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Analysis of Foreign Experience in the Financial Regulation of the Arctic Territories Development and Its Application in the Northern Regions of the Russian Federation*

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Abstract. The article examines foreign experience in implementing regional financial policy in relation to the Arctic territories. It assesses the experience of such sub-arctic countries as Canada, Finland, Denmark, Norway, Sweden, and the USA. The paper identifies two groups of financial instruments of territorial development: within the framework of general regional policy (instruments of fiscal capacity equalization, taxation instruments, instruments to increase investment attractiveness) and within the framework of special policy for the development of Arctic territories (program-targeted instruments, special development funds, direct allocation of funds for current expenses and development). It is concluded that the Arctic countries apply different approaches and tools to the development of the regions located in the Arctic zone, the choice of which is determined by the type of state structure, the degree of financial independence of the regions in the sphere of financial regulation, the level of development of the northernmost subjects compared to the rest of the country. In the conditions of Russia, it is possible to use the best foreign experience in the sphere of financial regulation of development of the regions located in the Arctic zone. In particular, it is possible to use the experience of applying program-targeted development tools, the formation of special development funds, which are based on revenues from the use of natural resources of the Arctic, as well as the experience of creating favourable conditions to attract investors for the implementation of economically attractive projects.
Keywords: *financial regulation, regional policy, Arctic territories, foreign experience, Canada, Finland, Sweden, Norway, Denmark, USA.*

Introduction

Financial regulation of territorial development occupies an important place in the modern system of regional management. This is due to the heterogeneity of development conditions of territorial entities within the state economic systems, the necessity to equalize economic processes and eliminate territorial imbalances in operation of investment resources distribution mechanisms, organization of financial flows and ensuring the implementation of the overall financial potential of regions.

In general terms, financial regulation is the impact on economic and social processes by the concentration of financial resources in certain structures and levels of the socio-economic system. In financial regulation of territorial development, the impact is directed to the object of regulation, which is the regional financial system (for more details [1, Verbinenko E.A., Badylevich R.V.]).

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The construction of an effective system of regional financial regulation, the choice of optimal financial levers and instruments, and their rational use are especially important for territorial systems, which are initially characterized by lower internal potential of economic growth due to their remote geographical location from financial and economic centres, difficult conditions for economic activity and residence, lack of infrastructure and labor resources. Such territorial systems should include the regions located in the Arctic zone. These regions, as a rule, are characterized by significant resource potential, large territories, access to the northern seas, which determine their strategic importance in the system of national security and implementation of economic development priorities. At the same time, the Arctic regions are characterized by low population density, unfavourable demographic processes, higher cost of living and economic activities due to difficult climatic conditions and remoteness from the centre. Under these conditions, the choice and rational use of effective financial levers to ensure their sustainable development are of particular importance and relevance.

The study of foreign experience in regional financial regulation of the Arctic territories development is an important condition for Russia for increasing the effectiveness of its own domestic regional policy, as well as for finding additional opportunities to ensure the development and implementation of the large-scale potential of territories located in the Arctic zone of Russia, the share of which is more than 18%.

Foreign practice of using financial regulation instruments for the development of the Arctic territories

At present, almost all the Arctic countries, including Russia, Canada, the United States, Norway, Sweden, Finland, Denmark and Iceland, face the problems of financial support for the development of their northernmost territories (Fig. 1).

Fig. 1. The distribution of Arctic territories among the countries [1].

[1] URL: https://pbs.twimg.com/media/CaOx51cWIAASpIB.jpg (accessed 16 December 2020).

In some countries (Russia, Canada, Finland, Denmark, Norway), the development of the Arctic territories is a priority national goal and a separate direction of state policy, in other countries (USA, Sweden, Iceland), the development of the northernmost regions is built into the general system of regional regulation. At the same time, the tools and levers used by both the first and the second groups of countries are of considerable interest for our country.

It should be noted that the experience of regional regulation in Iceland is of less interest for potential use in Russia due to the specifics of this country. Iceland is a small island state in the north of Europe. Despite the fact that an insignificant part of Iceland (Grimsey Island) lies in the Arctic zone, which is less than 1% of its total territory, it positions itself as a sub-Arctic country, entering the Arctic Council and other bodies that determine policy in the Arctic [2, Antyushina N.M., p. 17]. However, the insignificant territory of Iceland, the homogeneous climatic conditions throughout the territory and the absence of significant differences in the economic development of northern and other districts and communities (municipalities) of Iceland do not allow a full assessment of its regional policy and the range of financial development instruments applied in relation to its own Arctic territories.

The directions and instruments of financial regulation of territorial development, applied to the northern territories, vary significantly in the Arctic countries. This is due to the different proportions of territories in the Arctic zone in countries, differences in their resource provision, as well as various levels of differentiation of socio-economic development indicators of the northern and other regions.

In general terms, the system of instruments for financial regulation of the Arctic territories development in foreign practice is shown in Fig. 2.

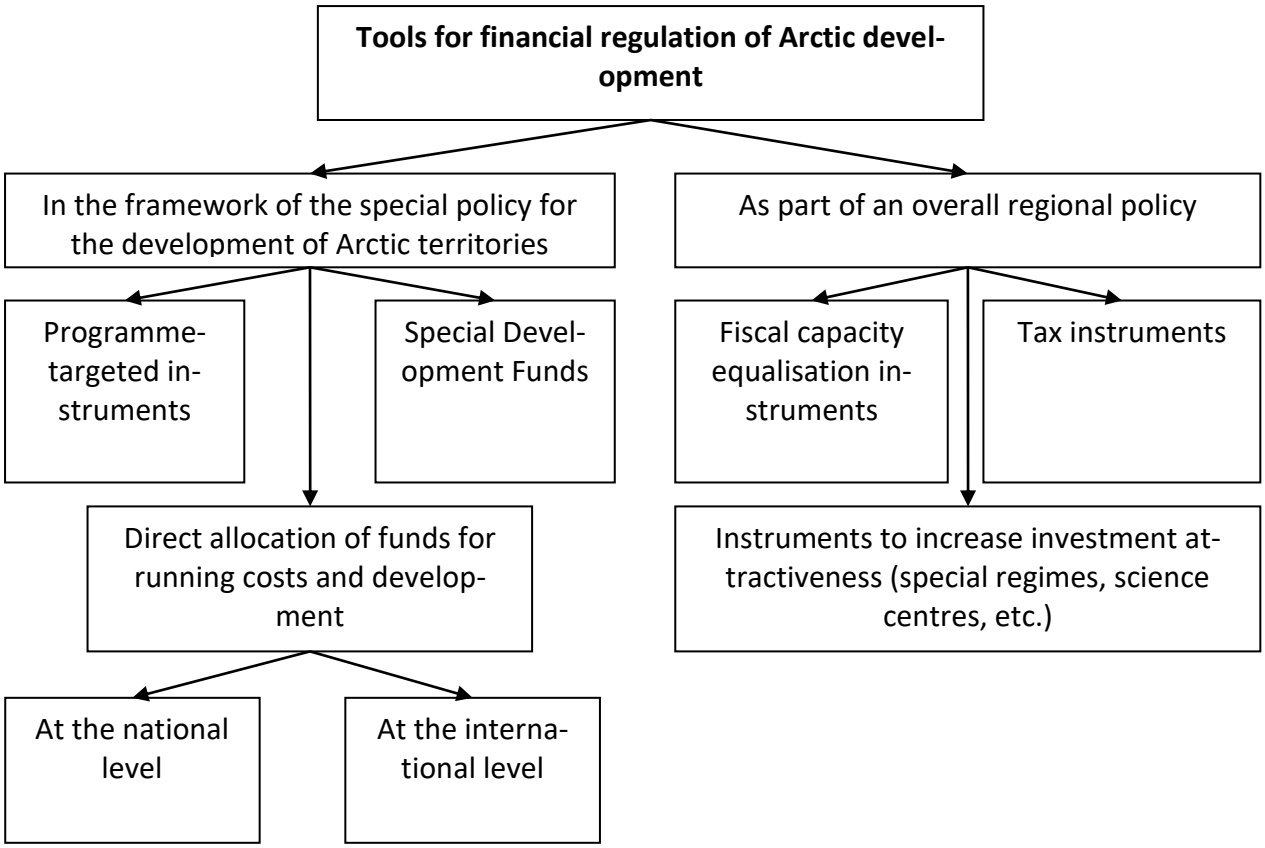

Fig. 2. Tools for financial regulation of the Arctic territories development in foreign practice.

All instruments of financial regulation of the Arctic territories development can be divided into those that are implemented within the framework of a general regional policy, and those that are implemented within the framework of a special policy for the Arctic territories development. When using the tools of the first group, the Arctic regions are considered on an equal basis with other subjects, while when the second group of instruments is applied, the Arctic territories are singled out as a separate priority object of state management. Definitely, none of the Arctic countries uses only one narrow range of financial regulation instruments. However, a priority group of financial levers can be identified for each country, which corresponds to the general policy of territorial development.

Financial regulation of Arctic development in Canada and Finland

Canada and Finland are two countries that have historically been dominated by policy-oriented instruments for the development of Arctic territories. Let us consider their experience in more detail.

Canada is the second country after Russia in terms of the area of the Arctic territories. Canada's Arctic area includes three regions: the Northwest territories, the Nunavut and Yukon territories, and the islands and water areas up to and including the North Pole. The Arctic covers about 35% of the country's total land area. However, the Arctic areas of Canada are much less densely populated than the more southerly regions, about 120 thousand people live here, which is only

0.3% of the total population of the country. Canada's northernmost territories have almost the same mineral endowment as Russia; significant reserves of natural gas, oil, coal, ferrous and non-ferrous metal ores are concentrated here, which makes these territories an important strategic object of country's regional policy. However, in the absence of completely safe technologies for extracting offshore resources, Canada is limited to the development of continental deposits, paying considerable attention to environmental issues.

Canada can be classified as one of the countries with an active regional financial policy towards the Arctic territories. In terms of the intensity of using various groups of instruments, Canada should be classified as a country where direct tools for the development of the northern territories prevail (program-targeted instruments and a system of interbudgetary transfers) (for more details [3, Verbinenko E.A., Badylevich R.V., Ostretsov V.S.]).

An active policy of support and development of the Arctic regions in Canada can be traced back to the 1950s–60s, when several state programs aimed at the northern provinces and territories were formed and implemented (in particular, the “Facing the North” and “Road to Resources” programs).

Currently, the development policy of these territories is based on a set of strategic documents that have been adopted in Canada over the past few decades. The key ones include the Framework for Northern Strategy, which became the main development strategy for the northern territories, outlined the principles, goals and objectives in this direction (after the adoption of this document in 2004, the Arctic provinces received a one-time tranche in the amount of $120 million to achieve short-term development goals) [4, Kharevsky A.A., p. 98]. Canada's Northern Strategy, adopted in 2009, outlined four key areas for the Arctic territories development: taking measures to protect state sovereignty in the north, ensuring sustainable socio-economic development of the Arctic territories, protecting the environment and enhancing interaction with local authorities in in order to develop self-government, as well as to achieve Canada's goals in the Arctic, taking into account the interests of local communities. In 2019, the Government of Canada presented a new version of the Northern Territories Development Strategy, an active role in the formation of which was played by the local authorities of the northernmost provinces of the country (Yukon, Nunavut, Northwest Territories), certain areas of the northern provinces of Manitoba, Quebec and Labrador. A distinctive feature of the strategic documents of Canada is the socio-economic orientation, emphasis on improving the quality of life, and focus on a person as a central actor in the system of the northern dimension [5, Korchak E.A., Serova N.A., p. 152].

The Government of Canada uses a wide range of financial instruments to develop its northern territories.

Significant financial resources are currently being allocated as part of federal targeted programs such as the North Employment and Tourism Development Program, Inclusive Diversification and Economic Advancement in the North Program (IDEANorth) of the Canadian Northern Econom-

ic Development Agency, which make fundamental investments in economic infrastructure, sectoral development and overall economic capacity building in the Arctic territories.

In recent years, funding through programme instruments has been actively used for major infrastructure projects in the north, shaping transport infrastructure, multi-purpose communications and energy security. For example, in 2019, more than $ 190 million was allocated to improve and expand the existing local air and maritime infrastructure, more than $ 71 million was directed through the National Trade Corridors Fund to four transport projects in the province of Nunavut (in particular, investments of $ 500 million in preparation of the largest port project and the Grace Bay road, which, if completed, would create the first road connecting Nunavut with the rest of Canada).

The Arctic territories of Finland (most often they include the provinces of Lapland and Oulu) occupy about 50% of its total area, while only 10% of the country's population lives on this territory, which makes the Finnish Arctic the least populated region of the country. At the same time, the northern regions have been economically underdeveloped throughout Finland's history. The reasons for this include harsh climatic conditions for life, which contributed to the population outflow to the southern regions of the country, significant distance from European financial and economic centers that made it difficult to establish economic ties with the leading European countries, which, after the break-up with Russia, turned into key partners of Finland. The features of the economy of the developed southern and southwestern regions were also noticeably different, where about 80% of the largest industrial companies were concentrated in the middle of the 20th century, mainly agricultural, specializing in forestry in the northern and eastern regions. In the last few decades, the processes of asymmetric development of various regions of Finland have only intensified due to the active development of new industrial sectors (development of the electronic industry) in southern Finland and, above all, in the Helsinki metropolitan area [6, A. V. Kuznetsov, p. 122–124]. Thus, the modern Finnish Arctic is characterized by such problems as the outflow of young population, gradual aging of population and reduction of labor resources in the overall age structure, remoteness from Finland's key European partners, higher costs of business due to difficult climatic conditions and less rich resource base in comparison with the Arctic territories of Russia, Canada, USA and other countries.

The Finnish Arctic economy, in contrast to other countries, is based less on extractive industries. The timber, metal ore, and energy industries account for no more than 10% of the region's output. In contrast, manufacturing accounts for more than a third of the gross product of the Finnish Arctic (with the electronics industry, centred in the city of Oulu, accounting for a significant part).

The economic policy towards the Arctic territories is a separate part of the regional policy of Finland, which started to develop actively in the 1960s. One of the first steps in the financial regulation of the northern regions development was the adoption in 1958 of the regional law “On tax incentives for industry in Northern Finland”, which established small industrial loans for rural

areas and tax incentives for enterprises in Northern Finland. It should be noted that interest subsidies, loans and tax incentives are the main financial levers that the Finnish government used to develop its Arctic territories until the mid-1970s.

The next significant step in the development of regional policy towards northern communes in Finland was the creation of the Regional Development Fund in 1971 to finance small and medium-sized companies operating in the regions [2], and the adoption in 1973 of legislative acts that provided development subsidies to companies operating in eastern and northern Finland, as well as transport subsidies to compensate the costs associated with the remoteness of the northern and eastern communes from the capital region and European markets. In general, the regional policy of Finland towards its northern territories in the late 1970s and early 1980s can be characterized as a policy based on the allocation of various types of subsidies for economic and business development. Simultaneously with support for entities operating in the less-developed communes of Finland, during this period the Government of the country took such extraordinary steps as restricting the development of the capital and the most developed regions, in particular a special building tax was introduced in 1973–1974, which was valid only in southern Finland. It was believed that the artificial limitation of industrial growth and development of the capital region would redirect financial flows to less developed regions and, above all, to the northern communes of the country [6, Kuznetsov A.V., p. 128]. At the same time, an agreement was concluded between the Government of Finland and large industrialists on priority areas for the location of industrial facilities.

In the 1980s, Finland's regional policy towards the northern territories shifted towards the use of point development tools, and the regional policy itself during this period, according to Matti Sippola's research, was called the period of regional diversification [7]. During these years, the main goals in relation to the northern communes of Finland were the alignment of regional development (primarily in terms of the level of population income), the adoption of programs focusing on solving certain problems most typical for northern communes, and the spread of industrialization processes to development areas (rural development programs, regional technology programs). Such measures led to a gradual shift in the policy of supporting growth centers in the regions towards a policy of supporting backward territories and least developed zones. The creation of the so-called support belts is of great importance in the system of financial base forming for the development of northern Finland. Finland's Arctic communes entered the first support belt, where the level of development funding was the highest.

In the late 1980s and early 1990s, there were no significant changes in Finland's northern policy; regional programs remained the basis for development. The innovations of that time included the increased involvement of regional authorities (primarily, provincial governments) in the formation of territorial development programs, as well as the adoption of the law “On the devel-

[2] Kera (Kehitysaluerahasto Oy) 1971. URL: http://www.finlex.fi/fi/laki/alkup/1988/19881298 (accessed 07 December 2020).

opment of regions" [3] in 1993, which consolidated the leading role of regional development programs in Finland's regional policy system. On the basis of these programs, state and local authorities under the leadership of a regional development body (a consortium of municipalities) drew up program agreements, which included the largest projects in various regions, as well as schedules and measures for their implementation. In the program agreements, the parties agreed on the distribution of funding for activities carried out within the framework of regional development programs. In order to implement the regional development programmes, the necessary financial resources were laid down in the state budget by establishing regional development funds, the use of which in the regions was coordinated and regulated in program agreements. The decision on the direct allocation of funds to the localities was taken by the consortia of municipalities, and the government of the country adopted annually a decision on the general criteria for the distribution of regional development funds among various administrative sectors. The maximum amount of funding for projects implemented by business entities was up to 70% of the total cost (exceptions were made for some projects in the northern regions of Finland, and the share of public funding exceeded this value). Besides, the law reaffirmed the division of the country's territory into three zones, depending on the need for development support.

Finland's regional policy underwent an important transformation in the mid-1990s when the country joined the European Union. Since then, the northern regions of the country have gained access to additional financial resources of European structural funds. Simultaneously with the expansion of financial opportunities for the development of remote northern regions, Finland faced the problem of limiting the adoption of its own decisions in the implementation of regional policy. In fact, over the past few decades, the European Union, through a series of directives, regulations and structural funds, has been guiding Finland's regional and local development policy, and the strategies and principles of the European Union determine the priorities financed by the EU structural funds. Local authorities are forced to formulate development policies in accordance with them.

The new conditions for the implementation of regional policy required organizational and regulatory changes. For example, important changes in the support system for the northern territories of the country are associated with the creation in 1999 of the Finnvera Special Fund, which was formed after the merger of the Regional Development Fund and the Guarantee Fund. It distributes a significant part of state and the European Regional Development Fund resources for the implementation of regional policy in Finland. In 2002, Finland adopted a new regional development law [4], according to which the main goal of the new regional policy was to create conditions

[3] Annettu Helsingissä 10 päivänä joulukuuta. 1993. URL: https://finlex.fi/fi/laki/alkup/1993/19931135?search%5Btype%5D=pika&search%5Bpika%5D=1135 (accessed 10 December 2020).

[4] Annettu Helsingissä 12 päivänä heinäkuuta. 2002. URL: https://finlex.fi/fi/laki/alkup/2002/20020602?search%5Btype%5D=pika&search%5Bpika%5D=602%2F2002 (accessed 11 December 2020).

for economic growth based on know-how and sustainable development, guaranteeing the competitiveness and prosperity of regions, developing economic activities and increasing employment, reducing imbalances in regional development and improving living conditions, as well as promoting balanced development of regions. The law explicitly stated that the objectives of the regional and structural policy of the European Community are taken into account in the implementation of Finland's regional policy. At the same time, the development of the northern territories of Finland is still based on the so-called provincial programs and plans (including the programs of regional structural funds of the European Union), which are formed by consortia of municipalities for a period of four years in accordance with the long-term goals of regional development that are developed and established by the Finnish government (programs are coordinated and approved by state authorities) in accordance with the priorities of the EU regional policy.

In recent years, several more noticeable trends in the system of implementing regional policy in Finland can be noted. In particular, there has been a noticeable shift in the priorities of financing regional development from direct assistance to business entities to creating conditions for the development of entrepreneurship and attracting additional investment in communes remote from the capital region. Besides, in 2007, the structure of zones that form conditions for financial support of local authorities was changed. Instead of the previously identified three zones, the division into two zones was established. In the urban development system, the emphasis is on the formation of innovation centers of growth, while in the northern and eastern regions of Finland, special emphasis is placed on supporting rural areas.

It should be noted that in the first years after Finland's accession to the EU, European structures allocated significant financial resources for the development of the country's northeastern territories, and the development of regions with the lowest population density was one of the priorities of structural funds in the Scandinavian countries. But in recent years, with the admission of new members to the EU, the financial resources allocated to Finland have significantly decreased (in the early 2000s, Finland accounted for up to 1% of total expenditures, by 2010 this figure dropped to 0.5% [6 , Kuznetsov A. V., p. 133]). In this regard, there are more and more frequent criticisms in Finnish academic community about the inability to solve problems of the northern remote areas of the country without increasing the involvement of local authorities in the decision-making process and reducing the influence of EU policy on internal regional processes. As a confirmation of this, in the north of the country imbalances in the development of some municipalities, the presence of unresolved problems of unemployment and aging of the population, and high rates of migration outflow of youth to the capital region are indicated [8, Lehtonen O., Muilu T.].

At the same time, it should be noted that, despite the problems in the area of the northern territories lagging in terms of industrial development from the capital regions, Finland manages to maintain a sufficiently high standard of living in the Arctic communes, to conduct an effective policy in the field of increasing the tourist potential, cultural identity and preservation of natural and

recreational resources of these territories. In this regard, the regional policy in Finland is considered one of the most balanced and advanced in the European Union.

Financial regulation of development in Greenland

Direct allocation of funds for operating expenses and development as a priority financial instrument is typical for the overseas territory of Denmark — Greenland.

Greenland is the largest island in the world, a big part of which lies above the Arctic Circle, and is an autonomous territory of Denmark. The high degree of political and economic independence of Greenland is confirmed by the special status of this territory. In particular, Greenland is not a member of the EU (although Denmark has such a status), and this territory is also an independent member of the Nordic Council. At the same time, the entry of Greenland into Danish possessions allows this small country to be a full member of the Arctic Council, which creates unique opportunities for foreign economic activity [9, Allayarov R.A.U.].

Greenland is rich in natural resources (significant deposits of oil, uranium, rare earth metals have been discovered on the island's territory). Greenland's difficult climatic conditions prevented the full exploitation of its resources for many centuries, but in recent years, with the development of technologies in the field of nature management, moderate warming of the climate and, as a result, the consequent removal of ice from parts of the island, interest in the resources of Greenland has increased, and the growth interest is noted not only from Denmark and the European Union, but also from such countries as the United States and China.

Over the past decades, the Greenlandic authorities have been promoting an active policy to increase the political and economic independence of the island. The last significant progress in this direction is associated with 2008, when the island territory received the right to limited self-government. According to the law on self-government, Greenland has the right to obtain complete independence from Denmark if the population supports this decision in a referendum [5], but in practice this scenario cannot be expected, primarily because throughout history, Greenland remains a highly subsidized region. Despite the fact that the population of the island is not large (about 56 thousand people), the total annual expenditures of Denmark for supporting Greenland are estimated at about 700 million dollars [6], which is a significant financial burden for such a small country. It should be noted that funding from Denmark is a significant source of revenue for the Greenland budget; currently, the share of financial support from Denmark in the structure of the island's income is about 50%. The instrument for allocating funds to Greenland from Denmark is grant funding.

[5] Zakon o grenlandskom samoupravlenii 2009 [Greenland Home Rule Act 2009]. URL: http://naalakkersuisut.gl/~/media/Nanoq/Files/Attached%20Files/Engelske-tekster/Act%20on%20Greenland.pdf (accessed 01 December 2020).

[6] In 2017, Danish Finance Minister Christian Jensen estimated the Danish budget expenditures for supporting Greenland at 4.3 billion kroons per year. According to the material of the Information Agency "TASS". URL: https://tass.ru/mezhdunarodnaya-panorama/6783122 (accessed 03 December 2020).

Another source of financial support for Greenland is revenue from the European Union. Currently, the amount of funds received from the EU is about 30–35 million euros per year, which is significantly less than transfers from the Danish budget. These resources are allocated to the Greenlandic authorities mainly for the development and maintenance of the education system. The autonomous status of Greenland limits the flow of financial resources from the EU (the island is not a part of the EU, but is a special territory of an EU member state, and Greenland residents are EU citizens). This situation, for example, does not allow Greenland to apply for funding from the European Investment Bank, a large financial institution for regional support of the EU.

Additionally, the European Union transfers annual payments to Greenland for the use of its territorial waters for fishing. From 2016 to 2021, there is an agreement between the EU and Greenland, according to which the annual transfers for compensation for the use of fish resources amount to about $ 18 million, of which about 74% is transferred to the island's budget for the use of the territorial waters of Greenland, 16.5% is directed to the development of the island's fisheries, and the rest goes to the reserve fund [7].

Greenland actively promotes foreign investment for the development of various sectors of its economy and, above all, the sphere of environmental management. In the past decade, the Greenlandic government has lifted many of the restrictions on various mineral resource extraction for foreign investors and granted exploration licenses to such major natural resource companies as BP Plc, ConocoPhillips, Royal Dutch Shell Plc, Dong Energy A/S и Statoil ASA [8].

The most substantive interest in investing in Greenland projects is currently shown by such large global players as China and the United States. At the same time, their interests are not limited only to the economic indicators of project implementation, but include the development of global interests in the Arctic and access to territories with significant strategic potential.

In recent years alone, Chinese companies have applied for investment in such major Greenlandic projects as the modernization of the international airport in the capital Nuuk, the development of a deep-water port, the exploration and development of rare earth metals, and many others. The United States is actively opposing the Chinese expansion, which, using links with the EU and directly with the Danish government, is trying to block deals with Chinese investors under the pretext of protecting the environment and ensuring security. In turn, the United States itself provides direct financial assistance to the Government of Greenland (in 2020, financial assistance in the amount of $ 12.1 million was allocated at the opening of the US Consulate), and in 2019, President D. Trump announced his desire to acquire an island in perpetual lease for an annual payment of about $ 700 million to Denmark [10, Drevet J.-F.].

[7] Evroparlament utverdil novoe rybolovnoe soglashenie s Grenlandiey [European Parliament approves new fishing agreement with Greenland]. Information material Fishretail.ru dated 14 April 2016. URL: https://fishretail.ru/news/evroparlament-utverdil-novoe-ribolovnoe-soglashenie-s-grenlandiey-356820 (accessed 04 December 2020).

[8] Grenlandiya zainteresovana v investitsiyakh iz lyubogo regiona mira. Material agentstva «Interfaks» [Greenland is interested in investments from any region of the world. Material of the Interfax agency]. URL: https://www.interfax.ru/business/351757 (accessed 04 December 2020).

The Greenlandic government, in conditions of limited financial resources, is forced to work with all potential investors, even at the expense of its own self-sufficiency and security interests. However, Greenland's financial self-sufficiency is to be expected to increase in the coming years. This will happen due to the introduction of new extractive industries on the island. At the same time, work in this direction is carried out both by attracting large international companies to activities in Greenland, and by creating their own state institutions (in recent years, the state oil company Nunaoil and the state company Nunamineral have been created). At this stage, the leading role in the Greenland economy belongs to fisheries (this industry accounts for up to 90% of the total exports of the autonomy), but currently ongoing projects to expand the production of ruby deposits, significant investments aimed at exploration and development of iron, uranium, aluminum ores , precious metal ores, as well as potentially economically attractive projects in the field of hydrocarbon development can significantly change the sectoral proportion of the Greenland economy.

Financial regulation of Arctic development in Sweden and Norway

An example of a country where the development of the northernmost territories located in the Arctic zone is carried out within the framework of the general state regional policy is Sweden.

According to the most common perceptions, among the Swedish läns (regions), the Arctic territories should include Norrbotten, which accounts for about 22% of the total area of the country and only about 2.5% of the population (260 thousand people).

Despite the fact that in some periods of history (for example, in the 1970–1980s) there was an outflow of population to the southern provinces of the country in Norrbotten, in terms of the level of economic development and the contribution of the region to the formation of the Swedish economy, this län cannot be classified as underdeveloped. Norrbotten has significant natural resources (forest resources, iron ore reserves and deposits of non-ferrous metal ores (copper, lead, zinc, silver)), the region is home to large enterprises of the steel industry. Län has played a key role in the industrialization of Sweden since the end of the 19th century until the second half of the 20th century.

Currently, Norrbotten's economy is based on mining iron ore production, forestry, as well as the small and medium-sized business sector, which is actively supported by the state. The level of economic potential of this territory is characterized, in particular, by the fact that more than 2.000 Norrbotten companies are participants in export-import operations. In terms of labor productivity, Norrbotten is consistently included (along with, for example, the province of Stockholm) in the top three among the territories of Sweden. In addition, the region is characterized by a high level of gross regional product and real investment per capita (according to the first indica-

tor, Norrbotten is in third place among regions (in 2019, $ 54.6 thousand per capita), behind Stockholm and Västra Götaland [9]).

There is no financial regulation of northern development in Sweden as part of the national regional policy. The development of the län Norrbotten is carried out within the framework of the application of common financial mechanisms and instruments for regional equalization. Currently, two instruments are of primary importance in the system of financial regulation: the tax system and the system of interbudgetary transfers.

Läns and municipalities in Sweden have rather wide authority to set individual taxes and regulate the income tax rate. It is the income tax that forms the basis of the revenue part of the budgets of the läns and municipalities (it accounts for more than 70% of tax revenues to the budgets of communes (municipalities) and more than 80% of tax revenues to the budgets of lästings (political organization of the läns management)). In Norrbotten, the income tax rate is close to the Swedish average of 32.74%.

Despite a relatively high degree of economic development, Norrbotten is a subsidised region for Sweden. The total amount of funds allocated to Norrbotten under the regional equalisation system in 2019 amounted to about $ 134 million (or $ 535 per capita [10]). In terms of the volume of budget transfers to the Norrbotten budget per capita, län is in twelfth place among all regions of Sweden. The system of interbudgetary equalisation in Sweden (introduced in 2005) is quite complex and includes several types of subsidies: income equalisation, expenditure equalisation, structural grant, transit grant and regulatory grant [11, Krivorotko Y.V.]. Currently, the main place in the system of intergovernmental transfers is occupied by subsidies for income equalisation (60–65% of the total volume of transfers to the Norrbotten budget), subsidies for costs equalisation (25–30%) and structural grants (10–15%).

Along with subsidies to Norrbotten, financial transfers are allocated to the municipal level (communes of the län). The total amount of funding allocated from the state budget to communes in 2019 was 1.7 times higher than the amount allocated directly to Norrbotten, and amounted to about $ 230 million. At the same time, in terms of budget transfers per capita, the communes of Norrbotten differ significantly (more than six times). The structure of interbudgetary transfers to municipalities by type of subsidies roughly coincides with the structure of financing allocated to the läns.

The system of regional equalisation allows Sweden to level out territorial differences in financial security and form a high standard of living and the basis for economic growth for all regions, including the northernmost county of Norrbotten.

The country where the regulation of the development of northern entities is carried out within the framework of the implementation of an integrated approach is Norway.

[9] Statistics Sweden. URL: http://www.statistikdatabasen.scb.se/pxweb/en/ssd/START__OE__OE0115/KomEkUtj/?rxid=e8d4bc01-3aec-4125-8b31-8e6035232aff (accessed 08 December 2020).

[10] Statistics Sweden. URL: http://www.statistikdatabasen.scb.se/pxweb/en/ssd/START__OE__OE0115/KomEkUtj/?rxid=e8d4bc01-3aec-4125-8b31-8e6035232aff (accessed 08 December 2020).

Norway is one of the northernmost countries in the world, with almost half of its territory (Nordland, Tromsø and Finnmark counties, Spitsbergen archipelago and Jan Mayen Island) located in the Arctic zone. This geographical location makes the Arctic a priority in Norwegian foreign and domestic policy.

The modern understanding of the Arctic territories importance for the realization of national interests has developed in Norway not so long ago. The starting point of the current Norwegian northern policy is the 2006 national strategy the "Norwegian Government's High North Strategy" [11], which identified the opportunities inherent in the northern regions as one of the Norwegian government's most important policies. Subsequently, the strategy was repeatedly updated and supplemented. In 2009, for example, an updated version of the strategy "New Building Blocks in the North" was adopted. While maintaining the main tasks and goals in the Arctic, it shifted the focus to the development of the activities of economic entities in the northern territories, taking into account the environment preservation and economic priorities. In 2017, a new strategic document, "Norway's Arctic Strategy — Between Geopolitics and Social Development" [12], was issued, in which the Government sets a large-scale task of transforming its Arctic territories into an innovative and sustainable region.

It should be noted that for a long time the northern territories of Norway were significantly inferior to its southern regions in terms of the level of development and quality of life, but at the beginning of the 21st century, the government has made significant efforts to eliminate the territorial imbalance. In order to improve the attractiveness of the northern territories, increase their industrial potential and investment attractiveness, an integrated approach was applied, which included a fairly wide range of tools: the introduction of a system of tax incentives for economic entities of the northern provinces, the allocation of significant budgetary resources for the implementation of large infrastructure projects and support of socially significant spheres (education, health care), the development of the scientific and innovative potential of the northern territories, including through the creation of a network of technoparks, as well as the implementation of several large interstate projects in the scientific field (in particular, in cooperation with large scientific institutions of Russia).

The state plays a key role in the development of the northern territories in Norway. Modern production base has been created in the north of the country due to state support and the allocation of significant financial resources. In recent years, with the support of the state, several large enterprises have been opened in the northern provinces, thousands of jobs have been created, and a program to support small and medium-sized businesses is being implemented. Many infrastructure projects have been realized within the framework of public-private partnerships, for

[11] The Norwegian government's high north strategy. 2007. URL: https://www.regjeringen.no/en/dokumenter/strategy-for-the-high-north/id448697/ (accessed 27 November 2020).

[12] Norway's Arctic Strategy – between geopolitics and social development. 2017. URL: https://www.regjeringen.no/contentassets/fad46f0404e14b2a9b551ca7359c1000/arctic-strategy.pdf (accessed 28 November 2020).

example, within the framework of partnership with Equinor in the field development and pipeline transport management system [12, Gutenev M.Yu., Konyshev V.N., Sergunin A.A.]. At the same time, such potentially attractive industries as Arctic tourism and maritime transport are actively developing in the north of Norway with the state participation. Direct budgetary expenditures in the Arctic increased from 140 million to 3.4 billion NOK in 2005-2017, not counting the share of northern Norway in national programs [13, Krivorotov A.K.].

One of the factors in the economic development of the northern territories in recent years has been the delegation of the right to make some decisions from the state level to the regional one, including in the financial sphere (through the transfer of tax powers). This has significantly increased the financial autonomy of the northern provinces.

Close attention of the Norwegian government to the development of the Arctic territories is associated not only with the desire to balance the economic development of individual regions, but also with the understanding of the role of the northern provinces in the system of further implementation of projects in the field of oil and gas resources production on the shelf of the Arctic seas, which currently form the basis of the production industry, occupying about 23% of the GDP structure [14, Kravchuk A.A.]. Access to the large-scale resource wealth of the Arctic, as well as a rational policy of environmental management allowed Norway to become one of the leaders in key economic indicators in the world (GDP per capita in Norway in 2018 amounted to 66.1 thousand dollars per person, which put the country in the top ten in the world on this indicator. In addition, Norway ranks first in the Human Development Index: in 2017, the indicator was 0.953 [13]).

At the same time, Norway does not seek to spend all of the revenues generated by Arctic oil sales on current consumption. In 1990, the State Oil Fund was created, which is formed from oil super profits, and its funds are invested outside Norway in the most promising stocks, bonds and real estate [15, Goergen M., O'Sullivan N.]. At the moment, the volume of the fund is about $ 1 trillion, and it is one of the largest in the world. The fund is managed by the Central Bank of Norway, and the funds received in the form of profit from the investment of the fund's resources are currently used, including for the implementation of large projects for the development of the country's Arctic territories.

In general, the regional financial policy of Norway in relation to its Arctic territories is considered one of the most progressive in the world, which is confirmed by the high rates of economic development of the northern provinces in recent years and the high standard of living of their population.

Financial regulation of Arctic development in the USA

[13] Byulleten' o tekushchikh tendentsiyakh mirovoy ekonomiki. Vypusk 51. Norvegiya: resursnaya model' ekonomicheskogo rosta razvitoy strany. Dekabr' 2019 [Bulletin on current trends in the world economy. Issue 51. Norway: a resource model of economic growth in a developed country. December 2019]. URL: https://ac.gov.ru/files/publication/a/26496.pdf (accessed 30 November 2020).

The financial powers vested in individual US states are wide enough and allow regional authorities to pursue independent financial policies.

One of the main areas of financial regulation and attracting additional investment resources in Alaska is the system of tax incentives and preferences for mining companies operating in this US state. Currently, up to 90% of the state's budget revenues come from oil revenues. In this regard, attracting financial resources to the oil industry is one of the priorities for the state authorities. In the mid-1990s, Alaska developed a system of incentives and subsidies for extractive companies to stimulate oil production, the attractiveness of which was noticeably reduced against the background of an increase in the volume of proven reserves and the profitability of their development in other US states. Over the next 20 years, the system of preferences for companies was gradually expanded and supplemented, and by 2015 tax incentives allowed oil producers to return up to 85% of investments in exploration and development of fields in Alaska (the annual volume of preferences in the mid-2010s reached $ 1 billion). The favourable situation on the commodity markets, high oil prices and growth in Alaska's carbon production helped to maintain this support system. In 2012, for instance, oil and gas revenues made up $9.9 billion (93.3%) of the state's $10.6 billion general fund [14].

But since 2015, the situation has changed markedly, the fall in oil prices led to the fact that the state's revenues fell by almost half, and the budget deficit in Alaska approached $ 3 billion. By 2019, adjusted for inflation, oil and gas revenues fell from $ 9.9 billion to $ 2.05 billion. This led to the need to revise the existing system of preferences and develop a plan to abolish a number of benefits and reduce subsidies.

Alaska's high degree of state financial self-sufficiency has led to the creation of a specialized development fund “Alaska Permanent Fund”, which is used to make periodic payments to residents of Alaska only on the basis of actual residence in the state.

The Alaska Permanent Fund was established in the mid-1970s and is formed by deductions from rent payments for the exploitation of mineral resources, royalties, net profit of oil companies and federal payments for the extraction of mineral resources received by the state from all subsoil areas. The fund was created to effectively manage income from the use of Alaska's raw materials (primarily oil) and support the population by annually transferring a fixed amount to each resident (while transfers are due to each resident regardless of gender, age, job availability, etc.) [16, Butler V.M.]. The amount of the annual payment depends on the current oil prices, the volume of oil production by companies in Alaska, and the number of permanent residents in the state. In recent years, after the fall in oil prices, the amount of payments has noticeably decreased and, if back in 2015 it was slightly less than $ 2100 per person, in 2018–2019 payments were about $ 1600 (according to the State Department of Revenue, payments in 2020 will be $ 992 per resident, the

[14] Alaska Department of Revenue, “Revenue Sources Book, Fall 2018: 60 Years of Revenue, 1959–2018”. Dec. 14. 2018. URL: http://tax.alaska.gov/programs/documentviewer/viewer.aspx?1491r (accessed 30 November 2020).

lowest level of payments since 2013 [15]). Despite the fact that, in comparison with the average weekly income level in Alaska (about $ 1100), the amount of payments is small, they provide quite significant support, primarily to the socially least protected categories of the population (pensioners, housewives, single mothers, etc.).

It should be noted that the mechanism of periodic payments to the population of Alaska in recent years has been the subject of heated political and public discussions [17, Onifade T.T.]. The reason for this was a significant decrease in the budgetary capacity of the Alaska authorities after the fall in oil prices in 2014–2015, which led to a decrease in budget revenues from oil and gas production by about 50%. With the budget of Alaska remaining in deficit in recent years, and the authorities are constantly looking for additional opportunities to reduce spending liabilities, the decision to direct more than $ 1 billion to direct payments to the population is increasingly criticized, and the amount of payments is turning into a subject of active political bargaining.

It should also be noted that direct financial payments from the Permanent Fund of Alaska are not the only preferences for residents of the northernmost state of the United States. The available measures to support the population of Alaska can also include the right to receive free land allotments.

Overall, despite the high dependence of the Alaska budget on commodity prices, the policy aimed at the development of the state in the past few decades has made this region attractive to investors and ensure a sufficiently high standard of living for the local population.

Possibilities of using foreign experience in the financial regulation of Arctic development in the Russian Federation

Previously, the author analyzed the state financial support for the development of the Arctic zone of the Russian Federation [18, Badylevich R.V.]. It was concluded that at present the state uses mainly fiscal methods for these purposes, primarily the system of interbudgetary transfers and program-targeted instruments. The Arctic regions are characterized by high indicators of non-repayable transfers and subsidies for budget equalisation in relation to the national average, but these resources are directed mainly to financing current expenditures and do not form a sufficient basis for the development of the regions of the Russian Arctic. Over the past twelve years, a large number of target-oriented documents have been adopted aimed at the socio-economic development of the Russian Arctic. However, they are characterized by such problems as the declarative nature of many of the stated goals, the lack of consistency and non-fulfillment of the planned indicators of financial support for the implementation of certain areas.

The analysis of foreign experience in the implementation of financial regulation of Arctic development makes it possible to assess the possibilities of using various financial instruments in Russian practice (Table 1).

