Transformation of Traditional Cultural Landscapes - Koper 2019

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Agriculture and land use in the North of Russia: Case study of Karelia and Yakutia

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Abstract: Despite harsh climate, agriculture on the northern margins of Russia still remains the backbone of food security. Historically, in both regions studied in this article – the Republic of Karelia and the Republic of Sakha (Yakutia) – agricultural activities as dairy farming and even cropping were well adapted to local conditions including traditional activities such as horse breeding typical for Yakutia. Using three different sources of information – official statistics, expert interviews, and field observations – allowed us to draw a conclusion that there are both similarities and differences in agricultural development and land use of these two studied regions. The differences arise from agro-climate conditions, settlement history, specialization, and spatial pattern of economy. In both regions, farming is concentrated within the areas with most suitable natural conditions. Yet, even there, agricultural land use is shrinking, especially in Karelia. Both regions are prone to being affected by seasonality, but vary in the degree of its influence. Geographical location plays special role, and weaknesses caused by remoteness to some extent become advantage as in Yakutia. Proximity effect is controversial. In Karelia, impact of neighboring Finland is insignificant compared with the nearby second Russian city – Saint Petersburg.

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1 Introduction

This article is based on the case study of two large administrative regions of Russian Federation – the Republic of Karelia (furthermore Karelia) and the Republic of Sakha (Yakutia). Territory of both regions is officially considered in Russia as the Extreme North. This notion applies to the whole territory of Yakutia, the largest unit of Russian Federation and also the largest administrative region worldwide with 3,084 thousand km^2 land area. Five administrative districts (uluses) of Yakutia have an access to the Arctic Ocean and officially belong to the Arctic zone of Russia. Even in the southern part of the Republic, the climate is sharply continental. Average temperature in January is from −29.0 to −38.0°C and in July – from 9.0 to 13.0°C. There are places where the annual temperature amplitude can reach 100° [1]. The territory of Yakutia is sparsely populated with an average population density of 0.31 inhabitants per km^2 as an average. Its extractive economy (gold, diamonds, coal mining, etc.) determines the focal settlement distribution. At the same time, the share of the rural population in Yakutia – almost 35% – is atypically high for the northern parts of Russia. The specifics of the agro-climatic conditions are determined by the severity of the climate (the "cold pole" of the Northern Hemisphere is located here) and widespread permafrost soils. The sum of active temperatures varies from 1,100 to 1,600°C, but the frost-free period in the Republic is rather short: 67–76 days only, depending on location. Nevertheless, cropping is practiced in the river valleys of Central and Southern Yakutia, where short but hot summers (on 17 July, 2011, a record air temperature of +38.4°C was registered in Yakutsk) enable even planting eggplants, corn, and watermelons [2]. Most crops require irrigation, as annual precipitation is only 250 mm in the lowlands and up to 600 mm in the mountains. Large

areas in Yakutia are suitable for pasturing cattle, horses, and reindeer.

In Karelia, roughly half of its 180.5 thousand km^2 territory is assigned to the Extreme North, while the rest administrative districts and urban municipalities are equated to this category. The climate in Karelia is milder than that in Yakutia and could be labeled as transitional one from marine to temperate continental, with an abundance of rainfall and, mainly, cyclonic type of weather [3]. Agro-climatic resources in the southern part of Karelia allow the cultivation of a range of crops typical for the Non-Chernozem (non-black soil predominance) zone of Russia, mostly grains (rye, barley, oat), potatoes, and vegetables. But the possibilities of plant growing in open ground are limited – the region is assigned to the risky farming zone. The average annual air temperature in the Republic is from 0.0°C in the north and up to +3.5°C in the south, and the annual temperature amplitude is between 23.0 and 30.0°C. The coldest month of the year is January (average monthly temperature is from –9.0 to –13.0°C) and the warmest month of the year is July (average monthly temperature is from +14.0 to +17.0°C). The sum of active temperatures in Karelia varies from north to south from 900 to 1,600°C. The frost-free period in the Republic is 80–130 days, and on the islands of Lake Ladoga – 150 days a year [4]. Excessive rainfall – up to 700 mm – is an obstacle for cropping, but is favorable for hayfields and natural pastures for dairy cattle.

Agriculture appeared in Karelia in the Middle Ages with the Novgorodian peasant colonization and the spread of cropping among the local Finno-Ugric people (the Karelians, Vepsians, and Finns). Furthermore, peasant agriculture was completed with the monasteries' large-scale cropping (grains and vegetables) and dairy farming. In Yakutia, the traditional activity of the indigenous people was reindeer breeding. In 14–15th centuries, Turkophonic tribes from Central Asia, the ancestors of Yakuts, settled in the valleys of central and southern parts of the present-day Yakutia. They introduced cattle and horse ranching. Horses are an important source of meat and milk in the Yakut diet till today. Russian colonization of Yakutia started in 17th century; from that period of time, cropping was practiced only in small nuclei near Russian settlements. The next stage of agricultural development in both Karelia and Yakutia started during Soviet times with the spread of mining activities. In the USSR, the concept of food self-sufficiency of the distant northern regions implied creation of large highly subsidized state farms. Only a part of them survived in Russia after transition to the market economy in the 1990s. In the present, there are attempts to redevelop some of these large farms with investments from mining companies. Hi-tech agri-technologies as hydroponics and greenhouses also started to develop. In order to support the indigenous populations, federal and regional governments launched programs for developing their traditional activities as reindeer and horse breeding.

All the above-mentioned factors have created very special conditions for agricultural development and imposed land use changes which are the subject of this research. We consider it important to state that the two regions chosen – Karelia and Yakutia – are representatives to reveal the main issues all the northern regions of Russia face in these fields.

