continued)

Agile principles	Stakeholders	The situation in the SPOD world (what it used to be)	The situation in the VUCA world and agile principles implementation (what it is like now)
			Agile: actively cooperating with employers in writing students' internship programs and research articles, conducting research, and joining university expert boards. Inviting employers to state appraisal panels, working individually with them
	2) Student needs	Virtually not taken into account. The university acted as if it provided "necessary and sufficient training"	**VUCA-world situation:** the student comes with a formed demand for his/her future education; that often does not match the reality in the learning process; the student looks for the information and courses he/she wants on online platforms, etc. **Agile**: being in constant contact with students, periodically clarifying priorities and interests, implementing projects in mixed groups (different fields of study), giving a wide choice of disciplines within the minors, developing own online courses, and opening them for free access, involving students in professors' research
	3) Regional expectations (Third Mission)	The region was not the obvious customer, delegating this right and influence to employers. The university was a "thing in itself"	**VUCA-world situation**: the region is aware of its role in the content of the university and the right to expect growth in the economy through growth in the knowledge economy **Agile**: engaging with the university administration and updating the courses, making the content up-to-date, and actively inviting representatives of

(continued)

Table 1 (continued)

Agile principles	Stakeholders	The situation in the SPOD world (what it used to be)	The situation in the VUCA world and agile principles implementation (what it is like now)
			local authorities and businesses to the educational process
	4) The position of the university itself	All processes are streamlined and in line with ministerial guidelines; the contents and rhythm of student practice are stable and predictable	**VUCA-world situation**: the number of stakeholders has greatly expanded to include local authorities, businesses sponsoring targeted study places and master's programs, and academic organizations that can test their achievements in the form of training courses **Agile**: considering the interests of all stakeholders will not only raise the level of minors considerably but also greatly diversify the set of majors, which will attract students and keep them interested in the courses of their particular university and help them choose the authors of these courses to supervise their internships
2. Working software over comprehensive documentation	*Comment (user story): the principle of Agile YAGNI (You Aren't Going to Need It) is often applied. Agile involves the rational abandonment of something unclaimed by consumers*		
	1) Employers' needs	Neglecting something that seems important to the university and finding graduates lacking the necessary skills. Accepting everyone and retraining	**VUCA-world situation:** employers interact more actively with universities and offer highly relevant courses that prepare graduates to work effectively in the organization, thus greatly reducing the time for retraining **Agile**: universities need to maintain working contact with a large number of organizations to update courses more substantially, expand the content of practical classes, and form

(continued)

Table 1 (continued)

Agile principles	Stakeholders	The situation in the SPOD world (what it used to be)	The situation in the VUCA world and agile principles implementation (what it is like now)
			a plan for internships in advance during the semester
	2) Student needs	We want to study, but we need to understand what and where to do it to be competitive in the labor market	**VUCA-world situation:** students realize that they need a set of specific disciplines that they can master much faster than general education and then improve their knowledge and skills in master's degree and beyond. There is a sense of a certain redundancy of courses and diversion to non-core knowledge **Agile**: the university should support students' understanding of the importance of the general level of education and erudition, provide opportunities to work in mixed professional groups, and combine creative and technical disciplines but set different assignments for sciences-learning and arts-learning students
	3) Regional expectation	It is good that we have our university, so we can train the minimum number of acceptable personnel.	**VUCA-world situation**: if a region is prepared to create jobs for graduates of its university and they stay there, for the most part, this is a factor of pride for local authorities. A negative example is a fact that training areas are being reduced as redundant for the region **Agile**: it is more rational for the university to work in constant contact with the ministries to constantly update the admission targets and involve businesses to create

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Table 1 (continued)

Agile principles	Stakeholders	The situation in the SPOD world (what it used to be)	The situation in the VUCA world and agile principles implementation (what it is like now)
			targeted study places and training programs, but these should also be relevant to the region
	4) The position of the university itself	We teach a little bit of everything, provide a professional outlook, and then the person themselves determines what skills and knowledge they need in life	**VUCA-world situation:** it is high time to update the courses, introduce the best international practices, and make them more relevant to the implementation of modern knowledge achievements in the real economy, preferably in the region **Agile**: universities maximize cooperation and collaboration with all stakeholders and dramatically increase the number of teachers from the real economy. While the attitude toward organizing and conducting internships for students is changing dramatically
3. Customer collaboration over contract negotiation	*Comment (user story): customers should be comfortable with the product; when customer preferences change, so should the product*		
	1) Employers' needs	We conclude a contract with a university without first assessing the skills and knowledge of the students, then we retrain them to our standards anyway	**VUCA-world situation**: enterprises immediately extend the requirements of the internal framework to the qualifications of the trainee or graduate and appoint a mentor to quickly "adjust" the young employee **Agile**: internship programs for students should fully address technology cycles and management issues in the enterprise
	2) Student needs	This is a good university, so I can enroll since the contract is the same for all. I will figure out what I want to focus on later	**VUCA-world situation**: an applicant chooses the university by the study programs published on the website, its academic staff, and the opportunities for

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Table 1 (continued)

Agile principles	Stakeholders	The situation in the SPOD world (what it used to be)	The situation in the VUCA world and agile principles implementation (what it is like now)
			internships and work placements **Agile**: the university constantly builds up the abovementioned features and carries out competent media promotion of its opportunities; still, these should be real, not fictitious, because in the era of social networking fakes will repeatedly lower the ratings of such universities
	3) Regional expectation	Regional authorities plan admission targets only to report to ministries	**VUCA-world situation**: echoes as much as possible the similar position of item 2 of this table **Agile**: identical to the above
	4) The position of the university itself	We are the only one preparing staff in the region, and everybody concludes internship agreements with us. Federal universities have an even stronger position.	**VUCA-world situation**: academic mobility is developing and the university should actively and successfully compete for applicants and retain students and undergraduates **Agile**: core subject schools, core subject school-level competitions (Olympiads), advanced summer school programs, intellectual competitions, and a wide range of specific loans and/or study grants for outstanding students are needed
4. Responding to change over following a plan	*Comment (user story): it is important to innovate quickly and respond to change*		
	1) Employers' needs	It is better to hire high achievers, because they quickly understand what and how to learn on the job, and are easier and faster to retrain.	**VUCA-world situation**: employers can organize open competitions for students of different universities for internships and trainee jobs with subsequent recruitment; the

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Table 1 (continued)

Agile principles	Stakeholders	The situation in the SPOD world (what it used to be)	The situation in the VUCA world and agile principles implementation (what it is like now)
			emphasis in the skills assessment is on the possession of innovative knowledge and skills, the ability to retrain or to add new knowledge and to update it at the workplace **Agile**: the company can quickly open up refresher, master's, and MBA programs for thematic training. Such a strategy attracts new students from other universities and regions for unique programs
	2) Student needs	Students have to study new and up-to-date courses online selecting from the most relevant ones offered usually by foreign universities. We work at nights and weekends; this work has little to do with our main studies, which is a pity	**VUCA-world situation**: students actively research the demand of the labor market and build up current competencies from the very 1st months of study **Agile**: actively participating in scientific circles or practical seminars at different faculties or in scientific organizations or enterprises. Increasing the number of summer internships or remote internships even at the expense of holiday time (on their initiative). Learning to write research papers and actively publishing them. Building up their CVs during their study years
	3) Regional expectation	We practically do not innovate ourselves; instead, we adopt ready-made solutions from central regions and cities. Individual specialists can be trained in a short period in advanced organizations, even for a fee	**VUCA-world situation**: opening new opportunities and industries in the region, expanding the number of jobs that do not compete with existing ones, and increasing communication with other regions **Agile**: together with business, universities can

(continued)

Table 1 (continued)

Agile principles	Stakeholders	The situation in the SPOD world (what it used to be)	The situation in the VUCA world and agile principles implementation (what it is like now)
			mobilize new educational programs and guarantee the employability of graduates. Requiring certain categories of employees to undertake retraining or refresher courses to maintain their competencies at a high level
	4) The position of the university itself	We learn about innovations from employers, less often from scientific literature, and even more rarely from in-service training courses (if these take place at universities in the region's capital)	**VUCA-world situation**: higher requirements for professors' publication activity dramatically increase awareness and practical orientation of teachers to reformatting courses. **Agile**: active cooperation with industry and academia, increasing the number of elective courses and the formation of interesting majors, the creation of a large number of short and highly relevant online courses, and the development of a large number of individual educational programs for students

Source: Compiled by the author

the Agile approach allows rapid adaptation to courses and entire educational programs, which is what is required in the VUCA world.

Directions for the Interdisciplinary SDG Agenda in Russian Universities: New Meanings, Possibilities, and Pedagogical Technologies

The global practice of modernizing educational systems and programs has come to recognize the need for a sustainable development agenda (Lozano et al., 2013). This is happening on all continents and at different levels of education. The understanding of the importance of social responsibility of universities, their awareness of new meanings of work, their responsibility to the region and the "customer" for professionals who will be able to contribute to the harmonious development of the world of the future and (Ganyushina et al., 2019; Waas et al., 2010) has come.

In fact, universities need to restructure the educational process and update educational programs and curricula; it is also important to build capacity in the following areas:

- Research – building knowledge, developing new strategies, producing relevant analyses on topical issues, and developing new technologies.
- Improving management within the university: responsible human resources policies, sustainable work with students, responsible procurement, responsible financing, etc.
- The third mission of universities is to work for local communities, especially in the Arctic zone, interact with NGOs and the public to update new areas of cooperation and inter-sectoral dialogue, taking into account the SDG agenda, and influence politicians and authorities to improve the quality of life in the regions.

This is now the focus of global leadership practices (Disterheft et al., 2015), which are mainstreaming new approaches to implementing the SDG agenda with more relevant methods and techniques.

The Main Vectors of Dissemination of the SDG Agenda in Russia Among Adult Youth

The traditional channels of influence and information dissemination in Russia are as follows:

Channel 1: State youth policy in the field of education. An analysis of information on the directions of the Department of State Policy in Higher Education in Russia showed a lack of requirements to localize the SDG agenda in educational content. In Russia's youth policy, the Youth Envoys of the SDGs in Russia program has been launched in 2018 (the operator being the National Council of Youth and Children Associations of Russia); the project is implemented with the support of the Russian Ministry of Science and Higher Education, Ministry of Foreign Affairs, Federal Agency for Youth Affairs and the UN Information Centre in Moscow, and the Russian Association of UN Assistance. Each year (in spring), an inter-ministerial commission selects one Youth Envoy for each SDG, i.e., 17 young people are allowed to implement their projects and scale them up to the whole country.

Channel 2: Activities of the university administration and the student scientific society. It has been established that targeted work in HEIs is carried out sporadically. However, from 2016 to 2018 there was an initiative of the Economic Club Oeconomicus (MGIMO University), which developed and implemented the initiative twice on the recommendation of the UN Russian Association, when student forums on the Sustainable Development Goals were organized and held in several universities of the country, including MGIMO University. The strong methodological support of the participating universities helped them to continue this work independently at the initiative level. There are now two or three smaller student forums operating independently, for example at the North-Eastern Federal University, which covers the needs of the Arctic region in terms of scientific and social developments for the region. The VUZECOFEST project is now in its 8th year holding the annual Youth Sustainability Festival (Evseeva, 2018).

Channel 3: Initiatives of NGOs and NGOs that are interested in improving socioeconomic conditions in the regions where they are located. As they cooperate with local universities (Russia has ten universities with federal status and a well-developed network of regional supporting universities), this looks like mutually beneficial cooperation.

In 2019, for the first time in Russia, an international seminar on the Sustainable Development Goals in the activities of NGOs was held, organized by the RNO Centre and partners including Bridge Helsinki, with the participation of FINGO, Finlandia, GRANI, Perm, ASI, Moscow, Civil Union, Penza, Sluzheniye, Nizhny Novgorod, Tyumen Community Development Fund.

It turned out that there is an extensive joint project agenda "Global goals in local agenda: sustainability principles in NPO activities in EU and Russia."

The Stepik platform hosts an 18-lesson training course in Russian called Sustainable Development Goals for NPOs.

The Moscow Chamber of Commerce and Industry operates the Guild of Sustainable Development, Corporate Social Responsibility and Social Entrepreneurship, which has developed an implementation mechanism named "Shaping the Development Policy Segment of the Nonprofit Sector in Moscow in the Field of NPO-Business-Government Interaction." Its goal is to analyze practices and develop a model of interaction that would allow the interests of businesses to be taken into account when working on social projects.

Channel 4: Initiatives in public agenda, educator activities, and education. For example, the Baikal International Environmental Water Forum.

Channel 5: Initiatives of state enterprises and businesses to develop and localize the requirements of the SDG agenda in their professional and social work, creation of ESG reporting. Tetra Pak's nationwide Campus program (in operation since 2013) has been established, with informational support from the World Wildlife Fund (WWF) to disseminate environmental knowledge to students and support their environmental initiatives. The first university to join the program was MGIMO, where it was seen "not as a tribute to fashion, but as an imperative, as one of the strategic priorities in the education and professional training of personnel for the country."

Other, more private, channels for developing the 2030 Agenda are also possible.

SDG Agenda in Russian Universities: Strategies and Tactics

Below are some works implemented at the regional, thematic, and federal levels (Ryazanova, 2018) that can help understand what initiatives are being implemented to localize the SDG agenda in Russia's universities and student environment. We are motivated by the need to develop approaches and criteria for national and regional adaptation of the SDGs in Russia; the need for training to achieve the SDGs in Russian regions; the low awareness of youth about the SDG ideology; and the importance of working with young people to involve them in practical and scientific activities to achieve the UN SDGs.

The implementation of this area is a set of activities organized according to a common methodology. The methodology is represented by methodological recommendations containing such sections as an overview of research topics, relevance, successful practices of implementation (Russian and foreign), setting research and project tasks, organizational forms of project teams' work, forms and methods of communication with the supervisor, and recommended literature. The forms of organization and delivery of activities can mainly be classified into three groups (Ryazanova et al., 2019a, 2019b, 2019c):

- Youth models – simulations of the work of major international or Russian social or political events, where participants must adhere to the established routines of the main event and fully simulate the content of the upcoming event agenda.
- Business games – a given situation with initial conditions, the result to be obtained in the process of preparation and presentation of the work in the final game.
- Project labs – short duration project works; the expected result may not be set to demonstrate the creative potential of the project teams.

Nineteen major youth events were implemented using the methods; project teams of players from different federal districts of Russia took part in some of them, including:

- *Baikal toward the World Water Forum: a regional reflection of the SDGs.* The event was implemented at the invitation of the government and governor of the Irkutsk Region. Three subjects of the Russian Federation were involved. There were over 200 participants.
  – Six working groups were arranged to address problematic issues of the region.
  – Recommendations from the Youth Government to the current Irkutsk Oblast Government.
  – A mechanism for dialogue between the region's decision-makers and young people on the subject of the SDGs was established.

The jury was headed by Vladimir V. Kuznetsov, Director of the UN Information Centre in Moscow.

- *UN Sustainable Development Goals: The Federal Dimension* The event was held at the invitation of the Federal Agency for Youth of Russia and involved leaders of youth governments of the Russian Federation from 76 regions of the country. More than 160 understudies of regional governments were involved, each of them working for their federal district.

A working group of youth governments from eight federal districts of the Russian Federation was modeled to draw up a roadmap for achieving the SDGs in the federal districts.

A Memorandum on Promoting the SDGs in the Regions of the Russian Federation was signed.

- *Opportunities and perspectives of science for achieving the UN Sustainable Development Goals: a thematic reflection of the SDGs.* The event was implemented at the invitation of the Ministry of Education and Science of the Russian Federation (Department of Competitive Procedures).

Student scientific societies of 11 federal universities were involved. There were over 250 participants.

- Eleven teams of student scientific societies from Russian universities.
- The Declaration on Support of Sustainable Development Goals in the Russian Federation by Young Scientists and Researchers was signed.
- Scientific achievements and projects of Russian institutions of higher education for the attainment of SDGs in Russia were identified.
- A mechanism for the cooperation of Russian universities in the achievement of SDGs at national and regional levels was suggested

The jury was headed by Vladimir V. Kuznetsov, Director of the United Nations Information Centre in Moscow, and Alexey Borisov, Head of the World Federation of United Nations Associations.

The Declaration on Promoting the SDGs by way of Scientific Activities through the system of Student Scientific Societies in the Russian Federation was signed.

- *Public Diplomacy for the Dissemination of the International Agenda in the Regions of the Russian Federation. SDG Floating University UN Sustainable Development Goals: the Russia Dimension* St. Petersburg – Veliky Novgorod – Moscow – Astrakhan. The project is branded under the name ECOWOLNA 2018.
- *SDG Arctic Dimension Youth Arctic Council Model*

The model was organized at St. Petersburg State University. More than 100 people from 5 universities were involved. The platform simulated the work of all six working groups of the Arctic Council, involving global and national SDG indicators for their early implementation in state planning documents and achieving sustainable development in the Arctic nations.

- *Sustainable Development of the Russian Arctic Project Office Youth Mode*

The event took place as part of the Arctic Days at Moscow International Forum.

More than 100 students from 6 universities were involved in the Model. Nine teams were created, each representing one of the selected Arctic regions of the

Russian Federation, for which a full strategic analysis of the current situation was carried out, and a development strategy and roadmap for its achievement were drawn up. A Youth Declaration on the Sustainable Development of the Russian Arctic was signed.

The jury was chaired by the Director of the Department of State Policy and Regulation in the Field of Hydrometeorology, Arctic, Antarctic, and World Ocean Studies.

In Russia, the indicated approaches and methods of adapting education for sustainable development for the Arctic need to be aligned with the main guiding documents for the region: Executive Order of the President of the Russian Federation of 02.05.2014 No. 296 On land territories of the Arctic zone of the Russian Federation; Executive Order of the President of the Russian Federation of 26 October 2020 No. 645 On the strategy of development of the Arctic zone of the Russian Federation and ensuring national security for the period until 2035, and Executive Order of the President of the Russian Federation of 5 March 2020 No. 164 On the Foundations of the state policy of the Russian Federation in the Arctic for the period until 2035.

Implementing Environmental Education for Sustainable Development Trajectories

The implementation of education for sustainable development (ESD) takes place in all nations of the world on the basis of UNESCO recommendations; the formation of competencies for sustainable development is also implemented (Ignatov et al., 2019; Sakharov & Kolmar, 2019), all the more in such a vulnerable region as the Arctic. There are no requirements for their development in Russia, no localization of these requirements in state documents (Lanshina et al., 2019), no specific national methodologies for implementation and quantitative indicators, and no roadmap for their achievement. However, some potential preferences and opportunities for creativity and independent work of scientific-pedagogical schools across the country can be found. Russian teachers are already making scientific contributions to the global ESD dossier. For example, the Arctic Science Learning Project, which has been implemented since 2018 with the support of the Russian Ministry of Natural Resources and the government of the Arkhangelsk region, has been established.

Research hypotheses in a VUCA-world context require educators to build short but effective learning chains to seamlessly prepare graduates for the needs of the labor market. Employers, especially in the Arctic region, have no time to adapt and "tweak" the skills of a young employee to the rapidly changing demands of the Arctic economy and the country as a whole. Today, Agile and project-based technologies have rapidly entered the education process in various types of formal, non-formal, and informal learning (Baginskyi, 2020; Wolfson, 2015). Immersion in the SDG ideology takes place along the lines of all three clusters (economic, environmental, and social) with the identification of specific SDG targets (SDGs) for the subsequent achievement of SDGs by various qualitative and quantitative methods, and the evaluation of the product (educational) outcome and the development of Agile mechanisms (Sureka et al., 2015; Masood et al., 2018; Noguera et al., 2018; Cubric, 2013; Manokin et al., 2018).

The novelty of the author's finding consists in creating a flexible functional block (consisting of blocks) model of project-based approach in education for sustainable development. It provides students with a relatively perfect and simple learning mechanism, which can be easily transformed to fit the tasks, ways of solving them, and allow educators to obtain a productive (educational) result. The model allows educators to adapt the raw data and set a new research task, with little or no further involvement from the players, giving them a sense of real work. The Agile model for the educational process is adaptive for the teacher, students, and potential employers, who can observe the process of formation of future specialists and evaluate the final result by the level of proposed solutions and the quality of formed skills. The work is carried out according to Agile methodology in different types of the learning process, forms skills of project work with the application of some elements of project management (eduScrum technology).

Pedagogical practices are supported by the creation of Roadmaps and soft pedagogical tools to support research teams to achieve them promptly. The model also allows for increasing competencies in communication development, teamwork, critical thinking, and creativity ("4K").

The model is adapted to form new approaches for the main learning process, student circles and clubs, big games, and project activities. Work formats include project laboratories, youth models of international and Russian processes, business games, simulations, foresight, hackathon, etc.

Methods and materials. Project management techniques in the eduScrum approach appeared in 2011 in the Netherlands and have already been implemented and recognized in 36 countries around the world. The eduScrum method has evolved from the developments of the IT field and it has proven to be relatively easy to adapt for education's own needs (Manokin et al., 2018). The agile teaching/learning methodology, or ATLM, was developed back in 2004 when Agile was adapted to education methods (Chun, 2004).

In a formal approach for educational purposes on the topic of the Arctic, the technology was implemented twice, in the core discipline of Environmental Science as two learning assignments. At the end of the chapter, one of the learning assignments, Youth Analytical Review, is given as an example of how to work with the model's implementation methodology. The other learning task was a course study on the topic "Comprehensive multi-criteria evaluation of the implementation of national projects to achieve sustainable development of the Russian Federation: an analysis of the current state and potential of each federal district."

The result was a multi-criterion analysis of the environmental and economic status and responsible governmental bodies, as well as an analysis of the potential for achieving the targets of the National Projects in accordance with the complementary SDGs and the creation of a functional model for achieving the SDGs. The final stage also included the development of criteria for assessing the achievement of the National Projects, taking into account the objectives of specific sustainable development goals within the federal district and the creation of a prototype roadmap for achieving sustainable development for each federal district.

In a non-formal approach, the technology has been implemented more than 15 times, e.g., through roundtables, student conferences, and models for mainstreaming the 2030 Agenda. One of the largest Youth Models was the World Water Forum model based on the Sustainable Development Goals objectives. In the process, six thematic teams (as in the original event) were created: Climate, People, Growth, Quality, Ecosystems, and Governance, and worked out the thematic content of each thematic section (in our case, the game team).

The research tasks were: to assign thematic roles for the content of the work within their team; to determine the list of background information and various sources for the preparation of their topic; to consult and cooperate with the official bodies supervising the given work direction in the regions; to work meetings (students + curators from local authorities) for the expertise of game materials and to determine the quality and quantity of information that will remain in the final presentation at the event; to update the background and final information of the event.

In the informal approach, the technology has also been implemented more than ten times. Governors or regional governments, public executive authorities (Ministries of Education, Natural Resources and Environment, and others), and Forum Organizing Committees have acted as customers for this kind of training for sustainable development. The methodology is implemented in the form of project laboratories, youth models of international and Russian processes, business games, simulations, etc. Teams from different universities in Russia are invited as players (Table 2).

A Model Agenda for the Russian Arctic Regions (Examples of Implemented Cases)

The scientific and methodological aspects of the training process for the sustainable development of Russia's Arctic zone in the formal, non-formal, and informal education process can be illustrated in the following two cases developed by the author.

Case 1: Youth Model Project Office "Sustainable Future of the Arctic" (Project Laboratory)

Project lab abstract. The Youth Model aims to foster several innovative competencies among young students, aimed at creating strategies for regional development by engaging with the ideology of sustainable development. In addition, a new topic for Russia, the markets of the National Technological Initiative, is involved.

Bachelors, master's, and post-graduate students studying in different fields at different universities are invited to take part in the modeling. The idea is that

Table 2 Technology for implementing project activities in all types of learning

Type of learning	Product owner (customer)	SCRUM master	Delivery team	Result
Formal education	Nation-state, potential employers	A teacher in cooperation with representatives of a prospective employer (from government, business, academia, etc.)	Study groups divided into working teams (mini-groups)	Analytical material (notes), coursework, research report, graduate qualification work
Non-formal education	Student clubs, clubs, informal communities, media groups, etc.	Event organizing committee	Students from as many departments, faculties, and institutes as possible; students from different courses, different ages, with different scientific and life experiences, with different ratings	Media analysis, publication of the event material, formation of a community of students and teachers interested in the development and maintenance of the relevant topic
Informal education	State authorities, executive authorities, business structures, scientific institutions, forum organizing committees, and others	Representative of the customer: a person authorized to interact directly with the participants of the process, who can correctly orient and advise the players in governing documents, targets, and the expected result of the simulation	Students from different higher education institutions in the country, studying in different fields of study. These activities are not always taken into account in the current educational process, are poorly integrated into it, and will not be appreciated by the university of the participating team	Development of strategies, plans, roadmaps, and strategic vision proposals for the client

Source: Compiled by the author

specialists with different professional profiles (engineers, ecologists, social workers, doctors, journalists, etc.) are needed for the development of sustainable development initiatives. Attracting students who are studying only in one area of activity will make project solutions unviable and far removed from the real needs of the region. In this way, the principle of the trinity is respected, where problems and solutions for the three clusters of sustainable development, or the economy, society, and the environment, are considered together. Future specialists from different fields learn how to work together and create multi-criteria and multi-level project solutions.

Youth project office model objectives

- Simulating the work of youth working groups from each Arctic region of the Russian Federation in achieving the SDGs
- Identifying the focus of complex problems related to environmental management in the regions and developing a road map for each of the thematic working groups for achieving the UN Sustainable Development Goals

Youth project office model goals

- Examining the specificities of the territorial location and the natural and geographical opportunities for economic and bio-resource development
- Proposing additional measures to implement innovative approaches in the economic structure of the region in order to preserve and multiply the existing potential and opportunities to solve complex problems for sustainable development of the regions while maintaining high environmental quality indicators
- Analyzing and highlighting already implemented legal, economic, scientific-technical, and technological measures in environmental safety as a decision table for each of the thematic working groups
- Proposing additional measures to introduce sustainability principles into the economic structure of the region
- Weighing existing short-term and long-term natural and anthropogenic risks for the region
- Formulating criteria for public assessment and proposing a framework for the development of tools for the long-term provision of socioeconomic and environmental security in the region.

Structure Block 1: Strategic analysis

- Study Annex 1 to the methodological recommendations (Methodological recommendations on the development and adjustment of the socio-economic development strategy of the subject of the Russian Federation and the action plan for its implementation)

  For each of the tables there, write two to three arguments for each section in the following order:
- Analytical Block, Targeting Block, Scenario Block, Strategy Implementation Package Block.
- SWOT analysis is a method of strategic planning, which consists in identifying the actors of the internal and external environment of the socioeconomic development of the subject of the Russian Federation and dividing them into four categories: strengths, weaknesses, opportunities, and threats.
- PEST analysis is a method for analyzing political, economic, social, and technological factors.
- Defining the key areas of development.

Block II: Adaptation of SDG indicators to regional development objectives

- Study Annex 2 (Methodological recommendations on the development and adjustment of the socioeconomic development strategy of the subject of the Russian Federation and the action plan for its implementation)

- Align it with the regional issues selected under the SDG Study Vectors. Analyze possible ways of overcoming the problems and propose indicative vectors for improving the situation.
- Identify possible options for the development of the main clusters in the SDG areas: Economy, Ecology, and Society.

Research vector 1. Economic security.

Research vector 2. Energy and transport security.

Research vector 3. Sustainable management of natural resources and environmental security.

Research vector 4. Food and agricultural security.

Research vector 5. Training of human resources for the region.

Block III: Implementation of road maps (nets) of the national technological initiative

- Russia has set the task of digitalization of the economy. This has proved to be a real challenge for many regions for a variety of reasons. The Arctic is one of these regions. We have to make our contribution in the form of ideas to the state task.
- In 2016, Executive Order No. 317 of 18 April 2016 On Implementing the National Technology Initiative established this goal.
- The Initiative aims to create favorable conditions for achieving and scaling breakthrough technological projects.
- The National Technology Initiative has proposed the implementation of nine roadmaps. It is proposed that the following roadmaps should be considered for implementation in the Arctic region.

Case 2: Sustainable Development Trends and Vectors in the Arctic: The Arctic Council and the Regions of the Russian Arctic. Environmental Cluster (Youth Analytic Review)

Youth analytic review abstract. Today, Russia has developed a large body of documents for the implementation of state policy in the Arctic zone, and based on these requirements, systematic and targeted training of human resources capable of meeting the challenges of the future is required.

First of all, such education should form such key competencies as legal, foresight, systems thinking, strategic vision, teamwork, critical thinking, self-awareness, and integrated problem-solving.

These eight key competencies should be formed both at the level of formal education (in the educational process) and the level of non-formal and informal education (additional activities).

New pedagogical forms and methods of Environmental Education for Sustainable Development (EESD) are being developed within the framework of the Sustainable Nature and Environment Lab. The main challenge of this education is the need to develop and integrate interdisciplinary competencies. For this purpose, methodology and techniques have been developed for organizing, preparing, and conducting large-scale student events and projects such as a business game, project laboratory, and youth model of an environmental event (e.g., Model of World Water Forum, Climate Congress, and others) (Ryazanova et al., 2019d, 2020, 2021; Vologzhina et al., 2020).

Student interest in the Arctic was motivated by Russia's assumption of the chairmanship of the Arctic Council in 2021. In order to determine the socio-political and ecological meaning and significance of this process, a youth analytical study was initiated on "Trends and Vectors of Sustainable Development in the Arctic: The Arctic Council and the Regions of the Russian Arctic."

The *study objective* was to carry out a multi-criteria assessment of the opportunities for transition to sustainable natural resource use models in the Arctic zone of the Russian Federation.

Two clusters of tasks were set up for the study: one for researchers working on the regional block and one for researchers working on the Arctic Council working groups (international block) (Table 3). The teams of researchers were distributed as follows: six teams according to the number of Arctic Council working groups, nine teams according to the number of Russia's Arctic regions. The total number of researchers is 30 persons. The total duration of the study was about half a year.

Stages of work and scope of study from the perspective of the Arctic Council working groups. The activities of the Arctic Council Working Groups have been of interest to researchers in terms of related research history, the expertise and resources

Table 3 Research goals

Regional block (Russia's Arctic regions)	International block (Arctic Council)
1. Aggregation of the public policy agenda for environmental management in the regions 2. Conducting thematic interviews with heads of environmental and natural resource management departments of the Russian Arctic regions 3. Interviewing local communities on the SDG Environmental Cluster agenda and cooperation with the Arctic Council 4. Analysis of the environmental situation in the regions in the areas of the SDG Environmental Cluster agenda 5. Analysis of environmental management implementation in the areas of the SDG Environmental Cluster agenda 6. Creation of ideal models for environmental management and improvement of environmental conditions and environmental management in Russia's Arctic regions and their adaptation to real regional processes	1) Aggregation of the public policy agenda in the field of environmental management according to the work of Arctic Council Working Groups 2) A retrospective analysis of the scientific work of the Arctic Council groups 3) Study of the complementarity of the agendas of Arctic Council Working Groups and the needs of the Arctic regions 4) A survey of Russian university students on their knowledge of the Arctic Council's work areas and its potential for real cooperation with Russia's Arctic regions 5) Comparative analysis of the scientific directions of the Arctic Council Working Groups with the agenda of the SDG Environmental Cluster 6) Development of ideal models of sustainable environmental management based on scientific work of the Arctic Council relevant to Russia's Arctic regions Model of project group work: Working groups: nine groups (according to the number of Russian Arctic regions) and six groups (according to the number of Arctic Council working groups)

Source: Compiled by the author

involved, and the potential opportunities derived from Russia's Arctic Council chairmanship. The formats and outputs of the activities and outputs were reviewed and analyzed to gain an understanding of the structure of the Arctic Council and its existing fields of work, the development of the research agenda and depth, and the outcomes of its annual and long-term activities.

Based on obtained knowledge the researchers tried to reframe the global sustainable development agenda, particularly on the Environmental cluster of SDGs (SDGs 2, 6, 12, 13, 14, 15), and analyze what the regional agenda should be concerning the objectives of each of the mentioned Sustainable Development Goals. In addition, the research tried to identify the relevant areas of work within each Working Group of the Arctic Council to understand which areas are most relevant to each region of the Russian Arctic and which specific objectives they can address.

The research process was divided into several stages (Table 4) that aimed to analyze, review, and synthesize the information obtained in such a way as to formulate rational recommendations for the expert participants of the Arctic Council working groups from the Russian Federation.

Table 4 Study essence and stages

Stages	Study
Stage 1	**Arctic Council's history and development** Study the actors behind, and the context of the establishment of the Arctic Council. Submit a diagram broken down by years. Provide a short comment on each stage
Stage 2	**The socio-political relevance of the Arctic Council** Study the effect of the Arctic Council on indigenous people and large society. How do nations cooperate within the Arctic Council? Which issues are out of the remit of the Arctic Council? Which issue lies within the remit of the Arctic Council? Are the decision of the Arctic Council binding for the member states? Are there oversight bodies and what do they oversee?
Stage 3	**Performance analysis of the Arctic Council's working groups** Brief overview of the groups. What is their purview and remit? Who do they cooperate with within member states and how? What have they done in the past and what are they working on now?
Stage 4	**Retrospective analysis of a particular working group** The Arctic Council website provides past results to show the number of years the work has been carried out in a particular area. Describe your study in briefs: topic, main objective, goals, duration of the project, specialists involved, members from Russian ministries and agencies, areas of interest for Russia
Stage 5	**Current activities and prospects for the development of the agenda of a particular working group during Russia's chairmanship of the Arctic Council** What are they working on now? What will they be working on later? What impact has Russia made during its chairmanship?
Stage 6	**Creation of an ideal model for the cooperation agenda of a specific Arctic Council working group for each of the Arctic regions of the Russian Federation** Write the preamble as a specific justification to use a particular working group's activities for the agenda of a Russian Arctic region. Substantially, align your project with the following structure: UN SDGs – national goals – regional needs and means of SDG attainment

Source: Compiled by the author

Nine working groups participated in this track. Some of the researchers were able to interview decision-makers as part of their research; these were the directors of specially protected areas:

Director of the Russian Arctic National Park
Director of the Ust-Lensky State Nature Reserve
Director of the Krasnoyarsk Pillars National Park

The questions framed by the students for the interviews concerned both the current ecological state of the region and the specifics of nature management and conservation. For all the researchers, the interview with the current head of the organization was their first experience and left a great impression on them.

The research relied on a large number of literature sources and information portals that provided an insight into some of the subtleties of the social and political life of the regions and the work of the Arctic Council groups, revealing areas of interest and the intense efforts of environmental organizations while analyzing some of the weaker points of the aforementioned work.

The processing of information sources and the compilation of the resulting research text required, for many students, the development of new skills. These skills may be called advanced in some sense as opposed to those acquired in the current ways of learning.

Stages of work and area of study from the perspective of the Arctic regions of the Russian Federation. According to state documents, nine regions of the Russian Federation are now officially part of the Arctic zone of the Russian Federation. Researchers have set out to investigate the main types of nature management and nature conservation in the Arctic regions of Russia, and to analyze the possibilities for achieving the Sustainable Development Goals in the Arctic regions of Russia. However, the global agenda and objectives of each of the SDGs that they chose to study had to be adjusted to the regional agenda. As no such analysis has been found to date by any organization or in current analyses, this made the study novel and gave it the relevance it needed to formulate and take decisions in environmentally oriented processes.

The study was divided into five stages (Table 5), and each was conducted within 7–10 days. Social and political currents and movements in the regions, news portals and political media and social networks, Telegram channels, and a host of other sources were analyzed.

In addition, the papers contain cartographic and other graphic material with references to the source of the original information while their content is integrated into the text of the analytical review.

The final collection of texts consists of chapters divided into paragraphs, where the titles of both chapters and paragraphs correspond to the research undertaken.

The study produced two volumes with information on the following:

Volume 1: Opportunities for engaging the research agenda of the Arctic Council working groups to improve environmental protection mechanisms and the implementation of sustainable environmental management in the regions of the Arctic

Table 5 Study essence and stages

Stages	Study
Stage 1	**Objective**: creating a database of all actors involved in the region, and using different sources of information Sources • Scientific papers • Websites • News resources of socio-political organizations • Social media and video hosting sites (YouTube, Telegram channels)
Stage 2	**Objective**: conducting an inventory of natural sites and assessing their current condition **Research objects:** • Physical and geographical characteristics of natural zones in the region • Water sources • Climate parameters and atmospheric air quality • Lithosphere, natural landscapes status • Regional biota status
Stage 3	**Objective: analyzing the main environmental problems of the region according to their physical and geographical characteristics in order to subsequently compile an information base on the region's environmental status**
Stage 4	**Objective**: analyzing socio-political actors active in the region **Research objects:** • Environmental activists in the region • Existing projects and proposals • International engagement in the region
Stage 5	**Objective:** assessing the region's contribution to future successful engagement with the Arctic region, creating a summary of current issues with conclusions and recommendations for decision-makers **Research objects:** • Organizations that can carry out eco-protection and eco-remediation activities • Existing resources (economic, administrative, financial, etc.)

Source: Compiled by the author

zone of the Russian Federation (eight chapters, including history and characteristics of Arctic Council work, an analysis of each Arctic Council working group and how they relate to the sustainable development agenda, as well as a chapter on key areas of work for the Russian Arctic Council Presidency from 2021 to 2023).

Volume 2: Trends of nature protection and rational use of natural resources in the regions of the Russian Arctic based on sustainable development ideology (nine chapters, according to the number of regions of the Arctic zone of the Russian Federation. A total of 30 students took part in the study. The results are being prepared for publication).

Conclusions

The technologies and approaches to personnel training for sustainable development, particularly for the Arctic region, as presented in this chapter, are somewhat different from those previously in place. The elements and principles of Agile are perfectly suited to the conditions arising between the demands of the regions, employers, and universities in the context of the VUCA world. In shaping educational strategies for Arctic universities, it is important to follow the main provisions set out in state documents (doctrines and strategies) for the Arctic zone of the Russian Federation. The chapter presents original guidelines in dealing with the agenda of sustainable development concerning the transforming demands of society, the preferences and workforce demands of employers, and the demands of university applicants and students. Approaches to creating more student-centered models are presented.

The education agenda in the Arctic region is becoming interdisciplinary and regionally specific, and capacity building in this area is taking place through the establishment of research and education centers, improved management in universities themselves, and the third mission of universities, which is acutely relevant since many regions are experiencing a population exodus. More jobs, a new national policy in education, university, and student community activities, non-for-profit and educational initiatives, and public and private organization initiatives may encourage people to remain in the region. The main implementation trajectories of education for sustainable development are its introduction into formal, non-formal, and informal education. The author has created a flexible functional block model of the project approach, which has made it possible to adapt it to youth models, project laboratories, and foresight for problem solving and regional development planning for the Arctic zone of the Russian Federation.

The cases presented show how to work with the socio-environmental and economic agenda of the Arctic region. The work in these areas is ongoing at full pace. Some specific youth business games and models aimed at solving the most urgent and challenging issues of the Arctic region are to be set up.

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Part XII

The Arctic Zone of Russian Federation

Russian Participation in Global Value Chains

Role of the Northern Sea Route

Lenka Fojtíková, Eva Jančíková, and Petra Doleželová

Contents

Abstract

As global production is currently fragmented into individual parts through different countries and regions, international trade plays an important role, namely for those subjects that participate in the so-called global value chains (GVCs) the most. Concurrently, many factors influence the form and level by which a country is linked to these production networks. Although Russia is the largest country in the world with a lot of raw materials and developed infrastructure, in order to diversify its economy and trade, participation in GVCs is also important. The aim of this chapter is to depict the Russian trade flows that are recorded in value added, and to determine their geographical location. Thus, the Russian participation in GVCs can shed light on the current Russian position in world trade in a more realistic way than what the traditional concept of international trade represents.

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Keywords

Global value chain · Backward participation · Forward participation · Fuels · Northern Sea Route · China

Introduction

Mobility has always been a fundamental component of the economic and social life of a society. In history, the evolution of transport was followed by rapid changes in technological innovations. The main example is the Industrial Revolution in the nineteenth century, followed by the mechanization of transport systems given by the development of the steam engine technology, which enabled the creation of a network of servicing regions. This process was further expanded in the twentieth century with global air transport, container shipping, and telecommunication networks (Rodrigue, 2020). The contemporary global economy is characteristic of an increasing population growth, which is followed by the existence of a new middle-income class in the most populous countries, such as China or India, and extensive trade and capital flows. Trade liberalization, which is especially the result of preferential trade agreements and the creation of free trade zones, has contributed to the growth of global trade and production. Many new players have entered the world market, meaning the competition among producers/countries has strengthened. Innovation in production and reducing *production costs* are ways how to remain competitive and expand to new markets.

In their turn, *transportation costs* are an important part of the total production costs. The cost of transporting goods from producer to user affects the volume, direction, and pattern of trade. Internationally renowned economists such as Johann Heinrich Thünen, Charles Kindleberger, and Paul Samuelson assumed in their trade models that transportation costs are proportional to the price of the traded good (the so-called "iceberg costs"). They supposed that higher transportation costs reduce the volume of trade, but do not necessarily change the composition of trade (WTO, 2013a). Other studies examined the impact of changes in transportation costs on the pattern of trade through a different quality of products, the extensive margin of trade (i.e., the increase in the number of products a country trades), and the potential diversification arising from reductions in transportation costs.

Another issue related to transportation in international trade is the uncertainty that arises from the method of organizing production along global chains. For global value chains dependent on manufacturing final products from a large array of parts and components, unsynchronized deliveries can disrupt the entire production process. Uncertainty about exact delivery times can reduce trade, as companies might source more of their inputs locally to reduce the risk of production interruption. Empirical studies estimate that a delay of 1 week in shipment can reduce the volume of exports by as much as 7% or raise the delivered price of goods by 16%. For exceptional time-sensitive goods, such as parts and components, the volume can be reduced by as much as 26% (WTO, 2013a). Regardless of these facts, with over 80%

of world merchandise trade by volume being carried by sea, maritime transport remains the backbone supporting international trade and globalization (European Commission, 2021).

Thus, transportation costs are one of the most important factors that will shape international trade and change the comparative advantages of a country in the future, even though the importance of e-commerce and digitalization has increased during the last years. The COVID-19 pandemic also showed the importance of free trade flows and a quick supply of medicines and medical goods across the world. All in all, the transportation of goods and people play many different roles in society. Lowering trade costs is determined by the distance to markets and transportation routes, infrastructure, trade facilitation, competition and regulation, transportation technology, and fuel costs (WTO, 2013a). For example, Limao and Venables (2001) found out that countries which make investments in transportation infrastructure decrease transportation costs by up to 12%. Besides the reduction of transportation costs, investment in physical infrastructure (such as new roads, ports, airports, etc.) can also facilitate the integration of a country into international supply chains. The policy decision of the Russian government to build the Northern Sea Route (NSR) is, from the economic point of view, possible to consider as a rationale.

The NSR is a maritime route through the Arctic along the northern coast of the Eurasian landmass, principally situated off the coast of northern Siberia in Russia (Britannica, 2021). The original idea to build the Northern Passage, as a channel that covers the distance between the Atlantic and Pacific oceans, was a European concept introduced first by Dutch and English merchants, and later also by Russian explorers. The concept arose as the Eurasian equivalent of the Northwest Passage across Arctic North America. The motive for the exploration of the Northeast Passage was trade with the Far East.

Although the Northern Sea Route is a very old concept that has been developed since the sixteenth century, the fact that a part of the Northeast Passage between the Kara and Bering Straits remains icebound for most of the year makes it the most difficult for ships to transit. Only specially strengthened vessels can sail along the Russian Arctic. The Soviet Union and then Russia developed and maintained a navigable channel of roughly 3500 miles (about 5600 kilometers) through the most challenging part of the passage. The first full traverse of the route by foreign merchant ships occurred in 2009. In 2010, a passenger ferry and a tanker ship, both Russian, became the first of their kind to successfully navigate the passage's entire length (Britannica, 2021). In 2011, Russian President Vladimir Putin stated that “the Arctic is a shortcut between the largest markets of Europe and the Asia-Pacific region. It is an excellent opportunity to optimize costs” (Reuters, 2011). The Russian new Industrial Project includes the waters between the archipelago of Novaya Zemlya and the Bering Strait, a distance of about 5600 kilometers. Thus, the NSR offers shippers a shorter route to Europe and Asia by 40% than through the Suez Canal (Barents Observer, 2019). Besides lowering transport costs, reducing time for transport is also important, namely at a time when the production of final goods is highly fragmented into individual parts around the world. In addition, the Russian plans to revive the Soviet-era shipping plane are more significant at a time of growing political tensions in the world. On the one hand, the foreign relations between Russia and West Europe are followed by many diplomatic conflicts, but on the other hand, there is a need to develop cooperation and trade between Russia and Asia, in which especially China plays a more significant role than in the previous decades.

Thus, the aim of this chapter is to depict the Russian trade flows that are recorded in value added, and to determine their geographical location. We assume that trade expressed in value added instead of the traditional method of gross exports brings a more real picture about trade flows and the position of Russia in global value chains. Although the Russian government expects the NSR to be used by Russian as well as foreign ships**,** the knowledge of Russian trade flows can also be beneficial for the development of transport and investment in new trade roads. For the purposes of this aim, the analysis will focus on territories, not the sectoral structure of trade flows.

The structure of the chapter is as follows: First, the principle of global value chains will be introduced. Afterward, the methodology of the research and analysis of the Russian trade flows by the value-added method will be carried out. Last, in the conclusion, the main facts will be summarized with respect to the intention of the Russian government to build the NSR.

Global Value Chain as an Important Phenomenon of the Twenty-First Century

International trade brings gains from specialization, which is determined by differences among countries. The principle of mutually beneficial trade was first formulated by classical policy economists, namely Adam Smith and David Ricardo. The traditional trade theory, such as the law of absolute advantage and the law of comparative advantage, has been deduced from relative efficiency: this means that a country does not have to be better at producing something than its trading partners to benefit from trade (absolute advantage); it is sufficient that it is relatively more efficient than its trading partners (comparative advantage). More recent theories point out other sources of gains from trade, such as economies of scale in production, enhanced competition, access to a broader variety of goods, and improved productivity (WTO, 2008). In addition, while the trade predicted by traditional theories occurs among industries (interindustry trade), and can involve countries with highly varied characteristics, a relative majority of international trade occurs among similar countries and comprises the exchange of products within the same industry (the so-called intraindustry trade). For many developed countries and emerging economies, intraindustry trade accounts for more than half of their total bilateral trade flow.

The economic history of the last seven decades has affirmed the fact that international trade and, more generally, globalization have brought enormous benefits to many countries and citizens. Trade has allowed nations to benefit from specialization and economies to produce at a more efficient scale. It has raised productivity, supported the spread of knowledge and new technologies, and enriched the range of choices available to consumers (WTO, 2008). Although the benefits of trade and globalization are not distributed in all countries evenly, international trade has generally contributed to economic growth and global peace. At the beginning of the new millennium, the International Monetary Fund (IMF) published: "over the past 20 years, the growth of world trade has averaged 6 per cent per year, twice as fast as the world output" (IMF, 2001). However, trade has been an engine of growth for much longer, namely, because of trade liberalization in the world that occurred under the General Agreements on Tariffs and Trade (GATT). In the last two decades, the world economy faced the economic crisis in 2008–2009 and growing tensions among countries, namely, under the protectionist policy of the former U.S. president Donald Trump. In total, in the period 2008–2018, world trade and GDP grew in tandem, both increasing by 26% (WTO, 2019a).

Although the concept of comparative advantage is as relevant today as it was 200 years ago, the nature of international trade flows has changed significantly. The recent world is characterized by globalized manufacturing, just-in-time production, and integrated supply chains. International production is currently structured into *global value chains* (GVCs) in which firms source parts, components, and services from producers in several countries and in turn sell their output to firms and consumers worldwide; thus, most goods can be marked with the label "Made in the World" (WTO, 2017). The term "value chains" was first introduced in business management studies in the early 2000s and was based on Porter's approach to the value chain in the framework of industrial organization (Porter, 1985). Besides this, GVC studies occurred in sociology as well. The current concept of GVCs was collectively framed in the discussion of the Global Value Chains Initiative in 2000–2005 (WTO, 2017), and further developed by Gereffi et al. (2006), who focused on the governance structure of organizing international production networks.

Economic theory provides an explanation for this increasing fragmentation of production. It might be the case that the various stages of production require different types of technology or skills, or they may require inputs in different proportions. Then the benefit of fragmenting production across countries is that the firm can locate different stages of the production process in the country where there is a relative abundance of the type of skill or input used relatively more intensively in that stage of production (WTO, 2008). In this way, the firm can lower the costs of production and be more competitive in the world market.

Trade liberalization has significantly contributed to the development of GVC production. Although the multilateral trade system under the WTO framework has not recorded significant progress in the last two decades, regional cooperation and signing preferential trade agreements among countries has strengthened since the 1990s. However, differences in the level of intraregional trade among regions have existed. While Africa's interregional trade stands at only 18% of its total exports, it is 58% for Asia and 67% for Europe (Wolff, 2020b).

Although the phenomenon of GVCs has become the subject of many empirical studies and serious policy discussion in different international fora, the view on the methodology of GVCs is not unanimous among economists. For example, Richard Baldwin stated: "The term "global value chains" does not describe what we see today in the world economy, because: the world economy is not global; it remains regionally segregated, such as *Factory Asia*, *Factory Europe*, and *Factory North America*, and what matters is not value (added) but jobs, especially good jobs. Production systems are not configured as a linear sequence of production stages like chains but consists of complex networks of hubs and spokes" (WTO, 2017, p. 15). Baldwin's ideas were also backed up by arguments. Value chains remain largely regional, but they are not static. Li et al. (2019) found out that between 2000 and 2017, intraregional GVC trade increased in "Factory Asia," reflecting, in part, the upgrading by China and other Asian economies. In contrast, intraregional GVC trade in "Factory Europe" and "Factory North America" decreased slightly relative to interregional GVC trade, reflecting stronger linkages with "Factory Asia."

Regardless of different scientific discussions, GVCs have become a dominant feature of world trade and investment, offering new prospects for growth, development, and jobs. More than two-thirds of world trade occurs through GVCs in which production crosses at least one border, and typically many borders, before the final assembly (WTO, 2019b). Participation in GVCs can create an opportunity for the growth of production in developed as well as emerging and developing countries. In 2008, the weight of the economic output produced by developing countries began exceeding 50% of the global output (OECD, 2018), and integrating with the world economy through trade and GVCs helps drive economic growth and reduce poverty (WB, 2018). Trade now represents 34% of developing countries' GDP on average, compared to 20% for developed countries. Fueled by trade, real GDP per person in emerging economies more than doubled from 1995 to 2019 and facilitates a rapid, broad-based economic expansion that has narrowed the income gap between countries and within them (Wolff, 2020a). Success in international markets currently depends as much on the capacity to import high-quality inputs as on the capacity to export: intermediate inputs account for over two-thirds of the goods and 70% of the services traded worldwide (WTO, 2013b).

All in all, the global value chain phenomenon promotes integration on multiple levels. Although GVCs integrate countries on different economic levels, there are some differences in the form of GVC participation between developed and emerging or developing countries. For example, the production of more sophisticated products is associated with growing domestic value added in exports in emerging economies, while skill intensities are significant in developed economies only, likely reflecting the differing nature of integration between different types of economies. Thus, gains from trade as well as GVC participation among countries have remained different.

As mentioned above, GVC production has brought economic gains from lower production costs. However, the fragmentation of production has also increased the economic interdependence between countries, and firms engaged in global manufacturing are more vulnerable to the disruption of their supply chains. For example, the earthquake and tsunami in Japan in 2011 had a negative effect not only on the Japanese economy, but also on global trade, with respect to the fact that many Japanese affiliates abroad and in some foreign industries, such as French automobile manufacturers, rely on Japanese input (Escaith et al., 2011). Besides this and other global natural disasters in the last two decades, GVCs faced political risks such as terrorism and financial risks from fragile financial systems and the uncertain costs and availability of trade finance as was recorded during the 2008–2009 financial crisis.

The Methodology of Value-Added Trade for Analyzing GVCs

The importance of the GVC phenomenon has called for new requests for researchers to develop new statistical approaches for recording trade flows in a more precise way. Pioneering initiatives, such as those of the Global Trade Analysis Project (GTAP), the WTO with IDE-JETRO, and the WIOD (World Input-Output Database) have contributed to the improvement of statistics, but these studies have generally been off in nature (WTO, 2013c). However, in 2012, the OECD and the WTO joined forces to develop a database of Trade in Value-Added (TiVA) indicators. The database was last edited in 2018 and contains data for 64 economies, including all OECD countries, the EU, and G20 countries, and 36 unique industrial sectors from the International Standard Industrial Classification (ISIC revision 4), and covers the period 2005–2015 only on a yearly basis. The next updated version of the TiVA indicators will have expanded the industry and the period up to 2018.

The value-added method makes it possible to track down the origin of value-added creation by the source country and by specific industries, as well as to eliminate double counting in mutual trade. This approach brings several advantages, namely: A better understanding of how much domestic value added is generated by the export or import of a good or service in a country; identifying how upstream domestic industries contribute to exports, even if those same industries have little direct international exposure (goods industries require significant intermediate inputs of services); showing the real picture of global imbalances (taking into account “trade in tasks” does not change the overall trade balance of a country with the rest of the world); and many other areas that have impact on job creation or environment. Understanding trade in value added is, thus, crucial for development strategies and industrial policies.

Instead of the value-added method, the conventional measures of trade record the gross flows of goods and services each time they cross borders, thus overestimating trade flows and lowering the validity of statistics. Graphically, the decomposition of gross exports is shown in Fig. 1.

Gross exports contain *domestic value added* (DVA) and *foreign value added* (FVA). The DVA content of exports is composed of three elements, such as DVA sent to the consumer economy, DVA sent to third economies, and DVA reimported in the economy, i.e., the DVA of exported intermediates, or inputs, which is sent back to the economy of origin as embodied in other intermediates and used to produce exports. In contrast, the FVA content of exports corresponds to the value added of inputs that were imported in order to produce the intermediate of the final goods or services to be exported. It is also referred to as vertical specialization (WTO, 2021). The decomposition of gross exports into DVA and FVA enables the determining of the position of a country in GVCs and the net gains from integration into GVCs.