[15] Alaska Residents to Get $992 from Permanent Fund Dividend. URL: https://www.usnews.com/news/best-states/alaska/articles/2020-08-18/tribal-health-executive-named-to-alaska-permanent-fund-board (accessed 07 December 2020).

Table 1

Possibilities of using various financial instruments in Russian practice (based on the analysis of foreign experience)

No.	Instruments of financial regulation for the development of Arctic territories	Experience of priority use in the circumpolar countries	Practice and limitations of use for development of the regions of the Arctic zone of the Russian Federation	Opportunities for use for the development of regions in the Arctic zone of the Russian Federation
1.	As part of a general regional policy			
1.1	Fiscal equalisation instruments	Finland, Sweden	Fully implemented, but with limited funds, mainly used to cover current expenditures of regional authorities	The prospects for increasing the amount of transfers allocated to the regions are low in the coming years
1.2	Tax instruments	USA, Sweden, Norway	Use is constrained by the strict scope of Russia's unified tax policy and low taxing powers of regional authorities	Opportunities are limited
1.3	Tools to improve investment attractiveness (special regimes, science centres, etc.)	Norway, Sweden, USA, Finland	Limited scope of application, low efficiency	Broad applicability with improved regulation and governance, including through foreign experience
2.	In the framework of the special policy for the development of the Arctic territories			
2.1	Programmatic-targeted instruments	Canada, Finland	Actively used over the last decade as a regional development tool in Russia	Currently not very effective, there is scope for improving effectiveness of this tool in Russia
2.2	Special Development Funds	USA, Norway	Not used until 2020 for the Arctic zone of the Russian Federation	Current prospects for use are related to the extension of the mandate of the Far East Development Fund to the Arctic regions
2.3	Direct allocation of funds for running costs and development (at national level)	Denmark, Canada	Used as a tool to finance recurrent expenditure if additional needs arise	Capacity is limited
2.4	Direct allocation of funds for running costs and development (internationally)	Denmark, Finland	Not used in RF	No capacity available

In the coming years, we should expect a change in priorities in the system of financial regulation of the development of the Arctic zone of the Russian Federation, the emphasis will shift from direct budgetary financing of large projects in the Arctic to increasing the attractiveness of these territories for potential investors and attracting large financial institutions to the development of the Arctic, which have proven themselves in the Far East (in particular, the Far East Development Fund). In this context, Russia will benefit from the experience of using tools to increase the investment attractiveness of the northern territories, which have shown their effectiveness in the Scandinavian countries and in Alaska, the experience of forming special development funds (Norway, USA), as well as the experience of implementing the mechanisms of the program-targeted approach used in Canada and Finland, which can significantly increase the effectiveness of government programs for the development of the Russian Arctic. At the same time, the possibility of adapting these tools to Russian conditions requires further scientific and practical research.

Conclusion

The study of foreign experience in the implementation of financial regulation of Arctic development and the possibilities of its application in the northern regions of the Russian Federation made it possible to formulate the following conclusions:

- The subarctic countries differ significantly in the area of their Arctic territories, their provision with natural resources, the density of the population living in the northernmost regions, as well as in the level of socio-economic development of the northernmost regions and the main territory.
- The territorial structure of the state, the principles of organization of government bodies and budgetary systems determine a different degree of financial independence of the Arctic regions and the choice of financial instruments for their development. In some countries (USA, Canada, Denmark) the Arctic regions are characterized by a high degree of financial independence and a wide range of opportunities in making financial decisions, in others (Finland, Sweden, Norway) such opportunities are lower.
- According to the presence of a pronounced internal Arctic policy, we can distinguish countries (Canada, Finland, Denmark, Norway), where the development of the Arctic territories is a priority goal at the national level and a separate direction of state policy, and states (USA, Sweden, Iceland), where the development of the most northern regions is built into the general system of regional regulation.
- Despite the fact that for the development of the Arctic territories, both as a separate state policy and as part of the unified regional regulation in the subarctic countries, a whole range of mechanisms is used, priority financial instruments can be distinguished: program-targeted approach (Finland, Canada) , the system of interbudgetary equalisation (Sweden), grant financing (Denmark), tax instruments and development funds formed from income from the use of Arctic resources (USA, Norway).
- In Russia, where the emphasis is shifting from direct financing of the Arctic to attracting potential investors to these territories and using financial institutions with state participation for their development, we are primarily interested in the experience of application of instruments to improve the investment attractiveness of northern territories, which have proved effective in the Nordic countries and Alaska, the experience of establishing special development funds (Norway, USA), and the experience of implementing mechanisms of target-oriented approach used in Canada and Finland, which can significantly increase the effectiveness of state programs for the development of the Russian Arctic.

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Best Practices of Oil and Gas Companies to Develop Gas Fields on the Arctic Shelf *

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Abstract. The development of the hydrocarbon potential of the Arctic shelf is one of the priority tasks for Russia, forming the conditions for its strategic presence in the region. Russia's official energy documents stipulate the need to increase oil and gas production in the Arctic, including offshore production, to ensure the stable operation of the country's oil and gas complex in the long term. However, the development of hydrocarbon fields on the Arctic shelf is a serious technological challenge for the domestic oil and gas industry. While offshore oil production in the Russian Arctic is already underway, natural gas production remains a promising future target. The article analyses the current gas projects on the Arctic shelf in terms of their technological complexity and unique solutions, and the strategies of operators to attract foreign participants to the project. We consider these in the contexts of technological issues, organizational features, securing foreign investment. The author believes that the provisions and conclusions of this study will help add to the comprehensive picture of the foreign oil and gas companies experience engaged in natural gas production on the Arctic shelf, which will minimise the errors and risks in the development of hydrocarbon resources on the Russian Arctic seas shelf.
Keywords: *Arctic shelf, foreign oil company, offshore hydrocarbon production, joint venture, risk.*

Introduction

The development of offshore oil and gas fields in the Arctic identified as an important long-term objective in official documents of the Russian Federation at the federal, regional and sectoral levels. Thus, the Energy Strategy of the Russian Federation for the period up to 2035, approved in June 2020, notes that "the development of the hydrocarbon resource potential of the continental shelf of the Arctic seas and northern territories is the most important geopolitical and technological challenge for the oil and gas complex of the Russian Federation, and an appropriate answer to it is to ensure sufficient production of hydrocarbon raw materials in the country beyond the 2035 time frame, compensating the inevitable decline in their production from traditional deposits" [1].

One way or another, the development of the Arctic shelf and the development of hydrocarbon projects, apart from the economic interest of the country, is a necessary component of its strategic presence in the region. At the same time, many experts today believe that natural gas as a cleaner fuel has great prospects in the long term. Analysis of energy documents of the country shows that among the main trends, for example, in the Strategy for Development of Mineral Resource Base of the Russian Federation up to 2035, it is emphasized that the global fuel and energy balance will gradually change, the share of oil use will gradually decrease, and the share of gas will

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[1] Minenergo [Ministry of Energy]. URL: https://minenergo.gov.ru/node/1026 (accessed 22 January 2021).

increase [2]. The Energy Strategy of the Russian Federation also predicts that "in terms of growth in demand in considered perspective gas will be the leader — a fossil fuel with the lowest greenhouse gas emissions".

The purpose of this article was to study a set of best practices (technological, organizational, financial) for the development of gas fields in the Arctic shelf. The article analyses what technological challenges foreign companies face when developing gas and gas condensate fields on the Arctic shelf, what forms of participation of foreign partners companies are considering when implementing projects, and what factors are taken into account in the long term.

It is important to understand that the issues listed above reflect only a part of the problems faced by oil and gas companies operating on the Arctic shelf, but they should be taken into account at the first stages of planning activities and launching projects on the Arctic shelf.

Is there any activity on the Arctic shelf?

Two gas projects are being fully implemented on the Arctic shelf today — the Norwegian Ormen Lange and Snøhvit, and one oil project — the Russian Prirazlomnoye project. The Goliat oil project in the Norwegian sector of the Barents Sea, launched in March 2016, is operating with interruptions and a number of restrictions: since the start of the Goliat FPSO operation, oil production at the field has been interrupted several times [3]. In the year the project was launched, production at Goliat was planned at 110.000 barrels of oil per day. However, according to the Norwegian Petroleum Directorate (NPD), production in 2018 was only 64.000 barrels of oil per day, and in the last two years it has completely decreased by half — 38.000 barrels of oil per day in 2019 and 2020, respectively. Such low production rates are explained by the fact that during 2017–2019 work on the platform was underway to eliminate defects that were discovered by the Norwegian Oil and Gas Production Safety Authority (Petroleumstilsynet) inspections. More than 30 defects were found on the platform, the most serious of which were damages of the hose used to transfer oil from the platform to tankers and release of chemicals into the Barents Sea. However, the operator of the Goliat project, VårEnergi, plans to increase production to 350.000 barrels of oil per day by 2023 [4], and is also considering the possibility of exporting gas contained in the field.

The implementation of these projects is technologically very difficult: Arctic conditions require unique knowledge and special technologies in construction of production units, in creation of transportation systems of hydrocarbons from shelf to shore. Along with technological problems, there is a range of issues related to the involvement of partners in the project and the distribution

[2] Strategiya razvitiya mineral'no-syr'evoy bazy Rossiyskoy Federatsii do 2035 goda [Development strategy for the mineral resource base of the Russian Federation up to 2035]. URL:http://www.mnr.gov.ru/docs/strategiya_razvitiya_mineralno_syrevoy_bazy_rossiyskoy_federatsii_do_2035_goda/strategiya_razvitiya_mineralno_syrevoy_bazy_rossiyskoy_federatsii_do_2035_goda/ (accessed 22 January 2021).

[3] Goliat-plattformen ble stengt ned fem ganger i fjor på grunn av feil og mangler. URL: https://www.dn.no/olje/olje-og-gass/goliat/eni/nytt-tilsyn-med-kriseplattform/2-1-25288 (accessed 11 May 2020).

[4] The company aims to reach 350,000 bopd by 2023 thanks to several new projects coming onstream. URL: https://www.reuters.com/article/us-eni-norway-oil-idUSKBN1ZF15Q (accessed 10 March 2021).

of risks between the participants. Each project that is currently being implemented in the Arctic requires a long preparatory period before the start of production at the field. For example, the construction of the Prirazlomnaya offshore ice-resistant stationary platform started back in the 1990s, but was delayed for more than 20 years. This was due to numerous changes in the design and constant replacement of parts of the installation, which did not pass the regular construction checks. The Norwegian projects Snøhvit and Goliat faced similar problems. It can be said that offshore projects in the Arctic always have much longer implementation periods: to search for and create new technologies specifically for each project, to refine these technologies after field operation, to develop allied industries in parallel and to prepare the infrastructure on the shelf and onshore [1, Brutschin E.]. There are frequent cases of business interruption and delayed project launch dates in the Arctic fields.

In this study, the analysis was based on the idea of expanding the number of comparable gas projects being implemented today on the Arctic shelf. The analysis included Shell's Ormen Lange, Snøhvit and Aasta Hansteen, operated by the Norwegian oil and gas company Equinor. The listed gas projects were considered in terms of the following features:

- natural (climatic conditions, depth of hydrocarbons occurrence, remoteness from the coast);
- technological (field development, presence of underwater complexes, type of natural gas transportation);
- organisational (project implementation, partnership with other companies, expansion of activities taking into account the built infrastructure, sharing of risks between participants).

The stages of the offshore gas projects implementation and the strategies of operators to attract partner companies were also analyzed.

Natural gas production on the Arctic shelf

Gas production projects on the Arctic shelf were launched just over 10 years ago, despite the fact that some fields and their reserves were known for a long time. The development of gas fields on the shelf requires the creation of a complex set of subsea and onshore installations, a multi-stage gas transportation system (laying an underwater pipeline, building a liquefied natural gas plant) and therefore, as a rule, is extremely capital-intensive and multi-stage.

Table 1 provides information on existing gas projects on the Arctic shelf. The analysis of these projects focused on such key characteristics as volume of recoverable reserves, production intensity, technological features, project launch date, and selection of participating companies. The strategies of the operators of the Ormen Lange, Snøhvit, Aasta Hansteen gas projects and the conditions for attracting foreign partners to these projects were analyzed.

Table 1

Existing gas projects on the Arctic shelf [5]

Project	Geographical coordinates	Reserves; daily production	Year of field discovery; Production start year		Technological uniqueness	Participating companies
Ormen Lange	(63° N; 5° E), Norwegian Sea, depth up to 1200 m, 140 km from the coast	400 billion m³ of gas, 29 million m³ of condensate **70 million m³ gas / day**	1997	2007 (10 years)	Difficulty in developing because of the depth. Unique solutions for laying underwater gas pipelines	Shell (operator, 17.8%), Petoro AS (36.5%), Equinor Energy AS (25.3%), INEOS (14%), Vår Energi (6.3%)
Snøhvit	(71° N;21° E), Barents Sea, depth 340 m, 160 km from the coast	193 billion m³ of gas, 113 million barrels of condensation **17 million m³ gas / day**	1984	2007 (24 years)	First project in the Barents Sea. Northernmost LNG plant	Equinor (operator, 36.8%), Petoro AS (30%), Total (18.4%), Neptune Energy Norge AS (12%), Wintershall Dea Norge AS (2.81%)
Aasta Hansteen	(67°4'N;7°E), Norwegian Sea, depth 1300 m, 300 km from the coast	55.6 billion m³ of gas; 353 million barrels of condensate **23 million m³ gas / day**	1997	2019 (22 years)	The deepest oil and gas project on the Norwegian shelf	Equinor (operator, 51%), Wintershall Dea (24%), OMV (15%), ConocoPhillips Scandinavia (10%)

Ormen Lange project
(practice of changing the operator at different stages of the project)

The first gas project on the Arctic shelf was the Ormen Lange project. The Ormen Lange field, discovered in 1997, has reserves of 400 billion m^3 of natural gas and 29 million m^3 of condensate, the second largest deposit after the Troll field in Norway. The Ormen Lange deposit is located in the Norwegian Sea, 140 km west of Kristiansan (Fig. 1). The development plan was approved by the Norwegian authorities in 2004, and the King of Norway personally launched a gas terminal on the Nyhamna gas terminal in October 2007 [6]. Gas production at the field began in 2007 and is planned to continue for over 40 years. Today, the technological complex of the Ormen Lange project consists of rigs that drill the world's longest gas wells, as well as subsea modules, the Nyhamna plant and the Langeled pipeline, which runs from the field to the British gas terminal in Easington [7].

[5] Source: compiled by the author based on data from oil and gas companies.
[6] The King opened Ormen Lange. 12.10.2007. URL: https://www.royalcourt.no/nyhet.html?tid=34480&sek=26939 (accessed 24 April 2020).
[7] URL: https://www.shell.no/about-us/projects-and-sites/ormen-lange.html (accessed 25 April 2020).

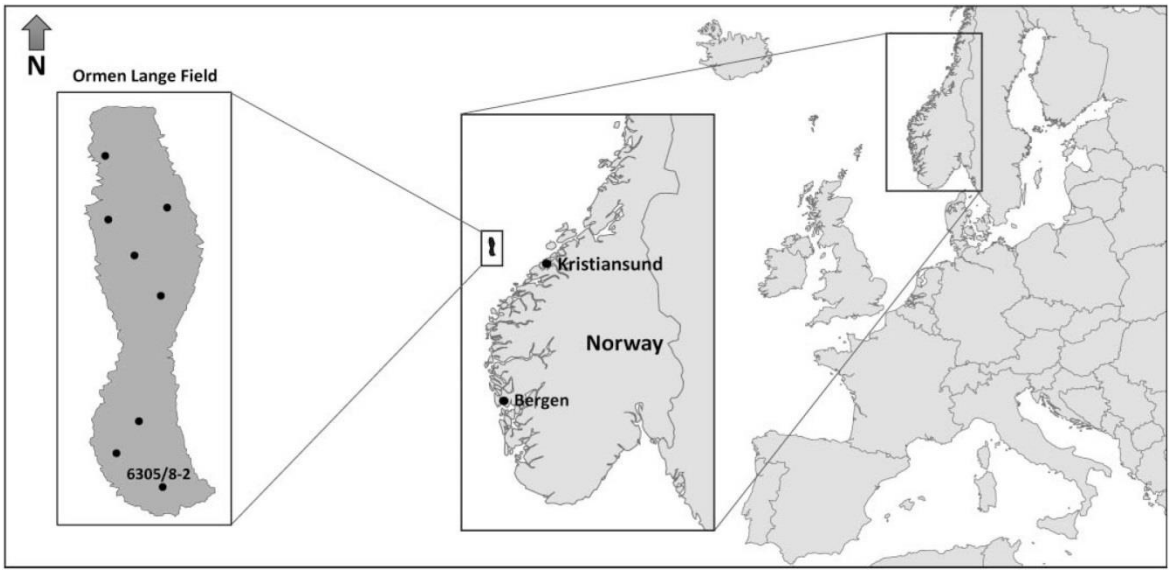

Fig. 1. Location of the Ormen Lange gas field.

It should be noted that the Ormen Lange project became a real technological challenge for the gas industry at the time, primarily due to the depths of the reserves and the complexities of building a gas transportation system:

- firstly, the sea depth in the area of the field is about 1200 m; therefore, the arrangement of the seabed was complicated by a number of natural features. The main and, at first glance, insurmountable difficulty was the laying of the gas pipeline: in addition to the great depth, the bottom of the Norwegian Sea has an extremely uneven surface (due to the Støregga underwater landslide [8] that descended on the continental shelf about 8200 years ago). In order to lay pipelines on uneven seabed, special support blocks up to 60 m high were built so that the gas pipeline crosses the rocks with an inclination of up to 40 degrees [2, AMAP];
- secondly, hydrates, which are formed due to low temperatures and reduce the efficiency of the gas flow in the pipe, making it difficult to transport the gas, have become a problem. In order to solve this problem, another pipeline was laid to supply a hydrate inhibitor. Methylene glycol is injected into the gas stream and acts on hydrate deposits, after which the gas is transported to the shore;
- thirdly, the transportation process is periodically complicated by ice formation, which is why, for example, in January 2010, production at the field was temporarily suspended [9].

Of course, the creation of the entire underwater and coastal infrastructure and the solution of the above-mentioned problems required significant investments. The Nyhamna processing plant was built in a remote and undeveloped region, where all construction materials were

[8] The gigantic submarine Storegga Slide occurred about 8200 years ago, and caused large waves (tsunamis) that also reached the coasts Norsk Hydro has initiated extensive work to evaluate the present stability conditions in the vicinity of the Ormen Lange gas field and to explain the prehistoric sliding. URL: https://www.onepetro.org/conference-paper/SUT-OSIG-02-199 (accessed 03 May 2020).

[9] Production from the field was stopped temporarily due to cold weather in January 2010. URL: https://www.offshore-technology.com/projects/ormen-lange-field/ (accessed 28 April 2020).

shipped in from other locations. Total investments in the project reached $5.2 billion, making it one of the most expensive projects on the Norwegian shelf. However, it is important to note that the Ormen Lange project has become strategically important primarily in terms of maintaining one of the major markets and export levels: since 2009, natural gas exported from the Ormen Lange field to Europe has provided a stable 20% of total gas consumption in the UK [3, Hall M.].

Technological complexity of the Ormen Lange project and its capital intensity exclude the option of implementing the project by one company, therefore, five companies are involved in the field development. The project operator today is Shell (A/S Norske Shell) with a 17.3% share, and the remaining shares are distributed:

- Petoro AS (36.485%). It is a fully state-owned company, the main task of which is to represent the interests of Norway in joint oil and gas projects implemented on the continental shelf;
- Equinor Energy AS (25.3452%). A state-owned company, the activities of which are actually controlled by the Ministry of Petroleum and Energy of Norway;
- INEOS E&P Norge AS (14.0208%). A private company, the main activity of which is focused on the implementation of projects on the shelf of the Norwegian and North Seas. The company operates the Forties pipeline system that supplies gas to the UK;
- Vår Energi AS (6.3356%). It is a joint venture between the Italian oil company ENI and the Norwegian private investment company HitecVision.

It is important to note that Shell became the operator of the Ormen Lange project only after the first phase of its implementation in 2007, when gas production began at the field. Norsk Hydro [2, AMAP] was the operator of the project at the initial stages of reserves exploitation, infrastructure construction and seabed development. Interestingly, in 1995, when the Norwegian government was just opening a licensing round in the waters of the future Ormen Lange project, none of the companies had any deep-sea drilling experience on the Norwegian shelf. However, Norsk Hydro had experience in implementing projects in Angola, where the depths were 1200–1400 m. “Hydro was well prepared to become the operator of Ormen Lange”, said E. Miklebust, CEO of the company, “we can cope with large innovative projects on the Norwegian continental shelf and for some time have been doing definite preparatory work for solving the task, which was assigned to us in 1996”. [10]

It is possible that the Ormen Lange project implementation scheme and the comprehensive approach of Shell and Equinor may be of interest to Russian oil and gas companies when planning the development of gas fields on the Arctic shelf. At first, Shell considered the Ormen Lange project as a high-risk project, since most of the offshore technologies for such depths and temperatures were developed for the first time. Therefore, the Norwegian oil and gas industry in general and local companies in particular assumed all the risks, and foreign partners were attracted to the

[10] Hydro’s President and CEO at the time Egil Myklebust. URL: https://www.hydro.com/en/about-hydro/history/1991-2005/1996-ormen-lange-a-fortune-in-the-halten-bank/ (accessed 28 April 2020).

project only later. At the same time, despite the scale of the Ormen Lange project and the presence of a number of technological difficulties, it was launched according to plan, which took 10 years, and which became a record-breaking minimum time for the commissioning of gas fields on the shelf [4, Henderson J., p. 37]. Thus, the Norwegian experience has demonstrated that close cooperation of oil and gas companies can significantly accelerate the commissioning of even technologically very complex projects on the Arctic shelf. It is possible that some elements of the Ormen Lange implementation, such as the practice of changing the operator at different stages of the project, can be used in the development of large and unique gas fields on the shelf of the Russian Arctic.

Snøhvit project
(practice of technological integration with future sales markets)

The second gas project launched on the Norwegian Arctic shelf is the Snøhvit project by Equinor (formerly Statoil). Located on the shelf of the Barents Sea, 160 km north-west of Hammerfest, the Snøhvit project is half the size of Ormen Lange in terms of reserves, but this project is no less progressive in terms of technology. It is developing three fields: the Snøhvit field of the same name, which accounts for 50% of the reserves, and two neighboring ones — Albatross and Askeladd. The total reserves of all three fields are 193 billion m^3 of gas and 113 million barrels of condensate. Natural gas reserves in this area were discovered in the early 1980s, but the process of preparation for their exploitation took more than 20 years [5, K. Jakobsson, p. 226–230]. The Norwegian government approved Statoil's development plan only in 2002, and the project started in 2007.

The peculiarity of the development process is the absence of stationary and floating installations and the use of a completely underwater exploitation system, controlled remotely from the shore. The technological component of the Snøhvit project today is a system of pipelines from the field to the coast, a plant for liquefied natural gas on Melkoya Island and LNG tankers. At the first stage of the project, two fields were brought into production — Snøhvit and Albatross. Production at the third field, Askeladd, commenced seven years after the start of the project. The operator plans to launch the second phase of Snøhvit project: several additional wells are to be drilled at the Askeladd field. However, the project is temporarily suspended at the moment. At the same time, T. Rød, Equinor's Vice President for Project Management, has repeatedly emphasized the importance of this step: “This is the next important step in the development of the Snøhvit project. The Askeladd field will help to maintain stable production and LNG plant operation in Hammerfest up to 2023, and now it is a profitable investment that will help keep jobs in the region.” [11] The Snøhvit project can be considered a successful Arctic project in terms of local community engagement. The people of Hammerfest followed the project development from the very beginning and participated in its implementation. The people of this Arctic region of Norway are now strongly

[11] Askeladd will help maintain a plateau production rate at the Hammerfest LNG plant until 2023. URL: https://www.equinor.com/en/news/12mar2018-investing-askeladd.html (accessed 20 July 2020).

supporting the development of the Snøhvit project primarily due to the employment opportunities as well as the financial benefits from its implementation. For example, after completion of the LNG plant construction, the local authorities introduced property taxes, the total amount of which brought 155 million NOK per year to the regional budget [4, Henderson J., p. 48], which were aimed at the development of the region.

The controlling stake in the Snøhvit project is held by the state through the state-owned companies Equinor (36.8%) and Petoro AS (30%). The rest of the project shares are distributed among foreign partners as follows:

- Total E&P Norge AS has a share of 18.4%. The company has been present on the Norwegian continental shelf for over 50 years and also has a stake in the Troll project;
- The British company Neptune Energy owns 12% [12];
- The German company Wintershall DEA Norge AS holds a 2.8% minority stake in the Snøhvit project.

The main focus in selecting partners for Snøhvit project was not only on technological competencies, but also on strategically important regions as importers of Norwegian natural gas. As the second largest natural gas exporter to Europe [13], Equinor has been able to attract partners from France, the UK and Germany to the Snøhvit project. Thus, the three main European importers of natural gas in Norway are now represented by Total, Neptune, and Wintershall DEA companies. Spain is also the main importer, in particular, of Norwegian liquefied natural gas. In the Spanish port of Cadiz (at the Izar offshore plant in Ferrol), Equinor decided to build a floating liquefaction plant. It was planned to take advantage of the parallel engineering at several shipyards. As a result, the floating barge, which is the centerpiece of the LNG plant, was completely built in Spain and transported as a single module to the pre-built dock on Melkoya Island [14]. This approach was expected to provide a number of advantages, such as the possibility of manufacturing individual structures in favorable weather conditions and accelerating the commissioning of capacities. But as a result, construction work in Spain fell behind the main schedule of the Snøhvit project, which led to a shift in the Norwegian offshore work schedule to a less comfortable winter time. Nevertheless, the project was successfully launched despite the increase in overall costs.

The experience of the Snøhvit project implementation shows that, despite the many difficulties associated with the organization of parallel engineering on the shelf, such bilateral cooperation between Norway and Spain is a good example of technological integration on the Arctic

[12] Neptune energy Norge as. URL: https://www.norskpetroleum.no/en/facts/companies-production-licence/neptune-energy-norge-as/ (accessed 28 May 2020).

[13] We're one of the world's largest offshore operators, the largest operator on the Norwegian continental shelf and the second-largest gas exporter to Europe. URL: https://www.equinor.com/en/what-we-do/fields-and-platforms.html (accessed 28 April 2020).

[14] Podkhody i tekhnicheskie resheniya pri sozdanii kompleksa SPG na mestorozhdenii Snovit v Barentsevom mo-re. Perevodye tekhnologii stoyat nedeshevo [Approaches and technical solutions for the creation of an LNG complex at the Snovit field in the Barents Sea. Advanced technology are not cheap]. URL: https://rogtecmagazine.com/wp-content/uploads/2014/10/121.pdf (accessed 28 April 2020).

shelf. Such agreements, when part of the work is carried out at the southern shipyards of future consumers, should be taken into account by Russian companies when implementing offshore projects in the Russian Arctic. The Snøhvit project was successfully launched and became a production project on the most offshore section of the Arctic shelf with a fully underwater production complex during those years. When comparing Snøhvit with Ormen Lange in terms of recoverable reserves and daily production, it is obvious that Snøhvit is a medium-sized project (Table 1). For example, in 2019, production at Ormen Lange amounted to 12.6 billion m^3 of gas, while at Snøhvit — 6 billion m^3. In 2020, Ormen Lange produced 12 billion m^3 of gas, while Snøhvit produced less than 4 billion m^3. From the given data, it can be seen that that Snøhvit is actually half the capacity of Ormen Lange, which in turn is not considered Norway's largest gas project. But, despite the fact that Snøhvit is a small production project, at the initial stages of its implementation it was important that it would become the basis for future activities on the shelf of the Barents Sea. Equinor plans to combine the technological capacity of the Snøhvit project with the nearby Goliat oil field, which also has natural gas reserves, and the Johan Castberg field, which is scheduled to start production in 2022 (Fig. 2).

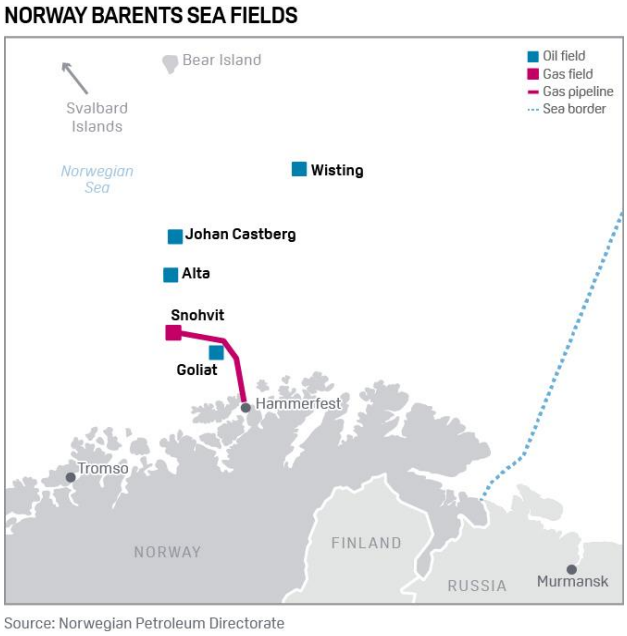

Fig. 2. Norwegian offshore oil and gas projects in the Barents Sea [15].

Aasta Hansteen project (practice of phased advancement to the north and linking the project to previously created facilities)

The Norwegian experience demonstrates a successful integrated approach to the development of the Arctic shelf with record-breaking short start-up time for gas projects. Thus, in December 2018, the next Arctic gas project, Aasta Hansteen, was launched, which is also operated by the state-owned company Equinor with a 51% share. In the project, foreign partners are:

[15] Source: Norwegian Petroleum Directorate data.

- Wintershall Norge AS with a 24% share, which regards the Aasta Hansteen project as an important part of Wintershell DEA's commitment to supply the European market with natural gas [16];
- OMV (Norge) AS (15%) is an Austrian oil company with a presence in Norway. OMV is also a partner in the Wisting field in the Barents Sea (Fig. 2) [17];
- ConocoPhillips Skandinavia AS owns 10% in the project. This American oil company has been present on the Norwegian shelf since the discovery of the Ekofisk field in 1969. The company considers its participation in the Aasta Hansteen project as an important step in expanding its competencies in the Arctic.

Equinor CEO, A. Upedal, notes: "Aasta Hansteen is a very complex project and a big challenge that requires new technological steps that we must take together with our partners Wintershall, OMV and ConocoPhillips, as well as our suppliers." [18] Indeed, Aasta Hansteen is currently the deepest offshore development project in the Arctic Circle [19]. Gas is transported through the Polarled pipeline, which runs from the field to the Nyhamna processing plant. Thus, Equinor intends to combine technologically all new northern fields of the western shelf with the Ormen Lange capacities and a system of gas pipelines to continental Europe and Great Britain (Fig. 3). The Aasta Hansteen project was launched at the end of 2018, as production at Ormen Lange was projected to reach its plateau by then. The project operator, Equinor, expects Aasta Hansteen to supply at least 6–7.5 billion m^3 of gas per year [3]. It is interesting to note that despite the long experience of the Norwegian oil and gas industry on the Arctic shelf, the design and construction of the SPAR platform for the Aasta Hansteen project was carried out at the South Korean shipyards (as for the Goliat project). Today, the Aasta Hansteen platform is the world's largest offshore SPAR platform.

[16] Aasta Hansteen. Wintershall Dea Norge. URL: https://wintershalldea.no/en/where-we-are/aasta-hansteen (accessed 20 March 2021).
[17] Wisting. OMV.no. URL: https://www.omv.no/en-no/aktiviteter/wisting-discovery (accessed 20 March 2021).
[18] "Aasta Hansteen has been a complex and challenging development project, requiring us to take new technological steps together with our partners Wintershall, OMV and ConocoPhillips as well as the suppliers," – says Opedal. URL: https://www.equinor.com/en/news/2018-12-17-aasta-hansteen.html (accessed 30 July 2020).
[19] Aasta Hansteen came on stream 16 December 2018 and Snefrid North towards the end of 2019. URL: https://www.equinor.com/en/what-we-do/norwegian-continental-shelf-platforms/aasta-hansteen.html (accessed 28 July 2020).

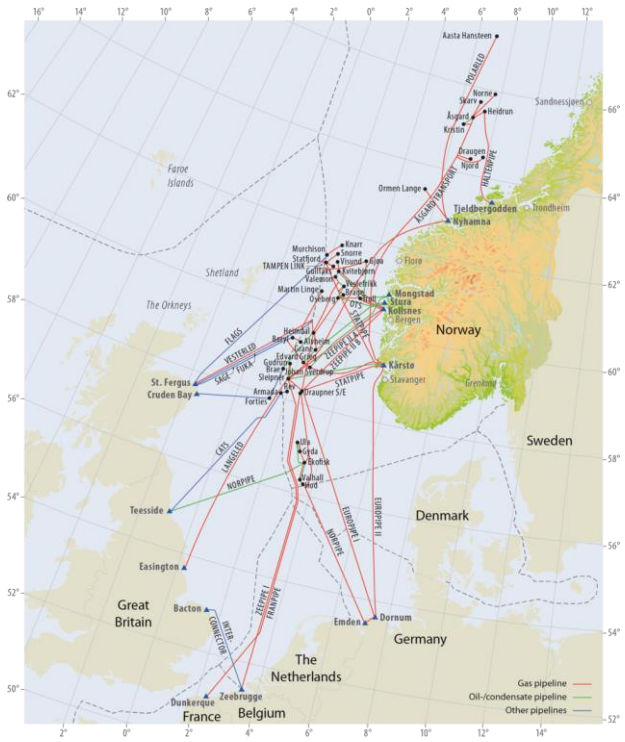

Fig. 3. Norwegian offshore gas and gas-condensate development projects on the Barents Sea shelf [20].

Norwegian experience in the implementation of gas projects on the Arctic shelf

Analyzing the successful practices of oil and gas companies in the development of gas fields on the Norwegian shelf, a number of interesting solutions can be identified. For example, it is known that the Ormen Lange and Aasta Hansteen fields were discovered at the same time, in 1997. But that year, Equinor decided to develop the Ormen Lange field first. At the same time, construction of the onshore gas terminal Nyhamna began. The decision to transfer operator functions to Shell in the second phase of the project allowed Equinor to focus on developing the technologically more complex Aasta Hansteen project. When the Aasta Hansteen plan was approved by the government in 2013, it was decided in 2013 to proceed with the third phase of Ormen Lange, which included expanding the Nyhamna plant and increasing its receiving capacity.

Thus, it is possible to trace the strategy of the Norwegian national oil companies on the Arctic shelf in the implementation of gas projects. Initially, Equinor, as a project operator, takes most of the risks, and when production at the fields reaches a plateau, transfers some of the functions to foreign partners, “moving further to north”, where, due to high risks, foreign participants are not ready to work in the first stages. Indeed, the implementation of such complex multi-stage projects in the Arctic is impossible without a “multilateral and even multi-country approach” [6, Pilyasov A.N., Putilova E.S., p. 24] and the participation of a number of partners at all stages.

Moreover, it is not uncommon for Arctic offshore projects to be temporarily suspended for climatic, technological and financial reasons. For example, in May 2020, Equinor shut down the

[20] Source: Equinor data.

LNG plant in Hammerfest for two weeks due to a drop in gas demand [21]. On September 28, 2020, there was a serious fire at the LNG plant [22]. The inspection found that the scope of repair work at the Hammerfest plant required a shutdown of the LNG plant for at least 12 months. According to the director of the LNG plant A. Sandvik, "Safety is our top priority and we will not start up the plant until we are sure that it is completely safe." [23] Equinor plans to use the downtime period for other works on maintenance, which were planned for 2021. At the same time, the Snøhvit example indicates another important component of the project implementation: Equinor often takes on most of the technological risks and further enriches its Arctic competencies with the acquired experience. For example, the unique carbon dioxide storage technology that the company developed for the Snøhvit project is now being adopted, scaled up and used by other offshore companies.

Conclusion

The development of gas and gas condensate fields in high latitudes is a complex task and, of course, a challenge for the global gas industry. An important feature of offshore gas projects is their technical and technological uniqueness at each stage of development: exploration, development, design and construction, operation and transportation. Therefore, a prerequisite for their implementation is close technological cooperation with partner companies. Thus, the experience of Norway shows that long-term and sustainable activities on the shelf are possible with the participation of a number of companies in the project, some of which are foreign participants with relevant competencies. Good practices such as technological integration with future sales markets and inviting key partners at different stages of project implementation make the development of offshore fields in the Arctic more resilient to risks in the long term.

When implementing projects on the Arctic shelf, it is necessary to take into account the fact that their investment has been carried out continuously for decades, since "Arctic shelf projects are classic long-term enterprises" [7, Yergin D., p. 48]. Another feature of projects on the Arctic shelf is the duration of operation (at least 40–50 years), which requires operators and participating companies to think about alternative ways of developing associated infrastructure at the earliest stages of an offshore project (example of the Nyhamna terminal).

Speaking about the prospects for the gas industrial development of the country's Arctic shelf, it should be noted that the size of the fields, huge reserves of resources and even more severe natural and climatic conditions will add a new level of complexity for the domestic oil and gas industry. The implementation of such projects will require some degree of technological integra-

[21] Equinor to shut Melkoeya LNG plant for two weeks in May. URL: https://www.reuters.com/article/us-equinor-lng/equinor-to-shut-melkoeya-lng-plant-for-two-weeks-in-may-idUSKBN22I0PA (accessed 08 May 2020).
[22] The fire at Hammerfest LNG-plant at Melkøya. URL: https://www.equinor.com/en/news/hendelse-melkoya.html (accessed 08 April 2021).
[23] Surveys of the damage after the fire at Hammerfest LNG on 28 September indicates that the LNG plant will be closed for up to 12 months for repairs. URL: https://www.equinor.com/en/news/20201026-hammerfest-lng-closed-repairs.html (accessed 08 May 2020).

tion and careful selection of participants in the partnership. It is important to study the best practices of oil and gas companies for the development of Arctic deposits on the shelf, when most of the technologies were created specifically for each project. The analysis made it possible to identify a number of successful practices of foreign oil and gas companies in the implementation of offshore gas projects in the Arctic, which can be useful for Russia. Namely, such successful solutions as the phased development of neighboring fields, expanding activities and linking existing capacities with new projects, changing the project operator at a time when the risks for the invited company are significantly reduced, parallel design in different geographic locations, can be applied by Russian oil and gas companies when planning long-term activities on the Arctic shelf.

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Forecasting the Economic Growth Limitations in the Northern Regions Based on the "Sustainability Windows" Assessment*

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Abstract. In modern conditions, the issues of assessing the sustainability of regional development are of particular relevance. The complex problems of interrelation of economic growth, environmental pollution and population well-being require the development and use of new, simpler and more understandable approaches for decision makers to assess, analyze, and predict sustainability at the regional level. The purpose of the article is to investigate the opportunities for sustainable development of the regions of the European North included in the Arctic zone, and to develop methods for forecasting their socio-environmental and economic development based on sustainability window assessment. The dynamics of changes in the relationship between environmental, social and economic indicators with the use of pollution functions is analyzed. The main factors contributing to the reduction of environmental pollution and increase of the population's well-being are identified. It is shown that structural changes in the regional economy and environmental investments have the greatest effect. A methodology for calculating sustainability windows for the regional economy is presented. The possibility of using the method has been demonstrated using data from the Republic of Karelia. A scenario of sustainable development based on the restriction of economic growth for some regions and the requirements for the structure of the economy has been developed. The results obtained can be used as an informational and methodological basis for assessing and elaborating sustainable development policies in the Arctic regions.
Keywords: *sustainable development, region, European part of the Arctic zone of the Russian Federation, environmental restriction, economic growth, sustainability window.*

Introduction

The most important requirement when working out the development strategies of countries and regions is sustainable development; besides, it is necessary to take into account the economic, environmental and social aspects [1, Karginova V.V., Tolstoguzov O.V., p. 77; 2, Heininen L., p. 197]. In order to assess the possibility of sustainable development of the northern regions, it is necessary to analyze the change in environmental and social indicators during the reforms.

The northern and arctic regions are characterized primarily by the vulnerability of the natural environment, and active resources development can cause serious ecological consequences [3, Stepanko N.G., Stepanko A.A., Tkachenko G.G.]. Harsh climate and unfavorable living conditions lead to significant additional costs for production activities, which creates the danger of neglecting environmental problems. Therefore, it is necessary to take into account the relationship between economic and environmental indicators in forecasting [4, Shelomentsev A.G., Belyaev V.N., Ilinbaeva E.A., p. 161]. Changes in the economy's structure and accelerated auto-mobilization of

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the population have resulted in the fact that the impact of automobile transport on the pollution level is not much less than industrial one [5, Pyzheva Yu.I., Pyzhev A.I., Zander E.V., p. 510]. An increase in environmental expenditures can significantly reduce the level of pollution [6, Zabelina I.A., Klevakina E.A., p. 79].