In this paper, we pretend to compare two regions, which represent two extremes of the variety of more than a dozen of large administrative regions of Russia, located in the North of this country. The two regions chosen – Karelia and Yakutia – represent European and Asian North of Russia, which have some common features, but also pronounced differences in land use and agricultural development. We are trying to reflect and explain the most recent data, using different kinds of sources, including the authors' field observations and in-depth interviews with local experts, which compensate insufficiency of available publications.

2 Methods

Comparison of agricultural development and land use in two Russian regions – Karelia and Yakutia (Figure 1) – is based on three different kinds of sources: official statistics, expert interviews, and field observations.

The last two are of particular importance because of imperfect methodology and low frequency of data collecting by the official statistical bodies. With regard to the statistical data, we must state that in Russia, especially on the regional level, it is sometimes hard to find a consistent statistical data on land use. For example, "agricultural land" in Russian statistics means the total land belonging to agricultural enterprises, farmers, and to households, even if it is out of use for years. It is often covered by secondary forests, spontaneously grown in the 1990s, when agricultural activities were drastically reduced. On the other hand, there are regions, i.e., over the shore of Ladoga Lake in Karelia and nearby Yakutsk, where agricultural land was massively converted to dachas (secondary houses on small private plots). That phenomenon could be clearly seen on satellite images, but has absolutely no references in official statistics.

Figure 1: Study area. Compiled by the authors.

In statistics, cropped area is counted with a high degree of error even during the agricultural census (the second one carried out in Russia in 2016). As for natural pastures and hayfields, their area is underestimated, especially in the remote northern regions. Same applies to the husbandry of domestic animals (mostly underestimated) and to the value of agricultural production. This does not allow to measure the intensity of land use properly. Huge discrepancies do exist with the estimation of the number of workers employed in the agricultural sector: in Russia, the average annual number of employees in agriculture, hunting, forestry, and fishing as the whole is counted, not to say that statistics totally neglect seasonal workers. Nevertheless, we have plotted general maps of agricultural land use structure for both regions studied on the level of their administrative subdivisions and consider them useful for comparisons and conclusions.

Finally, we need to mention the lack of research on land use in the northern regions of Russia based on remote sensing data. In Russia, there are only a few examples of this kind of research even for the regions [5] within the main developed parts of the country.

As far as statistics are concerned, we used: (1) statistical databases, acquired from the Russian Statistical Agency (Roskomstat), the federal government source; (2) datasets from the regional statistical agencies; and (3) from other authoritative bodies such as ministries of agriculture or similar.

A core component of this research relies on the analysis of expert interviews, carried out in the Republic of Yakutia in June–July of 2018 and in the Republic of Karelia in January–February of 2019. In Yakutia, six representatives of regional and local authorities, eight professors and researchers of local universities and scientific institutions, and 12 managers of agricultural enterprises and farmers were interviewed. These in-depth interviews were made part of the World Bank-sponsored project of the Eurasian Center for Food Security of the Lomonosov Moscow State University [6]. In Karelia, semi-structured interviews were carried out by the expedition of 12 students and researchers of the Faculty of Geography of Lomonosov Moscow State University, organized in cooperation with the Institute for Agrarian Studies of the Higher School of Economics, Moscow. Significantly larger number of participants of the Karelian expedition than of the Yakutian one explains a wider range of respondents there: 24 officials of regional and local authorities, 29 managers of agri-food enterprises and farmers, 38 representatives of educational and research centers, and 18 of cultural institutions. Finally, we consider field observations to be an important component of our case studies on land use and agricultural activities during our visits to the

Khangalasskiy and Namskiy administrative regions (ulus) and Yakutsk and Jatay city districts of Yakutia and three administrative regions of the southern part of the Republic of Karelia: Olonetzkiy, Priozerskiy, and Pryazinskiy.

We recognize that expert opinions are important as a broad approach to the land use studies. These opinions provide guidelines for a deeper plunge into the most important issues of land use, which, in case of being complemented by detailed analysis of statistical and remote sensing data, could allow to draw a consistent and much more detailed picture than presented in this article. Nevertheless, we consider it very important as the first step to share our findings on the matter, as the topic of land use and agriculture on the northern fringes of Russia and of other countries as well is not among the priorities in scientific literature.

3 Theoretical background

Agriculture and land use on the northern fringes of Russia (by that time USSR) became subject of the academician Nikolay Vavilov's report "The Problem of Northern Agriculture" to the Academy of Sciences of the USSR in the early 1930s [7]. Such issues as specifics of land amelioration in the North, selection of highly productive crops, and growing season management were raised there. Scientific and practical research in the 1940–60 s was mostly devoted to the improvement of agricultural technologies, in particular, greenhouses [8,9]. Finally, in 1970–80s, there appeared synthesis publications about main directions of northern agriculture development [10], but after the Soviet Union collapse this theme was abandoned for many years.

In 2000s, northern agriculture has become popular again, as reflected in scientific publications. Among new topics that draw attention of the scientific society is the possibility of reusing abandoned agricultural lands in Karelia [11]. Some papers are devoted to specific economic issues of modern types of "northern agriculture," sustainability of agricultural systems and food security [6,12]. There is also a completely new topic – urban agriculture in the Arctic – that is just beginning to be explored [13]. Traditional agriculture is a separate scientific direction that is being developed in those regions where indigenous people of the North live, including Karelia and Yakutia. There are many articles devoted to peculiarities of horse breeding [14,15] and reindeer herding in Yakutia [16–18].

Traditional types of land use are studied both in Yakutia [19] and Karelia, but at the same time they cover different issues. Articles about traditional land use in Karelia contain information about specifics of old villages [20] and how vanished villages affected the landscape of the region due to agricultural profile of local communities [21]. Another use of land in a form of rural tourism is considered to be a promising avenue as agriculture and forestry significantly dropped [22,23].

Russian Karelia is sometimes compared with Finnish one. They have similar nature, climate conditions, and common past, but at the same time the intensity of agriculture and forestry differs considerably in these regions which makes this comparison quite illustrative [24,25]. Generally, Finnish scientists also dedicate their studies to traditional land use [26] and importance of traditional knowledge in governance of bioresources [27].