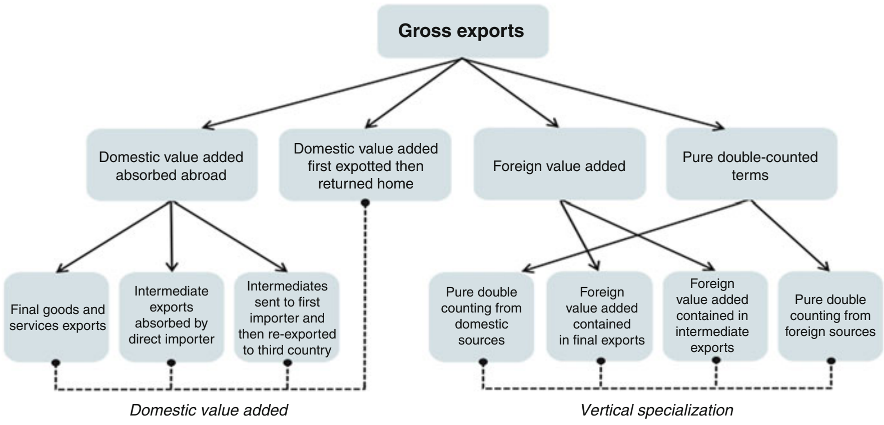

Fig. 1 Decomposition of gross exports. (Source: adapted from WTO (2017). *Global Value Chain Development. Measuring and Analyzing the Impact of GVCs on Economic Development*. Retrieved from: https://www.wto.org/english/res_e/booksp_e/gvcs_report_2017.pdf)

First, individual economies participate in GVCs by importing foreign inputs to produce the goods and services they export. This link is the *backward GVC participation* and expresses the ratio of the FVA content of exports to the economy's total gross exports. In other words, this is the case when an economy imports intermediates to produce its exports. Second, the *forward GVC participation* corresponds to the ratio of DVA sent to third economies to the economy's total gross exports. In this way, the forward links of a country in GVCs are captured by DVA contained in inputs sent to third economies for further processing and export through value chains. The process of the creation of value added in different countries is shown in Fig. 2. In this expression, GVC activities can be further subdivided into simple and complex cross-border production-sharing activities based on the number of border crossings. In simple GVCs, the value-added crosses national borders only once during the production process, with no indirect exports through third countries or re-exports or reimports. In complex GVCs, the value-added crosses national borders at least twice (WTO, 2017). Complex GVCs occur in the current globalized world more than simple GVCs, but the position of the individual countries in GVCs is different, namely, in dependence on the structure and size of the economy and its comparative advantages.

Results: Positioning Russia in GVCs

Russia is the largest country in the world, with many mineral resources and materials; thus, the openness of its economy is lower than that of small open economies, such as the Czech Republic or the Slovak Republic. For comparison, in 2019, around the world, merchandise trade-to-GDP was 45.5%, but services-to-GDP was 14.3% (Comtrade.un.org, 2021); in Russia, the exports and imports of goods and services shared in GDP by about 28% and 21% (WITS, 2021). Russia's main export partners

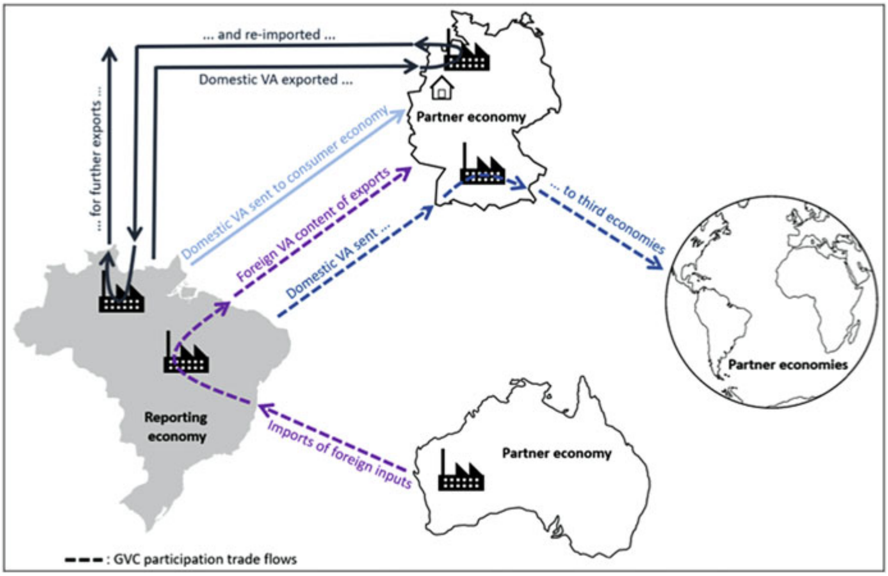

Fig. 2 The value-added components of gross exports and GVC trade flows. (Source: adapted from WTO (2021). *WTO "Trade in Value added and Global Value Chains" Profiles. Explanatory notes*. Retrieved from: https://www.wto.org/english/res_e/statis_e/miwi_e/explanatory_notes_e.pdf)

are currently China, the Netherlands, Germany, Belarus, and Turkey. These five destinations accounted for more than 40% of Russian gross exports. Contrary to export, Russia's main import partners are China, Germany, Belarus, the United States, and Italy. These five top import partners even accounted for more than 47% of Russian gross imports (WITS, 2021). On the other hand, Russia is one of the most important export destinations for Cyprus and Kazakhstan. While the share of Russia in China's exports was only about 2%, in Cyprus and Kazakhstan, it was more than 18% and 12%, respectively (OECD.Stat, 2021). On the import side, Russia shared the most in gross imports with many European countries, namely, Lithuania, Latvia, and Bulgaria (OECD.Stat, 2021). However, these trade flows can look different from the point of view of the creation of value added.

The aim of this chapter is to depict Russian trade flows that are recorded in value added, and to determine their geographical location. For the purposes of this aim, first, the position of Russia in GVCs through its links will be explored. Figure 3 shows the level of Russian participation in GVCs in comparison with other selected economies. Small economies generally tend to have higher rates of participation in GVCs due to higher "upstream" links of exports, as they source a large share of their intermediates from abroad. In terms of Russia, which is sufficiently equipped by sources, the level of GVC participation is high, specifically due to forward linkages. Lower than Russia, backward participation was only recorded by Saudi Arabia. To sum up, Russia's participation in GVCs was higher than that recorded by the largest economies in the world, such as the United States and China. However, in 2009,

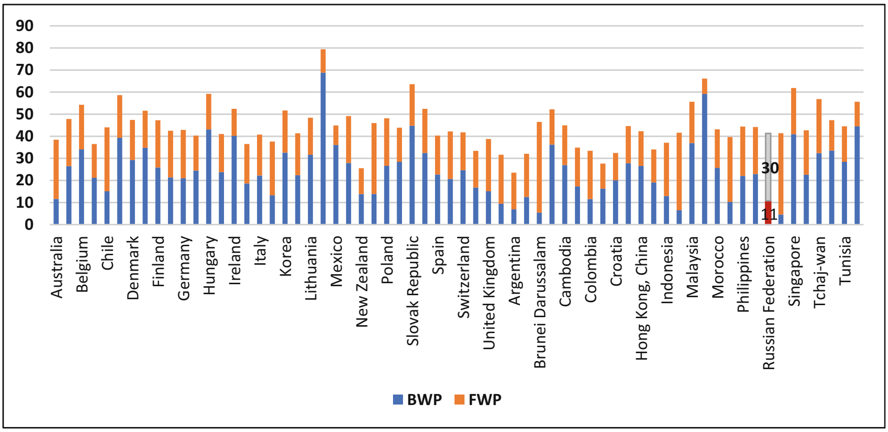

Fig. 3 Participation of the Russian Federation in GVCs in 2015 (per cent). (Source: compiled by the authors based on OECD.Stat (2021). *TiVA*. Retrieved from: https://stats.oecd.org/Index.aspx?DataSetCode=TIVA_2018_C1)

Russia participated in GVCs more than in 2015, thanks, largely, to the forward linkages that represented 43% of the Russian gross exports (OECD, 2009). While Russia's forward participation in GVCs declined in 2015 in comparison with 2009, Russia's backward participation in GVCs increased from 7% to 11% of gross exports (OECD, 2009). Regardless of the high level of Russia's participation in GVCs, the effectiveness of the participation is also important. As Chernova et al. (2018) state, the effectiveness of Russia's participation does not correspond to the potential of the Russian economy and the national tasks of industrial modernization.

In addition, higher participation in GVCs does not guarantee higher gains. There are several approaches for measuring the benefits from GVC participation. First, when we assume that the net value added represents the gains, then *high forward links indicate high gain from participating in GVCs*. Thus, the "winner" is Russia, with the highest gains in the entire monitored period (see Fig. 4, where the values of FWP divided by the values of BWP equal the net gains). On average, Russia recorded net gains of 3.54, but the United States only recorded 1.98, taking second place in the highest gains. China had a net gain from GVC participation of 0.77, which was the third highest gain among the considered countries. In contrast, Malta and Slovakia reached the lowest gains of 0.38 and 0.13. This shows the fact that countries with the highest GVC participation recorded the lowest gains from their links in GVCs, due to the low level of their forward linkage. In other words, these small open economies need more import to be able to export. They are more dependent on foreign inputs than Russia, which is determined by the structure of their economy and sources. As Volgina (2018) states, Russia is a specific case; it gets value added from supplying minerals along the value chain that other countries use as intermediates in their final demand and exports to third countries. Another study added that Russia retains a historically established specialization, with a predominance in the export of minerals and agricultural raw materials, which determines the

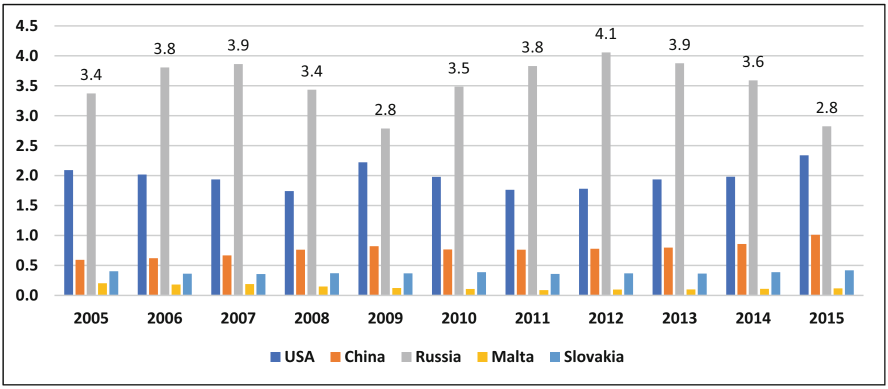

Fig. 4 Comparison of the net gains from participation in GVCs for Russia with selected economies in 2005–2015. (Source: calculated and compiled by the authors based on OECD.Stat (2021). *TiVA*. Retrieved from: https://stats.oecd.org/Index.aspx?DataSetCode=TIVA_2018_C1)

Table 1 Russia's net gains from participation in GVCs in 2005–2015

	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
EX	2.21	2.37	2.39	2.71	2.28	2.45	2.66	2.80	2.72	2.50	2.07
DVA	2.50	2.73	2.76	3.12	2.54	2.81	3.10	3.27	3.17	2.89	2.33
NG	0.29	0.36	0.38	0.41	0.26	0.36	0.44	0.48	0.45	0.39	0.26

Source: calculated and compiled by the authors based on OECD.Stat (2021). *TiVA*. Retrieved from: https://stats.oecd.org/Index.aspx?DataSetCode=TIVA_2018_C1

current profile of Russia's participation in GVCs (Chernova et al., 2018). All in all, mining and quarrying contributed to Russian gross exports on average by 28% in the monitored time (based on the author's calculations from the TiVA database). However, it is not the sole example of a country doing so; many other countries recorded a much higher share of this industry in their gross exports at the same time, for example, Brunei Darussalam (almost 84%), Saudi Arabia (almost 77%), Norway (49%), Kazakhstan (45%), etc.

Another way to determine the net gains from GVC participation was introduced by Volgina (2018): if the share of national exports in global exports is lower than the share of national DVA in global DVA, it means the country has clear gains from trade in value added. Table 1 shows the share of Russian exports in global exports in 2005–2015 (EX), and the share of Russia's DVA in global DVA (DVA). As the share of "EX" was lower than the share of "DVA," Russia recorded net gains (NG) for the whole monitored period even though we used another method of calculation.

As has been recorded in Fig. 3, Russia's backward participation was only 11%. Thus, the predominant part of the Russian gross exports, as well as the final demand, was created by the domestic value added (DVA). The Russian DVA shared in gross exports by 89% and by 80.8% in the final demand. This means that the foreign value added (FVA) accounts only for a small part of the Russian gross exports and final

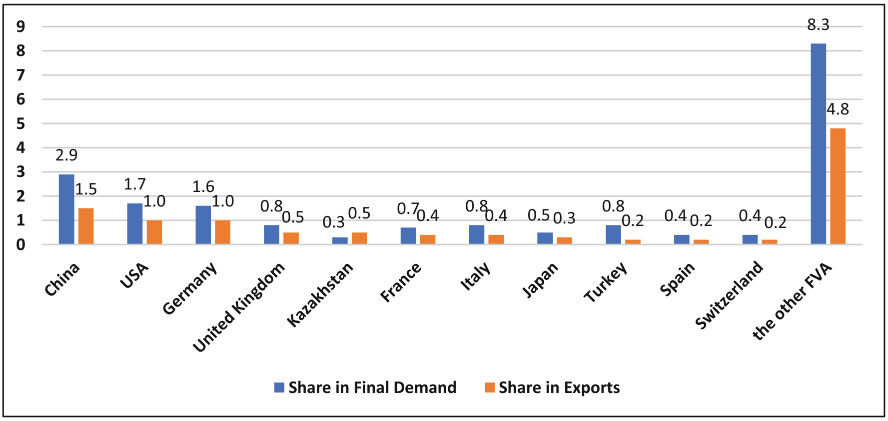

Fig. 5 Main source countries of Russia's gross exports and final demand in 2015 (per cent). (Source: calculated and compiled by the authors based on OECD.Stat (2021). *TiVA*. Retrieved from: https://stats.oecd.org/Index.aspx?DataSetCode=TIVA_2018_C1)

Table 2 Chinese value-added share in Russian gross exports by sectors in 2005–2015 (per cent)

	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Industry	80.27	79.61	81.05	81.32	78.81	79.55	79.76	78.15	76.88	75.96	74.77
M&Q	17.83	14.14	14.47	15.61	20.93	18.17	19.91	20.77	22.32	22.70	23.57
Services	17.44	18.42	16.77	17.20	19.34	19.24	18.82	20.38	21.93	22.43	23.56
Total	0.48	0.60	0.83	1.01	1.01	1.20	1.10	1.05	1.12	1.25	1.51

Source: calculated and compiled by the authors based on OECD.Stat (2021). *TiVA*. Retrieved from: https://stats.oecd.org/Index.aspx?DataSetCode=TIVA_2018_C1

demand. Figure 5 shows the shares of the main source economies from which Russia imported inputs, such as intermediates or final goods. The results indicate China's FVA contributed to Russia's final demand and its gross exports the most. The share of foreign value added in Russia's gross export was usually higher than the share of foreign value added in Russia's final demand. The only exception was Kazakhstan, where FVA shared more in Russia's gross exports than in its final demand.

In terms of China, value added in the Russian exports was higher in the industry exports than services exports in the monitored period, although the share of industry was lower in 2015 than in 2005 (see Table 2). However, the share of the Chinese value added in the Russian mining and quarrying (M&Q) exports increased from 18% in 2005 to 24% in 2015. On the whole, China increased its value added in Russian gross exports more than three times in 2005–2015.

Conclusions

Russia ranks among the 20 leading traders of goods and commercial services globally (WTO, 2020), and, as was confirmed, its participation in GVCs is also high. In addition, Russia is able to achieve higher gains from participation in GVCs than other large countries and economies, such as the United States and China. From the point of view of Russia's backward participation in GVCs, China especially is a source of different inputs and final goods that are imported to Russia. However, Russia achieved the gains from GVC participation mainly due to its high forward linkage and the fact that Russia is the world's leading exporter of fuels and mining products when excluding intra-European Union trade. Although data about TiVA are only available up to 2015, the structure of the Russian economy and trade did not vary significantly for two decades. The geographical location of Russia's trade flows is, thus, highly determined by the sectoral structure of its economy and factor endowments.

In addition, from the geographical point of view, China appears as Russia's strategic trade partner in both statistical approaches (i.e., in the gross export and import method) as well as TiVA. Thus, Russia's current external relations with China are influenced by the economic interests of both countries. On the one hand, Russia needs to export fuels; thus, investments in maritime transport in Russia are important for getting access to other world markets, namely, in Asia, where emerging markets will contribute by almost 60% to the global GDP by 2050 (Bloomberg Businessweek, 2020). On the other hand, the NSR is also a strategic path for China. China needs to import fuels from Russia, but also to export its products (intermediates and final goods) from Shanghai and other Chinese industrial centers to many countries around the world. Thus, the NSR can be an advantageous project for Russia as well as for China. Russia's strategic partnership with China was also confirmed by both presidents of these countries during the visit of the Chinese President Xi in Russia in 2019. The linking of Putin's plan to create the Eurasian Economic Union among Russia, Armenia, Belarus, Kazakhstan, and Kyrgyzstan on the one hand, and Xi Jinping's infrastructural project Belt and Road Initiative on the other hand represents a complementary project of Russia and China (Hillman, 2020; Lissovolik et al., 2021). Although the economic vision of both leaders (Putin and Xi) should contribute to economic cooperation, not only trade in natural resources, Hillman (2020) states that the growing partnership faces structural constraints, such as poor infrastructure in Russia, and also restrictions on both sides that limit trade.

State investment in new infrastructure followed by private investment will therefore be one of the most important factors that will shape Russia's comparative advantages and its position in the international market in the future. In addition, investment in the Northern Sea Route will also enable other ships to sail through the Arctic Ocean, transporting "value added" among the continents. Therefore, building the Northern Sea Route can increase the role of Russia in GVCs through backward as well as forward linkages, thus contributing to the growth of global trade, although the price will be high.

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Northern Sea Route's Development Potential and Resource Extraction in the Arctic Region of the Russian Federation

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Abstract

The development of the Russian Arctic is directly related to the development of the Northern Sea Route, which is a strategic direction of Russia's development at present within the framework of Arctic activities. It is important to note that Russia's international cooperation in the Arctic is actively developing, which has been concluded in a number of international agreements and initiatives. The authors present a theoretical overview of promising directions for the development of the Northern Sea Route and resource extraction in the Arctic region of the Russian Federation. The chapter has analyzed regulations, identified the main directions of strategic development of the Arctic Zone of the Russian Federation, including the analysis of the development plan, which allowed it to consider the existing problems in this area and identify ways to solve them. In addition, the largest promising deposits of the Arctic territory and the problems associated with their production were considered. Aspects of Russia's international cooperation in the Arctic are considered.

Keywords

Northern Sea Route · Development potential · Arctic region · Strategic direction

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Introduction

The development of the Arctic is a strategic direction in the development of Russia at the present stage. As part of Arctic activities, the effective implementation of this direction directly depends on the development of the Northern Sea Route (NSR).

The Northern Sea Route passes through four seas (Kara, Laptev, East Siberian, and Chukchi) and is the shortest route from Northern Europe and Siberia to Asia. It has a centuries-old history, but does not have a single generally accepted route.

The administrative boundaries of the Northern Sea Route in the west are limited by the entrances to the Novaya Zemlya Straits, as well as the meridian in the north from Cape Zhelaniya and the Bering Strait in the east. In a broader sense, the Northern Sea Route connects the ice-free port of Murmansk with Provideniya Peninsula and Vladivostok with St. Petersburg.

The idea of developing the Northern Sea Route was put forward by Mikhail Lomonosov. On his initiative, the polar expedition of Vasily Chichagov was organized in the mid-1700s. The first through voyage along the Northern Sea Route was only made in 1878–1879, however – the expedition of Adolf Nordenskjold, which, despite delays along the way, reached the coast of Chukotka. In 1914–1915, the Northern Sea Route was used by the hydrographic expeditions led by Boris Vilkitsky and Peter Novopashenny on the icebreaking steamers “Taimyr” and “Vaigach,” but in the opposite direction – from Vladivostok to Arkhangelsk.

On April 23, 1919, the Northern Sea Route Committee was established under the Russian Government. The main task of the first polar expeditions of revolutionary Russia was the delivery of goods primarily bread from Siberia, as well as the strengthening of borders and the establishment of Soviet power in the North.

In 1932, as part of the Second International Polar Year, an expedition was organized on the icebreaker steamer “A. Sibiryakov.” The ship, albeit with great difficulty, managed to pass the way from Arkhangelsk to the Bering Strait in one navigation. Based on the results of sailing “A. Sibiryakova,” a decided was made to create a new special organization – the Main Directorate of Semorput (GU SMP or Glavsevmorput).

From that moment, on December 17, 1932, the planned development of the main northern highway of the country began. The main tasks of the Northern Sea Route Directorate were defined as: “the final opening of the Northern Sea Route from the Barents Sea to the Bering Strait, the organization of sea, river and air communications, radio communications and research in the Soviet Arctic, the development of productive forces and the development of the natural resources of the Far North, the promotion of the rise of the indigenous population of the Far North and the involvement of this population in active participation in socialist construction.”

In 1934, another through voyage by the Northern Sea Route took place in one navigation. It was made by an ice cutter “F. Litke” from east to west.

Transcontinental flights, the North Pole drifting research station, the construction of new icebreakers, the deployment of meteorological stations, and observatories – all these successes achieved by the USSR in the Arctic accelerated the development of the Northern Sea Route, which stimulated scientific and technological progress in high latitudes.

All transports moving along the NSR could not pass Dixon, a hub on the Arctic highway. By the decree of the State Administration of the NSR of May 22, 1934, work began here on the construction of the first structures of the future seaport. On Cone Island in Dixon Bay, a site was identified for the creation of a coal base for bunkering ships. In 1935, the pier received 70 vessels, including 11 sea vessels. Dixon became a transshipment port for Norilskstroy. Subsequently the construction of the main pier was moved to the Southern Bay Cape located on the mainland coast. As the requirements for the bunkering base located the North Sea Route have increased, Konus Island has become unsuitable for these purposes due to its shallow depths and small area. The construction of the new port was planned to be completed in 1943.

During the Great Patriotic War, hundreds of vessels passed through the Northern Sea Route, which transported more than 4 million tons of cargo. For their safe delivery, sea convoys were organized, as well as protection from the sea and air. The fleet continued to be supplied with coal through the Arctic ports of Naryan-Mar, Igarka, Dudinka, Dikson, and Tiksi, which were transferred as units of the NSR Main Directorate to martial law.

The postwar years are the golden time of the Arctic. Ice breakers were built one after another – only seven nuclear-powered icebreakers were built in the Soviet postwar period. The first of them, "Lenin," began working on the NSR route in 1960.

Industrial growth – such as the construction of new mining and processing plants – all required a powerful breakthrough in shipbuilding and port development. Most important at this time was Dikson, which remained the main bunkering base in the Western Arctic until 1958. Later it lost its meaning, before acquiring a new one: In the 1960s, Dikson became a place for forming sea caravans and bunkering ships with liquid fuel and fresh water, supplying them with food. Dikson became the base port of the NSR, a transport and distribution hub for transshipment and delivery of various cargoes for polar stations, and many other objects of the Kara Sea basin. Dikson is rightly called the "gateway to the Arctic."

Until nearly the start of the 1990s, the NSR administration successfully carried out tasks for the delivery of national economic cargo to the Arctic regions of Russia. The ports of the Northern Sea Route became the main links of communication with the "mainland": Points of delivery of goods and export of products include, for example, the coast of Yakutia and Chukotka. The Northern Sea Route was single highway through which goods were supplied.

Today, the Northern Sea Route is gradually turning into a trade route with great prospects. Currently, due to the beginning of the development of Arctic deposits, the development of transit shipping, and the growth in the number of expedition and tourist flights to the Arctic, the importance of the NSR has significantly increased. In addition, it is important to acknowledge resource extraction in the Russian Arctic.

Thus, the research is based on a theoretical review of the prospective directions of development of the Northern Sea Route and resource extraction in the Arctic region of the Russian Federation. As part of the content analysis of regulatory acts, the authors identified the main directions of strategic development of the Arctic Zone of the Russian Federation. The NSR development plan is analyzed in order to consider the existing problems in this area and ways to solve them. The largest promising deposits of the Arctic territory and the problems associated with their production are considered.

Problem Statement

In the twenty-first century, one of the main factors influencing political and economic equilibrium is competition for resources. Traditional sources of raw materials are gradually being depleted, so the oil and gas potential of the Russian Arctic is considered in the future as the basis for economic development not only of Russia but of the whole world (Vazhenin, 2020). The Russian state is currently actively working on the creation of infrastructure and the further development of the Arctic region, including for the effective functioning of the NSR (Stepanov, 2019).

The Northern Sea Route is of interest to Western powers, as it is much shorter than through the Suez Canal, which means that it is economically profitable, even taking into account the need to use icebreakers.

The Northern Sea Route should become a promising profitable trade route. Therefore, in the future, to develop in line with deeply integrated production, processing of raw materials, their storage, and their transportation, the modern living conditions for people who are permanently or temporarily residing in the area should be considered, so as to develop as a single complex of all areas of human activities, including the environment and science (Chizhkov, 2017).

Russia's international cooperation in the Arctic is actively developing. Russia participates in a number of international agreements and initiatives. These include both agreements and initiatives of the Arctic Council and other regional organizations (the Barents Sea Council/European Arctic Region, Northern Forum, Arctic Parliamentarians' Conference) and international agreements on the regulation of navigation (International Maritime Organization, 2021), whether fishing (On approval by the Government of the Russian Federation, 2018), environmental protection (Official Site of Climate and Clean Air Coalition, 2021), or scientific and environmental initiatives (MOSAiC Expedition Official Site, 2021).

The development of the Russian Arctic in recent years has been hindered by the aggravation of relations with Western countries, increased military security risks, and sanctions policies against Russia; as a result, this includes the severance of corporate ties that are important for the implementation of technologically complex and capital-intensive oil and gas projects.

Since 2014, with the exception of some intensification of economic cooperation with Finland and France, Russia's bilateral Arctic cooperation with Western countries has sharply decreased, both in terms of planning and implementing joint projects. On the contrary, cooperation with Asian partners, especially with China, is being intensified, although, as in the case of Korea and Japan, it is constrained by the extraterritorial application of US anti-Russian sanctions.

Relations with Finland have been developing quite actively in recent years. Thus, at the St. Petersburg International Economic Forum in 2019, an agreement was signed between JSC First Mining Company and the Finnish company Outotec Oyj for the joint development of the Pavlovsky polymetallic deposit on the Novaya Zemlya archipelago (Rosatom, 2019). In addition, an agreement was signed to establish a consortium for the construction of a new underwater high-speed optical line under the Arctic Ocean between MegaFon PJSC and the Finnish infrastructure operator Cinia Oy (Vedomosti, 2019).

Russia and Finland cooperate in the areas of environmental protection, meteorological support for the MTA of navigation and aviation in the cross-polar routes, Arctic shipbuilding, security at nuclear power plants, protecting the Russian border (in 2016 it has more than 8.8 million people), and Arctic processing of food sources, mainly of berries and antlers. Companies in Northern Russia and Finland have started implementing a project for processing venison and wild berries under the KolArctic program with a budget of about €2.5 million euros, which involves the creation of new processing technologies. Despite the deepening of cooperation in these areas, the anti-Russian sanctions imposed by the USA and the EU forced the stopping or postponing of the implementation of a number of joint projects in the field of technological cooperation in the areas of offshore development and shipbuilding.

Russian-Swedish cooperation in the Arctic is mainly limited to interaction within the framework of multilateral formats – at the sites of the Arctic Council, the Northern Council, and the Barents Sea Council/the Euro-Arctic region, the International Maritime Organization, etc.

An important area of cooperation with Finland and Sweden is the support of indigenous small-numbered peoples of the North (Indigenous Peoples of the North) and contacts between them, both on a bilateral basis and within the framework of various interstate forums where the Sami peoples of the Northern European countries and the Kola Peninsula are represented. Russian-Norwegian cooperation in the Arctic is largely aimed at mutual consideration of interests in the border areas of the two countries – both on the mainland and in the Barents Sea. Since 1975, Russia and Norway have not been able to agree on the delimitation of the Barents Sea, which has created difficulties in hydrocarbon exploration and fishing. The contradictions were resolved in 2010, when the Treaty on Maritime Delimitation and Cooperation in the Barents Sea was signed. It laid the foundation for deepening border cooperation between the two countries, including in terms of collecting and exchanging seismic data in the Barents Sea near the boundary line. Also in 2010, Moscow and Oslo signed an agreement on local border movement, according to which residents of border areas were allowed to enter a 30-kilometer zone on the territory of a neighboring state. However, the question of the Svalbard Archipelago's continental shelf remains unresolved. The Norwegian government claims that it has exclusive rights to the shelf around the archipelago under the UN Convention on the Law of the Sea. The Russian side does not dispute Norway's sovereignty over Svalbard, which was established by the Svalbard Treaty of 1920, but insists that the treaty establishes special rights for Norway's control over the territories of the archipelago, which do not extend to the waters around it. In recent years, tensions in Russian-Norwegian relations have been growing due to the general deterioration of relations between Russia and NATO and periodic military exercises conducted by Russia and Norway near each other's borders. Opportunities for economic cooperation were seriously limited due to the introduction of anti-Russian sanctions. In particular, cooperation projects between Rosneft and Norway's Equinor (formerly Statoil) were canceled. Nevertheless, the two countries continue to work closely together on joint operations to prevent and eliminate the consequences of oil spills and protect vulnerable Arctic ecosystems, as well as on environmental protection, marine environment management, and fisheries regulation. Some success in cooperation has been achieved in tourism, fishing, telecommunications, and shipbuilding. Cooperation is also underway in the areas of healthcare, culture, education, and emergency response, including at the level of cross-border cooperation between the Murmansk Region and the Norwegian Fylke Finnmark.

Cooperation with Iceland is largely limited to participation in multilateral formats of interaction on issues common to the Arctic countries. At the beginning of 2010, Russian-Islandian contacts became somewhat more active – a number of agreements were signed in the areas of geothermal energy and tourism development. With a few exceptions (including an agreement to increase cooperation in the field of education and the fishing industry between Iceland and the Murmansk Region), there has been no deepening of cooperation between the parties since then. Bilateral cooperation with Denmark and Canada was largely curtailed after 2014. In addition to multilateral formats, the Russian side continues bilateral academic and expert dialogues, as well as information exchange with Canadian and Danish scientists on issues related to the submission of overlapping applications by all three countries for the extension of their continental shelves in the Arctic Ocean. There is no official interstate dialogue on this issue.

Russian-American relations in Arctic are directly dependent on their relations in the global political arena. The introduction of US sanctions against Russian energy companies has seriously affected cooperation between Rosneft and the American Exxon Mobil Corporation: Projects for geological exploration and development of hydrocarbons on the Russian Arctic shelf have been curtailed. The American side constantly accuses Russia of an aggressive policy in the region. However, despite the growing confrontation, cross-border cooperation between Russia and the United States in the Bering Sea continues. In particular, the coast and border services of both countries will conduct joint patrols and exercises to respond to oil spills. In early 2021, Moscow and Washington agreed to cooperate on environmental issues in the Arctic.

The French energy company Total is also actively involved in Russian gas projects in the Arctic. Since the initiation of the Yamal LNG project, it has been one of the main shareholders, and now it is also part of the approved ownership of the new Arctic LNG-2 project.

Today, the future of the Arctic is linked not only by the Arctic states, but also, to one degree or another, to states geographically very remote from it.

The main reason lies on the surface: About 30 percent of natural gas and 13 percent of undiscovered oil resources are located in the Arctic region, and the prospects for developing the Arctic shelf are very tempting. Of course, the growth rate of nuclear power is high, and the movement towards the development and use of alternative types of energy is also gaining momentum; however, according to experts, fossil fuels will be the main source of energy for at least another 25 years, until 2040.

The Arctic is also a source of nonferrous, rare, and precious metals, as well as coal, and constantly updated biological resources make up its traditional value. All this, coupled with the possibility of using the Arctic Ocean seas as a transport artery, attracts the attention of Asian states to the Arctic today. Five of them, which are experiencing steady economic growth and thus increasing demand for energy resources, are obviously interested in exploring the region and using its riches: India, China, the Republic of Korea, Japan, and Singapore.

It should be noted that the globalization and interdependence of everything on the planet is most clearly manifested in the Arctic. After all, it is here that there are huge reserves of minerals that will be developed when they run out in other places of the Earth, and the ice mass is located here, which is of great importance for the stability of the climate around the globe.

The interests of Asian countries in this issue are different, although there are also overlapping points.

For example, India, which (along with four other countries) has been a permanent observer of the Arctic Council since 2013, focuses its interests primarily on climate change issues, as the melting of the Arctic Ice Cap threatens its maritime navigation in the future and may redirect sea traffic away from Indian ports. Climate change can also disrupt weather cycles, affect agriculture, and affect the ice of Tibet and the Himalayas, which supply drinking water to the entire region. At the same time, India supports the idea of initiating the process of demilitarization and denuclearization of the Arctic region, believing that the United States, focusing on the Arctic region, will weaken it in the Indian Ocean, which will lead to a redistribution of economic opportunities in favor of China and reduce its dependence on transport routes passing near the Indian coast. Being interested in strengthening cooperation with Russia, including in the energy sector, India calls Russia "India's ticket to the energy riches of the Arctic" and considers it a teacher for all Asian countries in the Arctic region. For its part, Russia is also interested in developing cooperation with India in the development of natural resources in the context of Western sanctions.

China's main interests in the Arctic region are focused on the economy. Climate change opens the way for it to new resources and new promising routes that can change the entire course of world trade. Savings from redirecting trade routes through the North Sea Route are expected to reach $60–120 billion per year. Investment, trade development, and new geopolitical opportunities for economic expansion are priorities for this state. Arctic policy correlates with the main tenets of the strategy of the "peaceful rise" of China and the course of turning the country into a great maritime power. China has three key concepts for developing the region. The first is the concept of internationalization of the Arctic as a common heritage of humanity. The second is based on China's geographical proximity to the Arctic Zone, which, according to the authors, gives it special rights to defend its interests in the region. The third proposes the creation of the Northern Silk Road: Control of the Arctic means control of the entire global economy, and in this case, both Arctic arteries – the Northern Sea Route and the Northwest Passage – become a kind of "silk road" for transporting Chinese goods to Europe and North America. Today, China focuses significant resources on developing scientific research, Arctic expeditions, and building a fleet of icebreakers: One of them, the Snow Dragon, sailed the Northern Sea Route from the Chukchi Sea to the Barents Sea in August 2012, and the second is currently under construction. China also announced its intention to start developing technologies for constructing nuclear-powered vessels for polar research. Russia sees China as a market for its hydrocarbons, which are planned to be extracted in the Arctic and the transit of cargo along the Northern Sea Route.

Korea, seeking to strengthen its role in the Arctic, is guided primarily by the demand for energy resources and the diversification of sources of hydrocarbons and mineral raw materials. The long-term strategy for the Arctic is expected to be implemented by strengthening international cooperation in the Arctic, developing scientific research, creating new business opportunities, and influencing the development of legal conditions for Arctic development. Leading specialized centers are involved in the implementation of the strategy, and the strategy itself has a comprehensive scientific and practical nature, involving a wide range of management, research, and business structures in projects. President of Iceland Ólafur Grimson called the Arctic policy of the Republic of Korea, a model for countries with observer status in the Arctic Council. Korea has the world's largest shipbuilding complex, which can be involved in the implementation of Russian projects. It is likely that it will use the large-scale capabilities of the Northern Sea Route to transport its cargo or will participate in separate projects for the development of mineral and energy resources in the polar zone, environmental monitoring, and measures to protect the climate and Arctic nature.

Japan shows great interest in the Arctic, although it does not have its own access to this region. However, as a major world power that depends on freedom of navigation, as well as the stability and security of maritime trade communications, it can get a significant reduction in the length of its routes by taking advantage of the Northern Sea Route. Japan, which currently receives 80 percent of its oil from the Middle East via the unsafe southern route, is also interested in energy security issues. Therefore, the country's economic interests lie primarily in the development of the Northern Sea Route and the development of the natural resources of the Arctic basin-hydrocarbons and marine bioresources. Traditionally, Japan, which initiated the Kyoto Protocol (the first global agreement on environmental protection), attaches great importance to global warming, climate change, and the challenges associated with these processes. Experts in Japan generally believe that the Arctic is not yet ready for safe and reliable navigation. They have complaints about transit tariffs set by the Russian side, the state of meteorological services and ports and other infrastructure facilities on the Northern Sea Route, and compliance with international standards.

Singapore's interests in the Arctic, which is the second most important seaport in the world, are linked to vital factors for the country and are not political in nature.

Singapore defines the main motives for its presence in the Arctic as protecting the environment (the island state is located at a low altitude and rising sea levels directly threaten it), which entails ensuring security, sustainable economic development, and human capital development. Singapore is interested in Arctic mineral resources and participation in the development of environmentally friendly technologies. This state is already developing the world's first environmentally friendly installation and is actively involved in research activities in the Arctic. Experience of Singapore's participation in the construction of seaports, icebreakers (it is currently building three icebreakers), and ice-resistant self-lifting drilling rigs is an important factor for the development of joint Arctic economic projects with Russia.

At the same time, China is Russia's new Asian partner in the Arctic. The two countries cooperate on the production and transportation of LNG (the Yamal LNG and Arctic LNG-2 projects) and the construction of a coal terminal in Murmansk. Chinese companies are also involved in providing Russian gas projects with the necessary equipment and vessels for transporting LNG. However, China's Arctic strategy is not inherently complementary to the approaches of Arctic countries, including Russia. Diplomatically, China insists on the global role of the Arctic as the heritage of all mankind, which contrasts with the position of exclusivity of the rights of the northern states to the Arctic region. By offering an inclusive Arctic governance system, China, given its weight in the global economy, indirectly and unobtrusively claims one of the leading roles in managing the region, which is at odds with the interests of the Nordic countries.

Today, it is no secret that more than 90 percent of Russia's hydrocarbons are produced in the Arctic. There is not only oil and gas, but also a huge number of solid mineral deposits. To implement all the plans for the extraction and use of natural resources, the NSR, which has been modernized and corresponds to the current level of development of scientific and technical thought, will help. As a national transport communication, it has been showing more and more noticeable efficiency in recent years.

Mapping the Northern Sea Route: A Resource Perspective

In Arctic latitudes, the only highway that connects subarctic and Arctic regions is the Northern Sea Route. It has a great influence on the development of the Russian North as a whole, being a transport system that includes, among other things, numerous rivers that flow into the Arctic Ocean.

The Northern Sea Route in the west begins in the straits of the Novaya Zemlya archipelago and is bounded by the meridian passing to the north from Cape Zhelaniya, passing through the Arctic Ocean and Bering Sea (Pacific Ocean region). The final point of the route is Providence Bay. The length of the entire route (from the Kara Gate Strait to Provideniya Bay) is about 5600 kilometers in total. The first time it was passed by the Nordenskjold expedition in 1878–1879.

Today, the NSR is considered the main Arctic shipping route in Russia. This is the shortest route between the Far East and the European part of the country, connecting the ports of the Arctic and the major rivers of the Northern region. Vessels on this route carry equipment, fuel, food, furs, machine-building products, timber, coal, construction materials, etc. Navigation here lasts from 2 to 4 months, and on some routes where icebreakers are used, it can be longer.

Starting in the Barents Sea, the Northern Sea Route then passes through the Kara, Laptev, East Siberian, and Chukchi seas. The key ports are Murmansk, Arkhangelsk, Nordvik, Ambarchik, Igarka, Dudinka, Dikson, Tiksi, Pevek, and Provideniya. Moving east through Murmansk and Arkhangelsk, the ships reach Dikson, then Dudinka and Igarka in the Yenisei Bay area; in the Laptev Sea area, they go to Nordvik, in the Lena River delta to Tiksi, then at the mouth of the Kolyma to Ambarchik; the final stage of the journey is to Pevek and Providenie.

According to many experts, the prospects for the development of the Northern Sea Route lie in its competitiveness to the Suez Canal (Sdelnikova, 2017). According to analytical data, it is able to pass about 50 million cargo a year, becoming more and more popular every year, taking into account the actively developing gas and oil destinations in the Arctic (Gumelev et al., 2018). Moreover, Russia plans to regain its leadership position in the Arctic region, including through active actions in the development of infrastructure here.

In the future, the Northern Sea Route can become one of the key highways of international transportation, having enough advantages, taking into account piracy on the routes of the Southern Sea Route. The administrative boundaries of the Northern Sea Route in the west are limited by the entrances to the Novaya Zemlya Straits, as well as the meridian in the north from Cape Zhelaniya, and the Bering Strait in the east. The length of the Northern Sea Route from St. Petersburg to Vladivostok is slightly more than 14 thousand kilometers, whereas going through the Suez Canal, it is more than 23 thousand kilometers. In the first case, the journey will take approximately 23 days, while the second takes from 35 to 50 days.

Russia has created the world’s largest icebreaker fleet, which has already been updated, which opens up additional prospects for the development of the NSR. The ports of the Northern Sea Route at the mouths of major rivers serve as transshipment points for cargo ships. Icebreakers serve them according to the following principle: Murmansk-Dudinka (Western Arctic sector), assigned to the Murmansk Shipping Company, and icebreakers of the Far Eastern Shipping Company run from Dudinka to Chukotka (eastern sector). With great probability, it should be said that the NSR (if it does not completely replace other transport arteries) may become very popular. The main difficulty of moving along the Northern Sea Route is large masses of ice. Therefore, in some areas, the passage of vessels is possible only with the help of icebreakers. Nevertheless, the Northern Sea Route as an alternative to the southern routes is more profitable, because there are less fuel costs, freight, less queues for ships, not to mention security – notoriously, in the Suez Canal area, ships are often attacked by Somali pirates. In addition, due to global warming, many routes are already becoming navigable without icebreakers.

When traveling along the Northern Sea Route, the rules of navigation apply, which are determined by the laws of Russia. Some of these rules also require regular reporting. For example, when crossing the Western or Eastern border, the captain is required to send basic information about his ship to the Northern Sea Route Administration on a daily basis. These include geographical coordinates, the exact course, the planned time of the ship's stay in the Arctic, and speed. It is also necessary to report information about the presence of ice on the route.

In addition, if a source of contamination is detected along the route, the master must immediately inform the Northern Sea Route Administration. If there is a dense concentration of ice in which the vessel is unable to move, it is necessary to keep in constant contact with the Administration and coordinate their actions during the sea passage with the icebreaker flotilla.

In some cases, the term Northern Sea Route is replaced by the concept of area. It can be said to extend over a range of territorial waters 12 miles wide, as well as an economic zone of free navigation for ships 200 miles long.

There is another opinion that exists among navigators, according to which the Northern Route is a collection of a number of navigable routes that do not have a constant length. In this case, the North-Eastern route depends on how thick the Arctic ice is and in what places it is located.

In total, the Northern Sea Route includes more than 70 major points and ports. For a number of districts in this region (the coast of Yakutia with adjacent areas, Chukotka), the Northern Sea Route is the only highway that connects them to the mainland.

The main feature of movement along the Northern Sea Route is that it is impossible without icebreakers. At the moment, six nuclear-powered icebreakers are used here. With their help, the problems of the functioning of the route as a whole are solved, and access to the Arctic shelf and the regions of the Far North is simplified.

Icebreakers are used to guide ships for 8000 miles (from Murmansk to Vladivostok). These cities are home to two of the largest companies involved in the organization of North-Eastern shipping.

For Russia, the Northern Sea Route as a transport artery is of great importance, especially for those areas that connect large rivers with the waters of the Arctic Ocean – the Indigirka, Lena, Ob, Yenisei, Khatanga, etc. They are directly involved in the formation of the NSR. The duration of movement of vessels along the Murmansk-Bering Strait route depends on the climatic conditions and the specific route (traditional: 3500 miles; central: 3029 miles; high-latitude: 2890 miles; and circumpolar: 2700 miles).

It should also be noted that 20 percent of Russia's territory is located north of the Arctic Circle. It is here, on the mainland and on the shelf, that the main mineral reserves are located in the form of large deposits that have already been discovered or are known as forecast resources (Krutikov, 2020).

The shelf is an underwater extension of the coast, which has the same geological structure as it. The shelf goes gently into the sea, gradually increasing its depth, and then abruptly breaks off, passing into greater depths. The Russian shelf is approximately 21 percent of the length of the entire World Ocean shelf, due to the large length of its coast, mainly the Arctic Ocean.

The prospects for the development of the shelf for the country that owns it are incredible, because there are the richest deposits of hydrocarbons, which, among other things, explains the active development of the natural resources that the Arctic shelf stores. It is because of them that countries with access to the Arctic seas compete for every single meter of sea borders. The coast of Russia stretches for thousands of kilometers, so Russia rightfully claims a fairly large piece of the shelf "pie." However, the coasts of Russia are located mainly in the northern, Arctic Zone, and the development of the Arctic shelves is associated with great difficulties and costs.

It should be noted that useful resources here include not only oil and gas, as is commonly believed, but also coal, copper, Nickel ore, tin, rare metals and rare earth elements, gold, platinum group metals, tungsten, chromium, titanium, and more elements that are necessary for the effective development of the industry and sophisticated technology. For example, 97 percent of Russian tin is found in the Arctic, especially on the shelf, and there are huge projected resources of lead, zinc, and silver on the Southern Island of Novaya Zemlya. And the platina that are produced in the Russian Arctic, mainly in the Norilsk deposits, provide 20 percent of the global demand for platinum and 70 percent for palladium. According to experts, this trend will continue over the next century.

The prospects for developing the Arctic shelf are huge – the only proven hydrocarbon reserves here are estimated to be a quarter of all the planet's reserves. The Russian-owned shelf holds up to 25 percent of the country's oil reserves and up to 50 percent of all its proven gas reserves.

At the same time, it should be borne in mind that onshore hydrocarbon reserves have been explored more or less reliably, and the World Ocean shelf has been studied by less than 10 percent. At the same time, Russia is largely lagging behind its colleagues who are actively developing the shelf – large mineral reserves on the mainland and the need for huge investments in the exploration and development of the Arctic shelf pushed back the time to start these works. However, given the fact that onshore deposits are gradually being depleted, it is predicted that Russia, while maintaining the current rate of production, will develop oil reserves on the mainland in 30 years, which means that the development of the Arctic shelf is becoming more and more urgent.

Of the already explored riches that the Russian Arctic shelf holds, 49 percent is stored in the Barents Sea and 35 percent in the Kara Sea. The development of the Laptev Sea shelf, according to current estimates, can bring up to 8700 million tons, and the reserves that the Arctic shelf of the East Siberian and Chukchi Seas carries are estimated at more than a billion tons of hydrocarbons.

Given that, according to researchers' estimates, 93 percent of Arctic hydrocarbons (while the share of gas in the structure of Arctic hydrocarbon reserves reaches 78 percent) in the Arctic are concentrated in a dozen large deposits, and two-thirds of these deposits are located on Russian territory, the importance of the Russian Arctic in the global fuel field is easy to imagine.

Today, the oil and gas industry can be seen to be moving North, far from the existing production centers. The prospect of producing hydrocarbons in the Arctic is very attractive; however, the cost of production here is significantly higher than in traditionally developed fields, so only a few such projects still exist and are gradually developing.

Hydrocarbon resources are distributed over the sea areas in such a way that 67.98 percent of the total amount falls on the Russian Arctic shelf – the Kara Sea (40.35 percent) and the Russian part of the Barents Sea (27.63 percent). Thus, 4 million square kilometers of the Russian continental shelf is the world's hydrocarbon storehouse of the future. In the Pechora Sea (the southeastern part of the Barents Sea), the first Arctic oil was produced at the Prirazlomnoye field at a depth of 19–20 meters in 2013. Overall, Prirazlomnoye's recoverable reserves amount to 83.2 million tons.

The largest gas condensate field in the Arctic, and the fourth largest beyond the Arctic Circle, is the Shtokman field, which is also one of the 25 largest fields in the world. The proven reserves of the Shtokman field amount to 3.9 million cubic meters and about 56 million tons of gas condensate. The field is defined as a resource base for supplies via the Nord Stream gas pipeline to Western Europe, as well as for the production of Russian LNG. However, the work at the field is complicated by a number of unfavorable factors: The sea depth is up to 340 meters, the wave height is up to 27 meters, the annual temperature range is from −50 to +33 degrees Celsius, and there is also the presence of icebergs weighing up to 4 million tons.

A very important and promising region in terms of oil and gas production is the Yamal Peninsula, where 32 fields have already been discovered onshore and adjacent waters with total reserves of 26.5 trillion cubic meters of gas and 1.6 billion cubic meters of natural gas, Plus tons of oil and condensate. The largest of them is the Bovanenkovskoye gas field, with a projected gas production level of 115 billion cubic meters of gas per year, and in the future up to 140 billion cubic meters per year.

It is likely that there are large hydrocarbon deposits in the north-eastern part of the Arctic, but due to the remoteness of this region from the center, it is poorly studied. Be that as it may, exploring the Arctic, moving deeper into the Arctic, and developing its riches are absolutely unavoidable for Russia and humanity as a whole.

It is difficult to overestimate the importance of the Arctic for the Russian Federation as a source of resources, but the development of the Arctic is associated with a high resource intensity of economic activity and life support for the population. In 2020, Russia's centuries-old interest in developing the Arctic received a new development; strategic development documents were adopted about the Arctic Zone of the Russian Federation, the analysis of which is presented in Table 1.

These initiatives, which are analyzed in Table 1, are aimed at solving social problems, creating a comfortable living environment, attracting new investors, stimulating industrial production, and ensuring state security.

One of the main tasks outlined in these documents is "ensuring sovereignty and territorial integrity," alongside "preserving the Arctic as a territory of peace, stable and mutually beneficial cooperation." With the US confrontational policy towards Russia and China flowing into the region and the militarization of the Arctic as a whole, Moscow's priority tasks in the region are improving the composition and structure of the armed forces, developing the base infrastructure, carrying out

Table 1 Analysis of the main regulatory acts of strategic development of the Arctic Zone of the Russian Federation

Name of the regulatory act	Brief description
Fundamentals of the State Policy of the Russian Federation in the Arctic for the period up to 2035 (hereinafter referred to as the Fundamentals)	The main national interests are defined, and the goals and main directions and tasks of the Russian Federation in the Arctic are formulated. Assessment of the state of national security in the Arctic is given
Strategy for the Development of the Arctic Zone of the Russian Federation and Ensuring National Security for the period up to 2035 (hereinafter referred to as the Strategy)	The Arctic Zone is protected, which defines special approaches to its socio-economic development and ensuring national security in the Arctic. An expert assessment of the state of development of the Arctic Zone and the state of national security was carried out. Measures are planned to ensure the achievement of the national goals of the Russian Federation in the Arctic
Unified Action Plan for the Implementation of the Fundamentals of the State Policy of the Russian Federation in the Arctic for the Period up to 2035 and the Strategy for the Development of the Arctic Zone of the Russian Federation and Ensuring National Security for the Period up to 2035 (hereinafter referred to as the Plan)	By the end of 2021, it is planned to develop the section on Arctic tourism in the framework of the tourism development strategies in Russia, as well as the creation of a unified statistical and information-analytical system of monitoring of socio-economic development of the Arctic Zone Scheduled events are grouped into the following areas: - Social development of the Arctic Zone - Economic development of the Arctic Zone - Development of infrastructure in the Arctic Zone - Development of science and technology for the development of the Arctic - Preservation of the environment and ensuring environmental safety - Development of international cooperation - Protection of the population and territories of the Arctic Zone from emergency situations of natural and technogenic character - Public security in the Arctic Zone - Military security of the Russian Federation in the Arctic - Ensuring the protection of the state border of the Russian Federation - Implementation frameworks and strategies in Murmansk region, Nenets Autonomous Okrug, Chukotka Autonomous Okrug, Yamalo-Nenets Autonomous Okrug, separate municipalities of the Republic of Karelia, Komi Republic, and Saha Republic (Yakutia)
State Program for the Development of the Arctic	The objectives of the program are: - Accelerating the economic development of the territories that are part of the Arctic Zone of the Russian Federation

(continued)

Table 1 (continued)

Name of the regulatory act	Brief description
	- Increasing the contribution of the territories that are part of the Arctic Zone of the Russian Federation to the economic growth of the country - Ensuring conditions for sustainable socio-economic development of the macroregion. Defined Adachi Program: - Providing a competitive condition for the implementation of investment projects on the territory of the Arctic Zone of the Russian Federation, the creation of new jobs and attracting labor resources in the Arctic Zone of the Russian Federation - The provision of the legal regulation of socio-economic development of the Arctic Zone of the Russian Federation, the creation of conditions for sustainable socio-economic development of the indigenous minorities of the Russian Federation living in the Arctic Zone of the Russian Federation. Target indicators and Program indicators are set as: - Accumulated volume of extra-budgetary investments of residents of the Arctic Zone of the Russian Federation and the territories of advanced socio-economic development in the Arctic Zone of the Russian Federation, attracted for the implementation on the territory of the Arctic Zone of the Russian Federation of investment projects selected in accordance with the Government of the Russian Federation for state support (billion rubles) - The amount established in the territory of the Arctic Zone of the Russian Federation jobs as a result of the implementation of the Program The quantitative and qualitative expected results of the Program implementation are established as following. Quantitative indicators of the Program are: - The accumulated amount of off-budget investments of residents of the Arctic Zone of the Russian Federation and the territories of advanced socio-economic development in the Arctic Zone of the Russian Federation, attracted for the implementation on the territory of the Arctic Zone of the Russian Federation of investment projects selected in accordance with the Government of the Russian Federation for the state support will be 176.1 billion

(continued)

Table 1 (continued)

Name of the regulatory act	Brief description
	- The number established in the territory of the Arctic Zone of the Russian Federation jobs as a result of the implementation of the Program (cumulative) will be 30 thousand units Qualitative indicators of the Program include: - Improvement of conditions for attracting extra-budgetary investments and stimulating entrepreneurial activity in the Arctic Zone of the Russian Federation - Formation of mechanisms for accelerated socio-economic development of the territories of the Arctic Zone of the Russian Federation
Federal Law "On State Support for Entrepreneurship in the Arctic Zone of the Russian Federation"	Defines the legal regime of the Arctic Zone of the Russian Federation, measures of state support, and the procedure for conducting business activities in the Arctic Zone of the Russian Federation. The objectives of the law are: 1) Economic development of the Arctic Zone of the Russian Federation 2) Promotion and activation of investment and entrepreneurial activities in the Arctic Zone of the Russian Federation 3) Creation of an economic basis for advancing social development and improving the quality of life in the Arctic Zone of the Russian Federation

Source: compiled by the authors

measures for operational equipment of territories, improving the material and technical support systems of the armed forces, etc.