The northern and arctic regions of Russia are developing slowly after long decline in the 1990s, and population level is decreasing, in contrast to the Arctic regions of other countries [7, Fauser V.V., Smirnov A.V., p. 15; 8, Zharov V.S., Ivanova M.V.]. The growth of migration is associated with changes in the income level, decrease in the quality of life in the north, low availability of quality services [9, Ivanova M.V., Kasparyan Zh.E., p. 101]. At the same time, the trend in real incomes did not change in some northern regions, which made it possible to use time series for forecasting without taking into account other factors [10, Krivoshapkina K.V., Matveeva N.N., p. 12]. The dynamics of social indicators are closely related to the production development, and different equations that include the level of regional economy development are proposed to assess the standard of living [11, Ignasheva T.A., p. 362]. A number of works have shown that a slowdown in the population outflow from the Arctic zone requires acceleration in the growth of monetary incomes [9, Ivanova M.V., Kasparyan Zh.E.; 10, Krivoshapkina K.V., Matveeva N.N.; 12, Toropushina E.E.].

The development of the Arctic zone requires solving many problems that are associated with international conflicts and climate change [13, Labetskaya E.O., p. 83]. At the same time, the analysis of the implementation of the Development Strategy of the Arctic Zone of the Russian Federation [1] shows a slow solution of the accumulated problems, primarily social and environmental ones [14, Krutikov A.V., Smirnova O.O., Bocharova L.K., p. 258]. Slipenchuk M.V. [15, Slipenchuk M.V., p. 36] notes that it is necessary to take into account environmental constraints more strictly and to pay more attention to legal regulation. When constructing scenario conditions for the Arctic zone development, it is necessary to consider many factors affecting the sustainability of development [16, Zaikov K.S. et al, p. 10].

Since the 1990s, there are many significant and often promising efforts to assess sustainability and its indicators. Previously, the index of sustainable economic well-being was proposed, which estimates several aspects: gross domestic product (GDP) adjusted for the amount of damage caused to the environment, index of true savings, index of social sustainability developed by the Foundation for Sustainable Society, ecological footprint, index of inclusive development introduced by the World Economic Forum and others [2] [17, Kaivo-oja J., Panula-Ontto J., Vehmas J.,

[1] We are talking about the "Strategy for the development of the Arctic zone of the Russian Federation and ensuring national security for the period up to 2020". URL: http://docs.cntd.ru/document/499002465 (accessed 10 February 2021); in 2020, the Strategy for Developing the Russian Arctic Zone and Ensuring National Security until 2035 was adopted. URL: https://www.garant.ru/products/ipo/prime/doc/74710556/#review (accessed 10 February 2021).

[2] Tarasova N.P., Kruchina E.B. Indeksy i indikatory ustoychivogo razvitiya [Indices and indicators of sustainable development]. Ustoychivoe razvitie: priroda – obshchestvo – chelovek: Materialy mezhdunarodnoy konferentsii [Sustainable development: nature — society — people: Proc. Intern. Conf.]. Moscow, 2006, vol. 1, p. 127–144. URL: http://cawater-info.net/ecoindicators/pdf/tarasova_kruchina.pdf (accessed 10 January 2021).

Luukkanen J., p. 41; 18, Syrovatka M.; 19, Lyaskovskaya E.A., Grigoryeva K.A., p. 47]. Such indices make it possible to reduce complex and ambiguous information to a small number of understandable indicators.

A fairly simple new approach on the basis of sustainability windows was proposed, which makes it possible to analyze strategic decisions and forecasts [20, Luukkanen J., Kaivo-oja J., Vehmas J., Panula-Ontto J., Hayha L.; 21, Luukkanen J. et al, p. 820]. The construction and analysis of sustainability windows examine all three components of sustainable development and determine the extent to which the changes occurring or planned lead to greater sustainability.

The purpose of this article is to study the possibilities of sustainable development of the regions of the European North and to develop methods for predicting their socio-ecological and economic development based on the assessment of the sustainability window. To achieve this goal, data were collected and analysed for four regions of the European North, equations for the analysis of the retrospective period were proposed, and a method for constructing stability windows for the forecast period was developed.

Research methods

The research was conducted in four regions of the European North, fully or partially included in the Arctic zone of Russia — the republics of Karelia and Komi, Murmansk and Arkhangelsk oblasts (including the Nenets Autonomous Okrug). The retrospective period was analyzed and possible prospects for development of the European part of the Arctic zone of Russia were studied.

The following indicators were used for the calculations: gross regional product (GRP) $Y(t)$, GRP per capita $X(t)$, cumulative investment in the economy $K(t)$, population size, number of employed $L(t)$, level of employment $Z(t)$, share of pensioners in population $P(t)$, level of unemployment $U(t)$, real money income $R(t)$ and air pollutant emissions $E(t)$. All the indicators were considered in dynamics for the period 1990–2019. Calculations were made with other indicators (indices of industrial and agricultural production, number of pensioners, fresh water intake and wastewater discharge). Labor productivity was defined as the ratio of GRP to the number of employees. Standard statistical packages were used in the calculations and the indicators were adjusted to a comparable level.

In the course of analyzing the dynamics of the main indicators of the regions, graphs of the basic and derived economic indicators and their interrelations were built. On the basis of this analysis, the type of equations, the dynamics of main parameters reflecting the peculiarities of socio-ecological-economic processes in the regions were determined, and periods, when parameters differed, were distinguished. It was clarified what factors resulted in changes of trends, and peculiarities of each period were identified. The development of the economy was assessed by the function:

$$Y(t) = B \times K^{\alpha}(t) \times L^{\beta}(t) \times \exp(\gamma \times t) \quad (1)$$

where: *t* — year; *B, α, β, γ* — constants.

To assess the impact of economic processes on the environment, pollution functions were created [22, Druzhinin P.V., Shkiperova G.T., Potasheva O.V., p. 147]. For the calculations, the multiplicative pollution function was used:

$$E(t) = A(t) \times Y^{\mu}(t) \times I^{-\eta}(t) \quad (2)$$

where: *A(t)* — factor reflecting the impact of structural changes; μ, η — constants.

The dynamics of real money incomes of the population in the retrospective period was determined depending on the dynamics of GRP per capita, the level of employment, the share of pensioners in the population and the level of unemployment:

$$R(t) = C + D \times Z(t) + M \times X(t) + N \times P(t) + O \times U(t) \quad (3)$$

where: *C, D, M, N, O* — constants.

The main problem is to identify the periods correctly, since the parameters of equations (1) — (3) may differ significantly at different periods due to changes in economic policy or economic crises. It is therefore necessary to use a scenario approach in forecasting, where the parameters of the equations are linked to future policy options. When using data for several periods for retrospective calculations, the use of spline functions is desirable. For forecast calculations, it will be necessary to specify the employment dynamics and the share of pensioners, which will be determined through the forecast of the population size. The employment rate will be calculated through the ratio of the number of employed and the total population.

Three indicators — environmental, social and economic — have been selected to assess the windows of sustainability. Finnish researchers have used the indicators from the SSI (Society Sustainability Index) database and the World Bank database, which describe changes at the national level [17, Kaivo-oja J., Panula-Ontto J., Vehmas J., Luukkanen J., p. 41; 20, Luukkanen J., Kaivo-oja J., Vehmas J., Panula-Ontto J., Hayha L.; 21, Luukkanen J. et al., P. 820]. However, not all of these indicators are available at the regional level, in particular, GDP and greenhouse gas emissions.

When choosing indicators, the author relied on the previously proposed various sets of regional indicators that allow assessing sustainable development [23, Bobylev S.N., p. 17, 33, 35; 24, Uskova T.V., p. 98; 25, Gutman S.S., Basova A.A., p. 40; 26, Fauzer V.V., Smirnov A.V., Lytkina T.S., Fauzer G.N., p. 127; 27, Leksin V.N., Porfiryev B.N., p. 988]. As a result, the following indicators were selected: GRP in comparable prices, the volume of emissions of pollutants into the atmosphere from stationary and mobile sources, real money incomes of the population in comparable prices. Composite indicators can also be constructed to assess environmental and social development.

The boundaries of economic growth are set for the future. The maximum is determined in relation to the ecological indicator, GRP growth should not lead to growth of emissions into the atmosphere, and the minimum — in relation to the social indicator, GRP growth should not lead to decrease of incomes. It means that the maximum GRP growth will be at zero growth in emissions, and the minimum — at zero income growth, and the difference between them sets the width of the stability window. When economic growth is within the sustainability window, the environmental indicator goes down and the social indicator goes up. The sustainability window disappears if the social indicator grows slower than the ecological one or falls faster than it. Accordingly, the boundaries of the stability window were determined based on the equations [20, Luukkanen J., Kaivo-oja J., Vehmas J., Panula-Ontto J., Hayha L., p. 14494]:

$$G_{\min} = \frac{\delta_Y}{\delta_R} \qquad G_{\max} = \frac{\delta_Y}{\delta_E} \tag{4}$$

where: G_{min} — the lower boundary of the stability window; G_{max} — the upper border of the stability window; δ_Y — the GRP growth rate for the period under study (ratio of GRP of the last year to GRP of the base year); δ_E — the growth rate of emissions for the period under study; δ_R — the growth rate of income for the period under study.

It should be noted that the methodology allows using any values as a target benchmark of environmental and social indicators. In this study, the choice of a target for the upper boundary of sustainability is explained primarily by the tasks set in the Development Strategy of the Arctic Zone of the Russian Federation and Ensuring National Security for the Period up to 2035 [3]: 12 a) “the introduction of a special economic regime in the Arctic zone, contributing to the transition to a closed-cycle economy ... “, as well as 15 e) “minimization of atmospheric emissions, discharges of pollutants into water bodies during economic and other activities in the Arctic zone, as well as the establishment of state support measures aimed at introducing the best available technologies in the implementation of economic and other activities in the Arctic zone”. Unfortunately, the numerical values of the target environmental and social indicators are absent in the strategic documents for the development of the Arctic zone of the Russian Federation.

For the retrospective period, the dynamics of regional development was checked and periods of sustainable development were identified [28, Shkiperova G.T., Druzhinin P.V., Kurilo A.E., p. 650, 651]. Since the real economic growth of almost all the regions under study in the retrospective period is significantly lower than the ecological limit of sustainability, then the use of zero growth in atmospheric emissions as a target provides an opportunity for a gradual transition to a circular economy. Equations (2) and (3) were transformed with respect to environmental and social indicators for the forecast period.

[3] Ukaz Prezidenta RF ot 26 oktyabrya 2020 g. № 645 "O Strategii razvitiya Arkticheskoy zony Rossiyskoy Federatsii i obespecheniya natsional'noy bezopasnosti na period do 2035 goda" [Decree of the President of the Russian Federation of October 26, 2020 No. 645 "Strategy for Developing the Russian Arctic Zone and Ensuring National Security until 2035"]. URL: https://www.garant.ru/products/ipo/prime/doc/74710556/#review (accessed 10 February 2021).

If the ecological indicator is stable, we obtain the ratio of GRP to investments in air protection from equation (2). Having estimated reasonable upper bounds for the dynamics of environmental investments, we obtain an upper bound for GRP growth. Population dynamics and, consequently, employment may not change very much, while the scope for changing the dynamics and structure of investments is quite large. As a result, equation (1) gives the maximum investment dynamics in the economy with different changes in the number of employed people. The same is true for equation (3). If the social indicator is stable, we obtain relationship between GRP per capita and unemployment rate with two slightly changing indicators (employment rate and share of pensioners). In this case, a lower bound on GRP growth and a lower bound on investment dynamics through equation (1).

As a result, the forecast sustainability window for GRP is calculated basing on the forecast of the region's population and related rather slowly changing indicators — the number of employed, the employment rate, the unemployment rate and the share of pensioners, as well as environmental investments. Equation (1) also allows us to calculate the sustainability window for investment in the economy.

Data and analysis

The data for the research were obtained from the Federal Service for State Statistics (FSSS) website and the websites of regional offices [4], as well as from statistical reference books [5].

The development of the Arctic regions, like the Russian Federation as a whole, is characterized by three significantly different periods — up to 1998, 1999–2008 and since 2009. In order to construct the functions, the data of the second and third periods were used (Fig. 1).

[4] Federal State Statistics Service. URL: https://www.gks.ru/ (accessed 11 January 2021); Kareliastat. URL: http://krl.gks.ru (accessed 21 December 2020); Murmanskstat. URL: http://murmanskstat.gks.ru (accessed 21 December 2020); Komistat. URL: http://komi.gks.ru (21 December 2020); Arkhangelskstat. URL: http://arhangelskstat.gks.ru (21 December 2020).

[5] Regiony Rossii. Sotsial'no-ekonomicheskie pokazateli 2019 [Regions of Russia. Socio-economic indicators 2019] // Federal State Statistics Service. URL: https://gks.ru/bgd/regl/b19_14p/Main.htm (accessed 11 January 2021).

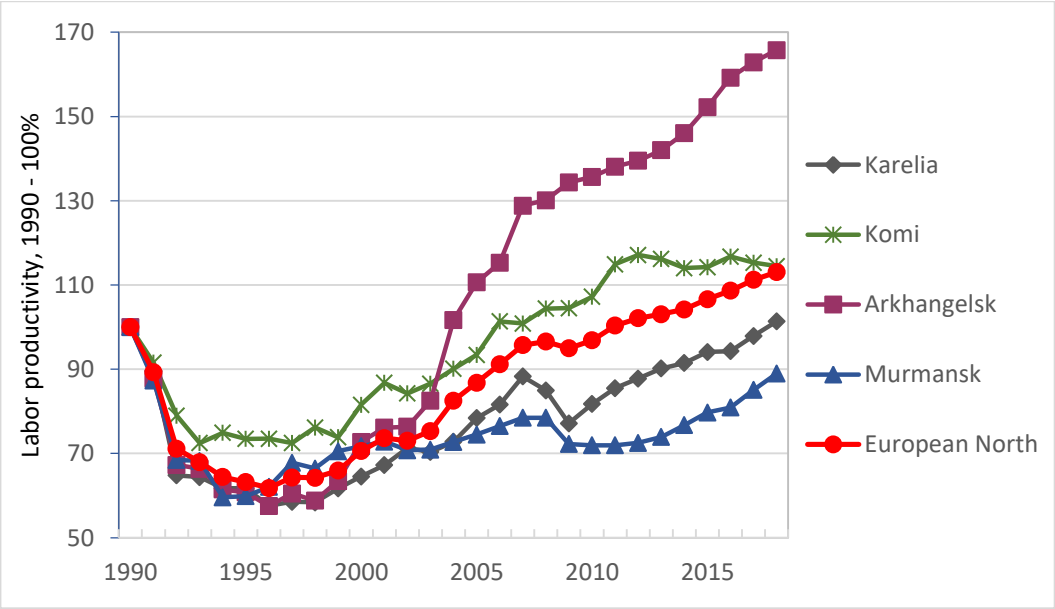

Fig. 1. Dynamics of labor productivity in the regions of the European part of the Arctic zone (1990 — 100%).

It is worth noting that labor productivity grew in all regions in the second period, and after 2009 its growth stopped in the Komi Republic. Labour productivity was also growing in all regions in the second period, but after the crisis of 2008–2009 labour productivity increased only in Murmansk Oblast. The dependence of labor productivity on the capital-to-labor ratio is similar in all regions under consideration, and it can be expected that the parameters of their functions (1) will not differ significantly (Fig. 2).

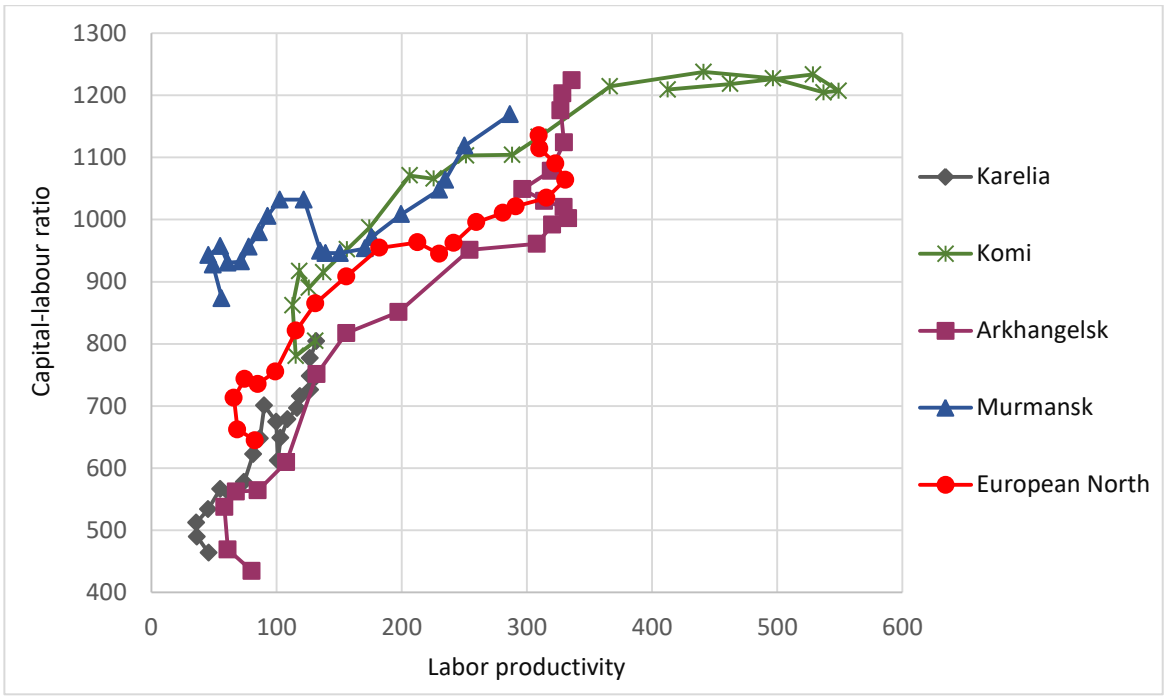

Fig. 2. Dependence of labor productivity on capital-labour ratio (thousand rubles) in the regions of the European part of the Arctic zone since 1998 (prices of 2015).

The growth of labor productivity in industry has slowed down. In the European part of the Arctic zone, it grew by an average of about 3.7% per year from 1996 to 2008, and in 2009–2019 —

by about 2.3% per year. Elasticity of funds, which reflects efficiency of investment policy, was low throughout the macro-region as a whole and in the majority of regions in the 2000s, but started to grow after the 2008–2009 crisis. Only in the Komi Republic elasticity was stable and approximately equal to the macro-region average in the 2000s, but decreased to zero in the 2010s.

Since there was little change in economic efficiency in the 2000s and a growth after the 2008–2009 crisis, the spline-function was used and technical progress in the third period was introduced into the Cobb-Douglas function.

The economic development of the regions in the European part of the Arctic zone was slower than in the whole of the Russian Federation, the volume of investments ranged from 50% to 60% against the level of 1990, which is noticeably lower than in the Russian Federation (Fig. 3).

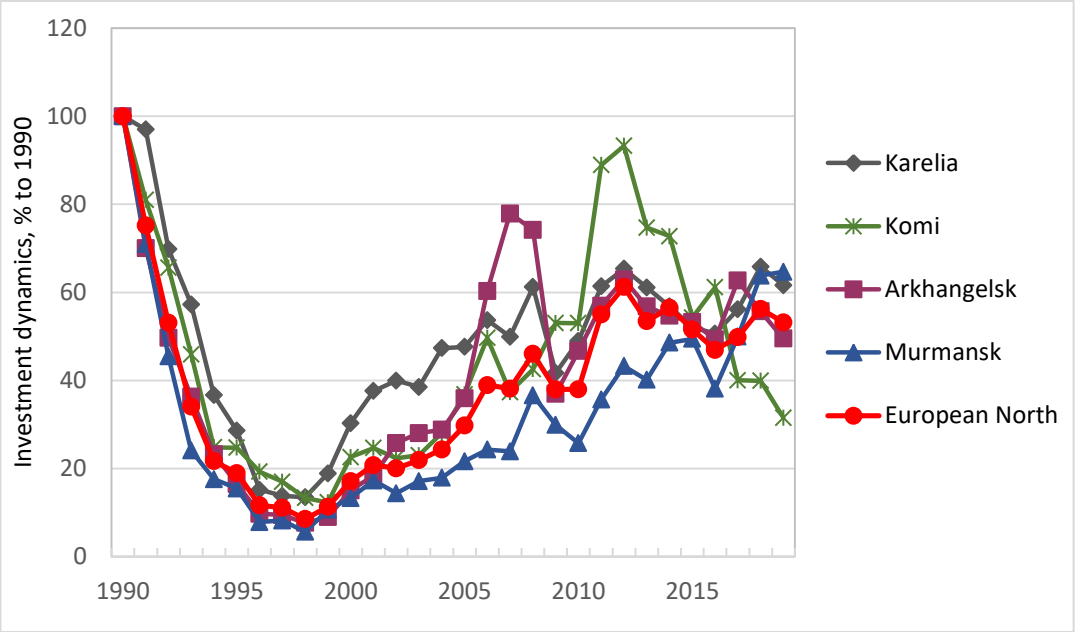

Fig. 3. Investment dynamics by regions of the European part of the Arctic zone (% to 1990) [6].

The dynamics of employment also differ radically in the three identified periods (Fig. 4). In the third period, employment started to decline rapidly, as the population continued to decline, largely due to the migration of young people to more southern regions [29, Galimullin E.Z., p. 99]. The population of the Murmansk Oblast and the Komi Republic has decreased by more than a third over 30 years, the population of the Arkhangelsk Oblast and the Republic of Karelia — by about a quarter. Additional comprehensive state support is required to reduce the migration outflow [30, Emelyanova E.E., p. 90].

[6] Calculated by: Regiony Rossii. Sotsial'no-ekonomicheskie pokazateli 2019 [Regions of Russia. Socio-economic indicators 2019]. Federal State Statistics Service. URL: https://gks.ru/bgd/regl/b19_14p/Main.htm (accessed 11 January 2021).

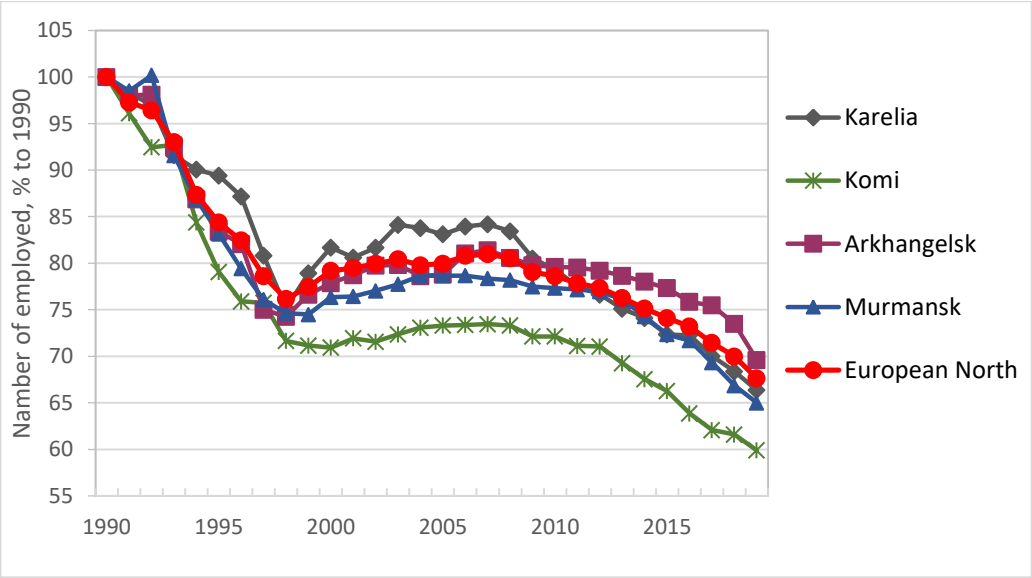

Fig. 4. Number of employed dynamics by regions of the European part of the Arctic zone (% to 1990) [7].

Decline in industrial production in the 1990s led to an improvement of the ecological situation. Economic growth in the second period led to a deterioration of the environmental situation in some regions, and in the third period, pollutant emissions into the atmosphere increased only in Karelia, accompanied by a sharp decline in environmental investment. The improvement in the environmental situation in the growing regions was largely due to structural changes in the economy, as well as economic modernization and environmental investments (Fig. 5).

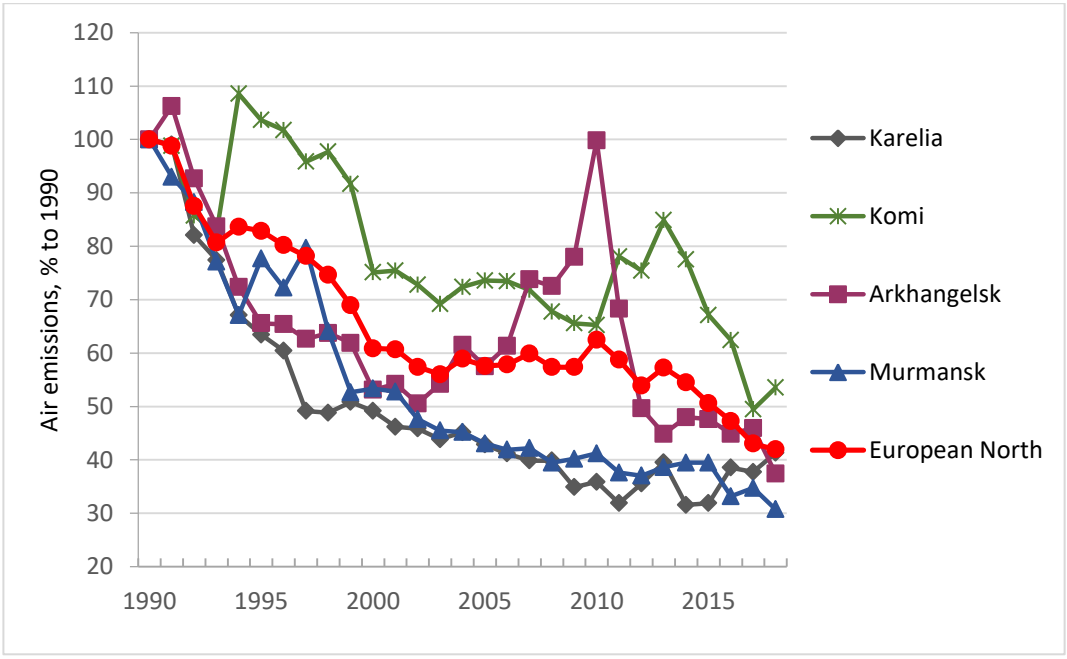

Fig. 5. Dynamics of emissions from stationary sources by regions of the European part of the Arctic zone (% to 1990) [8].

[7] Calculated by: Regiony Rossii. Sotsial'no-ekonomicheskie pokazateli 2019 [Regions of Russia. Socio-economic indicators 2019]. Federal State Statistics Service. URL: https://gks.ru/bgd/regl/b19_14p/Main.htm (accessed 11 January 2021).

[8] Calculated by: Okhrana okruzhayushchey sredy Rossii [Environmental protection of Russia]. URL: https://rosstat.gov.ru/folder/210/document/13209 (accessed 16 December 2020).

The dynamics of real incomes in the four regions are approximately the same. Relatively fast growth until 2008, decline during the crisis, then a short growth and then decline again to the level of about 2007–2008. (Fig. 6).

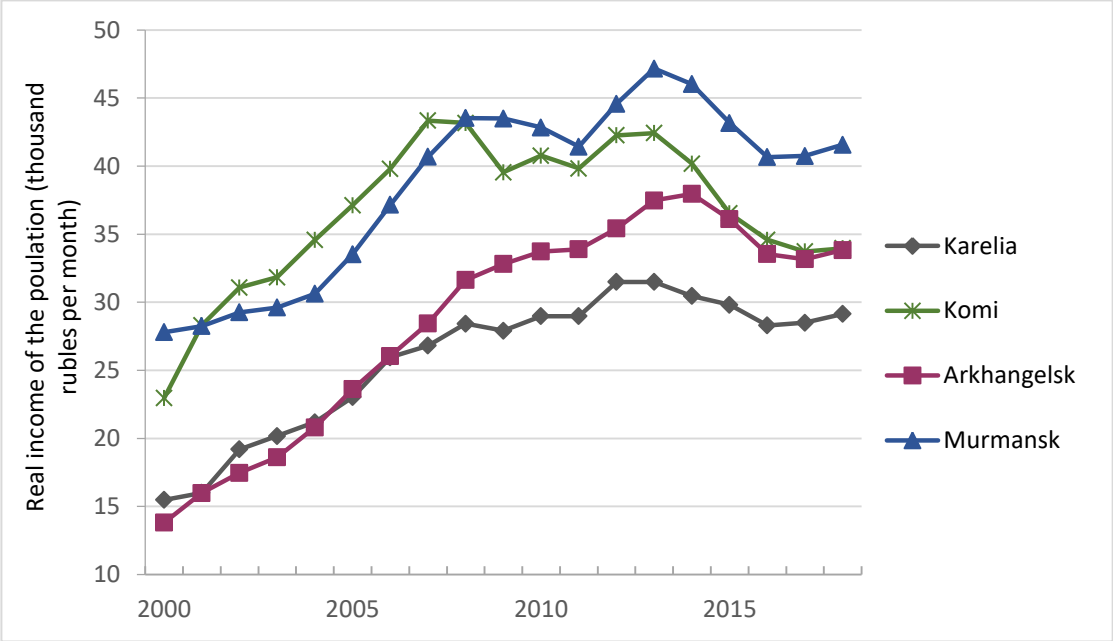

Fig. 6. Dynamics of real income of the population by regions of the European part of the Arctic zone (thousand rubles per month) [9].

The analysis of the development of the regions in the European part of the Arctic zone showed the existence of available sustainability windows for them [28, Shkiperova G.T., Druzhinin P.V., Kurilo A.E., p. 653]. Only in some years the socio-ecological-economic development of the regions went beyond their limits. For example, the real growth of GRP went beyond the stability window in the republics of Karelia and Komi in 2017 (in Karelia, it exceeded the permissible limit, and in the Komi Republic it was below the permissible limit). When comparing the results of calculations for different environmental indicators, it was noted that the problems of water use are being solved more successfully than the problems of air pollution.

Calculation results and discussion

As a result of the calculations, the parameters of the functions allowing to forecast the dynamics of GRP were determined. The parameter reflecting technical progress was introduced only for recent years (Karelia and Komi — 2014–2018, Arkhangelsk Oblast — 2008–2018, Murmansk Oblast and macroregion — 2009–2018). Development of the Northern Regions after the 2008–2009 crisis has slowed down, one could talk about the stagnation of economy, but, as calculations show, the efficiency of the northern regions' economy is growing. Investments in their economies are not increasing, the number of employees is decreasing, and labor productivity is growing steadily in three regions, only in Komi its growth is absent. A slight economic contraction is ac-

[9] Regiony Rossii. Sotsial'no-ekonomicheskie pokazateli 2019 [Regions of Russia. Socio-economic indicators 2019]. Federal State Statistics Service. URL: https://gks.ru/bgd/regl/b19_14p/Main.htm (accessed 11 January 2021).

companied by an increase in its efficiency. The growth of five-year investments in the economy of four regions by 1% increases the GRP by 0.26%, the growth of employment by 1% increases the GRP by 0.74%, the influence of technological progress over the past 10 years — 1.4% per year. Table 1 shows the results of calculations for the Republic of Karelia.

Table 1

The results of calculating the parameters of function (1) for 2000–2018

	lnB	*α*	*β*	γ_0	R^2	*F*	*p*
GRP of Karelia	0,14***	0.27***	0.666***	0.0221*	0.92	20.1	0.0000

*** p<0.01, * p<0.1

The calculations carried out for the regions showed that it is necessary to construct spline functions or pollution functions for separate periods, since in the third period the interconnection of indicators differs markedly from earlier dependencies. In Karelia, economic growth was insignificant in the third period, and no improvement in the environmental situation was observed. The impact of environmental investments was small, due to investments in the protection of atmospheric air, emissions decreased by 0.04% with an increase in cumulative investments over four years by 1% with a lag of three years (Table 2). Therefore, a significant increase in environmental investments will be required in order to extend the sustainability window.

Table 2

The results of calculating the parameters of the pollution function (2) for 2007–2018

	lnA	*μ*	*η*	R^2	*F*	*p*
Air emissions	0.37	0.78*	-0.04*	0.41	3.1	0.094

* p<0.1

Separate calculations were carried out for the period from 2000, and additional data were used for other indicators, in particular, various areas of investment. The results of these calculations were used to construct various scenario conditions. Calculations were also made for environmental pollution by individual substances by region.

The parameters of function (3) were determined according to data for 2000–2018, the spline function was used, some of the parameters relate to the period before the crisis of 2008–2009, and some of them — after the crisis (Table 3). Real income growth after the 2008–2009 crisis did not recover, but forecasts suggest its resumption.

Table 3

The results of calculating the parameters of function (3) for 2000–2018

	A	*B*	*C*	*D*	*K*	R^2	*F*	*p*
Real money incomes of the population of Karelia	12.5***	0.114*	0.095***	-0.985***	-1.192***	0.99	122	0.000

***p<0.01, * p<0.1

Scenario conditions were based on indicators that change, but not too much: population size, number of people employed in the economy, employment rate, share of pensioners, unemployment rate, and environmental investments. The article considered scenario conditions corresponding to a stable situation in the economy, without taking into account possible economic crises. For each variant of the scenario conditions, it is possible to determine the boundaries of the

GRP change and investment in the economy within the stability windows. Table 4 shows the forecast of changes in the population size for one of the variants of scenario conditions (in this case, extrapolation was used; for other scenarios, it is necessary to use the method of age shifting with a separate estimate of the level of migration).

Table 4

Population dynamics by regions, inertial scenario, thousand people, at the end of the year

	2020	2025	2030
Karelia	610.9	585.3	561.7
Komi	813.3	765.3	719.5
Arkhangelsk	1129.4	1090.9	1058.2
Murmansk	733.4	713.5	693.6
Four Arctic regions	3287	3155	3043

The population of the Arctic zone regions in this scenario will decrease by about 7% over 10 years. Possible changes in demographic and migration policies can improve the demographic situation in the North, so far the measures taken are ineffective. At the same time, in all northern countries, the population in Arctic cities is growing [7, Fauser V.V., Smirnov A.V., p. 15]. On the basis of this forecast the scenario conditions for the number of employed in the economy, the employment rate, the share of pensioners and the unemployment rate were built. The forecast of the dynamics of environmental investments was based on their reaching a level close to the maximum values in the 2000s, since in recent years there were practically no investments in air protection in Karelia and emissions of pollutants began to grow, exceeding the level of 2008.

Table 5 shows the results of calculations for Karelia for 2020–2030. It was assumed that there will be no radical changes in economic, environmental and social policies, which means that the obtained values of equations (1) – (3) can be used for forecasting until 2030. The Karelian economy is developing very slowly and it may return to the pre-crisis level of 2007 only by 2030. In this scenario, the level of employment decreases in accordance with the trends that have developed in recent years. The number of pensioners is stable until the transition to the new retirement age is completed, and then there is a return to the trend of growth in the number of pensioners. The unemployment rate declines slightly after the end of the pandemic and is then stable.

Table 5

Sustainability window for GRP of the Republic of Karelia, inertial scenario with an increase in environmental investments, 2020 — 100%

	2020	2025	2030
Upper limit	100	108.2	110.4
Lower limit	100	98.3	101.8

Low growth rates lead to the lag of the country not only from developed, but also from developing countries and will require changes in economic policy; therefore, forecasting for a longer period requires other parameters of the model equations. The resulting stability window is shown in Fig. 7, it presents one of the possible options for the GRP growth rate — 100.9%, higher growth rates require a more responsible environmental policy.

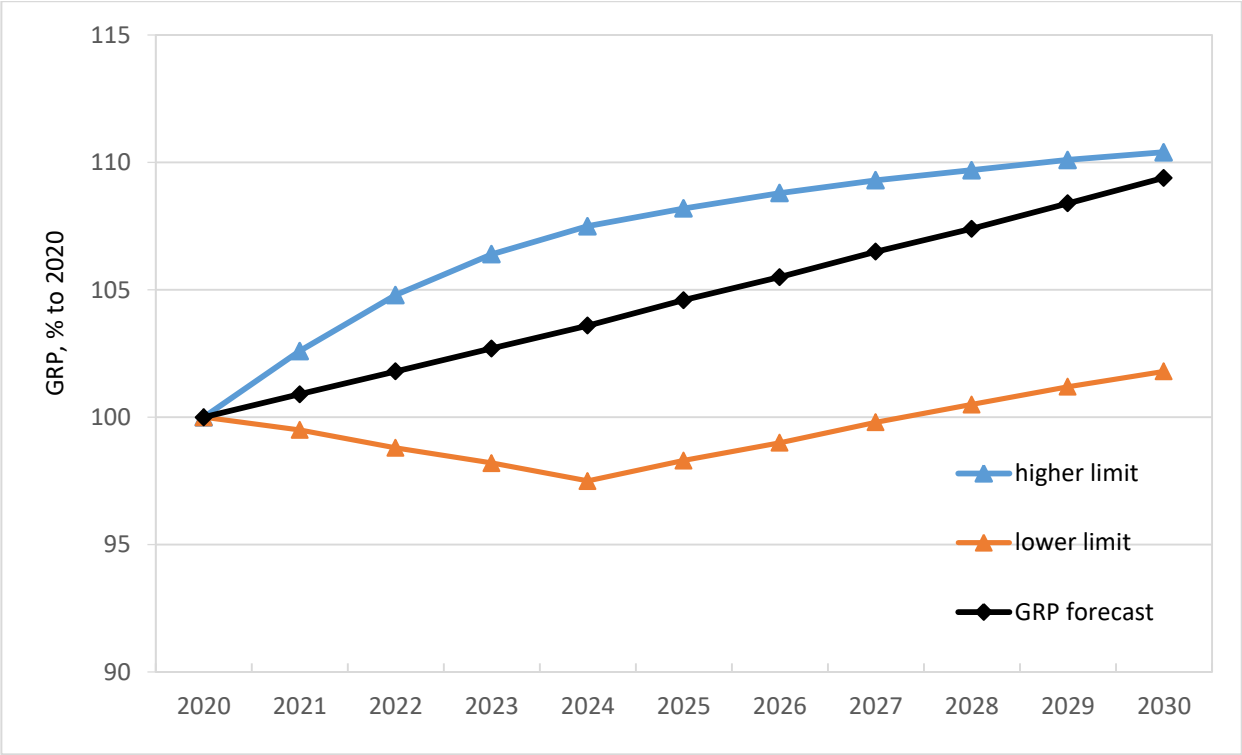

Fig. 7. Sustainability window of the Karelian economy for 2020–2030.

It is possible to change the scenario conditions by formulating the requirements for increasing the real incomes of the population and improving the environmental situation, then the sustainability window will be narrowed. By setting options for the growth of real incomes, changes in the level of employment (based on the deviation from the inertial option), the level of unemployment and the number of pensioners (based on changes in current trends), we obtain more stringent restrictions on the dynamics of GRP per capita in comparable prices. It resulted in limiting the minimum growth of the economy, providing a given level of well-being of the region's population. Besides, ensuring the growth of real incomes of the population with an increase in the number of pensioners receiving low incomes requires a noticeable acceleration in the growth of GRP, and the stability window is narrowing.

The calculations have shown that when equations become more complex, if technical progress related to structural shifts and economic modernization is taken into account in the pollution function, then formation of scenario conditions becomes more complex and the variability of the sustainability window increases. In order to study the impact of economic modernisation on the ecological situation, it is also possible to introduce the dynamics of investment in machinery and equipment into the equations, as information on investment in modernisation across regions is not available. As a result, it would be possible to construct a more accurate upper bound.

Conclusion

The methodology of sustainability windows calculation for regional economy presented in the article enables to investigate the consequences of decisions made, estimate possible variants of economic growth which do not violate the sustainability principle and allow increasing the pop-

ulation well-being and not worsening ecological situation. The article discusses the possibility of using the methodology on the data of the Republic of Karelia, and only on the example of emissions of pollutants into the atmosphere and the actual disposable income of the population. But it is also possible to use other indicators, and then the windows will superimpose on each other, and the total window will be reduced, it will be determined by the minimum of the maximum values and the maximum of the minimum. It is also possible to build two composite indicators and form the window on their basis, which will require increasing the number of factors on the basis of which the scenario conditions are formed.

Scenario conditions were set on the basis of calculations for the production function, pollution function and the equation for assessing the dynamics of the population's real disposable income. The model equations can be made more complex by taking into account more factors, in particular investment in economic modernisation and structural shifts.

Overall, the approach allows for an assessment of socio-environmental economic policy in recent decades and makes it possible, by setting different scenario conditions, to analyse the conformity of different economic policy options with the conditions of sustainable development.