Yakutia is a mining region for which traditional land use is studied in the context of natural resources extraction and the interactions between indigenous people and extractive companies [28,29]. The same issue is now an urgent one in Canada [30,31].

In recent years, traditional land use in the North is also being studied from the perspective of climate change [32–34]. Researchers are thinking about how this process can change the landscape and how traditional knowledge may help to cope with possible constraints.

Despite the increasing number of publications, the issues of land use and agricultural development in the studied regions are rarely approached by geographers. Some publications are rather broad and devoted mostly to economic analysis as the rationale for achieving sustainable agricultural development in Yakutia [35]. Others represent case studies, sometimes with a broader geographic range [6], or very local ones, based on field research in certain rural settlements [36].

To summarize, most scientific papers on land use and agricultural development in the northern regions of Russia are published in Russian, comparative analysis as a tool for justification of differentiated policy measures for federal and regional governments is very rare, and geographical approach dealing with different scales – from large regions to municipalities – is lacking. We hope that our paper will facilitate filling these gaps.

4 Results

Agricultural activities in both regions – Karelia and Yakutia – are currently being developed only on a small part of their territories with better natural conditions for cropping. These regions have rather narrow agricultural specialization as natural conditions allow to plant in the

open ground only limited number of crops. In the past, grains such as rye, barley, oats, and wheat were planted in both regions, the regional harvest even being sufficient for local consumption. In the 1960s, Yakutia was self-sufficient in wheat, nowadays producing only a symbolic yearly amount of 12 thousand tons, or 12 kilograms per capita (Table 1). Maintaining grains production there could be explained by remoteness and isolation, which encourages local producers. In Karelia, production of grains dropped to zero, being completely uncompetitive in comparison with national breadbaskets. Potatoes and vegetables, on the contrary, are produced in relatively large volumes, though not completely covering local demand. Yields of these crops are lower there than in Central and Southern Russia. Same applies to comparison with countries of Northern Europe. Although overall agricultural production per ha of agricultural land in Karelia is nearly the same as that in Finland and Sweden, average volume of agricultural production in both Karelia and Yakutia is much lower [37].

In both Karelia and Yakutia, dairy farming plays important role. It is much more developed in Yakutia because of several reasons: the already mentioned remoteness, subsidies, and traditions of the Yakut population. The last reason also applies to explain a large husbandry of horses and reindeer; the first one — a traditional activity in central parts of Yakutia and the second one is widespread in tundra in the north and in the mountains in the south.

In Karelia, among four agro-climatic zones, identified on its territory: northern, middle, southern, and southwestern, only two – the southern and the southwestern – are considered suitable for cultivation of grains and vegetables. Huge part of Karelia situated over 64°30′ N

Table 1: Main features of agriculture in the Republic of Karelia and the Republic of Sakha (Yakutia), Russian Federation

Region		Republic of Karelia (Karelia)	Republic of Sakha (Yakutia)
Area, 1,000 km^2		180.5	3,083.5
Share in total area of Russian Northern territories, %		1.9	33.1
Agricultural land – share in total land area, %		0.4	0.8
Total population, 1,000 (% rural)		617.9 (19.7)	967.5 (34.3)
Population density per square kilometer		3.4	0.3
Agricultural employment – share in total number of employed,[a] %		10.9	9.3
Contribution of agriculture to GDP/GRP,[b] %		6.3 (4.2)	1.7
Ethnic composition – share of indigenous people in total population,[c] %		7.9	48.7
Volume of subsidies for milk production, rubles per kg		3.00	35.00
Gross harvest, 1,000 tons	Grain	—	12.1
	Potatoes	34.3	78.9
	Vegetables	10.9	37.8
Yield, hundred kg/ha	Potatoes	133	99
	Vegetables	242	161
Cattle population, 1,000	Cattle	25.1	244.6
heads	Dairy cattle	25.1	240.8
	Beef cattle	0.0	3.5
	Sheep	4.1	0.4
	Goats	2.3	1.6
	Horses	0.1	242.6
	Pigs	12.6	23.4
	Poultry	266.3	746.9
	Reindeer	0.0	172.8
Outputs	Cattle and poultry for slaughter, 1,000 tons	5.3	22
	Milk, 1,000 tons	68.6	164.6
	Eggs, millions of eggs	7.9	118
Milk yield per cow, 1,000 kg		7	2.2
Area of greenhouses, 1,000 ha		0.52	29.43

Sources: [39,40,42]

[a] Agricultural employment includes also forestry, hunting, and fishing. [b] Including forestry, hunting, and fishing. [c] All-Russian population census 2010.

belongs to the northern agro-climatic zone and is not considered suitable for agriculture [38]. But even in the more fertile south and southwest of Karelia, the share of farmland in total area is less than 10%, except the Lakhdenpokhsky District (12%) on the border with Leningrad region (Figure 2). Farmland area by administrative district varies from less than 1 thousand hectares in the north to nearly 20 thousand in the south, which is still insignificant compared with the total area. Arable land roughly corresponds to a half of agricultural area in the southern part of Karelia, but since 1990s it is shrinking because of the decrease of cropping and dairy activities along with the area of pastures and hayfields.