In the field of foreign policy, Russia's priority remains to defend its rights to expand the continental shelf within the framework of the application submitted in 2015 to the UN Commission on the Limits of the Continental Shelf. The internal development policy of the region also gets a new dimension. The competence of the Ministry of the Far East Development of the Russian Federation has been expanded, whose activities, after being renamed in February 2019 to the Ministry of the Russian Federation for the Development of the Far East and the Arctic, are now largely aimed at developing the Russian North, in particular at improving the standard of living and quality of social services. Among other things, the development plans involve the launch of a number of new oil and gas projects, the construction of ports and infrastructure focused on them, and the implementation of a set of measures for the development of the continental shelf. A distinctive feature of Russia's new official Arctic policy is a much greater social orientation. In the field of healthcare, it is planned to modernize primary care, the transport and technological equipment of medical institutions, and financial, social, regulatory, and communication support for its entire system in the regions of the Arctic Zone. A number of priority tasks in the sphere of social development of the Russian Arctic also include the implementation of a set of measures to develop the education system, develop sports, preserve and popularize cultural heritage, develop culture (including the languages of indigenous small-numbered peoples of the North), etc. In addition to measures in the social sphere, the Arctic policy priorities include tax incentives and support for businesses, including those implementing industrial and infrastructure projects. The economic development of the Arctic, together with other state policy measures, according to the goals, should ensure an increase in life expectancy, an end to the outflow of population, and the creation of jobs in the region.

It should also be noted that, in accordance with the instructions of President Vladimir Vladimirovich Putin, work continues on the development of the Arctic region. For example, in the first half of 2021, the Russian Government adopted a new version of the state program "Socio-economic development of the Arctic Zone of the Russian Federation," approving a unified action plan for implementing the Fundamentals of the state Policy of the Russian Federation in the Arctic and the Strategy for the Development of the Arctic Zone and Ensuring National Security for the Period up to 2035. Starting from June 1, 2021, the post of chairman of the International Arctic Council will be transferred to Russia. The concept of the presidency and a plan providing for more than 100 activities in 10 main areas were approved.

Deputy Prime Minister and Presidential Envoy to the Far Eastern Federal District Yuri Trutnev, having held a meeting of the State Commission on Arctic Development in Moscow, stressed that "The development of the Arctic territories is one of the priorities of the Government's work." As part of the priority areas of Arctic development, they discussed the modernization and expansion of the main infrastructure, the implementation of the Snezhinka international Arctic Station project as a scientific and educational platform for researchers and developers of new technologies in the Arctic, and the use of technologies to reduce pollution in the seas of the Arctic Zone.

In a comprehensive plan for the modernization and expansion of the main infrastructure or the period up to 2024, the project for the construction of the Obskaya-Bovanenkovo-Sabetta railway corridor was included. The project of the Northern Latitudinal Route-2 is designed for the cargo base of more than 9 million tons per year, which will solve the problem of transporting products from the Yamal deposits to the routes of the Northern Sea Route.

The Ministry of Energy, together with the Government of the Yamalo-Nenets Autonomous Okrug, with the participation of Gazprom, developed and submitted to the Russian Government the concept of a comprehensive program for developing the source potential of the Yamal Peninsula, the purpose of which is to conduct a comprehensive study of the development parameters and logistics support of the Yamal mineral resource base, including the development of an optimal scheme for transporting liquid hydrocarbons.

In accordance with the Presidential Decree "On the Strategy for the Development of the Arctic Zone of the Russian Federation and Ensuring National Security for the Period up to 2035," the Ministry of Industry and Trade, within the framework of the state program "Development of the Electronic and Radio-electronic Industry," launched development work in 2021 on the creation of an integrated radio navigation system that provides consumers of the Arctic Zone with information for determining coordinates and accurate time based on ground-based radio navigation technologies. The advantage of this system is both its interface with global navigation systems (GLONASS, GPS, and others) and the possibility of autonomous operation in noise-resistant modes; the completion of this project is planned in December 2023.

In addition, the list of economic activities that will be supported under the state program of concessional lending to residents of the Arctic Zone, implemented by the Ministry of Eastern Development, has been confirmed. It includes 72 types of economic activities related to such sectors as healthcare, education, transport, agriculture, fish farming, the production of building materials, machinery and equipment, construction, trade, information technology, and tourism.

In this regard, development is a fundamental condition for the implementation of most projects in the Arctic Zone of Russia's Northern Sea Route. Currently, five nuclear-powered icebreakers are conducting ships in the waters of the Arctic Ocean. Four more nuclear-powered icebreakers of Project 22,220 will be commissioned by 2026, and the first icebreaker of the Leader project will be commissioned by 2027. By mid-2022, it is planned to develop a technical specification for the design and construction of four LNG-powered icebreakers. The ice-class cargo fleet will be more than tripled by 2030, with plans to build more than 30 tankers, 40 bulk carriers, and 22 containerships.

To monitor the ice situation, the Russian space program plans to launch three radar satellites, one satellite for meteorological monitoring, and four spacecraft to provide users in the Arctic Zone with satellite communications and the Internet until 2025. One satellite for meteorological monitoring has already entered orbit.

It is planned to create rescue stations in Pevek, Sabetta, Dikson, and Tiksi; the necessary aviation equipment has been purchased.

The development of the port infrastructure also does not stand still. There are 18 ports on the North Sea Route. Three of them are being upgraded; these are the ports of Pevek, Murmansk, and Arkhangelsk. By 2024, it is planned to upgrade four more. Construction of the Yenisei terminal, Bukhta Sever port, and Utrenny terminal in the port is underway. By 2024, the total cargo turnover of the ports of the Northern Sea Route will amount to 85 million tons of on after their commissioning.

Thus, the development of the Murmansk transport hub and the implementation of the Northern Latitudinal Passage-1 and Northern Latitudinal Passage-2 projects will allow connecting the ports of the Northern Sea Route with the Russian railway system (Pak, 2021; Pak & Sarkisov, 2014).

A new stage in the development of the Northern Sea Route will be the launch in 2022 of regular container transportation, which will ensure the delivery of fish products from the Far East to the European part of the country. Also in 2023–2024, year-round navigation in high latitudes will begin.

It should be noted that as part of the work on the development of the Arctic territories, active work is underway to improve the Arctic legislative framework. In 2020–2021, approval was given to the basic state policy of the Russian Federation in the Arctic, the development strategy of the Arctic Zone of the Russian Federation, and national security for the period up to 2035, a single plan of implementation was also approved, and both the state program "Socio-economic development of the Arctic First Zone of the Russian Federation" and of the Federal law "On state support of entrepreneurship in the Arctic Zone of the Russian Federation" were adopted.

The implementation of these projects and the improvement of the legislative framework will improve the quality of life of northerners, increase the contribution of the Arctic Zone to the Russian economy, and ensure the region's sustainable development. At the same time, the main practical mechanism should be Northern Sea Route Infrastructure Development Plan for the period up to 2035.

Discussion

It should be noted that the downward climatic changes in the Arctic Zone of the Russian Federation create the risk of adverse environmental consequences, but at the same time contribute to the emergence of new economic opportunities.

Experts estimate that the importance of the Northern Sea Route as a transport corridor of global significance used for the transportation of national and international cargo will increase, and Russia's growing "hydrocarbon prospects" pose not only the question of how to properly manage the resources already available and those that will be developed in the future.

For Russia, the efficient operation and development of transport infrastructure on the northern coast means dynamic economic growth. The main goals of the transport component development for the European North are shown in Fig. 1.

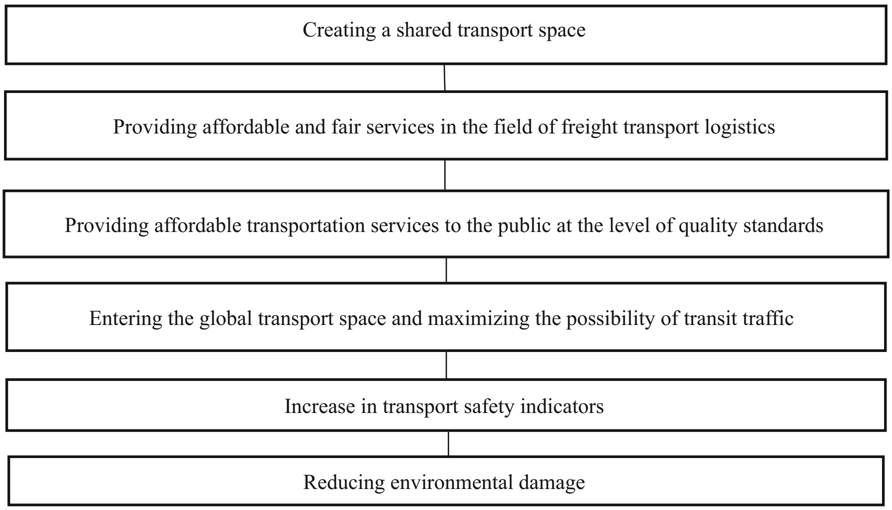

Fig. 1 Transport component development goals for the European North. Source: created by the authors

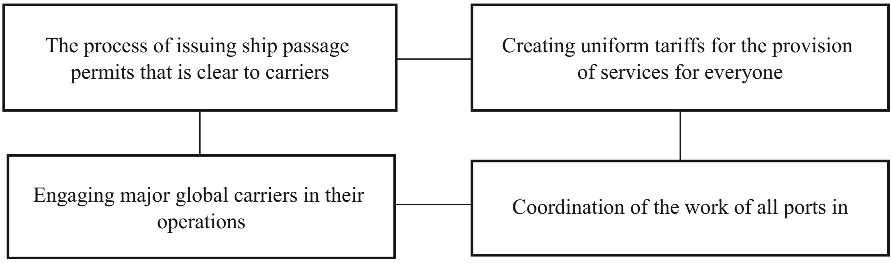

Fig. 2 Tasks related to the development of the NSR. Source: created by the authors

In the new historical realities, it is necessary to solve a number of problems related to the development of the Northern Sea Route, which are presented in Fig. 2. Predominantly, this means the development and development of the latest infrastructure, hydrometeorological, and navigation-hydrographic support. If these problems are successfully solved, the NSR will be able to increase its competitiveness.

In addition, in order to make the benefits of developing a sea route in the northern latitudes obvious, it is necessary to draw up a program demonstrating the potential of the NSR for the most significant international events (seminars, conferences, and exhibitions). For the development of the route, it is also necessary to plan and organize individual flights on a commercial basis during certain periods (preceding and following summer navigation).

A certain difficulty is to ensure the uninterrupted navigation of ships to freezing ports along the NSR. In this regard, solutions require improving the technical capabilities of nuclear icebreakers. Diesel-electric vehicles become helpless in the difficult ice conditions of the Arctic seas. The development of the coastal infrastructure will also give a new start to the NSR's functioning as a promising international route.

Conclusions

In conclusion, combining the largest river arteries in Siberia into a single transport network is able to create conditions for the infrastructure of seaports, railway, and river communications. The Northern Sea Route is a link between Asia and Europe, the western regions of the country and the Russian Far East; with the help of this Route, it is possible to provide a decent standard of living for the population of the northern territories of Russia, mining, transportation and export of minerals, and coastal and transit navigation.

The new age of the Arctic will require nontrivial approaches and, possibly, unexpected solutions from humans. This is a challenge, the consequences of which have not yet been determined, but, in any case, it is also a chance to show proper respect for nature, to understand the structure of the universe, and to create mechanisms for interaction with our neighbors on the planet. In the future, the attitude to the Arctic will depend on the life of the person himself.

It is wrong and short-sighted to talk about using the Arctic only as a rich storehouse. The Arctic is such a special region for the planet, with extreme natural and climatic conditions, with a low level of economic development, remoteness from industrial centers, and high resource intensity of economic activity. Therefore, its sustainable development requires nonstandard solutions. All the difficulties of living and working in the Arctic are compounded by the poor resilience of ecological systems to anthropogenic impact; ultimately, they affect the climate and determine the conditions of life on Earth.

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Residents of the Arctic Zone

Economic and Legal Aspects

Dinara N. Mukhamadieva, Julia A. Khudyakova, and Andrei A. Chirkin

Contents

Abstract

The development of the Arctic territories today is of strategic importance. Appropriate strategies are needed to improve the socioeconomic situation of the region. This seriously puzzled the Government of the Russian Federation. To implement the tasks set, massive investments are needed not only from budget funds, but also from private ones, which can be attracted only with the help of attractive investment conditions, and obtaining the status of a "resident" of the Arctic Zone of the Russian Federation is a key tool. Thus, the state residency program creates various preferences for the support and development of entrepreneurial activities in the Arctic Zone. The chapter reveals the main economic and legal aspects of

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obtaining the resident status in the Arctic, as well as promising areas of business development in this territory. The chapter deals with the legal and economic aspects of the status of a resident of the Arctic Zone of the Russian Federation.

Keywords

Arctic Zone of the Russian Federation · Residents of the Russian Arctic Zone · Investment interests · Socioeconomic development · Labor potential · Economic growth · Legal status

Introduction

The Arctic territories are of growing interest to the world community due to their strategically important location, rich range of natural resources in the Arctic depths, as well as the possibility to develop economically profitable transport arteries for international cargo transportation.

The Arctic Zone of the Russian Federation (AZRF) is the northernmost borders of the European and Asian parts of the Russian Federation. The AZRF includes the territories of such subjects of the Russian Federation as: Murmansk region, Nenets Autonomous Area, Chukotka Autonomous Area and Yamalo-Nenets Autonomous Area, as well as parts of the territories of the Republic of Karelia, Komi Republic, Sakha Republic (Yakutia), and the Arkhangelsk region (Guzov et al., 2020).

The AZRF is the longest region of the Arctic, which has a low population density and poorly developed infrastructure. The total area of the territory is 5 million square meters. The population of the AZRF is 2.5 million people (Investment Portal of the Arctic Zone of the Russian Federation, 2021b).

This region has always been extremely important for Russia because of many factors, and for many years, work has been underway to improve the quality of life in this region. In this regard, a program of preferences for organizing and conducting business and making investments in the Russian Arctic was launched in 2020, which requires obtaining the status of a “resident” of the AZRF. Therefore, the main goal of this study is to analyze the legal framework of the issue, as well as the economic characteristics of the main promising areas of business for work in the northern territories of Russia.

Literature Review

To study the subject of this chapter, the papers of many authors were studied.

The legal status of a resident of the Arctic Zone of the Russian Federation has a number of features that Abdullina (2018) considers. The need for state regulation for economic growth is studied by Umanskaya (2019) on the example of entrepreneurship in the Arctic.

The problem and importance of small peoples is reported by Lashov (2016), in our opinion, it is necessary to legislatively strengthen the position of these communities and prescribe the possibility of having the status of a resident to nonprofit organizations.

A voluminous study was conducted by Shestak et al. (2020), having studied the experience of the Arctic states in the most perspective areas of development of the Arctic territories. The main value of this study is about the methodological basis for the application of foreign experience in the development of the main industries for its application in Russia.

Pilyasov (2016), Leksin and Porfiriev (2019), and Guzov et al. (2020) write about the prospects of innovative development of AZRF, and Krainova and Laypanova (2020) describe in details the mechanism of tax preferences, and they also consider the international cooperation between Russia and China in the development of Arctic resources.

The development of the Arctic Zone of the Russian Federation is inextricably linked with improving the quality of life of the population living in these territories. The need for socioeconomic well-being of the region is confirmed by the growth of investment attractiveness of the territories, and for this all problems and ways to solve them must be clearly identified (Romashkina et al., 2017; Tatarkin et al., 2017; Voronina, 2021).

Climate change has a significant impact on the development of the Arctic (Alvarez et al., 2020), a detailed study of climate change in Russia is regularly described by the Institute of Global Climate and Ecology (2021).

Kondratiev (2020) explores the Arctic's richness of natural resources.

About the features of different modes of transport in the Arctic Zone write Gruzinov et al. (2019). The need to develop air traffic in high-tech conditions in the Russian Arctic is noted by Frolov (2016). The experience of navigation in the waters of the Canadian Arctic in conditions of climatic warming is described by Hussain et al. (2021). The possibility of lengthening the navigation period along the Northern Sea Route due to the accelerated melting of glaciers is investigated in the works of Eliseev and Naumova (2021) and Kiiski et al. (2018).

In the article, Belonozhko et al. (2020) consider possible options for ecotourism in the Arctic Zone of Russia. They conducted research and found out the criteria for the potential development of ecotourism in the Arctic territories of Russia.

Summarizing and independently researching information sources, the authors notice the imperfections of legislation and development prospects within the status of a resident of the AZRF.

Legal Basis of the Issue

The official interest in the formation of the Law on the Arctic within Russia dates back to 1996, when President Yeltsin B. was instructed to draft the Principles of State Policy of the Russian Federation in the Arctic. The drafting of a federal law on the

Arctic was assigned to the State Committee of the Russian Federation. However, work on several draft laws was unsuccessful.

The next stage is marked by the adoption of the Principles of State Policy of the Russian Federation in the Arctic up to 2020 and beyond. The development of the bill was carried out by the Ministry of Regional Development of the Russian Federation in 2012–2013, which on May 31, 2013, submitted a draft federal law "On the Arctic Zone of the Russian Federation" with tables of disagreement. The draft law turned out to be of poor quality, and further work on it was discontinued (Umanskaya, 2019).

On November 20, 2015, a meeting of the Expert Council on the Arctic and Antarctic under the Federation Council was organized to discuss the problem of drafting the law "On the Arctic Zone of the Russian Federation." The bill on improving the composition of the AZRF was adopted, it determined the powers of the President and the Government of Russia in this process, as well as this document adopted a decision on the creation of support zones, their description, the order of their formation and functioning (Umanskaya, 2019).

Attempts to improve the legislation in this area showed the importance of the Arctic Zone of the Russian Federation, the importance of development in this direction given the uniqueness of the geographical zone and the zone of economic development of the Arctic. Significant period of rulemaking in this area indicates that the AZRF required a special approach both from the side of legal regulation, and a special economic approach to the improvement of the issue.

The result of painstaking and long work was that the legal regime of the AZRF was finally defined. The point in this issue was set by adopting Federal Law № 193-FZ from July 13, 2020, " On State Support of the Entrepreneurial Activity in the Arctic Zone of the Russian Federation."

The above-mentioned law introduced the concept of a resident of the Arctic Zone – "an individual entrepreneur or a legal entity which is a commercial organization, whose state registration has been carried out in the Arctic Zone of the Russian Federation in accordance with the legislation of the Russian Federation. . ." (paragraph 2 of part 1 of article 2 of Federal Law No. 193-FZ of July 13, 2020).

At the same time, according to part 6 of article 9 of the Federal Law, an individual entrepreneur or a legal entity intending to acquire resident status in the Arctic Zone must meet the following criteria:

1. the planned type of entrepreneurial activity or investment project must be new;
2. the place of activity is the territory of the Arctic Zone of the Russian Federation;
3. the total amount of capital investments already implemented or planned must be more than ₽1 million.

During the short period of its existence, the Federal Law № 193-FZ from July 13, 2020, has been changed three times. This indicates both the imperfection of the legislation and the fact that it is impossible to take into account all the realities of the changing legal relations in the Arctic Zone at one time.

The changes also concerned the selection criteria for acquiring the status of a resident of the Arctic Zone.

The original editions of July 13, 2020, and June 11, 2021, in paragraph 2 of part 6 of article 9 of the Federal Law introduced a selection criterion in such a way that the Federal Law automatically imposed restrictions on entrepreneurial activity, linking it to the place of state registration of an individual entrepreneur or legal entity, as well as limiting this activity to the territory of one municipality.

These circumstances naturally could not suit the residents in full, since entrepreneurial activity has no limits in its development under certain conditions, and the imposed restrictions questioned the very purpose for which the Federal Law was adopted, while the objectives were clearly and precisely defined (part 2 of Article 1 of the Law):

1. “economic development of the Arctic Zone of the Russian Federation”;
2. “stimulation and activation of investment and entrepreneurial activity in the Arctic Zone of the Russian Federation”;
3. “creation of an economic basis for advanced social development and improvement of the quality of life in the Arctic Zone of the Russian Federation.”

These restrictions have been eliminated by the adoption of the new version of the Federal Law of July 02, 2021, which is currently in force.

This edition of the law has expanded the entrepreneurial activity of residents, not limiting them to the territory of one municipality and not tying them to the place of registration, which is more correct in terms of actual application and activity.

In the process of application of the Federal Law, such criterion as the total volume of made and planned capital investments was changed.

Thus, the total amount of made and planned capital investments may not be less than ₽1 million for persons applying for the status of resident of the AZRF. However, more interesting, from the point of view of practical application of the norms of the law and the above criterion, is not the amount of capital investment itself, but what exactly is taken into account in determining the amount of these investments.

The two previous editions of the Federal Law specify that “in determining the volume of capital investments the costs of creation (construction) or modernization and (or) reconstruction of objects of immovable property and (or) complexes of movable and immovable property shall be taken into account.”

The wording of this norm and accounting of costs, which were included in the volume of capital investments, were quite successful; however, this norm economically put different business entities in unequal position.

So, under this criterion getting the status of a resident of the AZRF is not very difficult for large companies, taking into account their equipment and possibilities in providing with equipment, manpower, associated costs, the accounting of which was not included in the volume of capital investments when getting the status of a resident.

In practice, this flaw in the legislation quickly affected.

Since August 28, 2020, a state program for accepting applications from potential investors for resident status in the Arctic Zone of Russia was launched.

As of the end of August 2021, 187 residents were registered, investments of ₽268 billion and 8697 new jobs were announced. These are mainly large "players" in the entrepreneurial field. Only 26 residents out of the total number of participants are individual entrepreneurs, i.e., only 14% of the participants.

The wording of the Federal Law of July 2, 2021 (starting from July 13, 2021), partially eliminated this gap, and clause 3 of part 6 of article 9 of the Federal Law was supplemented by the indication.

Thus, the situation of subjects of small-scale business was slightly improved, as the accompanying expenses for purchase of machinery, equipment, industrial inventory, were included in the volume of capital investments, which will allow to increase the volume of residents in the future at the expense of the entrepreneurs belonging to these subjects.

It should be noted that from the moment clause 3 of part 6 of article 9 of the Federal Law in its amended and finalized form came into force, i.e., from July 13, 2021, seven individual entrepreneurs received the status of resident of the AZRF just in a month of validity of this norm.

In addition to the fact that an individual entrepreneur or a legal entity intending to acquire resident status in the Arctic Zone must meet the established requirements for residents of the Arctic Zone, it is also necessary to comply with the procedure for acquiring resident status.

This procedure is described in sufficient detail in Article 9 of the Federal Law.

Based on the provisions of paragraph 2 of Article 9 of the Act, the applicant must attach the following documents to the application:

1. copies of constituent documents (for legal entities);
2. business plan in accordance with the requirements;
3. Extract from the unified state register of legal entities or an extract from the unified state register of individual entrepreneurs in the form;
4. copy of the certificate of registration with the tax authority.

Examination of the application for the conclusion of the agreement on the implementation of the investment activities and the documents attached thereto is realized by the commission within 10 working days from the date of receipt of the application and the documents attached thereto.

According to the results of consideration of the application and evaluation of the business plan, the commission makes two possible decisions: the decision of the agreement or refusal on the implementation of investment activities (part 8 of article 9 of the Law).

Part 9, Article 9 of the Federal Law "On State Support of the Entrepreneurial Activity in the Arctic Zone of the Russian Federation" contains criteria based on which the decision to refuse the conclusion of the agreement on the implementation of the investment activity is made.

At first sight, it seems that Article 9 of the Federal Law covers all the necessary selection criteria for obtaining the status of a resident of the AZRF, the list of documentation required for presenting this status to applicants, and also describes in detail the circumstances under which a decision to refuse to conclude an agreement on investment activities is made.

However, in practice gaps, problems, manipulations, and inconsistencies in the process of obtaining the status of a resident of the AZRF are possible.

So, part 1 and part 2 of Article 9 of the Federal Law contain, from the point of view of legislation, the exhaustive list of requirements and documents presented to the application for conclusion of the agreement on realization of investment activity. This list is closed and does not contain reference norms.

In turn, Part 9 of Article 9 of the Federal Law, establishing the conditions under which the authorized commission decides to refuse to conclude an agreement on the implementation of investment activities, including the conditions voiced in paragraphs 6 and 7 of this article, does not prescribe a mechanism for identifying the facts of "initiation of insolvency (bankruptcy) proceedings against a legal entity or an individual entrepreneur, as well as the presence of a legal entity or an individual entrepreneur and a reorganization or liquidation of a legal entity, as well as the presence of a legal entity or an individual entrepreneur in arrears on taxes and fees, insurance contributions to state nonbudgetary funds of the Russian Federation, arrears on other mandatory payments to the budgets of the budget system of the Russian Federation."

The law also does not specify who should provide this information, since the list of documents for applicants for resident status does not contain a reference to the provision of such information, nor does the law contain a reference to which body, within the framework of interdepartmental interaction, should request the information.

The Ministry of the Russian Federation for the Development of the Far East and the Arctic (Minvostokrazvitiya of Russia) decided to fill this gap in the legislation.

Minvostokrazvitiya of Russia has prepared a Draft Order "On approval of the procedure of consideration of the application for an agreement on the implementation of investment activities in the Arctic Zone of the Russian Federation and the documents enclosed thereto" № 114 dated August 13, 2020.

The specified Draft passed public discussions with regard to the text of the draft normative legal act, independent anticorruption expertise.

Point 4 of the Draft has an exhaustive list of documents attached to the application.

Nowadays the order of consideration of the application for conclusion of the agreement on investment activity in the AZRF and the documents enclosed to it was approved by the Order of the Ministry of the Russian Federation for the Development of the Far East and the Arctic Region of May 14, 2021, No. 81. As it follows from the text of this Order, it is fully brought in line with the Federal Law and in the final version the documentation not stipulated by the law was not included in the list.

However, the problem of revealing at the moment of application the conditions under which it is possible to refuse the conclusion of the agreement and provided by items 6 and 7 of the Federal law "On State Support of the Entrepreneurial Activity in the Arctic Zone of the Russian Federation" is not solved.

In this case several variants of the decision of gaps of the legislation are offered. The first one is the introduction of a point in the article of the Federal law that the authorized bodies have the right to demand additional documents to be attached to the application by the publication of subordinate normative acts, thus taking into account the dynamism of development of social relations in this field for the future and excluding the contradictions with the conservatism of the law.

The second option is to expand the list of documents specified in Federal Law, i.e., by amending the Federal Law.

The third variant is introduction in the Federal Law of instructions that the commission, after receipt of the application, has the right to demand all necessary information within the framework of interdepartmental interaction in order to make a decision on possibility of conclusion of the agreement on realization of investment activity or refusal of it (Abdullina, 2018).

In case of conclusion of an agreement on the implementation of investment activities, this agreement is concluded by an individual entrepreneur or a legal entity with the management company (Abdullina, 2018).

The agreement describes in detail the resident's future activity, investments, including capital investments, in the volume and terms provided by the said agreement, and the managing company undertakes to exercise powers, including assistance to the resident of the Arctic Zone in carrying out the activity stipulated by the agreement.

Execution of the agreement conditions is possible only by a person who is a party to the agreement.

The agreement on implementation of investment activities has signs of a mixed contract, due to which, legal relations stipulated by the agreement may arise, be changed or terminated.

Termination of the agreement on implementation of investment activities is permitted by agreement of the parties or by court decision. Agreement on implementation of investment activities may be terminated by the court at the request of one of the parties due to a material breach of the terms and conditions of such agreement by the other party.

Substantial violations by a resident of the Arctic Zone of the terms and conditions of the agreement on the implementation of investment activities are:

1. failure by a resident of the Arctic Zone to carry out the declared activities, within 36 months from the date of signing of the said agreement;
2. failure to make investments, including capital investments, in the amount and terms provided for;
3. exceeding of values of maximum permissible deviations from parameters of implementation of the investment project.

In case of termination of the agreement on implementation of investment activities, the expenses incurred in connection with its performance by the resident of the Arctic Zone shall not be reimbursed, except for the case if the reason for termination of the agreement was improper performance of the specified conditions by the managing company.

Termination of the agreement determines the loss of AZRF resident status of an individual entrepreneur or a legal entity.

However, a person who has lost the status of a resident of the Arctic Zone has the right to carry out entrepreneurial activities in the Arctic Zone, to dispose of movable and immovable property belonging to him, located in the Arctic Zone, except for the cases specified in part 4 of article 12 of the Federal law “On state support of entrepreneurial activity in the Arctic Zone of the Russian Federation.”

Part 4 of Article 12 of the Federal Law indicates that the loss of resident status in the AZRF does not prevent the continuation of commercial activities in the area, but the individual entrepreneur or legal person, who has lost this status, loses all possible preferences of a resident.

Federal Law No. 193-FZ of July 13, 2020, describes in detail conditions for obtaining the resident status, procedures of obtaining the status, signing an agreement on carrying out investment activities, termination of the agreement and legal regime of residents and persons who have lost this status.

However, the question remains whether the very concept of a resident of the AZRF is sufficiently complete, whether it is able to reflect the entire essence of the subject composition, which falls under the jurisdiction of the law. These issues may arise in the application of the norms of the Federal Law № 193-FZ of July 13, 2020.

Thus, the law introduces individual entrepreneurs and legal entities as subjects claiming the status of a resident of the AZRF.

The preferences stipulated by the mentioned federal law and the budget and tax laws adopted in its development do not apply, for example, to nonprofit organizations.

First of all, we are talking about rural consumer cooperative organizations supplying residents of remote settlements with food, bread, catering services, as well as communities of small indigenous peoples of the North, Siberia and the Far East of the Russian Federation.

Article 123.16 of the Civil Code of the Russian Federation includes indigenous communities of numerically small peoples of the Russian Federation in paragraph 6 “Non-profit corporate organizations” of Chap. 4 “Legal entities” of Part One of the Civil Code of the Russian Federation. As a general rule, under Article 5 of Federal Law No. 104-FZ of July 20, 2000, “On General Principles of Organization of Communities of Small Indigenous Peoples of the North, Siberia and the Far East of the Russian Federation” the activities of communities of small indigenous peoples of the North, Siberia and the Far East of the Russian Federation (respectively activities of family (clan) communities of small peoples) shall be of nonprofit nature. In turn, by virtue of Item 2 of Article 6.1 of the Federal Law No. 7-FZ of January 12, 1996, “On Non-Profit Organizations,” a community of small indigenous peoples of the Russian Federation has the right to engage in business activities.

According to Article 123.2 of the Civil Code of the Russian Federation, the Law of the Russian Federation of June 19, 1992, N 3085-1 “On Consumer Cooperation (Consumer Societies and their Unions) in the Russian Federation,” the Federal Law of December 08, 1995, N 193-FZ "On Agricultural Cooperation" consumer cooperation organizations, agricultural consumer cooperatives are nonprofit organizations and are entitled to conduct business in accordance with the objectives set at their creation.

These nonprofit organizations are important for the social and cultural component of the population's life, they implement activities aimed at expanding the services provided and their accessibility for local residents, improving their quality. Communities of Indigenous Peoples of the North, Siberia, and the Far East of the Russian Federation also contribute to the preservation and development of traditional activities, primarily reindeer herding, which requires substantial investment (Lashov, 2016).

These organizations, being formally noncommercial, fully meet the economic criteria of the resident of the Arctic zone, established by article 9 of the Federal law from July 13, 2020, N 193-FZ.

Thus, it is possible that Federal Law N 193-FZ of July 13, 2020, should provide for the expansion of the list of organizations that may be recognized as residents of the Arctic Zone, in terms of its addition to communities of small indigenous peoples of the North, Siberia and the Far East of the Russian Federation, agricultural consumer cooperatives.

The Economic Basis of the Issue

The development of the Arctic Zone of the Russian Federation involves large investments of investors in projects, so the attractiveness of the conditions for holding the status of a resident of the AZRF lies in both administrative and tax preferences (Table 1).

There are also territorial conditions for granting certain preferences. For example, in the city of Arkhangelsk, a benefit of 80% of the land tax for 5 years is provided (Krainova & Laypanova, 2020).

Thus, the system of preferences creates a favorable investment background for those who want to do business in the AZRF and in fact a special economic zone is formed (Leksin & Porfiriev, 2019; Arctic-Bulletin, 2019; Pilyasov, 2016).

In 2014, the Russian government approved a decree on the state program "Social and Economic Development of the Arctic Zone of the Russian Federation," which has been adjusted several times as of this year 2021. Table 2 shows the main adjustments for this program since 2017.

From the data in Table 2, we can conclude that the amount of budget funding for the state program is reduced by an average of 8 times. Significant adjustments were made in 2021, and the planned data for 2025 are not given at all. According to the Ministry for the Development of the Russian Federation, the reason is that the data were formed according to the three-year budget plan, and the reduction of budget financing itself is associated with its transfer for the prevailing number of activities of the state program to sectoral documents.

Table 1 Administrative and tax preferences for residents of the Arctic Zone of the Russian Federation

Administrative preferences	Tax preferences
The possibility of assigning a free customs zone to the equipped and equipped areas of the residents of the Arctic zone	Income Tax Federal portion of tax will be 0% for 10 years, regional portion will be 5% for 5 years and 10% for the next 5 years Charged from the date of first profit. Does not include solid mineral projects
Provision of state land plots to residents of the Arctic Zone without bidding	Insurance premiums Applies through subsidy mechanism at 7.5% for first 10 years, 3.75% for small- and medium-sized businesses. Applies only to new jobs. Does not include solid minerals projects
Inspections of residents are carried out by agreement of the Ministry of the Development of the Russian Federation and in a shorter time	Mineral extraction tax Half of the current rate also applies to solid minerals. Only for new deposits. The amount of the exemption cannot exceed the amount of private investment in infrastructure, beneficiation or processing. Valid until December 31, 2032
Parallel ecological expertise and state expertise of design and estimate documentation	Property Tax 0.1% for 5 years and 1.1% for the following 5 years. Relief is applied from the moment the property is on the balance sheet of the organization
	Land Tax Municipal tax from 0% to 1.5%
	Simplified system of taxation. The “income” system is taxed at the rate of 1% for 5 years. The “income-expense” regime is taxed at the rate of 5% for 5 years

Source: Compiled by the authors based on the data from Investment Portal of the Arctic Zone of the Russian Federation: https://investarctic.com/azrf.php

Table 2 Financing of the state program of the Russian Federation “Social and Economic Development of the Arctic Zone of the Russian Federation”

	Total budget allocations from the federal budget, ₽ thousand				
	2021	2022[a]	2023[a]	2024[a]	2025[a]
Decree of the RF Government of August 31, 2017. № 1064	25,756,503.7[a]	27,816,369.8	35,102,180	29,706,757.2	25,802,857.2
Decree of the RF Government of March 29, 2019. № 371	4,896,075.9[a]	40,080,512.7	48,837,822.9	44,779,700.1	39,877,000.1
Decree of the RF Government of March 30, 2021. № 484	3,427,636.9	6,061,431.2	5,169,466.6	4,900,000	–

Source: Compiled by the authors based on the data from The Russian Government. Retrieved from: http://government.ru

[a]expected performance

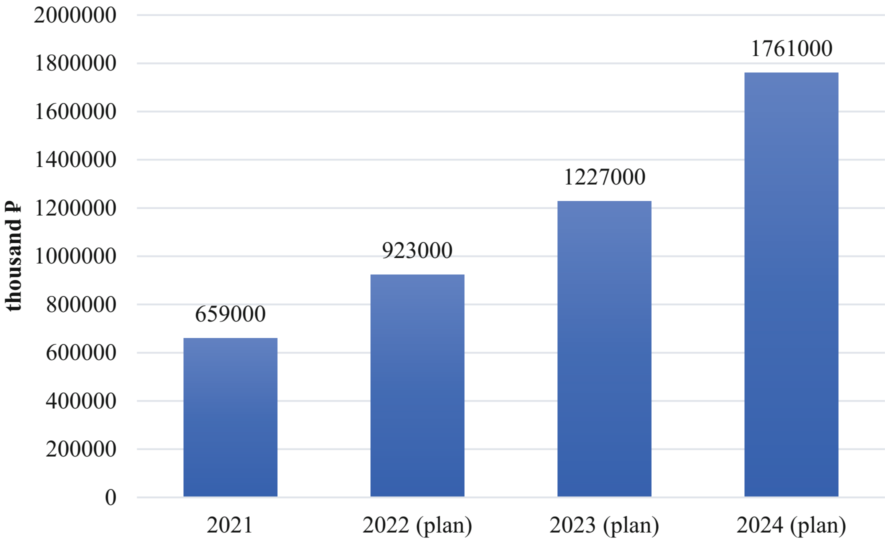

Fig. 1 Accumulated volume of nonbudgetary investments of residents of the Arctic Zone of the Russian Federation, ₽ thousand. (Source: compiled by the author based on the data from The Russian Government. Retrieved from: http://government.ru)

In addition to the budget financing of the state program, there is also extra-budgetary financing. Figure 1 presents the data on the accumulated volume of nonbudgetary investments of the residents of the AZRF.

The data presented in Fig. 1. show the growing dynamics of extrabudgetary investments under the state program of socioeconomic development of the AZRF by 30–40% annually, which indicates the potential interest of investors in the development of projects in this territory and the growth of the number of new jobs.

Prospects for socioeconomic development of the AZRF are associated with the possibility of business development of different levels (Voronina, 2021; Romashkina et al., 2017; Tatarkin et al., 2017).

Climate Changes

The complexity of socioeconomic development of northern territories is associated with the harsh climate of these places, and in this regard, the observed changes in temperatures toward warming are relevant to this topic.

Warming recorded for the period from 1980 to the current time leads to significant phenomena in the Arctic zone: the snow cover has decreased, the area of glaciers in the ocean is significantly reduced, Yakutia is blazing with forest fires due to high summer temperatures and drought.

The Arctic is warming twice as fast as other areas, and by 2030, the ice in the Arctic Ocean may completely melt in summer. By 2050, the temperature may rise by

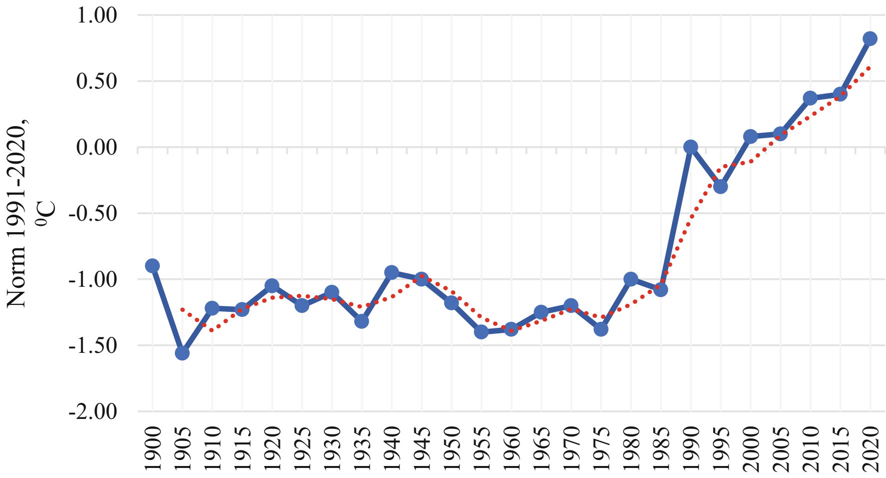

Fig. 2 Seasonal anomaly (spring: March–May) of surface air temperature averaged over the Northern Hemisphere (land) for 1900–2020. (Source: compiled by the author based on the data from Institute of Global Climate and Ecology 2021. Retrieved from: http://climatechange.igce.ru/)

4–5 °C compared to the end of the twentieth century, and for the northern hemisphere as a whole is predicted a temperature increase of 2–3 °C (Institute of Global Climate and Ecology, 2021). The reason, according to scientists, is the nonecological form of human activity and, above all, the results of the concomitant processes of the industrial revolution (Alvarez et al., 2020).

Figure 2 shows the growing trend of average temperature at the Northern Hemisphere land surface.

According to Fig. 2, there is a steady upward trend in average temperatures on land in the Northern Hemisphere, and in the future, the Arctic territory will be transformed into a region with a more favorable climate, where biological forms of flora and fauna are already reviving.

Extraction of Natural Resources

Arctic territories are the object of great attention and interest of many countries. There are impressive reserves of mineral resources: oil, gas, iron, copper, nickel, coal, gold, diamonds, and other resources.

Thirteen per cent of the world's estimated oil reserves and 30% of natural gas reserves are concentrated in the region, half of which are in Russia. Proven oil reserves in the region are 6% of the world's reserves (90 billion barrels). This volume is equal to 52% of Canada's reserves, 110% of Russia's reserves and 340% of the U.S. and 1677% of Norway's reserves. Explored natural gas reserves in the Arctic amount to 1669 trillion cubic feet (24% of the world's explored reserves). This compares to 99% of Russia's reserves, 500% of U.S. reserves, 2354% of Norway's

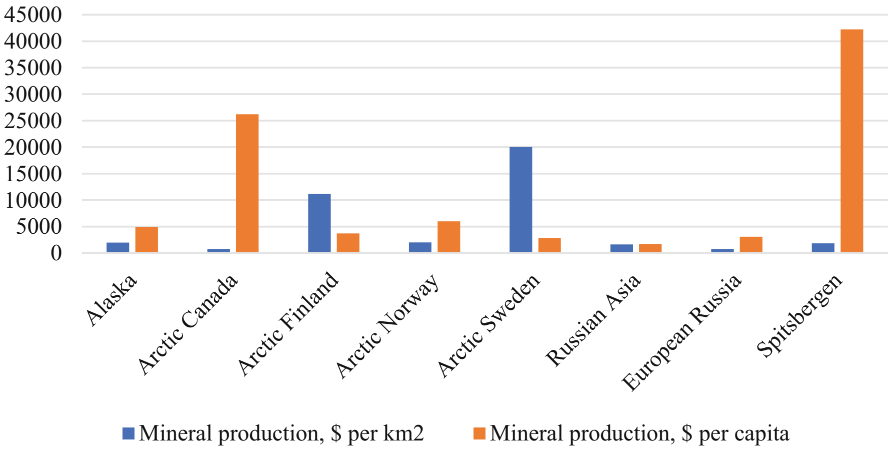

Fig. 3 Mineral production of the Arctic regions. (Source: compiled by the author based on Kondratiev (2020))

reserves and 2736% of Canada's reserves. Most of the hydrocarbons (more than 80%) are found offshore (Kondratiev, 2020).

Figure 3 shows data on mining production for the countries that make up the Arctic region.

As can be seen from Fig. 3, the richest in mineral resources per square kilometer is the territory of Arctic Sweden ($20.022 per kilometer squared), while Spitsbergen ($42.235 per capita) leads with this indicator per capita, due to the weak population of the area in question (Kondratiev, 2020).

As of 2021, 13 hydrocarbon fields had been discovered in the AZRF. The largest of these was discovered in 2018, the North-Obskoye gas condensate field, with reserves estimated at 274 billion cubic meters, and in 2019, the V.A. Dinkov field with a gas condensate deposit of 391 billion cubic meters. The Marshal Zhukov gas field is estimated at 800 billion cubic meters, and the Rokossovsky gas-condensate reservoir is estimated at 514 billion cubic meters. The less rich 75 Years of Victory gas field has 203 billion cubic meters (Rosnedra, 2021).

Large oil deposits have been found in the Arctic Zone of Russia. For example, significant volumes for potential production have been found in the Zapadno-Irkinskoye oil field, the reserves of which are estimated at 511 million tons (Rosnedra, 2021).

Today, the transition to the consumption of hydrogen is becoming a new environmental-friendly trend in the energy industry. Therefore, Russia is also conducting the corresponding developments in order to enter the world markets with this. The first project on the production of the "green" hydrogen will be realized together with "Rusnano" and "Enel Russia" on the capacities of the wind power station in the Murmansk region. It is planned to produce 12 thousand tons of hydrogen per year with its further supply to the EU countries. Investments in this project are estimated at $320 million.

The Arctic Zone of Russia annually provides extraction of apatite ores by almost 100% which amounts to 5.7 million tons, rare-earth metals by 124.5 thousand tons, titanium by 416 thousand tons and zirconium by 21 thousand tons. Also, in the Russian Arctic is extracted 10% of the total Russian indicator of gold mined at 37.2 tons and 11% of silver at 244.3 tons. There are 28% of Russia's 312.3 million carats of diamonds in the Arctic (Rosnedra, 2021).

There are rich deposits of solid minerals: tin, gold, rare-earth metals, coal and mammoth ivory in the north-east of the Arctic zone in Yakutia.

There are 630 thousand tons of tin deposits in the depths of Yakutia, which is 37% of the country's total reserves. The price of tin on the world market is steadily growing, as this substance is often used in the production of a large number of goods and materials (Rosnedra, 2021).

The company "Yanolovo" is a resident of Yakutia, which starts alluvial tin mining in the "Tirekhtyakh Ruchey" deposit in the Ust-Yansk district. The first stage of annual production is estimated at 600 tons, and the total resources are estimated at 68.4 thousand tons. The field is 900 km distant from Yakutsk, and the project will contribute to socioeconomic development of the area and create 80 new jobs. The total cost is estimated at ₽27.1 billion (Investment Portal of the Arctic Zone of the Russian Federation, 2020b).

In the Murmansk region, Olkon JSC (Olenegorsk Mining and Processing Plant) is developing the Pechegubskoye deposit; the iron ore reserves of this object amount to 80 tons. Investments in the project will amount to about ₽5.7 billion. Today, the company employs about 2 thousand people.

Yakutian diamonds are considered very famous in the jewelry industry. In fact, Yakutia accounts for about half of Russia's alluvial diamond production.

The Anabar ulus deposit in Yakutia has over 64% of Russia's loose diamond reserves (ALROSA, 2021).

To mine diamonds in the northern territories of the country, the ALROSA Group created a subsidiary, OAO Almazy Anabara, which accounts for 5% of the group's diamonds (ALROSA, 2021).

The famous Arkhangelsk diamondiferous province is rich in kimberlite pipes, where, among other things, diamonds are mined, whose reserves are estimated at 21.4% of the total Russian reserves. Severalmaz, which is part of ALROSA Group, mines about 4.2 million carats of diamonds per year from the deposit (ALROSA, 2021).

It is also noteworthy that after the exhaustion of the pipes, the mining company will ecologically eliminate the results of its activity, turning huge pits into lakes with clean water, and tailing pits with mostly sand and clay wastes will eventually be turned into forests.

Thus, the Arctic zone of the Russian Federation is a rich trove of a wide range of natural resources, which is attractive to mining companies and investors.

Transportation

The development of transport infrastructure significantly affects the socioeconomic indicators of the region. For territories with a special climate, transport arteries are vital due to the need for regular food supplies, medical care and other things.

However, the priority of the transport infrastructure of the Arctic states is the export of natural resources and the import of industrial and food products, as well as the provision of services for military facilities located on the Arctic coast and islands (Shestak et al., 2020).

The development of air transport in the Arctic territories is sometimes the only possible solution for passenger and cargo transportation. According to Statistics Iceland, the transportation of passengers in Iceland, cargo and mail is carried out through 18 airports, although their number is much larger, but they do not have runways. In Iceland, where there is no rail transport at all, the air transport is developing quite rapidly and the experience of this country can be useful for Russia. The emphasis on small aircraft is made in Greenland and Northern Canada due to the remoteness of settlements from each other and the involvement of helicopter transport is necessary for transportation of vital goods and products, as well as the delivery of passengers (Frolov, 2016).

In total, there are 73 airfields in the Arctic Zone of the Russian Federation, 8 of them are under the reconstruction (RIA News, 2017). State-owned enterprises were created on the infrastructure of unprofitable regional and local airports for the subsequent development of air communication of remote and northern territories.

There is also a program of preferences for residents of the AZRF. In the Murmansk region, a resident of Murmansk Airport is registered. It plans to build a new terminal and launch it in 2023. According to experts, the new airport will pass up to 400 passengers per hour and more than a million passengers per year. Investments in the project are estimated at ₽1.9 billion with new jobs for 200 people (Investment Portal of the Arctic Zone of the Russian Federation, 2021a).

Thus, the development of small aircraft, the production of new helicopters, the restoration of existing and the construction of new runways, warehouses with related materials, light navigation equipment is becoming an important element for the development of the economy of the Arctic territories of Russia.

Another important mode of transport is the automobile transport, which is highly developed in the Arctic territories. Of course, the roadway is very expensive to build, and in harsh climatic conditions cannot always be available for travel, so their density in the Arctic region is low. Nevertheless, the infrastructure of highways is developed in Northern Canada, Iceland, Alaska, Norway. The density of roads in the Russian Arctic is lower. For example, in the Taimyr Autonomous Area, it is 350 times less than the average for Russia; in Chukotka, it is less by 46.2 times; and in the Nenets Autonomous Area, it is less by 33.6 times. The quality of the roads is poor, only part of the tracks has an asphalt surface. The territories of the AZRF are provided with a hard coating only for 14% (Investment Portal of the Arctic Zone of the Russian Federation, 2020a). In 2017, total length of federal highways in AZRF was 729.5 km (RIA News, 2017).

For the construction of highways, the delivery of materials and equipment is necessary. For Arctic conditions, it leads to an increase in the cost of processes. Nevertheless, the need for a developed road infrastructure is recognized at the highest state level and is provided by various federal and regional programs. Also, the experience of the Nordic countries in this area can also be useful for the Arctic territories of Russia.

More expensive in construction, but more economical in the operation of the transport track is the railway, which is also one of the safest and most stable modes of transport, but not all countries have the opportunity to build it on their territory. Greenland, Iceland, and Northern Canada do not have railway infrastructure, but in Russia, this type of transport is recognized as strategically important.

The world leader in the length of the railway track is the Russian Federation; in 2019, the length of the railways was 85.494 km, which is 20.3% of the world's figures. The total number of railway lines in the world in 2019 was 421.204 km (Knoema, 2021).

There are several major railway development projects in the Russian Arctic. One of these projects is the construction of the Berkakit–Tommot–Yakutsk railway line, which is 900 km long. This path runs from the city of Amur to Yakutsk. The purpose of this section of the railway is to ensure year-round transportation of goods to hard-to-reach northern areas.

According to the Ministry of Transport of the Russian Federation, very important element in the development of the Arctic of Russia is the construction of the Northern Latitudinal Railway (NLR). This 700-km connection is supposed to connect the Northern and Sverdlovsk railways, as well as reduce the length of the transport route from the fields in the northern regions of Western Siberia to the ports of the Baltic basin. With the help of public-private partnership mechanisms and the AZRF "resident" program, many companies for the extraction and processing of natural resources declare their readiness to invest in this project, the construction of which is estimated at ₽236.7 milliard, taking into account the reconstruction of adjacent areas (Gruzinov et al., 2019). The projected volume of traffic on the NLR will be 23.9 million tons of cargo per year, the main part will be, in particular, the transportation of gas condensate. Also, the project will speed up the transportation of container cargoes (PRO-ARCTIK, 2021).

In 2019, a major project was announced for the construction of the Siberian Meridian transport corridor, which is the part of international route Arctic-Siberia-Asia. This road is planned to connect the entire railway infrastructure of the Arctic, and it will connect all points of the Northern Sea Route with the ports of the Pacific and Indian Oceans. This is one of the largest investment projects that will contribute to the powerful development of the Russian Arctic.

Maritime transport is the predominant mode of transport in the Arctic territories of Russia. Climate change contributes to the increasing opening of Arctic waters, and the development of sea routes today is very active. Russia has 18 seaports in the Arctic Zone. Iceland and Greenland each have 29 seaports, Alaska has 4 (Shestak et al., 2020). Ports accept a large percentage of products for export and import in all countries.

There are various Arctic shipping routes for navigation in such inclement conditions. The Northern Sea Route (NSR) is one of the most important sea routes in Arctic waters, which runs along the coast of Russia from the Bering Strait to the Kara Sea. The length of the NSR from Murmansk to Yokohama is 5770 nautical miles.

The time of passage of the NSR is 7–15 days at a speed of 5–13 knots, the duration of navigation on open water is 2–4 months. The volume of traffic in 2019 amounted to 31.5 million tons, by 2024 this figure is planned to increase to 80 million tons, and by 2035 it will go up to 160 million tons (Investment Portal of the Arctic Zone of the Russian Federation, 2021b). Ships of only ice classes follow the Northern Sea Route, and this feature is inherent in all Arctic shipping (Eliseev & Naumova, 2021).

Financing of the Northern Sea Route is approved in the amount of ₽735 billion of until 2024. Budget funds of ₽274 billion, and more than ₽460 billion should be invested by ROSATOM and subsoil users – NOVATEK, ROSNEFT and other companies (TASS, Russian News Agency, 2019).

The longer period of navigation in the sea waters of the Arctic, on the one hand, makes it economically more profitable, and, on the other hand, causes concern among environmentalists because of the concomitant destruction of the marine ecosystem due to the increased volume of navigation of icebreakers (Hussain et al., 2021; Kiiski et al., 2018).

Another area of interest of AZRF residents is the development of river transport in the Arctic territories. This type of transport deserves more attention. Funds for fleet renewal are not enough and many ships will soon reach their maximum service life. Also, the entire infrastructure of river navigation and a deep study of its legal aspect need investments.

Ministry of the Russian Federation for the Development of the Far East and the Arctic is developing a project to expand the capabilities of Arctic River navigation. The main document is expected to be prepared by 2022. With the implementation of the main measures, it will be possible to return cargo transportation for 600 million tons (Russian Newspaper, 2021). River transport is also extremely important for the life of the local population in remote Arctic territories, because river transportation may be the only way to provide locals with vital food and medical communication.

Thus, the transport system of the AZRF is an investment attractive. The development of the transport network directly affects the development of both related areas and individual ones, for example, tourism.

Tourism

The development of tourism in the Arctic is very promising. More and more people who want to visit authentic Arctic places and look at the unusual nature experience in a cold climate. Arctic territories come from several countries: Iceland, Norway, Sweden, the Russian Federation, Finland, Canada, Denmark, and the United States.

The interest in Arctic tourism is also increasing year by year. Figure 4 shows the dynamics of the number of tourists traveling to the Arctic.

According to the data presented in Fig. 4, we can conclude that the most actively visited countries of the Arctic tourist destinations are the United States, Iceland, and Norway, followed by Sweden, the Russian Federation, and Finland. The decrease in the number of tourists in Iceland by 15% in 2019 is due to the global financial crisis, which has caused a significant reduction in the economy of the country and, as a consequence, this has also affected the tourism sector.

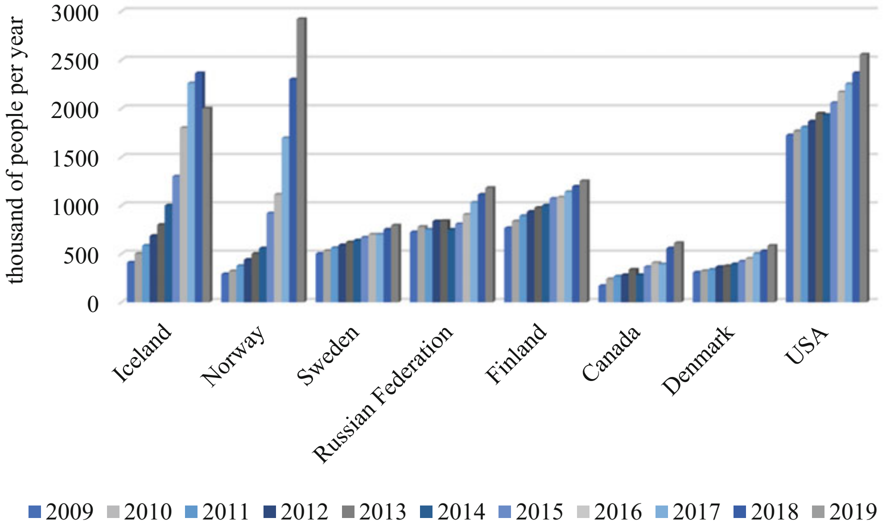

Fig. 4 The number of tourists in the Arctic territories, thousand people per year. (Source: compiled by the author based on the data from Federal Agency for Tourism 2020. Retrieved from: https://tourism.gov.ru)

Canada and Denmark were the weakest visited countries, which is explained by the remoteness of the Arctic territories of Canada and the island nature of the territory of Denmark, as well as the low population density of these regions determines the poorly developed infrastructure of tourist services.