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Selection of HR-Strategy in the Location of the Transport-Technological System of Oil Fields in the Russian Arctic *

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Abstract. The development of Arctic hydrocarbon resources is in the sphere of interests of many large companies. At the same time, the vast northern territories and polar seas do not have a developed infrastructure that would allow implementing various transport and technological solutions for the development of oil fields. The opportunities for attracting the resources of the Russian Arctic into economic circulation are currently being used to a small extent, which is caused by various factors, both objective and subjective, that were formed at the previous stages of the country's development. This work is devoted to the problem of choosing an HR strategy when placing objects of the transport and technological system of oil fields in the Russian Arctic, taking into account the ecological, economic and socio-economic features of this macroregion. Using the example of oil and gas fields in the coastal-shelf zone of the south-eastern part of the Barents and Kara Seas, the authors consider multivariate forecasts for the formation of a rational scheme for the transportation of hydrocarbons as an integral part of the regional oil and gas complex. The authors assign a special role to the important economic and socio-psychological components associated with the processes of organizing the work of oil workers. At the same time, they come to the conclusion that the shift method of labor organization, adopted by many large mining companies, should not displace, but only complement the traditional methods of attracting personnel to the Arctic oil infrastructure facilities. The use of the combined method of labor organization in the Arctic is the most optimal, allowing to integrate the advantages and localize the disadvantages of other methods of labor organization.
Keywords: *Arctic, oil field, HR strategy, transport and technological system, ecological and economic objects, expert assessment, socio-economic feature.*

Introduction

The stability of Russia's oil industry determines its geopolitical significance in the global community, since it holds the leading positions among oil and gas exporting countries. However, oil and gas reserves increase is significantly lower than production over the past decade. All large fields, which provide the bulk of oil, are in the stage of declining production. The development of new oil and gas producing regions has been practically curtailed. At the same time, the quality of the resource base is deteriorating, since the share of hard-to-recover reserves has exceeded 55%. The third part of oil reserves has a high degree of depletion (70–80%) [1, Gubaydullin M.G. et al.]. In this regard, the effective use and development of the resource base of the Arctic zone of the Russian Federation, aimed at the stable provision of Russia's demand for hydrocarbon resources, appears to be an urgent national economic task. The Russian Federation possesses vast northern

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territories and polar seas, therefore, the development of the resources in the Arctic zone of the Russian Federation (AZRF) is in the sphere of constant interests of Russian oil companies. At the same time, the country's Arctic zone remains very poorly developed. The involvement of Russian Arctic resources, especially the Arctic shelf, into economic circulation is currently taking place to a small extent, which is caused by various objective and subjective factors that were formed in the previous stages of the country's development.

As part of the implementation of the Arctic Zone Development Strategy [1] further development of the northern territories of the Timan-Pechora oil and gas province and hydrocarbon deposits on the continental shelf of the Barents and Kara Seas will be continued. The implementation of large infrastructure projects provides for the integration of the Arctic zone of the Russian Federation with the developed regions of Russia. This document also indicates the need to improve the transport infrastructure in the regions of Arctic continental shelf development in order to diversify the main routes of Russian hydrocarbons supply to the world markets.

The seas of the Arctic shelf of Russia contain huge reserves of hydrocarbons, which should ensure the economic development of the country in the 21st century. According to the latest estimates, up to 80% of Russia's potential hydrocarbon reserves are concentrated on the Arctic shelf. The total initial recoverable hydrocarbon resources (TIR) of the Russian maritime periphery are about 100 billion tons of oil equivalent (TOE) or, according to some authors, tons of fuel oil equivalent (TFOE) in the naphta equivalent (of which 13.5 billion tons of oil and more than 73 trillion m^3 of gas). Recoverable oil reserves amount to more than 400 million tons, and gas reserves are more than 10 trillion m^3. This is despite the fact that the exploration of the TIR of hydrocarbons on the Russian shelf does not exceed 9–12% [2, Gubaydullin M.G.].

The Timan-Pechora province, adjacent to the western part of the Russian Arctic shelf from the south, also has a significant reserve for studying prospective oil and gas territories: only 34 % of the total area of the province has been licensed so far. The total initial recoverable oil resources here amount to 5.6 billion tons, of which more than half (52.1%) are undiscovered resources of the C3+D categories, and the residual reserves of the ABC1+C2 categories amount to 34.6%. Geological TIR of free gas — 3.2 trillion m^3, undiscovered resources of categories C3+D amount to 62.6% [3, Kuranov A.V.].

The rate of exploration, construction and development of oil and gas fields in the northeastern part of the Timan-Pechora oil and gas province, as well as in the western AZRF sector, is largely determined by the availability of transport infrastructure, the development of which, as follows from the analysis of the prospects of poorly explored territories, is an independent task [4, Tutygin A.G. et al.]. In order to select the optimal transportation route for the produced petroleum

[1] Strategiya razvitiya Arkticheskoy zony Rossiyskoy Federatsii i obespecheniya natsional'noy bezopasnosti na period do 2035 goda (utverzhdena Ukazom Prezidenta Rossiyskoy Federatsii ot 26 oktyabrya 2020 g. № 645) [Strategy for Developing the Russian Arctic Zone and Ensuring National Security until 2035 (approved by the Decree of the President of the Russian Federation dated October 26, 2020 No. 645)]. URL: https://www.garant.ru/products/ipo/prime/doc/74710556/ (accessed 20 January 2021).

hydrocarbons from a particular field, it is necessary to consider several options to choose the most economically feasible and environmentally safe one [1, Gubaydullin M.G. et al.; 5, Korobov V.B.]. It is also necessary to take into account socio-economic peculiarities of the fields' development, which significantly increases the effectiveness of the decisions made. First of all, this refers to the validity of the choice by oil and transport companies of an appropriate strategy for providing these processes with qualified labor resources (HR strategies). The latter is not possible without a targeted state policy in terms of social support measures for the population in the territory of the Russian Arctic [6, Lipina S.A., Smirnov O.O., Kudryashova E.V.].

Peculiarities of the ecological and economic assessment of the Arctic zone facilities

The investigated problem of choosing the optimal alternative for location of oil transport infrastructure facilities can be solved by a variety of methods [7, Tutygin A.G., Antipov E.O., Korobov V.B.; 8, Ambrosio L.]. Existence of a large number of methods indicates the complexity of the problem. The difficulty lies in the fact that a large number of various influencing factors, which have varying and even contradictory impact on the final result, have to be taken into account. Therefore, in recent years, expert methods have been widely used in economics to solve this kind of problems, when at the initial stages of project implementation the information available is obviously insufficient or limited for decision making [9, Korobov V.B., Tutygin A.G.; 10, Orlov A.I.]. Their advantage lies in the fact that the technologies based on expert evaluations allow specialists in a given field to evaluate the state of an object, the relationship between its components, compare them with each other and predict the possible consequences based on their knowledge of the subject, extensive research experience and practice. Practice has shown that they are quite applicable for assessing transport alternatives for exporting oil from the western part of the Russian Arctic by sea [5, Korobov V.B.].

Expert assessments are formalized in the form of conclusions and prioritization, which can be expressed explicitly by ranking, and implicitly, when special scales are used to compare factors (situations) with subsequent processing of expert judgments by mathematical methods.

An increasing number of factors influence the analysis of events and decision-making. Often one has to deal with situations where the factors are partially or completely unrelated to each other, which does not allow using the concept of "system" for research. For such cases, the concept of object is proposed, which does not impose any rigid requirements on interrelations between its components, which makes it possible to solve a wider class of problems in various areas of fundamental and applied sciences [11, Korobov V.B., Tutygin A.G., Rusinov O.V.].

Ecological and economic objects, which are the elements of the transport and technological system (TTS) for hydrocarbon raw material export from the Arctic regions, consist of a large number of natural, technogenic and social components. Consideration of such objects as a set of not necessarily dependent components makes it possible to take into account the factors influencing their functioning to a much more complete extent. When solving such problems, the classical

conceptual scheme, which includes a number of stages from goal-setting through modelling and expert assessment to interpretation of the final results, appears to be the most appropriate from a practical point of view (Fig. 1).

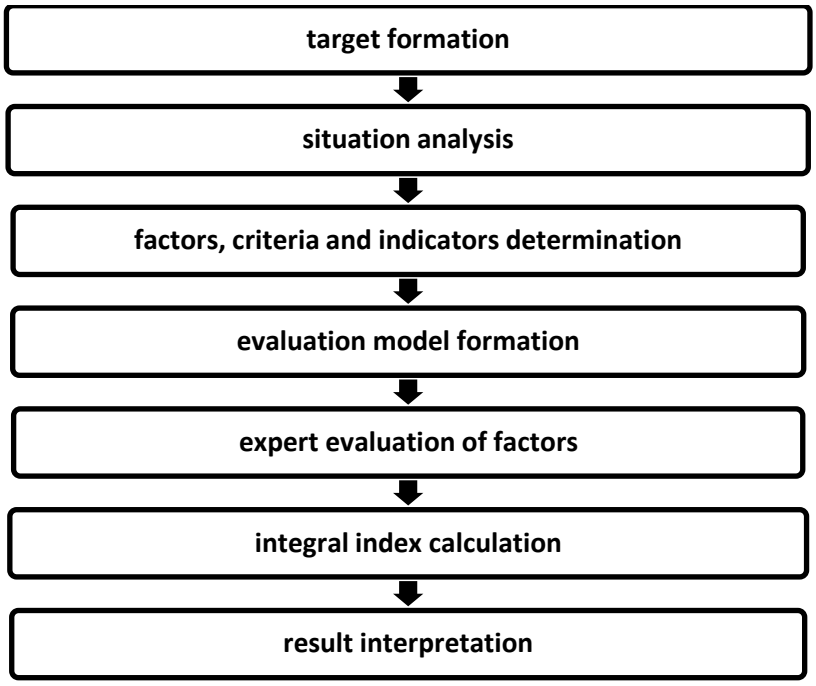

Fig. 1. Conceptual scheme for assessment of ecological and economic objects in the TTS.

When choosing factors for the expert evaluation procedure, one should take into account not only their influence on the transport infrastructure, but also infrastructure facilities influence on the natural environment in case of possible emergency oil spills [12, Nordam T. et al.; 13, Wein R., Bliss L.], since the costs of mitigation, especially in offshore areas, are time-consuming and require considerable expenses. In addition, the delivery of the necessary equipment to the sites of accidents is associated with certain difficulties in unloading it from ships to the shore [14, Eseev M.K. et al.]. Application of scoring classifications with weight coefficients of influencing factors makes it possible to solve successfully the logistics and related ecological and economic problems [9, Korobov V.B., Tutygin A.G.; 15, Gubaydullin M.G. et al.; 16, Tutygin A.G. et al.]. For calculation of weight coefficients of influencing factors, it is more expedient to use the method of ranking factors and, if necessary, analytical networks for their subsequent refinement. In this case, the indicators of factors can be found by any method with their subsequent reduction to a dimensionless form (for example, scores) by constructing appropriate scales. This kind of research is of an interdisciplinary nature, when specialists from different sciences, in close interaction, comprehensively study and evaluate projects for the development of Arctic resources based on the relationship of key indicators and factors.

The expert methods used in such cases, based on systemic knowledge of the subject, extensive experience of previous research and practice, allow specialists in this field to adequately assess the state of an object, the relationship between its components and subsystems, compare them with each other and predict the possible consequences of its further functioning. Based on

information obtained both from theoretical sources and by analyzing empirical material and judgments of experts, evaluation matrices are developed to rank factors that affect the location of oil transport infrastructure facilities. The analysis of such matrices shows the probability of external strategic factors occurrence and the degree of their potential influence both on the facilities themselves and on the external environment during field development. Quantitative estimates of factors are obtained by finding their weight coefficients, which are calculated by the ranking method used in multicriteria estimation tasks.

Analysis methodology of alternatives for oil and gas transport system construction

The main stage of the research sets a task to calculate an integral index for assessing the significance of factors affecting the construction of oil transport infrastructure in the development of fields and the production of Arctic oil, which is necessary for the formation of an integrated ecological and economic model. This model allows conducting a system analysis of factor groups assessment with development and analysis of corresponding matrices. As noted in [7, Tutygin A.G., Antipov E.O., Korobov V.B., p. 208], expert and analytical technologies can be successfully used for modeling when solving problems of placing pipelines, terminals and other objects of oil transport infrastructure.

As an example of the above procedure implementation, let us consider an issue related to choosing an alternative for construction of oil and gas transport infrastructure to deliver hydrocarbons from the Korotaikha Depression to the shipping terminal. In the north-east of the Timan-Pechora oil and gas province within the Korotaikha Depression, there is a significant reserve for increasing the explored raw hydrocarbon base [3, Kuranov A.V.]. It is associated with the involvement in the development of unclaimed promising oil and gas facilities of the zonal and local levels.

A scheme of possible alternative options for the export of hydrocarbon resources from the Korotaikha Depression is shown in Fig. 2. The southern direction (option 1) towards Usinsk and the northern direction to the Varandey terminal (option 2) involve pipeline transportation of oil. Option 3 to Indiga should be considered mainly for the export of natural gas.

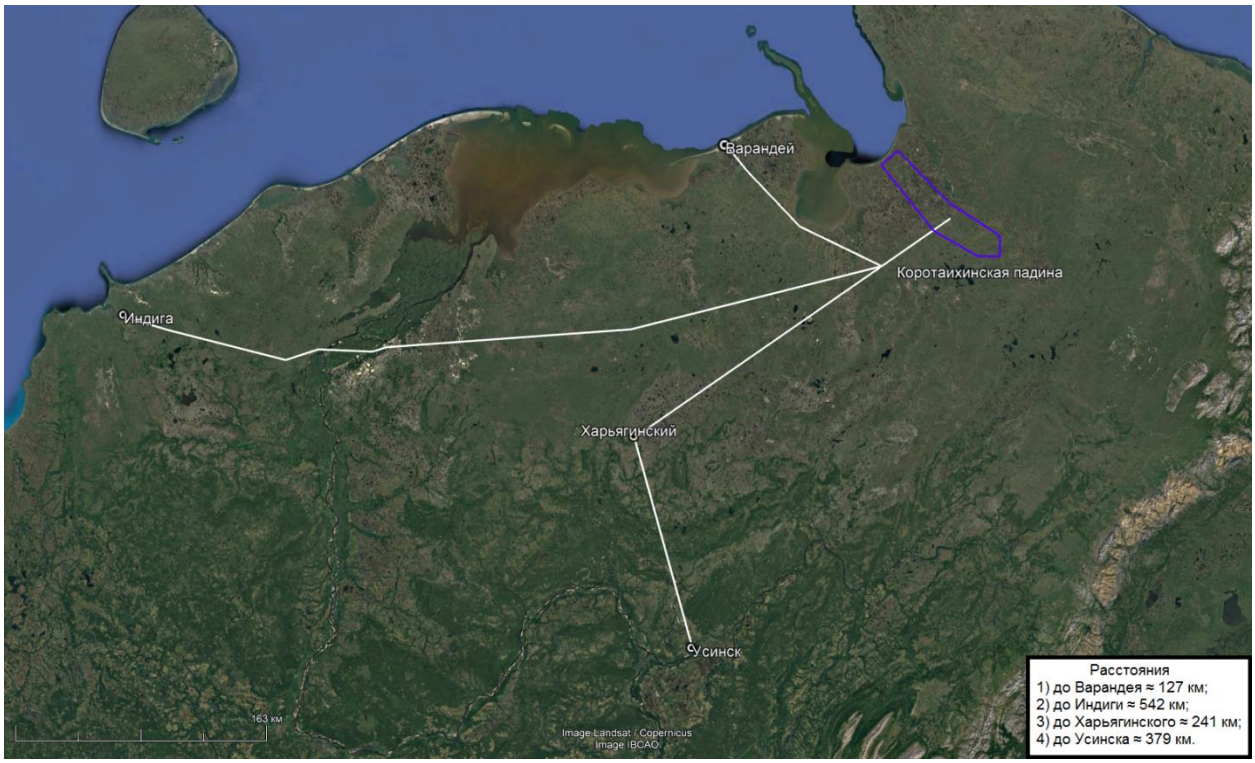

Fig. 2. Scheme of alternatives for transportation of oil hydrocarbons from the Korotaikha depression.

In a first approximation, the problem of choosing the most promising alternative can be solved by ranking the factors, taking into account their weight coefficients [5, Korobov V.B.; 9, Korobov V.B., Tutygin A.G.].

The integral indicator of the alternative is the ranking scores of the factors, taking into account their significance. Calculations are carried out according to the formula $R = \sum_{i,j=1}^{N} k_i r_{ij}$, where R — the total estimate of the alternative rank, and r_{ij} — the rank of i-factor of the j-alternative, k_i — the weight coefficients of the factors.

Labor organization process as an important socio-economic component of the oil transport and technological system

In research [16, Tutygin A.G. et al.], devoted to the assessment of the cost ratio in the construction of oil transport infrastructure in the Arctic, the authors have already conducted a detailed analysis of the influencing economic factors. To make the picture complete, social factors should be added, first of all, the availability of labor resources from both local residents and those recruited from other regions, including for shift work. In fact, the essence of HR-strategy of an oil or transport and technological company operating in the Russian Arctic is in a conscious choice of one or another option for providing facilities with labor resources. Let us consider the example of labor organization at oil pumping stations (OPS).

The main object for labor organization in pipeline system operation is intermediate pumping stations. It should be noted that the number of intermediate pumping stations is determined

by the length of a pipeline at the average rate of one station per 100 km of the route. Table 1 shows qualification characteristics and average number of service personnel.

Table 1

The number of industrial and production staff of OPS

Occupation	Number, people
Head of oil pumping station	1
Mechanic	2
Master on duty	4
Driver	8
Locksmith-repairman	8
Instrumentation locksmith	4
Electrician	4
Driver mechanic	4
Lineman	4
Tank farm operator (if any)	4
Total	43

It should be noted that while it may not be difficult to find a driver of a tracked vehicle in nearby villages, there are often neither a qualified mechanic nor other specialists with the appropriate skills and admission to technological equipment service among the local population. In general, the choice of staffing the oil pumping station — at the expense of the local population, either by shift workers, or in a combined way — is one of the key issues in the personnel policy of oil companies.

On the one hand, the availability of local labor resources is an important social factor, which must be taken into account when ranking oil export options. On the other hand, qualified personnel are often concentrated not in settlements located in the developed territories, but in cities and large industrial centers located far beyond the Arctic zone of the Russian Federation. In connection with the above, HR services of oil and gas companies do not have to rely solely on labor potential, which is formed only at the expense of the local population of the northern territories. Therefore, one of the features of the personnel policy of corporations working in the Arctic for the development of hydrocarbon deposits, including the creation and operation of pipeline transportation system, is the use of a rotational method.

Undoubtedly, the use of the rotational method of labor organization is cost-effective for enterprises, but at the same time, it has a number of significant disadvantages, manifested in negative socio-psychological effects on workers and their families, as well as generating conflict situations in relations with the local population, and considerable costs associated with the delivery of workers. In addition, the long-term presence of “shift workers” in the confined space of the working collective, cut off from the usual habitat, can lead to various kinds of psychological problems, which are described in detail, for example, in works [17, Janis I.L.; 18, Stoner J.; 19, Simonova N.N., Korneeva Ya.A.].

As noted in the work of one of the authors [20, Gubaydullin M.G. et al.], the development of oil and gas resources is still carried out mainly on a rotational basis. Rotational settlements are created both at the stage of construction of transport infrastructure facilities, and during the development and operation of oil and gas fields.

Let us consider some of the advantages and disadvantages of labour organisation by various methods.

Table 2

Comparative analysis of work organisation methods in the North and the Arctic

	Labour organisation methods		
	Rotational	Local population	Combined
Advantages	Factual absence of company costs for creation of new settlements with social infrastructure [2]; Ability to attract highly qualified personnel; Mobility of shift workers; Reduction of costs on transportation of the personnel to the place of work.	Decrease of social tension and unemployment rate in the region; Ensuring an increase of incomes of the local population; Stimulating local development; Promotion of small and medium-sized business development by stimulating solvent demand of the local population for goods and services [23].	Possibility of training service specialists at the level of the Arctic macro-region [24]; Eliminates the conflict of interests in the development of the territory and large business [23]; Has a long history of use in the practice of international companies (Total, EXXON, etc.)
Disadvantages	Lack of developed social infrastructure; Lack of recreational facilities; High social and psychological risks; The high risk of developing various diseases among the staff [21, p. 42]; High costs for medical and professional monitoring of personnel selection; Violation of the principle of balanced development of the territory where hydrocarbon production is carried out; Conflict of interests with the local population, including the indigenous peoples of the North [22].	Lack of the necessary potential at the level of municipalities and settlements of the Russian Arctic to provide corporate business with highly professional labor resources.	The need to make systematic adjustments to the HR policy of corporations in order to achieve a consensus of various social groups and a balance of territorial and public interests [23].

The comparisons of advantages and disadvantages of different labour organization methods given in Table 2 suggest that the choice of one or another variant of personnel policy when recruiting personnel to work at oil infrastructure facilities in the Arctic is far from unambiguous and is associated with a significant number of factors of a different nature. In confirmation of the

[2] Davydova N.S. Sotsial'no-ekonomicheskie problemy primeneniya vakhtovogo metoda organizatsii truda v sovremennykh usloviyakh Rossii [Social and economic problems of application of the rotational method of the organization of work in modern conditions of Russia]. Regional'nye problemy preobrazovaniya ekonomiki [Regional problems of economic transformation]. URL: https://cyberleninka.ru/article/n/sotsialno-ekonomicheskie-problemy-primeneniya-vahtovogo-metoda-organizatsii-truda-v-sovremennyh-usloviyah-rossii (accessed 20 Septenber 2020).

abovementioned it should be mentioned that, for example, according to the results of studies conducted by Russian psychologists [25, Korneeva Ya.A., Simonova N.N., p. 25] found that most of the surveyed employees of oil and gas companies (73.7%) have a high level of situational meteorological response, which indicates an increased sensitivity of workers to weather conditions.

The results of the study on the psychological safety of the personnel during shift work organization in the Arctic conditions are also of interest. In research [26, Tyulyubaeva T.O., Korneeva Ya.A., Simonova N.N., p. 84], on the basis of empirical data, it is shown that a number of professional groups of workers in the rotational work organization are characterized by different levels of psychological safety. The group of the greatest psychological danger includes representatives of the profession of a driver, an operator of a treatment plant, an operator of a boiler room. Engineering and technical workers, oil and gas production operators, maintenance specialists are more resistant to psychological risk factors [26, Tyulyubaeva T.O., Korneeva Ya.A., Simonova N.N., p. 85].

One of the acute problems of resource development in the Arctic is the preservation and development of the activities of the indigenous peoples of the North. It is no secret that intensive production of hydrocarbons causes irreparable damage to the territory of indigenous peoples' habitats and, as a consequence, to their health and demography. So "... in the conditions of a sharp increase in the technogenic and anthropogenic load on the natural complexes of the macroregion, associated with the intensive development of fuel and energy resources, deposits of rare and precious metals, the development of coastal transport infrastructure and a multiple increase in the population created in the Russian Arctic "support zones", the threat of disappearance of indigenous people is formed (there are about 200 Entsy people and less than 100 Vodi people) ..." [22, Pavlenko V.I. et al., p. 26].

It should be noted that for the regions of the Russian Arctic there is another serious problem that aggravates social disproportions — the imbalance of the economic situation, in particular, the dynamics of economic growth and the standard of living of the population, requiring the development and implementation of systemic strategic decisions [27, Tutygin A.G., Chizhova L.A., p. 131]. Thus, the low degree of economic diversification of cities, the monofunctionality of the settlements of the Russian Arctic becomes the cause of unemployment of the local population [28, Kryukov V.A., Skufyina T.P., Korchak E.A., p. 144]. In addition, for the entire territory of the Russian Arctic, the situation of natural population decline and migration outflow of the working age population has become typical [29, Tortsev A.M., p. 116; 30, Voronina L.V., p. 135]. Nevertheless, a very powerful industrial layer has been created in the Arctic zone of Russia, and the scale of economic activity significantly exceeds the indicators of such subarctic countries as Denmark, Norway, Sweden, Finland, Iceland [31, Pavlenko V.I. et al., p. 8].

Unfortunately, today, in the Russian Arctic, "... big business is aimed at a full-scale exploitation of resources in order to obtain the maximum economic result for itself, leaving behind social problems secondary to it. Indeed, local labor resources, and hence the population itself, are often

simply not of interest to corporate structures, which are increasingly using the rotational method of attracting personnel ...” [23, Tutygin A.G. et al., p. 39].

Conclusion

Thus, to summarise the above, the following conclusions can be drawn.

The situation in the oil and gas industry is characterized by a number of problems, including a deterioration in the quality of the raw material base, an increase in the share of hard-to-recover reserves, a poorly developed transport infrastructure, and a number of other environmental, economic and socio-economic characteristics.

Absence of the developed general theory of choice of influencing factors for the formalization of environmental and economic objects aggravates the situations that arise in the process of making strategic decisions related to the formation of a transport and technological infrastructure of oil fields in the Arctic.

The development of theoretical foundations for the choice of logistics flows for the export of hydrocarbons in the development of oil and gas fields in the coastal shelf zone of the south-eastern part of the Barents and Kara Seas using expert methods will allow to make an alternative forecast of a rational scheme formation for the transportation of oil and gas as an integral part of the regional oil and gas complex, taking into account social economic factors, primarily in terms of the provision of qualified labor resources.

The rotational work organisation as a key component of the HR strategies of oil companies should not displace, but can only complement the traditional methods of attracting personnel to the Arctic oil infrastructure facilities. In our opinion, the use of a combined method of labor organisation in the North and the Arctic is the most optimal, allowing to integrate the advantages and localize the disadvantages of other methods of labor organization.

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Military-Political Situation in the Arctic: Hotspots of Tension and Ways of De-Escalation*

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Abstract. The article describes the politico-military situation in the Arctic, including the development of military capabilities of states in the region, the coastal infrastructure, the scales and the manner of military exercises, as well as the dynamics of the military landscape in the Arctic. The authors argue that the military capabilities in most parts of the Arctic remain moderate, primarily due to harsh climate restraints. However, military activity both of NATO member-states and Russia has increased considerably recently in the Euro-Arctic area adjacent to the North Atlantic, in particular in the waters of the Barents and the Norwegian seas. Mutual military deterrence in this area represents a "new old" normal that will shape the security situation in the Arctic in the long term. The article concludes by considering possible options for preventing escalation and minimizing the concerns of the sides by restoring a full, regular and institutionalized military dialogue between Russia and the rest of the Arctic states.
Keywords: *Arctic, Russia, USA, Arctic state, NATO, security, military-political landscape.*

Introduction

In recent years, the nature of the discussion on possible conflict scenarios in the Arctic has changed. Predictions that there are reasons for future conflicts in the region in struggle for the “division” and “redistribution” of the Arctic spaces, resources and shipping routes have proved to be a strong exaggeration [1, Spohr K., p. 64, 123, 210, 226, 361]. However, after the Trump administration (2017–2021) based its national security doctrine on the thesis of the global rivalry between the United States and China and Russia, the question of how such rivalry would affect the military and political situation in the Arctic came into focus [2, Humrich Ch., p. 99–102]. The region today is often viewed as one of the arenas in which the struggle between the United States, Russia and China for global domination will unfold [3, Huebert R.]. In 2019, this thesis was included in the Arctic strategies of the US Coast Guard [1] and the Department of Defense [2]. It formed the basis of the Arctic strategy of the US Air Force (Air Force) [3], announced in the summer of 2020, and the

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[2] Report to Congress. Department of Defense Arctic Strategy. Washington, DoD, 2019.
[3] The Department of the Air Force Arctic Strategy. Ensuring a Stable Arctic through Vigilance, Power Projection, Cooperation, and Preparation. Washington, Secretary of the Air Force, 2020.

updated Arctic strategy of the Naval Forces (Navy) [4] and the US Army (Ground Forces) [5] in January 2021, on the eve of J. Baden's inauguration. The conclusion about growing competition between the leading nations in the region is also shared by the Russian military department [6].

Early signals from the new US administration suggest that military security issues are not at the top of its Arctic agenda. Although Biden is not expected to revise Trump's decisions to partially expand the US presence in the Arctic, the new president does not seem inclined to subject his policy in the region solely to the logic of confrontation with China and Russia and to invest heavily in military construction [7].

In May 2021, cooperation on "peaceful, sustainable economic development and environmental protection in the Arctic" was included by the G7 foreign ministers in a short list of issues on which they are ready to interact with Russia [8]. The speech of Secretary of State E. Blinken at the ministerial session of the Arctic Council in Reykjavik on May 20, 2021 [9], which contrasted sharply with the scrappy speech of his predecessor M. Pompeo in Rovaniemi two years earlier, may indicate Washington's cautious departure from the harsh Arctic rhetoric of the Trump administration.

This tendency, however, may turn out to be unstable against the background of alarmist narratives that still dominate the political discourse [10]. Both in the West and in Russia, the emphasis is on the most threatening scenarios for the development of military-political situation in the region. Western media are full of reports about testing of the Russian nuclear-powered unmanned submarine carrier "Poseidon", test launches of the hypersonic missile "Zircon" in the Northern Fleet, Russian icebreakers armed with missiles, large-scale Russian military construction in the Arctic, etc. All this is presented as a manifestation of Russia's desire to dictate its own rules in the Arc-

[4] A Strategic Blueprint for the Arctic. Washington, Department of the Navy, 2021.

[5] Regaining Arctic Dominance. The U.S. Army in the Arctic. Chief of Staff Paper no. 3. Washington, Department of the Army, 2021.

[6] Ministr oborony Rossii general armii Sergey Shoygu v khode poezdki na Severnyy flot provel rabochee soveshchanie v Severomorske [Russian Defense Minister General of the Army Sergei Shoigu held a working meeting in Severomorsk during a trip to the Northern Fleet]. Ministry of Defence, 13 April 2021. URL: https://structure.mil.ru/structure/okruga/north/news/more.htm?id=12354311@egNews (accessed 09 June 2021).

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[9] Secretary Antony J. Blinken Intervention at Arctic Council Ministerial, Reykjavik, Iceland, May 20, 2021. U.S. Department of State. URL: https://www.state.gov/secretary-antony-j-blinken-intervention-at-arctic-council-ministerial/ (accessed 09 June 2021).

[10] Rumer E., Sokolsky R., Stronski P. Russia in the Arctic — A Critical Examination. Washington: Carnegie Endowment for International Peace, 2021. URL: https://carnegieendowment.org/files/Rumer_et_al_Russia_in_the_Arctic.pdf (accessed 09 June 2021).

tic Ocean. China is credited with ambitions to challenge the Arctic countries, and, if necessary, with the use of force [11].

Russia is paying attention to the growing intensity and scale of military trainings of the US Navy and NATO in the Arctic region, approaching closer to the borders of the Russian Federation [12]. The US and NATO naval exercises military ships trainings in the Barents Sea since 2020 [13], Norway's decision to allow the US nuclear submarines to use the port of Tromsø in the north of the country [4, Anthony I., Klimenko E., Su F., p. 15], temporary deployment of four B-1B Lancer bombers at the Orland air base in the south of the country in February 2021 are regarded by Russia as provocative [14]. The Fundamentals of Russian State Policy in the Arctic, approved in March 2020, notes "a foreign military presence" and "an increase of conflict potential in the region" as one of the challenges to the country's national security [15].

The situation is complicated by the "freezing" of military cooperation with Russia by the Arctic countries since 2014. The lack of channels of regular communication between the militaries at various levels makes it impossible to discuss and resolve emerging concerns, including by agreeing on mutual restraint measures.

In order to maintain and strengthen the trend towards constructive cooperation within the framework of the Arctic agenda, it seems important to solve two problems as a first step. The first one is a *sober assessment of the military-political situation in the Arctic*. The IMEMO RAS uses the following parameters for its monitoring [5, Zagorskiy A.V., p. 20]:

- states' deployment of military assets in the region *on a permanent basis*;
- availability of assets for *temporary (seasonal) deployment* in the Arctic;

[11] Humpert M. U.S. Warns of Russian Arctic Military Buildup: "Who puts missiles on icebreakers?" High North News, 25 May 2020. URL: https://www.highnorthnews.com/en/us-warns-russian-arctic-military-buildup-who-puts-missiles-icebreakers (accessed 09 June 2021); Walsh N.P. Satellite images show huge Russian military buildup in the Arctic. CNN, 5 April 2021. URL: https://edition.cnn.com/2021/04/05/europe/russia-arctic-nato-military-intl-cmd/index.html (accessed 09.06.2021); U.S. Army Arctic Strategy — 2021. SOF News, 19 March 2021. URL: https://sof.news/defense/army-arctic-strategy-2021/ (accessed 09 June 2021).

[12] Nachal'nik shtaba Severnogo flota vystupil na Mezhdunarodnom arkticheskom forume [Chief of Staff of the Northern Fleet spoke at the International Arctic Forum]. Ministry of Defense of the Russian Federation, 11 December 2020. URL: https://function.mil.ru/news_page/country/more.htm?id=12329717@egNews (accessed 09 June 2021).

[13] Nachal'nik Glavnogo operativnogo upravleniya General'nogo shtaba VS RF general-polkovnik Sergey Rudskoy provel brifing dlya predstaviteley SMI [Colonel-General Sergei Rudskoy, Chief of the Main Operations Directorate of the General Staff of the RF Armed Forces, held a briefing for media representatives]. Ministry of Defense of the Russian Federation, 1 June 2020. URL: https://function.mil.ru/news_page/country/more.htm?id=12295316@egNews (accessed 09 June 2021); «V Arktike net problem, trebuyushchikh voennogo resheniya». Posol po osobym porucheniyam MIDa Nikolay Korchunov o predstoyashchem predsedatel'stve Rossii v Arkticheskom sovete ["There are no problems in the Arctic that require a military solution." Ambassador-at-Large of the Foreign Ministry Nikolai Korchunov on Russia's upcoming chairmanship of the Arctic Council]. Kommersant, 15 January 2021. URL: https://www.kommersant.ru/doc/4641929 (accessed 09 June 2021).

[14] SShA podali «signal» Rossii v Arktike [The United States sent a "signal" to Russia in the Arctic]. RIA News, 28 May 2021. URL: https://ria.ru/20210528/signal-1734638832.html (accessed 09 June 2021); U.S. Air Force Personnel Arrive for First-Ever Norway Deployment. U.S. European Command Public Affairs, 2 February 2021. URL: https://www.eucom.mil/article/41056/us-air-force-personnel-arrive-for-first-ever-norway-deployment (accessed 09 June 2021).

[15] Ukaz Prezidenta RF ot 5 marta 2020 g. N 164 «Ob Osnovakh gosudarstvennoy politiki Rossiyskoy Federatsii v Arktike na period do 2035 goda» [Decree of the President of the Russian Federation of March 5, 2020 N 164 "On the Fundamentals of State Policy of the Russian Federation in the Arctic for the Period up to 2035"].

- construction of *coastal infrastructure* for basing and ensuring operational stability of deployed or temporarily deployed assets in the Arctic;
- dynamics of *military exercises* in the region: their *frequency*, *scope* and *scenarios*.

At the same time, it is important to differentiate the conditions for *non-strategic (conventional)* military activity in different parts of the Arctic. They differ significantly in the colder Amerasian and central parts of the Arctic Ocean, constituting the major part of the region, and in the warmer (albeit also complex) "Euro-Arctic" seas adjacent to the North Atlantic [5, Zagorskiy A.V., p. 33; 1, Spohr K., p. 343].

The second task is to resume channels of regular communication between representatives of military departments at all levels to exchange assessments of the operational situation in the region and discuss measures to de-escalate not only military activity, but also rhetoric.

The first section of this article examines the military development programs implemented by the states of the region in the "big" Arctic, plans for the coastal infrastructure development, the scale and nature of military exercises, and the results of the defense policy review conducted by the Arctic states since 2014. In the second section, the dynamics of the military-political situation in the Euro-Arctic region is considered, and the third focuses on the possibilities for developing risk mitigation mechanisms, to be formed mainly in the "Euro-Arctic" part of the region.

Non-strategic forces in the "big" Arctic

With the exception of the Russian Federation, the Arctic states **do not permanently deploy non-strategic combat forces in the region**. For Russia and the United States, the Arctic is of particular importance mainly in the context of maintaining the strategic balance of nuclear deterrence. Most of the Russian naval strategic nuclear forces are based on the Kola Peninsula as part of the Northern Fleet. Russian and American anti-missile, anti-aircraft and anti-submarine defense facilities, and the US missile attack warning radar system are deployed in the region. In recent years, in the context of the return of Russia and NATO to the policy of mutual military deterrence in Europe, the military-political importance of the Arctic waters adjacent to the North Atlantic has increased.

Due to the harsh natural and climatic conditions, remoteness, underdevelopment of coastal infrastructure and other circumstances, non-strategic military construction in the "big Arctic" is considered not only costly, but also impractical. Climate change does not reduce, but rather increases the risks associated with military (and any other) activities in most of the marine and land Arctic, not only in winter, but also in summer [6, Soldatenko S.A., Alekseev T.V., Ivanov N.E. et al., p. 57–60; 7, Konovalov A.M., p. 139; 8, Christensen K.D.; 9, Balasevicius T., p. 25–26]. This circumstance is emphasized in the documents of the military authorities of the Arctic countries [16].

[16] Rapport: Forsvarsministeriets fremtidige opgaveløsning i Arktis. København: Forsvarsministeriet, 2016, p. 15; Regaining Arctic Dominance. Op. cit. P. 4; Report to Congress on Arctic Operations and the Northwest Passage. Washing-

While in winter the naval activity in the region is hampered by the ice cover, during the period of its melting in summer and autumn navigation is complicated by poor visibility, the danger of collision with drifting ice floes and icing, and many other factors [17].

During the most favorable period for Arctic navigation, many naval ships can be temporarily deployed in the Arctic seas and navigate through "clear water" up to the ice edge at low speed, avoiding collisions with drifting ice. During this period — from July to October — ships of the Northern Fleet make voyages along the water area of the Northern Sea Route. Nevertheless, the optimal solution for the implementation of regular surface naval activities and autonomous navigation in the Arctic is the construction of special ice-class ships. In order to ensure the operational sustainability of this activity, large-scale investments are required in the construction of coastal infrastructure, logistics and supply system for the fleet, communications, a large amount of hydrographic and cartographic work [10, Forget P.] [18].

Building special ships for the Arctic is not just costly. In terms of their tactical, technical and operational characteristics — speed, maneuverability, energy efficiency and others — they are inferior to modern naval ships, and their use outside the Arctic region is considered ineffective and inexpedient [19].

It is not surprising that the number of warships that the Arctic states could **temporarily deploy in the region** is extremely limited (non-Arctic countries have none at all [20]). The *Danish* Navy has four ice-reinforced Tethys-class patrol frigates built in the early 1990s. On a rotational basis, frigates patrol the waters of Greenland and the Faroe Islands, solving the tasks of the coast guard. In 2008–2017, the Danish Navy replaced three Agdlek-class patrol ships with Knud Rasmussen-class ships patrolling in the territorial sea of Greenland [5, Zagorskiy A.V., p. 91].

Canada is lagging significantly behind schedule in implementing the 2008 program to build six Gary De Wolfe-class Arctic patrol ships with light ice reinforcements for the Navy, capable of breaking ice up to 1.2 m thick. Based in the south of the country in Halifax, they will be deployed in Arctic latitudes from July to October for missions similar to those of the Coast Guard. The first

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ton: Department of Defense, 2011, p. 11–12; Report to Congress. Department of Defense Arctic Strategy, 2019, p. 3; The United States Navy Arctic Roadmap for 2014 to 2030. Washington: Chief of Naval Operations, 2014, p. 3.

[17] Arctic Planning. Navy Report to Congress Aligns with Current Assessments of Arctic Threat Levels and Capabilities Required to Execute DOD's Strategy. Washington: United States Government Accountability Office, 2018, p. 7; Bowes M.D. Impact of Climate Change on Naval Operations in the Arctic. Alexandria (VA): Center for Naval Analysis, 2009, p. 11. URL: https://www.cna.org/CNA_files/PDF/D0020034.A3.pdf (accessed 09 June 2021).

[18] See also Khramchikhin A. Severnyy fot podvesti ne dolzhen [A. Khramchikhin. The Northern Fleet Shouldn't Fail] // Nezavisimoe voennoe obozrenie [Independent Military Review]. 27 July 2018. URL: http://nvo.ng.ru/armament/2018-07-27/1_1006_fleet.html (accessed 09 June 2021); Arctic Planning. p. 11, 13–14; Bowes M.D. Op. cit. P. 30, 39; Report to Congress on Arctic Operations and the Northwest Passage, p. 3.

[19] Arctic Planning. p. 11–14.

[20] The only exception is, perhaps, the United Kingdom. British submarines of the Trafalgar class are capable of scuba diving in Arctic waters and surfacing in ice-covered areas. The British Navy also has an ice-reinforced patrol ship, the Protector, capable of breaking ice up to half a meter thick. Most of the time, the vessel is engaged in the South Atlantic and Antarctic. See: On Thin Ice: UK Defence in the Arctic. Twelfth Report of Session 2017–19. House of Commons, Defence Committee, 2018, p. 34, 39. URL: https://publications.parliament.uk/pa/cm201719/cmselect/cmdfence/388/388.pdf (accessed 09 June 2021).

ship of this series was commissioned the Canadian Navy in the summer of 2020. The program is planned to be completed in 2025 [21].

In 2017, an icebreaker of the Ilya Muromets-class came online in the Russian Northern Fleet, and in 2019 — the patrol ship Ivan Potanin, comparable in its characteristics with the Danish frigates Tetis [5, Zagorskiy A.V., p. 60].