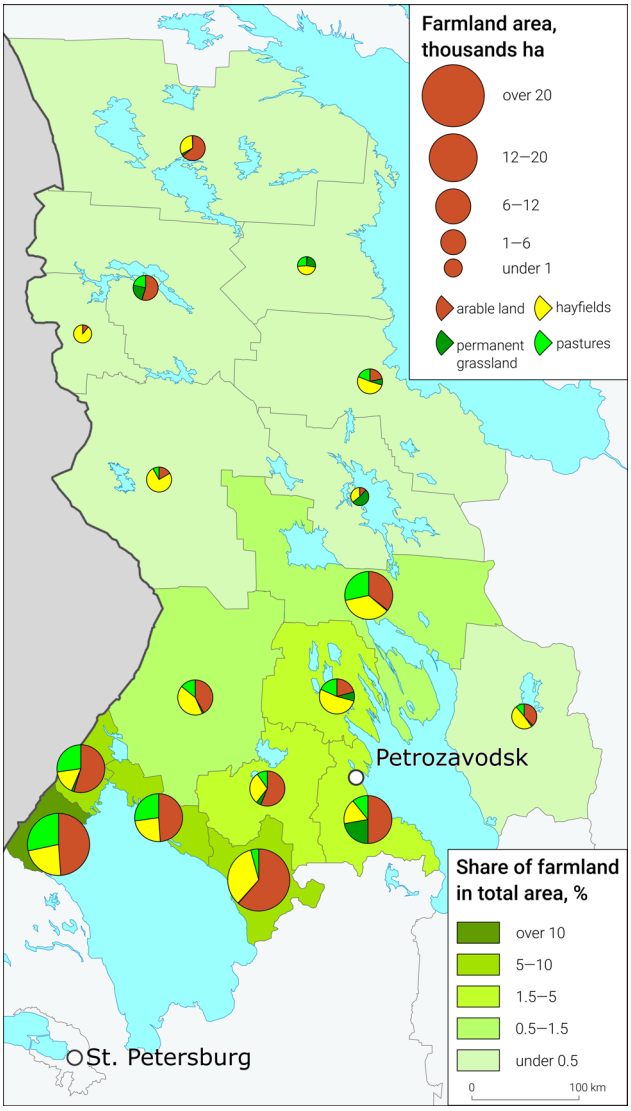

Figure 2: Structure of agricultural land use in the Republic of Karelia, 2016. Compiled by the authors based on Russian agricultural census, 2016.

In total, about 9 thousand people are employed in agricultural and fishery commercial enterprises, which in 2016 amounted to 4.5% of the total number of people employed in Karelia, 2.7 thousand of whom were employed in agriculture [39]. The planted area of crops in 2016 amounted to 33.5 thousand hectares [40]. At the same time, compared with 2000, the size of the planted area decreased by 1.9 times. Dairy farming is more widespread in Karelia than crop production and strongly depends on state subsidies. All dairy farms in Karelia receive a compensating subsidy to recover part of the costs. Yet, only those that claim to increase milk production will be able to apply for a stimulating one. In 2020, 34.6 million rubles will be allocated from the federal budget to compensate for the costs of dairy producers of the Republic. But this measure does not help much, as final volume of subsidies amounts to 3 rubles per kg of milk, or less than 10% of its wholesale price.

Facing the large enterprises' low profitability, the Republic of Karelia now gives priority to the development of dairy farming by encouraging and supporting family small farms. In many ways, the creation of peasant farms attracts entrepreneurs, since the general level of culture and the needs of the population are changing. People are willing to pay more for the "green" product, and the product "from the farmer" is now valued higher than the "industrial" ones. Small farms in Karelia are more specialized in crop production than large organizations as they produce niche commodities as vegetables and herbs. Vegetables are mainly grown in open ground in Karelia, and climatic conditions limit the possibilities for farmers: the vegetation period is much shorter here than in the Central and Southern Russia. In addition, there is the problem of wholesale distribution, since chain supermarkets are supplied with food products at lower prices from other regions of Russia.

One of the key problems of agricultural development in Karelia is the abandonment of farmland due to the nonprofitable specialization of Karelia in the production of vegetables (carrots, potatoes, etc.) and dairy farming, previously developed here. Now there are only 13 large agricultural enterprises left in Karelia, seven out of which are dairy farms. According to the representatives of Petrozavodsk State University, only four out of these large farms might be considered profitable. There are two main reasons for decrease of conventional agriculture in Karelia. The first one is depopulation due to the negative rate of natural increase and migrational activity towards closely situated Saint Petersburg and Leningrad region or to even Moscow. Secondly, location in the European part of Russia close to all main economic centers made the

domestic food market of Karelia strongly intertwined with the expansion of major food chain stores, thus making Karelian production expensive and uninteresting to the investors. For example, the director of "Megrega" mentioned that previously they had two main areas of activity: dairy cattle breeding and vegetable growing. Yet, with the introduction of chain supermarkets to the region, vegetable growing has practically ceased since the price of vegetables in chain stores is significantly lower (for instance, being transported here from Krasnodar region) than the price of the local farm products. Therefore, vegetable growing or crop production are the prerogatives of mainly small farms.

The only branch of the agri-food sector which has positive dynamics here is the development of the fishery complex. According to the data announced at the International Trout Forum in 2019 held in Karelia, nearly 90% of trout in Russia were grown in Karelia [41]. Such rapid development of trout farming was attributed not only to the cold water of its lakes, their depth, and purity of their waters, but also to the demand of large sales markets: Moscow and Saint Petersburg. Another important factor in increasing production in the fishery of the Russian Federation is the sanction on imported goods imposed in 2014. The growth of this industry allowed to flood the domestic market, which in 2013 was 45% dependent on imported products [41]. However, being one of the leading branches of specialization of the agri-food sector in Karelia, fish farming generates a small number of jobs (up to 10 each one on average) and does not compete with agricultural activities for the land.

Karelia has a high potential for harvesting and processing wild berries, the biological reserves of which (taking into account the average yield) are estimated to be over 120 thousand tons. In all rural settlements studied, locals do pick berries in summer for sale. Apart from wild berries, the residents mentioned that they also pick mushrooms, willowherb, and pine and spruce cones either to sell later or for their own needs. Fishing is also quite popular. However, residents do not catch much – mostly for their own needs or just to sell to their neighbors. This is largely due to the tightening of legislation regarding usage of fishing nets. The exception in some ways are Vepsian villages. The status of indigenous small-numbered people of the North gives the Vepsians the right to catch fish on special conditions. Some of the locals hope to use this advantage to attract tourists. Therefore, it is true to say that such activities are not the sole prerogative of indigenous peoples, instead everyone is free to take them up. Despite all economic benefits, collecting process of berries is uncontrolled and unaccounted. As it was mentioned by residents of visited rural settlements, gathering berries for sale is so important that during the so-called "berry season" (July–August), people often decline other possibilities of earning money. Then wild berries are sold at special collecting points, either official, e.g., belonging to the company "Jagody Karelii" (Berries of Karelia) or to individual entrepreneurs, or unofficial, e.g., on the highway near the rural settlement or in the city.