In terms of the volume of tourist services, not only Canada and Denmark, but also the Russian Federation have the most modest indicators (Fig. 5).

As can be seen from Fig. 5, the leaders in the volume of tourist services of the Arctic territory are Iceland, Norway, and the United States. During the period of 2009 to 2019, in Russia, there was a fall of the national currency against the dollar exchange rate, so if we assume the fixed prices, we can conclude that in Russia there is a steady growth in the volume of tourist services in the Arctic territories.

In Russia, today there are many projects on ready-made tourist routes. The official tourist portal of the Arctic Zone of Russia offers organized tours for almost every taste and budget from ₽10 thousand to ₽4.3 million for a tour (Investment Portal of the Arctic Zone of the Russian Federation, 2021b).

The world flow of tourists to the Arctic is 10 to 11 million people a year. Russia has the largest Arctic area, but it is inferior to other countries in popularity due to underdeveloped infrastructure. Every year, more than 1 million people visit the Arctic Zone of Russia, and this figure is to be increased to 3 million people. This number is optimal for the preservation of ecology of the northern territories. The volume of investment in this sector is significant. For example, six major investors are ready to invest ₽13 billion in the development of tourism in the Arctic Zone of Russia (Investment Portal of the Arctic Zone of the Russian Federation, 2021b).

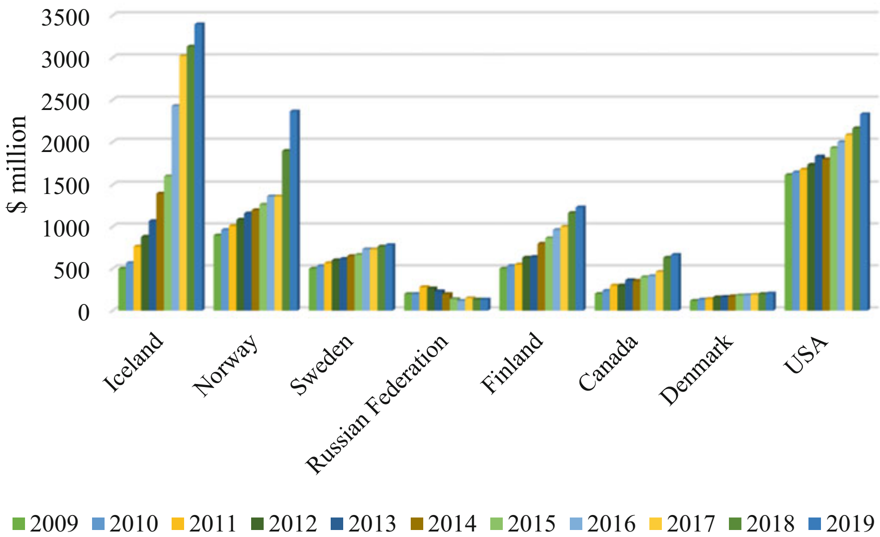

Fig. 5 The volume of tourist services in the Arctic territories, $ million. (Source: compiled by the author based on the data from Federal Agency for Tourism 2020. Retrieved from: https://tourism.gov.ru)

Thus, the tourism business of the Arctic territories is an important element in the development of the economies of the regions of the zone (Belonozhko et al., 2020). Due to the harsh climate of the Arctic territories that prevails during the year, the creation of tourist infrastructure and the provision of services require substantial investment. State support in this regard is extremely necessary, as it not only creates new jobs, but also has an overall positive economic effect.

Conclusions

As a result of writing this chapter, the authors came to some conclusions.

The problem of revealing at the moment of application the conditions under which it is possible to refuse the conclusion of the agreement and provided by items 6 and 7 of the Federal law № 193-FZ from July 13, 2020, "On state support of entrepreneurial activity in the Arctic Zone of the Russian Federation" is not solved.

In this case, several variants of the decision of gaps of the legislation are offered. The first one is the introduction of a point in the article of the Federal law that the authorized bodies have the right to demand additional documents to be attached to the application by the publication of subordinate normative acts, thus taking into account the dynamism of development of social relations in this field for the future and excluding the contradictions with the conservatism of the law.

The second option is to expand the list of documents specified in 2 of the Federal Law "On State Support of Entrepreneurial Activity in the Arctic Zone of the Russian Federation," i.e., by amending the Federal Law.

The third variant is introduction in the Federal law of instructions that the commission, after receipt of the application, has the right to demand all necessary information within the framework of interdepartmental interaction in order to make a decision on possibility of conclusion of the agreement on realization of investment activity or refusal of it.

The development of the Arctic Zone of the Russian Federation involves large investments of investors in projects, so the attractiveness of the conditions for holding the status of a resident of the AZRF lies in both administrative and tax preferences

The law introduces individual entrepreneurs and legal entities as subjects claiming the status of a resident of the AZRF.

The preferences stipulated by the mentioned federal law and the budget and tax laws adopted in its development do not apply, for example, to nonprofit organizations.

Nonprofit organizations are important for the social and cultural component of the population's life of the North, Siberia and the Far East of the Russian Federation.

It is possible that Federal Law N 193-FZ of July 13, 2020, should provide for the expansion of the list of organizations that may be recognized as residents of the Arctic Zone, in terms of its addition to communities of small indigenous peoples of the North, Siberia and the Far East of the Russian Federation, agricultural consumer cooperatives.

The amount of budget funding for the state program "Social and Economic Development of the Arctic Zone of the Russian Federation" is reduced by an average of eight times.

Prospects for socioeconomic development of the AZRF are associated with the possibility of business development mostly in three sectors: extraction of natural resources, investments in transport infrastructure and logistics, tourism.

The Arctic Zone of the Russian Federation is rich in minerals, so many companies have received the status of a resident in the mining industry. Here arises the problem that only large, capital-intensive companies have the opportunity to conduct their activities in the field of extraction and processing of natural resources.

Scientists observe the effect of global warming in the Arctic Zone. Since the 1980s, the Arctic climate has been steadily warming. This is expressed in the melting of Arctic ice, forest fires and so on. Therefore, on the one hand, such warming makes it possible to develop the Arctic territories and receive enormous economic benefits from this, and on the other hand, it leads to the destruction of the unique ecosystem of the Arctic with the accompanying negative influences of a planetary scale.

The development of transport infrastructure and logistics is impossible without large investments. Therefore, the State is actively involved in this process. To date, it is possible to use the experience of foreign countries in the development of road coverage, air traffic, in particular small.

The river transport infrastructure of the AZRF also needs development and state support, as it has great potential for domestic cargo transportation.

The experience of the Arctic countries shows that tourism is a promising direction for the socioeconomic development of the region. In Russia, this sector is just beginning to gain positive economic dynamics, but also needs state support.

It is extremely important to carry out its activities environmental-friendly and take care of the fragile ecosystem of the Arctic as much as possible.

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Environmental Protection and Indigenous Peoples in the Russian Arctic

Legal Aspects

Anna V. Kukushkina, Tatyana A. Shishkina, Vladimir N. Shishkin, Valery I. Salygin, and Renat A. Perelet

Contents

Abstract

The ecological factor is becoming increasingly important for the survival and continued existence of the indigenous peoples of the North, who are inextricably linked with nature and the landscape. Small-numbered peoples depend on natural conditions to a greater extent than the population of industrially developed territories. In this case, the protection of nature in the places of residence of indigenous small-numbered peoples is the key to the preservation of the ethnic group. The UN Declaration on the Rights of Indigenous Peoples states that indigenous peoples have the right to preserve and protect the environment and the productive capacity of their lands or territories and resources. States shall establish and implement assistance programs for indigenous peoples in order to ensure such conservation and protection without discrimination of any kind.

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Keywords

Arctic · Law · Indigenous peoples · Protection of biological diversity · Reindeer husbandry · Ecosystem approach

Introduction

The Russian Federation, like most civilized legal states, guarantees the rights of indigenous minorities in accordance with the generally recognized principles and norms of international law and international treaties of the Russian Federation (Constitution of the Russian Federation, Article 69).

Representatives of 19 indigenous small-numbered peoples live in the Arctic zone of the Russian Federation, there are objects of their heritage that represent historical and cultural value of global significance (Decree of the Government of the Russian Federation, 2000. No. 255). According to the All-Russian Population Census of 2010, the number of indigenous minorities is 102 thousand people.

About a third of the four million people living in the Arctic are indigenous, exposed to growing and intensifying climatic influences and globalization (Spitzer & Selle, 2020).

The Russian Federation is responsible for the adoption and amendment of the Constitution of the Russian Federation and federal laws, monitoring their compliance, regulation, and protection of human and civil rights and freedoms. Regulation and protection of the rights of national minorities, foreign policy and international relations, international treaties of the Russian Federation (paragraphs “a”, “b”, “k” of Article 71 of the Constitution of the Russian Federation), federal constitutional laws, and federal laws with direct effect on the entire territory of the Russian Federation are adopted on these subjects of competence (Part 1 of Article 76 of the Constitution of the Russian Federation).

In April 2021, in Moscow, representatives of the indigenous peoples of seven circumpolar countries discussed the prospects for the development and existence of their peoples in connection with the intensification of industrial development of the Arctic in the face of climate change. It was proposed to implement the Declaration on the Rights of Indigenous Peoples to ensure that industrial development in the circumpolar Arctic fully complies with the principles of sustainable development and self-determination of indigenous peoples and provides for free prior and informed consent (PIC). The meeting also confirmed the right of indigenous peoples to own ancestral land, manage resources, protect ecosystems that guarantee survival and preserve a unique culture, protect sacred sites, archaeological and historical sites located on the ancestral territories of indigenous peoples (Falch et al., 2016).

Climate change is also the driving force behind zoonoses. Greenhouse gas emissions-primarily from the burning of fossil fuels-cause changes in temperature and humidity, which directly affects the survival of microbes. Rapid habitat changes caused by unusual weather events, such as heat waves, droughts, floods, or forest fires, occur too quickly to allow ecosystems to balance sudden spikes in populations of group species, such as mosquitoes, which can be carriers of emerging diseases. Scheduled for release next month, a new UNEP operational assessment on zoonotics indicates that epidemics will become more frequent as the climate continues to change (Angell & Brekke, 2011).

On April 15, 2021, the Decree of the Government of the Russian Federation No. 978-r "On approval of the Program of State support for the traditional economic activities of indigenous small-numbered peoples of the Russian Federation carried out in the Arctic Zone of the Russian Federation" was adopted (Decree of the Government of the Russian Federation No. 978-r 2021).

The legal basis of the program is: The Constitution of the Russian Federation; Federal Law "On Guarantees of the Rights of Indigenous Small-Numbered Peoples of the Russian Federation"; Federal Law "On General Principles of Organization of Communities of Indigenous Small-Numbered Peoples of the North, Siberia and the Far East of the Russian Federation"; Federal Law "On Territories of Traditional Nature Use of Indigenous Small-Numbered Peoples of the North, Siberia and the Far East of the Russian Federation"; Federal Law "On State Support of Entrepreneurial Activity in the Arctic Zone of the Russian Federation"; Fundamentals of the State policy of the Russian Federation in the Arctic for the period up to 2035, approved by Decree of the President of the Russian Federation dated March 5, 2020, No. 164 "On the Fundamentals of the State Policy of the Russian Federation in the Arctic for the period up to 2035"; Strategy for the Development of the Arctic Zone of the Russian Federation and ensuring National Security for the period up to 2035, approved by Decree of the President of the Russian Federation dated October 26, 2020, No. 645 "On the Strategy for the Development of the Arctic Zone of the Russian Federation and ensuring National Security for the period up to 2035."

The implementation of the program is based on the following principles:

- Guarantees of the rights of indigenous minorities in accordance with the Constitution of the Russian Federation, generally recognized principles and norms of international law, as well as international treaties of the Russian Federation.
- Recognition of the importance of land and natural resources, as well as the well-being of the environment as the basis of the traditional way of life and traditional economic activities of indigenous peoples.
- Rational use of lands and natural resources in places of traditional residence and traditional economic activity of indigenous peoples;
- Recognition of the rights of small indigenous peoples to priority access to fishing areas, hunting, and biological resources in the places of their traditional residence and traditional economic activity.
- The need for representatives and associations of indigenous minorities to participate in decision-making on issues affecting their rights and interests in the development of natural resources in places of traditional residence and traditional economic activity.
- Coordination of actions of state authorities and local self-government bodies in addressing issues of socioeconomic development of indigenous peoples.

The legislation of the Russian Federation defines 13 types of traditional economic activity of indigenous small-numbered peoples of the Russian Federation:

- Animal husbandry, including nomadic (reindeer husbandry, horse breeding, yak breeding, sheep breeding).
- Processing of livestock products, including the collection, harvesting, and dressing of hides, wool, hair, ossified horns, hooves, antlers, bones, endocrine glands, meat, offal.
- Dog breeding (breeding of reindeer, sled, and hunting dogs).
- Breeding of animals, processing and sale of animal husbandry products.
- Beekeeping, beekeeping.
- Fishing (including marine St. John's wort) and realization of aquatic biological resources.
- Commercial hunting, processing and sale of hunting products.
- Farming (gardening), as well as breeding and processing of medicinal plants.
- Harvesting of wood and non-wood forest resources for their own needs.
- Gathering (harvesting, processing, and sale of food forest resources, collection of medicinal plants).
- Gratuitous use of common minerals for personal needs.
- Arts and crafts and folk crafts (blacksmithing and iron-making craft, manufacture of utensils, equipment, boats, sleds, other traditional means of transportation, musical instruments, birch bark products, stuffed commercial animals and birds, souvenirs made of deer fur and commercial animals and birds, other materials, weaving of herbs and other plants, knitting nets, bone carving, wood carving, tailoring of national clothing and other types of crafts and crafts related to the processing of fur, leather, bone, and other materials).
- Construction of national traditional dwellings and other buildings necessary for the implementation of traditional economic activities.

For indigenous small-numbered peoples, the conduct of traditional economic activities is not only the basis of life support, but also the support of culture, worldview, folklore, rituals, holidays, folk pedagogy, traditions, and the preservation of the continuity of generations (Sokolovsky, 1999).

The peculiarity of the Arctic zone of the Russian Federation, which determines special approaches to its socioeconomic development, is the vast demographic potential and the high sensitivity of the traditional way of life of the indigenous peoples of the Russian Federation to external influences.

The main factors forming the risks of the development of traditional economic activities of indigenous peoples are: intensive climate change in the Arctic; acceleration of the pace of economic development of the territories of the Arctic zone of the Russian Federation in the places of traditional residence of indigenous peoples; high costs in the implementation of economic activities; low level of development of transport and social infrastructure in the Arctic zone of the Russian Federation; poor communication quality and lack of high-speed access to the Internet information and telecommunications network in most places of traditional residence of indigenous small-numbered peoples; inconsistency of the system of secondary vocational and higher education with the need for qualified personnel to carry out traditional economic activities (FNs konvensjon om sivile og politiske rettigheter (ICCPR)).

The basis of the economy in the places of traditional residence of indigenous small-numbered peoples, which provides an increase in employment and self-employment of the indigenous population based on the mobilization of domestic resources of households and communities, is the development of entrepreneurship in the field of services and tourism, the creation of small-scale production, the development of artistic crafts, including the production of traditional products, traditional types of nature management, and processing of agricultural products (Burtseva et al., 2019).

However, the risk factors listed above cause low competitiveness of goods, works, and services of indigenous peoples and pose a threat to their livelihoods (Josefsen et al., 2015).

In addition, the goals and objectives of state support for the traditional economic activities of indigenous minorities have been worked out. Among them are the goals and measures of state support for the traditional economic activities of indigenous minorities – the creation of conditions for increasing the competitiveness of goods, works, and services produced within its framework, as well as the formation of a sustainable basis for the development of indigenous minorities (Kongens, 1997).

To achieve these goals, it is necessary to ensure:

- Creation and development of industrial and technological infrastructure of traditional economic activities of indigenous peoples.
- Promotion to the domestic and foreign markets of goods, works, and services produced within the framework of traditional economic activities of indigenous peoples.
- Development of the tourism industry in places of traditional economic activity of indigenous peoples.
- Training of personnel for the implementation of traditional economic activities of indigenous minorities.
- Expansion of the use of renewable energy sources, liquefied natural gas, and local fuel in places where traditional economic activities of indigenous peoples are carried out.
- Popularization of entrepreneurship among small indigenous peoples (Teps, 2006).

The joint responsibility of the Russian Federation and its subjects is to ensure compliance of constitutions (charters), laws, and other normative acts of the subjects of the Federation with the Constitution of the Russian Federation and federal laws, protection of human and civil rights and freedoms, protection of national minorities, protection of the ancestral habitat and traditional way of life of small ethnic communities, and implementation of international treaties of the Russian Federation (paragraphs “a”, “b”, “m”, “o” part 1 of vol. 72 of the Constitution of the Russian Federation). Federal laws are issued on these subjects of competence, and laws and other regulatory legal acts of the subjects of the Russian Federation are adopted in accordance with them (Part 2 of Article 76 of the Constitution of the Russian Federation).

It follows from the above provisions that indigenous small-numbered peoples in the Russian Federation are considered as a special subject of constitutional and legal relations. Their rights are secured and guaranteed primarily by the Constitution of the Russian Federation, international legal acts, federal laws, and laws of the subjects of the Russian Federation, the high legal significance of which (all of these acts in the established hierarchy) in the Russian legal system is predetermined by the Constitution itself. Of particular importance are, first of all, the Federal Law of June 15, 1995. "On International Treaties of the Russian Federation" and the Resolution of the Plenum of the Supreme Court of the Russian Federation of October 10, 2003, No. 5 "On the application by courts of general jurisdiction of generally recognized principles and norms of international law and international treaties of the Russian Federation."

Constitutional provisions concerning indigenous minorities are developed primarily in federal legislation. Its priority in regulating the relations under consideration is due to the existing difference between the subjects of jurisdiction of the Russian Federation and its subjects, as well as the powers of federal and regional state authorities, which have been enshrined in the Constitution of the Russian Federation (Articles 71, 72, 73, 76) and the Federal Law of October 6, 1999, "On the general principles of the organization of legislative (representative) and executive bodies of state power of the subjects of the Russian Federation."

The key role is played by the Federal Law of April 30, 1999, "On guarantees of the rights of indigenous small-numbered peoples of the Russian Federation," which reveals the basic concepts of "aboriginal" legislation, defines the powers of public authorities in the field of protection of small-numbered peoples, and enshrines the rights and guarantees of these peoples and persons belonging to them. Its provisions as a specialized Law have priority over other federal laws affecting the rights and interests of small peoples.

Other federal laws specify the named Federal Law. In particular, small-numbered peoples and persons belonging to them are guaranteed:

- Creation of an administrative-territorial unit with a special status (instead of the previously existing autonomous districts – Taimyr (Dolgan-Nenets), Evenki, and Koryak) – in the Krasnoyarsk and Kamchatka Territories (Article 5 of the Federal Constitutional Law of October 14, 2005, "On the Formation of a New Subject of the Russian Federation as a result of the unification of the Krasnoyarsk Territory, Taimyr (Dolgan-Nenets) Autonomous District and Evenki Autonomous District," Article 5 of the Federal Constitutional Law of July 12, 2006, "On the formation of a new subject of the Russian Federation within the Russian Federation as a result of the unification of the Kamchatka Region and the Koryak Autonomous Okrug");
- Conditions (by allowing deviations of up to 40 percent from the average rate of representation of voters in districts in places of compact residence of

small-numbered peoples) under which they are able to fully exercise their electoral rights (paragraph "b" of Part 2 of Article 18 of the Federal Law of June 12, 2002, "On basic guarantees of electoral rights and the right to participate in a referendum of citizens of the Russian Federation"); this remains the only ineffective preference aimed at ensuring the representation of these peoples in government bodies, although until 2004 the Federal Law "On Guarantees of the Rights of Indigenous Small-numbered Peoples of the Russian Federation" included a norm according to which the subjects of the Russian Federation could by their laws establish quotas for the representation of small-numbered peoples in the legislative (representative) bodies of the subjects of the Russian Federation and representative bodies of local self-government.

- As a general rule – the implementation of local self-government, taking into account historical and other local traditions, including recognition of the possibility in the territories of the subjects of the Russian Federation, in which historically traditional forms of animal husbandry have developed, to establish by law the territories and principles of municipalities of the relevant subject of the Russian Federation, taking into account the peculiarities of this animal husbandry and the settlement of the population in these territories; Part 2 of Article 1, paragraph 2 of Part 1 of Article 85 of the Federal Law of October 6, 2003. "On the general principles of the organization of local self-government in the Russian Federation," as well as a guarantee of the rights of small-numbered peoples – the transfer by the relevant local self-government body of state powers in the field of protection of the ancestral habitat and traditional way of life of these peoples (see, e.g., Article 15 of the Federal Constitutional Law "On the Formation of a New Subject of the Russian Federation as a Result of the Unification of the Kamchatka Region and the Koryak Autonomous Okrug."
- The right to establish communities as a special form of self-organization of persons belonging to small-numbered peoples and united by consanguinity and (or) territorial-neighborly characteristics in order to protect their ancestral habitat, preserve and develop traditional lifestyles, management, crafts, and culture (Federal Law of July 20, 2000, "On the general principles of organizing communities of indigenous small-numbered peoples of the North, Siberia and the Far East of the Russian Federation").
- The right to replace conscription military service with alternative civil service (in organizations of traditional branches of management and crafts) for persons from among indigenous small-numbered peoples leading traditional lifestyles, carrying out traditional management and engaged in traditional crafts (Articles 2, 4 of the Federal Law of July 25, 2002, "On Alternative Civil Service");
- Assignment of social pensions on special conditions (Articles 2, 11, 18 of the Federal Law of December 15, 2001, "On State Pension provision in the Russian Federation);
- Granting rights and developing measures to meet the cultural, linguistic, and educational needs of these peoples, taking into account their way of life (Federal Law of June 17, 1996 "On National and Cultural Autonomy" Law of the Russian Federation of October 25, 1991, "On the linguistic peoples of the Russian

Federation," the Law of the Russian Federation of July 10, 1992, "On Education," the Law of the Russian Federation of October 9, 1992, "Fundamentals of the legislation of the Russian Federation on Culture," etc.)
- Consideration of ethnic interests, compensation for the use of mineral resources in areas inhabited by small-numbered peoples (Article 7 of the Federal Law as amended on January 7, 1999 "On production sharing agreements."
- Rights related to the use of lands, forest and water resources, wildlife, and aquatic bioresources (art. 7, 31, 68, 78, 82, 95, 97 The Land Code of the Russian Federation, Articles 30, 48 of the Forest Code of the Russian Federation, Articles 3, 54 of the Water Code of the Russian Federation, Articles 48, 49 of the Federal Law of April 24, 1995, "On Wildlife, etc.) (Kryazhkov, 2007).

In its turn, the methodological basis of the article is based on the methods of scientific cognition, which make it possible to systematically and logically study the subject of research in the relationship, interdependence, and interdependence both at the theoretical (comparative legal, formal legal methods, analysis, synthesis, induction, deduction, and others) and at the empirical level (statistical analysis, research of normative legal acts and doctrine).

Problem Statement

In the Arctic, with a sufficiently low biological diversity of the Arctic systems, there are a significant number of endangered plant and animal species listed in the IUCN and Russian Red Books. The Arctic region has significant biological resources, both marine (fish, pinnipeds, cetaceans) and terrestrial (including such valuable commercial animal species as Arctic fox and sable). The biological resources of the Arctic for a number of centuries have been and remain the basis of the life of the indigenous peoples and peoples of the North, their unique economic structure and culture. Island territory of the Russian Arctic (the archipelagos of Novaya Zemlya, the Franz Josef Land, Severnaya Zemlya, the new Siberian Islands, Wrangel island) and a continental site (e.g., the Taimyr Peninsula, Chukotka Peninsula) have unique ecosystems, areas for research and tourism, which has no analogues (Yablokov, 1996a).

The Barents Sea is the largest offshore body of water in our country, surpassing the Baltic, Black, Azov, Caspian, and Aral Seas combined in its productivity. The Barents Sea produces from three to four million tons of seafood per year.

Highly productive shelf ecosystems of the southern part of the Barents Sea, along with pollution sources common to all Arctic seas, are affected by such a specific source as the Gulf Stream. Its polluting influence is manifested on the shores of the eastern part of the sea. They have turned into the largest European landfill of wood, garbage (nylon, plastics, glass, metal), the period of natural decomposition of which is hundreds of years. The width of these landfills, lying above the littoral, reaches 5–10 m. on the coastline with a length of more than 4 thousand km. The pollution of the shelf by long-range atmospheric transport from the mainland is of serious concern.

Arctic climate change is one of the most relevant areas of modern climate research. The fate of sea ice in the Arctic Ocean occupies a prominent place in them, since the cryosphere, of which they are a part, reacts particularly acutely to climate change and can both accelerate and slow down their development (Alekseev et al., 2013).

Along with the cryosphere, the peculiarities of the formation of clouds and atmospheric boundary layer, low moisture content of the air, unusual stratification of the Arctic Ocean, the specific role of the subarctic seas of the North Atlantic in the global thermohaline circulation (created by density gradients due to the heterogeneity of the distribution of temperature and salinity of ocean waters), and other features make the Arctic an extremely difficult object for forecasting and constructing climate scenarios (Kattsov & Porfiriev, 2013).

Coronaviruses are getting to people more and more often, because we provide them with more opportunities for this. In the last 50 years alone, the world's population has doubled, and the global economy has grown almost fourfold. Rapid migration from rural to urban areas and the creation of new urban centers have affected the demographic situation, lifestyle, and consumer behavior.

The most fundamental way to protect yourself from zoonotic diseases is to prevent the destruction of nature. Where ecosystems are healthy and bioavailable, they are resilient, adaptable, and help regulate diseases.

Under the leadership of Finland, a program for the conservation of natural diversity has been compiled for the Arctic region. This program is part of the promotion of the new global goals of the UN treaty on the conservation of biodiversity, which will be discussed in China in the fall of 2021. The post of chairman of the working group on environmental protection is another recognition of Finland as a country with extensive knowledge of the Arctic region – we have something to share with others (Pettersen, 2012).

A new report on the state of the natural diversity of the Arctic land territories proves that climate change is causing significant and partially unpredictable changes in the earth's ecosystems.

The Arctic is one of the four regions of the world designated by the intergovernmental panel on Climate Change.

Over the past 30 years (1980–2009) statistically significant positive temperature trends have been observed almost everywhere in the PDF in all seasons and in the whole year. The increase in the average annual air temperature over 30 years in the northern polar region was about 1.3 degrees Celsius (Alekseev et al., 2013).

Species characteristic of southern ecosystems are moving to the Arctic regions, the forest boundary is shifting to the north, and southern harmful insects and pathogens are actively multiplying in the North. Changes in the habitat and the number of important species used as food have an impact on food security, the existence, and the culture of indigenous peoples and local communities. Ensuring environmental sustainability is extremely important from the point of view of economic and social sustainability (Damski, 2021).

With regard to living resources, the necessary measures should be taken to ensure the protection of Arctic flora and fauna and the ecosystems on which they depend throughout all stages of intrusive work – it is necessary to pay special attention to biological species (e.g., fish, birds, whales, seals, polar bears, and other marine mammals), which represent resources consumed by humans and, first of all, by the indigenous population, as well as special habitats (such as ice field edge zones, coastal lagoons and barrier islands, wetlands, estuaries, bays, and deltas of rivers). Coastal natural objects that also need to be protected and/or avoided during offshore exploration and production include places widely used by waterfowl (places of dense nesting, brood rearing, molting, and stops during flights), reindeer (places of birth of offspring and insect shelters), and musk oxen. In the Russian Arctic, reindeer husbandry is the basis of life support for the vast majority of indigenous ethnic groups (Yablokov, 1996b). Many tundra reindeer herding farms are characterized by a reduction in the area of pastures due to overgrazing of deer. The condition of pastures is deteriorating, which is associated with a large number of deer and environmental violations associated with the development of explored deposits of natural gas, oil, and other minerals. For example, in November 2011, Anglo American, which owns 85% of the De Beers diamond monopoly, announced the discovery of a large-scale copper-nickel deposit in the municipality of Sodankul in Finnish Lapland and later submitted several applications for additional exploration work in the area of Sodankul and Inari municipality – the center of Finnish Lapland culture. Such actions of the company, as well as the possible start of the construction of mines, caused concern of the Sami Parliament and the concern of residents of Finnish Lapland (Selle & Strømsnes, 2010), mainly the area of the municipality of Inari, reindeer farms Ivalo, Hammastunturi, etc., since these works can have a negative impact on the nature of the region – its numerous reservoirs and fish stock, as well as traditional Sami crafts, such as, first of all, reindeer husbandry (Union of Reindeer Herding Associations, 2013).

Responding to the interests of human security and well-being, the main guiding policy in the Arctic should be the conservation of resources, which allows us to count on their sustainable rational use (Nordvågm, 2019).

Thus, the 1973 Polar Bear Conservation Agreement recognizes that the polar bear is an important resource of the Arctic region that needs additional protection, and Article 1 says that the extraction of polar bears is prohibited and for the purposes of the agreement, the term “extraction” includes hunting, shooting, and trapping. At the same time, each of the Contracting Parties takes appropriate measures to protect the ecosystems of which polar bears are a part, paying special attention to the components of habitats, as well as the nature of migration.

The Convention on Wetlands of International Importance, mainly as Waterfowl Habitats of 1971, states that the essential ecological functions of wetlands as regulators of the water regime and as habitats that ensure the existence of characteristic flora and fauna, especially waterfowl, and also that wetlands are a resource of great economic, cultural and recreational importance, the loss of which would be irreparable.

According to Article 1 of the Convention, wetlands are areas of swamps, fens, peat lands, or reservoirs – natural or artificial, permanent or temporary, standing or flowing, fresh, brackish or salty, including marine waters, and waterfowl are birds that are ecologically associated with wetlands (Convention on Wetlands of International Importance, mainly as Habitats of Waterfowl 1971).

Probable large oil spills, for example, only in the Pechora Sea threaten the death of most of the waterfowl of the western Arctic from the coast of Murmansk to Taimyr (Yablokov, 1996a).

In 1992, the Convention on Biological Diversity (CBD) was adopted in Rio de Janeiro. The preamble of the Convention notes the great importance of biological diversity for the evolution and conservation of life-sustaining systems of the biosphere and notes that in cases where there is a threat of significant reduction or loss of biological diversity, the absence of indisputable scientific facts should not be a reason for postponing measures to eliminate or minimize such a threat, and also recognizes the large and traditional dependence of many local communities and indigenous populations, who are the custodians of the traditional way of life, on biological resources, and the desirability of sharing, on an equitable basis, the benefits associated with the use of traditional knowledge, innovations, and practices relevant to the conservation of biological diversity and the sustainable use of its components. The objectives of the Convention (Article 1) are the conservation of biological diversity, the sustainable use of its components, and the sharing of benefits on a fair and equal basis. At the same time, according to Art. 2 "Biological diversity" means the variability of living organisms and their sources, including, inter alia, terrestrial, marine, and other aquatic ecosystems and ecological complexes of which they are part; this concept includes diversity within species, between species and ecosystem diversity (Convention on Biological Diversity, 1992).

In 2000, the 5th Conference of the Parties adopted the ecosystem approach as a strategy for integrated management of land, water, and living resources, aimed at protection and sustainable use based on the principle of social justice. It makes it possible to balance the three objectives of the CBD: protection, sustainable use, and fair distribution of benefits resulting from the exploitation of biological resources.

In 2004, the Arctic Council adopted a Strategic Plan for the Protection of the Arctic Marine Environment, which states that human activities affecting the marine environment of the North should be managed in such a way as to promote its conservation and protection, biological diversity, and sustainable development (Kukushkina et al., 2007).

The 1972 Convention on the Protection of the World Cultural and Natural Heritage notes that some values of cultural and natural heritage are of exceptional interest, which requires their preservation as part of the world heritage of all mankind and for this purpose an effective system of collective protection of monuments of outstanding universal, cultural, and natural significance is established.

According to Article 1, "cultural heritage"means, among other things:

- Elements or structures of an archaeological nature, inscriptions, caves or groups of elements that have outstanding universal value from the point of view of history, art or science

- Places of interest: works of man or joint creations of man and nature, as well as zones, including archaeological sites of outstanding universal value from the point of view of history, aesthetics, ethnology or anthropology

In Article 2, "natural heritage"means:

- Natural monuments created by physical and biological formations or groups of such formations that have outstanding universal value from the point of view of aesthetics or science
- Geological and physiographic formations and strictly restricted areas representing the range of threatened animal and plant species of outstanding universal value from the point of view of science or conservation
- Natural places of interest or strictly restricted natural areas of outstanding universal value from the point of view of science, conservation or natural beauty (Convention for the Protection of the World Cultural and Natural Heritage, 1972)

Health and safety of people in the Arctic, including indigenous and small peoples, given COVID-19 is a reminder that human health and environmental health are closely linked. There are about 8 million species of life on Earth, of which man is only one. They include approximately 1.7 million unidentified viruses recognized as a type that can infect humans, existing in mammals and waterfowl. Any of them can be transferred to people if we don't take preventive measures now.

Threats to human health and safety, including dangerous working conditions, are factors contributing to accidents that can lead to environmental pollution. Potential threats or hazards affecting the health and safety of personnel during offshore oil and gas operations in the Arctic can take different forms and come from many sources. The main sources include, in particular, the severe climatic conditions of the Arctic, the structural integrity of the installation, blowouts, fires, and explosions, failure of equipment, transportation of personnel and materials supplied, and work on drilling, development, injection wells, and her overhaul (American Petroleum Institute (API), 1993).

Another tool to combat the risk factors and their elimination was the creation of the "Committee for health, safety and the environment" (Canadian Standards Association (CSA), 1991).

Twenty-six small indigenous peoples live in the regions of the Far North of the Russian Federation, who have preserved to this day the continuity of the main forms of traditional nature management: hunting, fishing, fishing of sea animals, and marine living resources. Observance of cultural traditions and knowledge of the languages of the peoples of the North are increasingly being displaced from everyday life and remains mainly in the field of traditional nature management and folklore and observance of beliefs and rituals. Therefore, traditional nature management is becoming increasingly important not only from an economic point of view (as a means of life support) but also as a barrier protecting the small peoples of the North from dangerous processes of degradation and ethnocultural assimilation, which, against the background of a low birth rate, can lead to the disintegration of spiritual culture and ethnic identity (Yablokov, 1996b).

According to the results of AMAP research, in the future the most serious threats to the Arctic marine environment are persistent organic pollutants (POPS), as well as the development of oil fields and the transportation of petroleum products.

Considering that pops pose a serious and increasing threat to human health and the environment, the Stockholm Convention on Persistent Organic Pollutants was adopted in 2001, including a list of 12 pops (aldrin, chlordane, DDT, dieldrin, dioxins, endrin, furans, hexachlorobenzene, heptachlor, mirex, PCBs, and toxaphene). The preamble notes that organic pollutants have toxic properties, exhibit resistance to decomposition, are characterized by bioaccumulation, are subject to transboundary transport by air, water, and migratory species, and are deposited at a great distance from the source of their release, accumulating in terrestrial and aquatic ecosystems.

The Convention notes that Arctic ecosystems and indigenous communities are at particular risk as a result of bio-amplification of the effects of persistent organic pollutants, and that contamination of traditional food products used by them is a public health issue.

The Convention reaffirms once again that States, in accordance with the Charter of the United Nations and the principles of international law, have the sovereign right to develop their own resources in accordance with their policies in the field of environment and development, and are responsible for ensuring that, as a result of activities carried out within their jurisdiction or under their control, they do not cause damage to the environment of other States or areas not falling under their national jurisdiction.

Article 3 deals with measures to reduce or eliminate emissions from deliberate production and use. According to it, each Party:

> "(a) prohibits and/or takes administrative measures necessary to eliminate: (i) its production and use of chemicals listed in Annex A.
>
> (ii) Its import and export of chemicals listed in Annex A. It includes Aldrin, Chlordane, Dieldrin, Endrin, Heptachlor, Hexachlorobenzene, Mirex, Toxaphene, Polychlorinated Biphenyls (PCBs)."

According to the Convention, "best environmental practices" means the application of the most appropriate combination of environmental management measures and strategies (Stockholm Convention on Persistent Organic Pollutants, 2001).

The UN Declaration on the Rights of Indigenous Peoples adopted at the 61st session of the UN General Assembly notes that respect for the knowledge, culture, and traditional practices of indigenous peoples contributes to sustainable and equitable development and proper care for the environment (Kryazhkov, 2007). And paragraph 1 of Article 29 says that: "Indigenous peoples have the right to preserve and protect the environment and the productive capacity of their lands or territories and resources." States create and implement assistance programs for indigenous peoples in order to ensure such conservation and protection without any discrimination (Andreev, 2006; Teps, 2006).

It is also necessary to take into account the ILO Convention No. 169 On Indigenous and Tribal Peoples in Independent Countries (Lee, 2004; Tkachenko & Koryukhina, 1995). The ecological factor becomes extremely important for the ethnic survival of the indigenous peoples of the North, inextricably linked with nature and landscape. Small-numbered peoples depend on natural conditions to a greater extent than the population of industrially developed territories. In this case, the protection of nature in the places of residence of indigenous small-numbered peoples is the key to the preservation of the ethnic group.

In 2000, the European Convention on Landscapes was adopted in Florence within the framework of the Council of Europe. It speaks about the desire for sustainable development based on a balanced and harmonious relationship between the requirements of society, economic activity, and the natural environment, and it is noted that the landscape plays an important role in ensuring the attention of society to cultural, environmental, and social issues and is a resource conducive to economic activity.

According to paragraph a) of article 1 the “landscape” means an area, as perceived by people, whose characteristic features are the result of the action and interaction of natural and/or human factors;

n.) says that “landscape policy“means an expression by the competent public authorities of General principles, strategies and recommendations that allow to take special measures for the protection, management and planning of landscapes;

d) notes that “landscape protection“means actions to preserve and maintain specific or characteristic features of the landscape, justified by its value for heritage in connection with its natural features and/or human activity.

It should be noted that the scope of the Convention includes not only land areas but also inland waters and marine areas. The Convention concerns landscapes that can be recognized as having special value, as well as unremarkable areas and areas experiencing decline. Unfortunately, in many areas of the Arctic, the soil layer has been disturbed and equipment, used barrels, etc. have been abandoned. Of course, these disturbed landscapes need to be restored to their original state (restitutio in integrum) as far as possible. Here it could be proposed to adopt a law of the Russian Federation on the recognition of Arctic landscapes as legally protected objects and an essential component of the surrounding world, embodying the diversity of the common cultural and natural heritage of people and the basis of their lives.

Programs to identify biota (flora and fauna) that are particularly sensitive to pollution from oil production and particularly sensitive to marine oil pollution should take into account not only adult stages and stable communities (e.g., feeding areas of seabirds, coastal communities, etc.) but also those early stages of the life cycle of plants and animals, including gestation periods, which are most vulnerable to the effects of oil and chemical products, compared with adult stages. Thus, before the implementation of the monitoring program, not only the most vulnerable species should be identified but also the most vulnerable stages of the life cycle should be identified.

Wherever appropriate, developing companies should consider the possibility of involving indigenous groups in monitoring contract work, as well as using their traditional knowledge to identify historical extreme conditions and environmental dynamics.

The most effective way to protect human health and the environment from the threats posed by hazardous waste is to ensure that their production is reduced to a minimum in terms of their quantity and/or capabilities. To minimize the production of hazardous waste, it is necessary to introduce environmentally friendly, low-waste technologies, develop various methods of recycling, conscientious control and dispatch and management systems. Of course, it is necessary to take measures to ensure that the collection and disposal of hazardous waste are carried out in accordance with the interests of protecting human health and the Arctic environment.

Paragraph 2 of Article 29 of the UN Declaration on the Rights of Indigenous Peoples of 2007 states that: “States take effective measures to prevent the storage or disposal of hazardous waste on the lands or territories of indigenous peoples without their free, prior and informed consent” (Kryazhkov, 2007).

In 1989, the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal was adopted, which notes the risk of damage to human health and the environment by hazardous and other wastes and their transboundary movement, and indicates the growing threat to human health and the environment as a result of the increase in the production and transboundary movement of hazardous and other wastes and their complex nature.

Wastes fall into any category specified in Annex 1, unless they possess any of the properties listed in Annex III.

Annex 1 “Categories of substances subject to regulation” includes, among others:

Y9 Waste in the form of mixtures and emulsions of oils/water, hydrocarbons/water;

Y10 Waste substances and products containing polychlorinated biphenyls (PCBs) and/or polychlorinated terphenyls (PCTs) and/or polybrominated biphenyls (PBBs) and/or their Impurities (Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal, 1989).

Article 2 states that: “wastes” are substances or objects that are disposed of, intended for disposal, or subject to disposal in accordance with the provisions of national legislation.

Discussion

Readiness in connection with oil pollution should ensure that the sources of any oil pollution will be blocked, and the spilled oil will be efficiently collected and localized near the source of the release as soon as possible. Such readiness should also include the protection of public health and environmental resources such as coastlines, water, and ice boundaries, as well as economic resources and cultural values. The prevailing consideration here should be the health and safety of all people who may be involved in the incident (e.g., the local population, members of response teams, volunteers).

When planning offshore oil and gas operations, it is necessary to consult with the indigenous population living in the area, take the necessary measures to ensure that cultural traditions, values, customs, rights of indigenous people, and their use of resources are taken into account. In cooperation with oil and gas companies, the Arctic states should look for ways to meet the economic, social, medical, and educational needs of the indigenous inhabitants of the Arctic. At all stages of oil and gas works, it is necessary to try to leave untouched historical sites, archaeological sites of prehistoric sites, places of worship, shipwrecks of historical significance, and other potentially important cultural sites, taking into account the Convention on the Protection of the World Cultural and Natural Heritage of 1972.

Conclusions

We believe that it is necessary to develop a comprehensive approach to restoring the disturbed environment of the Russian Arctic, which would not only meet the goals of industrial and social development but also meet the interests of the population living in the Arctic, including indigenous peoples, and would also contribute to sustainable development.

Thus, it is necessary to create relations of cooperation and mutual understanding with the indigenous population for the selection of biological samples, observation, and monitoring of the state of the environment.

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Spatial Development Institutions of the Russian Arctic Zone

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Contents

Abstract

The chapter presents the results of a study into the institutional foundations of the Russian Arctic zone spatial development, provided both by Russian normative documents and state programs and by international treaties and agreements. Institutional foundations are represented not only by formal institutions, but also by informal ones (the culture and traditions of the Arctic peoples). It should be noted that informal institutions for regulating social relations among the peoples of the Arctic are of greater importance than formal institutions, which is the basis for developing the concept of strategic socioeconomic development of the Arctic. Spatial economic development should to a greater extent be based, according to the authors, on informal institutions – no efforts are required by the authorities to embed these institutions, since society is already ready to build economic and legal relations on the basis of already embedded informal

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institutions. Here lies the possibility of both successful spatial development and potential conflicts between local informal institutions and federal formal institutions.

Introduction

Institutions are an integral part of any national economy functioning. They provide the basis for the development of industries and territories. However, not so many papers are devoted to institutional research. The popular topic in Russian papers is the institutions of entrepreneurship, which is largely due to the development of market relations, but the institutional aspect of the development of territories, regions, or the state, which contains economic systems and has spatial characteristics, is revealed in a small number of papers and is not main purpose of these studies.

There are two approaches to understanding content of institutions in this chapter – behavioral and structural. According to the behavioral approach, we use one of the most common definitions proposed by North: "the rules of the game in a society or, more formally, are the humanly devised constraints that shape human interaction" (North, 1990). This definition intersects with the concept of Williamson's *institutional environment* – "the rules of the game that define the context within which economic activity take place" (Williamson, 1993). A third interpretation is necessary, which complements the understanding in the development institutions' study: "the sets of working rules that are used to determine who is eligible to make decisions in some arena, what actions are allowed or constrained, what aggregation rules will be used, what procedures must be followed, what information must or must not be provided, and what payoffs will be assigned to individuals dependent on their actions" (Ostrom, 1990). The second approach includes the institutions as organizational structures whose activities are aimed at providing and regulation different spheres of life. Williamson called such institutions as institutional set-up – "the contractual relation or governance structure between economic entities that defines the way in which they co-operate and/or compete" (Williamson, 1993).

Conducting a comparative analysis of domestic and foreign experience in strategic planning for the development of the Arctic, Nikolaev has laid the processes of improving the economic space organization and the population territorial organization as the framework of the strategic plan realization for the regions' development, which referred to the Arctic, as the basis of spatial development (Nikolaev, 2021). Kondral and Morozov wrote about the significant influence of foreign policy factors on the Arctic spatial development, which transfers the development processes from the economic and organizational plane of the national and world economy to the geopolitical (Kondral & Morozov, 2016).

Innovations as an important factor in the space and economy development of the Russian Arctic regions, primarily in the mining and transport industries, are considered in the many researchers' papers (Nikiforova, 2014; Tsukerman, 2013). A significant role is assigned to the Northern Sea Route, which can serve both internal needs (connecting the continental shelf and the mainland) and external (cut the time for transporting goods by sea from the Pacific to the Atlantic) (Agarkov et al., 2019; Pankova & Tarasova, 2020). Sevastyanov et al. consider tourism as the basis for sustainable development of the Russian polar regions due to the positive experience of the Arctic countries (Sevastyanov et al., 2015).

Considering the problem of the Arctic regions spatial integration, Kozhevnikov and Patrakova propose not unifying the model of the territory spatial development but considering the peculiarities of the regional socioeconomic system and development goals for the long term (Kozhevnikov & Patrakova, 2020). Leksin and Porfiriev showed the space limits beyond the region boundaries, the need to consider the mutual penetration of neighboring regions' spaces, and the reflection of these facts in regulatory documents (Leksin & Porfiriev, 2018).

Pliseckij and Pliseckij draw attention to the need to consider the region peculiarities (both functioning and adopting target indicators) when forming a policy for the Arctic development and developing complex, rather than sectoral programs (Pliseckij & Pliseckij, 2019), as it possible to formulate regional spatial development strategies (Proskurnova, 2020).

There are two directions of an institution concept of the Arctic spatial development – institutions as rules, and institutions as organizations. At the first direction, the spatial development institutions of the Arctic are based on international and national law. International law primarily determines the spatial limits of territories and zones of interest in the Arctic for each state. The Arctic specificity lies in glaciers, which can push the zone of economic interests further than 200 miles for country, and the priority right of states to the continental shelf and its mineral resources under the Arctic Ocean remain incompletely resolved (Mazur, 2010).

Revenko and Isachenko linked the institutional processes of the Arctic space development with the state industrial policy and the programs, primarily the development of infrastructure facilities, the scientific and educational projects, and measures to protect and restore the Arctic ecology (Revenko & Isachenko, 2017).

Balobanov identifies the sequential elements of the Arctic spatial development that forming the institutional framework: policy-strategy-program-project (Balobanov, 2020). At the same time, the functioning of this program institution takes place in two planes – the interaction of state and municipal government, as well as the use of "manual control" in certain situations, and secondly, the realization of private interests in the context of using shadow relations.

Gubina and Provorova characterized the legal and regulatory framework for the development of the country's Arctic space as underdeveloped, with low efficiency of application, incompletely covering all aspects of the socioeconomic sphere (Gubina & Provorova, 2018), which necessitates the improvement of the legal institution for the development of the Arctic and its space.

Zhavoronkova and Agafonov note that in the Arctic it is possible to realize and test projects that will be of a programmatic, international, economic, environmental, scientific, and technical nature and may contain new solutions and developments (Zhavoronkova & Agafonov, 2018). These projects will require the improvement of legal and regulatory frameworks to form a unified documental base for the Arctic spatial development.

Tatarkin et al. proposed factors for assessing the institutional security of the Arctic territories development such as federal laws, government decrees, different agreements on Arctic subsoil use, state strategies and programs for Arctic development (few directions), business concepts of companies engaged in the Arctic, etc. (Tatarkin, 2013).

Within the framework of the organizational approach, it is possible to note the development model of the Far North part of the country, including the Arctic, created by Bashmakova (2012). There are three levels in this model – global, national, and regional; each consists of institutional organizations or institutions at the micro level (companies) that perform the functions of developing and preserving the Arctic (Bashmakova, 2012). At the global level, the main institutions, related to the functioning and development of the Arctic, include different organizations and forums such as the Arctic Council, the Council of the Baltic Sea States, International Work Group for Indigenous Affairs, etc. The national level includes the institutions responsible for the formation and realization of state policy in the field of sustainable development of the Far North and the Arctic. The regional level is represented by the activities of the regional governments and businesses whose activities are related to the Arctic.

Although at the international level the Arctic Council is considered the main institution, which is a platform for discussing the problems of the Arctic existence, Stokke (2011) described it as "soft" with little impact on Arctic environmental issues.

Katorin notes the role of state and nonstate structures that realize political, economic, and sociocultural functions in the institutionalizing process of the Russian Arctic zone development (Katorin, 2016). The complexity of the institutionalization process itself lies in the heterogeneity of the institutional environment, because of which is it necessary to coordinate and consider actions at the regional, federal, and international levels, including developing and accepting the documents (programs, projects, regulatory acts).

Pliseckij and Shedko note that particular institutions – such as coordinating departments, information centers that accumulate and provide data sets on the Arctic, interregional development centers whose activities are related to innovations, venture funds, the promotion of regional products in foreign markets, etc. – are not used or are used insufficiently in the development of undeveloped territories, which include the Arctic zone (Pliseckij & Shedko, 2019).

Activities in the Arctic are associated with natural and climatic resources. Any changes in the Arctic environment can have negative consequences for the rest of the planet – from rising sea levels in the event of melting glaciers to changes in the flora and fauna of the world's oceans. These difficulties imply the coordination of the formal and informal institutions functioning to prevent the negative consequences of both the environment and the people living in the Arctic. Rahman et al. analyzed the problem of institutional gaps in natural resource management. They consider both formal institutions based on legal acts of the national and international level, and informal ones, which are formed by the usual norms of behavior adopted in a particular community but have no legal force (Rahman et al., 2017). Informal institutions in the Arctic depend on the elements of the local population culture, which in our opinion include both the conventions and traditions of the Arctic indigenous peoples, and the population that migrated to these territories, as well as the system of interaction between the local indigenous and nonindigenous population (Yankovskaya et al., 2020; Osipov et al., 2020, 2021).

Based on the behavioral and structural approaches to defining the concept of institutions, this study carried out a content analysis – detailing regulatory documents and state programs for the Arctic spatial development as the basis of a formal institution in a behavioral context, the status and functions of Russian and international nonprofit organizations and governments related to activities in the Arctic and belonging to the category of structural formal institutions – and also analyzed the correlation of regulatory documents governing any activity in the Russian Arctic zone with the traditions and conventions of the indigenous peoples of the Russian North, which determine informal institutions that affect the spatial development of the Arctic parts of the Russian Federation.

The sources of data and documents for the analysis of the formal institutions of spatial development of the Russian Arctic zone were the official bases of regulatory documents, the government of the Russian Federation, and international organizations and associations. To analyze informal institutions of spatial development, we used data from papers by Russian and foreign researchers about the traditions, conventions, and way of life of the Arctic indigenous peoples.

Rethinking Spatial Development Institutions of the Russian Arctic

The spatial development institutions of the Russian Arctic include several areas. Formal institutions are represented by behavioral ones, regulated by Russian and international laws and programs, or structural ones, which are represented by Russian and international governments and organizations. Informal institutions are formed by the conventions and traditions of the Arctic indigenous peoples, as well as by the system of interaction between the indigenous and nonindigenous population of the Arctic zone.

The first group of institutions is primarily represented by the Spatial Development Strategy of the Russian Federation until 2025, the State Program for the Socio-Economic Development of the Arctic Zone of the Russian Federation, and the Presidential Decree on the foundations of the state policy of the Russian Federation in the Arctic for the period up to 2035. In addition to general provisions within the framework of the Spatial Development Strategy in the Arctic part, it is planned to develop the international transport corridors that ensure the traffic flows in the east-west and north-south directions, which will include the development of transport networks and nodal points (ports, stations, airports), as well as an icebreaker fleet capable of providing traffic along the Northern Sea Route. The transport network development should increase the involvement of far sparsely populated areas of the Arctic zone in every economic process. Also, the programs are envisaged to develop information and telecommunication networks and reduce the regions digital inequality (Osipov, 2021), which is especially important for the Arctic due to the low population density, the great distance of settlements from each other, and restrictions on access to high-speed Internet due to the impossibility of laying networks in permafrost, etc. In this strategy, infrastructure development is linked to mineral resource centers and services to the Northern Sea Route, not prioritizing the development of living conditions for the indigenous and nonindigenous population – this means it is mainly focused on the functioning of the mining industry and the marine fleet, including the ice fleet. The Strategy classifies the Arctic zone as a resource region, and not as a place of permanent residence and activity of population groups with different traditions and lifestyles. In the strategy, the perspective specialization of the Russian Arctic regions is mainly related to the traditional sectors of the national economy, alongside the characteristic of these territories. Tourism can be considered a relatively new direction, which might become quite popular if the tourism infrastructure becomes developed like Norway or Iceland.

The next document is the state program of the Russian Federation "Socio-economic development of the Arctic zone of the Russian Federation." Even though one of the principles of state policy and this state program is the sustainable development of indigenous peoples living in the Russian Arctic zone, the subprograms are mainly focused on the development of the material base and production, primarily mining, and the Northern Sea Route's infrastructure. According to this state program and its *subprogram 1 "Formation of support zones of development and ensuring their functioning, creation of conditions for accelerated socio-economic development of the Arctic zone of the Russian Federation,"* only one region – the Chukotka Autonomous District – declared support for the development of the traditional economy activities of Arctic indigenous peoples (reindeer husbandry, marine animal hunting, fishing, folk crafts, etc.).

State policy in the Arctic by its goals coincides with the strategies for the spatial development of Russia and the Arctic socioeconomic development and is a generalizing document on the goals, objectives, and areas of activity in the Arctic. The state policy goals are to improve the living standards of the Arctic population, including indigenous peoples, the economic development, environmental protection (which should contribute to the preservation of the habitat and traditional way of life of the indigenous peoples), ensuring national security in this region, and maintaining mutually beneficial international cooperation.