The *Norwegian* Navy does not have ice-reinforced ships, but there are five Fridtjof Nansen-class frigates and six Ula-class diesel-electric submarines that can be deployed in the ice-free waters of the Norwegian and Barents Seas [12, Wezeman S.T., p. 12–13]. The U.S. Navy also has no ships with ice reinforcements. Until recently, they have refused to build them, citing their high cost and inexpediency, given the low level of military threats in the Arctic [22]. Despite the change in the tonality of the US Navy's Arctic strategy 2021, the issue of building ice-class ships is not raised in it.

There are ships with icebreaking capabilities in the Coast Guard of Canada, Norway and Russia. In 2019, the United States decided to replace two old Coast Guard icebreakers, built in 1976–1978, with three new ones ("Polar Security Cutters"). The first of them should be built in 2024. The long term plan is to build a total of six new icebreakers for the US Coast Guard [23].

With the exception of Russia, Arctic naval warships that could be deployed in polar waters are not permanently based in the region and cannot "operate" in the Arctic year-round. The analysis of the planned **defense policy reviews** conducted by the Arctic countries after 2014 has shown that none of them have revised their previously adopted modest military construction programs in the region upwards [5, Zagorskiy A.V., p. 96–103].

In the greater (freezing) part of the Arctic region, there is practically no **coastal infrastructure** that could ensure the operational stability of seasonal naval activities, not to mention the permanent deployment of naval forces and assets in the region. Moreover, melting permafrost, storms and erosion of the coastline threaten existing and impede the construction of new coastal infrastructure [24].

However, in 2021, the United States approved a plan to build a deep-water port in Nome on the Pacific coast of Alaska [25]. Located about 250 km south of the Bering Strait, the port, which

[21] Arctic and offshore patrol ships. Government of Canada. URL: https://www.canada.ca/en/department-national-defence/services/procurement/arctic-offshore-patrol-ships.html (accessed 09 June 2021).
[22] Arctic Planning, pp. 10, 16; Regaining Arctic Dominance. The U.S. Army in the Arctic. P. 4; O'Rourke R. et al. Changes in the Arctic: Background and Issues for Congress. Congressional Research Service Report, May 17, 2021. URL: https://fas.org/sgp/crs/weapons/RL34391.pdf (accessed 09 June 2021); Schreiber M. The US Navy's new Arctic strategy is limited in scope and details, say critics, Arctic today, 29 April 2019. URL: https://www.arctictoday.com/the-us-navys-new-arctic-strategy-is-limited-in-scope-details-say-critics/ (accessed 09 June 2021).
[23] O'Rourke R. Coast Guard Polar Security Cutter (Polar Icebreaker) Program: Background and Issues for Congress. Congressional Research Service Report, March 11, 2021. URL: https://fas.org/sgp/crs/weapons/RL34391.pdf (accessed 09 June 2021).
[24] Report to Congress. Department of Defense Arctic Strategy (2019). P. 3; O'Rourke R. et al. Op. cit. P. 46.
[25] Arkticheskiy byulleten': Monitoring sotsial'no-ekonomicheskogo razvitiya Arkticheskoy zony Rossii. 2021. Vypusk 61 [Arctic Bulletin: Monitoring the socio-economic development of the Arctic zone of Russia. 2021. Issue 61 (February)],

freezes from November to May, has for many years been considered as the northernmost point for the possible construction of a deep-water port to ensure the safety of navigation in the region and the potential basing of US Coast Guard patrol ships (their main base is located in the port of Dach Harbor on the Aleutian islands, and the Coast Guard icebreakers are based on the west coast of the United States in Seattle). Nome could potentially be used for the temporary deployment of warships in US Arctic waters, which is envisaged in the Navy's plans as a long-term prospect. A ship supply station was established in northern Canada in Nanisivik, Nunavut province, in accordance with a program approved in 2008 [12, Wezeman S.T., p. 7] [26]. This, in fact, limits infrastructure projects (not including Russian ones) in the "big" Arctic.

Neither Denmark nor Canada has permanently stationed **ground forces** in the region, although it is possible to deploy them temporarily if necessary. A few troops and subdivisions of the Norwegian armed forces are evenly distributed over the territory of the country [5, Zagorskiy AV, p. 76–78, 81, 83]. The United States does not have military bases beyond the Arctic Circle, but there are three US Army bases in southern Alaska, in the subarctic zone — Fort Wainwright, Fort Greeley and the joint Elmendorf-Richardson Air Force base. 11600 servicemen are permanently stationed in two brigades. These forces are part of the Indo-Pacific Command of the United States, while the Northern Command, which is responsible for Alaska, does not have its own forces and assets there [27]. The US Army's Arctic Strategy 2021 outlined the prospect of creating a headquarters structure and a task force in Alaska that could be deployed in different regions of the world with similar climatic conditions [28].

After the end of the Cold War, the Norwegian ground forces were reduced to a single mechanised brigade "Nord", which includes two mechanised battalions and a light infantry battalion. The brigade is located mainly in the central part of the Troms province, north of the Arctic Circle [12, Wezeman S.T., p. 11] [29]. Against the background of the growing crisis in in Russian-Western relations and a return to mutual military deterrence, the most heated discussion of plans for military construction after 2014 took place in Norway.

During the planned review of the country's defence policy in 2015–2016 and 2019–2020, the General Staff, referring to the change in the security situation in the country, suggested a significant strengthening of the armed forces. It was proposed, in particular, to double the size of the armed forces, to create a second brigade of ground forces, concentrate them in the north of the

p. 29. URL: https://963a4334-2b68-4690-8cbf-11e0da0f83f6.filesusr.com/ugd/f29d46_722bb033915c4d65be28b24bb2b95b6c.pdf (accessed 09 June 2021).

[26] Wezeman S.T. Military capabilities in the Arctic: A new cold war in the High North? SIPRI Background Paper. 2016. P. 7. URL: https://www.sipri.org/publications/2016/sipri-background-papers/military-capabilities-arctic (accessed 09 June 2021).

[27] Regaining Arctic Dominance. The U.S. Army in the Arctic. Pp. 6–7.

[28] Rempfer K. Army's new Arctic strategy aims to build expeditionary capability. Army Times, 17 March 2021. URL: https://www.armytimes.com/news/your-army/2021/03/17/armys-new-arctic-strategy-aims-to-build-expeditionary-capability/ (accessed 09 June 2021).

[29] See also Khramchikhin A. Strana boevykh ledokolov [Khramchikhin A. Country of Combat Icebreakers]. Voenno-promyshlennyy kur'er [Military Industrial Courier]. 17 August 2016. URL: http://vpk-news.ru/articles/31866 (accessed 09 June 2021).

country and increase the level of combat readiness, significantly increase the number of tactical aircraft, patrol aircraft, air defense systems, tactical helicopters and helicopters for the Navy, purchase an additional new submarine and two frigates [30].

However, in the long-term military plans for 2016 and 2020, the ambitious proposals of the General Staff were largely rejected, and the approved plans are even more modest than the previous ones. Instead of a significant build-up of a permanent military presence in the north, the Norwegian government has focused on modernising early warning capabilities on the one hand, and on developing a reinforcement infrastructure with NATO countries (temporary deployments) in a threat period on the other [31].

Since 2014, **there has been little change in the scope of military exercises conducted by the Arctic states in the region, but the nature of the exercises has changed**.

The largest exercise, held annually in the Canadian Arctic since 2007 (Operation Nanook), is practicing the interaction of the military and civilian agencies in emergencies. The maximum number of participants in these studies was registered in 2010–2012. Against the background of the crisis in Russia's relations with the West, the scenarios, intensity and nature of the exercises conducted in northern Canada have not changed [32]. The country's 2019 Arctic strategy announced a revision of the "Operation Nanook" concept [33]. However, in 2020 and 2021, their scale was reduced due to the pandemic [34].

The main winter combat training for the Norwegian Armed Forces since 2006 is the Cold Response exercise. Since 2010, they have been held every two years instead of annually. Invitations to participate are sent to NATO countries, as well as Finland and Sweden. The number of military personnel which took part in the Cold Response did not increase after 2014. Some increase

[30] Norwegian Armed Forces in transition. Strategic defence review by the Norwegian Chief of Defence. Abridged version. Norwegian Armed Forces, 2015. P. 5. URL: http://isbirligi.ssm.gov.tr/Lists/Duyurular/Attachments/103/Norway%20Strategic_Defence_Review_2015_abridged.pdf (accessed 09 June 2021); A stronger defence. The military advice of the Chief of Defence 2019. Abridged version. [Oslo]: Norwegian armed forces, 2019. URL: https://forsvaret.no/en/newsroom/news-stories/a-stronger-defence (accessed 09 June 2021).

[31] Capable and Sustainable. Long Term Defence Plan. [Oslo]: Norwegian Ministry of Defence, 2016. URL: https://www.regjeringen.no/globalassets/departementene/fd/dokumenter/rapporter-og-regelverk/capable-and-sustainable-ltp-english-brochure.pdf (accessed 09 June 2021); The defence of Norway. Capability and readiness. Long Term Defence Plan 2020. [Oslo]: Norergian Ministry of Defence, 2020. URL: https://www.regjeringen.no/contentassets/3a2d2a3cfb694aa3ab4c6cb5649448d4/long-term-defence-plan-norway-2020---english-summary.pdf (accessed 09 June 2021).

[32] Operation NANOOK. Government of Canada. URL: https://www.canada.ca/en/department-national-defence/services/operations/military-operations/current-operations/operation-nanook.html (accessed 09 June 2021).

[33] Arctic and Northern Policy Framework: Safety, security, and defence chapter. Government of Canada. 2019. 10 September. URL: https://www.rcaanc-cirnac.gc.ca/eng/1562939617400/1562939658000 (accessed 09 June 2021).

[34] See: Military exercises. National Defence and the Canadian Armed Forces. Government of Canada. 2019. 5 February. URL: http://dgpaapp.forces.gc.ca/en/exercises/index.html (accessed 09 June 2021).

was expected in 2020, but the exercises had to be canceled due to the pandemic [5, Zagorskiy A.V., p. 104–107] [35].

However, *the nature of the exercises in Norway has changed* in recent years. While previously the Cold Response scenarios were focused on increasing the level of interoperability and practicing interaction skills as part of multinational formations participating in international crisis management operations, today's scenarios are based on the possibility of a crisis situation in the North of Europe requiring the redeployment of NATO allied forces to Norway under Article 5 of the Washington Treaty. This scenario was also the basis for the NATO Trident Juncture exercise, which took place in autumn 2018 in Norway and the North Atlantic. They were attended by about 50 thousand servicemen of 31 states (29 NATO countries, Finland and Sweden), 250 combat aircraft, 65 warships, about 10 thousand combat vehicles [5, Zagorskiy A.V., p. 107].

These exercises are cited as an example of building up the scale of NATO's military activities in northern Europe [36]. However, they were not a regular event of combat training in the region. Such exercises were conducted by NATO every three years in different regions of Europe. Today they have been replaced by the Defender of Europe, an exercise that focuses on the redeployment of forces from the U.S. to Europe. The 2022 Cold Response exercise may set a new scale for Norwegian combat training. It is expected to be the largest since the end of the Cold War [37]. It should be assumed that in the future, *temporary Allied deployments* to Norway will become the norm. However, this *does not imply a permanent deployment* of alliance forces in the country.

The *US* European Command does not conduct independent exercises in northern latitudes, but participates in combat training events organised by the Nordic countries — Cold Response, the Arctic Challenge Regional Air Force Exercise, and others. The Indo-Pacific Command has regularly conducted tactical exercises "Northern Edge" in sub-arctic latitudes in the Gulf of Alaska since 1993. In the early 1990s, they were attended by from nine up to fifteen thousand servicemen, in the 2000s — up to nine thousand [38]. In 2015, the Northern Edge exercise involving 6000 military personnel worked out a scenario for responding to a crisis situation in the Asia-Pacific region. The US Northern Command, in cooperation with the Coast Guard, organizes the SAREX exercise in Alaska on the interaction of the armed forces, the coast guard and civilian authorities in the course of search and rescue operations [5, Zagorskiy A.V., p. 108–109] [39].

In recent years, the nature of military training activities conducted by the United States in the northern latitudes has changed. For the first time in three decades, the Northern Edge exer-

[35] See also Norvegiya otmenila sovmestnye s NATO ucheniya Cold Response [Norway canceled joint Cold Response exercise with NATO]. Interfax, 11 March 2020. URL: https://www.interfax.ru/world/698624 (accessed 09 June 2021).
[36] O'Rourke R. et al. Op. cit. P. 28.
[37] Norvegiya planiruet provesti «gigantskie» ucheniya u granits Rossii [Norway plans to conduct "giant" exercises near the borders of Russia]. Federal News Agency, 21 November 2020. URL: https://riafan.ru/1339558-norvegiya-planiruet-provesti-gigantskie-ucheniya-u-granic-rossii (accessed 09 June 2021); O'Rourke R. et al. Op. cit. P. 43.
[38] Joint Exercise Northern Edge Ensures Maritime Security. America's Navy, 17 June 2009. URL: http://www.navy.mil/submit/display.asp?story_id=46241 (accessed 09 June 2021).
[39] In the late 1980s, up to 26 thousand servicemen took part in exercises in Alaska. See: Northern Edge History. U.S. Air Force Fact Sheet, 9 May 2007. URL: http://www.firebirds.org/menu23/nedgehistory.htm (accessed 09 June 2021).

cise scenario in 2018 envisaged organization of defensive actions in low Arctic temperatures. About 1500 military personnel took part in practical shooting exercises at the Indo-Pacific Command ranges on the southern coast of Alaska [40]. With the adoption of the US Army's Arctic strategy in 2021, such exercises are likely to become regular.

In 2019, the US Navy conducted the first "Arctic expeditionary potential" exercises announced in the 2019 US Department of Defense's Arctic strategy, on the southern coast of Alaska with the use of Coast Guard bases in the Aleutian Islands. About three thousand marines took part in it [41]. The US Navy's multi-purpose submarine patrolling in the Arctic Ocean became more intensive. In 2018, a British submarine conducted joint exercises with the US Navy in the western part of the Arctic Ocean. In May 2020, for the first time since the 1980s, a five-day exercise of the US and British navies took place in the Barents Sea [1, Spohr K., Hamilton D.S., p. 202–203] [42], and in September 2020 — joint exercises of ships of Denmark, Norway, Great Britain and the United States [43].

Based on this review, it can be concluded that the Arctic NATO member states

- do not deploy significant combat forces in the Arctic on a permanent basis;
- do not invest heavily in the construction of coastal infrastructure in the region;
- change the nature of their exercises, taking into account the return to the policy of containment of Russia, although until recently they did not increase their scale and intensity.

The United States, whose military presence in the Arctic until recently was practically minimal, made a choice in favor of the gradual formation of a potential for the temporary deployment of forces and assets in the Arctic latitudes.

This picture will be incomplete without taking into account the intensification of Russia's military activity in the Arctic in the last decade. In 2012, for example, in Pechenga District of Murmansk Oblast and in the Barents Sea, an inter-service command post exercise involving over seven thousand servicemen, over 20 surface ships and submarines was conducted. In 2013, a large-scale exercise by the Pacific Fleet ended with an amphibious assault landing on the coast of Provideniya Bay. The operation was attended by about three thousand military personnel, more than ten ships and support vessels. In 2015, 38 thousand servicemen, 3360 units of military equipment, 41 warships, 15 submarines, 110 aircraft and helicopters were involved in a snap check of the combat

[40] Arctic Edge Exercise Dates Announced. Defense Visual Information Distribution Service. 2018. 12 February. URL: https://www.dvidshub.net/news/265770/arctic-edge-exercise-dates-announced (accessed 09 June 2021).
[41] Eckstgein M. Navy, Marines Practice 'Littoral Combat Force' Construct in Alaska. USNI News. 2019. 23 September. URL: https://news.usni.org/2019/09/23/navy-marines-practice-littoral-combat-force-construct-in-alaska (accessed 09 June 2021).
[42] See also U.S., U.K. Ships Operate in the Barents Sea. U.S. 6th Fleet official web-site, 4 May 2020. URL: https://www.c6f.navy.mil/Press-Room/News/Article/2174342/us-uk-ships-operate-in-the-barents-sea/ (accessed 09 June 2021).
[43] Danilov P. International Exercise in the Barents Sea: Norway Wants to Assert Its Defense Capacity in the Arctic. High North News, 9 September 2020. URL: https://www.highnorthnews.com/en/international-exercise-barents-sea-norway-wants-assert-its-defense-capacity-arctic (accessed 09 June 2021).

readiness of the Arctic group of forces, individual formations of the Western Military District and the airborne troops. From July to September 2016, monthslong exercises were held in the Northern Fleet. In 2018, a Northern Fleet detachment consisting of 36 surface ships, submarines and support vessels made a transarctic transition from the Barents Sea to the Bering Sea and back. In 2019, during a two-month long-distance cruise of a detachment of warships and support vessels of the Northern Fleet, more than ten large-scale exercises were held at sea and on land [5, Zagorskiy A.V., p. 109–112]. In August 2020, the forces of the Pacific Fleet took part in the Ocean Shield naval exercise. In the water area of the Bering Sea, on the Chukotka Peninsula and in Kamchatka, 30 warships and support vessels, more than three thousand servicemen were involved [44]. The Northern Fleet is carrying out an intensive training programme in 2021 [45].

Political-military dynamics in the Euro-Arctic region

The changes in the politico-military situation outlined above are characteristic primarily for the Euro-Arctic part of the region, adjacent to the North Atlantic, and less significant in the "Amerasian" Arctic and the central part of the Arctic Ocean. This is due to a number of circumstances.

Firstly, difficult natural and climatic conditions, high military construction costs and the seasonal nature of ice cover retreat continue to limit regular military activities in most of the Arctic region. In the summer-autumn period, the greatest losses of sea ice are observed in the East Siberian Sea and significant losses are in the Kara, Laptev, Chukchi and Beaufort seas, then in winter the main losses of the ice cover are in the Barents Sea, while the main part of the Arctic Ocean is covered with ice [46]. The Barents and Norwegian Seas are the most accessible for various activities, including military ones. The coastal infrastructure is more developed here, the population density is higher [47]. But a significant part of the Arctic Ocean waters for the foreseeable future for most of the year will remain inaccessible even for the temporary deployment of surface forces [48]. The boundaries of the Arctic, which differ in their natural and climatic conditions, may serve as a conventional boundary for applying the provisions of the Polar Code, which contains requirements for ships navigating in polar waters (Fig. 1).

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[44] V Beringovom more zavershilis' ucheniya Tikhookeanskogo flota [Exercises of the Pacific Fleet ended in the Bering Sea]. Ministry of Defense of the Russian Federation, 1 September 2020. URL: https://function.mil.ru/news_page/country/more.htm?id=12311532@egNews (accessed 09 June 2021).

[45] Sily i voyska Severnogo flota v ramkakh ucheniya razvernulis' v Barentsevom more i na Kol'skom poluostrove [The forces and troops of the Northern Fleet, as part of the exercise, deployed in the Barents Sea and on the Kola Peninsula]. Ministry of Defense of the Russian Federation, 20 April 2021. URL: https://function.mil.ru/news_page/country/more.htm?id=12357075@egNews (accessed 09 June 2021); Podlodki i korabli Severnogo flota nachali ucheniya v Arktike [Submarines and ships of the Northern Fleet begin exercises in the Arctic]. Interfax, 20 April 2021. URL: https://www.interfax.ru/russia/762239 (accessed 09 June 2021); Severnyy flot vyvel na ucheniya v Barentsevom more 20 korabley i podlodok [Northern Fleet brings 20 ships and submarines to exercise in the Barents Sea]. Interfax, 7 June 2021. URL: https://www.interfax.ru/russia/771027 (accessed 09 June 2021).

[46] Meredith M., Sommerkorn S. et al. Polar Regions. IPCC Special Report on the Ocean and Cryosphere in a Changing Climate. H.-O. Pörtner, D.C. Roberts, V. Masson-Delmotte et al., eds. IPCC, 2019. Pp. 222–223, 207, 260–261. URL: https://www.ipcc.ch/site/assets/uploads/sites/3/2019/12/SROCC_FullReport_FINAL.pdf (accessed 09 June 2021).

[47] Report to Congress. Department of Defense Arctic Strategy [2019]. P. 9.

[48] The United States Navy Arctic Roadmap for 2014 to 2030. P. 3, 8, 10–12.

Secondly, the main arena of mutual military deterrence between Russia and NATO is Europe and the North Atlantic. The Arctic seas adjacent to the North Atlantic — the Norwegian and the Barents seas — are today, as during the Cold War, an integral part of this activity. For this reason, many of the alliance's decisions in recent years have had an impact on the politico-military situation in the Euro-Arctic, although the increase in military activity there lags significantly behind its scale in the Baltic and the Black Sea. The region is given special significance by the fact that Russian strategic submarines with ballistic missiles on board are based on the Kola Peninsula, and any intensification of military activities by the United States and NATO countries in the Barents Sea cannot but cause concern in Russia.

Fig. 1. Boundaries of the application of the Polar Code provisions [49].

The main decisions of recent years, adopted by Western countries in the broader context of Russian military deterrence and affecting the Euro-Arctic region, include the following.

The policy of deterring Russia on NATO's eastern flank in the Baltic region does not presuppose the permanent deployment of significant military forces there, but *building infrastructure and reinforcement capabilities* by transfer forces from other alliance states and the United States. The same approach is applied in Northern Europe [4, Anthony I., Klimenko E., Su F., p. 14], primarily in Norway. The task of strengthening the Norwegian forces was practiced in 2018 during the Trident Junction exercise and served as the basis of future scenarios for the Cold Response exercise.

In order to ensure the redeployment of troops from the United States to Europe in 2018, it was decided to replace the NATO Atlantic Command that was disbanded in 2002 with two new structures: the Joint Atlantic Command (Norfolk, USA) and the Joint Logistics Command in Germa-

[49] Source: International Maritime Organization.

ny. The *US Second Fleet*, disbanded in 2011, was reconstituted in 2019 to ensure the safety of transatlantic sea communications [5, Zagorskiy A.V., p. 46]. Its area of responsibility includes the North Atlantic and the Euro-Arctic seas — the Norwegian and Barents [50].

The *anti-submarine Greenland – Iceland – UK gap (GIUK)* is being restored (Fig. 2), which during the Cold War was supposed to prevent Soviet Northern Fleet nuclear submarines from entering the North Atlantic in the event of a crisis. For this purpose, the U.S. decided to upgrade the airstrip at its base in Thule, Greenland, which until recently had been used solely for the radar of the American missile attack warning system [51]. The Keflavik air base in Iceland, which the US has not used since 2006, was upgraded to serve as a base for anti-submarine, transport and fighter aircraft of NATO countries. A maritime operations centre will be created there in 2019 and will work in close cooperation with the US Second Fleet [52]. The decisions on strengthening the anti-submarine defence forces of Denmark and Norway, renewal of the military planning of the UK for the Euro-Arctic region [11, Todorov A.A., Lyzhin D.N., p. 88–90] [53], including the decision of London to procure new anti-submarine warfare aircraft (in 2010, the UK gave up the old ones) fit into the logic of rebuilding the North Atlantic waterfront [54]. The expediency of such measures is justified by the resumption of Russian submarines' cruises in the North Atlantic.

With the restoration of the anti-submarine line in the Norwegian Sea, the *alliance's annual anti-submarine exercises* with the participation of multipurpose submarines and GMW destroyers "Swift Mongoose", which have been held since 2012 in the North Sea, have shifted [55]. In April 2021, Norway and the United States signed an additional agreement on defense cooperation, which will enable the United States to use the Norwegian Air Force facilities after modernization in the south and north of the country for the temporary deployment of R-8 anti-submarine aircraft and B-1 bombers, as well as the base Ramsund Navy to service US ships and submarines [56].

[50] U.S. 2nd Fleet Reactivates to Counter Russian Navy. The Maritime Executive, 31 December 2019. URL: https://www.maritime-executive.com/article/u-s-2nd-fleet-reactivated-to-counter-russian-navy (accessed 09 June 2021).
[51] Report to Congress on Strategy to Protect United States National Security Interests in the Arctic Region. P. 11.
[52] Op. cit. P. 15.
[53] See also On Thin Ice: UK Defence in the Arctic.
[54] Nordenman M. Russian Subs Are Reheating a Cold War Chokepoint. Defense One, 4 March 2016. URL: https://www.defenseone.com/ideas/2016/03/russian-subs-are-reheating-cold-war-chokepoint/126428/ (accessed 09 June 2021).
[55] «Stremitel'nyy mangust» ishchet rossiyskie submariny v Atlantike ["Swift Mongoose" is looking for Russian submarines in the Atlantic]. Voenno-promyshlennyy kuryer [Military Industrial Courier], 29 June 2020. URL: https://vpk-news.ru/news/57561$ (accessed 09 June 2021); Eckstein M. NATO Anti-Submarine Exercise Dynamic Mongoose Kicks Off With U.S. Destroyer, SSN. UBNI News, 30 June 2020. URL: https://news.usni.org/2020/06/30/nato-anti-submarine-exercise-dynamic-mongoose-kicks-off-with-u-s-destroyer-ssn (accessed 09 June 2021).
[56] O'Rourke R. et al. Op. cit. P. 44.

Fig. 2. The anti-submarine line Greenland — Iceland — Great Britain [57].

It is not a question of permanently deploying US forces and assets in Norway (in 2020, it was reported about the withdrawal from the country's territory of the US Marine Corps battalion, which was deployed in 2017 to ensure the American troops redeployment to participate in the exercises [58]), but about the possibility of their temporary deployment. At the same time, *the Euro-Arctic territories and water areas are viewed in the United States and NATO not as an independent space, but as a continuation and component of the North Atlantic area of naval activity*.

The same can be said for the Russian Northern Fleet. In addition to solving the main tasks of ensuring the operational stability of the country's naval strategic forces based on the Kola Peninsula, it has always been focused on actions in the North Atlantic, not in the Arctic [59]. Limited tasks to protect the interests of the Russian Federation in the Arctic zone appeared in its portfolio quite recently. The most intensive combat training activities of the Northern Fleet forces both in winter and in summer are held *in the waters of the Barents, Norwegian and White Seas*, and lately in the North Atlantic as well. So, in 2019, the forces of the Northern Fleet were for the first time represented on a large-scale basis in the Ocean Shield inter-fleet exercise in the waters of the Northern and southern parts of the Norwegian Seas, which involved more than 4.5 thousand military personnel, over 20 warships, submarines and support vessels, up to 20 aircraft and helicopters of anti-submarine, fighter and bomber aviation [60].

Against this background, *the main change in the military-political situation in the Arctic lies in the intensification of military activity in the mutual intersection zone of the operational areas of*

[57] Source: The Heritage Foundation.
[58] O'Rourke R. et al. Op. cit. P. 45.
[59] Khramchikhin A. The ind. compos.
[60] Flot nadezhno zashchishchaet Arktiku [The fleet reliably protects the Arctic]. Krasnaya Zvezda. 9 December 2019. URL: http://redstar.ru/flot-nadyozhno-zashhishhaet-arktiku/ (accessed 09 June 2021).

the Russian Northern Fleet and the US Second Fleet in the Barents and Norwegian Seas, as well as in the North Atlantic. So far, the intersection of their activities has not reached a critical scale, but as it intensifies, the risks of dangerous military incidents at sea and in the air, as well as their escalation, increase.

De-escalation options

A broad consensus has long been formed in the expert community regarding the need to resume the military contacts interrupted in 2014 in the interest of de-escalating the military-political situation in the region. Various solutions have been proposed as to how this could be done. In most cases, some form of Arctic forum with military representatives from the Arctic countries to discuss the politico-military situation and agree on confidence-building measures in the region has been proposed [61]. However, practical steps in this direction have not yet been agreed at the intergovernmental level. It seems important to take into account three aspects of this issue when discussing possible de-escalation measures.

First, it should be assumed that the policy of mutual military deterrence is a "new old" norm that will determine the military-political situation in the North Atlantic and the Euro-Arctic region in the long term, regardless of possible fluctuations in the political situation between Russia and the West. In other words, the refusal of the parties to implement the decisions they have made in recent years, which changed the military-political situation in the region for the worse, is not on the agenda today. Although the scale of mutual deterrence today is far from the scale of the Cold War, the logic of containment makes a fundamental "reset" in relations between Russia and the West, virtually impossible in the foreseeable future.

Second, it is necessary to realistically assess the readiness of the United States and NATO countries, which froze military cooperation with Russia in 2014, to reconsider this decision, without waiting for any serious shifts in relations between Russia and the West. Moreover, all the parties today consider the level of risks associated with dangerous military incidents acceptable [62]. More serious arguments are required to substantiate the need to restore full-fledged communication along the military line without preconditions.

Third, given the fact that the modern intensification of military activity in the Arctic is mainly limited to the Euro-Arctic region adjacent to the North Atlantic, and that not only the Arctic states are involved in this activity, it is necessary to answer the question on the optimal composi-

[61] See: Berbrick W., Saunes L. Conflict Prevention and Security Cooperation in the Arctic Region. Report of the U.S. Naval War College, September 2020. URL: https://usnwc.edu/Portals/0/News%20and%20Events/Arctic/Conflict%20Prevention%20and%20Security%20Cooperation%20in%20the%20Arctic%20Region-Frameworks%20of%20the%20Future%C2%A0Report.pdf (accessed 09 June 2021); See also [1, Spohr K., Hamilton D.S., p. 206–209].

[62] Zellner W. et al. Reducing the Risks of Conventional Deterrence in Europe: Arms Control in the NATO-Russia Contact Zones. Vienna: OSCE Network of Think Tanks and Academic Institutions, 2018, p. 7. URL: https://osce-network.net/file-OSCE-Network/Publications/RISK_SP.pdf (accessed 09 June 2021).

tion of participants in a dialogue or forum on security issues in the Euro-Arctic region, and not just in the "big" Arctic as a whole.

Why there is a need in a forum for dialogue on Arctic security issues?

The general logic of the arguments about the need to restore dialogue on military issues is understandable [63]. The gap in regular communications between Russia and other Arctic countries that arose after 2014 is being filled by the parties with rhetoric and demonstration of their military capabilities. Thus, they send signals to each other, denoting "red lines" that should not be crossed. But these signals can be misinterpreted, which can lead not to de-escalation, but, on the contrary, to a further exacerbation of the military-political situation, especially in a situation when all parties are calculating the worst scenarios, based on the assessment not of intentions, but opportunities for each other. Therefore, it is necessary to agree on certain rules or "code" of conduct.

However, it would be wrong to assume that contacts between the military structures of Russia and the West are completely absent today. Since 2018, the Chief of the General Staff of the Russian Armed Forces has met with the Supreme Commander of the NATO Joint Armed Forces in Europe. The participants of these meetings exchange assessments of the European security situation, inform each other about the planned major operational training events, and discuss measures to prevent incidents on the Russia-NATO contact line [64].

Understanding the risks of misinterpreting military activities, the General Staff of Norway maintains communication channels with the command of the Northern Fleet and the Russian General Staff [13, Wither J.K.]. Despite the sanctions, the annual Russian-Norwegian joint search and rescue exercise in the Barents Sea continues [65]. In accordance with the Vienna OSCE Document on Confidence and Security-Building Measures, Norway notifies in advance of upcoming major exercises on its territory and provides relevant information about them. Although naval activities are not covered by the provisions of the Vienna Document, the United States informed Russia about the upcoming naval exercises in the Barents Sea in 2020 [66].

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[63] See, in particular: Depledge D. Hard security developments. J. Jokela (ed.), Arctic security matters. EU ISS Report No 24, 2015, p. 59–67. URL: https://www.iss.europa.eu/sites/default/files/EUISSFiles/Report%2024.pdf (accessed 09 June 2021).

[64] Petrov I. Kontakty prodolzhat. Nachal'nik Genshtaba VS Rossii vstretilsya s glavkomom sil NATO v Evrope [Contacts will continue. The Chief of the General Staff of the Russian Armed Forces met with the Commander-in-Chief of NATO Forces in Europe]. Rossiyskaya gazeta, 10 July 2019. URL: https://rg.ru/2019/07/10/nachalnik-genshtaba-vs-rossii-vstretilsia-s-glavkomom-sil-nato-v-evrope.html (accessed 09 June 2021); Bednyakov P. Nachal'nik Genshtaba VS Rossii vstretilsya s glavkomom sil NATO v Evrope [Bednyakov P. Chief of the General Staff of the Russian Armed Forces met with the commander-in-chief of NATO forces in Europe]. Izvestiya, 10 July 2019. URL: https://iz.ru/897996/2019-07-10/nachalnik-genshtaba-vs-rossii-vstretilsia-s-glavkomom-sil-nato-v-evrope (accessed 09 June 2021).

[65] Gavrilov Yu. V Barentsevom more zavershilos' rossiysko-norvezhskoe spasatel'noe uchenie [A Russian-Norwegian rescue exercise ended in the Barents Sea]. Rossiyskaya gazeta. 6 June 2021. URL: https://rg.ru/2021/06/06/v-barencevom-more-zavershilos-rossijsko-norvezhskoe-spasatelnoe-uchenie.html?utm_source=yxnews&utm_medium=desktop&nw=1623179666000 (accessed 09 June 2021).

[66] Nachal'nik Glavnogo operativnogo upravleniya General'nogo shtaba VS RF general-polkovnik Sergey Rudskoy provel brifing dlya predstaviteley SMI [Colonel-General Sergei Rudskoy, Chief of the Main Operations Directorate of the Gen-

In the context of a return to the policy of mutual deterrence, the 1972 Agreement between Moscow and Washington on the prevention of incidents on the high seas and in the airspace became relevant again. The practice of applying this agreement is being improved taking into account modern realities. Russia has a similar agreement with Great Britain and a number of NATO countries [67]. Both the Northern Fleet and the US Second Fleet follow the requirements of the agreement in the areas of contact.

These and other similar examples support the arguments of those who believe that the existing agreed measures are sufficient to prevent the uncontrolled escalation of potentially dangerous military incidents. However, the current intensification of military activity in the Euro-Arctic region raises a number of questions to which the existing measures do not provide an answer.

It is clear that any military activity in the Barents Sea region, even in relative proximity to the basing and patrolling areas of Russian strategic missile carriers, would be perceived by the Russian side as potentially hostile. The Northern Fleet has an echeloned defense system for Russia's naval strategic nuclear forces, known in the West as “Bastion”. In the West, primarily in Norway, there are concerns that the range of Russian anti-aircraft, anti-submarine and anti-ship defense systems in the Barents Sea allows Russia to “close” vast sea areas far beyond Russian territory for any activity — up to the reconstructed NATO anti-submarine GIUK gap [1, Spohr K., Hamilton D.S., p. 200–202].

Measures to prevent the escalation of dangerous military incidents and occasional communication between senior military officials are clearly not enough to remove or at least minimize the corresponding concerns on both sides. This requires a regular, desirably institutionalized dialogue at various levels, to discuss assessments of the military-political situation in the region, mutual concerns and the motives of their activities in the region, including conducting exercises, snap checks of the combat readiness of forces and means or relocation of large combat teams.

The dialogue could lead to formal or informal arrangements that would help to ensure that the new military-political situation in the Euro-Arctic region remains stable, predictable and controlled. This could include agreeing on a standardised procedure for mutual emergency notification of military movement in the Arctic during natural disasters or other emergencies to avoid misinterpretations and miscalculations [68].

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eral Staff of the RF Armed Forces, held a briefing for media representatives]. Ministry of Defense of Russia, 1 June 2020. https://function.mil.ru/news_page/country/more.htm?id=12295316@egNews (accessed 09 June 2021).

[67] Frear T. Lessons Learned? Success and Failure in Managing Russia-West Incidents 2014–2018. ELN Euro-Atlantic Security Policy Brief, 2018, p. 6. URL: https://www.europeanleadershipnetwork.org/wp-content/uploads/2018/04/11042018-Incidents-Management-Review-Tom-Frear.pdf (accessed 09 June 2021); Raynova D., Kulesa L. Russia-West Incidents in the Air and at the Sea 2016–2017, Out of the Danger Zone? ELN Euro-Atlantic Security Report, 2018, p. 8. URL: ttps://www.europeanleadershipnetwork.org/wp-content/uploads/2018/10/Military-Incident-Report.pdf (accessed 09 June 2021).

[68] Collins J.F., Sfraga M, Virginia R.A., Yalowitz K.S. Arctic Council Initiatives to Sustain Arctic Cooperation. Conference Report and Recommendations from February 23, 2015. University of the Arctic Institute for Arctic Policy and Dartmouth College, 2015. P. 2. URL: https://carnegieendowment.org/2015/04/20/arctic-council-initiatives-to-sustain-arctic-cooperation-pub-59839 (accessed 09 June 2021).

Who should be involved in such a dialogue?

The Russian Federation favours re-establishing dialogue forums on military-political issues among the eight member states of the Arctic Council. Since military security issues were excluded from the Arctic Council mandate, Moscow proposes to resume regular meetings of the chiefs of general staff of the Arctic countries' armed forces, which were held on an annual basis until 2014. If this cannot be done immediately, it is proposed to start with military expert meetings of the eight countries' general staffs. At the same time, Moscow is sceptical about the possible expansion of the number of participants in such a dialogue [69].

Of course, discussion of military security issues in the Arctic should not exclude any of the Arctic states, and the independent format of such discussions within the Arctic G8 is important. But is it possible to ignore the fact that military activities in the Euro-Arctic region today are carried out not only by the Arctic states, but also by individual non-Arctic NATO member states, as well as the alliance as an organisation, and they would not be bound by any agreements that can be achieved without their participation?

For obvious reasons, Russia is not satisfied with the option of NATO's involvement in a dialogue on security issues, not only in the entire "big" Arctic, but also in the narrower Euro-Arctic region. Moscow has long and consistently advocated that the alliance should not be endowed with any formal role in the Arctic. And the current paralysis of dialogue within the Russia-NATO Council does not allow counting on productive communication on significant security issues in the region.

For these reasons, the decision to resume discussions on security issues in the Euro-Arctic region along with the Arctic G8 in an expanded format that would include individual NATO countries that are somehow engaged or capable of engaging in military activities in the region seems to be optimal.

This format existed until 2014. This is a round table of the Arctic security forces. Its meetings have been held since 2011 with the participation of Navy representatives not only from the Arctic countries, but also from Great Britain, Germany, the Netherlands and France — non-regional states that regularly participate in military exercises in the Arctic and, therefore, whose involvement in the discussion of issues security is quite justified [5, Zagorskiy A.V., p. 69–70]. Since 2014, Russian representatives have no longer been invited to round table meetings. Regardless of whether the resumption of Russia's participation in its meetings is possible, this composition of participants roughly determines the circle of states with which it is advisable to discuss security issues in the Euro-Arctic region.

[69] Vystuplenie i otvety na voprosy SMI Ministra inostrannykh del Rossiyskoy Federatsii S.V. Lavrova v khode sovmestnoy press-konferentsii s Ministrom inostrannykh del Islandii G.T. Tordarsonom po itogam XII Ministerskoy sessii Arkticheskogo soveta, Reyk'yavik, 20 maya 2021 goda [Speech and answers to media questions by the Minister of Foreign Affairs of the Russian Federation S.V. Lavrov during a joint press conference with the Minister of Foreign Affairs of Iceland G.T. Thordarson following the XII Ministerial Session of the Arctic Council, Reykjavik, May 20, 2021]. Ministry of Foreign Affairs of the Russian Federation 1005-20-05-2021. URL: https://www.mid.ru/ru/foreign_policy/news/-/asset_publisher/cKNonkJE02Bw/content/id/4739617 (accessed 09 June 2021).

What could be the format of the dialogue?

The restoration or establishment of any new official formats (meetings of chiefs of general staff or just their representatives, round table meetings, etc.) to discuss security issues in the Arctic as a whole or in a narrower Euro-Arctic region seems unlikely in the foreseeable future. A decision of the leadership of individual Arctic countries is not enough, but a consensus of the NATO and EU member states will be needed to review the sanctions they adopted in the context of the Ukrainian crisis in 2014. But even in some Arctic countries, such a decision would not be easy to make.

In particular, the US Congress annually extends the 2014 ban on any bilateral military cooperation with Russia [70]. Similar bans exist in other NATO countries. As a first step, some experts have suggested establishing an informal forum to discuss military security issues in the Arctic, which would bring together military representatives from all Arctic countries (possibly adding some European non-Arctic states), but not in their official status, but as experts, thus circumventing Western formal restrictions on military contacts [71].

If the participation of representatives of the military departments of Western countries in such a format nevertheless turns out to be impossible, the gap in dialogue could initially be partially filled by regular roundtable meetings or conferences on Arctic security as part of the "second track", with participation of competent experts from the relevant states, including retired officers [14, Zagorskiy A.V., p. 16].

Conclusion

In the context of Russia and Western countries returning to a policy of mutual military restraint, the military-political situation in the Arctic is also changing. But the changes are uneven across the region. While in the most part of the region military activity is still hampered by severe climatic conditions, it has appreciably intensified in the Euro-Arctic region adjacent to the North Atlantic in the recent years. Today, the waters of the Barents and Norwegian Seas have again, as in the years of the Cold War, become an integral part of the military activities carried out by both Russia and NATO countries in Europe and the North Atlantic. This occurs in the context of a significant, if not total, cessation of military dialogue between Russia and Western countries, which contributes to a further deterioration of the military-political situation in the Euro-Arctic region.