In addition, there exists another kind of seasonal income for dwellers of rural settlements in Karelia – harvesting strawberries in the farms of nearby Finland. That way, citizens of Karelia go to Finland to develop not so promising agricultural activities within their region (due to the existence of the main producer Krasnodar region with lower costs) and bring the capital back to the Republic.

The Republic of Karelia, due to its climate, topography, prevailing coniferous vegetation, and rich historical and cultural heritage, is an attractive region for tourists. The volume of organized tourist flow in 2017 amounted to 780 thousand people and unorganized – 507 thousand people [39]. Overlooking its undeniable economic benefits for local budget, tourism has significant influence on the land use as well as severe ecological consequences due to the negligent behavior of entrepreneurs and their customers. Almost all rural settlements visited during the expedition were oriented to tourism, but to a different extent. Some of them utilized their cultural heritage, others natural wealth of possibilities for active tourism. Main touristic areas are concentrated near or on the shores of the largest lakes of the Republic of Karelia: Onega and Ladoga. Proximity to the sources of tourist flows also determines their volume. Petrozavodsk has a great influence on the surrounding rural settlements: the townspeople are the main users of tourist camps near Lake Onega. On Lake Ladoga, a stream of tourists from Saint Petersburg and Moscow is noticeable.

Another two-edged sword is a distribution of "summer residents" (dachniki, those who spend summer on dacha, or a seasonal or year-round second home, often located in the exurbs). Significant growth of population caused by the arrival of summer residents was mentioned by all respondents in all studied settlements. On the one hand, they occupy farmland, put pressure on the infrastructure, transport, trade, etc.; on the other hand, they support the life in dying villages.

One more problem connected with land use was unearthed in Karelia. The head of the local administration in the city of Olonets, as one of the most pressing problems, spoke of the overcrowding of local cemeteries, where,

due to relative cheapness, more and more residents of Saint Petersburg have been buried in recent years. The plots allocated for cemeteries are practically completely and utterly filled up; literally, there are no places for burial left there. The significance of this problem was also outlined by the abbot of the local church parish.

In the economy of Yakutia, agriculture plays a minor role as most of the revenue of this region is generated by mining industries. At the same time, agricultural employment here is much more numerous, than in Karelia. In 2016, the total of 90 thousand people were employed in agriculture and fishery, which amounted to 9.3% of the total employment in Yakutia [42], which is the highest level of agricultural employment among northern regions of Russia.

Geographic specifics and huge territory determine uneven agricultural development in terms of agricultural industries and produced value. There are five nature-and-agricultural zones in Yakutia: reindeer breeding and hunting on the banks of the Arctic Ocean, livestock farming and hunting in the mountainous taiga regions, livestock farming in the Viluy River basin, livestock and crop farming in the southeast and southwest of the Republic, and suburban areas of Yakutsk. This zoning is very different compared with the regions of European North of Russia, i.e., Karelia. Agriculture is mostly developed in uluses in the middle course of Lena River valley near Yakutsk and near the main mining towns [6,43]. But even in these more agriculturally developed uluses, farmland rarely occupies slightly more than 10% of their total area, surpassing 50 thousand hectars only in six of them (Figure 3). In comparison with Karelia, share of arable land in farmland area everywhere in Yakutia is much smaller than share of pastures and hayfields due to traditional importance of cattle ranching and horse breeding. In uluses of the Arctic zone, same in the mountains in the south of Yakutia, size of farmland area is insignificant. Large commercial farms created on the base of former collective and state farms, nowadays financed by mining companies, dominate in meat and milk production for domestic market of the region. There are also small farms.

Despite difficult agro-climatic conditions, people in Yakutia are growing grains, potatoes, vegetables, and even watermelons in open ground. It has become possible due to the development of quickly ripening varieties, artificial irrigation, and government support. Subsidies have a critical importance for development of both sustainable agribusiness (without losses) and rural areas. Yakutia is one of the leaders of all the Russian regions in terms of the amount it receives in state support for agriculture. High level of regulatory and legal support of agribusiness operations sets this Republic apart. Since 2002, the State Assembly (Il Tumen of the Republic of Sakha (Yakutia)) has been regularly adopting laws that set guidelines for developing this sector. Funds allocated for subsidies account for half of the cost of agricultural output in Yakutia. Despite an increase in federal equalization transfers to Yakutia, which amounted to almost 44 billion rubles in 2018 (Yakutia ranked second among all Russian regions), farm subsidies went down from the previous year by 3 billion rubles and amounted to 7 billion rubles. Subsidies are provided primarily to compensate for the costs to produce and process milk, to construct industrial livestock farms, and to breed stock. Because of subsidies, in 2015, the purchasing price for cow milk in Yakutia was 38.2 rubles per kilogram (45 rubles in 2018, with 35 rubles compensated by subsidies), while in most Russian regions the price was only around 20 rubles. The ongoing state program of Yakutia includes 21 areas of subsidizing agricultural production and rural development; all large companies and every third farm (out of 2,500) of the Republic receive support. At the same time, Yakutia's agricultural food market is far from being perfect.

According to some of the experts interviewed, Yakutia should strive for the transition from subsidized to self-sufficient development. However, without state support, most of the local agricultural products will not withstand competition from imported ones both from the main agricultural regions of Russia and from abroad.