In addition to these documents, the spatial development and greater involvement of the Arctic territory in economic activity are also laid down in the federal project "Northern Sea Route" as part of the Comprehensive Plan for the Modernization and Expansion of the Main Infrastructure for the Period up to 2024, which provides for the development of the port infrastructure of the Northern Sea Route, trails, and safety.

The spatial development of the Arctic zone in terms of measures and programs should not contradict the Federal Law "On guarantees of the rights of the indigenous peoples of the Russian Federation" (Federal Law 82), which provides the rights to protect the original habitat, traditional lifestyle, economic activities, and crafts, which implies considering the indigenous peoples interests in the measures for the region development. The Arctic territories' use for the development of priority specialization, which mainly include the transport and mining industries, is also regulated by the Federal Law "On the territories of traditional nature management of the indigenous peoples of the North, Siberia, and the Far East of the Russian Federation" (Federal Law 49). Despite the fact that indigenous peoples have the right to conduct activities and use natural resources in territories of traditional nature use, there are certain restrictions: free use of minerals only from the list of common minerals, which is determined by each region of the Russia, but not any mineral, located in the subsoil, and the lands located in these territories, can be withdrawn for state and municipal needs, but with the payment of compensation. These restrictions reflect the incompleteness of the indigenous peoples' rights to natural resources.

International legislation, as a formal institution, is represented by many normative documents, some of which have a recommendatory nature or have not been ratified by separate countries. International laws cover various issues of the Arctic, but in terms of spatial development, the UN Convention on the Law of the Sea, which contains the basic principles of using the sea space and the state maritime boundaries, can be attributed to the main ones. In the Arctic, the bounds of the exclusive economic zone are complicated by the issue of the limits of the continental shelf and assigning a mineral deposit to that state located on the mainland, the continuation of which is a specific continental shelf. The resolution of issues related to the boundaries of exclusive economic zones in the Arctic Ocean would make it possible to adopt long-term development programs, both national and international.

At the structural approach of the spatial development institutions of the Russian Arctic zone, there are two groups of institutions – national and international. National ones include governments and organizations, while the other category consists of international organizations and forums.

The national institutions consist of specialized ones – the Ministry of the Russian Federation for the Development of the Far East and the Arctic, the State Commission for the Development of the Arctic, and the Corporation for the Development of the Far East and the Arctic. The Ministry performs the functions of realizing state programs for the Arctic development, as well as attracting investments in projects carried out in the Russian Arctic, including in the development of the Northern Sea Route and tourism. The State Commission is responsible for clarifying the state policy for the Arctic development according changes in the internal or external environment and coordinating the activities of state and municipal administration, as well as organizations. The activities of the state commission are advisory in nature. The Corporation for the Development of the Far East and the Arctic was created to provide support to investors and residents in the projects or activities in the Arctic. The Corporation is responsible for the investment area of the Ministry for the Development of the Russian Far East – support for investors, the development of the Northern Sea Route, and tourism in the Arctic.

International institutions are primarily represented by the UN and its subdivisions dealing with issues related to the Arctic – ecology and environmental protection, preservation of the heritage of indigenous peoples, defining the borders of states, carrying out activities in the Arctic, etc. The spatial development of the Russian

Arctic is directly related to the Commission on the Continental Shelf, to which the Russian Federation applies to resolve the issue of the boundaries of the economic zone of interest in the Arctic Ocean, which could develop mining in the Arctic and realize of the Northern Sea Route project.

Another institution of this group is the international forum Arctic Council, which was formed in 1996 to discuss the problems of the Arctic region. It includes 8 Arctic states, 5 organizations of Arctic indigenous peoples and observers represented by non-Arctic states, and organizations that interparliamentary, intergovernmental, or nongovernmental. Due to the Arctic spatial development, this Council exerts influence through the discussion of the Arctic environment protection, reduction of pollution, prevention and resolution of the consequences of emergencies, and promotion of sustainable development. These issues involve the development of uniform requirements, approaches, and principles for conducting activities in the Arctic, which can increase the costs of projects in the Arctic due to stricter requirements and develop a common vision and strategy for conducting activities, which increases the degree of interaction between states and the predictability of the behavior of partners in the region. Spatial development is linked to the Working Group on Sustainable Development in the Arctic, whose activities are related to the discussion of the information and transport infrastructure development to increase their accessibility, the introduction of sustainable energy throughout the region, and the business development in the Arctic in every sector, including traditional activities of indigenous peoples.

Informal institutions can be divided into two subgroups – the organizational culture of the Arctic territories, and the culture of the Arctic indigenous peoples. The region organizational culture accumulates the organizational cultures of economic entities, industries, government, etc. of this region. The Russian Arctic zone includes several subjects of the Russian Federation in whole or in part, and each region will have its own organizational culture, which influences the policy of spatial development of the Arctic regions.

There are about two dozen indigenous peoples with their own unique cultures in the Russian Arctic. Common to these peoples is the extreme living conditions, activities, and dependence on nature. Indigenous peoples engaged in traditional economic activities are highly dependent on the natural conditions and the need to minimize the consequences of the industrial development of the Arctic, including in the realization of programs for the spatial development of the region. Protection of the rights and interests of indigenous peoples is ensured by both federal and regional legislation. Tishkov et al. (2016) mention the practice of the administration of the Yamalo-Nenets Autonomous District to attract business for protecting the habitats and cultural heritage of indigenous peoples. Land allocation for the company’s activities is carried out with the participation of the Association of Indigenous Minorities of the North “Yamal – to the descendants!”, at the same time, companies, in the case of granting land that belonged to pasture places, must make compensatory payments to the indigenous peoples who used these territories. This example characterizes the system of interaction between stakeholders not only in determining the purpose of land, as the main element of the economic and

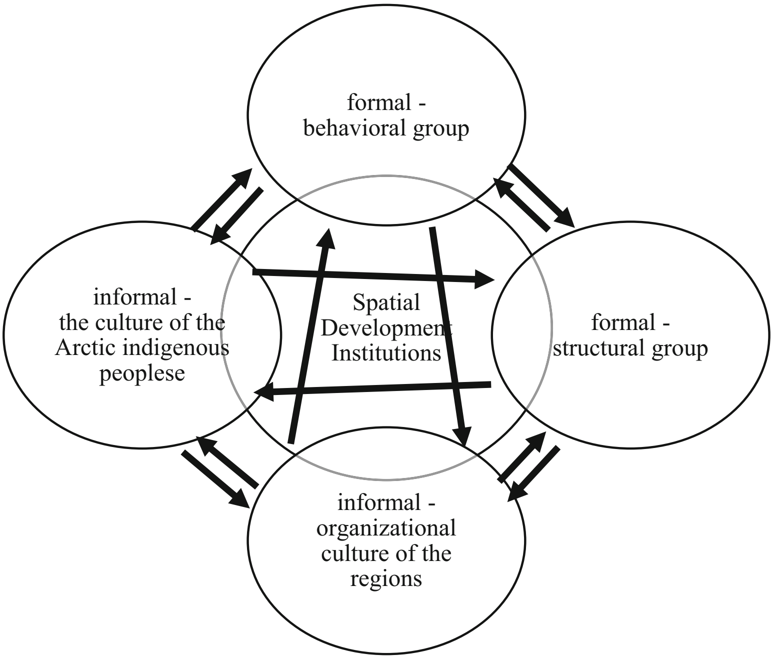

Fig. 1 Scheme of interaction of spatial development institutions. (Source: compiled by the authors)

spatial development of the region, but also the interaction of the previously considered institutions: behavioral formal (federal and regional legislation), structural formal (executive authorities of the Yamal-Nenets Autonomous District), informal institutions (the organizational culture of the region as a system of interaction between subjects (government–companies, government–indigenous people, companies–indigenous people)), and traditional economic activities of indigenous peoples.

Figure 1 shows the scheme of interaction and mutual influence of the spatial development institutions of the Arctic region. It can be noted that, unlike the well-developed territories of the country, an informal institution consisting of the Arctic indigenous peoples' cultures has a significant impact on the spatial development. In both national and international legislations, agreements between governments and various organizations representing the interests of indigenous peoples are aimed at protecting the indigenous peoples of the North and their traditional economic activities. At the same time, in the Russian well-developed territories, the local population in this system of relations would be represented by the organizational culture of the region as an informal institution, as well as by public associations and organizations as a formal one. The state policy, both in general and in terms of the spatial development of the Arctic zone, presupposes the preservation and maintenance of all cultural elements of the indigenous peoples.

Discussion and Conclusions

There are two groups of institutions influencing the spatial development of the Arctic, each represented by two subgroups. Despite the different approaches to identifying groups, we can talk about their close coherency and mutual influence on each other. The cultural traditions and conventions of indigenous peoples, including in economic activities in a traditional way, are directly related to the environment, which is unique in the Arctic. The constitutionally guaranteed right to preserve the historical and cultural heritage due to the uniqueness of living conditions in the Arctic necessitates the existence of additional legislation aimed at protecting and supporting the cultural heritage of the living environment of the Arctic indigenous peoples. Many companies that invest in facilities in the Arctic and carry out their activities are realizing social projects for supporting the local population. The example of the interaction of stakeholders in the distribution of lands in the Yamalo-Nenets AD allows us to draw attention to the fact that such stakeholder as the local population is divided into two groups – indigenous peoples and nonindigenous people permanently residing in this territory – when we talk about various projects and development programs in the Arctic. Therefore, the Arctic is characterized by a greater number of formal and informal institutions of spatial development, which reflect and protect the interests of all participants and contribute to the state policy in this macroregion development. However, we would like to draw attention to the incomplete consistency in the functioning of all institutions in the spatial development policy of the Arctic. The analyzed programs and documents related to the Arctic zone's development contain goals and objectives that involve improving the quality of life of this region's residents, while the subprograms and activities are aimed only at the investment projects of business and attracting partners. The link between the regional economy development and an increase in the level and quality of life is unconditional, but the specific natural and climatic conditions, the far distance of the Arctic, the complexity of the construction, and maintenance of infrastructure imply the acceptance of additional programs and projects for the development of social living conditions in this region, which would make possible to increase the attractiveness of the Arctic territory for permanent residence and development of the national economy sectors that are not related to mining, and also preserve the opportunity for the Arctic indigenous peoples to lead a traditional way of life and at the same time use modern achievements of science and technology.

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State Policy Implementation in the Arctic

Reputational Potential and Risks of the Russian Government

Nina N. Rozanova and Yulia V. Gnezdova

Contents

Abstract

The chapter presents the results of the analysis concerning the state policy of the Russian Federation in the Arctic in the context of the reputational approach. It is reasonably considered that Russia turns up trumps presenting the Arctic as one of the main geopolitical territories, which adds to its international image. At the same time, internal political trust is also important. Moreover, we should consider the opinion of the country's citizens themselves about the Russian Government, which is formed through the assessment of its activities and effectiveness in the Arctic, an important area of national priority. We systemize positive and negative aspects of the implementation of the state policy of the Russian Federation in the Arctic. The research is based on possible increase in the reputational potential of the government for the country's population, as well as potential risks that become threats to its reputation.

Keywords

The Arctic zone · The Russian Arctic · Reputation of power · Reputational potential · Reputational risks

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Introduction

The world community's interest in the Arctic has significantly increased over the past decade. Literature often notes that we live in the "Arctic age," since this region is a key for the future of humanity (Pupkova, 2014). A unique region with the richest reserves of natural resources and prospects arising due to climate change, the possibility of organizing and developing new global routes is becoming the object of competing interests of many countries.

Russia is a key player in the Arctic. It has been since the eighteenth century, when M.V. Lomonosov, an outstanding Russian scientist, stated that "Russian power will grow in Siberia and the Arctic Ocean" (Kontorovich et al., 2010). According to experts, the total value of all minerals in the northern territories of Russia exceeds $22.4 trillion. Less than 10% of the total population of the country lives in the Russian North, while its ratio in national income is up to 20%. The twenty-first century proves that the present and future development of the state largely depends on using the potential of the Russian Arctic. The spectrum of Russian national interests in the Arctic includes the spheres of economics, geopolitics, science, and ecology. A transition to the sustainable development of the Arctic zone is a key factor of the transition to the country's accelerated development as a whole (Pilyavsky, 2011). It is the most important driver of the expansion of the country's economic and geopolitical positions (Polar Index, 2018).

For Russia, the Arctic is a historically formed sphere of strategic and geopolitical interests. Russian navigators made the first attempts to go north in the eleventh century. However, in the seventeenth century, tsarist decrees secured the exclusive rights of Russia in some Arctic regions (the history of Arctic exploration is an independent subject of study, referred to, e.g., by Agapov and Kliueva (2018), Mazur (2014), Serikova (2016), and Shirina (2001)). The active development and exploration of the Arctic, elevated to the tasks of national importance, accompanied the history of both imperial and Soviet Russia. On April 15, 1926, the Presidium of the CEC of the USSR adopted a resolution, according to which all lands and islands between the meridians of $32°4'35''$E and $168°49'30''$W located in the Arctic Ocean to the north of the USSR coastline and to the North Pole were declared the territory of the Soviet Union (TASS, 2019). This regulatory act is considered the birth of the Russian Arctic.

A rebirth of the region happened in the 2000s, when the regulatory framework regarding its development was formed; the current borders were defined in 2014 by the Presidential Decree "About Land Territories of the Arctic Zone of the Russian Federation" (President of the Russian Federation, 2014). Over the years, the borders of the Arctic were expanded twice in accordance with Presidential Decrees No. 287 of June 27, 2017 (President of the Russian Federation, 2017) and No. 220 of May 13, 2019 (President of the Russian Federation, 2019b). In 2020, territories receiving state support for entrepreneurship were added to the Arctic zone (Federal Assembly of the Russian Federation, 2020).

Contemporary state policy of Russia in the Arctic dates back to September 2008, when the President approved the Basics of the State Policy of the Russian

Federation in the Arctic for the Period till 2020 and for a Further Perspective (President of the Russian Federation, 2008). In 2013, a corresponding strategy for the development of the Arctic zone was adopted (President of the Russian Federation, 2013). In 2014, the Government adopted a state program (Russian Government, 2014). These have become the main mechanisms for implementing state policy according to other federal and departmental target programs, industry strategies, regional and municipal programs, and programs of major companies providing for measures for the integrated development of the territory of the Arctic zone.

The assessment of the state policy effectiveness in the Arctic has an important value domain in the opinion of the citizens of the Russian Federation, converted into the level of domestic political trust and the authorities' reputation (trust is a key essential indicator of reputation; refer to Shtompka (1996), Fukuyama (2008)). Being the most important of the national priorities, the state policy for the development of the Arctic region is becoming one of the main focuses of public attention. Hence, the public assessment can significantly affect the overall reputation of the Russian Government.

The study of the government's reputation, conducted by the author on the example of the state authorities of the Smolensk region since 2012, allowed us to define the reputation considering the public opinion significant for the citizens themselves (based on the results of sociological studies of the public opinion in the region). The (regional) government's reputation is a set of stable, objectively formed value beliefs and rationally conscious evaluative opinions of the public in the region about the government. They cause a sense of trust and reflect the degree of effectiveness of the government's activities to meet the citizens' interests and needs in creating conditions for a decent life. The government's reputation is the most important resource for its development; it gives government additional, socially significant advantages.

The results of the expert assessment within the framework of Russian Foundation for Basic Research (RFBR) research project "The concept of "reputation of power": the essence, content, laws of functioning in the reputation space" allow us to identify the reputation of the Russian Government with a value attitude to it (formed due to its key characteristics such as closeness between the authorities and people, honesty, responsibility, justice, openness, etc.) involving the idea of a proper, normative, reference model of power, as well as citizens' opinions, assessments of the authorities' actions, and their effectiveness.

Thus, considering the implementation of the state policy of the Russian Federation in the Arctic, we address the issue through the prism of the reputational approach. By reputational potential of the authorities, we understand those aspects of the state policy implementation in the Arctic that form a positive opinion about the Russian Government and create its reputational capital. By reputational risks, we understand those actions of the government that can put its reputation at risk because of ill-considered or wrong solutions, low efficiency, and negative consequences of the state policy implementation in the Arctic zone.

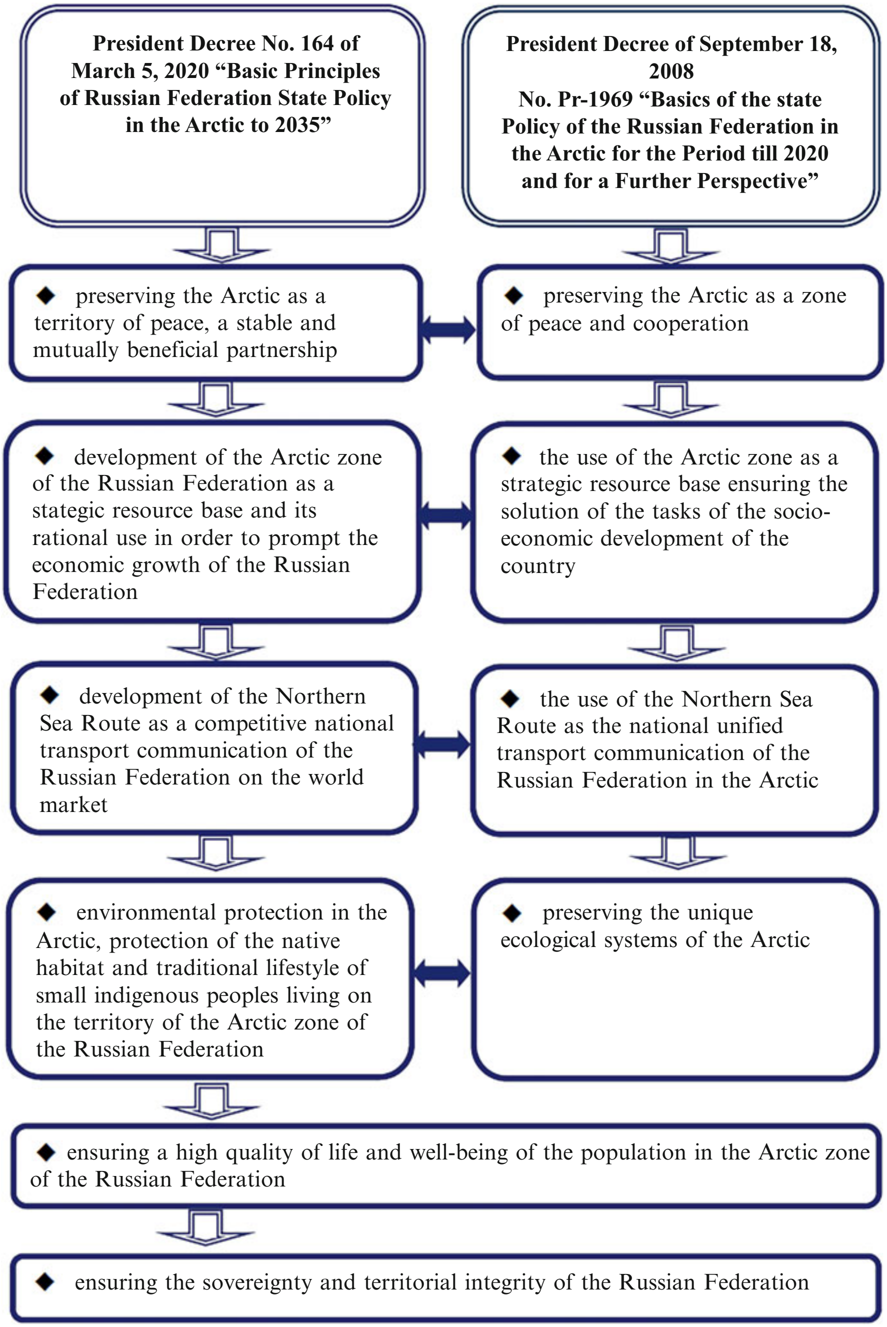

Fig. 1 (continued)

Measuring the Reputation Potential in the Russia Arctic

In March 2020, the Presidential Decree adopted the Basics of Russia's State Policy in the Arctic Region until 2035 (President of the Russian Federation, 2020a). In October 2020, the Development Strategy was adopted (President of the Russian Federation, 2020b). In March 2021, the Russian Government established a corresponding state program "Socio-Economic Development of the Arctic Zone of the Russian Federation" (Russian Government, 2021). This regulatory and organizational mechanism offers the basis for the development of the Russian Arctic for the long term. Our goal is to analyze the implementation of the state policy of the previous stage until 2020. However, we should note that contemporary state policy expands and qualitatively updates the content of the key national interests defined in the Basics of the State Policy till 2020 (President of the Russian Federation, 2014) (Fig. 1).

The research specifies tasks related to preserving the Arctic as a zone of not only peace and cooperation but also mutually beneficial partnership. Subsequently, in the section "Assessment of the Development of the Arctic Zone and Status of National Security," the Russian part of the Arctic is emphasized exclusively as the defender of private interests "the Arctic zone includes objects of strategic deterrent force to prevent aggression against the Russian Federation and its allies" (President of the Russian Federation, 2020a). We focus on the competitiveness of the Northern Sea Route on the world market and pay special attention to the historical and cultural heritage and the protection of small indigenous peoples. The chapter clarifies the role of the Arctic as a strategic resource base not only in the context of the country's development but also as its driver. The most significant change, which largely determines the new perspective of state policy till 2035, is the emergence of two additional national interests: ensuring the sovereignty and territorial integrity of the Russian Federation and a high living standard and well-being of the population in the Arctic zone of the Russian Federation.

These changes highlight a new state program and distinguish it in the light of information-based promotion, which is significant due to the Russian Government's increasing political reputational potential. A positive reputational effect is created by defining the role of the Arctic as a key area of strategic and geopolitical interests in safeguarding sovereignty and territorial integrity of the country and by the special

Fig. 1 Russian Main National Interests in the Arctic: Regulatory Changes, 2008–2020. (Source: compiled by the author based on President of the Russian Federation (2014). *Presidential Decree "On the Land Territories of the Arctic Zone of the Russian Federation"*. Retrieved from: http://www.consultant.ru/document/cons_doc_LAW_162553; President of the Russian Federation (2020b). *Presidential Decree No. 645 of October, 26, 2020 "Strategy for Developing the Russian Arctic Zone and Ensuring National Security until 2035"*. Retrieved from http://www.consultant.ru/document/cons_doc_LAW_366065) attention to the population's living standard in the Arctic zone of the Russian Federation.

The Government's self-assessment of the effectiveness of state policy in the Arctic till 2020 is reflected in the Basics of the State Policy till 2035. It can also be positive according to reputational approach, because the Government itself has an adequately balanced assessment showing not only its own policy but also its problem areas, identifying them as prevailing dangers, challenges, and threats that generate risks for the development of the Arctic zone and ensuring national security. Overcoming them is, in fact, a task for the long term.

Meanwhile, the achievements have qualitative nature: for example, the creation of conditions for the implementation of major economic projects on the territory of the Arctic zone of the Russian Federation; the expansion of special environmental management regimes and environmental protection in the Arctic zone of the Russian Federation, etc. (President of the Russian Federation, 2020a). They also present quantitative features (President of the Russian Federation, 2020b) (Fig. 2).

We shall note that these indicators are reflected as targets in the implementation of the Strategy for the Development of the Arctic zone, with their values determined for 2024, 2030, and 2035. It is noteworthy that their final values are quite ambitious – for example, by 2035 the coefficient of the population's migration outflow with a base value of -5.1 (2018) is planned to be replaced by an increase of 2 people for every 1000 people, which should radically expand migration flows in the Russian Arctic. On the one hand, these ambitions of the state policy will have reputational potential for the Russian Government if they are achieved, since they solve important problems of national development. On the other hand, they create reputational risks – for example, the threat of their failure – at least at the indicated level (the implementation of the Government's policy till 2020 did not succeed in achieving migration growth).

The results of the state policy implementation in the Russian Arctic should also be directly addressed in the context of the reputational approach. An undisputed achievement with a positive reputational effect is the creation of legal and regulatory framework and the necessary organizational conditions for the protection of national interests of the Russian Federation in the Arctic (President of the Russian Federation, 2020a).

At the federal and regional level of the Arctic zone, a range of statutory instruments was adopted. They include fundamental ones (a strategy, principles of state policy, a state program) and substantive instruments governing its separate areas, for example, Federal Law of 13 July, 2020, No. 193-FZ "About the State Support of Business Activity in the Arctic Zone of the Russian Federation" (Federal Assembly of the Russian Federation, 2020). The Russian Arctic has also become a full-fledged object of state statistical observation. At the same time, researchers and legislators note that:

> it is necessary to adopt a systemically important federal law with a provisional name "About the Development of the Arctic", on the basis of which the constituent entities of the Federation will develop their regulatory legal acts. Then, there will be no room for legal disagreement. The adoption of a special law on the Arctic, which establishes the special status of the macro-region, makes it possible to approve that Russia has a full legislative framework regulating relations in this region of the country. (Zhuravel, 2016)

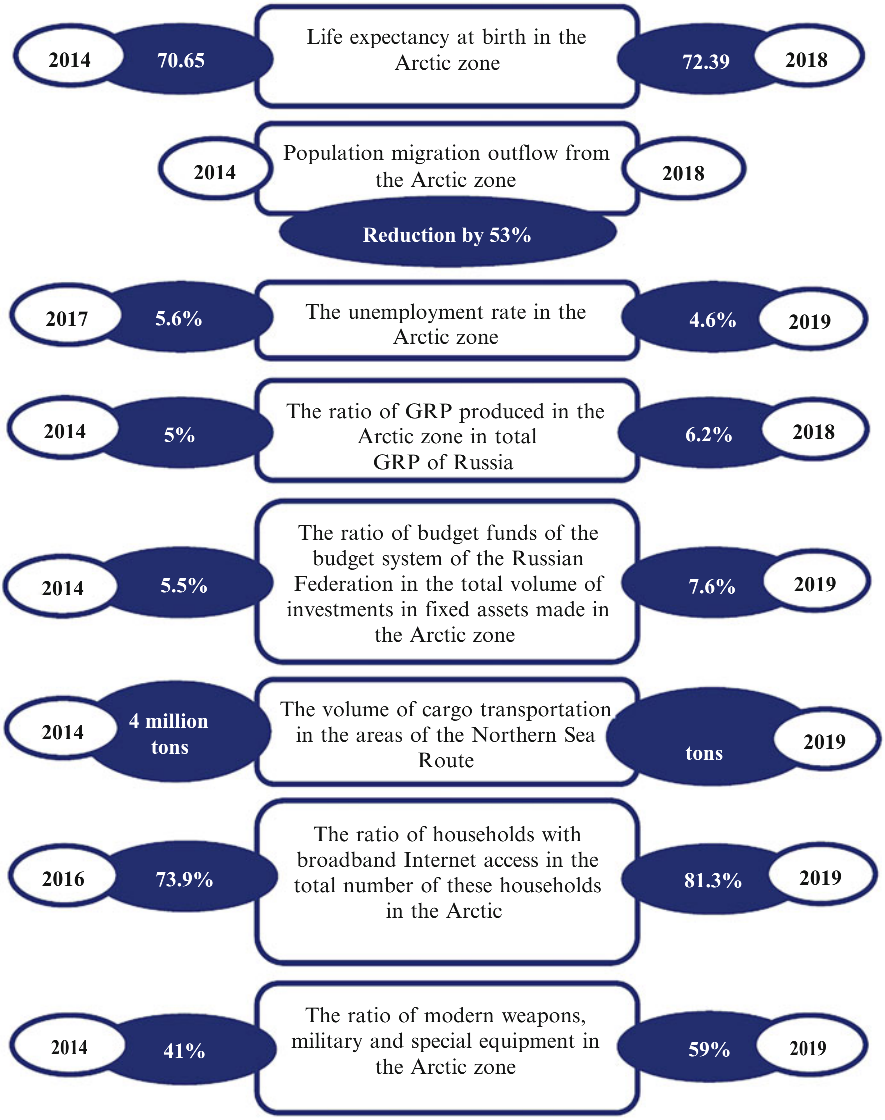

Fig. 2 Achievements of the state policy of the Russian Federation in the Arctic till 2020. (Source: compiled by the authors based on President of the Russian Federation (2014). *Presidential Decree "On the Land Territories of the Arctic Zone of the Russian Federation"*. Retrieved from: http://www.consultant.ru/document/cons_doc_LAW_162553)

However, at the present moment, Draft Federal Law "On the development of the Arctic Zone of the Russian Federation," prepared by the Ministry of Economic Development of Russia back in 2016, has not been submitted to the State Duma of the Russian Federation yet (Ministry of Economic Development of the Russian Federation, 2016).

In accordance with Presidential Decree, "The State Commission for the Development of the Arctic" was established in 2015 (President of the Russian Federation, 2015), and the corresponding regulation was adopted (Russian Government, 2015). The Commission is a coordinating body providing interaction of federal executive authorities, executive authorities of constituent entities of the Russian Federation, other state bodies, and local government and organizations in addressing socioeconomic and other challenges related to the development of the Arctic Zone and the national security of the Russian Federation.

Thus, the Arctic has become a separate entity of state administration. However, the region received independent status in 2019, when, in order to improve the efficiency of state management in the development of the Arctic zone in accordance with the Presidential Decree, the Ministry for the Development of the Russian Far East was renamed to the Ministry for the Development of the Russian Far East and Arctic. It gained additional functions on development of the state policy and legal regulations in the sphere of development of the Arctic zone of the Russian Federation (President of the Russian Federation, 2019a).

We will now analyze the effectiveness of the state policy in the Arctic according to the key strategies of its implementation.

The military and political direction of the state policy in the Arctic creates a predominantly positive reputational effect in assessing the activities of the Russian Government among the population of the region and citizens of the country as a whole. For Russia, the North is a gigantic strategic military zone and the most important security belt, since a number of key military-industrial complex enterprises and largest naval bases are located in the northern territories (Pupkova, 2014). The Basics of State Policy until 2035 note achievements in the military sphere by 2020 according to the state of national security in the Arctic. They imply creating a group of general military troops (forces) of the Armed Forces of the Russian Federation capable of ensuring military security in various military-political conditions and creating an actively functioning coastguard system of the Federal Security Service of the Russian Federation (President of the Russian Federation, 2020b). A significant result is achieved due to the establishment of a new military structure on the basis of the Northern Fleet, viz., the Northern Fleet Joint Strategic Command required to provide comprehensive security for the Russian Arctic region, as well as a unified management of military forces and assets in the area from Murmansk to Anadyr. Unique military facilities and a network of radar stations have been built, military airfields have been restored, modern military equipment is supplied to the Northern Fleet Joint Strategic Command, etc. In addition, the Ministry of Defense of the Russian Federation is engaged in solving the problems of eliminating pollution in the Arctic Zone (Kolpakov & Semiryaga, 2020).

This direction of the state policy is closely related to the tasks of maintaining the balance of forces and ensuring the necessary level of military security in the conditions of foreign states' increasing military presence in the Arctic. A possible heightened conflict as the main modern challenge in the region and incompleteness of the international legal marine delimitation are the reasons for the policy stated above. In the context of the increasing geopolitical status of the Arctic, the pressure has increased on Russia. The issue relates to determining the external boundaries of the continental shelf, dividing marine zones, developing oil and gas resources, exploiting biological resources, and access of foreign states to the Northern Sea Route (Konyshev & Sergunin, 2011). A national priority in foreign policy is to defend the country's rights to expand the boundaries of the continental shelf according to the framework of the application submitted in 2015 to the UN Commission on the Limits of the Continental Shelf; Russia adheres to the sectoral principle of jurisdiction of countries in the Arctic latitudes.

The Russian active position on protecting its geopolitical interests in the Arctic, including those related to the demonstration of military force, traditionally finds public support, which is associated with preserving the image of a strong government, alongside a "strong hand" in the priorities of Russian political culture. According to the study results provided by Russian Public Opinion Research Center, almost half of Russians (44%) believe that Russia should be strongly committed to the struggle for "its own sector" of the Arctic for its subsequent economic development (RBC, 2007). The survey was conducted in the context of the Arctic-2007 expedition, the purpose of which was to search for evidence that the Lomonosov Ridge is an extension of Russian territory. In 2013, the environmental organization Greenpeace held an action against oil production in the Arctic that was associated with the incident in the Pechora Sea. The majority of Russians (42%) were inclined to perceive this action as a conspiracy of foreign special services and governments, who, under the name of Greenpeace, were trying to deprive Russia of valuable natural resources and territories (VCIOM, 2013). In the present situation of even greater aggravation of international tension, the expansion of the military presence in the Arctic is one of the priorities of state policy in the region. It is coupled with the tasks of ensuring national security and can form a positive reputation potential of domestic policy of the Russian Government.

Changes have also taken place at the level of development of the Russian Arctic due to the state policy implementation creating a positive or negative reputational effect, especially among the Arctic population.

We have obtained an integrated assessment of the level indicating the development of the territories in the Arctic zone due to ratings. At the present moment, the first (and only) rating of the Russian Arctic regions is the "Polar Index" proposed by the Expert Center "PORA" and the Department of Environmental Management of the Faculty of Economics of Lomonosov Moscow State University. It estimates the sustainability of the Arctic development at the macro level (PORA, 2020).

The researchers note that the Arctic zone still does not have a centralized management system and a single vector of development; they offer it as a principle of sustainable development. The concept of the "Polar Index" is based on the "concept of a triune result": sustainable development is characterized by a balanced relationship of its economic, environmental, and social indicators.

The rating calculation methodology includes three stages. The first calculates the quantitative index of sustainable development of the region.

There are three groups of indicators:

- *11 socioeconomic indicators*: a ratio of the population's average income per capita and the subsistence minimum; a regional decile coefficient; the population's migration outflow; a proportion of the population with monetary income below the regional subsistence minimum; a volume of production of the gross regional product per capita; a level of the population's satisfaction with the activities of authorities at all governmental levels to ensure social guarantees; provision of transport infrastructure of all types; respect for small indigenous peoples' rights; housing provision; a proportion of the population using the Internet of total population; a proportion of employment and unemployment in the total population
- *8 ecological and economic indicators*: a proportion of environmental costs; a ratio of the growth rate of reserves and extraction of the most important mineral resources; a proportion of reclaimed land of the total area of reclaimed land; proportion of polluted and insufficiently treated wastewater from the total volume of wastewater; a proportion of renewable sources of the resource base reproduction in total volume of the resource base; organization and financing of monitoring the state and changes in the environment; percent of GDP indicating the fee for permissible and excess emissions; percent of disposed hazardous waste in total waste
- *3 socioeconomic indicators*: the number of people with access to high-quality drinking water supply; an increase in the life expectancy of small indigenous peoples of the North, Siberia, and the Far East living in the Arctic zone; the availability of regional and municipal programs for adapting the population and economic systems to climate change

The second stage of the rating includes an expert survey, and the third stage presents calculation of an integral index of sustainable development, which is from 0 to 1 (PORA, 2020).

The rating results in regions of the Arctic zone of the Russian Federation are presented in Table 1.

In addition to the opportunity of identifying the leading regions and outsiders of the sustainable development in the Arctic, we can observe generally positive dynamics in the development of the majority of the regions in 2018–2020 and the deterioration of the situation in the last three ones, viz., the Republic of Karelia, Chukotka Autonomous Okrug, and the Komi Republic. Correlating the rating results with the tasks of the state policy in the Arctic, at least, indicates its imbalance in covering all the territories of the Arctic zone, since the positive dynamics should have extended to each of them. It is obvious that the situation creates a serious reputational risk for the Russian Government and even the threat of forming a negative reputation, primarily among the population of those territories of the Arctic zone where there is a disproportion of development.

We can also thoroughly analyze several indicators according to the assessment of the Government's activities by the population of the Russian Arctic and the citizens of the country as a whole.

Table 1 The results of the rating of the Arctic regions of the Russian Federation "Polar Index. Regions" in 2018–2020

Place in 2020	Region	Polar Index 2020	Polar Index 2019 (place)	Polar Index 2018 (place)
1	Murmansk Oblast	0.733	0.720 (1)	0.673 (1)
2	The Republic of Sakha (Yakutia)	0.706	0.667 (3)	0.670 (2)
3	Yamalo-Nenets Autonomous Okrug	0.698	0,696 (2)	0.628 (4)
4	Arkhangelsk Oblast	0.657	0.612 (5)	0.631 (3)
5	Krasnoyarsk Krai	0.641	0.646 (4)	0.620 (5)
6	Nenets Autonomous Okrug	0.619	0.601 (6)	0.595 (8)
7	The Republic of Karelia	0.572	0.583 (7)	0.602 (7)
8	Chukotka Autonomous Okrug	0.542	0.565 (8)	0.604 (6)
9	The Komi Republic	0.521	0.511 (9)	0.590 (9)

Source: compiled by the authors based on the rating of the Project Office for Arctic Development (PORA) (2020). *"Polar Index. Regions", 2018–2020*. Retrieved from: https://polarindex.ru/rating-of-regions/

An absolute productivity indicator of the state policy in the Arctic zone relates to the people's desire to live in the region ("the people vote with their feet"), to give birth, and to raise children there; these desires are reflected in population size, birth and mortality rate, migration flows, indicators of migration, or population growth/decline.

The Federal Law "About the State Support of Business Activity in the Arctic Zone of the Russian Federation" (Federal Assembly of the Russian Federation, 2020) made it difficult to determine various types of indicators of the Russian Arctic that are possible for comparison. This happened as a result of the addition of nine new urban districts and municipal districts in four Russian subjects to the list of Arctic territories. This situation made statistical data look significantly better (of course, this fact is obvious to specialists, but, in general, it may not be the same for the population). It can be clearly observed on the example of demography, which is evident in comparing the population of the last two years (Table 2).

There is a significant increase in the population of the Arctic zone between 2014 and 2020. As of January 1, 2014, the population was 2,400,580 people, while as of January 1, 2021 it was 2,605,769. Calculating the population size without considering the new territories that became a part of the Arctic in 2019 and 2020, it will be 2,420,203 people; the positive trend in comparison with 2014 remains, but it obviously becomes less significant. According to the last 2 years, the population growth is replaced by a decline of 11,315 people. "Handling" with numbers creates, in our opinion, the potential for possible reputational risks in the perception of the results of the state policy in the Arctic in general and demographic policy in particular, since it may create illusion of its unreasonably high efficiency.

Table 2 Estimation of the resident population number of the land area of the Arctic Zone of the Russian Federation in 2020–2021, as of January 1

	2020	2021
The Arctic Zone of the Russian Federation	2,431,518	2,605,769
The Republic of Karelia	***40,528***	***111,254***
Kostomuksha City District[a]	...	***30,273***
Belomorsky District	15,433	15,151
Kalevalsky District[a]	...	6489
Kemsky District	14,263	13,961
Loukhsky District	10,832	10,619
Segezhsky District[a]	...	34,761
The Komi Republic	***73,123***	***152,573***
Vorkuta City District	73,123	72,423
Inta City District[a]	...	26,339
Usinsk City District[a]	...	42,825
Ust-Tsilemsky District[a]	...	10,986
The Republic of Sakha (Yakutia)	***67,652***	***67,798***
Abyysky District	3949	3916
Allaikhovsky District	2697	2726
Anabarsky National (Dolgan-Evenki) District	3653	3672
Bulunsky District	8513	8501
Verkhnekolymsky District	4003	3984
Verkhoyansky District	11,059	10,989
Zhigansky National District	4112	4179
Momsky District	3974	4051
Nizhnekolymsky District	4260	4228
Oleneksky Evenkiysky National District	4247	4326
Srednekolymsky District	7332	7312
Ustyansky District	7008	7035
Eveno-Bytantaysky National District	2845	2879
Krasnoyarsk Krai	***229,411***	***237,686***
Norilsk City District	182,496	183,299
Taymyrsky Dolgano-Nenets District	31,415	31,466
Turukhansky District	15,500	15,364
Evenkiysky District[a]	...	
Rural settlement of Surinda village[a]	...	421
Rural settlement of Tura village[a]	...	5362
Rural settlement of Nidym village[a]	...	147
Rural settlement of Uchami village[a]	...	95
Rural settlement of Tutonchany village[a]	...	208
Rural settlement of Essey village	...	663
Rural settlement of Chirinda village[a]	...	206
Rural settlement of Ekonda village[a]	...	281
Rural settlement of Kislokanvillage[a]	...	93
Rural settlement of Yuktavillage[a]	...	81

(continued)

Table 2 (continued)

	2020	2021
The Arctic Zone of the Russian Federation	2,431,518	2,605,769
Arkhangelsk Oblast except of Nenets Autonomous Okrug	***640,557***	***662,668***
Arkhangelsk City District	354,103	352,032
Novaya Zemlya City District	3367	3576
Novodvinsk City District	37,699	37,256
Severodvinsk City District	182,970	181,768
Leshukonsky District[a]	...	5840
Mezensky District	8294	8127
Onezhsky District	29,031	28,402
Pinezhsky District[a]	...	20,496
Primorsky District	25,093	25,171
Nenets Autonomous Okrug	***44,111***	***44,389***
Murmansk Oblast	***741,404***	***732,864***
Chukotka Autonomous Okrug	***50,288***	***49,527***
Yamalo-Nenets Autonomous Okrug	***544,444***	***547,010***

Source: compiled by the authors based on Statistical information on the Federal State Statistics Service (2020). *Statistical Information on the Socio-Economic Development of the Arctic Zone of the Russian Federation*. Retrieved from: https://gks.ru/free_doc/new_site/region_stat/arc_zona.html; Federal State Statistics Service (2021). *Statistical Information on the Socio-Economic Development of the Arctic Zone of the Russian Federation*. Retrieved from: https://gks.ru/free_doc/new_site/region_stat/arc_zona.html

[a]City districts and municipal districts of these subjects of the Russian Federation are included in the list of land areas of the Arctic zone of the Russian Federation by Federal Law No. 193-FZ of 13.07.2020 "About the State Support of Business Activity in the Arctic Zone of the Russian Federation"

The problem of the continuing decline in the population of the Russian Arctic, its causes, and its consequences is the subject of special attention from domestic researchers (refer to, e.g., Volgin et al. (2019)). At the same time, this decline is typical for most of the territories in the Arctic zone (Table 3).

The most dramatic population decline during the implementation of the state program occurred in the Vorkuta District (by 14.5%), the Onezhsky District of Arkhangelsk Oblast (by 13.8%), and the Turukhansky District of Krasnoyarsk Krai (by 11.2%). The population decline is associated with birth rate and mortality rate, as well as with the dynamics of migration. Table 4 presents the values of the population natural growth coefficient in the Arctic zone (statistical information on the socioeconomic development of the Arctic zone of the Russian Federation 2014–2020).

In comparison with the average number for the country as a whole, the situation in most regions of the Arctic zone is more favorable. At the same time, there is a significant negative dynamic for the Arctic zone as a whole: the natural growth rate has declined by almost 6 times in 7 years; in 2020, it was replaced by a population decline. The population growth is typical for five regions: Krasnoyarsk Krai, the Republic of Sakha (Yakutia), Nenets Autonomous Okrug, Yamalo-Nenets

Table 3 Estimation of the residential population of the land areas of the Arctic zone of the Russian Federation in 2014–2021, as of January 1

The Arctic zone of the Russian Federation	2014	2021
The Komi Republic		
Vorkuta City District	84,707	72,423
The Republic of Sakha (Yakutia)		
Allaikhovsky District	2764	2726
Anabarsky National (Dolgan-Evenki) District	3403	3672
Bulunsky District	8507	8501
Nizhnekolymsky District	4414	4228
Ustyansky District	7359	7035
Krasnoyarsk Krai		
Norilsk City District	177,326	183,299
Taymyrsky Dolgano-Nenets District	33,861	31,466
Turukhansky District	17,306	15,364
Arkhangelsk Oblast except of Nenets Autonomous Okrug		
Arkhangelsk City District	357,409	352,032
Novaya Zemlya City District	2530	3576
Novodvinsk City District	39,613	37,256
Severodvinsk City District	188,420	181,768
Mezensky District	9629	8127
Onezhsky District	32,968	28,402
Primorsky District	26,055	25,171
Nenets Autonomous Okrug	*43,025*	*44,389*
Murmansk Oblast	*771,058*	*732,864*
Chukotka Autonomous Okrug	*50,555*	*49,527*
Yamalo-Nenets Autonomous Okrug	*539,671*	*547,010*

Source: Compiled by the authors based on Federal State Statistics Service (2021). *Statistical Information on the Socio-Economic Development of the Arctic Zone of the Russian Federation*. Retrieved from: https://gks.ru/free_doc/new_site/region_stat/arc_zona.html; Federal State Statistics Service (2014). *Statistical Information on the Socio-Economic Development of the Arctic Zone of the Russian Federation*. Retrieved from: https://gks.ru/free_doc/new_site/region_stat/arc_zona.html

Autonomous Okrug, and Chukotka Autonomous Okrug. Meanwhile, a clear negative trend can be observed in these regions, which is especially typical for Yakutia and Chukotka: the population growth there has declined by almost three and two times.

In comparison with the indicators of natural growth (decline in 2020) of the population, the indicators of migration in the Arctic zone are negative throughout the entire period under the study (Table 5).

The highest population outflow is observed in Chukotka Autonomous Okrug and Murmansk Oblast. Moreover, its intensity has been increasing throughout the years of the state policy implementation in the Arctic zone. Lytkina and Smirnov (2019) note that in absolute terms, the largest outflow of the population is observed in employment age. This situation – and the natural processes of an aging population and low birth

Table 4 The coefficient of population natural growth/decline in the Arctic zone of the Russian Federation (per 1000 people of the population) in 2014–2019

	2014	2015	2016	2017	2018	2019
The Arctic zone of the Russian Federation	**4.0**	**3.9**	**3.1**	**2.2**	**1.5**	**0.7**
Krasnoyarsk Krai	8.4	8.3	7.3	6.6	6.3	6.0
The Republic of Karelia	...	...	...	−10.7	−13.0	−12.5
The Komi Republic	3.6	3.6	0.9	1.3	0.6	−1.1
The Republic of Sakha (Yakutia)	8.2	6.0	7.0	5.2	4.5	3.3
Arkhangelsk Oblast	0.1	0.3	−0.5	−1.3	−2.3	−3.3
Murmansk Oblast	0.3	0.3	−0.3	−0.8	−1.5	−2.4
Nenets Autonomous Okrug	7.9	8.4	9.6	6.6	5.1	4.7
Chukotka Autonomous Okrug	2.8	4.1	3.6	3.7	1.6	1.4
Yamalo-Nenets Autonomous Okrug	11.8	11.3	10.1	9.1	8.7	7.9
For reference: *The Russian Federation*	*0.2*	*0.3*	*−0.01*	*−0.9*	*−1.6*	*−2.2*

Source: compiled by the authors based on Federal State Statistics Service (2014–2020). *Statistical Information on the Socio-Economic Development of the Arctic Zone of the Russian Federation in 2014–2020*. Retrieved from: https://gks.ru/free_doc/new_site/region_stat/arc_zona.html

rate – leads to the aging of the population. The result of the deformation of the age structure is the reduction of the proportion of the population of reproductive age. Thus, we observe a fertility decline (Lytkina & Smirnov, 2019). One of the negative migration trends is typical for the Russian Arctic as a whole. It is an outflow of young people and highly educated and qualified personnel, the so-called “brain drain” observed in almost all constituent entities (Sokolova, 2016). The only entity with a population inflow is Nenets Autonomous Okrug, but even here this trend is multi-directional (we observe a migration decline in the 2016–2018).

The study results of migration processes in the Russian Arctic obtained by Fauzer and Smirnov (2020) indicate a decisive role in the dynamics of interregional population migration and “internal migrations distribute population within the region without changing the total population. They affect the pattern of settlement reducing the population of the regions located in climatically unfavorable areas in favor of the places with the best living conditions (for example, the residents of Vorkuta often choose Syktyvkar as their residential place)” (Fauzer & Smirnov, 2020). A third of the population prefers Moscow and St. Petersburg as a migration destination, while the regional capitals are attractive for residents of the majority of rural territories. The researchers identify three gender and age models of migration processes. Their use makes it possible to build projection scenarios for the development of the Arctic.

According to the results of the analysis concerning the age composition of people involved in migration processes, specialists state that the more mobile part of the population is represented by people of employment age. It is associated with the inflow of working-age population in oil- and gas-producing regions, rotation-based work, and the outflow of people of retirement age to regions with more favorable climate (Sokolova, 2016).

Table 5 Indicators of population migration in the Arctic zone in 2015–2020

Year	2015	2016	2017	2018	2019	2020
The territory of the Arctic zone	Migration growth, person/the coefficient of migration growth per 1000 people of the mid-year population					
The Arctic Zone of the Russian Federation	**−22,835/ −9.6**	**−14,021/ −5.9**	**−14,447/ −6.0**	**−12,335/ −5.1**	**−9490/ −3.8**	**−7827/ −3.0**
The Republic of Karelia	. . .	. . .	−670/ −15.5	−648/ −15.4	−565/ −13.8	−186/ −1.7
The Komi Republic	−1811/ −22.0	−1451/ −18.0	−2854/ −36.3	−2610/ −34.3	−1549/ −20.9	−515/ −3.4
The Republic of Sakha (Yakutia)	−242/ −9.3	−99/ −3.8	−339/ −13.0	−140/ −5.4	−371/ −3.4	−42/ −0.6
Krasnoyarsk Krai	−1553/ −6.8	−1990/ −8.8	−740/ −3.3	−477/ −2.1	−904/ −3.9	−400/ −1.7
Arkhangelsk Oblast except of Nenets Autonomous Okrug	−2385/ −3.6	−1811/ −2.8	−3036/ −4.7	−2168/ −3.4	−551/ −0.9	−523/ −0.8
Nenets Autonomous Okrug	101/2.3	−320/ −7.3	−231/ −5.3	−392/ −8.9	77/1.8	129/2.9
Murmansk Oblast	−4384/ −5.7	−4343/ −5.7	−3503/ −4.6	−4402/ −5.9	−4863/ −6.5	−4459/ −6.0
Chukotka Autonomous Okrug	−589/ −11.7	−516/ −10.3	−656/ −13.2	237/4.8	554/ 11.1	−760/ −15.2
Yamalo-Nenets Autonomous Okrug	−11,972/ −22.3	−3491/ −6.5	−2418/ −4.5	−1735/ −3.2	−1318/ −2.4	−1071/ −2.0

Source: compiled by the authors based on Federal State Statistics Service (2015–2020). *Statistical Information on the Socio-Economic Development of the Arctic Zone of the Russian Federation in 2014–2020*. Retrieved from: https://gks.ru/free_doc/new_site/region_stat/arc_zona.html

The Arctic still observes the policy of temporary residence due to rotation-based work, which in no way contributes to the growth of the permanent population. In the Arctic zone, 14% of employees in the organizations have rotation-based work. In some regions, this figure exceeds 40% (Sokolova, 2016). The modern trend in the development of the Arctic and a certain image of the "rotation-based Arctic" formed among the population of the country can be a clear reputational risk. It indicates an insufficiently conscious policy by the Russian authorities unable to improve this unfavorable situation. Moreover, its potential may increase because of the threat and lead to the effective development of the region. At the same time, the region still faces the problem of the optimal ratio of labor resources involved in rotation-based work in the Arctic and permanent residents.

According to experts:

> many leaders of the Polar Regions openly declare: I do not need permanent residents here. This is a serious burden on the social sphere, it is necessary to build high-quality housing for them, develop healthcare and education, arrange leisure activities. At the same time,

> rotation-based work results in different problems from employees' careless attitude to equipment to the problems of destroyed families. (Strauss, 2017)

Despite the fact that the Government promotes programs to stimulate labor migration and consolidate labor resources in the Arctic, they do not show appropriate results. It is necessary to overcome administrative barriers for employers, eliminate gaps in legislation, change the situation due to increasing all kinds of benefits and allowances, etc.

However, despite all the negative phenomena of the population migration outflow, a significant decrease in the negative dynamics of migration loss should be recognized as an undoubted achievement of the state policy in the Arctic zone (the migration loss coefficient decreased by more than three times from −9.6 in 2015 to −3 in 2020).

It is noteworthy that the Arctic has a correlation between migration indicators of economic standards and living standards (Lytkina & Smirnov, 2019). The higher the population outflow is, the lower the comfort of living, and the possibility of professional self-realization is observed (Sokolova, 2016). A robust and purposeful state policy in the Arctic till 2035 is able to neutralize the reputational risks arising in the ineffective policy up to 2020 if the achieved positive trends in certain areas of its implementation continue, which indicates reputational potential of the Russian Government.

The latter confirms the opinion of the population of the Arctic zone. According to surveys conducted by NAFI Research Centre in 2020, the majority of residents of the Arctic regions like their cities. "Residents of Nenets and Yamalo-Nenets Autonomous Okrug are mostly satisfied with the living standards there. Residents of Krasnoyarsk Krai, the Republic of Sakha (Yakutia) and the Komi Republic are less satisfied with the living standards. Most of the population is not satisfied with the state of infrastructure, labor market, healthcare and housing stock. To improve the living standards, it is necessary to focus on these problems" (SeverPost, 2021b).

According to the results of the survey conducted by Russian Public Opinion Research Center (VCIOM) earlier in 2021, the specialists presented the opinion of the population living in Murmansk Oblast. As such, 26% of residents are satisfied with the situation in the region, another 40% assess the situation as average, and 33% expressed dissatisfaction. It is important that 38% of respondents note an improvement in the situation over the last two years. This relates to improvement of the city in general, road conditions, snow-shoveling service in the streets and backyards, waste disposal, and the condition of social facilities. 16% of respondents say that the situation has worsened, and 43% believe that there have been no significant changes. Residents note the problems leading to poor living standards in the region, such as state and availability of medical services, poor roads and lack of jobs, and unemployment (VCIOM, 2021a).

The problems outlined are confirmed by the opinion of public experts from Murmansk, despite the high rating of the Arctic capital in the rating of the most comfortable and affordable cities in Russia (6th place). The Spatial Planning Institute, Urbanica, made this rating on the basis of the results obtained due to the work with statistical data of 2019. Experts note that "dry statistics does not reflect the real situation; the urban environment is not formed only by figures" (SeverPost, 2021).

Thus, the public opinion in the territories of the Russian Arctic, of course, reflects the real situation, though it more truly indicates a certain situation and testifies to a rather "fragile" balance in the ratio of the reputational potential and reputational risks of the Russian authorities (with predominance of the latter). On the one hand, positive trends are observed in the assessment of the changes occurred. On the other hand, there is a large proportion of dissatisfied people and those who do not see significant changes. The issues remain, and they should have been addressed to the state policy.

Let us consider the economic results of the state activities in the Arctic zone. In the Basics of the State Policy until 2035, its achievements by 2020 include the creation of conditions for the implementation of major economic projects in the Arctic zone of the Russian Federation and the beginning of work on the creation of an integrated infrastructure of the Northern Sea Route, a system of hydrometeorological, hydrographic, and navigation support for its waters, and the modernization of the icebreaking fleet (President of the Russian Federation, 2020a). These results have found wide information coverage and a positive reputational effect. As an example of major economic projects, we can cite the commissioning of a plant for the production of liquefied natural gas and the seaport of Sabetta within the framework of Yamal LNG project; a project for the construction of a marine transshipment complex of liquefied natural gas in Kamchatka Krai; the opening of the Arctic Gate terminal for the sea shipment of crude oil from the Novoportovskoye field; and the expansion of the infrastructure of the Varandey terminal (included in the Guinness Book of World Records as the northernmost permanent oil loading terminal in the world). In 2014, Russia started the world's first oil production from the Prirazlomnoye offshore field in the Arctic.