Russia is particularly concerned with renewed military activities of the US and some NATO countries in the Barents Sea region, where a significant part of Russian maritime strategic nuclear forces is based on the Kola Peninsula. Increasing concerns on the part of the alliance countries are the capabilities of the Northern Fleet to “close” vast spaces in the Barents and Norwegian Seas to

[70] "None of the funds authorized to be appropriated for fiscal year 2017 for the Department of Defense may be used for any bilateral military-to-military cooperation between the Governments of the United States and the Russian Federation". См. Sec. 1233, H.R.4909 - National Defense Authorization Act for Fiscal Year 2017, 114th Congress (2015-2016). URL: https://www.congress.gov/bill/114th-congress/house-bill/4909/text (accessed 09 June 2021).
[71] Berbrick W., Saunes L. Op. cit. Pp. 57–60.

military activities by Western countries far beyond Russian territory. It is also believed that the regular voyages to the North Atlantic by Russian multipurpose nuclear submarines could threaten the alliance's maritime communications.

The remaining tools to prevent the escalation of possible dangerous military incidents at sea and in the air are not enough to remove or minimise these concerns of both sides. This circumstance emphasizes the urgent need to restore a full-fledged, regular and institutionalized dialogue along the military line between Russia and the rest of the countries of the region, with the possible involvement of a number of non-Arctic states carrying out military activities in the Arctic. Such measures could include the resumption of the annual meetings of the chiefs of general staff of the Arctic countries, which were held until 2014, or, as a first step, military experts of the general staffs, as well as the resumption of participation of Russian representatives in the round table meetings on Arctic security.

However, these options are difficult to implement in the context of the continuation of the Western sanctions policy. The post-2014 freezing in military communications with Russia prevents Russian officials from inviting them to dialogue on military security in the Arctic. In this regard, much will depend both on the political will of the NATO member states and on progress in resolving current conflicts that have become a pretext for imposing sanctions against Russia, primarily the Ukrainian conflict.

Since Western countries at this stage are not ready to resume the dialogue, it could initially take the form of an informal forum, with civilian and military participants acting in a personal capacity, or regular roundtable meetings or conferences on Arctic security issues under "second track".

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matic Risks and Vulnerability of Natural and Economic Systems in the Marine Arctic Zone of the Russian Federation]. *Problemy Arktiki i Antarktiki* [Arctic and Antarctic Research], 2018, vol. 64, no. 1, pp. 55–70. DOI: 10.30758/055-2648-2018-64-1-55-70

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Arctic Corporations and Development Risks: Challenge and Response *

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Abstract. The realities of the Russian Arctic in recent decades make it possible to determine a special phenomenon of corporate development risks, which can be structured into resource, institutional and ecosystem risks. The resource risk reflects the contradiction between the conjuncture of the global resource markets and the specific conditions for the development of unique deposits located in the Arctic zone; institutional risk — between federal norms and rules for the development of natural resource deposits and local specific conditions for the construction and operation of resource facilities in the Arctic; ecosystem risk reflects the contradiction between large-scale economic activity and the fragility of Arctic natural systems. As a result of a comparative assessment of the development risks of three Arctic corporations in Russia, it was found that the highest risk is typical for the facilities of Norilsk Nickel, the lowest — for NovaTEK, and Gazpromneft is in the middle. Using the OLI paradigm of John Dunning, it can be argued that Arctic corporations respond to the challenge of development risks by adapting their spatial, institutional and organizational structure to the conditions for the development of resources and resource territories. The spatial factor is most efficiently used by Norilsk Nickel, then NovaTEK, in the strategy of adaptation to development risks, with the receipt of benefits from localization and the creation of a regional cluster, while Gazpromneft is the least effective. The institutional factor is most effectively used by NovaTEK and Gazpromneft, and the least by Norilsk Nickel. The organizational and structural factor as a tool for adapting to risks is most skillfully used by Gazpromneft, weaker — by NovaTEK and Norilsk Nickel. Integrally, the best positions in the strategy of adaptation to development risks are held by Gazpromneft, and the worst positions by Norilsk Nickel, which has the most significant contrast between the size of development risks and the means of adaptation to them. Strengthening the internal competencies of the company and its corporate innovation system is the most important way to successfully cope with the high risks of corporate development of resources and spaces of the Arctic.
Keywords: *development risk, Arctic corporation, OLI paradigm, risk adaptation strategy.*

Introduction

High corporatization is a specific feature of the Arctic and Northern economies [1]. For example, a comparison of the structure of investments in fixed assets shows a twofold excess of the Arctic share in expenditures of production drilling associated with the production of oil, gas and gas condensate extraction, other expenses and costs in fixed assets, which are usually carried out by large corporations — 15.1 % versus 7% in Russia as a whole (section "other investments") [1].

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[1] Statistics of the socio-economic development of the Arctic zone of the Russian Federation. URL: https://rosstat.gov.ru/storage/mediabank/rz0CLQRR/Calendar1-2021.htm; https://gks.ru/free_doc/new_site/region_stat/arc_zona.html (accessed 11 June 2021).

Numerous statistical comparisons of the coastal Arctic territories with areas of the "continental", mainland North, confirm that within the single zone of the North, the Arctic is significantly more corporate in terms of the institutional structure of the economy than other northern areas. For example, the share of corporate income tax and property tax in the total tax revenues of the consolidated regional budgets is higher here [2]. This feature of the Arctic was clearly manifested during the COVID-19 pandemic in 2020, when in certain "corporate" territories, companies essentially took over the state functions of the "high readiness" regime — and not only in matters of free distribution of masks, provision of PCR tests at Arctic airports, but also in support of small and medium-sized businesses in the regions where corporations are present (subsidies for the delivery of goods, interest-free loans for development, etc.) [3].

Arctic corporations face unprecedented risks compared to the more standard and predictable conditions of a large company, for example, in the manufacturing industry in long-established areas. This is evidenced by the frequent postponements of the implementation of large resource projects, and sometimes even their complete cancellation (or postponement for an indefinite period), as was the case with the Shtokman gas condensate field. In this regard, a business decision has to be considered in the context of the extent to which it reduces or increases the total amount of risks and whether the expected super-profits, for which it operates in the Arctic, outweigh the possible damage from the risks of specific development projects.

In the Arctic, therefore, business risks cannot simply be reduced to questions of financial insurance. These are the problems of the entire company's activity, all of its strategic decisions, the whole complex of planning of current and future activities. Corporate risk acquires an integral, expanded interpretation, and all the economic behavior of corporations should be understood in the context of the colossal risks arising here: either as a desire to cope, neutralise, or vice versa — to accept them deliberately.

The subject of this article is the topic of development risks that are forcedly borne by companies operating in the Arctic, and the object of the study is three large Russian corporations, the main material assets of which are located in the Arctic zone: PJSC NovaTEK, PJSC Gazpromneft and PJSC MMC Norilsk Nickel (NovaTEK, Gazpromneft and Norilsk Nickel).

The main research question (objective) of the paper is how do the three Arctic corporations respond to the challenge of high development risks in their current operations? This objective required the solution of three tasks:

- to conduct a comparative assessment of the Arctic companies' development risks (to develop the necessary approaches and methodology);

[2] Calculated on the basis of tables given in the collection: Problemy Severa i Arktiki. Vyp. 5 (razdel «Itogi 2006 goda»). Sovet Federatsii. 2007 god [Problems of the North and the Arctic. Issue 5 (section "Results of 2006"). Council of the Federation. 2007], p. 41–42.

[3] Nornikel': Otchet ob ustoychivom razvitii 2020. Nash Krayniy Sever [Norilsk Nickel: Sustainability Report 2020. Our Far North]. 127 p. URL: https://www.nornickel.ru/files/ru/investors/disclosure/NN_CSO2020_RUS_28.04.pdf (accessed 12 June 2021).

- to show through the evolution of the three components of J. Dunning's OLI paradigm [2] how companies cope with the challenge of development risks;
- to assess the role of companies' competencies and accumulation of knowledge potential for a successful response to development risks.

The novelty of this work lies in the introduction of a new concept of exploration risk, its structure (as a result of integrating our work on the development of the Arctic 2.0 [3] and the classic works of F. Knight [4] on risk and uncertainty and D. North on natural and social risks [5], developing a methodology for comparative assessment of corporate exploration risks and the main forms of company adaptation to them) in Arctic research.

Research methodology. Materials and methods

The core of the proposed methodology is the new concept of development risk, which, in contrast to individual risks (for example, ecological, financial, property, etc.), has a more complex and qualitative (difficult to measure) nature. Development risk emerged as a distinct phenomenon in the Russian Arctic in the 1990s with the transition from the state to the market-oriented, corporate development model. Our numerous recent works are devoted to understanding of its new nature, spatio-temporal organization, territorial framework and other basic features [6–8].

In the state model, the development risk was "dissolved" within a single national-economic complex. However, everything changed with the transition to the corporate model, when it became isolated, and resource corporations began to carry it as the main actors in the modern development process of the Russian Arctic.

The development risk is the sum of private risks (ecosystem, resource and institutional), which characterizes the significant uncertainty in the process of involving large deposits and natural resources areas in the Arctic into the market circulation, varies between the poles of maximum continuity and maximum discreteness, up to stopping the entire process of economic development. The development risk includes threats to corporations at all stages of the deployment of economic development in the Arctic: search (information), construction and operation of resource facilities, promotion of the resource chain to the main world markets. The development risk includes a natural component, which depends on the state of the natural environment and the resource base, and a closely interacting social component, which is associated with the processes taking place in society at different levels — local, regional, national and global. It is the development risk as a complex, integral phenomenon of economic activity in the Arctic that determines the main decisions of the companies operating there.

The internal structure of the development risk is formed by those particular specific components (resource, institutional, ecosystem risks) that reflect the fundamental contradictions in the process of modern economic development of the Arctic. This makes it possible to assess these risks in terms of the strength and severity of the contradiction (imbalance).

Resource risks (global contradictions) can be understood as contradictions of not always reliably determined local (attractive) conditions between local (attractive) conditions of mineral and raw material base, which are not always reliably determined, and its geological and economic evaluation; and the constantly changing and hardly predictable global price of key resources of the Arctic, which can radically increase or nullify the profitability of many Arctic natural resources. In view of the geological uncertainties typical for many Arctic land and shelf areas, uncertainties often exist about the actual size of the resource base. These uncertainties are reinforced by the typical transport inaccessibility of the Arctic resource project.

Institutional risks (contradictions between assets and institutions) can be understood as a tension between the state of the company's main natural and material assets in the development areas, which, as a rule, is very changeable and mobile, and more inertial institutions of the federal and regional levels, which determine the conditions for involvement Arctic natural resources into the market. The phenomenon of institutional remoteness, first described by the Alaskan economist Lee Husky [9], illustrates this contradiction. Local conditions for exploiting natural resources in the Arctic are usually highly specific. Meanwhile, the basic norms and rules, the institutional framework that defines the basic conditions for their exploitation, are far removed from national centres and very often cannot account for the local features of a particular resource object in the Arctic. This is how a conflict arises between changeable assets and inertial institutions, described by Karl Marx for the macro level as a conflict between productive forces and production relations [10].

Ecosystem risks (natural and economic contradictions) reflect the inevitable conflicts of economic development and the limited carrying capacity of the Arctic natural systems. In view of the new climatic dynamics (the average annual temperature fluctuating much more rapidly in the Arctic than in the rest of the world), the role of natural turbulences is again rising, as in the period of pioneering economic development of the Arctic in the early industrialization era. The previous topic of the Arctic ecosystems fragility to anthropogenic, economic impact [11] is replaced by vulnerability of the economic, corporate activities in the face of rapid and unpredictable changes in the natural environment and climate. The current features of Arctic ecosystems (thawing of permafrost soils, increasing climatic variability, reduction of the area covered by Arctic sea ice, increasing of snow cover thickness in many Arctic terrains, etc.) are the source of most serious risks for the companies working there.

The nature of the internal structuring of the development risk into private risks (resource, institutional, ecosystem) significantly depends on the previously discovered fundamental dichotomy of the Arctic resource development process: from scratch — greenfield projects of pioneering development or projects based on the infrastructure of the previous layer of development — brownfield [12].

In greenfield projects, development risk depends on the company's current actions and decisions. As examples of Russian corporations show, an effective way to reduce risks is to scale (rep-

licate) the success of a pilot project to subsequent projects. This saves on knowledge and training and radically reduces risks.

Brownfield projects, on the other hand, are heavily path-dependent: the risks inherited from the past prevail, for example, from previously unfulfilled necessary expenses to renew obsolete equipment. In these projects, development risk is strongly influenced by social factors, uncertainties in the socio-economic environment of the global, national, and local levels. On the other hand, in greenfield projects, development risk is strongly influenced by uncertainties in the resource base, natural environment and climate.

Previous scientific publications on risk assessment of corporate activities in the Arctic [13, 14] tend not to distinguish strongly between greenfield and brownfield projects, and often focus on the risks associated with only the first group of projects. However, the accident at TPP-3 in May 2020 in Norilsk city clearly demonstrated the need to differentiate the risks of new and old projects.

The traditional view that only new Arctic projects carry significant risks for corporations, and that there are no development risks in brownfield projects, should be revised. Due to significant depreciation of equipment, the risks of old development projects may be higher than those of greenfield ones. It is no coincidence that Arctic corporations often prefer to build a project and a development base from scratch, even having a close alternative in the form of an already existing development base or an abandoned resource project of the previous development cycle.

A significant advantage of the development project from scratch is that it is possible to implement a modern high-tech scheme immediately, updating all the advantages of the latest intellectual achievements and organizational, financial schemes, and immediately resolve those issues that have not been solved for decades at old fields and resource facilities of other companies. This advantage of lower development risks of greenfield projects can even, as the recent history of Russian corporations shows, overlap the difficulties of complex, heterogeneous natural assets and the insular position of new development territories, which differ from brownfield Arctic projects in their location in areas with limited, seasonal delivery schedules.

OLI-paradigm of D. Dunning [2] in its classical interpretation is used to characterize the strategies of economic behavior of multinational corporations in the manufacturing industry of developed countries. In this study, it is used for the first time to characterize the response of resource corporations in the Arctic to the challenge of development risks. This is entirely appropriate that, given the high uncertainty of the natural and socio-economic conditions for the Arctic resources development, the companies operating there rely to a much greater extent on non-financial methods of neutralising and adapting to risks through shifts in their territorial, organisational, and institutional structure.

Thus, the main methodological framework of this study was the research on the phenomenon of Arctic exploration 2.0; the views of F. Knight and D. North about fundamental differences between types of risk: measurable risk and immeasurable uncertainty, risk from the physical envi-

ronment and risk from social environment and systems; J. Dunning's empirical OLI-paradigm for describing the behavior of multinational companies in conditions of high development risks.

The empirical data for the study was the annual reports of three Arctic corporations — NovaTEK, Gazpromneft and Norilsk Nickel for the entire period of their publication on the companies' websites [4].

Research results

1. Assessment of development risks of Arctic corporations

It is not enough to simply note that the pressure of risks and uncertainty on Arctic corporations is significantly higher than on large companies in the manufacturing industry in densely populated regions of Russia. They have a completely different nature (Table 1).

Firstly, for all Arctic corporations working in both greenfield and brownfield projects, the value of the uncertainty created by the natural environment is always higher than that of companies in the temperate zone. They are more exposed, directly related to its rhythms, force majeure, tied to its resource potential more than their counterparts in the main settlement areas, where the impact of the natural environment is suppressed by social and economic processes.

Secondly, the location of the main material assets of an Arctic corporation is determined by production factors (S-factors), including the most important one — the uneven distribution of unique natural assets across the territory and water area. On the other hand, the location of core material assets of classic companies in developed countries is determined by proximity to the consumer (D-factors). In textbooks on regional economics and distribution of productive forces, this difference is recorded as distribution according to Weber or Lesch-Kristallller [15]. In the first case, the risks depend on the capriciousness of the development of large, unique, “talented”, “single” resources; in the second — from the capriciousness of numerous atomic consumers, their changing values, fashions and trends. In the first case, production factors put pressure on the company roughly, rigidly, without any alternatives and more sudden; in the second case, it is softer and, as if more spread over time, giving the possibility of gradual adaptation to them.

Thirdly, for resource corporations in the process of natural assets development of the territory, the issue of transport logistics and large physical volumes of cargo becomes urgent — first for the delivery for the production site arrangement, then for the export of multi-tonnage resource products. The pressure of the physical cargo volumes to/from a remote, peripheral territory creates production and logistics risks and challenges that merge together. If they are not handled, the entire development project may “drown”. On the other hand, logistical issues do not pose any particular risks for large corporations in well-equipped, well-developed regions. Here, the main issue for launching a new project is the formation of a sufficient pool of investment resources. For Arctic projects, this is not enough.

[4] NovaTEK: annual report 2005–2019, company sustainability report 2004–2019; Gazpromneft: 1999 (Sibneft) - 2019; Sustainable Development Report 2007–2019; Norilsk Nickel: Annual Report 2008–2019, Corporate Social Responsibility Report 2008–2019.

Fourthly, if we consider the corporate innovation system, the main risk for the Arctic corporation is the imbalance in the interaction of the search and operational subsystems, i.e. the failure to ensure the repayment of reserves as a result of production by the growth of new, profitable for the development, natural resources. This imbalance is objectively built into the innovation system due to the inevitable depletion of once discovered unique deposits of natural resources. On the other hand, there is no such doom in the innovation system of manufacturing companies: new R&D discoveries are able to maintain the stability of the production subsystem for a long time [16].

Fifthly, the leading natural resource risk of the Arctic corporation's activities leads to the fact that all three components of the Dunning paradigm — accommodation, institutional and organizational — are aimed primarily at neutralizing it. On the other hand, for processing enterprises, the main risk is associated with the threat of incomplete consumption of manufactured products, and the main components of the Dunning paradigm (O, L and I) are directed to its extinguishing.

Indirect evidence of the high risks of development activity in the Arctic is the significant mobility of spatial (determined by the location of licensed areas of exploration and production activity and large processing industries), organizational (determined by the evolution of the company's internal management structure) and ownership structure (determined by processes of nationalization/privatization, mergers/acquisitions, formation of joint ventures, changes in the structure of share capital, etc.) of manufacturing enterprises. It can be assumed that there have not been such constant rapid changes in the structure of large manufacturing companies in Russia in the last two decades. The external rapidly changing natural and social environment of the activities of large Arctic corporations carries constant risks, which are forced to follow the same quick reaction of the internal structure of companies.

Table 1

Risk and the corporation: differences between mining and processing enterprises

	Resource corporation	Processing MNC
1. The ratio of natural and social risk	All three components of the development risk — resource, institutional and ecosystem — depend in a decisive way on environmental factors, the role of the social environment at all levels in the overall risk is significant, but secondary.	Factors of the social environment, social interactions have the main, primary significance in the total risk of the company. Natural factors (natural environment, climate, ecosystems) are secondary.
2. Factor/demand allocation of the company's main tangible assets	The aggregate risk is non-alternatively determined, first of all, by the presence of unique, single, "talented" production factors, without which the development process will not begin.	The aggregate risk depends on the need, the demand for the manufactured products of numerous atomic consumers, determined by fashion, trends, tastes.
3. Physical volumes or financial resources	The aggregate risk is determined by the transport and logistics factors of transportation of significant physical volumes of material and natural resources.	The aggregate risk is determined primarily by the possibility of forming the required pool of investment (financial) resources.

4. Subsystems of the corporate innovation system (research and implementation)	Risk of inevitable depletion of a once discovered resource province and an increasing imbalance between exploration and production subsystems.	There is no doom of growing imbalance: new discoveries in the research subsystem can support the stable operation of the production system for a long time.
5. OLI-paradigm for corporate risks	All components work to protect against natural resource risks.	All components work to protect against the risks of underconsumption of manufactured products.

Against the background of strong development risks of Arctic corporations, the profile of each company is specific. Let us consider the comparative strength of resource, institutional and ecosystem risks for NovaTEK, Gazpromneft and Norilsk Nickel (Table 2). The assessment was carried out for each type of risk based on the strength of internal contradictions specific to each type of risk — strong, moderate, weak.

Table 2

Comparative assessment of development risks of arctic corporations

Types of risks	NovaTEK	Gazpromneft	Norilsk Nickel
Resource	1*	2	2
Institutional	1	2	3
Ecosystem	1	2	3
Total development risk	3	6	8

*1— weak, 2 — moderate, 3 — strong.

The resource risk is minimal for NovaTEK, because the company specialises in the production of liquefied natural gas, the world market of which has been growing rapidly in recent years. Therefore, the contradiction between global demand and local resource potential is minimal here: all gas fields assets involved in corporate turnover are doomed to be in demand on global markets. Resource risk is higher for Gazpromneft because the company has deposits and assets on the Arctic shelf, the demand for which is lower in the near future due to significant costs and complexity of development and operation of such fields. Overall, the company's resource risk is moderate. Norilsk Nickel produces a wide range of non-ferrous and noble metals, each of which has its own, sometimes contrasting, specific global market conditions. The exploitation of the unique Norilsk deposits has been in production for over 90 years and the first signs of depletion are likely to appear. Therefore, the interaction between the local natural resource potential and global markets is problematic and highly probabilistic for the corporation here, so the resource risk is moderate.

Institutional risk, defined by the severity of the contradiction between natural assets and external institutions that determine the regulations for mining activities, is minimal for NovaTEK: in recent years, as a result of skilful lobbying of its interests by top government officials, the company has achieved uniquely favourable regulatory and legal conditions for its activities. The main adopted strategic documents of the federal level (Energy Strategy [5], Development Strategy of the Arctic Zone of the Russian Federation [6]) contain special provisions for the company's projects.

[5] Rasporyazhenie Pravitel'stva Rossiyskoy Federatsii ot 9 iyunya 2020 g. № 1523-r «Ob Energeticheskoy strate-gii Rossiyskoy Federatsii na period do 2035 goda» [Order of the Government of the Russian Federation of June 9, 2020 No.

On the other hand, Gazpromneft has less lobbying potential and opportunities to "exclusivise" each of its projects, which was demonstrated, for example, by the long period of normative integration of the Prirazlomnaya shelf project into the context of federal legislation. NovaTEK has proceeds according to the format of exclusive separation of its projects into a "separate production", while for Gazpromneft it looks like a more labour-intensive and agonising process of fitting a unique project into the context of dozens of existing normative legal acts. The status of a subsidiary (spin-off) of Gazprom also prevents the company's top managers from actively lobbying for their projects at the federal level. Therefore, there is a moderate institutional risk. In general, Norilsk Nickel today has no exclusivity in the regulatory "arrangement" at the federal level: the company works on a common basis with all others, regardless of its Arctic status, and encounters attempts to create competition for it on the part of other mining companies at the federal level. Institutional risk in this case is high.

Ecosystem risk is determined by the severity of natural and economic contradictions, conflicts between the fragile Arctic natural environment, rapid climate change and development activities. In a broad sense, ecosystem risk also includes the conflict between the traditional way of life of the indigenous small-numbered peoples of the North and the deployment of mining activities in the territories of their traditional residence. So far, NovaTEK has been able to cope with the challenges of the interests of indigenous peoples in the regions of its development, there are no major conflicts between traditional and new types of economic activity. Although critics note the risks of Sabetta, the company's flagship project, repeating the fate of the modern depressed Igarka (formerly a showcase of the Soviet Arctic), its current situation with permafrost and Arctic ecosystems looks favorable. Gazpromneft has more ecosystem risks: simply because the company's production sites are extremely dispersed, the uncertainty that the natural and economic balance may be disturbed in an onshore or offshore area is higher. However, Norilsk Nickel has the highest ecosystem risk due to its long-term presence in the territory of permafrost, which, under the influence of rapid climate changes, has begun to degrade in recent years.

Thus, Norilsk Nickel has the highest aggregate development risk, while NovaTEK has the lowest one (Table 2). Comparative risk assessment clearly demonstrates that in the Arctic the risks of continued activity in the old industrial territory may be higher, despite its better infrastructure and urbanization, compared to the areas of new development. One of the reasons for this is a radical change in the entire model of economic development of the Arctic in the early 1990s: as a result, companies that were ready to start a new development from scratch, without burdening old assets and problems of the old economic system, have gained an advantage. This contains the Arc-

1523-r "On the Energy Strategy of the Russian Federation for the Period up to 2035"], N 0001202006110003. URL: https://docs.cntd.ru/document/565068231?marker=65A0IQ (accessed 12 June 2021).

[6] Ukaz Prezidenta Rossiyskoy Federatsii ot 26.10.2020 № 645 «O Strategii razvitiya Arkticheskoy zony Ros-siyskoy Federatsii i obespecheniya natsional'noy bezopasnosti na period do 2035 goda» [Decree of the President of the Russian Federation dated October 26, 2020 No. 645 "On Strategy for Developing the Russian Arctic Zone and Ensuring National Security until 203 "]. N 0001202010260033. URL: https://docs.cntd.ru/document/566091182?marker=25UINTU&section=text (accessed 12 June 2021).

tic paradox: with a radical change in the model of economic development, the advantages of the old development infrastructure seem to be zeroed out, because companies are implementing greenfield projects on completely different principles, territorial structures, etc. The Jack London effect [17], when the infrastructure of the former development actively helps to start a new cycle, works only if the principles of the assimilation model itself (for example, corporate-market) are preserved intact. When the model changes, for instance, from government to corporate, the Jack London effect is significantly weakened or completely nullified.

2. OLI-paradigm as a tool for determining the forms of company's adaptation to development risks

It is not the development risks themselves that matter, but the company's response to them. Dunning's OLI-paradigm, developed for a large multinational company, provides us with a tool for analyzing how Russian Arctic corporations adapt to the high risks of economic activity in the Arctic.

2.1. L-factor: social embeddedness + territorial integration (compactness)

This factor (it can be called geographical factor — L — location) is responsible for company's relations with the territory of its presence and for spatial location of the license areas and main processing centres of the company. Skillful L-factor maneuvering can reduce development risks of a company.

Ideally, the company's high social rootedness in the territory of its presence simplifies the process of its "saturating" with local specifics and learning in the process of development activities, which are important for the elimination or reduction of Arctic risks due to the actualization of the potential of implicit local knowledge. It is important to emphasize that this is not the usual corporate social responsibility of a company in the territory where it operates, but the active involvement of dispersed local knowledge and local experts in the production process, exploration and extraction activities. Because, as shown by numerous works [18, etc.], only the simultaneous accumulation of local and global knowledge ensures the success of the corporate innovation system and development innovation process.

The most striking indicator of the degree of social rootedness of a company is the relationship with the nearest urban development base. Modern realities confirm that Arctic companies are actively "grope", which of the nearest urban settlements are able to perform effectively the functions of expert support for a new project before and during the new development process. On the other hand, the fact of transferring the local headquarters of the company from the nearest town to a distant one, i.e. the fact that the local town loses the function of local / outpost base for development, indicates the company's disappointment in the intellectual potential of the local base or further resource prospects of this territory (for example, transfer of the headquarters of Lukoil from Naryan-Mar to the Usinsk city in the Komi Republic). It is no coincidence that after the accident at TPP-3 in May 2020, Norilsk Nickel made active efforts to cooperate with the admin-

istration of the city of Norilsk on the risks and opportunities associated with climate change, i.e. to intensify exchanges of tacit knowledge with local experts.

Practice shows that the more specific the resource is, the more it requires creation of associated infrastructure and production facilities, the more socially embedded the company is (for example, gas production provides a higher social embeddedness than oil one).

Indeed, the degree of social embeddedness, which is important for minimizing development risks, may differ significantly from full integration of the company into the local innovation system and the economic development of the nearest city-base (as a result of active subcontracting with the local manufacturing business, the company has created a production cluster, there is a network / association of local suppliers, etc.) to the situation of complete alienation from innovative processes in the nearest base city, when its participation is limited to festive events and the construction of social (leisure, sports) objects. For example, Norilsk Nickel is firmly integrated with the city of Norilsk, Gazpromneft's integration with the outpost base city of Noyabrsk is average, and NovaTEK's integration with the capital of the Purovskiy District and the company's local headquarters — Tarko-Sale — is weaker (Table 3).

Territorial integration (compactness) means the possibility of obtaining regional effects using common infrastructure, routes and development bases. No less important (and new in comparison with the previous development of the late Soviet period) is the possibility, with a compact, geographically close location of mining sites, to actualize the effect of scaling — replication of advanced techniques, organizational and management practices worked out at the pilot facility to neighboring projects, which provides important savings in knowledge in the face of high arctic risks.

The champion of territorial integration is NovaTEK, which carries out all its production activities in the Yamalo-Nenets Autonomous Okrug, has two clearly defined northern and southern mining zones, in which the license areas are located extremely compactly. In the south, they are confined to the gas transmission pipeline system, in the north — to the marine logistics of the delivery of construction equipment and main production modules, as well as the export of liquefied natural gas. The production activities of Norilsk Nickel are highly integrated within the Norilsk industrial region, but the company has production assets technologically connected with Norilsk in the Murmansk region. Because of this, the degree of territorial integration of Norilsk Nickel can be considered moderate. Gazpromneft is minimally integrated: due to the fact that Gazprom transferred all its oil assets to a subsidiary, they are presented as if in bulk, and it is impossible to obtain a regional effect on them. It is no coincidence that the company is making super-efforts to remotely communicate its fragmented areas and link them to the intellectual headquarters in St. Petersburg.

It turns out that Norilsk Nickel and NovaTEK use L-factors in neutralizing development risks most actively, while Gazpromneft uses them minimally (Table 3).

Table 3

Adaptation of companies to development risks through L-factors

	NovaTEK	Gazpromneft	Norilsk Nickel
1. Social embeddedness	1*	2	3
2. Territorial integration (district and localised effect)	3	1	2
Total by L-factors	4	3	5

*1 — factor is not used, 2 — used in moderation, 3 — used actively

2.2. O-factor: the genesis of the company + the ability to create a joint venture

The founder of the OLI-paradigm, J. Dunning, understood the O-factor as ownership of the company's assets. Specifying and narrowing its concepts for the real conditions of origin and evolution of Russian Arctic companies to make them more tangible (up to the possibility of expert scoring), based on the empirical generalization of the annual reports of NovaTEK, Gazpromneft and Norilsk Nickel, we will understand this component as the circumstances of the company's birth, which determine much in its current ownership structure and behavior in matters of acquisition and sale of assets; and in a more particular sense — as the ability to create joint ventures with other companies, i.e. to maneuver their property, pooling assets and competencies with partners, and thereby effectively reduce the significant risks of new development projects.

Consider how the genesis of a corporation affects its ability to cope with development risks. Norilsk Nickel was established as a state enterprise about 90 years ago, underwent denationalization and privatization during the years of Russia's radical economic reforms, and became a private resource corporation with a diversified share capital structure. Despite the change in the form of ownership, the company has nonetheless retained the social and industrial complex of the Norilsk industrial region: today it owns over a hundred production and service companies in the transport, energy, logistics, repair, and social institutions. This is an unprecedented phenomenon for a private company not only for the Russian, but also for the global Arctic. In fact, the phenomenon of the resources and territory development in the Arctic is preserved here in the integrated sense (with a wide plume of "departmental" objects), as was accepted in the Soviet model of economic development of the North (Table 4). For the company, however, this means significant risks of responsibility for the entire local social and production system not just the natural resource extraction process.

Table 4

Adaptation of companies to development risks through O-factors

	NovaTEK	Gazpromneft	Norilsk Nickel
Genesis of the company	3	3	1
Ability to create JV	3	3	1
Total by O-factors	6	6	2

*1 — factor is not used, 2 — used in moderation, 3 — used actively

In addition, the decades-long development trajectory of the corporation's local natural resources inevitably leads to rutinisation of the process and a lack of innovation. The risks of proper-

ty liability for everything are partially neutralised by deliberate risk avoidance in the development and implementation of a production strategy, which remains very conservative.

The situation is completely different for Gazpromneft, which, after the transformation of Sib-Neft, became a subsidiary of Gazprom, which took over the main oil assets of the parent company. This dependent ownership structure allows Gazpromneft to redirect (impute) the main risks to the parent company and makes its position in this respect comfortable and free enough for innovative experimentation (there is always a solid support foundation). In contrast to Norilsk Nickel, the ownership structure of Gazprom's subsidiary, which has been formed due to its genesis, damps the risks and allows Gazprom Neft to be exceptionally bold in implementing new offshore projects, new logistical schemes, etc. Without a conservative parent company (ready to absorb the risks of an experimental subsidiary), this would be much more difficult.

The situation is completely different for NovaTEK, which is an Arctic startup in the full sense of the word and, unlike Norilsk Nickel, has neither the traditions of three generations of employees during almost a century of development of Norilsk deposits, nor a large conservative parent company, like Gazpromneft. In its modern form, the company was assembled on the competencies of three key top managers: construction project manager L. Mikhelson, geological manager A. Natalenko, and financial manager M. Jetvey. Apart from tangible assets, the ownership of the key competences of the three main top managers played an exceptional role in the company's assembly in the zero years. They were designed to reduce the initial development risks at the sites of the Yamal gas condensate fields in the Purovskiy region (today the so-called southern zone of the company's activity).

Further expansion of the company's activity to the north of the Yamalo-Nenets Autonomous Okrug, to the Yamal and Gydan peninsulas, was associated with the formation of strategic technological, property and financial partnerships with large Chinese, Japanese investors and the French oil and gas company Total. Therefore, the Yamal LNG and Arctic LNG 2 projects received the status of NovaTEK joint ventures. In order to mobilise limited investment resources for several projects at once, the company weakened its sole ownership rights by forming the joint venture consortia Yamal LNG and Arctic LNG 2.

In this ownership configuration — with the legal separation of each new project within the parent company — a portfolio approach was implemented to neutralise development risks: the more stand-alone projects in the company's portfolio, the lower the overall development risk increase for the entire portfolio (individual project development risk is higher than the total risk increase after a new development project is launched).

Compared to Gazpromneft, the situation is reversed: in the first case, development risks are damped by the possibility of redirecting them from the parent company's subsidiary in case of emergency; in the case of NovaTEK, there is no external formation of a new spin-off legal entity, but an internal one (what is called a spin-out in Western literature).

The three Arctic corporations in Russia are radically different in their ability to create joint ventures that ensure consolidation of financial, material assets and competencies, thereby reducing development risks. It should be emphasized that we are considering intercorporate partnerships at the stages of the development process, that is, in search, exploration, construction and operation. Moreover, each company has numerous cooperation agreements with universities, industrial associations, institutes of the Russian Academy of Sciences, etc. We are primarily interested in cooperation between corporations in the economic development of resources and territories of the Arctic.

The leader in this process is NovaTEK (Table 4) that forms every new project as an international consortium of companies, banks and funds, i.e. it actively uses the legal framework of JV to develop its fields.

Gazpromneft is a similar leader, using the legal form of a JV for prospecting, exploration and development, i.e. to mitigate risks at all stages of the development process (from pioneering studies to construction and operation) by entering into intercorporate alliances, including those with NovaTEK. Inheriting the tradition of Sibneft, which was one of the leaders among Russian oil and gas companies in cooperation with foreign production and service partners, Gazpromneft is forming a joint venture for prospecting and exploration in areas of poor exploration and remoteness, such as with Shell in the northeast the Gydan Peninsula [7].

Norilsk Nickel, on the other hand, has long made no efforts to form joint ventures in certain areas of its deposits in the Norilsk industrial area, the Murmansk region, and the Trans-Baikal Territory. In 2018, the first agreement of intent to create the Arctic Palladium JV was signed between Norilsk Nickel and Russian Platinum, but in 2020 Russian Platinum withdrew from the agreement — it was not possible to create a joint venture. The reasons are clear: Norilsk Nickel incurs huge costs to maintain the production system and the entire life support system of the Norilsk industrial island area. In these conditions, any partner or incoming company automatically becomes a “free rider”, i.e. it uses the infrastructure and the entire social security system that has been created for decades and is supported annually at the cost of significant efforts and risks of Norilsk Nickel with minimal costs. The reluctance of Norilsk Nickel to enter into strategic partnerships on its “own” corporate territory is understandable, but as a result, an important tool for reducing development risks, which other companies are actively using, remains untapped (Table 4).

[7] Gazprom approved the creation of a joint venture between Gazprom Neft and Shell at Gydan. Gazprom has agreed to sell a 50% stake in Gazpromneft-Aero Bryansk to the Anglo-Dutch Royal Dutch Shell for the benefit of the Anglo-Dutch Royal Dutch Shell, - reads the message from Gazprom. OOO Gazpromneft-Aero Bryansk owns the Leskinsky and Pukhutsyayakhsky blocks in Gydan. Thus, Gazprom approved the creation of a joint venture between Gazprom Neft and Shell under the Yenisei project, which will include the Leskinsky and Pukhutsyayakhsky blocks. Gazprom Neft and Shell are counting on the emergence of a large exploration cluster in the northeast of Gydan. URL: https://www.interfax.ru/business/736683 (accessed 10 June 2021).

2.3. I-factor (internalisation): make or buy + organisational structure transformations

The classical interpretation of the I-factor is the decision of the company, which activities to perform within its scope and which of them — on the "free" market. In other words, it refers to a specific way of saving transaction costs — through the institutions of the company or the market [19]. For Arctic companies, this factor can be specified as decisions on the most important issues of production service (including science-intensive) — to keep it in the company or to isolate it in the form of autonomous market structures; and as decisions on changes in the organizational structure — to a flatter (horizontal) or more hierarchical (vertical) one. The assumption is that the dynamics of this factor are an important part of the company's strategy in neutralising development risks.

Let us now look at how skillfully companies use this tool in their practice. If we evaluate the patent policy, the champion in self-sufficiency is Norilsk Nickel, which develops the maximum share of patents independently in its divisions [20]. The company repeats its approaches in matters of production, social infrastructure and equipping: to make it its own structures and to rely to a lesser extent on external actors. In the conditions of almost a century of existence of the island economic structure — the Norilsk industrial region — such a strategy is quite justified.

On the other hand, NovaTEK relies to the greatest extent on external sources for its patent policy, including developments by Gazprom. But the company also prefers not to accept transport, port and other facilities into its pipeline but rather to enter into long-term contracts. This strategy is the exact opposite of Norilsk Nickel's strategy, but it is explained by the company's desire to minimize development risks by maintaining its mobility and a relatively simple compact internal structure without burdening with numerous and often inertial service and infrastructure organizations.

An intermediate position between these poles is occupied by Gazpromneft, which retained in its core only high-tech production services, for example, geophysics (including seismic exploration), and outsourced increasingly simple production and service operations. However, unlike NovaTEK, it does not charter, but has its own fleet for its Arctic projects.

How to assess three completely different situations in the "make-or-buy" dichotomy in terms of development risks? Let us accept the hypothesis that all extremes of maximum freezing in the Arctic soil and maximum "volatility" and unencumberedness carry greater risks than a moderate average (compromise) situation, which provides the company with the necessary flexibility to cope with development risks. Under this hypothesis, Gazpromneft will have the best positions, while NovaTEK and Norilsk Nickel will have the average positions (Table 5).

Table 5

Adaptation of companies to development risks through I-factors
"Traffic light" assessment of the OLI factors of companies in dealing with risk

	NovaTEK	Gazpromneft	Norilsk Nickel
1. Make or buy?	2*	3	2
2. Flexibility of organisational change	2	3	1-2
Total by I-factors	4	6	3-4

*1 — factor is not used, 2 — used in moderation, 3 — used actively

Let us assess the flexibility of organisational structural transformations and the degree of centralisation of the company's internal management (verticality of the organisational structure). Until recently, Norilsk Nickel was an exceptionally inertial and highly centralised corporation in terms of organisational structure. Other corporations carried out flexible adjustment to changing external conditions, experimenting with their organisational structure, turning it into a more horizontal and networked one, consisting of economically independent and autonomous subdivisions-nodes of a unified corporate network, which is now generally recognized as a good mechanism of adaptation to external uncertainties and risks in conditions of increasing external instability (including in the development environment).

There are also objective prerequisites. In greenfield projects carried out by NovaTEK and Gazpromneft, the probability of radical internal transformations of the corporate organisational structure is higher simply because of the faster pace and change of events that need to be promptly responded to, including through the dynamics of the organisational structure. In the development projects in old industrial territories, the dependence on the previous path is higher, and therefore the transformations in the internal services activities are slower and less radical.

Force majeure circumstances in 2020 (an accident at TPP-3 of the Norilsk-Taimyr Energy Company [8], when over 20 thousand tons of diesel fuel spilled as a result of subsidence of piles onto the adjacent water area) [9], prompted Norilsk Nickel to abandon the previous management vertical divisional management structure (Norilsk, Kola, and Zabaikalsk divisions bear “comprehensive operational responsibility for the production process, infrastructure facilities, financial results and risk management”). New structural subdivisions were established within the Company: the Risk Management Committee under the Management Board, an autonomous Environmental Department, an Environmental Monitoring Center, the Inspectorate for Monitoring Technological, Production and Environmental Risks within the Internal Control Unit, and new positions of Deputy Director for Industrial Ecology and Environmental Protection in the Polar Division of Nornickel and Senior Vice President for Sustainable Development were introduced [10].