As to the abandonment of state support, there comes another problem – traditional agricultural activities of indigenous population such as reindeer herding. There are problems connected with poor logistics as well as incomplete technological chains for reindeer meat, skins, and horns processing and the high cost of living for reindeer herders who lead a nomadic lifestyle (housing, schools for children, healthcare, etc.). Traditional agriculture becomes impossible in a market-oriented economy without support from the government and the right of indigenous people to conduct their traditional lifestyles is enshrined in the Federal Law No. 82 "About guarantee of the rights of indigenous peoples of the Russian Federation."

Almost all the problems of agricultural development and land use in Yakutia are determined (to varying degrees) by geographical features of its vast territory. Besides natural and climatic factors, the biggest challenges to food security and agriculture development in Yakutia include an underdeveloped transport infrastructure (there are just 11.900 kilometers of paved roads in Yakutia [42]) and seasonal peculiarities. Transport and logistics problems are especially significant for the

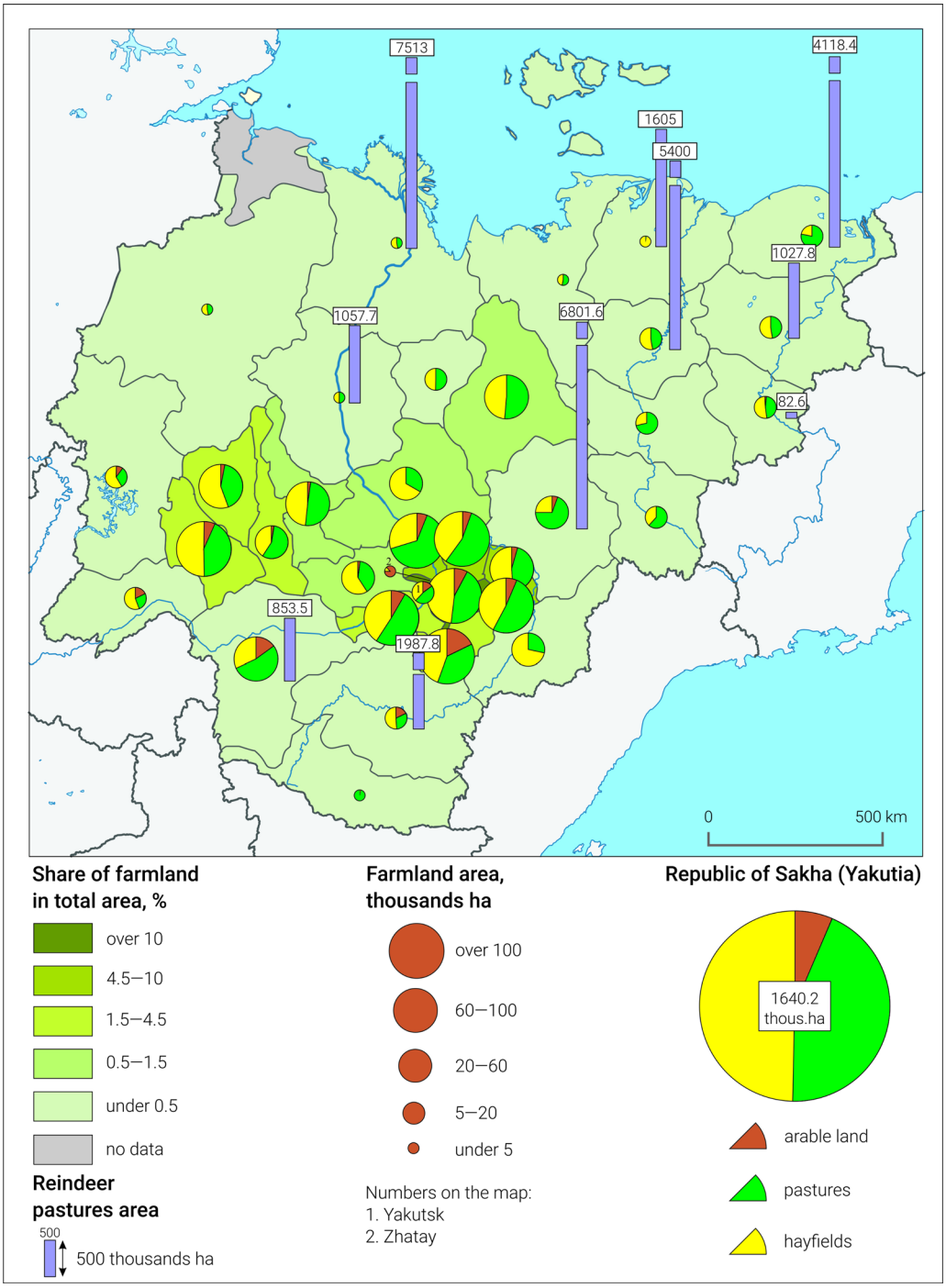

Figure 3: Structure of agricultural land use in the Republic of Sakha (Yakutia), 2016. Compiled by the authors based on Russian agricultural census, 2016.

districts belonging to the Arctic zone. Food supply of these territories is carried out through a special state program of food provision. It is a seasonal delivery of one year (sometimes two years) of vital products in a short period of navigation along rivers and by sea. The effectiveness of this system depends not only on the careful planning, but also on the state of the cargo fleet, as well as the availability of warehouses.

Problems with storage of agricultural products are very acute even in the most densely populated parts of the Republic: there is a shortage of potato warehouses in the suburbs of Yakutsk. Because of the cold climate,

construction costs are very high and electrical heating is expensive. This region also faces transport problems. Farmers from Churapchinsky ulus have trouble with transporting their food products to Yakutsk because there is still no bridge across Lena river. Producers have to use a ferry service in summer and on the so-called winter roads upon river ice during the cold season. It leads to additional costs and time losses which is critical for perishable foodstuff. As local farmers say, their products are in principle much more expensive than imported ones, especially from China. For example, 1 kilo of cucumbers imported from China in Yakutsk costs about 100 rubles, while local vegetables from the nearby village cost at least twice more.