Projects have been launched to create a necessary transport infrastructure between the Arctic industrial centers in the conditions of focal development in the Arctic zone (railway "Northern Latitudinal Passage," Murmansk transport hub, etc.). The connection of the mainland and port infrastructure into a single logistics system creates a logistics base for attracting investment in the extractive industries and improves the supply of hard-to-reach Arctic regions.

The adoption of Federal Law "About the State Support of Business Activity in the Arctic Zone of the Russian Federation" creates broad opportunities for attracting investment in the Arctic (Federal Assembly of the Russian Federation, 2020). Initiators of new investment projects with an investment volume of more than ₽1 million can apply for an expanded preferential business regime, as well as administrative and tax preferences (Arctic-Russia, 2021).

According to the statement made in August 2021 by Alexey Chekunkov, Minister for the Development of the Far East and Arctic, "today the Arctic is the largest economic zone in the world and of high interest to business. 181 investment projects worth more than ₽267 billion have already been implemented in the Arctic zone. At the same time, about a third of the projects relate to the tourism industry, sports, gastronomy, and a healthy lifestyle" (PRIME, 2021).

Indeed, the tourist flow to the region has been increasing recently. The tourist attractiveness of the Arctic is much higher, which indicates a certain reputational potential of the Russian Government among the residents of the country when they evaluate its activities in the field of tourism development. A number of experts refer to the significant opportunities of the Arctic, “no less than that of Krasnodar Krai,” while it is very important to properly brand and show the North (SeverPost, 2021). Local authorities are also optimistic about the prospects for tourism development. According to Governor of Krasnoyarsk Krai, Arctic tourism will thrive in the near future (Interfax, 2021).

However, the results of opinion polls – in particular, the survey of Russian Public Opinion Research Center conducted in February 2021 – show a less promising picture: 41% of Russians expressed a desire to go on a trip to the Arctic, but more than half of Russians (55%) would not like to see the Arctic (VCIOM, 2021b). At the present moment, a significant deterrent for tourists includes the high cost of Arctic tours – for example, a 10-day trip through the northern part of the Polar Urals to the geographical object “The Extreme Eastern point of Europe” costs ₽100,000 per person (Arctic-Russia, 2021).

The Northern Sea Route, as a national transport communication of Russia in the Arctic, is extremely important for ensuring the further development of the economy of the northern regions and the country as a whole. In the future, this is a high-latitude transpolar passage, which can serve as an alternative to the existing inter-continental transport links between the countries of the Atlantic and Pacific Basins through the Suez and Panama Canals (Atomflot, 2021). Currently, the United States and a number of NATO countries are trying to internationalize the Northern Sea Route and oust Russia. This is explained by the following supposition: if the ice continues melting, it can turn into an important transport corridor of global importance (Pupkova, 2014).

With regard to the development of the Northern Sea Route, the creation of its integrated infrastructure has begun. In addition, the Russian Government has approved a plan for the development of the infrastructure of the Northern Sea Route for the period up to 2035 (Russian Government, 2019). Thus, the modernization of existing ports and the construction of new terminals have begun. Considering the possible increase in cargo traffic, search and rescue services at sea are being created to ensure the safety of ships throughout the entire route, etc. Rosatom State Corporation has been identified as a single infrastructure operator.

During the period of the state program implementation until 2020, the volume of traffic along the Northern Sea Route has significantly increased in the Arctic, almost by 8 times (from 4 million tons in 2014 to 31.5 million tons in 2019).

In the context of high international competition for the resources of the Arctic shelf, the Russian nuclear icebreaker fleet is increasingly important as the most effective tool for ensuring transport and economic activity in the Arctic zone. Currently, Russia is a world leader in the use of the nuclear icebreaking fleet for solving transport problems in the Arctic seas and non-Arctic freezing seas. Transit navigation along the routes of the Northern Sea Route has become one of the most promising areas. For successful competition in the Arctic, Russia must not miss the leadership and constantly develop and improve the nuclear icebreaking fleet as a key link in the functioning infrastructure of the Northern Sea Route and **ensuring its geopolitical interests in the Arctic** (Atomflot, 2021).

A large-scale program of modernization and construction of new icebreakers has been launched. At present, with the commissioning of the largest and most powerful nuclear icebreakers of Project 22220, the main task will be to ensure year-round navigation along the entire Northern Sea Route for the delivery of hydrocarbon products to the markets of Europe and the Asia-Pacific region. In total, it is planned to build five icebreakers, which will positively affect the state and prospects of the fleet, as well as give new opportunities.

The "Arktika" nuclear icebreaker, the lead ship of Project 22220, was put into construction in November 2013 and commissioned in October 2020. In September 2017, the second mass-produced nuclear icebreaker "Siberia" of Project 22220 was launched (the deadline is the end of 2021). In May 2019, the third icebreaker "Ural" appeared (the deadline is August 2022). In 2020, two more icebreakers of Project 22220, i.e., "Yakutia" and "Chukotka," were put into construction (Atomflot, 2021). In early September 2021, it was decided to expand the line of icebreakers of Project 22220 with two new ones, which will serve as infrastructure support for the regular transit line on the Northern Sea Route (RIA Novosti, 2021).

In 2020, a state contract was signed for the construction of the lead nuclear icebreaker of Project 10510 "Leader" (it was given the name "Russia"). The unique design of the newest Russian nuclear-powered vessel will provide it with unprecedented passing ability in the ice; even large-capacity tankers and freighters now can use the Northern Sea Route. The "Leader" will be able to easily overcome the Arctic ice of 4-m thickness and lay a navigation channel for tracking ships of 50-m width. The main tasks of the icebreakers are to ensure year-round navigation along the Northern Sea Route and conduct expeditions to the Arctic (USC-Iceberg Central Design Bureau, 2021).

However, it was hard to fully implement most of the planned economic development of the Arctic. The infrastructure of the Northern Sea Route, the construction of icebreakers and rescue and support fleets, and the creation of land vehicles and aircraft equipment for working in difficult natural and climatic conditions of the Arctic were not fully implemented either. The dates have been postponed to a later period and already included in the new state program. Most of the main effective management decisions on the development of the Arctic were made only in 2018–2019 at the final stage of Basics of the State Policy till 2020 (Zhuravel, 2020) or already in 2020–2021 as part of the implementation of Basics of the State Policy until 2035.

This state of affairs is to a large extent associated with the underfunding of the projects or its complete absence, as well as sanctions against Russian and foreign oil and gas companies operating in the Arctic (Zhuravel, 2020). Cooperation with western companies, which implied investment and technology transfer, was curtailed. As a result, several promising offshore projects were frozen (Orlov, 2018). Still, this stimulated Russia to search for new partners to attract capital and technology to the Arctic projects. China has become a key partner herein. In addition to financial support (providing loans), China provides significant technological assistance (Military Review, 2019). Russia and China are actively developing the Ice Silk Road megaproject, the implementation of which can be a greater impetus in the development of the Arctic and benefit to both countries (Mikhailichenko, 2019).

In addition to the undoubted positive reputational effect on the results of the development of the Northern Sea Route and, especially, the construction of the icebreaking fleet, as well as the Russians' pride for their country as the most powerful icebreaking power in the world, there are also reputational risks. They are associated with the reassessment of the role of the Northern Sea Route and the possible discrepancy in the expected results of huge financial investments in its development that could be directed to improving the population living standards in the Arctic zone, which will result in an obvious reputational effect. According to the researchers, "the commercial opportunities for the development of international shipping in the Arctic, despite their competitive advantages in distance as opposed to the southern sea or land routes, are often exaggerated in the current conditions. The real prospects for the development of international transit here are limited by external factors" (Karaganov, 2021). "Moreover, there is a threat of not achieving the ambitious indicators defined by the new state program. The current Strategy for the Developing the Russian Arctic Zone provides for the achievement of 130 million tons by 2035, with a base value of 31.5 million tons in 2019" (President of the Russian Federation, 2020b).

The tasks of the economic development of the Arctic are closely connected with those ones related to ensuring environmental security in the region. From an ecological point of view, the Arctic territories play a significant role in preserving a biological balance of the Earth. The unique ecosystems of the Arctic require a careful and responsible attitude; therefore, the economic development of the region actualizes the problem of compliance with environmental requirements for environmental protection (Pupkova, 2014). Environmental problems and risks are a special focus of researchers' attention and a modern trend in assessing public opinion. Thus, the state environmental policy in the Arctic has a significant impact on the formation of the Russian Government's reputation. Negative environmental processes in the Arctic – which have already led to a strong transformation of the natural geochemical background; atmospheric pollution; the degradation of vegetation, soil, and terrain; the introduction of harmful substances into the food chain; and increased morbidity in the population – cause high reputational risks. The serious environmental problems require increased due attention from the authorities to the solution of the issues stated above (Fadeev, 2012).

The basic principle of ensuring the environmental safety of the Arctic is the priority of environmental problems in the implementation of economic measures (Pashchenko, 2016); environmental indicators are central to assessing the state of the Arctic economy. The preservation of the Arctic's unique ecosystems, as well as the neutralization of environmental threats in the conditions of increasing economic activity and the elimination of accumulated pollution in the Arctic, become key areas of the Government's activity. A great deal of work is being done within the framework of targeted state environmental programs, environmental projects of public-private partnership. We observe an expanded application of special environmental management regimes of nature protection in the Arctic zone and creation of new national parks. The annual state reports of the Ministry of Natural Resources and Environment of the Russian Federation “On the State and Protection of the Environment in the Russian Federation” assess the state of the environment of the Arctic zone, as well as the anthropogenic impact on it, and present measures to preserve the environment (refer to, e.g., Ministry of Natural Resources and Environment of the Russian Federation, 2020).

However, despite the presence of positive results in the Government’s environmental activities, periodical environmental disasters cause a negative reputational effect, wiping out previous achievements. For example, an accident in May 2020 on the territory of the CHP Plant 3 of Norilsk-Taimyr Energy Company (part of the Norilsk Nickel Group) received a wide negative public response. 17,700 t of diesel fuel got to the northern rivers; the area of pollution was 180,000 m^2. Environmentalists assessed it as a large-scale environmental disaster, as a result of which a whole unique ecosystem was lost. It had no analogues in the world (MK.ru, 2020). Moreover, it brought suffering to small indigenous people engaged in fishing and commercial hunting for wild reindeer in the area of the affected territories (Ivashchenko, 2020).

These environmental disasters always lay the primary responsibility on the authorities and supervisory bodies. They should exercise enhanced control over the activities of economic entities of the Arctic zone, since such situations cannot arise if there is sufficient control. To neutralize environmental tensions in the region and minimize corresponding reputational risks, the Russian Government should conduct environmental impact assessments and exercise strict control over the compliance with prohibitions on resource exploitation and the launch of economic projects without considering the impact on the ecosystem. It is also necessary to develop effective mechanisms for companies’ liability in case of accidents, as well as to support the development of new competitive and environmentally friendly technologies (Pupkova, 2014).

The changes occurring at high latitudes can have an impact on the development of many countries. In this regard, it is relevant to conduct a scientifically based search for solutions for the challenges arising due to development of the resources in the Arctic zone (Zaikov et al., 2016). All historical periods have shown that the state policy implementation in the Arctic is closely connected with the development of scientific research (Samarin, 2017). Scientific basis and support are necessary to provide a basis for determining the legal status of the Russian Arctic and for implementing applied economic and defense tasks. The need to strengthen the Russian position in the economic, scientific, and military development and use of the Arctic is identified as one of the most significant major challenges and relevant strategic priorities of national scientific and technological development (President of the Russian Federation, 2016).

In the implementation of the State Program for the Arctic Development till 2020, mainly organizational conditions for the development of science were created. Federal universities have become an innovative scientific and human resource base for the intellectual development of the Arctic. They are the Northern (Arctic) University named after M.V. Lomonosov in Arkhangelsk and M.K. Ammosov North-Eastern Federal University in Yakutsk. These universities apply innovative forms of scientific and educational cooperation – for example, Arctic Floating University is an expedition project on board the research vessel Professor Molchanov, which gives opportunity for young Arctic researchers to gain knowledge and skills in real conditions of the northern seas (Northern (Arctic) Federal University named after M.V. Lomonosov, 2021).

On the basis of Northern (Arctic) Federal University, the association "National Arctic Scientific and Educational Consortium" was established in 2016. It united 32 Russian scientific organizations. Also in 2016, the Federal Center for Integrated Arctic Research of the Russian Academy of Sciences was established on the basis of Arkhangelsk Scientific Center (the official website of the Federal Publicly Funded Institution of Science "Federal Center for Integrated Arctic Research" 2021).

The Presidential Decree "On the National Goals and Strategic Objectives of the Development of the Russian Federation for the Period up to 2024" determined the need to create at least 15 world-class scientific and educational centers (SEC) (President of the Russian Federation, 2018). In 2019, the world-class Scientific Center "Arctic: New Materials, Technologies and Research Methods" was created on the basis of the scientific and educational capacities of three Arctic regions: Murmansk Oblast, Arkhangelsk Oblast, and Nenets Autonomous Okrug. The purpose of the Scientific Center is to introduce new materials and technologies and to conduct research ensuring the competitiveness and the internationally respected level of research and development. It also assists in personnel training to solve major scientific and technological problems in the region in the interests of the industry and economy of the Russian Arctic to ensure advanced progress in the spatial development of Russia. The work of the Scientific Center is defined in five key areas: materials and technologies for the Arctic shipbuilding and marine equipment; development of high-tech industries in the Arctic (mining and processing of minerals, synthesis of new materials); human activity in the Arctic; bioresources of the Arctic zone; and the Northern Sea Route and connection of the Arctic territories (Scientific Center "Arctic" 2021). For 2021, the Scientific Center received a federal grant of ₽128 million.

The development of science in the Arctic receives significant funding. At the same time, in the implementation of Basics of the State Policy till 2020, we observe no appropriate target programs. Scientific research funding depended on the program for the socioeconomic development of the Arctic zone and current grant projects. For example, in 2017 the Ministry of Education and Science of the Russian Federation on behalf of the State Commission for Arctic Development developed the federal comprehensive scientific and technical program (CSTP) "Scientific Potential for the Arctic Development and Use." This is aimed at ensuring implementation of scientific and technical projects in the Arctic. Murmansk Arctic State University was to be its regional coordinator (Murmansk Arctic State University, 2018). However, the implementation of the program has not been started, and in addition, none of the CSTPs has been launched for 3.5 years since their approval (TASS, 2020).

Experts note that insufficient funding for scientific research remains one of the greatest challenges. In 2020, about ₽650 billion was allocated from the federal budget for scientific research, though about ₽6.7 billion was allocated for the projects on the Arctic, accounting for barely more than 1% of the total amount of scientific research funding in the country, despite the fact that the contribution of the Arctic to Russian GDP is up to 20%. As a result, there is not enough scientific support for the implementation of large investment projects in the Arctic. Organizations face an acute shortage of specialists and scientific personnel. Experts of the Project Office for Arctic Development proposed to create a target program for scientific and technological development of the Arctic zone of the Russian Federation and to form a state order for scientific research at high latitudes and to introduce incentive payments for those researchers who will work in the North (Mikhailov, 2021).

The coordination of scientific research in the Arctic (more than 500 scientific organizations located in 50 constituent entities of the Russian Federation that are engaged in research on the Arctic) is a promising task. In September 2020, it was decided to create a Scientific Arctic Council under the State Commission for Arctic Development, which is designed to coordinate the work of officials and scientific organizations and form an agenda of research on the Arctic. In addition, it is planned to create the Arctic Fund for Research and Development Grants for the scientific development. Neither the Scientific Council nor the Grant Fund has yet been established, which, among other things, does not contribute to increasing the competitiveness of domestic science in the Arctic research.

At the same time, if we evaluate the reputational effect of the Russian Government's activity in the scientific field in the Arctic, it is generally positive, but the evidence is given by the public opinion in the country. In the Year of Science and Technology, the Russian Public Opinion Research Center conducted a study to assess the specifics of residents' perception of the current level of scientific and technological development. More than half of the respondents reported increased state attention to the development of new territories in space, the ocean, the Antarctic, and the Antarctica (51%) (VCIOM, 2021c).

Experts note that the status of the Arctic power is not given automatically according to its geographical location, but requires daily hard work. Meanwhile, scientific research and innovative activities make a priority area for new efforts. The scientific and technological development is a factor of protecting Russian interests in the Arctic, which will determine the preservation of Russian control over the Arctic zone in the future (Pilyasov, 2012; Pupkova, 2014).

Conclusions

Thus, according to the results, we have studied the implementation of the state policy of the Russian Federation in the Arctic through the prism of the reputational approach. The chapter has determined the reputational potential and reputational risks of the Russian Government. Despite the creation of favorable regulatory and organizational conditions for the development of the Arctic zone and certain positive dynamics for a number of indicators given earlier, we cannot state the high efficiency of the state policy implementation in the Arctic zone according to the results of its evaluation (based on the tasks of the integrated development of the region). Thus, the reputational potential of the Russian Government – embodied in the very fact of launching a large-scale strategy for the Russian Arctic development, as well as positive effects in certain areas of its implementation – outweighs the reputational risks associated with problems of its effectiveness. Experts note the persistence of negative trends associated with the deteriorating demographic situation in the region; a growing shortage of professional personnel; insufficient funding (Pashchenko, 2019); the poor development of social, transport, and information and communication infrastructure of the land territories of the Arctic zone including places of traditional residence of small indigenous peoples (Zhuravel, 2020); and much besides.

It is evidenced by the assessment of the authorities themselves, both within the Basics of the Strategy for Arctic Development and Ensuring National Security for the Period up to 2035 (which identifies persistent hazards, challenges, and threats forming risks for the development of the Arctic zone and ensuring national security) and within the reports of the highest authorities. According to the results of 2018, the Ministry of Economic Development of Russia stated that the state program "Socio-economic Development of the Arctic Zone of the Russian Federation" is not effective (only 9.2%). At the meeting of the State Commission for Arctic Development held by the Deputy Prime Minister of the Russian Federation in 2019, it was noted that the state of the social sphere of the Arctic zone is significantly worse than the average in Russia. As an example, the following data were presented: in 16 out of 23 territories, life expectancy is lower than the average in Russia; 15 territories have a proportion of dilapidated and dangerous housing stock higher than the average in Russia. The researchers observed a slow growth in the volume of new housing construction and the low density of roads.

These conclusions show the need to prepare a new state program, but its draft was negatively evaluated by Accounts Chamber of the Russian Federation on a number of parameters. One of the most relevant discrepancies is an increase in a number of indicators with a significant reduction in budget allocations, for example, by 34.4 times for 2020 (Accounts Chamber of the Russian Federation, 2020). As a result, instead of a qualitative revision of the development programs of the Russian Arctic for the period up to 2025, a conclusion was made about the feasibility of their early withdrawal, the Development Strategy for the Arctic Zone of the Russian Federation and Ensuring National Security until 2035, and the corresponding new state program.

Among the main possible reputational risks in the current stage of the state policy implementation in the Arctic, we note the complexity of priorities (Kryukov et al., 2020) and a growing threat of unbalanced development of the Arctic territories. For example, Zhuravel (2020), analyzing the Basics of the State Policy until 2035, notes that they do not mention the support development zones. They are defined in the state program "Socio-economic Development of the Arctic Zone of the Russian

Federation until 2020" as the main mechanisms of state policy representing complex projects of socioeconomic development. They imply a simultaneous use of appropriate tools and mechanisms. In this regard, in the near future, the danger may arise that the status of the Arctic territories will be determined according to significance of the implemented projects, as well as development of targeted territories in the Arctic (Zhuravel, 2020).

As a result, we observe an increase in institutional risks and restrictions in the economy of the Russian Arctic. One of the constraints in achieving the necessary multiplicative effects in realizing the socioeconomic value of its natural resources is the implementation of large projects. However, the necessity should be given to an innovation-oriented environment aimed at the formation of various types of companies. The result and driver of this environment is small- and medium-sized businesses (Kryukov et al., 2020). A lack of competition and the unilateral dependence of Russian regions on the activities of large raw materials companies (state policy is largely confined to providing large-scale benefits to companies implementing resource projects) bring increased environmental risks. It is seen as a consequence of economic activities, simultaneously causing serious domestic and foreign political reputational damage (Karaganov, 2021).

The researchers of the Department of The World Economy and World Politics and the Center for European Integration Studies of HSE University distinguish three groups of risks, the worsening of which is possible in the further because of the regional development by extensive methods. They are:

- Sunk cost of capital-intensive projects devoted to the Arctic research; these are planned for decades ahead and require enormous costs.
- Increasing the production and export of primary energy resources, which will exacerbate aggravation of the technological dependence of the Russian economy (e.g., a significant part of the equipment is produced in China); it gives no multiplicative effects for industry, science, and human resource development.
- The expansion of economic activity in the Arctic, which can lead to negative environmental consequences or even man-made disasters, causing not only environmental damage but also domestic political risks and undermining the international prestige of the country (Karaganov, 2021).

At the same time, it should be acknowledged that the long-term prospects for the further development of the Russian Arctic, determined at the new stage of the state strategy implementation until 2035, are able to neutralize emerging threats. They can bring a high reputational potential for the Russian Government in achieving ambitious goals while preserving and strengthening Russian leadership in the Arctic megaregion.

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Virtual Entrepreneurial Networks in the Russian Arctic

Design, Management, and Assessment of Network Entrepreneurial Potential

Irina N. Tkachenko and Marina A. Meteleva

Contents

Abstract

Modern conditions for the development of society include informational socio-economic relations, the system-forming role of entrepreneurship in the knowledge economy, and the need for business process performers to undertake social distancing due to the global pandemic. All these conditions actualize the need for the development of network forms for business organization, the virtualization of management systems, and improvement of the principles of their design. When designing, an important task is to select strong actors, in particular large corporations, whose potential and interests are most "useful" to the network; therefore, the purpose of this study was to determine the role of large corporations in the design of entrepreneurial innovation networks. To achieve the goal of the study, a

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method is proposed for assessing the entrepreneurial potential of corporations and determining their role in the projected networks. This method is based on the system and network approaches, using correlation and network analysis tools. Using the example of corporations operating in the Arctic Zone of the Russian Federation, the capabilities of the method are demonstrated. For this aim, operational data from open sources were collected, the entrepreneurial potential of a pool of the largest corporations was assessed, a network model of corporations' potentials was visualized, and a network analysis of individual corporations as potential actors of entrepreneurial networks was presented. It is concluded that the hypothesis that all large corporations are potential effective actors for the formation of entrepreneurial alliances is not confirmed. The potential of each corporation must be assessed taking into account the specific requirements of the projected network. In the course of further research, it is planned to expand the pool of potential actors of entrepreneurial networks, develop a methodology for assessing their entrepreneurial potential, and form a methodology for selecting actors for multicomponent or multilevel models of entrepreneurial networks.

Keywords

Networks · Management · Entrepreneurship · Corporations · Coronavirus · Virtuality · Design · Entrepreneurial potential

Introduction

The modern paradigm of society development, characterized as informational capitalism, is based on the capitalist mode of production, in which technologies of knowledge generation, information processing, and symbolic communication are the sources of productivity or modes of development. The informational technological paradigm of society development is characterized by a network logic of organization of economic and social relations, as the network morphology provides increasingly complex interactions between elements of social and economic systems which use new information technologies (Kastels, 2000).

The modern interpretation of the economic content of entrepreneurship focuses on such features of this form of economic management as:

- A special economic role in the "process of creative destruction" in the search for market imperfections and mistakes by participants in creating new conditions that are the source of entrepreneurial rents (Amit et al., 1993; Asaul et al., 2008)
- The pursuit of profit maximization through innovations created by a nontrivial combination of resources in the face of market uncertainty (Bull & Willard, 1993)
- Venture capital form of activity financing

Thus, a specific feature of entrepreneurship, unlike other types of economic activity, is not the creation of competitive advantage, but the formation of better economic conditions for oneself through the realization of a specific property: innovation, which is a source of market disequilibrium, expansion of market demand, and entrepreneurial gain.

In turn, in the informational model of economy, the basis for sustainable development of socio-economic systems is information and knowledge – the sources of the new ideas and innovation.

The relationship between the function of sustainable economic growth in the new paradigm of informational productivity, which is the basis of the knowledge economy, and the modern interpretation of the economic content of entrepreneurship is obvious, which demonstrates the system-forming role of innovative entrepreneurship in the formation of socio-economic relations of knowledge economy, implementing the advantages of the informational development paradigm.

The network approach to the organization of entrepreneurial activity generates the logic of expediency of a virtual (i.e., information technology-based) approach to management of entrepreneurial structures. The most important distinguishing feature of the virtual network form of entrepreneurial activity organization is the possibility of dynamic coordination and real-time replacement of partners – participants in the chain of innovation value creation according to the speed and scale of change of project implementation conditions, regardless of the geographical location of the actors based on IT-technologies (Travica, 1997). The principle of maximum electronization of relationships between elements of virtual organizational structure has become an important advantage of this form of governance during the corona crisis.

The peculiarities of informational socio-economic relations, their more complex configuration, their system-forming role in entrepreneurship and the realization of the principles of the knowledge economy, the need for social distancing of executors of business processes in the conditions of the global pandemic – all these conditions actualize the need to develop network forms of organization of business activities and virtual management systems, as well as the principles of their design.

An important task of designing or reconfiguring enterprise networks is to continuously monitor the pool of potential actors based on analysis of their changing capacities and to form unique compositions in accordance with changing conditions of entrepreneurial projects. In network management, the network broker or network regulator constantly evaluates the "usefulness" of potential actors for the network, and the potential actors, in turn, analyze the "profitability" of their participation in the network enterprise.

It seems that the participation in innovative network projects of actors endowed with powerful economic, social, or power potential can have a significant positive impact on the characteristics of the network system – the level of network and its participants' goals, configuration, efficiency, sustainability, etc. Such actors appear to be large corporations. In connection with the above, the hypothesis requires consideration that large corporations that provide high indicators of socio-economic development of the regions of presence are sources of potential support for entrepreneurial innovation initiatives and potential network actors (Ketova & Ovchinnikov, 2015).

Consequently, the task of developing a methodological approach to assessing the network entrepreneurial potential of corporations, with the possibility of continuous automatic monitoring of financial and economic performance from open sources of information to determine their network role in the implementation of the entrepreneurial idea, is relevant.

Literature Review

Approaches to assessing the potential of business entities are represented by an extensive theoretical and methodological framework agreed upon in scientific circles. The potential of an organization is understood as all factors of production and exchange processes that an enterprise has for economic activity (material, financial, technological, labor, information, organizational, institutional, etc.) in various manifestations: competitiveness in value creation or costs in the value creation process. These provisions have been explored by Tkachenko and Starikov (2008), Tkachenko (2019), Sheresheva (2010), Barney (1991), Krueger and Brazeal (1994), Thompson (2004), Waltersmanna et al. (2019), and Hofer et al. (2019).

The notion of the network entrepreneurial capability of an organization is based on the definition of entrepreneurial network characteristics. The founders of the academic school of entrepreneurship and innovation – Asaul et al. (2008) – define an entrepreneurial network as a set of network partners: organizations that come together to effectively use the resources and competitive advantages of participants in the implementation of entrepreneurial projects aimed at achieving a specific entrepreneurial goal – "solving market management problems by activating entrepreneurial initiatives, flexibility, strategic agility and permanent innovation." Thus, to effectively implement entrepreneurial ideas, the capabilities of network actors should first of all correspond to the following distinctive features of entrepreneurship:

- *Creativity* – motivation to constantly search for new ideas
- *Innovativeness* – ability to create and distribute innovations
- *Informativeness* – readiness to generate and share information and knowledge, including on a global scale
- *Reasonable risk-taking* – the ability to respond flexibly to challenges in an uncertain environment and to create a positive image for venture capitalists

A model of the "utility" or entrepreneurial potential of corporations is proposed to be formed on the analysis of the points of convergence between corporate and entrepreneurial interests. In order to establish the analytical directions, it is necessary to compare a number of properties inherent in the economic categories of corporation and entrepreneurship.

Any corporation, as an economic entity, has an identifying feature that is perceived worldwide – a formal corporation always takes the form of a joint stock company, whose capital is formed by the equity participation of several persons (legal and/or physical).

Within a corporation, business entities pool their resources and enter into organizational, economic, and managerial relations, coordinating their private interests with the business strategy of the corporation (Dubrovskij, 2004; Stout, 2005). In the course of business, a relationship is formed between the corporation and many organized groups of people, the stakeholders, whose interests are related to the activities of the corporation. These groups are: shareholders of the company, managers, employees, customers, suppliers, competitors, creditors, government agencies, etc. The synergistic effect of stakeholder interaction forms the resource and, among other things, the entrepreneurial potential of the corporation.

Neoclassical economic doctrine declares the maximization of shareholders' interests as the main goal of the corporate organization. However, modern corporate objectives are inextricably linked to the objectives of the sustainable development of society, which require the creation of values of global scale and consideration of the interests of a wide range of stakeholders (Tkachenko, 2018; Freeman, 2001). The common axiom that the purpose of a corporation is profit maximization, which ensures the interest of its shareholder participants in the growth of return on investment, turns from a goal into one of the conditions of the organization's development when the perspective is changed. As J.K. Galbraith points out, any kind of organization that is no longer owner-managed, but techno-structured, tends to increase the size of the firm to the detriment of profit maximization (Galbraith, 1979).

In today's world, corporate development is not only about increasing economic efficiency through higher profits and lower costs, but also about increasing social and power weight, according to the global trends of the modern social development paradigm. Consequently, an important condition for corporate development today is the implementation of the principles of entrepreneurship into the activities of corporations, which are innately drawn to the classical principles of business management. However, while entrepreneurs gain rents by using the mistakes of market participants to create new, entrepreneurially beneficial market conditions, corporations play on eliminating market imperfections, thereby ensuring an increase in stakeholder value – the value received by holders of interests because of business operation. Market imperfections are one of the points of convergence between the interests of modern corporations and business actors where they can interact.

Given the global and national crisis in attracting investment in the real economy and the recognition of the priority of the informational efficiency paradigm, the development of technological innovation becomes almost the main mechanism for maintaining and increasing the competitiveness of corporations. At the same time, the initiation and implementation of innovative projects is a high-risk activity that requires large one-time investments and requires special competencies, often running counter to corporate interests, and requires outsourcing. Thus, the interests of corporations and entrepreneurial actors converge in the area of venture innovation research. When designing entrepreneurial networks, it is important to determine a point in this plane and in what way the interests of corporations and business entities can converge.

In the context of globalization, increasing transnational competition, and the crisis of investment attraction, corporations are intensifying innovation processes and are trying on the economic behavior characteristic of entrepreneurial actors in order to ensure the necessary level of profitability (Smolander et al., 2021).

A distinction is made between two philosophies of the innovation process – corporate entrepreneurship and start-up entrepreneurship (Freeman & Engel, 2007). Each has distinctive features, advantages, and disadvantages.

The advantages of large stable companies over newly created creative start-ups are large capital, engineering and management resources, legal and market weight, established strategic connections, opportunities for reconfiguration of organizational structure, and clear and well-organized business processes. However, most of the managerial and structural advantages of advanced corporations are a source of their disadvantages, since the specific activity of creating breakthrough innovations requires that the corporation have at least two enabling conditions: (1) resource mobility and (2) an understanding of the contradictions in the innovation management process.

The classical organizational behavior of corporate managers is characterized by a tendency to conserve resources as a guarantee of implementing their own duties and interests, which slows down the transfer of resources from current turnover to innovative projects. This tendency contradicts the distinctive feature of entrepreneurship, which is the outstripping of breakthrough innovative ideas compared to competitors. The rapid market launch of new products is an advantage for entrepreneurial structures in the competition for the market. The sluggishness of large corporations in mastering new technologies devalues the results of their entrepreneurial impulses.

The conflict between the interests of corporate owners/management and innovators is referred to as the “paradox of creativity and control” (Freeman & Engel, 2007). The bureaucratic organizational structure of corporations struggles to accept the changes needed to participate in the innovation development paradigm. Conversely, in a structure focused on creativity, there is often less emphasis on formalizing and streamlining management processes – the focus of innovators on the creative process generates the problem of bringing an idea to a marketable product. Organizations that can create innovative solutions are often unable to execute plans to implement them quickly and accurately, and the process of creating an innovation requires both competencies.

One of the sources of contradictions between corporate owners (investors in idea development) and entrepreneur-innovators is the inventor’s personal commitment to the innovative idea and aversion to the transfer of ownership of the invention to corporate shareholders.

The resolution of the paradoxes of corporate and entrepreneurial relations is implemented through mechanisms that combine the entrepreneurial model of generating innovative ideas and the corporate model of scaling up technology and increasing the profitability of the innovative product, which determine the corporate venture strategy.

Two types of corporate venture strategy have been generally distinguished (Guseva, 2019).

The *first type* of entrepreneurial behavior of a corporation involves the deployment of innovative projects outside the internal business processes and represents various forms of cooperation with entities external to the corporate environment of innovation and entrepreneurship (O'Connor et al., 2020).

Mechanisms such as investment in external ventures and venture takeovers are used to implement external venture strategies.

The goal of financing high-risk innovative projects for a large investor is often not to create breakthrough technologies per se, but to generate returns that are significantly higher than the rate of return of less risky investments. A venture investor may enter an entrepreneurial project at any stage from the birth of the business idea to the marketing promotion of the product, as well as being able to invest in the development of existing enterprises with high innovation potential. It should be noted that today, the notion of venture financing is linked to the life cycle stage of a business – investing in an enterprise at the start-up stage is considered to be venture financing (Rijnsoever & Eveleens, 2021). When the venture project reaches its peak and its market value reaches the projected maximum, venture capitalists realize their goal of making super profits by selling their stake in the company. This approach, on the one hand, is not contrary to the inventors' interests regarding the ownership of the idea, but on the other hand, the reorganization of the company due to the exit of the venture capitalist often leads to the collapse of the company.

This trend opens up opportunities for corporations to employ a venture takeover strategy. When a start-up venture capitalist exits the company at the completion of one innovative project, there is an opportunity for other corporations to exploit its infrastructural and public-preferential advantages in another project by introducing some changes. The following possible strategies are implemented:

- A takeover of a venture capitalist in order to re-purpose and integrate it into a corporation
- Takeover of several related ventures in order to merge and integrate them into the corporation

The *second type* of entrepreneurial behavior of a corporation involves the incorporation of entrepreneurial relationships into the organizational and economic processes of corporate structures and is considered as domestic entrepreneurship or intrapreneurship.

Intrapreneurship is carried out through strategies of creating domestic ventures and spin-outs.

The strategy of creating domestic venture involves the allocation of specialized units within the corporation, providing a full cycle of innovation activity – from the generation of ideas to bringing the innovation to market. The strategy of creating spin-outs is carried out through the reorganization of the corporation – the spin-off of an independent legal entity in which the corporation is the majority shareholder, controls operational and financial activities, and provides comprehensive support.

Thus, it is possible to identify the most important parameters of corporate activities, indicating their capabilities and commitment to the principles of entrepreneurship (points of convergence between corporate and entrepreneurial interests) as follows:

- The scale of the corporation's activities, characterizing the opportunities to divert capital to ventures without significant risk to stakeholder interests
- Its own productive innovation activities, indicating the implementation of venture policy in the form of domestic entrepreneurship, when corporations can be seen as sources of an established innovation infrastructure
- Venture investments, not yet resulting in an innovative product, indicating the advantage of the corporation's external entrepreneurial policy, that is, an interest in developing an innovative product outside the corporation's business processes

Existing Approaches to Network Analysis

The model of the entrepreneurial potential of a corporation is a source of information for a network broker or entrepreneurial network management system in forming an effective composition of actors according to the objectives of a particular project (Jarrahi & Sawyer, 2019; Kenis & Raab, 2020; Marchiori & Francj, 2020). The present study needs to address the challenge of forming a methodological approach to assess the entrepreneurial capacity of corporations, in terms of their usefulness for the newly created network, taking into account the requirements of automatic operational monitoring of changes in their financial characteristics and the absence of territorial constraints in a virtual governance environment.

When designing innovation alliances, the intensity of ties between actors depends on the entrepreneurial capabilities of each actor and any inducement to collaborate requires an analysis of partner capabilities, as the realization of competitive advantage of the network depends on the congruence of actors (Holmberg & Cummings, 2009; Fierro et al., 2020).

It seems to be reasonable to solve this problem using methods and tools of network analysis, which is the result of development of graph theory (a field of mathematics). A graph or a network is defined as a set of elements (vertices or actors) and edges (links) connecting them. This research focuses on characteristics of links and actors' positions (Burt, 1980; Newman, 2003).

Network analysis methods have developed powerfully in operations research and in solving technical flow problems. The clarity and logical validity of these methods make it possible to apply them in solving problems from almost any field of science or industry. As noted by Filips and Garsia-Dias (1984): "an important property of the network research method is that it can be used to conduct initial studies of a complex control system and produce a preliminary schedule for the operation of its components in a visually convenient format." In particular, the following classical algorithms for solving flow technical problems using graph theory are widely known, the logic of which can be adapted to study network models of nontechnical systems: the shortest network problem "Dijkstra algorithm," Phillips's problem on oil transportation, maximum flow problem, multipole maximum flow problem "Gomory-Hu algorithm," maximum-capacity multipole circuit problem, etc.

An analysis of recently published works by Hernandez-Carrion et al. (2019), Cabello-Medina et al. (2019), Larraneta et al. (2019), Etriya et al. (2019), De Vaana and Wang (2020), Cehan et al. (2021), Aparicioa et al. (2021), and Adu-Baffour et al. (2021) devoted to the research of social, economic, political networks have allowed to identify the methods and tools of network research that are most frequently used by scholars and characterize the current achievements of network analysis.

A generalized algorithm of the modern approach to network research can be presented as follows:

- Defining the problem, determining its theoretical foundations, the composition of empirical data, and forming the author's hypothesis about the network elements and the trajectories of network interactions
- Forming a wide pool of respondents (100 to 1000 or more respondents) who are relevant to the problem, most often on the basis of open information from the Internet system, in particular social networks
- Conducting an empirical experiment to establish relationships between the identified elements by questionnaires using various assessment tools – Likert scale, Fisher scale, ranking, etc.
- Structuring and describing the data obtained using descriptive statistics
- Intra- and inter-network correlation analysis of data, the results of which are presented in the form of a correlation matrix (adjacency matrix)
- Visualization of network relationships and calculation of network parameters using network parameterization software such as SmartPLS 3.0 or UCINET for Windows

The presented set of approaches and tools, in various combinations, is most commonly used in studies of social and technological networks, with existing linkages. The task that is addressed in this study has some peculiarities.

There are not yet any links between the actors, and the object of network analysis in this case is the capabilities (potentials) of the actors, based on which the optimal object composition of the network is determined, providing in the future a set of the most effective interactions. Thus, a methodology of network analysis is required, an "inverse" of the widespread one.

The virtuality of the management system of the designed network reduces the impact of the territorial constraint of the network associated with transaction costs (communication, time) of interactions between actors (Cenamor et al., 2019; Kohtamäki et al., 2019). At the same time, constraints remain, due to the territorial competition of actors for resources allocated in public regional policies, the interests of potential investors, the social interests of actors in the area of operation, and the political interests of actors. Thus, when designing networks with a virtual governance system, created for implementation of entrepreneurial innovation projects, it should be remembered that they remove the territorial limitations on geographical location of potential actors, unlike territorial clusters, but cannot ignore the interests of actors as stakeholders of entrepreneurial idea and residents of certain administrative-territorial units.

The requirement for the speed of actor capacity analysis to reconfigure network composition and linkages within the virtual alliance excludes the use of widely used network analysis tools such as surveys and questionnaires of network stakeholders. Therefore, the sources of data for the design of new networks should be the open Internet resources, which in turn makes it possible to automate data collection, continuously monitor them, and provide the network agent with the most relevant data on potential actors for decision-making (Harris, 2021).

Rationale for the Selection of the Study Site

As of today, one of the priorities of Russia's state regional policy is the development of the Russian Arctic, a territory of great strategic, and resource importance for the development of the national economy and national security. At the same time, due to the climatic, natural, and anthropogenic properties of this territory, alongside their global impact, the industrial development of the Arctic, like no other region, requires the application of nonstandard innovative approaches. The solution to each development challenge in the Arctic must be based on individually tailored technologies that aim to preserve the balance of the fragile ecosystem of the area.

In this regard, innovative entrepreneurship plays a special role in the development of the Arctic territories, and the development of its organizational and economic forms in the nonstandard conditions of the Far North is becoming more important. The leading role in the implementation of the task of developing the Russian Arctic is played by resource corporations, whose share in total Russian investments is 8%, 100% in physical indicators of apatite concentrate production, 91% in gas, 17.2% in oil, 10% in iron ore concentrate, 9.9% in the production of pulp, 5.6% in paper and cardboard, and 2.6% in the production of hard coal and brown coal (Pilyasov & Bogodukhov, 2021). They are also sources of increased negative impact on the environment and centers of responsibility for the formation of social infrastructure, which implies their high activity in the initiation of innovation processes. The peculiar scientific challenges have predetermined the Arctic Zone of the Russian Federation (AZRF) as the testing ground for this study.

Methodology: Description of the Author's Model

In order to form effective entrepreneurial networks, it is necessary to adequately assess the capabilities of a wide range of actors, meaning stakeholders of the socio-economic system or project: existing network forms of public administration; the entrepreneurial potential of the public authorities, businesses, corporations, non-profit organizations, and the population and its individual groups; and the research and educational institutions of the Arctic Zone of the Russian Federation (Meteleva, 2019, 2020a, b).

It is proposed to assess the network potential of large corporations in the AZRF according to three parameters, which, as argued above, characterize the capabilities of corporations most significant for supporting entrepreneurial innovation projects, such as:

- The corporation's potential as a *source of venture capital* (Net Corporate Potential for Venture Capital)
- The corporation's potential to implement an *internal venture capital policy* (Net Corporate Potential for Innovation Result)
- The corporation's capacity to implement external venture capital policy – innovation activity (Net Corporate Potential for Innovation Activity)

The model of the corporation's *Net Entrepreneurial Potential* is:

$$NCP_i = NCP\ (VC)_i + NCP\ (IR)_i + NCP\ (IA)_i, \tag{1}$$

where

NCP_I – the network capacity of the i-corporation
$NCP\ (VC)_i$ – module for assessing the network potential of the i-corporation as a source of venture capital
$NCP\ (IR)_i$ – module for assessing the network capacity of the i-corporation in terms of innovation performance
$NCP\ (IA)_i$ – module for assessing the network capacity of the i-corporation in terms of innovation activity

To consider corporate structures as a source of venture capital investment in innovative projects, it is necessary to emphasize the fact that, as potential actors of entrepreneurial networks, large manufacturing corporations are preferable. The scale of their activities levels out the impact of investment risks on the financial stability and liabilities of corporations, which, in turn, increases the probability of their participation in the processes of entrepreneurial creativity. We are looking for such organizations that are more open to external collaboration, which makes it possible to count on their active participation in the metamorphosis of entrepreneurial networks.

Therefore, the first action in the algorithm for assessing corporations as potential actors of entrepreneurial networks is to assess the largest corporations as potential donors of venture capital in the region of operation.

Assessing the Network Potential of a Corporation as a Source of Venture Capital

The network potential of a corporation as a source of venture capital is proposed to be assessed based on the scale of its operations or production volume. The scale of operations is defined as the proportion of the corporation's revenues to the total amount of revenues generated by enterprises in the region over the period:

$$NCP\ (VC)_i = \frac{R_i}{R_r} \tag{2}$$

where $NCP\ (VC)_i$ – the entrepreneurial potential of the i-th corporation as a source of venture capital; R_i – is the revenue of the i-th corporation for the period; R_r – the amount of revenue generated by businesses in the region over the period.

Assessing a Corporation's Network Capacity for Innovation Result

If a corporation carries out innovation activities within the framework of an internal venture policy – that is, in-house – and as a result has its own developments, such a corporation is of interest to an entrepreneurial network as a source of an established innovation infrastructure. This evaluation criterion is positive if the technologies or products developed are real assets of the corporation and participate in the creation of innovation value.

In this regard, the authors propose evaluating the innovative result of the corporation based on the analysis of the degree of influence of the results of scientific research carried out by the corporation within the internal business processes on the volume of innovative goods produced in the region. For this, we will apply the technique of correlation analysis to the results of the corporation's research and development (hereinafter referred to as R&D) and the share of innovative goods, works, and services in the total volume of shipped goods, as well as works and services (Innovation Goods to Total Sales) in the region of the corporation for the period.

The direct correlation between the variables is considered as a positive impact of scientific research of the corporation on regional innovation processes and makes it possible to identify corporations with the most successful internal policy of innovative entrepreneurship, giving socially significant results and, therefore, having the best entrepreneurial potential. No connection, or a negative relationship between the corporation's internal R&D and the output of innovative products in the regions of presence (when R&D expenditures do not create an innovative product), is considered as a zero NCP (IR) potential.

The Corporate Potential for Innovation Result is defined as the value of the correlation coefficient r between the Innovation Goods to Total Sales (Y) and Scientific Research (X) variables defined above:

$$NCP(IR)_i = r, IG\ (TS)_i = rSR_i, \tag{3}$$

where $NCP(IR)_i$ – the network entrepreneurial capacity of the i-th corporation in terms of innovation result; r – correlation coefficient; $IG\ (TS)_i$ – the share of innovative goods, works and services in the total volume of goods shipped, works performed, and services rendered in the region where the i-corporation operates for the period; SR_i – is the amount of R&D performed by the i-th corporation during the period.

Assessing a Corporation's Network Capacity for Innovation Activity

Corporate-funded R&D may not result in an innovative product. However, research activities have taken place, and knowledge and experience have been accumulated. Such expenses are accounted at the enterprises as part of the item "Other expenses" on the balance sheet, and within the framework of statistical reporting in the subject of the Russian Federation, they are reflected in the form "Internal current expenses on research and development (hereinafter referred to as R&D)." The analysis of this information makes it possible to estimate the scale of entrepreneurial activity of the corporation, which has not yet led to an innovative result. Since the open information in the Internet system about internal current expenditures on R&D is presented by region, and to solve the research problem, it is necessary to obtain data on individual corporations, to assess the potential of the corporation the authors propose using the criterion of presence or absence of the relationship between the corporation's expenditure on R&D not reflected in assets and R&D expenditure in the RF constituent entity as a whole. The Corporate Potential for Innovation Activity of an individual corporation is defined as the value of the correlation coefficient r between the variables Internal current costs of R&D in the subject (Y) and Expenses, including R&D with Zero Result (X):

$$NCP(IA)_i = r, \quad IC\ (R\&D)_i = rEZR_i, \tag{4}$$

where $NCP(IA)_i$ – the network entrepreneurial capacity of the i-th corporation in terms of innovation activity; r – correlation coefficient; $IC\ (R\ \&\ D)_i$ – internal current R&D expenditure in the constituent entity of the Russian Federation of the i-th corporation for the period; EZR_i – other expenditures, including R&D with zero result for the i-th corporation for the period.

In the proposed approach, the correlation matrix for network analysis of entrepreneurial potential of corporations and determination of the effective composition of actors reflects the strength of influence of entrepreneurial activity of corporations on innovation processes in the socio-economic system under study, in contrast to dichotomous matrices reflecting the presence or absence of yes/no relationship between actors.

Assessment of Network Entrepreneurial Capacity of Corporations in the Arctic Zone of the Russian Federation

Based on publicly available data on the financial and economic activities of Russian enterprises, the 450 largest enterprises (50 for each subject of AZRF) are identified by the scale of activity based on the revenue indicator for 2019, as well as the volume of revenue of all enterprises by subjects of the Arctic Zone of the Russian Federation for its nine regions. For the largest enterprises of the subjects of the Arctic Zone of the Russian Federation, the positive results of R&D in the form of enterprise assets are reflected, if available. Based on open statistical reporting, an array of data on the indicator of the share of innovative goods, works, and services in the total volume of shipped goods, performed works, and services in the subjects of the Arctic Zone for the period 2011–2019 was formed. It should be noted that the period of data on the share of innovative goods in the total volume of shipped goods in the regions of the ASRF is 1 year apart from the period of data on corporations' investment in R&D – as a time lag of R&D results from investment in innovative developments.

The indicator of the network entrepreneurial potential of a corporation as a source of venture capital cannot have a negative value – all positive values of the correlation coefficient are taken as significant for the assessment of the entrepreneurial potential of a corporation in terms of innovation performance and activity.

The methodology of data collection and calculations on the example of the Murmansk Region are presented in Tables 1, 2, and 3.