The final scores for the I-factor indicate a very high flexibility and adaptability of the internal structure of Gazpromneft (the company recently began a large-scale digital transformation), moderate flexibility of NovaTEK, which the corporate management seems to consider sufficient given the relatively simple and compact internal structure, and a less flexible internal structure of Norilsk Nickel. Only in the last year the situation has started to change.

[8] Some of the piles, in violation of the project requirements, were not deepened into the rock, and permafrost soils became "fluid" as a result of climate change.

[9] The arctic reason for this accident is that the main fuel of CHPP-3 is natural gas, and the diesel fuel that has spilled is a reserve fuel and is stored in the fuel tank. If the station operated in the main Russian, and not the island Norilsk, settlement zone, then there would be no need to have reserve fuel.

[10] Nornikel': Otchet ob ustoychivom razvitii 2020. Nash Krayniy Sever [Norilsk Nickel: Sustainability Report 2020. Our Far North]. 127 p. URL: https://www.nornickel.ru/files/ru/investors/disclosure/NN_CSO2020_RUS_28.04.pdf (accessed 12 June 2021).

3. Development risks of corporations: priorities for strengthening competencies and corporate innovation system

The generalization of the challenge of development risks and the adaptive response to them of three Arctic corporations in Russia reveals interesting imbalances (Table 6). The arithmetic average of all development risks (point estimate) is the highest for Norilsk Nickel, but its average arithmetic potential for adaptation to these risks (according to Dunning's triad of factors) is the lowest among all three corporations — 3.5. The strongest challenge is followed by the weakest response. The situation for NovaTEK and Gazpromneft is comparable, but still better for NovaTEK, which has the lowest average development risk among all three companies, but has an almost maximum adaptive response potential. On the other hand, Gazpromneft has the best positions in terms of the average adaptation potential (response to risks) among all companies, but it also has a higher average development risk than NovaTEK.

Table 6

Company challenge and response to development risks

	NovaTEK	Gazpromneft	Norilsk Nickel
Final development risk	3	6	8
Average development risk	**1.0**	**2.0**	**2.7**
L-factor adaptation potential	4	3	5
O-factor adaptation potential	6	6	2
I-factor adaptation potential	4	6	3-4 (3.5)
Final adaptation potential	14	15	10.5
Average adaptation potential	**4.7**	**5.0**	**3.5**

Having obtained this general picture of the distribution of companies in the challenge-response space to development risks, it is useful to analyse, on the basis of annual report data, which specific competences each company uses to respond to the challenges of high risks and uncertainty in the development of Arctic resources. After all, it is the competencies, the corporate innovation system and the company's training potential that ultimately guarantee the company's successful response to these challenges. Let us try to stratify these corporate competencies according to the stages of the development process — search and exploration, construction, production, transportation and integral (system) development competencies.

NovaTEK possesses the competencies that are important for the pioneer stage of development of the “smooth”, without loss of knowledge, communication between geologists and oilmen, in fact, the exploration and operational subsystems of a single corporate innovation system: only those license areas are opened that can be easily and quickly involved in the corporate turnover due to clear logistics and proximity to infrastructure facilities. The company's competencies at the construction stage are associated with the art of managing integrated projects, when production, processing, transportation are immediately considered in a systemic unity (also by the competencies of ultra-compact layout of new projects). At the production stage, the competencies of NovaTEK may be inferior to Gazpromneft, but NovaTEK is also beginning to apply technological solutions focused on the use of unmanned schemes and artificial intelligence. In terms of competencies in maritime logistics, NovaTEK became one of the first Russian companies in the develop-

ment of the Northern Sea Route, within the limits of its year-round use for LNG transportation to Asian markets. The company's cross-cutting competencies are its masterful ability to use the institution of a pilot project to save on knowledge while further replicating best practices and experience to other company projects.

Gazpromneft accumulates in its top managers the best engineering traditions of Leningrad technical universities of the late Soviet era. The company's competencies at the prospecting and exploration stage are related to innovative technologies for drilling complex exploration wells (developed at the Gazprom Neft Science and Technology Center). In recent years, the competences of processing big data, creating geological models, etc. have been actively introduced here. The company does not have its own unique competencies at the stage of building new projects; partner competences are used. Since 2017, the Center for Offshore Competencies has been systematising industry knowledge on offshore projects. The November division is working out technologies for additional development of residual reserves at depleted, long-term exploited oil fields. At the stage of logistics and transportation, the company is rapidly developing new competencies in digital solutions, smart logistics, remote control (for example, the Captain program for real-time online support of vessels in the Arctic), and managing its own fleet, including the icebreaker one. The cross-cutting development competencies that are being developed in the company are a system of external and internal corporate communications, cognitive technologies for using artificial intelligence (machine learning, digital assistant, etc.), a knowledge management system, innovations, and distribution of best practices between divisions (through regional centres of specialised competencies — at a certain link in the resource chain, the company's technical solutions library and other corporate institutions). In recent years, the company has embarked on a massive digital transformation.

The pool of *Norilsk Nickel* available competencies is largely explained by its dependence on the previous, almost a century-long, trajectory of economic development of the Norilsk industrial area. No new prospecting and exploration competence is needed, because the reserves discovered in the industrial region will suffice for decades of exploitation. This phenomenon explains the paradoxical geological understudy of nearby Taimyr: the company, over-supplied with reserves for decades, simply had no need for detailed geological exploration of the nearby Taimyr riches, remained poorly studied for decades. Norilsk Nickel's core competencies were accumulated in metallurgy, not in geology. The company's unique competences in construction are related to permafrost, the permafrost formations where the company's main production and social facilities were built. Today, they are supplemented with competencies on the degradation of permafrost and previously constructed foundations of buildings and structures in the context of climatic changes in the Arctic. New competencies at the operational stage are associated with a new spatial layout of old production assets (for example, the Southern Cluster) and innovative modernisation of old, created in Soviet times, production chains for ore processing. Over the past ten years, the company has been developing maritime logistics competence to export its products to Asian markets.

The natural limitations of the unstable Internet on the Norilsk “island” have hampered digital transformation for many years, and only in recent years, the company has begun to rush to overcome its lag in creating digital twins in underground mining processes and sustainable data transmission from underground equipment and faces in mines.

Discussion

A large and still poorly researched topic, only slightly touched upon in this work, is a comparative analysis of the development risks of greenfield and brownfield projects. The 2020 accident at the Norilsk TPP-3, the gradual aging of material and natural assets involved in the national economic turnover back in Soviet times, the rapid degradation of permafrost put forward the topic of protection from risks in the old industrial territories of the Arctic as the most important one. Meanwhile, the bulk of the work devoted to the topic of economic risks in the Arctic, has so far turned to new development projects.

It is obvious that the mechanisms of corporate protection and adaptation to development risks in new and old projects, with some common features, have significant specificity. In the first case, the institution of pilot project and scaling up the best practices for future projects is often used; in the second case, companies often prefer to rely on their existing competences and proven experience.

The work touches upon an important topic that requires special research — how to implement a modern portfolio approach to risk management (and it is necessary, because it guarantees that the risks increase in a separate unit does not mean an equal increase in risks for the entire company — additional risks are partially damped within the corporation), the company must reform its internal organisational structure. This is evidenced by the latest experience of Norilsk Nickel. The over-centralised management structure of the company, in fact, removed responsibility for admitted force majeure situations from the lower level and redirected risks and responsibility to the upper level of the corporation's management. The corporation had to make a radical change in the internal structure from a vertical to a flatter one, consisting of subsidiaries (Zapolyarniy, Kola, Zabaikalskiy) that received significant autonomy. Obviously, in conditions of high uncertainty in the development of Arctic resources, the organisational structure of a corporation should be more decentralised, with more rights delegated to polar divisions than, for example, in the branches of the same corporation in a densely populated temperate zone (in this case a vertical hierarchical corporate management structure within the Polar Division itself could be justified).

The present study has not yet succeeded in providing a systemic view of the company's adaptation to development risks — the forms of response were considered according to the components of the OLI-paradigm. The task of integrating individual reactions into the overall picture of a corporation's strategy for coping with high risks in the Arctic is a challenge for further studies of this topic. However, it is obvious that such an integration platform should be the idea of the com-

pany's common pool of competencies and its corporate innovation system. Only by building up their potential, the company guarantees itself successful protection against Arctic risks.

Conclusion

1. Corporate development risk is a relatively new phenomenon in the socio-economic development of the Russian Arctic. In the Soviet era, it was not singled out separately because all the uncertainties caused by the special conditions of the Arctic and the North were assumed not by the Arctic economic entities, but by the all-Union state departments, trusts and central administrations. Everything changed with the beginning of a radical economic reform in Russia, when large corporations became the main actors in the economic development of the Arctic resources. Now, instead of the state, they undertake the risks of economic exploitation of deposits, onshore and offshore areas of new exploration. Corporate development risk is structured into resource risk, which reflects the contradictory interaction of global resource markets and the local unique resource base of the Arctic; institutional risk, which reflects the contradiction between remote unified state institutions that determine the rules for the development of Arctic resources, and the very specific local conditions of a particular resource project; ecosystem risk, which reflects the natural and economic contradiction between intensive development activities and the fragility of the Arctic ecosystems.

2. In the old-developed areas of the Arctic, corporations often bear greater risks than in the areas of new development. This is confirmed by the comparative score of the aggregate risks for Arctic corporations, which turned out to be the highest for Norilsk Nickel, which has been developing non-ferrous metals in the Norilsk industrial region for about a century (lower than the value of NovaTEK and Gazpromneft). The most dangerous situation in terms of risks is not just accumulated old tangible assets, but old assets in the context of a radically new institutional development environment that has arisen. In these cases, man-made accidents, force majeure situations are almost inevitable for the company.

3. In order to assess the corporation’s response to the challenge of development risks, it is fruitful to use the OLI-paradigm of J. Dunning. Acquaintance with all publicly available annual reports of the resource companies NovaTEK, Gazpromneft and Norilsk Nickel allowed us to specify the general parameters of the paradigm for the specific conditions of the Arctic resources development (to give its parameters a narrow interpretation).

Geographic factor L (location of the company’s assets) is understood by us as the degree of social rootedness of the company in the territory of presence (first of all, in the nearest cities-bases of development) and the ability to obtain spatial effects on the compactness of projects and on their clustering with infrastructure and service facilities , connectivity with each other, in areas of new development.

Ownership factor O (ownership of the main material, natural, intellectual assets) in our case is understood as the genesis of a specific Arctic company (in other words, where the compa-

ny's assets originally came from and how they were acquired by the current owners) and the company's ability to create joint ventures, enter into strategic partnerships with other corporations, thereby obtaining an inter-corporate effect on pooling resources, competence and risk sharing.

Organisational factor I (internalization — the tendency to take assets internally or use them under contracts with structures in foreign markets) is understood as a type of corporate organisational structure (vertical — hierarchical, horizontal — network or hybrid) and the ability to flexibly adapt the type of contract in production service to specific conditions of place and time: in some cases, to take it for independent execution, in another case — to outsource it to external departments.

Concretisation of J. Dunning's OLI-paradigm allowed us to carry out a comparative assessment of companies' adaptation strategies for all three factors. The most successful was Gazpromneft, then — NovaTEK, the least successful in developing an adequate response to the challenge of risks is Norilsk Nickel.

4. Each Arctic corporation has its own separate "profile" on how to protect from development risks. NovaTEK is extremely successful in the ability to obtain regional and localised effects in the space of new development, in the ability to create a joint venture and mobilise the competencies of top managers to neutralise development risks, weaker in the art of internal organisational structural transformations and the degree of social rootedness in the territory of presence. Gazpromneft is a champion in the ability to create a joint venture and thereby share risks with others. The company, as a subsidiary of Gazprom, has the advantages of a conservative parent structure that supports it and, at the same time, freedom to experiment (this is a superfavorable situation for innovation), has considerable flexibility in organisational restructuring and the ability to determine exactly which production service units in specific circumstances of space and time are rational to leave within the company and what should be outsourced. The company's position in terms of opportunities for spatial effects is weaker, and its social embeddedness in the territory where it operates is weaker. On the other hand, Norilsk Nickel has the best positions among the three companies in terms of social rootedness, but loses in terms of flexibility of organisational transformations, ability to create joint ventures, accuracy of decisions, what to do and what to buy on the foreign market.

Norilsk Nickel has the strongest imbalance between the size of development risks and the adaptive capacity to respond to them; Gazpromneft and NovaTEK have a much smaller imbalance. Modern versatile competencies and a strong corporate innovation system focused on the search for radical innovations can reduce the imbalance between the challenge of development risks and the corporation's response to them.

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The Role of Innovation in Solving the Demographic Problems of the Arctic: A Population Perception Study *

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Abstract. The decline in the birth rate, the increase in migration outflows and the deterioration of the health of the Russian Arctic population make it necessary to find innovative solutions to these issues. The scientific problem is to reveal the mechanisms of the influence of innovations and methods of their implementation in the sphere of the formation and realizing of the Arctic demographic potential. The aim of the article is to study the perception of innovation by the population of the Arctic territories when solving personal demographic issues and to assess the relationship between this perception with socio-demographic characteristics. The novelty of the study is in an attempt to link demographic and innovation processes in the Arctic. It was reflected in the substantiation of the theoretical model. The key element of the model is the zone of innovations perception by the population, formed on the basis of the interaction of demographic and innovation processes and combining the following directions of perception: population innovative activity, the desire to learn, the willingness to invest in innovations, the assessment of the innovations availability and willingness to use them, the inclusion of the population into the digital environment when solving demographic problems. The empirical basis was formed by the author's sociological survey of the Arctic municipalities population of the Arkhangelsk region, conducted in 2019. It was revealed that innovation perception is mainly influenced by the age and education and, to a lesser extent, by the level of their income. The results obtained can be used to develop a state regional policy for the demographic development of the Arctic territories based on the use of innovations.
Keywords: *perception of innovation, demographic process, Arctic territory.*

Introduction

The Arctic zone of the Russian Federation, which is home to about 5.3% of Russia's population (2019), loses about 1% of its permanent population every two years [1]. From 2000 to 2019, the loss amounted to 836.5 thousand people due to negative trends in the natural population movement and migration outflow. One of the demographic trends in the Russian Arctic is a decrease in the birth rate, which has been observed since 2015 and corresponds to the all-Russian one, but differs at a faster pace (Table 1). In 2018, the absolute birth rate (87.8 thousand births) practically returned to the 2001 level (88.7 thousand births). A characteristic tendency that complicates the processes of natural reproduction is an increase in the average age of mother at the birth of her

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[1] Unified interdepartmental information and statistical system. URL: https://www.fedstat.ru/indicator/31557 (accessed 14 June 2020).

first child. Despite the younger population (in 2018, the average age of the population in the Arctic was 37.4 years, in Russia — 40.0 years) [2], the average age of a mother at the birth of her first child corresponds to the average Russian value — 28.7 years.

Table 1

Key indicators of demographic processes in the Arctic [3]

Indicators	AZRF regions, average value					Russian Federation, average value				
	2000	2005	2010	2015	2018	2000	2005	2010	2015	2018
Total birth rate, ‰	10.5	12.3	14.1	14.4	11.7	8.7	10.2	12.5	13.3	10.9
The average age of mother at the birth of her first child, years	26.1	26.4	27.2	28.0	28.7	25.8	26.5	27.6	28.2	28.7
Total birth rate, births per woman	1.2	1.5	1.7	1.9	1.7	1.2	1.3	1.6	1.8	1.6
Abortions per 100 births	181	137	81	61	58	169	117	67	44	42
General mortality rate, ‰	12.2	13.4	12.3	10.9	10.7	15.3	16.1	14.2	13	12.5
Infant mortality rate, ‰	16.4	12.4	8.7	7.2	5.7	15.3	11	7.5	6.5	5.1
Mortality rate at working age, per 100.000 people employed age	746.1	932.1	809.4	642.9	588.9	723.5	826.5	634.	546.7	482.2
Primary morbidity rate, cases per 1000 people	933.7	1035.9	1115.9	1049.3	1095.1	730.5	743.7	780	778.2	782.1
The incidence of diseases with a high percentage of fatalities, cases per 1000 people	23.6	35.6	43.8	41.05	43.4	25.7	32.6	36.9	42.6	44.2
Life expectancy, years	63.6	63.1	66.3	69.6	70.4	65.3	65.3	68.9	71.4	71.4
Migration growth rate, ‰	-4.1	-3.4	-4.4	-4.7	-3.4	1.6	0.7	1.1	1.7	0.9

A negative factor influencing fertility processes is the high level of abortions, which exceeded the average Russian values in the Arctic regions over the past two decades, which is most typical for Arkhangelsk Oblast, Krasnoyarsk Krai and Chukotka Autonomous Okrug. While in the early 2000s, the abortion rate in the Arctic exceeded the national average by only 5–7%, by 2018 the gap had increased to 40%. The Arctic has a higher infant mortality rate, exceeding the national average by 10–15%, and in some regions — more than twice as high, for example, in the Chukotka Autonomous Okrug. The Arctic model of mortality is characterized by lower values of the total mortality rate along with a high mortality rate of the population of working age. In 2018, mortality in the Arctic regions was 15% lower than the national average, while mortality at working age exceeded the national average by more than 20%. High rates of premature mortality reduce reserves for increasing life expectancy, which is lower in the Arctic than in Russia.

A negative feature of public health in the Arctic is a very high level of primary morbidity, which exceeds the Russian average by 30–40%. As in the whole country, there has been an increase in the morbidity rate for some highly lethal diseases, such as neoplasms and diseases of the cardiovascular system.

[2] Demograficheskiy ezhegodnik Rossii. 2019: Stat. sb. [Demographic Yearbook of Russia. 2019: Stat. Col.]. Rosstat. M., 2019. 252 p.
[3] Compiled from data: UISIS. URL: https://www.fedstat.ru (accessed 14 June 2020).

The demographic processes in the Arctic are characterized by a constant migration outflow, which increased significantly in 2011, thereby repeating the all-Russian growth in the migration activity. In the Arctic, however, the migration balance is negative, in contrast to the positive migration balance in Russia as a whole.

Despite the insignificant share of the Russian Arctic population in the total population of the country, the preservation and expanded reproduction of the demographic potential of the Arctic territories is of great economic, geopolitical and cultural-historical significance [4]. First of all, from the position of ensuring territorial security, satisfying the need for human resources for the purposes of economic development through the involvement of the Arctic population adapted to the harsh climatic conditions, as well as preserving the cultural heritage of the indigenous Arctic population, including ethno-cultural nuclei of small peoples of the North.

The relevance, specificity and special acuteness of demographic problems in the Arctic determine the need to search for non-trivial innovative practices in the implementation of reproductive plans, health preservation, increase in the duration and quality of life, and the formation of migration attitudes. The intensity of the use of innovations depends on the personal perception of the available innovative technologies, methods and solutions. In this regard, the purpose of this article was to study the perception of innovations by the population of the Arctic territories when solving personal demographic issues and to assess the relationship of this perception with socio-demographic characteristics.

The object of the study is the population of the territories of the Russian Arctic. The subject of the research is a system of relations between the population and innovations, which reveals the nature of their perception by a person in the implementation of personal demographic plans and the formation of a personal strategy of demographic behavior.

Theory and methodology

S.A. Sukneva reveals the demographic potential of the territories as a set of resource opportunities of population reproduction through the interaction of such demographic processes as fertility, mortality and irretrievable migration, taking into account regional features of demographic behavior of the population (reproductive, matrimonial, self-preserving) [1, Sukneva S.A., p. 10]. Within the framework of this approach, the importance of innovations in addressing demographic problems if the Arctic will be considered from the standpoint of their positive impact on increasing the birth rate, reducing mortality and ensuring the migration balance.

In our study, we rely on the definition of innovation introduced by J. Schumpeter, which is interpreted as innovation, new combination, the best way of using, which ultimately affects the entire development process [2, Schumpeter J.]. In a similar way, the concept of innovation is re-

[4] Ob Osnovakh gosudarstvennoy politiki Rossiyskoy Federatsii v Arktike na period do 2035 goda: Ukaz Prezidenta RF ot 5 marta 2020 g. N 164 [On the Fundamentals of State Policy of the Russian Federation in the Arctic for the period up to 2035: Decree of the President of the Russian Federation of March 5, 2020 N 164]. URL: https://www.garant.ru/products/ipo/prime/doc/73606526/ (accessed 16 March 2020).

vealed by W. Thompson: "...the creation, adoption and implementation of new ideas, processes, products or services" [3, Thompson V.A., p. 2]. At the same time, innovation is such as long as people perceive the idea as a new one, even if it can seem like an "imitation" of something [4, Van de Ven A., p. 591]. In the middle of the 20 century, innovations abroad began to be perceived not only in terms of economic profit, but also as having social value with a positive impact on the quality of life [5, Tewksbury J., Crandall M.S., Crane W.E., p. 660]. The well-established opinion is that the environment for innovations is society as a whole [5]. This idea is supported by Russian researchers, noting the social role of innovation [6, Folomyev A.N. et al.]. The modern view of innovation allows us to perceive them not only as a product or service, but also as a process, a new organizational structure, plan, program [7, Baregheh A., Rowley J., Sambrook S.], or a form of management. The scope of application of innovations is also expanding [8, Franz H.W., Hochgerner J., Howaldt J.], when they can be in demand in the social [9, Mulgan G.], institutional, administrative and cultural environments [10, Sener S., Schepers S.].

Demographic processes in society are a special environment for the introduction of innovations, which are quite difficult to study in a complex way. The fundamental connection between demographic and innovation processes was established in the work of V.G. Dobrokhleb et al., in which it was shown that there are lower mortality rates in the innovatively active regions of the Russian Federation. Following the strategy of national saving, the authors develop the idea of necessity to introduce innovations not only in the economy, but also in the sphere of demography, in particular, in health preservation and increase of life expectancy [11, Dobrokhleb V.G., Medvedeva E.I., Kroshilin S.V.]. M.Yu. Arkhipova, on the basis of cross-country comparison, showed that the higher the innovative activity in the country, the higher the level of human development is [12, p. 94]. Based on the previously presented definition of the demographic potential, which is formed as a result of fertility, mortality, migration, we will give some examples of the influence of innovations on these processes, described in domestic and foreign sources, as well as the experience of their use in the Arctic.

Some Russian studies show that the innovative technologies, introduced in recent years in the field of maternal and child protection, have a confirmed socio-demographic effect, which is expressed in a decrease in maternal and infant mortality in Russia from 2005 to 2016 by 50% and 29%, respectively [13, Krivenko N.V., p. 1646]. The experience of integrating information and communication and organizational innovations in Canada as part of an innovative programme of remote obstetric care showed a positive effect by reducing the need for patients to travel to central hospitals from distant locations. The patient was able to receive expert advice from an on-call doctor by telephone through a nurse on a 24-hour basis [14, Dooley J. et al.].

The introduction of innovative technologies in healthcare sector contributes to the improvement of methods of diagnosis and treatment of diseases, increases the awareness of pa-

[5] Phills J.A., Deiglmeier K., Miller D.T. Rediscovering Social Innovation Stanford Social Innovation Review. 2008. № 6. URL: https://www.researchgate.net/publication/242511521_Rediscovering_Social_Innovation (accessed 18 March 2020).

tients about their state of health, and transforms the mechanism of interaction between doctors and patients, making it more convenient and effective. Examples of innovations in the field of healthcare include electronic maps, patient routing, telemedicine, health information infrastructure (medical databases, expert systems) [15, Shevtsova E.V., p. 60]. For example, information systems contribute to the efficient collection and reliable analysis of information, which allows us to provide patients with the highest quality services and get the best treatment results.

Telemedicine plays a special role among innovations in the organization of medical care, which solves the problem of providing emergency medical care in remote, sparsely populated and poorly developed territories. The practice of applying telemedicine technologies to provide medical care to seafarers and fishermen on voyages in the Arctic has shown a high demand for its individual areas, such as teleconsultation and telecardiology [16, Woldaregay A.Z., Walderhaug S., Hartvigsen G.]. Telemedicine as a tool for providing high-quality medical care in the shortest possible time and immediate on-site diagnostics is successfully used on oil rigs in the northern and arctic seas and is considered to be an effective way of providing assistance that avoids cases of unreasonable and costly evacuation [17, Anscombe D.L., p. 662]. At the same time, the effectiveness of this kind of medical care would be determined by the quality of professional training of nurses and doctors, the availability of appropriate equipment and medicines, the availability of complete medical information about the patient, the absence of language barriers [18, Horneland A.M.]. The development of telemedicine as an innovative form of medical care in the regions of the Russian Arctic is limited by the lack of a ubiquitous Internet. In terms of the density of channels formed by digital systems, the Nenets Autonomous Okrug (0.0005 thousand channel-km / km^2) and Chukotka Autonomous Okrug (0.01 thousand channel-km / km^2), Republic of Sakha (0.46 thousand channel-km / km^2) are in the worst position among the Arctic regions [6]. In the Murmansk Oblast, the five most remote Arctic municipalities are not covered by telemedicine, and in Chukotka — 5 out of 7 municipal districts are not included in the telemedicine network. In terms of the number of consultations carried out, the leaders are the Nenets Autonomous Okrug, Krasnoyarskiy Krai and the Republic of Sakha, where consultation in the formats “doctor-to-doctor”, “doctor-to-patient” is practiced and telemonitoring is introduced.

The provision of health care is complicated by the extremely uneven distribution of healthcare institutions across the Arctic. Therefore, the development of innovations in health care will be associated with the introduction of innovative methods of organizing medical care, ensuring its availability. A relevant example, in our view, is the use of innovative models of primary health care based on the continuum of care for patients with chronic conditions in remote, peripheral areas. The positive effect of providing treatment for patients with asthma and diabetes mellitus in remote rural areas is described. This model has resulted in reduced mortality, fewer admissions and re-hospitalisations, resulting in lower costs of treatment [19, Laurence C.O. et al.].

[6] Regions of Russia. Socio-economic indicators 2019. URL: https://www.gks.ru/folder/210/document/13204 (accessed 16 March 2020).

Innovations in healthcare will be developed in the direction of introducing new methods of diagnosis and treatment of diseases, for example, through the provision of high-tech medical care (HTMC). In the regions of the Russian Arctic, despite its acute demand, the volume of high-tech assistance is insignificant. On average, the need for this assistance within the Arctic regions is satisfied by 65%. At the same time, there is a fairly rapid growth in the volume of high-quality medical care in some regions of the Russian Arctic: in Karelia — in 5 times [7], in Yakutia — in 16 times during 2009–2017. This type of high-tech medical care, such as assisted reproductive technologies (ART), is developing in the Arctic due to the expansion of geography and an increase in the number of institutions providing these services (from 4 to 9 centers in 2016–2018). Neither ART, nor HTMC are currently available in the autonomous okrugs.

The introduction of innovations is also associated with educating the population about health-saving measures. The use of personal devices for assessing health indicators (tonometers, glucose meters, etc.), electronic applications for self-monitoring of vital signs, remote participation in online training and schools for healthy lifestyles, training in computer literacy courses are innovative ways of health-saving.

The implementation of environmental innovations into production processes contributes to the formation of an environmentally friendly lifestyle, ensuring the preservation of health. The Arctic is characterized by a low level of implementation of eco-innovations [20, Tortsev A.M., Tortseva T.V., p. 1586], and their role in health saving issues is still insignificant.

The scientific literature describes examples of the impact of innovation on the nature of migration processes, one of which is intellectual migration. Firstly, the development of scientific and educational centres with a modern material and technical environment and learning technologies attracts young people striving to get high-quality education in innovative conditions. Thus, Finland uses the mechanism of attracting educational immigrants from other countries to their universities to solve national demographic problems [21, Strielkowski W., Kiseleva L.S., Sinyova A.Yu., p. 37]. Secondly, an innovatively developed territory attracts educated and qualified personnel, thereby ensuring the migration inflow and development of the demographic potential of the region of entry [22, Voronina N.A.]. On the other hand, the use of innovative information and communication technologies in public life allows people to receive the benefits they needs without changing their place of residence. In this case, the possibility of employment, medical and educational services, communication opportunities, cultural enrichment are not the key factors in population migration [15, Shevtsova E.V., p. 60].

The increasing role of the educational process in the innovative development of the Arctic implies increased investment in the creation of new, highly productive jobs. The development of innovative industries encourages the recruitment of highly qualified specialists from other regions

[7] Doklad o sostoyanii zdorov'ya naseleniya i organizatsii zdravookhraneniya po itogam deyatel'nosti ministerstva zdravookhraneniya Respubliki Kareliya za 2017 god [Report on the state of health of the population and the organization of health care based on the results of the activities of the Ministry of Health of the Republic of Karelia for 2017]. URL: http://zdrav.gov.karelia.ru/ (accessed 15 March 2020).

and restrains the migration outflow of labor resources. The intensified industrial development of the Arctic and the influx of migrant labour predetermine the need to introduce innovations that ensure rapid human adaptation to harsh conditions and regulate the qualitative component of the migration flow. Examples include developments to identify genetic markers in the human body [23, Krivoshchekov S.G., p. 87], technologies to study the adaptation of internal metabolic processes to the conditions of a discomforting environment [24, Silin A.N.] to prevent people moving to polar regions, whose adaptation in high latitudes can cause premature aging and chronic diseases. The criteria for selecting migrants can be education level, qualifications, and health status. The State Migration Registration Information System with regional migrant databases and electronic migration cards is becoming an effective innovative tool in Russia.

In the study, we considered innovations as novelties, new ideas, without highlighting their specific types (product, service, technology) or stages of the innovation process, focusing on their social role, when society is the sphere of their implementation, and their use allows solve its problems, including demographic ones. Adhering to the approach to understanding innovation as a novelty, a new idea or a product used to solve demographic problems, the authors proposed the following grouping:

- *technological innovations*, including innovative processes and methods for improving the quality of the population (innovative methods of family planning, including modern contraception, high-tech care, educational technologies, individual devices for assessing health indicators);
- *management and organizational innovations*, representing new methods of organizing institutions and receiving services (telemedicine, personalized medicine, innovative psychological and pedagogical methods of working with the family, “silver volunteering”, forms of life placement and support for single citizens);
- *information innovations* related to the use of digital information technologies to solve demographic issues (unified information systems and databases (digital health care circuit, digital health care circuit), innovative educational platforms and resources, services for the provision of services in the field of medicine , education, migration);
- *marketing* (take-home tests, “patient-friendly registration”).

According to the object of influence, we will distinguish *social, economic* and *environmental* innovations.

According to the scale of distribution: *local* (individual health control), *large-scale* (innovative technologies used by specific socio-demographic groups), and *global* innovations (technologies in the field of environmental protection).

When investigating the issue of the population’s perception of innovation, we use J. Bruner’s classical interpretation of the term “social perception” — people’s understanding and assessment of the surrounding reality. The development of terminology has led to the selection of the

subject, object and the process of perception in this definition, in the course of which a holistic image of the environment is created. As a subject we mean the population of the Arctic region, as an object —innovations, the use of which can, in our opinion, improve the demographic situation.

The opinion that the success of innovation implementation in society is directly related to its positive perception by members of the social system appeared in the 1970s. [25, Zaltman G., Duncan R., Holbek J.]. The perception of innovations is influenced by a person's readiness for new innovations, the availability of knowledge and skills to adapt to new conditions, and activity [26, Zhuravlev A.L.]. S.A. Ilyinykh notes that the level of perception of innovations is determined by a person's ability and willingness to create, master and implement them, as well as the desire to acquire new knowledge [27, Ilyinykh S.A., Mikhailova E.V., p. 13]. According to E.E. Kuchko, the perception of innovation depends on gender and age characteristics, level of education, type of thinking, worldview, innovative disposition and level of innovation [28, Kuchko E.E., p. 66–67].

L. Gokhberg and V. Polyakova revealed that only a third of the country's population estimates innovation as a factor or source of economic growth. Men are more positive about new technologies, and among women, especially the elderly, a negative perception of innovations dominates. Researchers note the relationship between the perception of innovation and education, income level and the availability of electronic skills [29, Gokhberg L., Polyakova V., p. 96–97]. Ilyinykh S.A. confirmed that men are more receptive to technical innovations, and women are more receptive to social innovations [27, Ilyinykh S.A., Mikhailova E.V., p. 14]. A.S. Zaitseva and O.R. Shuvalova established a relationship between the level of perception of innovations and the inclusion of the population in the digital environment (Internet accessibility, computer skills) and in the process of continuous education [30, Zaytseva A.S., Shuvalova O.R., p. 17, 29].

According to studies to identify innovators capable of producing innovative ideas in society, there is a higher share of them (9.6%) in Russia [31, Fursov K., Thurner T., p. 14] than in foreign countries (Great Britain, Japan), where the figures vary from 3 to 6% [32, Von Hippel E., Ogawa S., de Jong J.P.J., p. 32; 33, Von Hippel E., de Jong J.P.J., Flowers S., p. 1676]. Depending on the motives of innovative behavior, two groups are distinguished: the population of large cities, which stimulates the desire for career growth, and the population of small, remote from the center cities with a lower level of income, whose innovative activity is aimed at solving everyday problems and improving the quality of life.

Studies on the perception of innovations used in solving demographic problems have shown that the employed population is not ready for technological changes at the workplace, low involvement in lifelong learning practices (39% of those employed at the age of 18–65), which can complicate adaptation in the labor market in the case of robotization of workplaces [34, Polyakova V.V., p. 3, 4]. Despite the rapid and necessary implementation of distance education, its perception remains quite complex, but, as the NRU HSE study conducted in April 2020 showed, 69% of Russian school teachers would continue to use online resources when returning to traditional education. The main challenge of implementation of the "distance" in education was the lack of sus-

tainable Internet connection and computers [8].

There is also an insufficient need for innovative health-saving technologies: services of remote communication with a doctor are in demand only in 45% of respondents, the use of fitness bracelets — in 31%, genetic tests that reveal the abilities and risk of diseases of the unborn child — in 30%. The respondents are wary or note the uselessness of their use [35, Voynilov Yu.L., Polyakova V.V., p. 199]. The degree of patient satisfaction with the quality of remotely provided medical services is important [36, Kim J., Alanazi H., Daim T.]. Research study of population perception of introduction of telemedicine services in Greenland showed that people are quite positive about this innovation, as they are concerned about the acquisition of acute or chronic diseases in conditions of insufficient constant and qualified medical care. They are particularly anxious about travelling to a distant hospital or lack of a suitable vehicle for transportation in complicated cases [37, Nielsen L.O. et al., p. 442–443].

The analysis of existing theoretical studies concerning the population's perception of innovation made it possible to formulate the assumption that the population of the Arctic territories has a certain level of perception of innovations, which is used in solving personal demographic issues and problems. At the same time, there is a connection between the perception of innovations by the population and its socio-demographic characteristics (gender, age, level of education, income).

Based on the idea of the interaction of demographic and innovative development, the authors propose a theoretical model of the population's perception of innovation in the Arctic territories. The key component of the model was the “innovation perception zone” by the population, which is formed in the process of implementation of demographic potential in the innovation environment (Fig. 1).

[8] Problemy perekhoda na distantsionnoe obuchenie v Rossiyskoy Federatsii glazami uchiteley: Laboratoriya media-kommunikatsiy v obrazovanii NIU VShE [Problems of transition to distance learning in the Russian Federation through The Eyes Of Teachers: Laboratory of Media Communications in Education, National Research University Higher School of Economics]. URL: https://icef.hse.ru/data/2020/04/15/1556221517/Дистанционное%20обучение%20глазами%20учителей.pdf (accessed 10 April 2020).

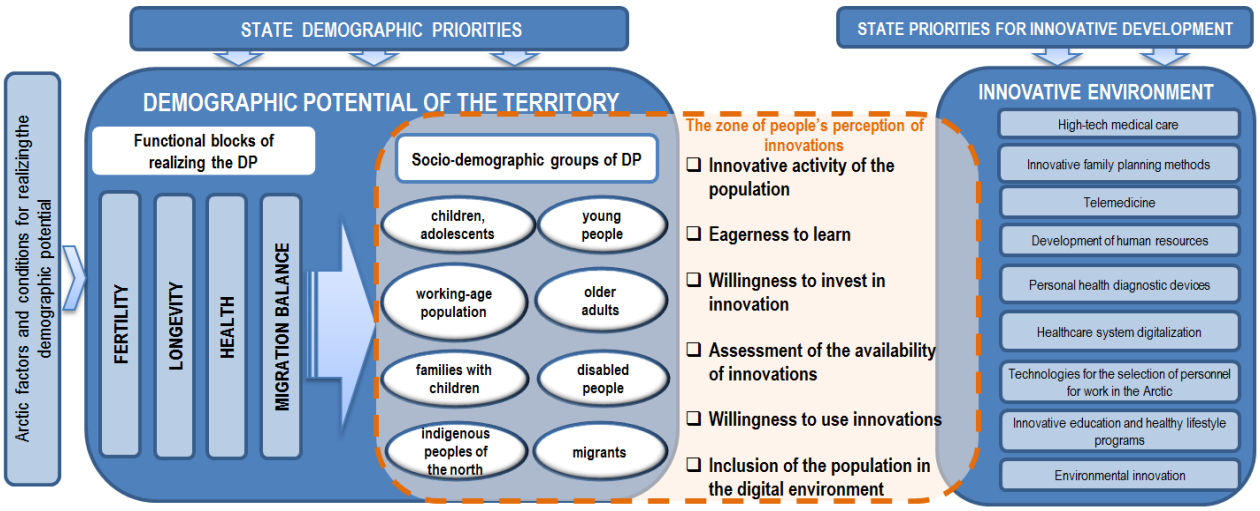

Fig. 1. Scheme of formation the model of innovation perception by the population of the Arctic territories in the aspect of realizing the demographic potential (compiled by the authors) [9].

The zone of population's perception of innovation, characterizing the relationship of demographic and innovation development, includes several areas of perception. The formation of these directions was based on a system of priorities for innovative and demographic development, defined at the level of state policy in the strategic documents of the Russian Federation [38, Gubina O.V., Provorova A.A., p. 388–389]. The priorities of the state demographic policy in the Arctic are increasing the birth rate, reducing mortality, ensuring healthy longevity and balancing migration flows. The state policy of innovative development in the Arctic is based on the following priorities: stimulating research and development, building professional innovative competences, creating conditions for innovation activities, modernizing the material and technical base, introducing and using innovations, organizing a common information space and digitalization. The idea is that the implementation of measures within the framework of the priorities of innovative development will help to improve the demographic situation: an increase in the birth rate, a decrease in mortality, and a migration balance. State innovation priorities, adapted to the level of perception by the population, were formulated as follows: innovative activity of the population (innovation), the desire to learn, the willingness of the population to invest in innovation, the assessment of the availability of innovations, the willingness to use innovations, the inclusion of the population in the digital environment (Table 2).

In order to study the perception of innovations in April 2019, the authors conducted a mass standardized survey of the population of the Arctic municipalities of the Arkhangelsk region (Arkhangelsk city, Severodvinsk city, Novodvinsk city, Primorskiy district, Mezenskiy district, Onezhskiy district, Novaya Zemlya urban district) by online questionnaire using Google Forms application. The sample consisted of 406 people with a maximum error of 5%. Its representativeness is ensured by the proportionality of the distribution of questionnaires by municipalities in accordance with the size and sex and age structure of the population. The survey results were processed in the IBM. SPSS. Statistics program (Ver. 21) using descriptive statistics and correlation analysis.

[9] Compiled by the authors.

Table 2

Methodological basis of a sociological study of people's perception of innovations in relation to the priorities of innovative development and realizing the demographic potential

Priorities for innovative development	The essence of people's vision of innovations in relation to the realizing demographic potential	Directions of people's perception of innovations	Question in the questionnaire
Encouraging research and development	People's inclination to the emergence of new ideas and ways of their implementation is the basis of their innovative activity. The result of personal innovative activity in relation to the development of demographic potential is, for example, the choice of a non-standard individual strategy of demographic behaviour, the search for non-trivial methods of recovery.	Innovative activity of the population	How often do you have new ideas and ways to implement them?
Forming professional innovative competencies	People's desire to acquire new knowledge contributes to the growth of professional competencies, improving the quality of demographic potential.	Willingness to learn	How do you feel about the opportunity to acquire new knowledge, develop skills necessary in the modern world?
Creating conditions for conducting innovative activities	People's willingness and desire to take financial and organizational steps to introduce and use innovations in order to maintain health, to receive an education, to move, for example, labor mobility.	Willingness to invest in innovation	What would you do in order to receive medical, educational and other social services if they are provided at a high modern level using modern technologies and equipment?
Upgrading physical infrastructure	People's assessment of the availability of modern devices and technologies in the field of health care, education, information services as the results of innovative achievements contributing to the improvement of demographic potential (health, educational level, the possibility of having a healthy child).	Assessment of the availability of innovations	How satisfied are you with the availability of modern devices and technologies in institutions where you apply for treatment, education, and other social services?
Implementing and using innovations	People's readiness to use in everyday life existing innovative methods of diagnosis and treatment, education, ways to adapt to new living conditions while implementing personal demographic plans (having children, moving) and solving their own demographic problems (recovery).	Willingness to use innovations	How much are you prepared to use something new, modern (innovations) in your life in order to improve your health, get an education, and resolve migration issues?
Organizing a single information space and digitalizing	The development of the digital environment creates favorable conditions for stimulating human innovative activity and provides an effective solution to demographic issues.	Inclusion of the population in the digital environment	How often do you use the Internet? What do you use the Internet for?
Compiled by the authors			

Results and discussion

The results of a population survey conducted in the Arctic municipalities of the Arkhangelsk Oblast make it possible to assess the perception of innovations in terms of their use in solving personal demographic issues.