One of the critical challenges in Yakutia's agri-food sector is also the poor development of food value chains, including retail distribution channels. This is attributed to the low level of agricultural enterprises' technical equipment, their weak links with the food industry, and distribution channels. Large industrial livestock farms and food processing factories in Yakutia, such as the Yakutsk city milk factory, appeared in the Soviet era and were oriented toward the centralized delivery of raw materials from other regions. Now it is really difficult for them to exist under market economy conditions.

Despite the fact that the share of agricultural lands in the total area of Yakutia is small, a number of environmental issues impede development of the agricultural sector. Horse grazing is not controlled at all: as local people say, "they are pasturing wherever they want." The head of a big horse breeding enterprise couldn't point to the area where 1 thousand horses and another 1 thousand of cattle belonging to this farm are grazing. Absence of legal framework concerning the limitation of grazing pressure is leading to the grassland's degradation, especially near Yakutsk where many rural residents have small herds, whose population is not taken into account. High demand for colt and horse meat and the population growth will make the problem even worse.

A shortage of water for farmland and inefficient use of irrigation methods such as sprinkler and inundation irrigation are also an important issue, taking into consideration the dry and hot summer here. The Republic's authorities spend much money on the construction of irrigation systems for large farms. However, small farmers and owners of subsistence plots irrigate their fields from nearby water reservoirs. They do not control water consumption and nobody takes care of secondary salinization of soils which is rather common.

Despite big agricultural subsidies to producers of raw agricultural products, there is still a lack of investment for small-scaled production. Representatives of the Technology Park told us that they were given grants to develop their innovative technologies, but afterwards they suffered a lack of investments. As a result, it is often impossible to start mass production and to market their inventions. Farmers are also having troubles with getting a loan to provide their farm with equipment. The farmer we talked to had to assemble an equipment for his potato storage and processing units by himself using second-hand units.

One more problem is connected to weak collaboration between local researchers and producers. For example, a farmer from Churapchinsky ulus that is growing potatoes had interactions with Novosibirsk region (more than 2,500 km away) and bought seed potatoes from there, though there are local varieties developed by Yakutsk Agricultural Research Institute (180 km away) which are well adapted to the local climate. The same situation tended to occur with strawberry production. Local farmers were looking for appropriate kinds of berries using social media, but not local institutions.

Like many other Extreme North territories, Yakutia is affected by global warming. Forecasts of global warming effects on Russian agriculture are so far too general. However, it is already clear that in Yakutia rising average annual temperatures threaten areas inhabited by indigenous communities of the North, while melting of permafrost will lead to the swamping of agricultural lands. In the Nizhnekolymsky ulus, increasing air temperature has already led to a reduction in the number of deer. Rain and snowstorm led to the formation of incrust, which made it difficult to access reindeer moss.

5 Discussion and conclusions

Our approach presents a complex overview of a range of features concerning socioeconomic development in terms of agriculture and land use, whereas most studies tend to focus on one specific issue at a time such as the impact of climate change, traditional activities of the indigenous population, food security, etc. We have tried to survey agricultural development and land use changes in Karelia and Yakutia from all these different angles.

Climate change, according to J. D. Ford, G. McDowell, and J. Jones [44], is an important driving force as it affects marine and terrestrial ecological dynamics, which in turn has a strong influence on the commercial harvesting and subsistence-based livelihoods common among the Arctic's Indigenous populations. In addition, the issue of

land-based travel and transportation has become more pronounced (e.g., ice road access to communities and mine sites appears to be more unpredictable and difficult). Moreover, the manifestations of climate change such as thawing permafrost, coastal erosion, and sea level rise have direct impact on municipal and industrial infrastructure (e.g., airstrips, housing, pipelines). Warming also affects economic sectors including forestry and agriculture via a longer growing season, but with increased exposure to pests. In order to mitigate the consequences of climate change, new adaptive techniques are being adopted (e.g., new tools by Indigenous land-users such as GPS, development of policies to manage increased economic activity and geopolitical concerns in the circumpolar north, raising awareness about the current changes in the Arctic, etc.). Yet, all these measures are primarily behavioral in nature, reactive, and taking place at the individual/household level.

Both Karelia and Yakutia are prone to being influenced by global warming, which already affects northern regions by causing swamping and permafrost melting. This mostly applies to Yakutia, where most of the cropped area is on the permafrost soils. As for negative consequences of human impact on the environment, overgrazing and salinization due to excessive irrigation with carbonated water in Yakutia should be mentioned. Indeed, it affects agriculture, thus a visible share of pastures and fields already lost their productivity, which is particularly relevant regarding the Middle Lena river course uluses.

C. Poeplau et al. [45] determine that global drivers may not be the only factors that foster land use change in the Circumpolar North; regional drivers may also play a role (e.g., imported food is quite expensive and lack in quality, thus increasing the demand for locally grown food in remote areas). This matches with our findings for Karelia and Yakutia. As the main common feature, we can name low profitability of the conventional agricultural activities as cropping of grains and vegetables in the open ground and dairying. Without state support through subsidies, the future of these activities is questionable, which undoubtedly also implies land use. Many fields in Karelia and Yakutia are already abandoned, which caused their "reverse" afforestation.

Institutional and economic conditions for agricultural development and land use in these regions vary. In both regions, agriculture strongly depends on state subsidies, which is a necessary condition taking into consideration harsh climate and low fertile soils of the North. In Russia, it is recognized in the State Program of the Development of Agriculture and Regulation of the Markets of Agricultural Production, Raw Materials, and Food for 2013–2020, where among priorities the socially important development of forage production and agricultural use of low fertile land of Far North is stated. But implementation of this program depends not only on the federal government actions, but also on economic wellness of regions. Yakutia due to its mineral wealth has much more potential for subsidized agriculture than Karelia. Diamond and coal mining and natural gas piping companies support regional agricultural producers, which supply to their workers fresh milk, meat products, and vegetables. In Karelia, it is hard to find such sponsors.