Table 1 Data and calculation of the entrepreneurial potential of the largest corporations of the Russian Arctic as sources of venture capital (on the example of the Murmansk region)

Subject of the Russian Federation	The corporation	The potential of the corporation as a source of venture capital		
		Production volume (revenues) 2019, (₽ million)	Total production (revenues) of companies in the territory in 2019, (₽ million)	*CP (VC)*
Murmansk region	LLC Kola Mining and Metallurgical Company Monchegorsk	210,686	749,982	0.28
	JSC Olenegorsk Mining and Processing Plant Olenegorsk	22,864	749,982	0.03
	CJSC Arktikservice, Murmansk	13,739	749,982	0.02
	Murmansk Trawl Fleet, Murmansk	12,239	749,982	0.02
	JSC North-West Phosphorous Company Kirovsk	11,002	749,982	0.01
	JSC Marine Arctic Geological Exploration Expedition, Murmansk	10,078	749,982	0.01
	JSC Norebo ru Murmansk	8436	749,982	0.01

Source: Compiled by the authors based on Interfax. *Spark*. Retrieved from: https://www.spark-interfax.ru/ru/sources; "Counterparty. Pro". (2021). *Professional Counterparty Verification System.* Retrieved from: https://kontragent.pro/

Table 2 Data and calculation of the entrepreneurial potential of the largest corporations of the Russian Arctic in terms of innovative performance (on the example of the Murmansk region)

Subject of the Russian Federation	The corporation	The innovation performance potential of the corporation					
		Period	R&D expenditure, ₽ thousand, X	Period	Share of innovative goods, works, services in the total volume of goods shipped, percent in AZRF subject, Y	*CP (IR)*	CP accepted
Murmansk region	LLC Kola Mining and Metallurgical Company Monchegorsk	2012	1693	2013	–	−0.31	0.00
		2013	0	2014	3.6		
		2014	0	2015	1.7		
		2015	0	2016	1.5		
		2016	52,823	2017	1.3		
		2017	0	2018	0.8		
		2018	0	2019	4.7		
	JSC Olenegorsk Mining and Processing Plant Olenegorsk	2012	18,608	2013	–	0.20	0.20
		2013	14,755	2014	3.6		
		2014	9685	2015	1.7		
		2015	4615	2016	1.5		
		2016	1336	2017	1.3		
		2017	33	2018	0.8		
		2018	0	2019	4.7		
	CJSC Arktikservice, Murmansk	2012	0	2013	–	0.00	0.00
		2013	0	2014	3.6		
		2014	0	2015	1.7		
		2015	0	2016	1.5		
		2016	0	2017	1.3		
		2017	0	2018	0.8		
		2018	0	2019	4.7		
	Murmansk Trawl Fleet, Murmansk	2012	0	2013	–	−0.14	0.00
		2013	0	2014	3.6		
		2014	0	2015	1.7		
		2015	2228	2016	1.5		

(continued)

Table 2 (continued)

Subject of the Russian Federation	The corporation	The innovation performance potential of the corporation					
		Period	R&D expenditure, ₽ thousand, X	Period	Share of innovative goods, works, services in the total volume of goods shipped, percent in AZRF subject, Y	*CP (IR)*	CP accepted
		2016	1256	2017	1.3		
		2017	3187	2018	0.8		
		2018	2528	2019	4.7		
	JSC North-West Phosphorous Company Kirovsk	2012	1850	2013	–	0.38	0.38
		2013	1650	2014	3.6		
		2014	1450	2015	1.7		
		2015	1250	2016	1.5		
		2016	9449	2017	1.3		
		2017	10,618	2018	0.8		
		2018	18,119	2019	4.7		
	JSC Marine Arctic Geological Exploration Expedition, Murmansk	2012	0	2013	–	0.00	0.00
		2013	0	2014	3.6		
		2014	0	2015	1.7		
		2015	0	2016	1.5		
		2016	0	2017	1.3		
		2017	0	2018	0.8		
		2018	0	2019	4.7		
	JSC Norebo ru Murmansk	2012	0	2013	–	0.00	0.00
		2013	0	2014	3.6		
		2014	0	2015	1.7		
		2015	0	2016	1.5		
		2016	0	2017	1.3		
		2017	0	2018	0.8		
		2018	0	2019	4.7		

Source: Calculated and compiled by the authors based on Rosstat. *Regions of Russia. Socio-economic indicators*. Retrieved from: www.rosstat.ru. *Spark*. Retrieved from: https://www.spark-interfax.ru/ru/sources; “Counterparty. Pro”. (2021). *Professional Counterparty Verification System.* Retrieved from: https://kontragent.pro/

Table 3 Data and calculation of the entrepreneurial potential of the largest corporations of the Russian Arctic by innovation activity (on the example of the Murmansk region)

Subject of the Russian Federation	The corporation	Potential for corporate innovation activity: Period	Other expenses, ₽ thousand, X	Period	Internal current costs of R&D in the subject AZRF, ₽ thousand, Y	*CP (IA)*	CP accepted
Murmansk region	LLC Kola Mining and Metallurgical Company Monchegorsk	2013	5,230,000	2013	2,460,400	0.05	0.05
		2014	2,930,000	2014	2,526,800		
		2015	3,470,000	2015	2,480,800		
		2016	0	2016	2,368,100		
		2017	0	2017	2,245,900		
		2018	0	2018	2,536,200		
		2019	0	2019	2,711,400		
	JSC Olenegorsk Mining and Processing Plant Olenegorsk	2013	704,960	2013	2,460,400	−0.48	0.00
		2014	559,890	2014	2,526,800		
		2015	822,770	2015	2,480,800		
		2016	459,220	2016	2,368,100		
		2017	461,270	2017	2,245,900		
		2018	0	2018	2,536,200		
		2019	0	2019	2,711,400		
	CJSC Arktikservice, Murmansk	2013	645,270	2013	2,460,400	−0,61	0,00
		2014	909,160	2014	2,526,800		
		2015	1,970,000	2015	2,480,800		
		2016	4,660,000	2016	2,368,100		
		2017	5,320,000	2017	2,245,900		
		2018	1,060,000	2018	2,536,200		
		2019	2,660,000	2019	2,711,400		
	Murmansk Trawl Fleet, Murmansk	2013	142,850	2013	2,460,400	0.48	0.48
		2014	1,990,000	2014	2,526,800		
		2015	1,480,000	2015	2,480,800		
		2016	853,170	2016	2,368,100		

(continued)

Table 3 (continued)

Subject of the Russian Federation	The corporation	Potential for corporate innovation activity					
		Period	Other expenses, ₽ thousand, X	Period	Internal current costs of R&D in the subject AZRF, ₽ thousand, Y	*CP (IA)*	CP accepted
		2017	126,710	2017	2,245,900		
		2018	1,420,000	2018	2,536,200		
		2019	928,920	2019	2,711,400		
	JSC North-West Phosphorous Company Kirovsk	2013	487,780	2013	2,460,400	0.06	0.06
		2014	1,340,000	2014	2,526,800		
		2015	1,970,000	2015	2,480,800		
		2016	1,080,000	2016	2,368,100		
		2017	1,030,000	2017	2,245,900		
		2018	902,990	2018	2,536,200		
		2019	1,060,000	2019	2,711,400		
	JSC Marine Arctic Geological Exploration Expedition, Murmansk	2013	100,890	2013	2,460,400	0.44	0.44
		2014	342,050	2014	2,526,800		
		2015	595,210	2015	2,480,800		
		2016	476,320	2016	2,368,100		
		2017	369,910	2017	2,245,900		
		2018	1,110,000	2018	2,536,200		
		2019	734,190	2019	2,711,400		
	JSC Norebo ru Murmansk	2013	1820	2013	2,460,400	0.64	0.64
		2014	12,700	2014	2,526,800		
		2015	6990	2015	2,480,800		
		2016	24,730	2016	2,368,100		
		2017	13,910	2017	2,245,900		
		2018	20,820	2018	2,536,200		
		2019	70,260	2019	2,711,400		

Source: Calculated and compiled by the authors based on Rosstat. *Regions of Russia. Socio-economic indicators*. Retrieved from: www.rosstat.ru. *Spark*. Retrieved from: https://www.spark-interfax.ru/ru/sources; “Counterparty. Pro”. (2021). *Professional Counterparty Verification System.* Retrieved from: https://kontragent.pro/

Table 4 Matrix of entrepreneurial potential of the pool of large corporations by constituent entities of the Russian Federation AZRF, shares

ID	Subject of the Russian Federation	The corporation	CP (VC)	CP (IR)	CP (IA)
K1	Arkhangelsk region	LLC Arkhangelsk Pulp and Paper Mill Novodvinsk	0.05	0	0.39
K2		LLC Arkhangelskgeoldobycha Diamonds Arkhangelsk	0.03	0	0.44
K3		LLC Production and Commercial Enterprise Titan Arkhangelsk	0.03	0	0.3
K4		PLLC Severalmaz Arkhangelsk	0.02	0	0.66
K5		LLC Arkhangelsk Trawl Fleet	0.01	0	0.62
K6		LLC SPO Chemical Reagents Plant Arkhangelsk	0.004	0	0.66
K7	Republic of Karelia	LLC Alternativa Loukhsky district	0.25	0	0.16
K8		LLC Virma Fishing Company Belomorskiy district	0.29	0	0.74
K9	Republic of Komi	LLC Vorkutaugol Coal Production Vorkuta	0.66	0	0.02
K10		LLC Vorkuta CHPP Vorkuta	0.09	0	0.75
K11	Krasnoyarsk region	PLLC Mining and Metallurgical Company Norilsk Nickel Taimyrsky (Dolgano-Nenets) District	0.57	0.71	0
K12		LLC Logistik-Centre, Norilsk	0.01	0	0.42
K13	Murmansk region	LLC Kola Mining and Metallurgical Company Monchegors	0.28	0	0.05
K14		JSC Olenegorsk Mining and Processing Plant Olenegorsk	0.03	0.2	0
K15		CJSC Arktikservice Murmansk	0.02	0.2	0
K16		Murmansk Trawl Fleet, Murmansk	0.02	0	0.48
K17		JSC North-West Phosphorous Company Kirovsk	0.01	0.38	0.06
K18		JSC Marine Arctic Geological Exploration Expedition, Murmansk	0.01	0	0.44
K19		JSC Norebo ru Murmansk	0.01	0	0.64
K20	Nenets Autonomous District	LLC Bashneft-Polyus Naryan-Mar	0.44	0.73	0
K21		CJCS Kolvinskoye, Naryan-Mar	0.1	0	0.64
K22	Chukotka Autonomous District	JSC Chukotka Mining and Geological Company Anadyr	0.31	0	0
K23	Republic of Sakha (Yakutia)	JSC Sakhaenergo Bulunskiy ulus	0.87	0	0
K24		CJSC Kolymstroysnab, Verkhnekolymsky ulus	0.01	0	0.78
K25	Yamal-Nenets Autonomous District	PJSC Novatek Purovsky district	0.14	0	0.52
K26		JSC Gazprom Dobycha Yamburg	0.09	0	0.38
K27		JSC Gazprom Neft - Noyabrskneftegaz Noyabrsk	0.06	0	0.36

(continued)

Table 4 (continued)

ID	Subject of the Russian Federation	The corporation	CP (VC)	CP (IR)	CP (IA)
K28		JSC Novatek-Yurkharovneftegaz Novy Urengoy	0.05	0	0.38
K29		PJSC “"State Transport Leasing Company” Salekhard	0.04	0	0.23
K30		LLC Yargeo, Nadym	0.02	0	0.96
K31		JSC Achimgaz Novy Urengoy	0.02	0.22	0.2
K32		LLC Gazprom dobycha Noyabrsk Noyabrsk	0.02	0.34	0
K33		CJSC Severneftegazprom from the village of Krasnoselkup. Krasnoselkup	0.01	0.51	0

Source: compiled by the authors based on modeling

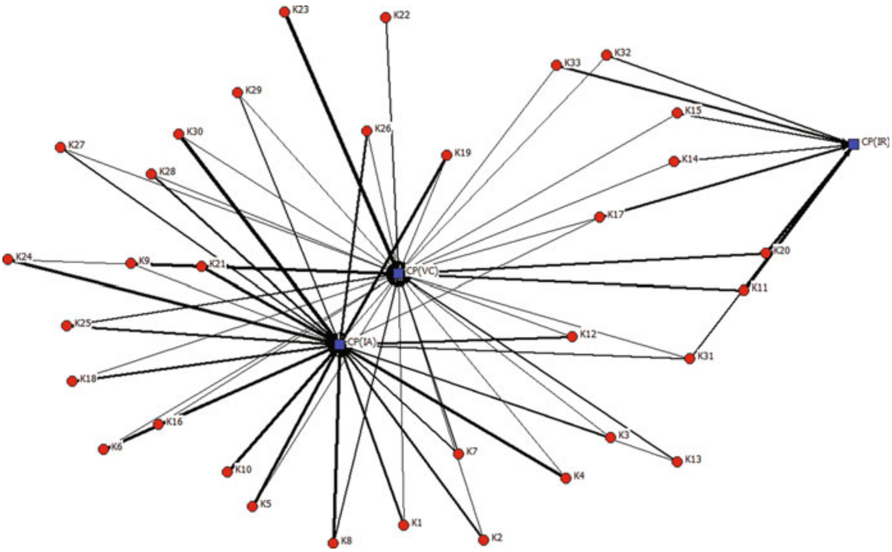

Fig. 1 Network of entrepreneurial potential of corporations operating in the Russian Arctic. (Source: compiled by the authors based on modeling)

A matrix of the entrepreneurial potential of a pool of large corporations by constituent entities of the Arctic Zone of the Russian Federation is presented in Table 4.

A network diagram of the entrepreneurial potential of corporations operating in the Arctic Zone of the Russian Federation is shown in Fig. 1.

A visual analysis of the diagram led to the following conclusions:

- In the Arctic Russia macroregion, the pool of large corporations is characterized by the predominance of entrepreneurial capacity as sources of venture capital CP

(VC); for this node, there is a high degree of centrality of incoming links and their strength.

- The second position in terms of connections and strength is occupied by the CP (IA) node of entrepreneurial potential of corporations as sources of innovation activity
- The smallest number of corporations in the AZRF have the innovation performance potential CP(IR); this node shows the lowest degree of centrality in the diagram, at the same time, the strength of ties in this node is high.

Operational assessment of the entrepreneurial potential of the corporations in the Arctic zone of the Russian Federation using the network diagram is advisable to expand the analysis of 2-Mode Centrality, which identifies the most important nodes of the graph, carried out with the help of UCINET 6.730 software (Fig. 2).

Thus, the presented analysis demonstrates the leadership in all parameters (degree of node, 2-locality, proximity, mediation, eigenvector) of the K17 and K31 nodes, namely, *North West Phosphorous Company*, Kirovsk, Murmansk region (hereafter NWPC) and *Achimgaz*, PJSC Gazprom, Novy Urengoy, and YNAO.

Conclusions

The research reveals that out of the 450 corporations in the Arctic region of Russia, only two corporations (*North West Phosphorous Company* and *Achimgaz*) – far from the ones that are commonly regarded as pillars of social responsibility and socio-economic development in their regions of operation – have entrepreneurial capabilities. This leadership can be explained by the fact that these corporations have all three of the three types of entrepreneurial capability in question and, therefore, in terms of networking have more value than corporations with two types of stronger connections. They are dynamic subsidiaries of large corporations that prioritize innovation in their organization.

Corporations with at least one type of capability may be in the pool of potential actors and of interest depending on the goals of the entrepreneurial project. However, the hypothesis that all large corporations with a significant impact on the socio-economic situation of the region of operation are potentially effective actors for the formation of entrepreneurial alliances is not supported. The potential of each corporation should be assessed taking into account the specific requirements of the projected network.

Thus, the chapter proposes a methodology for assessing the innovation potential of corporations to design entrepreneurial networks, assesses the potential, and, based on the network analysis, identifies the best in terms of networking corporations in the Arctic Zone of the Russian Federation to design virtual entrepreneurial innovation networks in the macroregion. The proposed methodology differs from the existing ones in that it is aimed at finding strong actors to establish effective links between them when forming new networks, while the objects of widely used network analysis techniques are already formed links between the actors, analysis of their characteristics, and decision-making within the established relationships.

The aim of further research on this topic is to develop a methodology for assessing the entrepreneurial potential of other actors that may be involved in innovation projects and a methodology for organizing their optimal interaction.

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                                   ucinetlog8
2-MODE CENTRALITY
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Input dataset:                         CP (E:\UCINET\CP
Output ROW measures:                   CP-rowcent (E:\UCINET\CP-rowcent
Output COLUMN measures:                CP-colcent (E:\UCINET\CP-colcent

2-Mode Centrality Measures for ROWS of CP
```

		1 Degree	2 2-Local	3 Closeness	4 Betweenness	5 Eigenvector
1	K1	0.667	0.586	0.971	0.001	0.187
2	K2	0.667	0.586	0.971	0.001	0.187
3	K3	0.667	0.586	0.971	0.001	0.187
4	K4	0.667	0.586	0.971	0.001	0.187
5	K5	0.667	0.586	0.971	0.001	0.187
6	K6	0.667	0.586	0.971	0.001	0.187
7	K7	0.667	0.586	0.971	0.001	0.187
8	K8	0.667	0.586	0.971	0.001	0.187
9	K9	0.667	0.586	0.971	0.001	0.187
10	K10	0.667	0.586	0.971	0.001	0.187
11	K11	0.667	0.414	0.971	0.007	0.123
12	K12	0.667	0.586	0.971	0.001	0.187
13	K13	0.667	0.586	0.971	0.001	0.187
14	K14	0.667	0.414	0.971	0.007	0.123
15	K15	0.667	0.414	0.971	0.007	0.123
16	K16	0.667	0.586	0.971	0.001	0.187
17	K17	1	0.667	1	0.015	0.208
18	K18	0.667	0.586	0.971	0.001	0.187
19	K19	0.667	0.586	0.971	0.001	0.187
20	K20	0.667	0.414	0.971	0.007	0.123
21	K21	0.667	0.586	0.971	0.001	0.187
22	K22	0.333	0.333	0.944	0	0.102
23	K23	0.333	0.333	0.944	0	0.102
24	K24	0.667	0.586	0.971	0.001	0.187
25	K25	0.667	0.586	0.971	0.001	0.187
26	K26	0.667	0.586	0.971	0.001	0.187
27	K27	0.667	0.586	0.971	0.001	0.187
28	K28	0.667	0.586	0.971	0.001	0.187
29	K29	0.667	0.586	0.971	0.001	0.187
30	K30	0.667	0.586	0.971	0.001	0.187
31	K31	1	0.667	1	0.015	0.208
32	K32	0.667	0.414	0.971	0.007	0.123
33	K33	0.667	0.414	0.971	0.007	0.123

```
33 rows, 5 columns, 1 levels.

2-Mode Centrality Measures for COLUMNS of CP
```

Fig. 2 (continued)

```
                            ucinetlog8
              1     2     3     4     5
          Degre 2-Loc Close Betwe Eigen
              e    al  ness ennes vecto
                                s     r
          ----- ----- ----- ----- -----
   1 CP(VC)     1 0.667     1 0.662 0.759
   2 CP(IR) 0.242 0.182 0.425 0.024 0.155
   3 CP(IA) 0.758 0.525 0.698 0.260 0.633

3 rows, 5 columns, 1 levels.


Closeness and betweenness are calculated on binarized data. The other measures
use valued data.
The 2-local measure is the normalized sum of normalized degree of a node's
alters.