Conflicts between traditional (indigenous) and modern (industrialized) land use in northern regions worldwide are probably the most popular topic of research, including Russian Far North and Arctic. K. Stephen [46] investigates societal impacts of changes happening in Arctic region. One of the main findings is that new levels of accessibility in many Arctic regions and associated expectations for new economic activities often lead to conflict between traditional and new land uses (and non-uses like nature conservation). AV. Evseev et al. [47] analyze the land use conflicts at Indigenous Population Territories in the Russian Arctic. In spite of advanced institutional support measures for preservation of the territories of traditional nature use, the most typical cause of nature management conflicts reflects "the Tragedy of the Commons" theory (when the members of one group, in a pursuit of their own personal gain, actually ignore the rights of another group for ecosystem services). This leads to their exhaust, undermining ecological, economic, and social stability of local population. The solution here includes not only provision in ecosystem services (hunting, fishing, wild berries resources) used by indigenous minorities and to a certain extent by newcomers as well, but also regulating, supporting their distribution as well as developing cultural services. S. Crate [48] studies the unprecedented change caused by thermokarst on the territories of indigenous land use. R. Weber et al. [49] concentrate on the importance of involving stakeholders in land use planning, creating dialogue, and gathering opinions in order to maximize the specifics of the locality while increasing its livability and effectiveness. G. Ivanova and T. Safronova [50] analyze the gastronomic habits of the indigenous population, the dietary features of the Northern people, and the effect on the body of children of products from other latitudes.

Traditional economic activities play an important role in both Karelia and Yakutia. Although we consider that ethnic factor is also a driving force for land use changes, not always these changes occur in accordance with the principles of sustainable development. In

Karelia, only the Vepsians are officially considered as indigenous people of the North; as a result, they enjoy benefits in using such natural resources as forest and water. The other ones, the Karelians (another ethnic minority, mostly assimilated by the Russians) or representatives of all other ethnicities, do not have any preferences, but widely practice gathering of wild berries and mushrooms, also fishing. In Yakutia, the status of indigenous people is assigned to small ethnicities of the Arctic, who are reindeer breeders. But as the Yakutians are becoming the ethnic majority in the Republic, many regional laws promote their traditional activities as cattle ranching and horse breeding.

Most studies on land use and agricultural development in the North tend to concentrate on one administrative region or province of a given country. Our research strives to compare two Russian regions attributed to Extreme North, which brought us to conclusion that there are both differences and similarities in the features of their agricultural development and land use. Therefore, it is true to say that some measures or policies of socio-economic development may indeed be similar; however, most of them have to differ in accordance with the specifics of the regions. The studied regions could be considered as the models for the other administrative subdivisions of the vast northern fringes of Russian Federation, depending on how similar they are with these studied cases. They provide examples of efficient policy measures and successful agricultural practices, including innovative and traditional ones. Indigenous agriculture, along with specific natural resources of northern landscapes, can provide food not only for domestic consumption, but also for the whole Russian and international markets. Promoting these products could be a successful policy measure. It also contributes to a more sustainable land use, which is important for a vulnerable nature of the North.

Other important findings imply the role of geographical location and specifics of natural seasonality on agriculture and land use. Both regions are prone to being affected by seasonality, but vary in the degree of its influence. In Yakutia, due to the continental climate, it is more pronounced: short hot summers (that allow some vegetables to grow in the open ground) and long very cold winters. In Karelia, the seasonal conditions are much softer (especially in the South) due to its location within the path of several cyclones and a great deal of influence is also exerted by many water bodies situated in Karelia. Dairy farming that exists both in Karelia and Yakutia is quite adapted to local conditions; special breeds were developed with regard to the climate conditions.

Geographical location plays very special role, and weaknesses caused by remoteness and isolation to some extent become advantages: decline of agriculture and abandonment of agricultural land in Karelia are the result of proximity to the Center of European Russia. In Yakutia, where some uluses are hardly accessible by land, maintaining domestic agriculture guarantees food security, at least partially. Karelia has become a popular destination for tourists and an attractive place for the "dachas," or summer houses of the Saint Petersburg dwellers. This phenomenon creates a very special feature of land use, nearly a phantom in terms of the official registers and statistics. Some villages in the South of Karelia count only 2–3 inhabited houses in winter, but in summer their seasonal population can be over several hundreds. In Yakutia, dachas also exist, but mostly they are not as far spread.

Another geographical location feature is the border with Finland for Karelia and a relative proximity of China for Yakutia. In the last region, land use is much influenced by the pressure of the relatively close giant. In the case of Karelia, Finland does not have much of an impact on the land use; the main consequence to be mentioned is a wide land strip along state border with a special regime, not allowing visitors admission without passes.

An important observation we made is the changing geographical pattern of land use. In both Karelia and Yakutia, population is more and more concentrated in the regional capitals. About 44% of total residents of Karelia live in Petrozavodsk and nearly 1/3 of population of Yakutia – in Yakutsk, which grew nearly twice in number of inhabitants since 1980s [42]. This implies a much heavier pressure on land use around these urban cores and simultaneously shrinking of all kinds of agricultural use on the periphery. This effect is enhanced by the obvious lack of road infrastructure.

As a general conclusion, we can state that the assessment of impact of different driving forces on agricultural development and land use in Karelia, Yakutia, and other northern regions of Russia and evaluation of their agricultural potential could be an important and challenging subject for further study. As the most reliable source for this kind of research is concerned, we consider it to be remote sensing, along with collection of data during field surveys with different groups of agricultural producers – employees of large and medium enterprises, small farmers, indigenous reindeer and horse breeders, and owners of dachas and subsidiary plots. Only this way,

land use and agriculture in the remote northern margins of Russia could be understood and mapped properly.

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