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Running time: 00:00:01 seconds.
Output generated: 26 авг 21 16:17:15
UCINET 6.730 Copyright (c) 2002-2021 Analytic Technologies
```

Fig. 2 A 2-Mode Centrality Analytics. (Source: authors' calculations based on modeling)

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Freight Transport Management in the Arctic Zone of Russia

Natural and Climatic Factors

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Abstract

The North of Russia is an important supplier of strategic materials for the industrial needs of both the country and the whole world. In this regard, it is urgent to improve the efficiency of the entire transport and technological system to ensure normal living and working conditions for the population of the North of Russia and the Arctic Zone. This chapter describes the features and main risk factors affecting the transport and technological processes of moving essential goods. Currently, active efforts are being taken at the state level to launch projects for the development of the relevant infrastructure in the Arctic to solve problems with transport and logistics support of freight transportation. The climatic factor, creating sever conditions of living, is considered the priority. It has a significant impact on the operation time of temporary transport routes. For instance, in the summer, the period of navigation along the northern rivers depends on the climatic conditions. In the course of transport planning for the delivery to the northern territories (*Severny Zavoz*), the beginning and end of navigation can be predicted, which makes it possible to improve the transportation plans and reduce economic losses from downtime during multimodal transportation. With the effective development of the methodology for creating the structure of the organizational-managerial management system of the transport-logistical center, an analysis was carried out of the processes of planning and managing the northern delivery of goods to the Republic of Sakha (Yakutia). The availability of year-round communications makes it possible to reduce the volume of inventories in warehouses, reduces the number of transshipments, and shortens transportation time; as a result, there is no need for cargo storage, and, consequently, credit resources are saved, transport and logistics services of the region are improved, and the northern delivery plan to each region of the north of Russia will be fully implemented.

Keywords

Republic of Sakha (Yakutia) · Arctic zone · Transportation of goods · Freight transport management system · Natural and climatic factors · Severe conditions

Introduction

In modern conditions, effective management of the transportation process is impossible without up-to-date information about commodity and material flows (Agafonova & Vasilenko, 2020; Barabadi & Markeset, 2011; Carlton & Devore, 2017; Fadeev et al., 2021; Glinskiy et al., 2017; Ivanov et al., 2020; Kapskij et al., 2017; Kerimov et al., 2020a, b; Kharitonova, 2014; Gutbord, 2020; Kurganov et al., 2019; Lavissière et al., 2020; Lee et al., 2020; Lepov et al., 2020; Lobanova & Evtiukov, 2020; Makhutov et al., 2020; Marchenko & Babyr, 2021; Marusin et al., 2018; Nazarova, 2016; Novoselov et al., 2017; Olsen et al., 2020; Romashkina et al., 2017; Safiullin et al., 2020; Sergeev et al., 2021; Sidortsov, 2019).

At the modern level of technical development, methods of freight transport management in the Arctic Zone of Russia (delivery to the northern territories, or *Severny Zavoz*) represent a unique logistics process. The reliable, safe, and timely delivery of goods in the required volumes is necessary to ensure normal living and working conditions for the population in these territories. Today, the North of Russia is a strategically important region due to huge reserves of gas (up to 95% of the explored areas) and oil (up to 70% of the explored areas), as well as the development of the Northern Sea Route, the potential year-round operation of which promises significant economic benefits (Sergunin & Konyshev, 2018). Geopolitical factors and the need to ensure state security are also essential. However, the area is characterized by a low population density as well as poorly developed infrastructure compared to Central Russia. Harsh climatic and natural conditions require the use of innovative approaches to maintain environmental safety at a high level (Tsukerman & Ivanov, 2013).

The Arctic logistics is affected by the following factors:

1. The economic need for the delivery of goods, the availability of a cargo base (cargo traffic for the needs of real and/or potential transportation customers), the need for transportation, the economic justification of the cost of resources for the acquisition, and/or manufacturing of products having commercial value and their export to the sales markets.
2. Organization of logistics activities, modern management technologies. In Arctic conditions, it is important to have a system for predicting the dynamics of weather and climatic conditions since people's safety and lives depend on it.
3. Technology (a set of methods and processes used in logistics), as well as means of transport, equipment for loading and unloading, and other jigs, fixtures, and tools necessary for transportation and warehouse processing of goods in polar conditions.
4. Logistics connections of the territory with the outer world (intrastate interregional connections with the country's transport system, as well as interstate connections to ensure foreign trade), including transport routes and logistics infrastructure with the allocation of support centers that ensure the reliable functioning of logistics chains and the stability of economic activity in general. The support centers perform logistics functions as well as repair and maintenance and provide solutions to the entire range of social tasks (medicine, culture, leisure, etc.). The concept of "transport corridors" is the most suitable for denoting logistics connections with the outer world (Pak, 2020).
5. Energy supply.

6. Communications and relations.
7. Transport connectivity within the territory where economic activity is carried out. Internal transport connectivity ensures the solution of local production tasks (movement of raw materials and semi-finished products for the needs of companies within the territory) and satisfaction of social needs (trips of those living in the area for different purposes: medical care, cultural experience, consumer goals, etc.). In some cases, the transport network that provides connectivity within the territory may have, to some extent, a "focal" nature, in contrast to "transport corridors."
8. Supply of staff, employees with a high level of motivation, strong-willed qualities, and appropriate professional training. The incentive system should not only provide a decent salary, but also meet the motivating needs of different categories of personnel (the need for comfortable living and working conditions, high-quality medical care, self-development, and self-realization).

Theoretical Studies and Analysis of Risk Factors of the Transportation Process in the Arctic Zone of the Republic of Sakha (Yakutia)

External factors have a significant impact on Arctic logistics. Factor analysis showed that taking into account the special operating conditions of road transport and the influence of previously unstudied external and internal factors on the technology and organization of the northern delivery will increase the efficiency and reliability of road transport based on risk management (Kurganov et al., 2018).

An expert assessment of the collected statistical data, relationships, and mutual influence of factors leading to deviations in the implementation of the operation plan and potential losses caused by the negative impact of the identified factors was carried out. The work performed ensures the implementation of the main control actions in the existing transport and technological process and the technology of controlling this process (Kurganov et al., 2017).

It was established that the natural and climatic features of the North of Russia and the operating conditions of road transport play a significant role in increasing the efficiency of the northern delivery (Filippova et al., 2017, 2019a).

For instance, the continental climate is characterized by a larger amplitude of temperature fluctuations at the same latitude and a smaller shift. The annual temperature trend in terms of night temperature corresponds to a cooler and less continental climate (Alexandrov et al., 2019; Diaz et al., 2003; Wypych, 2010). To operate vehicles, it is necessary to take into account that the coldest nights in this climate are in February and the coldest days are in January (Shiklomanov & Lammers, 2014). This should be considered when planning and organizing the delivery of goods by winter roads.

Consider a model for forecasting and planning the delivery of goods to the Republic of Sakha (Yakutia). The model was created on the basis of the developed strategy for the socio-economic development of the republic until 2030. The strategy contained a concept for the development of the region, including the northern delivery, for the long and medium term. On the basis of the concept, annual programs for the delivery of goods are adopted. In accordance with it, the government of the Republic of Sakha (Yakutia):

- Analyzes and evaluates the state of the northern delivery
- Develops an appropriate forecast, taking into account external factors, including growth in prices for goods and transport services, as well as the state of the country's internal market
- Substantiates the main goals, as relates to the volumes of consumption of material resources for the stable functioning of objects: heat and energy supply for housing and communal services, enterprises and organizations of the social sphere, transport and communications, and wholesale and retail trade
- Determines the strategy of delivery, including methods of priority delivery of resources to consumers located on small and rapidly shallowing rivers, sets the volume of centralized food supplies, determines sources of financing for all types of products, forms the institute of state customers, clarifies their functions, and so on
- Conducts the stage of approval of the draft decision on the import campaign with interested structures (who, where, when, what should be done)
- Monitors the implementation of the decisions made, collects data on purchases, accumulation, shipment, and delivery of goods to the end consumer, and makes adjustments to goals and methods of achieving them

An important element of the northern delivery management system is the development of measures for systematic protection against risk, and these measures can be summarized in the following groups:

- *Managerial*: monitoring the volumes of delivery of goods and their financial support; prompt response to possible deviations and making the necessary adjustments
- *Organizational-economic*: application of a marketing approach in the external and internal markets; diversification of investments in local industrial enterprises or enterprises located in other regions; expert assessment of risk situations with the possible invitation of highly qualified specialists from outside
- *Law:* professional contract drafting; application of the principle of limited liability
- *Personnel*: leadership competence, experience, management art, openness, teamwork, trust as a way to reduce risk
- *Informational*: reducing the uncertainty of the situation and the ability to make better informed decisions
- *Insurance*: insurance of goods, commercial risks, property and fixed assets, civil liability

It should be noted that in the regions, it is not practiced to make decisions on the delivery of goods based on an expert assessment of risk situations with the invitation of highly qualified specialists from outside. Also, insurance of fixed assets and goods in transit is not always applied, although, in our opinion, it is an effective measure of protection.

The negative aspects of the planning mechanism at the regional level are that:

- When forming the annual regional budget, planning of funds for the purchase and delivery of goods from third-party and republican suppliers is not provided in full, which does not allow avoiding many negative situations and impedes the timely preparation of vehicles for the start of the campaign.
- The tax system does not provide for effective economic levers to solve the problems of northern delivery, including through preferential taxation of enterprises involved in the import process.
- Decisions are made that are not supported by financial sources, which reduces the effectiveness of management activities and, ultimately, the efficiency of the northern delivery system.

Forecasts, programs, and plans for the development of the northern delivery are to be filled with new content, to strengthen their social and innovative orientation. In the foreseeable future, in particular, it is necessary for the development of the main functions of the northern delivery:

- Create a “critical mass” of prerequisites for the “launch” of mechanisms for the self-development of the regions of the North, maintaining a competitive environment in them with an orientation towards a fuller use of all types of available local resources
- Stimulate the expansion of the export of products of regional specialization, as well as its competitiveness in interregional, Russian, and world markets
- Create conditions (organizational, financial, legal, and others) for the accelerated development of territorial “points of growth” and avoidance of critical asymmetry in the social and economic situation of the region
- Initiate the orientation of the economic structures of the region towards their safe and sustainable functioning in the present and future

It should be noted that the work on forecasting and planning the delivery of goods in individual local government bodies is poorly organized. Basically, these tasks are solved at the level of the executive authorities of the territory, although in the future, part of the work from the regional level should “go down” to the local level, but for this the municipalities will have to solve many legal, organizational, economic, and personnel issues.

The regional economic authorities annually compile the balance of fuel and energy resources and the balance of food products as the fundamental links in forecasting the northern delivery. The production of goods within the republic is taken into account, and the need for import by types of resources from other regions is determined. Since 1999, when substantiating forecasts of socio-economic development, projects of regional and local budgets, or territorial financial balances, materials have been developed for a special section "Delivery of goods for state needs," which balance the linking of needs for products with sources of financing supplies. In regional and local budgets, separate items are allocated only to the costs of enterprises in the public sector and housing and communal services for goods included in the nomenclature of state needs.

Government customers (agents) perform the following functions:

- Organizing the supply of products for state needs through competitive bidding
- Organizing and conducting competitions for the selection of suppliers and carriers of products for state needs
- Concluding government contracts in accordance with the procedure established by the Civil Code of the Russian Federation
- Providing the financing of supplies for government needs, settlements with suppliers, processors, and cargo carriers
- Ensuring the execution of government contracts
- Exercising control over suppliers – winners of tenders
- Being responsible for the execution of contracts, for the effective, targeted use and return of budgetary or borrowed funds

Among the measures for the rehabilitation and qualitative modernization of forecasting and planning, including in the system of regional management, it is necessary to emphasize an attempt to organize planning. These attempts do not oppose the practice of developing sectoral, intersectoral, and territorial programs, but complement them.

The objective prerequisites for the development of these measures are as follows:

- *Firstly*, it is necessary to systematically improve public administration in the region.
- *Secondly*, the number of subjects of economic, political, or similar fields is growing on the territory; coordination of management activities in terms of goals, means, and timing requires special efforts.
- *Thirdly*, the quality of management at individual enterprises, especially in the market sphere, is somewhat higher than in government agencies.

Therefore, the integration of experience can stimulate the growth of the quality of management activities of government agencies.

The Sakha (Yakutia) government has developed measures to improve the state management of the region's economy. They are based on the introduction of indicative management. The main elements of the approved innovations are:

- The introduction of the practice of drawing up and publishing in the media a Declaration of the Government of the Republic of Sakha (Yakutia) on intentions in the field of economic policy for the planned period

- Maintaining a list:
  1. Indicators characterizing the socio-economic development of the republic as a whole
  2. Indicators characterizing the development of uluses and cities
  3. Indicators for the characteristics of enterprises
- The introduction into the system of indicative management of the parameters of the delivery of material resources for state needs, as well as for the activities of enterprises with a focus on achieving the planned parameters of the republic's development.

The mechanism for financing the delivery of products will be carried out by providing the Ministry of Finance with budgetary loans (credits) to state customers who conclude contracts for the supply and transportation of products within the funds provided by the state budget for the delivery of a particular product. When the product is delivered, the consumer buys it out at the expense of the budget allocated to pay for this type of product, and the Ministry of Finance writes off the debt of state customers for budget loans (credits).

Naturally, it is impossible to instantly solve the problems of northern delivery. There is only one conclusion – the delivery should be improved, the quality of its management, its organization, and execution should be improved, and the cost and dependence on the whims of nature should be reduced.

The introduction of control into the northern delivery management system is formed sequentially, in several stages.

At the initial stage, control is local and fragmented and provokes discussions and natural resistance, including from specialists.

At the second stage, special measures are taken to support innovations in the field of control. Appropriate decisions are being prepared, experience is being generalized, personnel are being trained, etc. As a result, progressive undertakings are gradually accepted by employees, and a legal and methodological base is created; the number of employees who are ready to apply new technologies, principles, or methods is growing.

At the third stage, positive changes and changes become irreversible, that is, the norm of management activity. When the "critical mass" of innovations is reached, a new quality of the entire control system appears. It is more successful if the region has the appropriate resources, which allows it to actively support positive changes, and above all by the first persons with responsibility.

Management is impossible without control. The purpose of the control is to detect deviations. Control is present in the actions of both the leader and any member of the team. Control is an integral part of other management functions with which it provides the necessary feedback. Feedback is at the heart of control.

An important component in the work of the executive authorities of the regions of the North is constant contacts with ministries, departments, district administrations, organizations, enterprises, and commercial structures that import products to the region that are needed by the economic complex and the population.

Determination of the Main Elements of the Organizational and Managerial Structure of the Automated Management System of the Transport and Logistics Center

The automated control system of the transport and logistics center monitors and regulates the transportation of goods from the northern delivery, including the control of road transport on temporary routes. The results of scientific research and the experience of practical work on the creation of automated navigation and information dispatch control systems for various types of road transport made it possible to determine the architecture of these systems, as well as the composition of the main elements of the digital infrastructure. The study of the experience of building these systems in road transport made it possible to determine the main elements of the architecture of an automated control system for a transport and logistics center (TLC). Based on the results of the analysis, the following elements of the architecture of this system have been identified:

- Bodies of general management and control (transport administration of the region)
- Objects of operational management of the transportation process
- Transport companies
- Bodies carrying out collection and processing of statistical information on the performance of transport work
- Service centers for the maintenance of mobile and stationary telematics equipment of the control system
- Organizations providing additional control functions (information flows, transport flows)
- Organizations using information about the process of transporting goods from the northern delivery
- Complexes of means, networks, and communication lines providing communication between the organizational elements of the system, the transfer of information, and control actions to perform the tasks of managing the transportation of goods from the northern delivery

A number of additional requirements are imposed on this system due to the need for the effective exchange of information between subsystems of different levels with the connection of additional subsystems.

In this regard, one of the problems of building an automated navigation control system for a transport and logistics center is to ensure the unification of codes and information compatibility of various subsystems. In particular, this concerns the creation of a traffic data analysis subsystem, a system for informing participants in transport processes. Their creation requires the development and creation of uniform systems of reference information registers (lists and codes of transport and logistics infrastructure facilities, transportation routes, and carrier registers).

The implementation of these requirements leads to the need to build the architecture of the logistics center management system in the form of a hierarchical structure that unites all levels of management.

Construction of Hierarchical Levels of Situational Management of the Processes of Transportation of Goods of Northern Delivery in the Transport and Technological System

The hierarchical system determines the order of information interaction at various levels and the tasks they solve. Four hierarchical levels have been identified, the interaction between which is carried out according to the “bottom-up” principle. This principle means that the functioning of any upper level of the hierarchical system largely depends on the efficiency of information exchange with the lower levels of the hierarchy.

The scheme of interaction of hierarchical levels of management of the transport system for the regions of the north of Russia is shown in Fig. 1.

The characteristics of each of the formed management levels are as follows:

Level 1 is the fundamental level from which the construction of the system begins in accordance with the “bottom-up” principle. This level includes:

- A database of a specialized navigation system, digital models of routes by mode of transport: permanent routes (regional and municipal roads and railways) and temporary routes (winter roads, river routes, and ferry crossings)

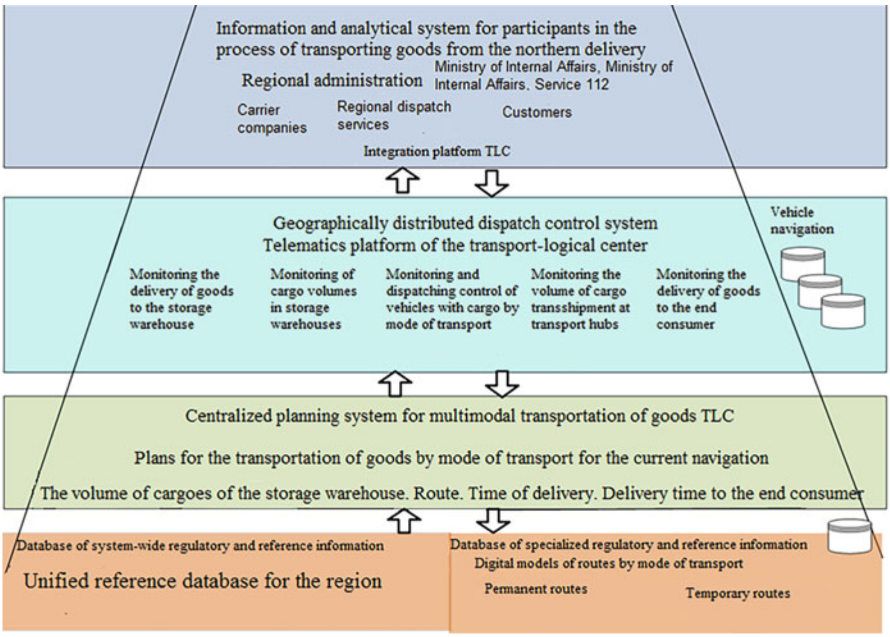

Fig. 1 Scheme of interaction of hierarchical levels of transport system management for the regions of the north of Russia. (Source: Adapted from Filippova et al., (2019b))

- Data of system-wide normative and reference information (unified reference database for the region, including OKATO codes of settlements, railway stations, river ports, airports, and codes of hard-surface roads)

The development and implementation of hardware, software, and information support of level 1 of the control system provides the possibility of implementing:

- New technologies based on satellite navigation, specialized geographic information systems (GIS), adapted to the spatial and topological features of transport processes for the north of Russia
- Information and analytical systems based on technologies (Internet)
- Mobile communication systems based on digital data transmission technologies; modern technical means and technologies of transport telematics – special solutions to ensure the operation of transport in harsh natural and climatic conditions

Level 2 represents the functions of the TLC in terms of planning – long-term, medium-term (determination of cargo volumes, the use of storage warehouses), and operational plans for the delivery of goods (for the current navigation, the timing of delivery of goods to the end consumer, and determination of routes).

Level 3 represents the TLC telematics platform, on the basis of which a geographically distributed dispatch control system is created. She is responsible for monitoring the volumes of delivery of goods to the storage warehouse and dispatch control of the vehicle with cargo by mode of transport (AT, railway, river, aviation), monitoring the transportation of goods in transport hubs, and the delivery of goods to the end consumer.

Level 4 is an integration platform for the TLC, which has an information and analytical system for participants in the process of transporting goods from northern delivery: for the administration of the region, the Ministry of Emergency Situations, the Ministry of Internal Affairs, the 112 service, regional dispatch centers, cargo owners (customers), and carrier enterprises (vehicle drivers).

Purpose: Ensuring the safety, reliability, and efficiency of technological processes for the transportation of goods from the northern supply through optimal control and management of the transport complex in real time for all types of transport.

Digital Infrastructure of a Multimodal Transport System

The study developed a digital spatial model that reflects the position and nature of the main objects of transport infrastructure, making it possible to effectively and reliably organize the monitoring of transport in the process of transporting goods and ensuring the calculation of operational indicators of a multimodal transport hub.

The development of digital technologies – covering such areas of science and technology as telecommunications, satellite navigation, mobile communications, and electronic cartography – has led to the emergence of a new technological entity

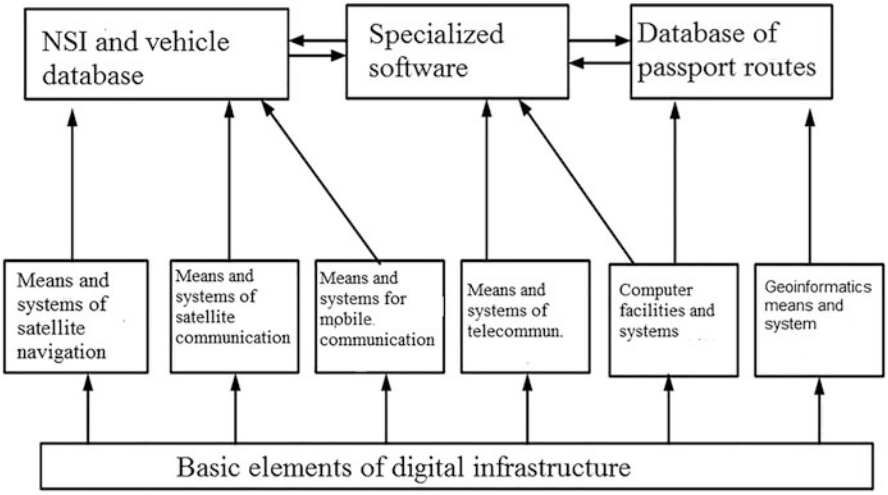

Fig. 2 Scheme of interaction of the main elements of the digital infrastructure of the multimodal transport system of the northern delivery. (Source: Adapted from Filippova et al., (2019b))

in the field of multimodal transport system (MTS) management, which can be called "MTS Digital Infrastructure." By this term, we will mean a set of interconnected and interacting digital information technologies implemented by the elements of the MTS transport management of the northern delivery, operating on a single information base of regulatory and reference information and spatial and navigation information organized within the framework of the database.

The work developed and presented the composition and relationships of the main elements of the digital infrastructure of MTS Northern Delivery.

The interaction diagram of the main elements of the digital infrastructure is shown in Fig. 2.

The composition and purpose of the main elements of the digital infrastructure of MTS has been developed, which are presented in Table 1.

The digital infrastructure of northern delivery control systems is a necessary element and basis for the functioning of a modern MTS transportation management.

Development of the Main Subsystems of the Automated Control System of the Transport and Logistics Center (ACS TLC)

Basic Principles for the Development of an Automated Control System for a Transport and Logistics Center (ACS TLC) and Their Implementation

The development and operation of an automated control system for TLC should be based on the following fundamental principles:

Table 1 The composition and purpose of the main elements of the digital infrastructure of the multimodal transport system of the northern delivery

№ p/p	Group of elements	Elements of digital infrastructure	Purpose of digital infrastructure elements
1	Basic infrastructure elements	1.1. Means and systems of satellite navigation	Determination of the location and parameters of movement of controlled vehicles of freight transport
		1.2. Means and systems of mobile communication	Exchange of information between controlled vehicles of freight transport and the dispatch system using elements of stationary infrastructure
		1.3. Means and systems of satellite communication	Exchange of information between controlled vehicles of freight transport and the dispatch system using a constellation of communication satellites
		1.4. Means and systems of telecommunications	Exchange of information between stationary elements of dispatch control systems of freight transport enterprises and enterprises of transport infrastructure facilities
		1.5. Tools and systems computers	Collection, storage, and processing of data from the transport and logistics center
		1.6. Geoinformatics tools and systems	Cartographic display of information about the elements of digital infrastructure. Spatial data processing by means of GIS
2	Telematics equipment for commercial vehicles	2.1. Onboard navigation and communication equipment	Determining the location of the vehicle. Collection and transmission of navigation and other telematic information to the dispatch center
		2.2. Sensors for monitoring the status of components and assemblies	Recording of information about the parameters of the state of components and assemblies of a cargo vehicle. Data transmission to on-board navigation and communication equipment for binding to the location of the vehicle at the time of forming the parameter

(continued)

Table 1 (continued)

№ p/p	Group of elements	Elements of digital infrastructure	Purpose of digital infrastructure elements
			values and transferring the associated data to the technical service of the enterprise according to the established regulations
3	Database of electronic passports of routes of movement of vehicles of northern delivery	3.1. Unified database of regulatory and reference information	Contains uniform codes and values of the requisites of normative and reference information used in various subsystems of the passenger traffic dispatch control system. Provides information compatibility of subsystems
		3.2. Information of passports of routes of movement of vehicles	Contains general information about the route of movement with a description of the route of routes, checkpoints, a spatial model of the route of the route, formed by GIS tools, including temporary (seasonal) sections of routes with an indication of hazardous areas and their characteristics.
		3.3. Data on the time of movement of freight vehicles on route sections	Contains information about the values of the time of movement of freight vehicles on the sections of the routes of the northern delivery
4	Specialized software	4.1. Software for technological preparation of the control process	Automates functions: • The formation and maintenance of reference books, reference files, database files of electronic passports of routes, the function of planning the process of transportation of the northern delivery • Forecasting the timing of the functioning of temporary sections of the route network (winter roads, ice crossings, navigable sections of northern rivers used for the transportation of goods from the north)

(continued)

Table 1 (continued)

№ p/p	Group of elements	Elements of digital infrastructure	Purpose of digital infrastructure elements
			• Calculation of the maximum throughput of the transport and technological network of the northern delivery
		4.2. Subsystem software for dispatch control of the transportation process	Automates the functions of monitoring, operational control, and regulation of the process of transportation of goods from the northern delivery Provides the formation of operational inquiries and reports on the results and the current state of the transportation process Transmits operational data on the movement of freight vehicles on the routes of movement to the interested authorities
		4.3. Software for the subsystem for monitoring the time of movement of freight vehicles on route sections	1. Automates the functions of collecting and processing primary statistical information about the time of movement of passenger vehicles along sections of the route network based on the processing of data on the actual time of movement of freight vehicles along the sections transmitted by on-board equipment as part of navigation information as one of the parameters 2. Provides processing of primary navigation information in order to generate data on the average time of movement of freight vehicles on sections of the route network and provide this information as initial data for calculating the time of movement of vehicles on sections of routes

Source: Adapted from Filippova et al., (2019b)

(1) Methodological unity
(2) Unity of normative and reference data and their codes
(3) The use of telematics technologies in the automation of the management of the transportation of goods from the northern delivery
(4) The unification of information exchange protocols both between elements of the control structure at the same level and between elements of different levels of this structure

The principle of methodological unity is executed in the implementation of the main provisions of the Transport Strategy of the Russian Federation for the period up to 2030, which is the most important regulatory document that defines the methodological framework for organizing the planning of all types of transportation.

The principle of the unity of normative and reference data and their codes when organizing northern delivery is implemented by using regulated normative documents and codes by mode of transport. It makes it possible to increase the efficiency of the northern delivery and to ensure effective computer processing of information in the subject area. The use of a single database of normative and reference data will allow a user, on a single methodological basis, to form planned and reported indicators of transport work for all types of transport, as well as to obtain comparable operational indicators on the operation of transport on the basis of approved data processing algorithms.

The principle of using telematics technologies in the automation of transportation management is implemented through automated monitoring and control of the movement of rolling stock in real time. The implementation of these functions is possible only with the use of mobile communication technologies and satellite navigation.

The principle of unification of information exchange protocols both between elements of the control structure at the same level and between elements of different levels of this structure is implemented by using technologies of modern digital mobile communication and telecommunication systems operating on unified data exchange protocols. The implementation of this principle will enable combining into one whole a large number of various automated subsystems and control objects in the dispatch control system as part of the TLC. Telecommunication systems will provide legitimate users with access to a unified database of regulatory and reference data, a unified geoinformation database in the TLC control system. Figure 3 shows a scheme for the exchange of information by participants in the transport processes of transportation of goods from the northern delivery.

The basic requirements for the architecture and functions of telematics equipment for vehicles participating in the process of multimodal transportation of goods from the northern delivery have been developed. The function of collecting and transmitting information is carried out by means of telematics, which are equipped with vehicles of enterprises.

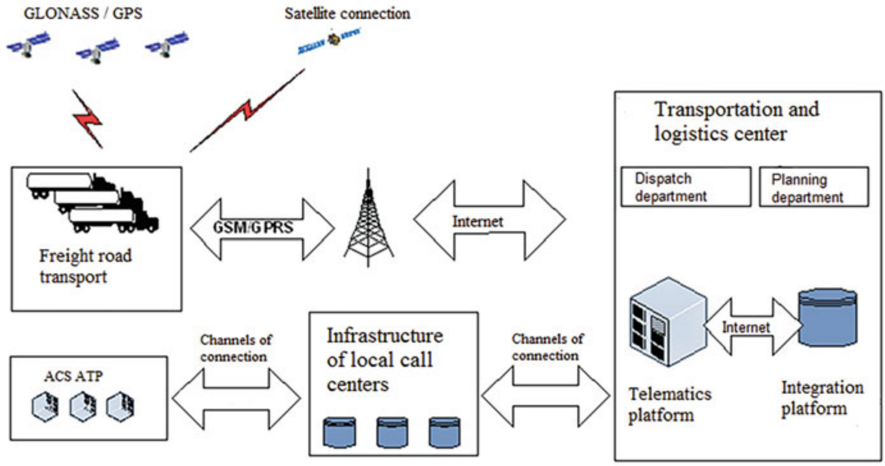

Fig. 3 Scheme of information exchange of the navigation system for accounting and control of the operation of automobile vehicles. (Source: Adapted from Filippova et al., (2019b))

Determination of the Architecture Elements and the Main Functions of the Automated Control System of the Transport and Logistics Center

The developed architecture of the system is three level (Fig. 4).

Upper level of the system: It is proposed to build on the basis of the "Regional state government institution" Center of Transport of the Irkutsk Region, which is a subordinate organization of the Ministry of Housing Policy, Energy and Transport of the Irkutsk region. The main task of the enterprise should be to organize and conduct tenders for the selection of executors of the state order for the northern delivery of essential goods for the northern regions of the Irkutsk region, concluding contractual obligations and monitoring their implementation.

Second level is being built on the basis of the proposed creation of a regional TLC. To solve the tasks of the TLC, it must include two main departments:

- A planning department
- A dispatch center

The main tasks of the planning department of the TLC are:

(1) The formation and maintenance of a database of regulatory and reference information of the system
(2) The formation and maintenance of a spatial database of the system by means of a GIS

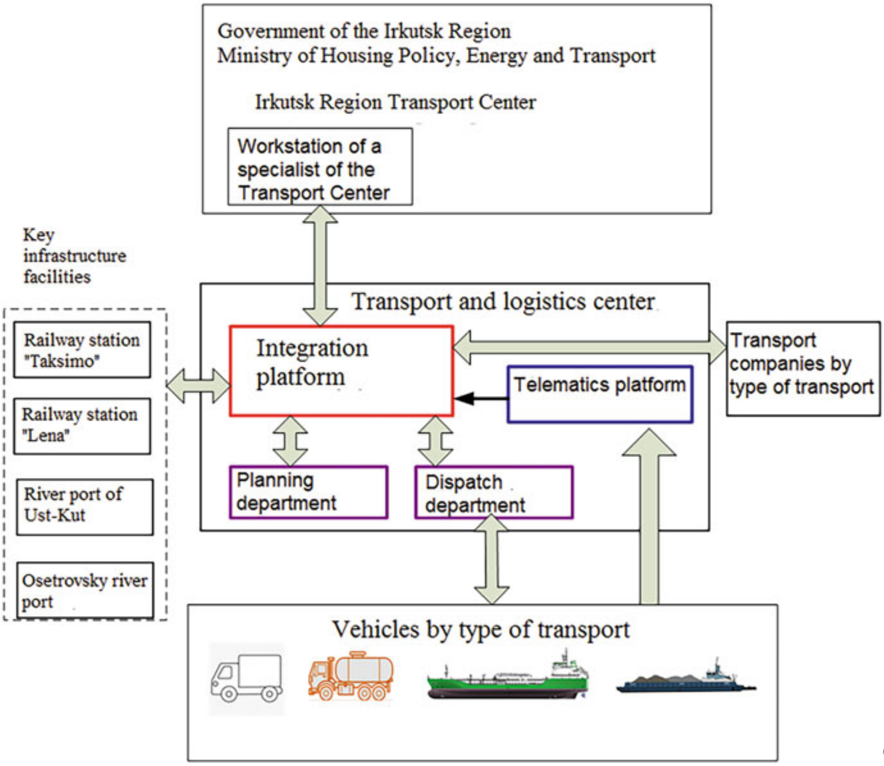

Fig. 4 The architecture of the transport and technological system of the northern delivery of the Irkutsk region on the basis of the transport and logistics center. (Source: Adapted from Filippova et al., (2019b))

(3) Automated planning and instrumental control of transportation of goods from northern delivery in a multimodal transport and technological system in summer and winter periods
(4) The centralization of information resources of the system based on the telematic server of the system
(5) The organization of access of legitimate users to system resources on the basis of the communication server of the system
(6) The automated planning and instrumental control of the operation of the nodal points of the multimodal transport and technological system in the summer and winter periods of northern delivery. Such nodal points are:
   - Taksimo railway freight station
   - Railway cargo station Lena
   - River port Osetrovo (Ust-Kut)
   - River port (Bodaibo)

As initial information, the planning department of the TLC receives applications from municipalities agreed with the regional administration for the supply of goods delivered from the north with the specified volumes and delivery times. On the basis of the initial data obtained, the department technologists formulate plans for the supply of goods from the northern delivery. For this purpose, the specialists of the department must apply the algorithms for predicting the duration of temporary transport routes, determining the maximum throughput of the transport and technological network, described in the framework of this work. These data should be taken into account when choosing suppliers.

The creation of the TLC dispatch center is aimed at comprehensive automation of the functions of situational management of the delivery of goods from the northern delivery and communication with external transport systems in order to harmonize the interaction of participants in multimodal transport processes.

The dispatch center of the TLC carries out general control and coordination of the actions of the network hubs, transport enterprises, consignors, and consignees, based on the application of the situational management methodology.

The dispatch department is engaged daily in general control, harmonization, and regulation of the processes of multimodal transportation of goods. These functions are carried out by dispatchers of the TLC in close cooperation with specialists from carriers, specialists from warehouse structures, and other transport infrastructure facilities. Unlike traditional methods, information interaction of specialists is carried out using automated workstations that have access to a single TLC database.

Communication of the dispatch center of the TLC with the nodal points of the system is carried out on the basis of the installation of remote terminals of specialists who control the technological processes of movement of goods at the nodal points. These specialists have access to the system database via the Internet.

Third level is achieved at the expense of transport enterprises involved in the delivery of goods from the northern delivery, as well as the expense of key transport infrastructure enterprises. In order to organize information interaction in the system in each of these enterprises, an automated workstation (AWP) of an enterprise specialist should be installed and connected to the system.

The main task of a transport company when working in the system is the formation of operational plan data on vehicles performing transportation. These data include information about the vehicle, drivers (crew), data of the consignment note (for road transport), the point and timing of dispatch, and the delivery of cargo. All this information is generated and stored on the telematics server.

The direct implementation of dispatch control processes is entrusted to a specialist of a transport company. Information in online mode is sent to the TLC server, so the TLC dispatcher has complete information on the implementation and changes in the transport and technological process, exercising effective control. The functions of this dispatch center should be based on the receipt and processing of navigation and other telematic information that should come from controlled vehicles. Dispatchers of transport companies also participate in the process of monitoring the operation of vehicles of their company.

To carry out the automated control of vehicles, specialists of the enterprise receive from the dispatch center of the TLC an operational daily transportation plan, a pre-prepared digital model of the route, and the planned time for passing control points of the route to control the movement of vehicles on the route. In order to provide instrumental support for this function, each vehicle is equipped with on-board navigation and communication equipment.

Control of the movement of vehicles at the nodal points during loading/unloading operations is carried out on the basis of the use of the created spatial models of the nodal points of the network.

Development of the Main Subsystems of the Automated Control System of the Transport and Logistics Center (ACS TLC)

Methods and Approaches Used in the Development of Architecture and Functions of the Main Subsystems of the Automated Control System of the Transport and Logistics Center

In order to develop the main subsystems of the automated control system of the transport and logistics center, a model of information interaction of the structural elements of the dispatch control system was created. A methodology for information support of measures to eliminate emergencies arising in the process of multimodal transportation of goods from northern delivery has been developed.

For the design and development of the dispatch center database, for the control and accounting of transport work within the framework of a distributed multimodal transport system for the transportation of goods by road, a deductive method of analyzing the subject area was used.

At the first stage of the analysis, the information needs of users are systematized.

During the analysis, the entire subject area was described using some isolated scenarios that reflect the specifics of interrelated transport and technological processes. For each isolated scenario, a process tree was formed with the allocation of specialized functions and subfunctions up to the level of elementary data processing tasks. The division of data processing tasks into routine (deterministic) and operational tasks was carried out.

The main tasks solved by the dispatch center as part of the TLC were described, and the composition of the TLC subsystems and the composition of the transport enterprise subsystems were determined.

The Composition of the Main Subsystems of the TLC ACS

ACS TLC includes the following subsystems deployed in the transport and logistics center:

- Telematics platform
- Integration platform

- Subsystem of information presentation and analysis
- Information security
- Transportation planning
- Situational management
- Monitoring of rail traffic
- Monitoring of river transport
- Monitoring of air traffic
- Management of warehouses and cargo areas

ACS TLC includes the following subsystems of a freight motor transport enterprise:

- Subsystem of operational planning
- Subsystem of dispatching control of cargo transportation

Below is a brief description of the main subsystems of the TLC ACS (except for the description of the passenger transport control subsystem).

Purpose and Functions of the Telematics Platform

The telematics platform is designed to receive, process, temporarily store, and transmit information about the location and condition of vehicles from GLONASS/GPS navigation and communication equipment to adjacent subsystems of telematics platforms, as well as to transfer executable commands and messages to the navigation communication equipment of vehicles.

The telematics platform realizes its functions by using the functions of the telematics server software components in the following composition:

- Control component
- Information security component
- Administration component

The control component of the telematics server software provides the following functions:

- The reception and processing of telematic data, including position data, from on-board navigation and communication terminals of vehicles
- Sorting, grouping, and temporary storage of data from onboard navigation and communication terminals
- Data transmission from on-board navigation and communication about the location of controlled vehicles to the AWP of dispatchers of enterprises or dispatchers
- Processing of alarm signals from on-board terminals
- Transmission of messages to drivers to subscriber terminals

Purpose and Functions of the Information Presentation and Analysis Subsystem Based on the Integration Platform

The subsystem is designed to collect, summarize, and store all information, analyze it, generate summary reports, and visualize the activities of the TLC for the management, interacting enterprises and organizations, and consignees.

At the first stage of the development of the analysis, the information needs of users are systematized.

In the course of the analysis, the entire subject area was divided into some isolated fragments of the MTS, reflecting the specifics of interrelated processes. For each isolated part, a process tree was formed with the allocation of specialized functions and subfunctions up to the level of elementary data processing tasks. The division of data processing tasks into routine (deterministic) and operational tasks were carried out.

The design of the subsystem included the design stage of the dispatch center (DC) database. When designing and developing a DC database for monitoring and accounting of transport work within the framework of a distributed multimodal transport system for the transportation of goods by road, a deductive method of analyzing the subject area was used.

The composition and structure of the record of the main database tables has been developed, which directly depends on the general organizational structure of the system.

The subsystem is implemented by the software and hardware of the integration platform in order to provide information for all other subsystems of the TLC ACS and for all control levels.

The subsystem carries out information integration with external systems and information systems of shipping companies.

The subsystem provides the following functions:

- Integration of data from all external interacting transport systems and subsystems, including their own subsystems, into a single database of the automated control system of the TLC
- Ensuring ongoing interconnectivity between subsystems
- The centralization and processing of data streams coming from all modules of the system for the purpose of making decisions by specialists of the TLC and transport companies
- A comprehensive analysis of incoming information using the report generator
- A presentation of data on the progress of transportation of goods from northern delivery for all interested parties using the Internet
- A presentation of spatial data using GIS technologies
- Providing specialists of the dispatch center of the TLC, or transport specialists, with operational information on the planned and actual state of the processes of delivery of goods from the northern delivery in a multimodal system by various modes of transport
- Ensuring the uniformity of reference information for all subsystems of the automated control system of the TLC

- Data archiving
- Records of the event log, log of actions of operators, dispatchers, and system
- Monitoring the performance of the entire system
- Diagnostics of the technical condition of the equipment and recording the diagnostic results in the logs of the equipment condition

Purpose and Functions of the TLC Planning Subsystem

The TLC planning subsystem automates the tasks of the TLC planning department. On the basis of the initial information of the requests of municipalities for the supply of goods delivered from the north, experts formulate plans for the delivery of goods for the summer and winter periods.

The main task of the planning department is to determine the possibilities for the delivery of goods along temporary transport routes. To this end, the specialists of the department must use software for automated forecasting of the timing of ice phenomena and the start and end dates of the auto winter. Based on the results of the analysis of the capabilities of transport enterprises in the region, an estimate of the maximum throughput of the transport and technological network should be obtained and compared with the figures of the plan for the northern delivery of goods. These data should be taken into account when choosing cargo suppliers from the external transport system, which are more reliable and predictable, since the delivery of goods "from the mainland" by rail is not affected by the climatic conditions of the north of Russia.

When concluding contracts with suppliers of goods shipped by rail and air transport, the specialists of the planning department of the TLC can use the services of electronic trading platforms.

Purpose and Functions of the Situational Control Subsystem of the TLC Dispatch Center

The work of dispatchers of the TLC is organized according to the principle of situational management.

Situational management is designed to support decision-making, display operational information, promptly solve problems arising at the junction of various modes of transport, and organize feedback from users and participants in the multimodal process of delivering goods from the northern delivery.

The complex of programs of the dispatch center of the TLC as a component of the ACS of the TLC is a set of applied programs that solve the problems of timely informing representatives of various organizations about the state of the elements of the transport system, about the progress of transportation of goods from the northern delivery.

Formation and construction within the dispatch center of the situational management subsystem for the transportation of goods to the northern regions serves to solve a number of complex problems:

- Automated determination of the location of rolling stock in order to provide comprehensive traffic safety
- Escorting and ensuring the safety of the movement of vehicles in the conditions of the north of the Russian Federation
- Effective planning of operations accompanying the transport process to optimize the costs of physical and material resources
- Making decisions on changing the planned traffic in real time due to unforeseen circumstances
- Conjugation and harmonization of multimodal transportation of goods performed by different modes of transport in order to increase the efficiency of the transportation process
- Improvement of the safety of the functioning of ground transport due to information support of measures to eliminate the consequences of road accidents and emergencies
- Improvement of the information system of interaction of the main participants in the transportation process

The dispatch center makes decisions when there is a mismatch in the processes of transportation of goods in a multimodal system. For this purpose, the TLC dispatch center uses information from specialized subsystems for monitoring railway, air, and river transport.

Railway traffic monitoring subsystem is designed to receive and process data on operations with rolling stock carrying goods from the northern delivery.

The functioning of the subsystem is carried out by means of the following software and hardware tools:

- Central equipment of the TLC, including database servers, application servers, disk arrays
- Equipment for data transmission systems, active and passive network equipment
- Automated workstations of dispatching personnel
- Systems for displaying information on GIS
- Software for remote access to electronic trading platforms for tracking and monitoring the movement of goods delivered by rail under contracts concluded using the electronic platform

When using the services of Russian Railways Logistics, a subsidiary of Russian Railways OJSC, in order to carry out railway transportation of goods from the northern delivery, it is proposed to use the software of this company for the interaction of TLC specialists with suppliers and tracking the movement of goods.

Air traffic monitoring subsystem is designed to receive and process data on the transportation of goods from northern delivery by air.

The air traffic monitoring subsystem ensures the automated execution of the air traffic plan in order to implement the plan for the northern delivery of fruits, vegetables, and other food.

The functioning of the subsystem is carried out by means of the following software and hardware tools:

- Central equipment of the TLC, including database servers, application servers, disk arrays
- Equipment of the data transmission subsystem, active and passive network equipment
- Systems for displaying information on GIS
- Automated workstations of dispatching personnel
- Software for remote access to electronic trading platforms for tracking and monitoring the movement of goods delivered by air transport under contracts concluded using the electronic platform

When concluding contracts with suppliers of goods shipped by air, it is proposed to use the services of electronic trading platforms to track and monitor the movement of goods by TLC specialists. One of the most famous electronic platforms is the universal trading platform of Sberbank of Russia (Sberbank-AST), which carries out purchases in accordance with the Federal Law "On the procurement of goods, works, services by certain types of legal entities" dated July 18, 2011 No. 223-FZ at the universal trading platform.

The trade section "Procurement under 223-FZ" is a solution for procurement organizers who are subject to regulation of the federal law No. 223-FZ "On the procurement of goods, works, services by certain types of legal entities." The universal electronic platform provides the ability to place any methods of procurement in electronic form: competition, auction, request for quotations, request for proposals, request for quotations, competitive negotiations, procurement from a single supplier, or qualification selection. System users can simultaneously be both procurement participants and organizers.

The site is integrated with the official website of the unified procurement information system for posting information on procurement by certain types of legal entities www.zakupki.gov.ru, which allows customers to ensure compliance with the requirements of Law No. 223-FZ on procurement information support. The register of planned purchases is posted on the official website of the Unified Information System in the field of procurement.

River transport monitoring subsystem provides an automated receipt of a plan for river transportation of goods of northern delivery from the Osetrovsky port, the port of Ust-Kut, and tracking the movement of vessels (tugs) using navigation data received from on-board equipment.

Purpose and Control Functions of a Freight Motor Transport Enterprise

1. Operational planning subsystem

   The initial data for planning is the operational daily traffic plan transmitted from the dispatch center of the TLC. In order to implement the received operational plan, the company's specialists form an operational daily order for the release of vehicles on the line and prepare an operational task for the driver using the AWP software of the transport company technologist.

2. Subsystem for managing freight road transport of a transport company

   To carry out automated control of vehicles, specialists of the enterprise receive from the dispatch center of the TLC an operational daily transportation plan, a pre-prepared digital model of the route, and the planned time for passing control points of the route to control the movement of vehicles on the route.

   The stages of control of the main technological processes during the transportation of goods have been developed; they are monitored by the dispatch system using navigation and communication equipment installed on controlled vehicles. These stages include:

   - Arrival of the vehicle at the starting point at the sump site before the flight
   - Delivery of the vehicle to the technological site
   - Departure of the vehicle on the flight
   - Arrival of the vehicle at the parking lot of the intermediate destination
   - Departure of the vehicle from the parking lot of the intermediate point
   - Arrival of the vehicle at the parking lot of the final destination

In the process of monitoring the movement of the vehicle on the route, the system periodically records information on the location of the vehicle in the database in the course of transportation. The dispatch control process is implemented at the level of transport enterprises and at the level of the dispatch center of the TLC.

Specialists of transport companies perform the following functions:

- Automated current planning, taking into account the peculiarities and specifics of the process of transportation of goods imported from the north by the appropriate mode of transport
- Visualization of the current location of vehicles using electronic maps of the region
- Automated control of the movement of vehicles with the determination of their location by navigation data
- Operational communication with drivers using cellular and satellite mobile communications
- Operational analysis of the progress of transportation processes in the multimodal transport system of the northern delivery

The sequence of the structure of the route of movement of road transport was described, and the actions of the dispatch system were determined using navigation data obtained from vehicles as well as from the prepared spatial models of transport infrastructure objects. The sequence of elements and actions is mainly as follows:

- Arrival of the vehicle at the starting point at the sump site before the flight
- Delivery of the vehicle to the technological site
- Departure of the vehicle on its journey
- Arrival of the vehicle at the parking lot of an intermediate point of travel

Table 2 The main functions and tasks of the TLC dispatch center

Main functions	Tasks to be solved
Technological preparation of production	Creation of reference books of checkpoints Development of codes used in the system
Daily and operational planning	Composing outfits Preparation of operational tasks
Operational accounting, control, and analysis	Accounting for the issue of vehicles on the line Monitoring the execution of operational tasks Accounting and control of the movement of rolling stock when organizing multimodal transportation of goods Correction of the TP course using satellite navigation and mobile communications with drivers
Analysis of the work performed	Formation of operational information on the status of TP Formation and printing of reporting forms on the work of drivers and vehicles Formation of reporting forms on the time spent by the vehicle at the points of transshipment of goods Formation of reporting forms on the results of the transport process Formation of reporting forms on violations during the TP

Source: Adapted from Filippova et al., (2019b)

- Departure of the vehicle from the parking lot of the intermediate point
- Arrival of the vehicle at the parking lot of the final destination

In the process of monitoring the movement of a vehicle along the route, the system periodically records information on the location of the vehicle in the database during the transportation. The frequency of formation of records is set by the system administrator. The list of main functions and tasks to be solved is given in Table 2.

The main algorithms for processing navigation data received from vehicles carrying out the transportation of goods along given routes have been developed. The peculiarity of the algorithms under consideration is that they are equally applicable to control freight traffic throughout Russia and regions of northern Russia, provided that the route is described in the form of an ordered sequence of control points. Another feature of the presented algorithms is the use of geoinformation technologies for the formal description of the route and the boundaries of control points to transport infrastructure objects.

The developed algorithm provides a formal basis for the creation of specialized software for automated dispatching control systems for AT cargo transportation.

Conclusions

Increased attention to the issues of economic development in the Arctic Zone of Russia leads to the design and implementation of large transport projects in this region, which are the basis for its further economic development.

A typical example is the territory of the Republic of Sakha (Yakutia), where fundamental changes in the transport and logistics scheme will occur due to the construction of a bridge over the Lena River near Yakutsk. This project will become a key element of the Northern latitudinal belt of Russia, which will connect the federal highways “Kolyma,” “Vilyui,” “Lena,” the regional highway “Amga,” and the railway and will provide year-round communication between the Republic of Sakha (Yakutia), Amur, Magadan, Irkutsk regions, and Khabarovsk Territory. The implementation of this project, as well as other transport projects in the Arctic Zone of Russia, will increase the supply of goods, especially in the winter period. This situation leads to a number of problems associated with the growing transit, storage, and transshipment of goods, arriving through the freight terminals of the railway and road infrastructure. The expected significant increase in the total volume of cargo turnover presupposes the availability of not only infrastructure capacities sufficient for transit, storage, and transshipment of goods, but also modern control systems for cargo transportation processes in multimodal transport systems operating in the Arctic Zone of Russia and the Russian North.

The material presented in the chapter lays down the organizational, technical, and technological foundations for the design and implementation of transport and logistics centers (TLC), which should play the role of control centers at the hubs of the transport network of the Arctic Zone of Russia.

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Development of the Personnel System of Maritime Transport

Case of the Arctic Zone of Russia

Marina A. Kazanina

Contents

Abstract

The development of Russia's maritime transport is impossible without a well-trained human resource. Digitalization in the management of maritime transport at all levels of this process cannot yet ensure the "deserted" management of complex maritime systems. At the same time, the personnel potential in such a complex job in Russia is exposed to the risks associated with national demographic challenges associated with a sharp decline in the birth rate in the 1990s and, consequently, with a decrease in the level of human potential reproduction, to which areas requiring special skills and psychological characteristics are especially sensitive. In the context of a significant increase in Russia's maritime trade turnover, the issue of providing maritime transport with its own personnel acquires the scale of a national security issue. The chapter analyzes and discusses the prospects for optimizing the personnel system of Russia's maritime transport, taking into account the peculiarities and dynamics of the personnel training system and the tasks of developing the country's maritime transport. The solution to the problems of staffing Russian maritime transport in the Arctic and the Far East is in the plane of the need for comprehensive solutions to the staffing

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problem in the Arctic and the Far East, on the other hand, with the need to increase attention to the problems of staffing the industry as a whole. The most powerful tool for solving the personnel problem of maritime transport is the increase in wages in the industry as a whole and in the Arctic and the Far East, in particular. However, this is often difficult to implement in practice. The key prospect of solving the problem for success is an increase in the tonnage of ships and an increase in the level of digitalization – the automation of the process of managing them – which will lead to a decrease in the number of personnel in maritime transport and open up opportunities for increasing wages.

Keywords

Sea transport · Personnel of sea transport · Digitalization · Higher education · Vocational education · Russia · Port cargo turnover

Introduction

The development of the Northern Sea Route as one of the new transport arteries of global importance is closely related to the solution of personnel problems in the maritime transport of Russia and the Arctic as a whole. In the Strategy for the Development of Maritime Activities of the Russian Federation until 2030, it is noted as a problem "a small share of ships sailing under the State Flag of the Russian Federation in the tonnage of the world merchant fleet, insufficient participation of the Russian merchant fleet in global international transport"; it is planned to increase the share of such ships, which is important for ensuring the national security of the country. Among other problems (age, insufficient carrying capacity of ships), personnel support of maritime activities and high accident rates in maritime transport come to the fore, as the average age of the vessels was supposed to be reduced by 40% (15 years). At the same time, however, their age is rarely to blame for the accident rate of ship; 90% of accidents are human factors. In general, at present, the sea transport of Russia is showing good growth indicators, following the growth of port transshipment. At the same time, in the context of a significant increase in Russia's maritime trade turnover, the issue of providing maritime transport with its own personnel acquires the scale of a national security issue. In connection with the above, the purpose of the work is to identify the most optimal mechanisms for solving the problem of staffing the sea transport in Russia.

Literature Review

In Russia, the topic of staffing in maritime transport is considered mainly through the prism of the pedagogical process in training seafarers, economically, as a key basis for the development of maritime transport – rather fragmentarily, mainly in the media. At the same time, in foreign science, the topic of staffing has been variously worked out, not only in the aspect of training but also work with personnel. So, Neto

(2015) suggests a correlation between educational motivation and self-realization. It is assumed that the most academically motivating factors are intrinsic factors associated with self-realization, and it is believed that instant gratification is critical to the learning process. Other studies argue that a seafarer must be able to sacrifice “belonging” to a group or family for “respect,” which is quite rare at a young age.

Of particular importance is the gender issue; many marine workers come from countries where, as a rule, a lower view of the value of women’s life prevails, all of them, in different cases, although in different ways, negatively affecting the participation of girls and women in formal education (Brock & Cammish, 1997). Scientists believe that some men traditionally go to sea to “run away” from women or expect women to stay at home and depend on men. Many women professionals in the maritime professions face conflict over how to deal with the problem of profession and family (Brock & Cammish, 1997). One of the common problems women face at sea is the problem of sexual harassment, which causes some women to live alone on board and some to abandon their careers. More than 80% of the questionnaires completed by women mentioned this in one form or another.

Pollution of the environment by ships. To address this issue, there are the Standards for Training Certification and Surveillance (STCW), the International Convention for the Safety of Life at Sea (SOLAS), and the largely influential International Safety Management (ISM) Code. The latter is widely known both among all members of the maritime community and among others who are not directly related to it.

Accidents including marine accidents can happen due to human error. Past analyses and reports of marine casualties have shown that casualties at sea often lead to loss of life and significant damage to the marine environment. Analysis of these accidents has shown that the vast majority of these incidents are a direct result of operational errors, as well as a lack of crew knowledge. The safety of ships, the quality of the crew and companies, and the protection of the environment can only be supported through training. From this point of view, since training activities should be seen as vital to the maritime sector, one way to ensure safety is through “targeted” continuing education courses for seafarers who are well aware of the dangers at sea.

At the same time, the accident rate of ships, especially those carrying hazardous and flammable cargo, can have consequences far beyond the scope of actual marine accidents (Pecota & Buckley, 2009). Human errors are often cited as the main causes of accidents; numerous studies have focused on this issue. According to the literature on this subject, there have been many disasters due to actions that could have been easily avoided (Akyuz et al., 2018; Ung, 2018; Schröder-Hinrichs et al., 2012; Tzannatos, 2010). Statistically speaking, 75–96% of marine casualties is attributed to human error (Uğurlu et al., 2015; Pennie et al., 2007).

About 50% of the oil produced globally is transported by ship (Sharmina et al., 2017). Considering those numerous accidents, some of which resulted in real environmental disasters, have already been recorded throughout the history of the transportation of petroleum products, the International Maritime Organization has developed a new set of strict rules and regulations to ensure safety (Dalaklis, 2017). The new specialized curriculum lists the learning objectives and target competencies to be achieved after the completion of the course. Safe and secure transport is a prerequisite for the smooth running of global commerce, which is often referred to as the “backbone of globalization” (Dalaklis, 2012).

Building a sustainable shipping sector is essential to the development and growth of the global economy. Despite the current global economic downturn, the demand for transportation services will continue to grow over time. But this supply of labor is by no means guaranteed. Currently, more than 1.5 million people are employed as seafarers. If the global economy continues to grow, more trained and skilled seafarers will be required. Related activities such as shipbuilding, ship repair, and ship recycling will also have growing human resource requirements.

If the global fleet expands in size by 70% between now and 2030 (as broadly predicted based on the growth trend over the past five decades), the current 500,000 officers would be expected to rise to around 850,000. Given the expected retirement, almost 600,000 new officers will need to be recruited and trained from today. This corresponds to the annual requirement for officers of the order of 40 thousand people (IMO, 2015).

Certification and control of seafarers’ activities are regulated by the International Convention on the Training, Certification and Watchkeeping of Seafarers, adopted in 1978 (amendments and additions were made in 1995, in 2006, and in 2012 within the framework of the so-called Manila amendments).

It is no exaggeration to say that the safety and protection of life at sea, the protection of the marine environment, and more than 90% of world trade depend on competence – which corresponds to the education and training of seafarers.

The largest fleet is registered under the flags of the United States, Japan, Indonesia, China, the Russian Federation, and Panama.

The processes of globalization in the maritime industry contributed to the emergence of the “flags of convenience” system, which, on the one hand, is due to economic expediency and, on the other hand, runs counter to national security requirements, since in the event of international sanctions, “native” cannot be used in its own service.

The Department of Transportation of the US Maritime Administration made a review based on the results of an analysis of the national composition of ships calling at US ports. The analysis included 7247 ship roles, which were submitted by the masters of 2759 ships at the time of entry into US ports in 2004, as well as 149,327 individual seafarers’ declarations. Research has established that during the period under review, US ports were visited by seafarers from 123 countries, of which 10 nationalities dominate in the number of crews – 77.9% (the Philippines with 36.6%, China 9.3%, India 8.1%, Ukraine 5.4%, Russia 5%, Poland 4.5%, Croatia 2.1%, Latvia 2.0%, South Korea 1.9%). Nationality, of course, does not usually correspond to the flag.

The need for marine personnel is well forecasted. The Nippon Foundation demonstrated that, provided that the current trends in the development of the maritime industry and world trade continue, the need for seafarers in 2015 compared to 2010 will grow by 3.5% (about 25 thousand privates and 15 thousand officers). In 2020, the need will increase by 7.2% (about 50 thousand privates and 30 thousand officers) (Washizu, 2010). These forecasts practically coincide with the data of the

IMO. Of particular interest are the proposed measures to meet this growing demand for "quality" seafarers.

Seafarers have a wide variety of professions and ranks, and it is necessary to constantly maintain discipline, which also creates increased psychological demands.

Today there is a problem of personnel shortage in many categories of specialties (China MSA, 2016). This problem is especially noticeable among the rank and file on the ships of the icebreaker and service and auxiliary fleet. In general, the following measures are proposed:

1. Reduction of the duration of training in programs of higher professional education to 3–4 years for an employee with an appropriate secondary vocational education
2. Carrying out activities for the development of education with specialization in all types of maritime professions
3. Ensuring the continuity of the system of advanced training and retraining of maritime workers
4. Preservation of state support for the maintenance and operation of training ships, the material and technical base of educational institutions of the maritime industry, expansion of the network of maritime schools for children, and clubs for young sailors and river sailors (Korabel, 2012)

This problem is directly reflected and most acute in the regions of the Arctic and the Far East that are rapidly developing in terms of transport, which are remote from central Russia and have harsh climatic conditions.

The research is rooted in general scientific methods of analysis and synthesis, comparative analysis. The main theoretical approach is the systems approach. The author consistently considered the external conditions for the development of the human resources of Russia's maritime transport, including the growth of the country's sea freight turnover, the prospects for the spatial development of Russia, demographic conditions for the reproduction of human resources in general and maritime transport in particular, and the state of the Russian merchant marine fleet in the context of the need to ensure economic security countries in difficult global conditions. The author examines the processes associated with the personnel potential of the maritime industry within the framework of the idea of the existence of a personnel system that combines both the personnel potential itself in its dynamics, the processes of its reproduction associated with recruiting and training personnel, and other conditions and processes.

Maritime Industry of Russia: General Overview

Since the new millennium, the cargo turnover of Russian seaports has grown almost five times; its maximum value took place in 2019 – 840.3 million tons. The capacity of Russian ports has increased 2.5 times over 15 years: from about 452 million tons in 2004 up to 1.13 billion tons in 2019. By 2025, this figure should reach 1.3 billion

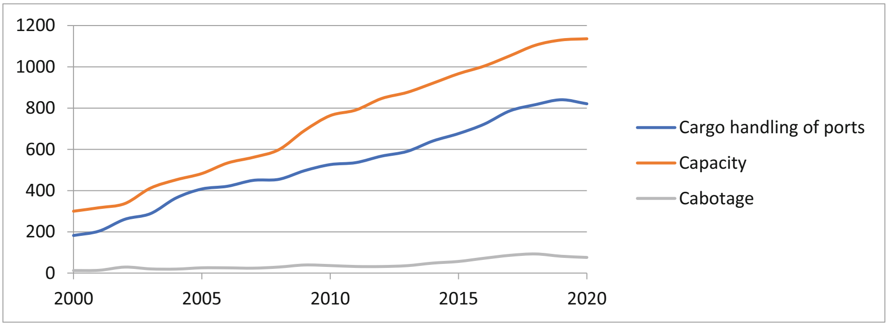

Fig. 1 Freight turnover and capacity of the seaport facilities of Russia in 2000–2020 (million tons). (Note: The volume of cargo turnover of cabotage (domestic) transportation is also indicated. Source: compiled and calculated by the author based on Russia's national statistics (Rosstat). Retrieved from: https://rosstat.gov.ru)

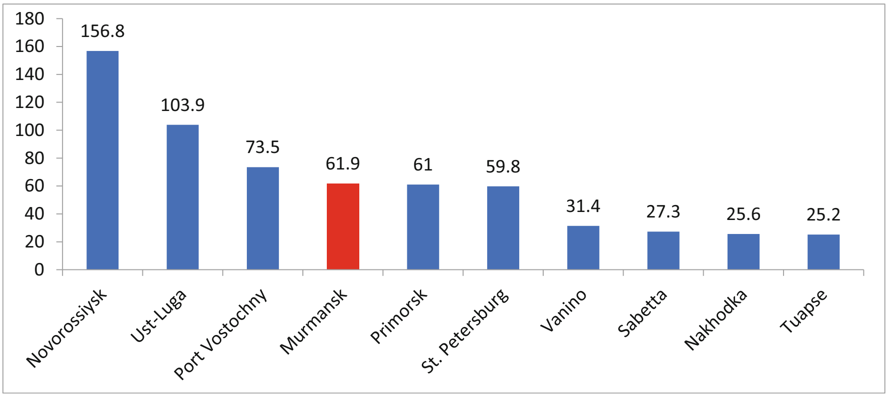

Fig. 2 Top 10 Russian seaports in terms of cargo turnover in 2019 (million tons). (Source: compiled and calculated by the author based on Russia's national statistics (Rosstat). Retrieved from: https://rosstat.gov.ru)

tons. In all two decades, the growth was uniform. Only in the pandemic year 2020 that the cargo turnover slightly decreased by 2.3% compared to the same period last year, amounting to 820.8 million tons (Figs. 1 and 2).

Murmansk is the largest city in the Arctic world and has the largest seaport in the Arctic basin. In general, the cargo turnover of the seaports of the Russian Arctic in 2020 amounted to 96.0 million tons (a decrease in comparison with last year by 8.4%): dry cargo with 30.1 million tons (−4.9%) and liquid cargo 65.9 million tons (−9.9%). The pandemic led to a decrease in cargo handling in almost all Arctic ports: Murmansk with 56.1 million tons (−9.3%), Sabetta 27.8 million tons (+ 0.5%), Varandey 4.9 million tons (−31.8%), and Arkhangelsk 3.3 million tons (+ 22.4%).

At the same time, the capacity of Russian ports is expected to reach 1.3 billion tons by 2025.

At the end of the last decade, in terms of cargo volume, the leader was the Azov-Black Sea basin (33.3% of the total volume), in the Baltic basin 30.2% of the total volume, in the Far East 24.6%, in the Arctic 11.3%, and in the Caspian 0.6%. The raw material bias of the cargo turnover of Russian ports, however, does not interfere with the development of container cargo turnover, developed, it should be noted, to a lesser extent. The transshipment of containers in 2018 amounted to 5.1 million TEU.

The development of cargo turnover is directly related to an increase in the efficiency and capacity of Russian maritime transport, especially in the intensively developed regions. In 2018, the shipment of goods by sea under the Russian flag amounted to 23 million tons and the turnover of goods 45 billion tons-km. The delivery of goods to the regions of the Far North and equivalent areas in 2018 in the total volume of shipped goods amounted to 6.6 million tons (an increase of 124.2%). The volume of passenger traffic by sea in 2018 amounted to 7.5 million people.

According to the Central Research Institute of the Marine Fleet, the sea transport fleet controlled by Russian companies for February 2020 includes the fleet of Russian shipping companies registered under the Russian flag with 1176 vessels, with a total deadweight of 7.7 million tons, and 247 ships under foreign flags with a total deadweight of 14.7 million tons.

The total number of vessels of the sea transport fleet, which is controlled by domestic companies, is 1423, and their total deadweight is 22.4 million tons, of which 65.7% of the tonnage operates under foreign flags. Since 2019, the number and tonnage of vessels has slightly increased: + 2% in terms of the number of vessels and + 3.0% in terms of deadweight. In general, according to the Russian Maritime Register of Shipping, there are 425 shipping companies in Russia, including 71 companies (17%) with sea vessels. The top ten shipping companies in Russia (by deadweight) are as follows: PJSC Sovcomflot, LLC LC Volga, LLC RPK Nord, PJSC North-Western Shipping Company, JSC Rosnefteflot, LLC Gazpromneft Shipping, LLC Novograin, "JSC" Shipping company "Volga Shipping Company," LLC "Palmali," and LLC "Pola Rise" (Institute of Marine Fleet, 2020).

At the same time, the volume of cargo transportation by sea under the Russian flag has decreased. The decrease in 2018 was 12% (up to 32 million tons), which is explained by Rosmorrechflot mainly by the departure of cargo to land modes of transport after the Kerch Bridge was put into operation.

In 2019, the Russian Ministry of Transport initiated a campaign to transfer the Russian fleet under the flag of the Russian Federation. It is proposed to oblige to export up to 50% of cargo by ships registered in the Russian register; today, it is only 12 million tons of cargo per year – and this is less than 2% of sea exports. At the same time, Gazprom asked the Ministry of Energy to identify cases when it is possible to use vessels under foreign flags to carry out certain technical operations in the Arctic. Since the beginning of 2019, amendments to the Merchant Shipping Code have been in effect in Russia, prohibiting the use of ships flying a foreign flag for the carriage of goods (including oil, gas, and coal) in the Arctic along the Northern Sea Route, as well as cabotage. These measures were taken by the Russian Ministry of Industry and Trade to support Russian shipbuilding. Gazprom

Table 1 Sea transport: availability of sea vessels (at the end of the year), units

	2005	2010	2015	2017	2018	2019
All ships,	3574	2779	2760	2718	2717	2726
including:						
Oil tankers	310	311	430	407	397	397
Other bulk	20	22	18	18	19	17
Oil bulk and oil carriers	44	32	24	18	15	14
Ore carriers and bulk	31	20	13	12	9	6
For general cargo	811	620	533	505	545	541
Cargo-passenger	9	9	13	15	16	12
Container, barge carriers, dock	13	8	10	10	10	11
Fishing bases and fish transport vessels	84	38	26	22	20	20
Fishing	1455	932	843	820	818	832
Passenger and passenger dry	51	47	42	39	38	37
Supply vessels serving vessels	27	36	42	49	46	45
Tugs	272	312	338	370	363	369
Dredgers	16	16	14	17	15	14
Icebreakers	26	34	31	33	32	32
Research	77	73	75	74	72	68
Others	328	269	308	309	302	311

Source: compiled and calculated by the author based on Russia's national statistics (Rosstat). Retrieved from: https://rosstat.gov.ru

asks the Ministry of Energy for exceptions to this rule in cases where the required type of vessel under the Russian flag is absent at all. At the same time, as noted, Russia has created the Russian International Register of Ships for ships that sail under foreign flags, but maintain contact with Russia, which is a kind of compromise for the use of flags of convenience. The register includes only Russian citizens, although companies have long been asking to open it for foreign companies.

Most shipowners continue their fleet development and modernization programs. In 2019, using their own funds and with the help of loans, shipping companies managed to build 32 sea transport vessels, as well as 24 supply vessels. At the beginning of 2020, 8283 vessels were registered in the Russian maritime registers under the flag of the Russian Federation, and 1482 vessels with deadweight of more than 6 million tons were registered in the Russian International Register of Vessels.

Table 1 shows the indicators of the number of various types of ships in the Russian sea transport.

From the data in Table 1, it can be seen that for all types of ships, there was a decrease in their number (despite the fact that the process of updating the ship fleet with an increase in its tonnage is underway). At the same time, the number of workers in water transport in Russia is decreasing, but wages in the industry are growing (Fig. 3).

At the same time, the demand for the development of domestic sea transport is growing, which is also associated with an increase in the capacity and cargo turnover of Russian ports. The port economy of Russia is more than 900 complexes

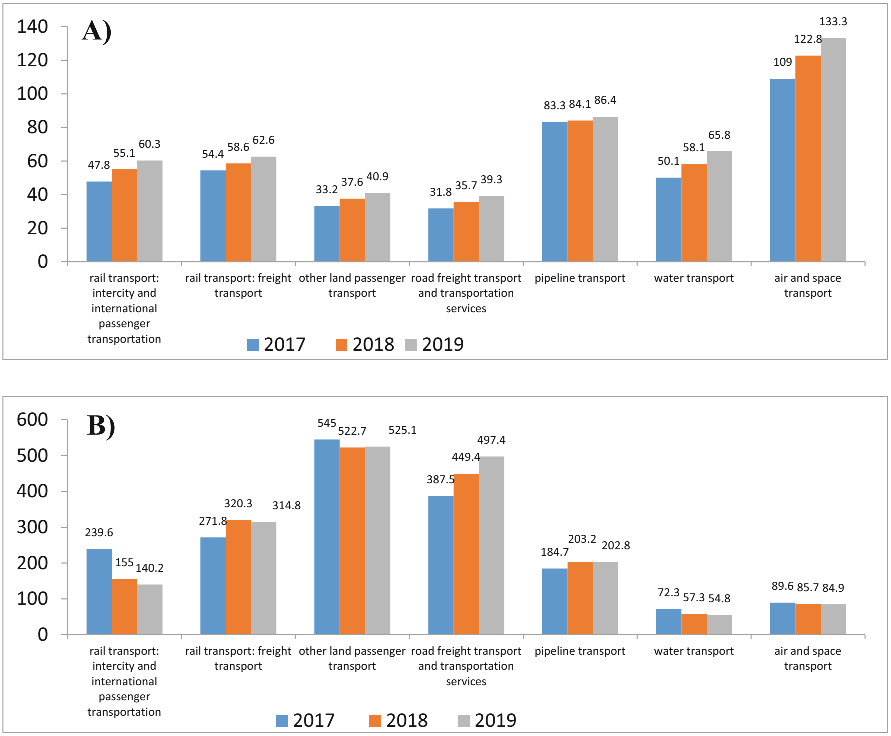

Fig. 3 Salaries (in thousand ₽) of specialists in various transport industries in Russia (**a**) and their number (thousand people) (**b**) in 2017–2019. (Source: compiled and calculated by the author based on Russia's national statistics (Rosstat). Retrieved from: https://rosstat.gov.ru)

in 67 seaports of the country; their total capacity exceeds 1 billion tons. By 2024, according to the Comprehensive Plan for the Modernization and Expansion of the Main Infrastructure, the capacity of Russian seaports will increase by 338 million tons. In our country, sea transport provides transportation of about 60% of export cargo. Thus, the growth of port cargo turnover in the context of the growing importance of national security issues in Russia will inevitably lead to an increase in the demand for domestic maritime transport and its personnel; however, the number of these personnel in recent years has been quite dramatically reduced.

Sectoral educational organizations (5 universities, 24 branches) play a decisive role in providing the marine fleet with personnel. In 2019, such organizations graduated about 11 thousand specialists. In total, more than 54 thousand people studied at universities in 2019, and more than 33 thousand are studying in swimming specialties. In 2018, the number of applications for swimming specialties doubled compared to 2017 and amounted to about 10 thousand (Morskie Vesti Rossii, 2019).

Following the results of the admissions campaign in 2018, the following were accepted for training at the expense of the federal budget:

- For vocational education programs: 4400 people in swimming specialties and 85 people in coastal specialties
- For HE programs: 3940 people in swimming specialties and 785 people in coastal specialties

To carry out work of an organizational and educational nature, the Marine Federal Resource Center for Continuing Education of Children was created in 2018.

The formulation of industry standards is important in the process of training specialists. So, in 2018, 13 industry-specific professional standards were developed, 2 of which were approved, and 2 more are under consideration by the National Council for Professional Qualifications and at the stage of approval by the Ministry of Labor of the Russian Federation. For the swimming specialties of higher education, three federal state educational standards of the third generation have been approved (60 exemplary programs for the training and advanced training of crew members of inland navigation vessels) (Sidorov 2019).

More than 6 thousand people work in universities, and almost 3 thousand are professors and teachers (1.3 thousand – with academic degrees of candidate of sciences and higher). A reserve of leading personnel is formed annually. For 2019, in addition to universities, institutions subordinate to Rosmorrechflot included 4 enterprises and 38 other organizations (8 seaport administrations, 15 administrations of inland waterways basins, 10 other organizations) (Morskie Vesti 2019).

Thus, if we proceed from the current number of workers in the maritime transport of Russia (about 50 thousand people), then with an average possible working time of a professional of 30–35 years, the current production of maritime transport specialists covers 5–7 times the future needs of the Russian maritime transport, which suggests that not all graduates are employed in their specialty and go to work in the Russian sea transport. The strategy for the development of maritime activities notes both the lack of proper personnel and "insufficient level of provision of scientific and pedagogical personnel, the development of laboratory, training and training and methodological base of educational organizations that train specialists for the field of maritime activities and the introduction of innovative technologies in the educational process." The shortage of employees in the industry in the middle of the last decade was estimated at 13 thousand people (Order of the Government of the Russian Federation of August 30, 2019). At the same time, the total number of those holding a sailor's passport in Russia is estimated at 168 thousand people, of which at least two-thirds work under the flags of other states. The peculiarity of maritime education is that a diploma of any country is recognized in the fleet of a foreign state. A crew member of a foreign ship receives 4–8 thousand dollars per month. Flags of convenience, i.e., Panama and Cyprus, for their owners' fees and taxes are minimal. On domestic courts, earnings are several times lower. It is proposed to solve the problem field in a comprehensive manner through vocational guidance, as in St. Petersburg in which up to 40 schools are covered. However, this work can be done for foreign companies.

Within the framework of the Northern Sea Route, there is a procedure for navigation of ships with permits. In 2018, the FSBI “Administration of the NSR” issued about 800 permits for navigation of ships within the NSR, of which foreign ships are about 100. The Arctic basin, thus, is developing largely thanks to the domestic fleet.

Currently, there is practically no Russian commercial fleet as such. There are structures of Sovcomflot (less than 10 thousand employees), two or three large companies with a stable staffing situation (salary at least $535, the base amount determined by IMO). In other Russian companies, and for the most part, these are small firms with two or three obsolete courts, and this requirement is ignored. The personnel shortage is only partially made up by employees from Belarus and Ukraine, but in general, in Russian companies, on research vessels, mostly pensioners work (Chereneva, 2014).

According to open data from the Federal Service for Supervision of Transport, there was a critical increase in accidents at sea: from 2014 to 2017, their frequency doubled, from 45 to 84 cases, and for merchant ships from 36 to 49. The number of very serious accidents has grown 8 times – from 1 to 8 – and for merchant ships from 0 to 5. The most difficult situation is in the fishing fleet, in which the number of accidents increased from 9 to 35.

It turns out that the reason for 90% of accidents lies in the fact that small (mostly) shipping companies operating on very old ships with low wages cannot attract highly qualified workers; they are unattractive for an experienced seafarer. The most qualified personnel leave foreign companies, often – under the flags of other countries – including new ships, taxes from which could give money to the budget of our country.

Naturally, the bulk of supplies to and from Russia falls on the foreign fleet, which leads to colossal budget losses. Charterers do not take the risks of transport on old ships, so they turn to foreign ones. At the same time, a foreign flag does not provide seafarers with the protection of Russian legislation, to say nothing of qualified personnel work.

A striking example is PJSC Sovcomflot, which is wholly owned by Russia, which, in contrast to many non-state companies, has a sufficiently qualified personnel potential with a good salary. The company is engaged in the strategically important transportation of energy carriers (mainly) in all sea basins.

Cadets and trainees of maritime universities undergo swimming practice on the ships of the Sovcomflot Group of Companies, and the most promising graduates are selected for further work. At the same time, in 2018, 166 cadets of maritime universities and 21 trainee sailors and minders underwent floating practical training on the company’s ships. If we divide the number of employees of the company by the approximate number of years of professional activity, we get 35–40; then, it turns out that the number of young people is far from sufficient for simple reproduction of personnel. The Sovcomflot Group of Companies works with human resources; it promotes the professional development of personnel, their acquisition of additional education, the study of modern technologies, and the training of employees in master's and postgraduate studies. Among the engineers of the company, there are 17 employees who have completed their postgraduate studies and have a PhD in technical sciences. However, this figure is only 2.5% of the total number of employees, which is more than in the country as a whole (approximately 1% of the total employed population).

In light of the need to develop the scientific organization of labor, the importance of training specialists for working with industry personnel is increasing. Moscow State University named after Admiral G.I. Nevelskoy is the only one in Russia that trains personnel for personnel management in the maritime industry (Maritime trade union bulletin, 2017). Personnel marketing usually begins with an analysis of the external environment. As a rule, business prefers to get a ready-made specialist from the outside, reducing the cost of training youth. At the same time, a feature of the global labor market for the maritime industry is cheap labor from Asian countries, competition due to social dumping.

The lack of seafarers makes it necessary to attract women, but there are obvious limitations in the industry.

Optimization of the personnel composition of vessels by reducing the number of crew members has a negative impact on the safety of navigation. Legislative requirements for the composition of crews are not met, which often occurs on small vessels with crews of less than 15 people, even more often with crews of less than 8. A problem is double recording of working hours, designed to mislead control authorities (Crewman, 2016). There is great (in recent decades) fatigue at the workplace of navigators (Filimonov, 2016), while the load of seafarers with reporting "paper" work is growing. This was mainly due to poor work organization.

In 2019, the number of inland navigation vessels amounted to 30.4 thousand, their average age is 37 years, and the total deadweight is 9.7 million tons (Morskie Vesti, 2019). The systems run by FSUE "Rosmorport" are kept in good technical condition, certified by the relevant authority, and effectively perform their functions. The strategy for the development of the seaport infrastructure until 2030 presupposes a significant strengthening of the sectoral human potential. There will be a transition to demand-driven training. It is supposed to involve specialists in the educational sphere in the process of planning the development of the industry. The Comprehensive Plan for the modernization and expansion of the trunk infrastructure for the period up to 2024 also pays significant attention to personnel issues (Association of Commercial Seaports, 2019).

The growth of cargo turnover and the capacities of Russia's ports significantly outstrips the growth rates of its economy; port cargo turnover, and, therefore, the sea fleet supporting the activities of ports, as well as the transport fleet, undoubtedly has a positive impact on the development of the regional economy, which especially applies to the Arctic and the Far East, where the growth rates of transport flows and freight turnover are ahead of other regions of the country.

Currently, the importance of the role of sea transport in solving the export of agricultural products is growing; more than 90% of such products is exported by sea, of which 93% through the ports of the Azov-Black Sea basin; however, the Ministry of Agriculture of Russia is interested in the development of the Arctic and Far Eastern directions for the export of grain, for example, within the framework of grain transportation along the Irtysh and Ob and further along the Northern Sea Route.

The growth rate of cargo turnover in 2019 decreased, and its real decline occurred in 2020. This may be partly due to the difficulties in staffing the development of the port industry and the associated maritime transport industry.

Against the background of problems in private organizations, the leading monopolists, due to the increased demand for port and export transport services, are doing relatively well in terms of personnel. Thus, FSUE "Rosmorport" had the following dynamics before the beginning of 2015: in 2013, 6408 people; as of January 1, 2014, 6643 people; and at the beginning of 2015, 7098 people. The annual growth in the number of staff was 3.5–6.5%. The growth continued further and as of January 1, 2016, the established staffing amounted to 7.9 thousand units. Of these, functional personnel are 3518, pilots 684, and seafarers 2726 units.

The increase in the average headcount is primarily due to an increase in income, construction, and growing volumes of work, including the creation of the Far Eastern Basin Branch (as a result of the transfer of property to OJSC NORFES, other branches and centers). In 2015, more than 2000 employees underwent training, which is almost a quarter of the entire team; at the same time 1500 students completed an internship at an enterprise – not university graduates.

The previous period 2011–2013 was also characterized by an increase in the number of staff: 2011, 6075 people; 2012, 6408 people; 2013, 6643 people; that is, the annual growth was 3.7–5.5%. The number of functional personnel left was 2909 units, VTS and GMDSS personnel 889 units, pilots 603 units, and floating structure 2242 units.

The study of the personnel structure showed that with the overall growth in the number of employees, the share of administrative personnel at the enterprise over the past 3 years has remained stable and does not exceed 22%. The structure of the production personnel of the enterprise consists mainly of swimming personnel – 35%.

The average salary was ₽45 thousand in 2011, ₽48 thousand in 2012, and ₽51 thousand in 2013.

Staff turnover has been low over the past 3 years and has begun to decline across the industry (from 9% in 2011 to 8% in 2013). For example, in 2009 the staff turnover was about 19%.

The growth for the period 2011–2013 is due to the transfer of various objects to the FSUE "Rosmorport" economic management, the transfer of vessels to the management of branches, and the arrival of new vessels, as well as the beginning of operation in 2012 of branches in the Far East and Makhachkala.

In 2011, 1650 employees of the enterprise underwent training. In 2012, the number was 1700 and already in 2013 more than 2500, including those from branch educational institutions – 261 students. In 2013, 21 graduates were employed, and 13 of them graduated from industry-specific educational institutions.

Previously, the situation was more complicated than later – the company grew mainly by attracting employees from other organizations.

In general, we repeat, the relatively good staffing situation in FSUE "Rosmorport" is explained by the growth of cargo turnover in Russian ports and the organization's assets. Thus, FSUE "Rosmorport" revenues from port dues in 2017 amounted to ₽19,759.3 million; the fulfillment of the planned indicator was 102%.

According to the current program of the FSUE "Rosmorport" event, a lot of attention is paid to personnel. It is planned to introduce professional standards as they are approved by the Russian Ministry of Labor on the basis of the plan for organizing their application at the enterprise (the entire period from 2017 to 2025). It is important to increase labor productivity and quality of services, which is impossible without raising the qualifications of personnel; events for the exchange of experience of employees, including national and international ones; and internship by students of specialized educational organizations in the divisions and branches of the enterprise.

In general, with the number of professional seafarers in the country over 160 thousand, it can be argued that organizations train workers "with interest" in excess of the required number for simple reproduction in the scenario of no growth in personnel requirements in the numerical measurement of workers. Perhaps an adjustment should be made taking into account that the share of only swimming specialties will turn out to be about 62% of the output, that is, 6.2 thousand people of the potential future sailing personnel, which, with an assumed term of their service in the fleet, not even 40, but 30–35 years, provides simple reproduction. At the same time, no one anywhere measures the drain of personnel to other areas of the national economy, which complicates our measurements of the personnel system.

It is reasonable to assume that only systemic principles of personnel management can provide a balance of needs and opportunities to attract the necessary personnel to a shipping company, as well as to the entire industry as a whole.

Discussion

The problem of the development of the Russian marine fleet, including in the Arctic, has two sides: One is the awareness of the need to develop its own fleet, build its own ships, and invest in it; the other is the conviction that there are many other problems in the economy, and funds need to be invested in completely different sectors, and as for the fleet, you can use ships flying a foreign flag.

The USSR possessed a huge fleet. Domestic fleet registered more in foreign jurisdictions (Knyazev, 2019). At the same time, the owners of the ships support the requirements of the ministry only when the requirements for the use of the Russian flag are reduced. The shippers themselves note the confidence that they will have to export their products through other countries.

Changes in the personnel requirements of Russia's maritime transport over the past 15 years can be traced by changes in the ship and personnel composition of Sovcomflot. At present, there are 146 vessels with a total deadweight of 12.6 million tons. As of December 31, 2018, the fleet of the Sovcomflot Group of Companies includes 144 vessels with a total deadweight of 12.44 million tons, and the number of personnel is about 7.8 thousand (53 people per vessel and 619 per 1 million deadweight tons). In 2012, the fleet includes 157 vessels with a total deadweight of 12 million tons, and the number of personnel is more than 9.3 thousand people (59 persons per vessel and 775 persons per 1 million deadweight) (Sovcomflot, 2012). As of January 1, 2006, the fleet consisted of 50 vessels with a total deadweight of 3.95 million tons, and the total number of personnel was about 3 thousand people (Sovcomflot, 2012) (60 persons per vessel and 759 persons per 1 million deadweight). Thus, there is a clear tendency to save human resources with an increase in the deadweight of individual ships.

By 2020, the development of standards, other educational and methodological documentation, the further development of the infrastructure of universities, and, which is important for career guidance activities, the development of the maritime federal resource center for additional education of children. At the same time, there are still difficulties in the implementation of the Bologna Process in Russia. The fact is that secondary education in the European Union takes 12 years; the last years have been devoted to vocational guidance. Thus, the real European bachelor's degree lasts 5 years, and until 2011 the bachelor's degree in Russia was practically equal to the specialty. As a result, the middle management level in Russia suffers, since, according to the established requirements, undergraduate graduates are equated with graduates of colleges and technical schools (Dybskaya & Sergeev, 2013). In this regard, it can be concluded that the currently existing two-level system "bachelor-master" does not provide staffing needs for engineers and middle managers or rather creates obstacles for it. In this regard, it is possible to propose a modernized structure of higher education within the Bologna system (Kostylev, 2011); it is necessary to strengthen the practical component in teaching bachelor's degree and in master's degree to prepare in two profiles: engineering and managerial.

All this complicates the solution of personnel problems of maritime transport in the interests of Russia and, in general, pose challenges and threats to its security.

The Arctic region, which provides Russia with free access to the Pacific Ocean, and is also a concentration of rich natural resources. The following are highlighted as the official strategic priorities of state policy in the Arctic and the Far East:

- Improving the quality of life of the region's population and its human capital
- Activation on a large scale of scientific and applied research on the development of the region, along with the use of new technologies
- Expansion and renewal of the infrastructure of the region, its transport system, and fishery complex

The level of direct and indirect impact of the transport industry on the economy of the Arctic and the Far East is much higher than the average for Russia. The level of personnel involvement in the transport sector also has a higher level compared to the average Russian level. The transport industry as a whole has a higher level of wages compared to the average for the region, which ensures the work of a "personnel pump" that affects both the residents of the region and migrants, involving and retaining the most active areas in the port industry and directly related areas, and able-bodied workers. The trade and services sector adjacent to the port industry is developing. However, there is also the effect of the redistribution of resources and personnel in favor of the transport sector, as a result of which the development of the region as a whole can lead to certain imbalances, giving negative effects on the construction sector, social sphere, and foreign trade and restraining the innovative development of the region. An important addition to the description of the situation is the fact that the industries are directly related to the region's science that is quite developed in comparison with the average Russian level (development of mineral resources, important indicators of the development of the region – the level of its innovativeness). The Maritime Doctrine of Russia (2015) defines a number of tasks, the implementation of which is necessary to ensure the transition of the Arctic and Far Eastern economies to a new path of development of an innovative nature and has a personnel component.

An important aspect of the national maritime policy is the development of the training system for seafarers. More than 20 years ago, problems with personnel appeared: the number of qualified sailing personnel decreased, the motivation of young people to master maritime professions decreased, the scale of maritime production decreased, and many specialists in the maritime business retrained and went to work in other economic sectors. In addition to this, there was a significant deterioration of the infrastructure and equipment of the fleet and a deterioration in the working conditions of seafarers. All this led to a serious deterioration in the country's maritime industry.

Thus, improving the quality of maritime education is fundamentally important for the development of the Arctic (and the Far East). The shortage of specialists in the maritime industry stimulates the growth of youth orientation towards maritime professions. This process takes place from an early age at the expense of children's specialized associations focused on maritime professions: a network of children's maritime centers, clubs for young sailors, naval cadet schools, etc.

Within the framework of the regional development strategy, the corresponding tasks for the development of maritime education in the Arctic and the Far East are outlined. Currently, the most promising is the so-called advanced training of specialists for maritime activities (Sedykh, 2007).

Research and technological development of the World Ocean requires the provision of advanced training of specialists. Unfortunately, the Russian education system does not take into account the sectoral features of the staffing of maritime activities.

Summing up the results of the study, we received the following conclusions about the state and indicators of staffing in the development of maritime transport in Russia:

1. The reproduction of personnel in maritime transport depends on the needs for personnel in the relevant labor market, the number of youth cohorts ready to study at the university and in the organizations of relevant vocational education, and the possibilities of the educational system for the admission and release of trained personnel. These circumstances form the basis of the problematic field for

Russian maritime transport personnel, including the uncertainty of long-term plans for the development of maritime transport, an unfavorable demographic situation for personnel reproduction in general, and the problems of the organizations themselves involved in the training of relevant personnel.

2. The system of staffing for maritime transport is highly globalized, which poses certain problems for maintaining the level of staffing for the sea and river fleet in Russia due to the high gradient of wages towards working on foreign ships with high-quality Russian specialists.
3. The problematic field of staffing of maritime transport in the Arctic and the Far East is complicated by an even more complex demographic situation in the region compared to the national average, i.e., a relatively low proportion of young people with a high educational migration to the central regions of the country and the development of other types of migration population, which does not give the region an opportunity for outstripping innovative development due to the permanent staff shortage in recent decades. At the same time, the progressive development of port capacities and cargo turnover in the region is mainly associated with an increase in demand for low-skilled labor, since to a large extent this cargo turnover is associated with the transshipment of Russian coal; the necessary gradient of wages in the industry is absent in full. In addition, the problems of maritime transport in the region are complicated by the uncertainty of the prospects for its development, as well as in Russia as a whole, tied to the conjuncture of the raw material markets.
4. In recent years, there has been a tendency towards a decrease in the quality of training for maritime transport, determined by such an indicator as the level of accidents, which indirectly reflects not so much the state of the training system as a whole, but the quality of the student (and training) contingent itself; this phenomenon is associated with the outflow of the most capable personnel for maritime activities to other industries.
5. There are general tendencies to optimize the needs for personnel in the domestic fleet by increasing the deadweight of ships and the level of automation of their management, within limited limits (for the transportation of export cargo, first of all, this can provide significant benefits) contributing to the solution of personnel problems in maritime transport; however, without a long-term program to improve the efficiency of maritime transport management and the attitude of this trend towards the raw material transportation sector, the positive effect for the personnel system will be very limited.

Thus, based on the results of the study, the main recommendations for improving the quality of staffing in Russia's maritime transport (using the example of the Arctic and the Far East) can be as follows:

1. Formation of a system of strategic planning of the personnel needs of Russia's maritime transport, based on long-term forecasts for the development of exports, construction and acquisition of ships, increasing port capacities, and preparation of relevant strategic and program documents

2. Increasing the level of scientific support for personnel training, as well as the intensity of scientific activities in the field of maritime transport on the basis of relevant universities and research centers
3. Increasing the flexibility of the training system for maritime transport (e.g., in the Arctic and the Far East, increasing the level of interaction between the leading universities in the region up to their merger with the possibility of obtaining maritime specialties by any students as additional)
4. Increasing the level of attracting schoolchildren from the interior regions of the country to maritime professions through early career guidance with benefits for studying at specialized universities
5. Increasing the level of digitalization of the educational process and the development of distance educational, educational, and vocational guidance programs
6. Formation of career guidance and pre-university training programs for promising migrants in relation to maritime professions (relevant for the Arctic and the Far East), attracting promising foreigners to work on Russian ships
7. The introduction of a system of restrictive measures for the work of Russians for foreign sea transport companies immediately after graduation
8. Increased automation of management and an increase in the deadweight of Russian vessels, which may lead to a decrease in personnel requirements for sea transport

The economic effect of the implementation of the proposed management solutions is to increase the efficiency of the training process and work with them throughout the service life to ensure the strategic objectives facing the maritime transport industry.

It can be expected that there will be a three- to fivefold decrease in accidents and optimization of the costs of training specialists; the predicted growth of income from the port industry and its development in general will be ensured; and there will be an indirect effect on the economic efficiency of maritime transport through an increase in the quality of its personnel potential.

Conclusions

The personnel problems of Russia's maritime transport are obvious. From the point of view of structure, each link of the corresponding personnel system has problems. At the same time, the personnel system that provides a particular industry depends on the demand for services or goods in this industry. That is, if it is supposed to ensure the development of the Russian maritime industry through the growth of income from it, then the personnel problem, it seems, should be solved "by itself."

However, even at the global level, despite the growing demand for maritime transport services, the demand does not provide for the attraction of the required number of personnel. Its significant deficit is predicted, which manifested itself in the past decade, despite forecasts of an increase in demand for industry services. The same big plans exist in Russia; in the next 5 years, it is planned to increase the turnover by about 1.5 times.

On the other hand, demographic forecasts of the number of Russian youth who could choose the maritime profession are unfavorable for the coming years; only in 2020 will the minimum number of students be passed. That is, one should not expect a large increase in personnel.

In addition, the general demographic dynamics directly in the Arctic and the Far East shows negative trends. The programs for attracting personnel to the Arctic and the Far East demonstrate only relatively weak success. The necessary gradient of salaries in the region is missing. The demand for personnel goes mainly to the port industry – for stevedoring services in the coal sector. These are mostly low-skilled personnel.

However, there are shipbuilding and ship repair facilities in the region. And their staffing remains problematic.

In general, the development of maritime transport flying the flag of Russia can be ensured by foreign ships; however, this is not profitable for foreigners. Therefore, no one will voluntarily go to the Russian maritime transport sector. At the same time, not flying the Russian flag is unsafe for possible sanctions.

Thus, the solution to the problems of staffing Russian maritime transport in the Arctic and the Far East is in the plane of the need for comprehensive solutions to the staffing problem in the Arctic and the Far East, on the other hand, with the need to increase attention to the problems of staffing the industry as a whole. Directly for the industry, they are limited to the above measures. The most powerful tool for solving the personnel problem of maritime transport is the increase in wages in the industry as a whole and in the Arctic and the Far East, in particular. However, this is often difficult to implement in practice.

In general, thus, the key prospect for the success of solving the problem is an increase in the tonnage of ships and an increase in the level of digitalization – automation of the process of managing them – which will lead to a decrease in the number of personnel in maritime transport and open up opportunities for increasing wages.

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