First of all, the general level of the population's perception of innovation is determined by individual creative, innovative activity. The question of how often a person has new ideas and ways of their implementation allows us to assess whether a person is aware of himself/herself as a

creative person, whether he/she is inclined to innovate or passive with regard to the generation of new ideas. As a rule, it is a creative idea that becomes the beginning of future innovation [39, Luecke R.]. We assume that an innovatively active person will be more inclined to make non-standard decisions when choosing a strategy of demographic behavior, and focused on the search for original methods of recovery, treatment, and education. The survey revealed a fairly high activity of the population in relation to the production of new ideas: 41% of the population have ideas very often. About 35% of the respondents are not inclined to the production of ideas at all, or do it very rarely, trying to solve problems using standard methods (Table 3).

Table 3

Distribution of answers to the question "How often do you have new ideas and ways to implement them?" (% of the number of respondents, N=406) [10]

	I often have new ideas, and I start to actively think about how to realize them	I have new ideas quite often, but I rarely think about how to realize them	I rarely have new ideas, I try to solve problems in standard ways	I never have new ideas, I like the usual way of life	Total:
Overall distribution of responses	41	25	21	13	100
Age					
15-29 years old	44	40	10	6	100
30-59 years old	46	25	21	8	100
over 60 years old	24	9	34	33	100
Gender					
Male	44	24	22	10	100
Female	38	25	21	16	100
Education					
Basic general	17	33	17	33	100
Secondary general	38	29	21	12	100
initial vocational	20	30	40	10	100
Secondary vocational	31	24	21	24	100
incomplete higher	38	38	19	5	100
Higher	47	20	22	11	100
Postgraduate	53	34	13	0	100
Income level					
Very high	41	32	9	18	100
High	47	22	22	9	100
Average	39	23	23	15	100
Below the average	34	33	20	13	100
Low	46	18	9	27	100

A peculiarity of the population's innovation activity indicator is its negative age dynamics, which becomes evident after age 60. While the percentage of respondents aged 15–29 and 30–59 years who considered themselves capable of generating ideas and willing to take steps to implement them was 44% and 46% respectively, only 24.2% of people over 60 consider themselves creative. The gender distribution showed that men are most inclined to innovate and implement their ideas, while women are more likely to prefer the usual way of life. Assessment of the correlation between innovation activity and the level of education of the population suggests

[10] According to the author's sociological research in the Arkhangelsk region, 2019.

that higher education is the main factor of such differentiation. The correlation between innovation activity and income levels did not show a clear relationship.

The second direction of assessing the perception of innovations is the desire of a person to increase the level of education, which contributes to the improvement of the qualitative characteristics of the population as a carrier of demographic potential. This desire is manifested in a higher level of general and medical culture of the population, which determines a self-preserving way of life. Educated people have more developed skills in searching and analyzing information for the implementation of their own demographic plans in the field of health preservation, family planning, change of place of residence (Table 4).

Table 4

Distribution of answers to the question "How do you feel about the opportunity to acquire new knowledge, develop skills necessary in the modern world?" (% of the number of respondents, N=406) [11]

	I am willing to accept any opportunity to improve the level of education	I would like to learn, but I don't have time	I would like to learn, but I have no money	I would like to learn, but where I live there are no conditions for learning	I can only learn in case of ur-gent need	I don't want to get new knowledge	Total:
Overall distribution of responses	35	10	13	3	29	10	100
Age							
15-29 years old	45	6	15	9	23	2	100
30-59 years old	35	16	14	2	29	4	100
over 60 years old	22	1	10	1	33	33	100
Gender							
Male	34	11	10	4	32	9	100
Female	35	10	15	3	26	11	100
Education							
Basic general	8	8	25	0	42	17	100
Secondary general	32	9	6	15	20	18	100
initial vocational	10	0	0	0	20	70	100
Secondary vocational	18	9	15	2	39	17	100
incomplete higher	47	5	13	3	29	3	100
Higher	40	12	14	3	27	4	100
Postgraduate	60	13	7	0	13	7	100
Income level							
Very high	32	5	9	4	41	9	100
High	39	15	5	6	30	5	100
Average	35	9	15	3	27	11	100
Below the average	27	9	22	2	24	16	100
Low	18	0	18	9	46	9	100

The analysis of answers to the question "How do you feel about the opportunity to acquire new knowledge and develop skills necessary in the modern world?" has revealed, on the one hand, a fairly high readiness of the population to receive education, and on the other hand, we have identified factors significantly constraining this motivation. Out of 61% of those wishing to improve

[11] According to the author's sociological research in the Arkhangelsk region, 2019.

their education level, 26% cannot do this due to lack of time, money and conditions for obtaining education (lack of the Internet, the necessary educational courses). 29% of the respondents represent a passive part of society, who would study in case of urgent need.

It was found that as people grow older, their interest in acquiring new knowledge diminishes: among those aged 15–29 the share of respondents who expressed a desire to improve their level of education was 45%, and it was 22% among those over 60. A third of older people (33%) will study only if absolutely necessary, perhaps to stay in the labour market. Young people in their desire to learn are constrained by a lack of finance. For the middle-aged population, this factor is complemented by a lack of time for education. Naturally, there is a high need for acquiring new knowledge of the population with higher education. Among those who will study in case of urgent need, the population with a secondary vocational education prevails (39%).

The population's desire to learn is constrained by the lack of finance (13%). Among people with very high and high income levels, the categories of those who want to study at every opportunity (32% and 39%, respectively) and those who will study only in case of urgent need (41% and 30%, respectively) prevail. The population with a low level of income is less likely to find an opportunity to study, noting a lack of money (18%) and can afford education only in case of urgent need (46%). No statistically significant relationship was found between the desire to learn and gender.

The third direction of perception is a person's willingness to invest in their health, education in case of the possible receipt of medical, educational, and other social services through the use of innovations. According to the theory of human capital, the financial aspect of individual investment in relation to our research involves the costs of education, the purchase of modern devices and equipment for treatment and diagnostics, or the implementation of the costs of obtaining modern medical services, as well as labor mobility and relocation. The organizational and behavioral aspect of personal investment [40, Roshchina Ya.M.] consists in taking measures to implement individual demographic plans: a trip to obtain medical help, time spent on searching for information about new methods of treatment, education, and options for labor mobility. Based on the presented justification, the respondents were asked the following question (Table 5).

Table 5

Distribution of answers to the question "What would you do in order to receive medical, educational and other social services if they are provided at a high modern level using modern technologies and equipment?" (% of the number of respondents, N=406)

	I am ready to use all possible ways to take advantage of new modern methods of treatment, education	I am ready to spend money to take advantage of modern methods of treatment, education, if they find themselves in my locality	I am ready to travel, actively seek information about new methods of treatment, education, but I am looking for free ways	I am not ready to spend neither money nor time to take advantage new modern methods of treatment, education	Total:
Overall distribution of responses	16	24	37	23	100
Age					

15-29 years old	19	33	29	19	100
30-59 years old	19	23	40	18	100
over 60 years old	8	20	34	38	100
Gender					
Male	20	26	34	20	100
Female	14	23	39	24	100
Education					
Basic general	8	17	25	50	100
Secondary general	15	26	38	21	100
initial vocational	0	20	10	70	100
Secondary vocational	13	20	34	33	100
incomplete higher	10	32	32	26	100
Higher	19	26	40	15	100
Postgraduate	33	7	53	7	100
Income level					
Very high	32	22	23	23	100
High	25	37	25	13	100
Average	12	24	43	21	100
Below the average	7	11	38	44	100
Low	27	0,0	36	37	100

The results of the survey showed a low willingness of the population to invest in innovative methods of health improvement, education, and labor mobility. The reluctance to make financial investments became a significant limiting factor. The majority of the respondents (37%) prefer to use innovations for free.

Young people are distinguished by a high level of readiness to use innovations. The lack of financial constraints is explained by a poor awareness of financial costs, the lack of independent marriage and family relations and obligations within the family. Among those who are ready to invest only with their own time, there is a large proportion of people aged 30–59 years, whose desire to use innovations is limited by financial possibilities. The willingness to make financial and organizational investments decreases with age.

Men are more (26%) than women (23%) willing to invest in innovation. But men (34%) are more inclined to pay for innovations, while women (39%) are more inclined to spend time searching for them.

Analysis of the distribution of answers did not reveal a relationship between the willingness to invest and the level of education. Interestingly, people with a higher level of education prefer to apply their knowledge in order to find a cheaper way to use innovation, saving financial resources. The expected was a high willingness to invest in innovation, due to the high income of the population.

The fourth direction in the perception of innovations by the population concerns the assessment of the level of modernization of healthcare, education, and other social spheres, the development of which affects the dynamics of demographic processes (Table 6).

Table 6

Distribution of answers to the question "How satisfied are you with the availability of modern devices and technologies in institutions where you apply for treatment, education, and other social services?" (% of the number of respondents, N=406) [12]

	In the institutions where I apply for treatment, education, and the provision of other social services, modern devices and technologies are used…			Total:
	in sufficient quantities	not wide enough	extremely rare and few	
Overall distribution of responses	15	55	30	100
Age				
15–29 years old	25	50	25	100
30–59 years old	10	58	32	100
over 60 years old	18	50	32	100
Gender				
Male	15	56	29	100
Female	15	54	31	100
Education				
Basic general	25	42	33	100
Secondary general	20	59	21	100
Initial vocational	40	40	20	100
Secondary vocational	13	51	36	100
Incomplete higher	16	63	21	100
Higher	13	55	32	100
Postgraduate	14	73	13	100
Income level				
Very high	32	54	14	100
High	14	61	25	100
Average	13	56	31	100
Below the average	20	44	36	100
Low	9	45	46	100

The study showed a low level of population's satisfaction with the availability of modern devices, equipment, technologies in the field of the implementation of human demographic functions. The degree of dissatisfaction with the availability of innovations increases with age. Young people who do not feel an acute need for medical examinations, but rather widely use gadgets, including for receiving educational services, highly appreciate the availability of modern devices and technologies. The most economically active age group, which is the main consumer of innovations, and the age group from 30 to 59 years old, characterizes its accessibility as insufficiently broad (58%).

The distribution of answers to the question showed no relationship between the assessment of the accessibility level of devices and technologies and the level of respondent's education, which ensures the objectivity of the general opinion of the population.

Among the poor, the share of those who believe that modern devices and technologies are used extremely rarely and very little (46%) exceeds the share of the population with a high (25%) and very high income level (14%), who also assesses accessibility of innovations as low. This can be explained by the greater access to innovation of people with higher incomes. But wealthy people have a high level of requirements for innovations and the results of their use, in connection with which there is a larger percentage of them who are not sufficiently satisfied with their availability.

[12] According to the author's sociological research in the Arkhangelsk region, 2019.

The fifth direction of assessing the perception of innovation is the willingness of the population to use innovative technologies that will contribute to solving their own demographic problems (Table 7).

Table 7

Distribution of answers to the question "How much are you prepared to use something new, modern (innovations) in your life in order to improve your health, get an education, and resolve migration issues?" (% of the number of respondents, N=406) [13]

	I am ready to actively use innovations in my life	I am ready to actively use innovations in my life, if that's the only way to solve my problem	I use innovations if someone has a positive experience	I am not ready to use innovations in my life	Total:
Overall distribution of responses	16	23	41	20	100
Age					
15-29 years old	22	23	40	15	100
30-59 years old	14	26	43	17	100
over 60 years old	14	18	35	33	100
Gender					
Male	15	23	44	18	100
Female	16	24	39	21	100
Education					
Basic general	8	17	50	25	100
Secondary general	15	15	50	20	100
Initial vocational	0	40	30	30	100
Secondary vocational	15	25	32	28	100
Incomplete higher	21	24	47	8	100
Higher	17	23	41	19	100
Postgraduate	13	33	47	7	100
Income level					
Very high	18	23	41	18	100
High	15	20	49	16	100
Average	16	24	37	23	100
Below the average	17	27	38	18	100
Low	9	18	64	9	100

The survey results showed a low willingness of the population to use innovations in their lives. Only 16% of the population is ready for the unconditional use of innovations, while about 65% of the respondents realize the need to apply innovations only under certain conditions, for example, relying on someone's positive experience.

There is a twofold difference in the level of readiness to use innovations between the poorest and the richest categories of the population. At the same time, both rich and poor people, demonstrating practicality and frugality, are focused on the use of innovations, relying on the positive experience of other people. For the population with an average income, the main motive for using them is the impossibility of solving their demographic problems in a standard way. A statistically significant correlation between the willingness to use innovations and the level of income was not confirmed ($p > 0.05$). Consequently, even a financially unprepared person can show a high willingness to use innovations if they realize their benefits, seeking money, for example, to receive modern dental care or pay for an IVF procedure.

[13] According to the author's sociological research in the Arkhangelsk region, 2019.

An analysis of the distribution of answers to this question by age groups revealed, firstly, a decrease in the willingness to use innovations with aging. Secondly, the low level of readiness to use innovations by people aged 30–59 years, who are their largest consumers as the most numerous, economically and socially active category of the population. They are ready to use mostly "proven" innovations, which can be explained both by distrust of the possible effect of their application, and by the manifestation of financial savings within the family budget.

The distribution of the population by sex did not show a clear differentiation in terms of the willingness to use innovations, but men mainly rely on someone else's experience when deciding to use them.

Analysis of the distribution of responses showed no statistically significant relationship between the willingness to use innovations for the purpose of health, education and migration issues and the level of education of the respondents ($p>0.05$). The population with incomplete higher education (21%) and higher education (17%) expresses greater readiness to use innovation than people with basic general education (8%) and general secondary education (15%). The unwillingness to use innovations is more manifested in the population with primary and secondary vocational education (30% and 28%, respectively) compared with the population with incomplete and higher education (8% and 19%).

The sixth direction of assessment includes the study of the level of organization of digital environment in the aspect of population's perception (Table 8). The indicator characterizing the level of the population's involvement in the digital environment is the intensity of Internet use.

Table 8

Distribution of answers to the question "How often do you use the Internet?" (% of the number of respondents, N=406) [14]

	Every day	Few times a week	Few times a month	I do not use it because there is no internet connection	I do not use because I do not want / do not know how	Total:
Overall distribution of responses	81	8	1	2	8	100
Age						
15-29 years old	99	0	0	0	1	100
30-59 years old	92	6	1	0	1	100
over 60 years old	38	21	3	7	31	100
Gender						
Male	85	10	1	1	3	100
Female	79	7	1	2	11	100
Education						
Basic general	67	8	0	8	17	100
Secondary general	76	3	0	0	21	100
Initial vocational	30	0	10	10	50	100
Secondary vocational	72	11	1	3	13	100
Incomplete higher	97	3	0	0	0	100
Higher	85	10	1	1	3	100
Postgraduate	100	0	0	0	0	100
Income level						
Very high	73	5	5	4	13	100

[14] According to the author's sociological research in the Arkhangelsk region, 2019.

High	84	12	1	1	2	100
Average	83	8	1	1	7	100
Below the average	73	5	2	4	16	100
Low	82	0	0	0	18	100

The survey revealed a fairly high intensity of Internet use, with 81% of respondents using the Internet every day (in 2019), which is a prerequisite for developing a positive perception of the digital environment. In Russia, 60.6% of residents used the Internet daily or almost every day in 2017, and in 2018 — 68.8%. On average, in the Arctic regions, the share of such a population was 69.3% in 2017, and 75.3% in 2018 [15]. Our research has shown that age is the main factor determining the intensity of Internet use. Older people are characterized by unwillingness or inability to use the Internet, which may be due to a lack of knowledge. The second reason may be the low income level against the background of the high cost of Internet services in the Arctic. The population uses the Internet mainly for information search, communication in social networks and for leisure purposes (Fig. 2).

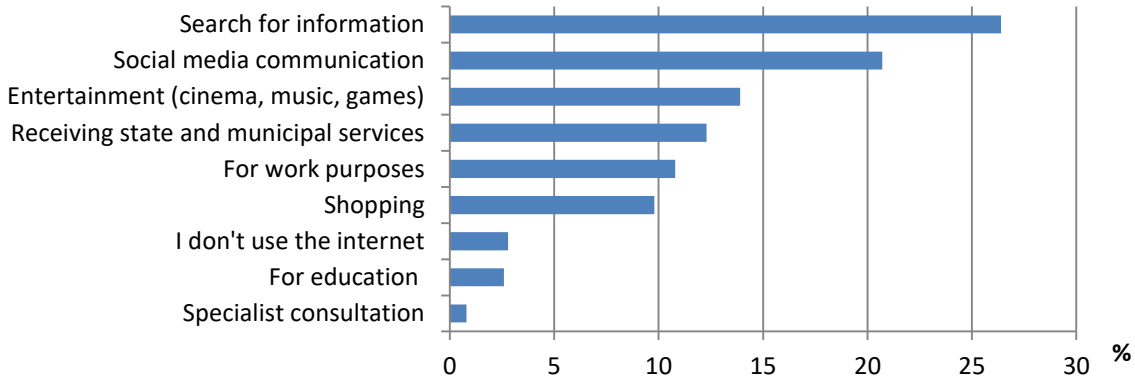

Fig. 2. Distribution of answers to the question "What do you use the Internet for?" (% of the number of responses received, N=406.

The use of Internet technologies as an innovative means of teaching, obtaining medical care, state and municipal services, organizing the work process has not found widespread use, which allows us to conclude that the resources of the digital environment are insufficiently used for the development of demographic potential. In order to determine the closeness of the relationship between the socio-demographic characteristics of the population and the directions of perception of innovations, a correlation analysis was performed using the rank correlation coefficients τ-Kendall and r-Spearman (Table 9).

Table 9

Correlation coefficients between the directions of innovations perception and socio-demographic population characteristics of the Arkhangelsk region [16]

Directions of people's perception of innovations	Correlation coefficients	Age	Gender	Education	Income
Innovative activity of the population	τ-Kendall	0.242	-	0.141	-
	r-Spearman	0.300	-	0.166	-

[15] Tsifrovaya ekonomika: 2020: kratkiy stat. sb. [Digital Economy: 2020: A Brief Stat. Col.]. Moscow, NRU HSE, 2020. 112 p.

[16] Calculated by the authors.

Eagerness to learn	τ-Kendall	0.150	-	0.189	0.100
	r-Spearman	0.192	-	0.226	0.118
Willingness to invest in innovation	τ-Kendall	0.151	0.090	0.156	0.248
	r-Spearman	0.187	0.098	0.184	0.280
Assessment of the availability of innovations	τ-Kendall	-	-	-	0.087
	r-Spearman	-	-	-	0.096
Willingness to use innovations	τ-Kendall	0.083	-	-	-
	r-Spearman	0.102	-	-	-
Inclusion of the population in the digital environment	τ-Kendall	0.456	0.092	0.194	-
	r-Spearman	0.523	0.094	0.216	-

- moderate association (0.3 – 0.5) - weak association (0.1 – 0.3)

Table 9 shows only statistically significant correlation coefficients (at p≤0.05). It was found that the main socio-demographic characteristic most closely related to the perception of innovation is the age of the population. The closest (moderate on the Chaddock scale) relationship with age is manifested in relation to the inclusion of the population in the digital environment. The relationship between innovation activity, desire to learn, willingness to invest in innovation, and age is characterized as weak. The level of education and income have less influence than age on the level of perception of innovation, but the degree of closeness of the relationship is outside the lower boundary of the scale taken as a basis. Correlation analysis showed no significant difference between men and women in the perception of innovation.

Conclusion

Extreme climatic conditions, remoteness and underdevelopment of the territory, uneven development of social infrastructure in the Arctic create a special environment for the generation and use of innovations [41, Zamyatina N.Yu., Pilyasov A.N., p. 204]. As noted by A. Petrov, the development and implementation of innovations in the periphery can have a significant impact on the socio-economic development of the Arctic communities [42, Petrov A., p. 161]. To solve demographic problems in the Arctic regions, the use of innovative technologies and methods is of particular importance, for example, high-tech medicine, medical and diagnostic “health trains”, mobile laboratories, telemedicine, distance learning, modern methods of selecting labor migrants.

The theoretical model proposed by the authors made it possible to substantiate the existence of a connection between the directions of innovative and demographic development of the Arctic territories of Russia. This connection can be established in the course of assessing the perception of innovations that people use in their daily life when solving their own demographic issues, thereby improving the demographic situation in general in the Arctic regions. The scientific novelty of the model, which is of theoretical significance, lies in a special approach to disclosing the structure of the perception of innovations by the population, the directions of which were determined on the basis of the priorities of the region’s innovative development. This model was laid in the basis for assessing the perception of innovation by the population through a sociological survey. The results of the study showed that the population has a certain level of perception of innovations in relation to solving demographic issues. A positive fact is the high innovative activity of the population, which determines non-standard solutions in the strategy of their demographic behavior. The population of

the surveyed Arctic territories is ready to improve their skills and acquire new knowledge; they are characterized by wide involvement in the digital environment. At the same time, the population is not ready to make financial investments in the use of innovations, shows a low willingness to use them in their lives, and is also not satisfied with their availability. A statistically significant relationship between the perception of innovations and the age of a person, his education and income level was revealed, which manifested itself in the fact that the population at a younger age perceives and uses innovations better. Growth in income and education also has a positive effect on perceptions and willingness to use innovation in addressing demographic issues.

The research results can be incorporated into the process of making managerial decisions in the development and adjustment of regional state programs in the field of health care, education, migration, development of the digital environment and innovation infrastructure. The practical significance of the results is confirmed by the fact that the Arctic territories, due to their inaccessibility and low population density, are often excluded from the objects of monitoring the country's population [25, Zaltman G., Duncan R., Holbek J.].

Prospective author's research can be aimed at studying the perception of innovations in relation to the demographic plans and life strategies of the Arctic population: migration intentions, reproductive plans, programs of self-preservation behavior and healthy longevity. Further research will help to obtain a much larger array of data on which innovations will be in demand in the implementation of the demographic potential in terms of the greatest effect for the Arctic.

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The Formation of a Career Trajectory by Students of Secondary Vocational Education in the Russian Arctic Zone *

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Abstract. The purpose of the article is to identify the features of professional self-determination and formation of career trajectories of secondary vocational education students in the subjects of the Russian Arctic zone, their orientation towards professional implementation in the Arctic zone of Russia. The study is based on the survey of secondary vocational education students in the constituent entities of the Russian Arctic zone in the framework of the All-Russian career guidance lesson "Start your career in the Arctic and the Far East!". A total of 686 questionnaires of respondents from Krasnoyarsk Krai, Murmansk Oblast, Komi Republic and the Republic of Sakha (Yakutia) were selected for analysis. The results of the study showed that only about a third of students have decided on further plans for building career trajectories. Most students, when shaping their professional future, are guided by personal desires and preferences, as well as by material well-being. Every tenth student does not clearly associate his/her future with employment in the specialty. About a third of students are focused on professional implementation in the Russian Arctic zone. The results of the study can be useful for researchers, specialists in professional self-determination, teachers and consultants of educational institutions of secondary vocational education, as well as authorities in the field of education, labor and employment.
Keywords: *student, Arctic zone of the Russian Federation, professional self-determination, career building.*

Introduction

The formation of a career trajectory is a continuous process that, in a rapidly changing world, forces both students and specialists to assess the current professional position, to form and revise the vector of the desired path of professional development. For students of programs of secondary vocational education (SVE), the vector of a future career is formed already while mastering educational programs of a special discipline, industrial practice and internships; a career trajectory is formed within the educational trajectory. Further, these trajectories can be divided into the track of continuing professional education (training at a higher level of the education system within the same or another specialty) and the track of entering the professional space — the labor market.

In the context of labor resources shortage [1, Stepus I.S., p. 76] and population decrease in the regions of the Arctic zone of the Russian Federation (AZRF), it is necessary to pay attention to the study of the peculiarities of the career trajectories formation of secondary vocational education students. At the same time, it is important to take into account that the formation of a career trajectory is laid in the process of students' professional self-determination. The choice of the pro-

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fessional self-realization path includes, according to the authors' interpretation [1]: "comparison of the probable positive and negative consequences of the choice; development of a personal position to the objective conditions that create a situation of choice; determination of life perspective of the individual, and the formation of life plans" [2]. In this study, in accordance with the interpretation of L.B. Schneider [2], we will understand the formation of the career trajectory of SVE students as the active process of building own personal development path in the professional field, accompanied by a sense of personal fulfillment.

The purpose of this article is to identify the peculiarities of professional self-determination and formation of career trajectories of secondary vocational education students in the subjects of the Russian Federation and their orientation towards professional implementation in the Arctic zone of Russia.

Research methodology

According to the legislation, the concept of "Arctic zone of the Russian Federation (AZRF)" is defined by Presidential Decree No. 296 of May 2, 2014 [3]. Within the framework of this study, the term "subjects of the Arctic zone of Russia" will be used to refer to the Russian regions, which are territorially, fully or partially, part of the AZ of the Russian Federation. The research results will be presented for the region as a whole. Hereinafter, the definition "subjects of the AZRF" will be used.

The study is based on the results of a survey of secondary vocational education students in the framework of the second All-Russian career guidance lesson "Start your career in the Arctic and the Far East!" [4] held in February – March 2020 by the Budget Monitoring Center. The author of the article was the responsible executor of this project, including developing the program and tools for the sociological part of the project. The algorithm for the work of SVE students in the framework of the lesson was built on the basis of integration of vocational guidance materials with the direction of training students. The survey of students was conducted within the framework of their acquaintance with career guidance and information materials about the Arctic "before" and "after" the lesson. The data was processed and analysed using the program for statistical data processing SPSS and MS Excel.

[1] Romanov M.S. et al. Professional'noe samoopredelenie studentov SPO: formirovanie motivatsii vyborov i kar'ernykh predpochteniy [Professional self-determination of secondary vocational education students: the formation of motivation for elections and career preferences]. Gumanitarnye, sotsial'no-ekonomicheskie i obshchestvennye nauki [Humanities, socio-economic and social sciences], 2017. No. 12. URL: https://www.online-science.ru/userfiles/file/njey7hytywzrcfam0xwu1yftw5ke2nnw.pdf (accessed 15 December 2020).

[2] Ibid.

[3] O sukhoputnykh territoriyakh Arkticheskoy zony Rossiyskoy Federatsii: ukaz Prezidenta Rossiyskoy Federatsii №296 ot 2 maya 2014 goda (s izmen. na 5 marta 2020 goda) [On the land territories of the Arctic zone of the Russian Federation: Decree of the President of the Russian Federation No. 296 dated May 2, 2014 (as amended on March 5, 2020)]. URL: http://docs.cntd.ru/document/499093267/ (accessed 15 December 2020).

[4] Internet portal of the All-Russian vocational guidance lesson "Start your career in the Arctic and the Far East!". URL: http://dv-arctic.labourmarket.ru/ (accessed 15 December 2020).

Within the framework of the lesson, students got acquainted with the employment potential of the speciality they were studying and with the professions in demand within this specialty, leading employers, and internship opportunities in the Arctic regions. The career guidance lesson is aimed at the formation of a conscious understanding of the possibilities of building a prestigious career and life in the Arctic, the formation of a positive image of these territories in the youth environment [3, Simakova A.V.; 4, Simakova A., Pitukhina M., Stepus I., p. 107–117].

Thus, SVE students (1–4 courses) of full-time education of all financing forms of the AZRF subjects were the research object. The features of career trajectories formation among secondary vocational education students have been determined as a subject of research. Students filled out questionnaires before and after the lesson. In one volume or another, SVE students of all AZRF subjects took part in the lesson, however, for a more detailed analysis, the most representative regions were selected by the number of students surveyed — the Murmansk Oblast, the Republic of Sakha (Yakutia), the Krasnoyarsk Krai and the Republic of Komi. The dry-hop territories of these subjects, with the exception of the Murmansk Oblast, are partly included in the AZRF. A total of 971 people took part in the survey. Expanding in detail the subject of the study, it is necessary to make a clarification that the features of career trajectories formation of students are determined by the sectoral focus of the training profile. With this clarification, for the analysis, 6 enlarged groups of specialties/areas of training (EGST) were selected out of 38, for which SVE training is conducted in the AZRF subjects. After selection the specialty, 686 questionnaires “before the lesson” and 509 questionnaires “after the lesson” were selected for analysis. The number of survey participants is proportional to the number of students according to the EGST industry characteristics: the majority of respondents are in the field of Engineering, Technology and Technical Sciences — 75.7%, 9% — in the field of Social Science, and 15.3 % — Education and Pedagogical Sciences. The reliability of the survey is 95%.

Table 1

Characteristics of the implemented sample population of the study for the Krasnoyarsk Krai, the Komi Republic, the Sakha Republic (Yakutia) and the Murmansk Oblast as a whole [5]

Enlarged group of specialties / areas of training (EGST)	Contingent of students, 2019, people (full-time education) [6]	Number of students surveyed (full-time education), people	The share of students surveyed in the EGST contingent,%	Structure of surveyed students by EGST,%
Engineering, Technology and Technical Sciences (4 out of 19 EGST of SVE system of the AZRF subjects are presented)				
08.00.00 — Construction techniques and technologies	7637	46	0.6	6.7
09.00.00 — Informatics and computer engineering	6116	50	0.8	7.3
15.00.00 — Mechanical engineering	8396	141	1.7	20.6
23.00.00 — Engineering and technology of land transport	12800	282	2.2	41.1

[5] Source: compiled by the author.

[6] The data are given according to the information of the statistical form of Rosstat: Information about the educational organization carrying out educational activities on educational programs of secondary vocational education: Form of state statistical reporting No. SPO-1. Moscow: Rosstat, 2019.

Social Sciences (1 out of 5 EGST of SVE system of the AZRF subjects are presented)				
38.00.00 — Economics and Management	6484	62	0.9	9
Education and Pedagogical Sciences (all EGST of SVE system of the AZRF subjects are presented)				
44.00.00 — Education and pedagogical sciences	5467	105	1.9	15.3
Total	46900	686	1.5	100

The formation of a strategy for building a future career can also depend on the course of study. The duration of training in SVE educational programs is usually 3 years; four-year training is carried out for certain educational programs if the student enters an educational institution after the 9th grade. Students of all courses of study took part in the survey, 31.3% of them study the first year, 35% — the second one, 28.6% — the third, and 5.1% — the fourth year.

The results of the study, due to their small representativeness, can be disseminated only for the enlarged groups of specialties / areas of training presented in the study.

Features of professional self-determination of SVE students

Professional self-determination of a person is one of the most important stages of growing up. Further educational and career trajectories are formed on its basis. E.A. Klimov described this life stage as “searching for development opportunities, understanding oneself as a full-fledged member of the community of “doers” something useful, a community of professionals” [5]. Studying in the 2–3 course, SVE students get acquainted with the specialty in detail, their interest in professional activity is formed at this stage, and, as a consequence, their professional interest is narrowed to a specific subject area. Students are first exposed to various activities that are components of the future profession and contribute to the formation of professional competencies. At this stage of growing up, young people (students) once again face the need for professional self-determination, but in this case it is not so much a question of choosing a profession as of choosing a general professional path. The choice of training direction in the framework of vocational education is not a prerequisite for future graduates to plan their career trajectory in the specialty for which they have received their diploma. According to the all-Russian study of the Higher School of Economics, “among all the holders of diplomas of secondary vocational education institutions, the share of those working in their specialty is a little over 30%” according to a broad interpretation (educational specialty and actual profession coincide) [6, Gimpelson V. et al., p. 27]. The situation of students' determination with the future profession during the development of the educational program in the SVE system before the demonstration of career guidance materials is interesting for the research profile.

Only 62.9% of future teachers (SVE students of the EGST “44.00.00 — Education and Pedagogical Sciences”) and half of the students of the EGST “15.00.00 — Mechanical engineering” have chosen their future profession. About half of the SVE students of AZRF subjects, enrolled in the programs of the EGST “09.00.00 — Informatics and Computer Engineering” and “23.00.00 — Engineering and Technology of Land Transport”, have decided on their future profession. Every third

student enrolled in the EGST “08.00.00 — Construction Engineering and Technology” and “38.00.00 — Economics and Management” has not decided on the future profession (Fig. 1). Based on the data obtained, the fact that students receive professional education does not guarantee the formation of a career trajectory within the chosen direction of training.

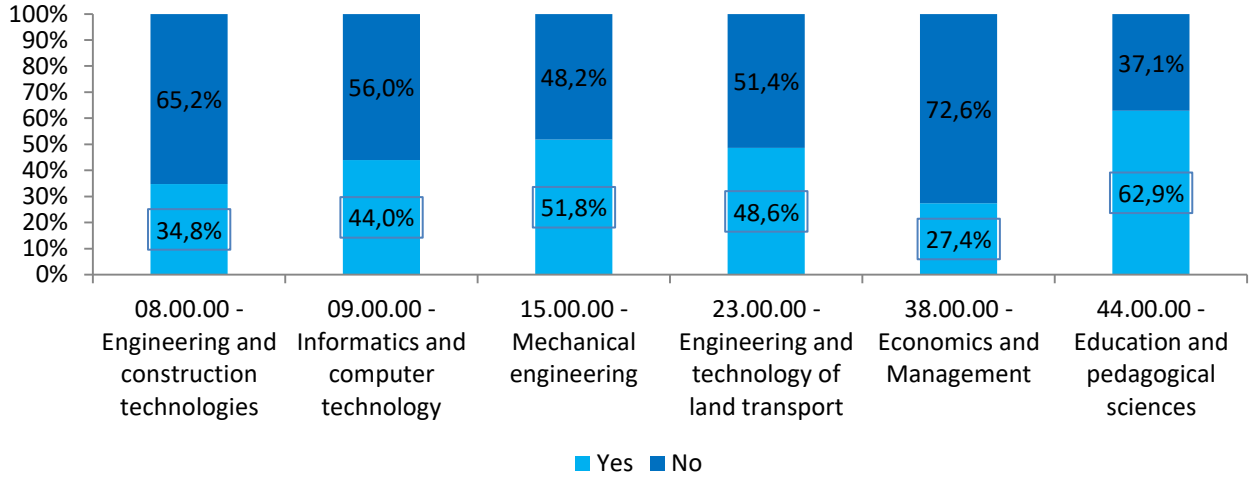

Fig. 1. Respondents' answer to the question "Have you decided on your future profession?" in the context of EGST, in % by column (N = 686, questionnaire before the lesson).

SVE students act as a subject of professional choice in the socio-cultural space. The choice of the future career trajectory is aimed, among other things, at achieving certain positions in the professional sphere and in society as a whole in future. In research of D.L. Konstantinovskiy, it is noted that recently the motivation for choosing training in the secondary vocational education system is moving from “predominance of compulsion in motivation to the rationality of choice” [7, Konstantinovskiy D.L., Popova E.S., p. 41], where students explain their choice by their interest in professional activity and material necessity. In this context, it is interesting to consider the factors that influenced the SVE students' choice of the AZRF subjects. The main factor is the desire of students to work in this professional field (53.1% of students), i.e. they make their choice of future profession based on their own motives and interests, relying on self-development [8, Filonenko V.I. et al, p. 293]. The economic factor is also one of the most important when choosing a profession. This factor is significant when choosing a specialty/direction of training from external (demand for a profession in the labor market) and internal (financial situation of students and their families) points of view: “the demand for specialists of this profession in the labor market” was chosen by 31.3% of students and “the possibility of free-of-charge education” — 35.4% of students (Fig. 2). When choosing a profession, almost every fourth student of secondary vocational education in the AZRF subjects, when choosing a profession, paid attention to the prestige of the profession, which is also manifested in the amount of wages in the labor market. The choice of future profession and place of study of every fifth student was determined by an indifferent position — “I didn't care where to go”, and for 16.4% — it was important to get a professional education close to home.

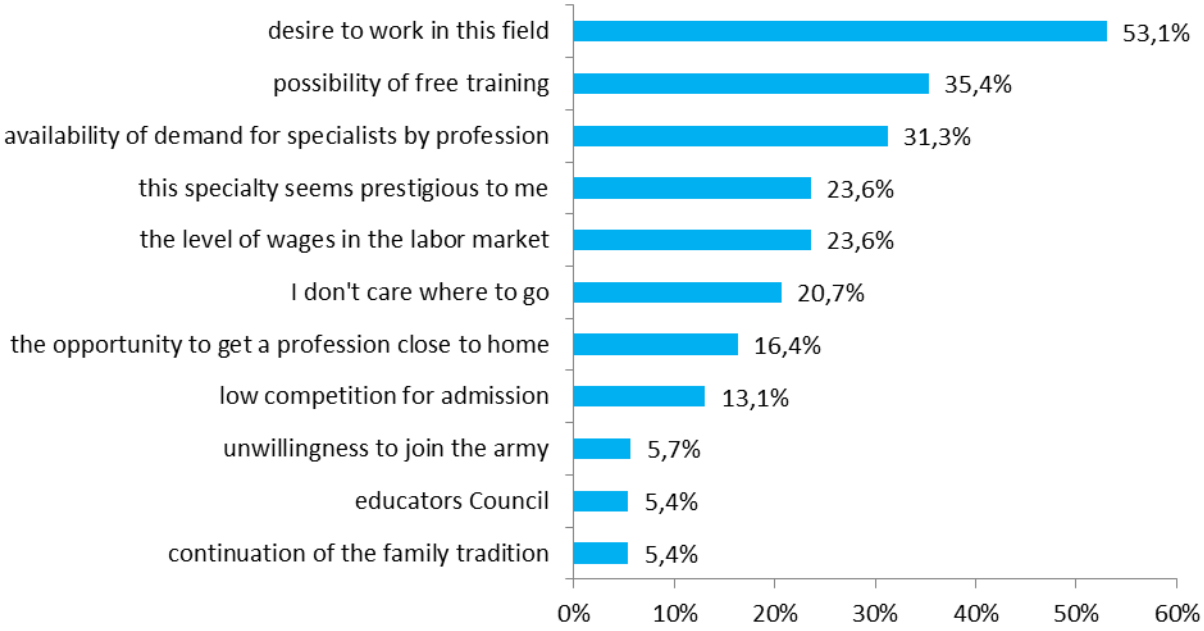

Fig. 2. The main reasons why SVE students of AZRF subjects chose to study in their specialty / direction of training (N = 686, questionnaire before the lesson).

The results obtained on the factors of choosing the profession of SVE students of AZRF subjects are similar to the results of similar all-Russian studies, in which the main way in choosing a strategy for obtaining vocational education in the vocational education system combines factors of interest in the chosen profession and material necessity [9, Konstantinovskiy D.L., Popova E.S., p. 12].

Getting a professional education is not only an element of social, but also territorial mobility — "migration biography" [10] begins with the choice of a new place of study. Among SVE students of AZRF subjects, more than half receive vocational education in the place of permanent residence (63.1%), every third student (34.4%) came to study from another district/city, and only 2.5% of the surveyed students came to receive professional education from other regions of Russia. The intraregional type of educational migration is more widespread among SVE students of AZRF subjects, the track of which, as a rule, is directed from remote areas to the center. In this case, the attachment of young people to their native places should be taken into account [11].

Thus, the problem of professional self-determination does not lose its relevance among SVE students, who have already entered a certain professional field, within which they will have to narrow their choice to a certain professional field and profession. In the process of training and vocational guidance activities, a professional orientation is formed, which determines the variety of motives for choosing a profession [7]. During their studies, about a third part of students have decided on their future profession and are therefore thinking about their future career path.

[7] Romanov M.S. et al. Professional'noe samoopredelenie studentov SPO: formirovanie motivatsii vyborov i kar'ernykh predpochteniy [Professional self-determination of secondary vocational education students: the formation of motivation for elections and career preferences]. Gumanitarnye, sotsial'no-ekonomicheskie i obshchestvennye nauki [Humanities, socio-economic and social sciences], 2017. No. 12. URL: https://www.online-science.ru/userfiles/file/njey7hytywzrcfam0xwu1yftw5ke2nnw.pdf (accessed 15 December 2020).

Formation of SVE students' career trajectory

One of the key stages in career development is the transition from studies to work. Secondary vocational education is often considered by students as the initial stage of professional development [9, Konstantinovskiy D.L., Popova E.S.]. At the same time, obtaining an SVE diploma expands employment opportunities for graduates and their professional skills development. About 30% of students in the secondary vocational education system of the AZRF subjects plan to continue their education at a higher level and to work, only 6% of those who plan to improve their professional skills are not oriented towards a job during their studies (Fig. 3). It is important to note that for graduates of vocational education and training programmes for skilled workers and clerks, the next step in improving qualifications is SVE under the programs of mid-level specialists, and for the latter — the higher education system. The educational track and the social mobility channel "to the university through college" is popular among young people [12, Alexandrov D.A. et al; 13, Cherednichenko G.A.], according to which, on average, 31% of SVE graduates of programs for the preparation of mid-level specialists enter universities immediately after graduation from college [8]. Every fourth graduate, after receiving a diploma, plans to join the ranks of the Armed Forces of Russia (military service), every fifth graduate will get a job. Only 7.5% of SVE students did not decide on plans after completing their studies.

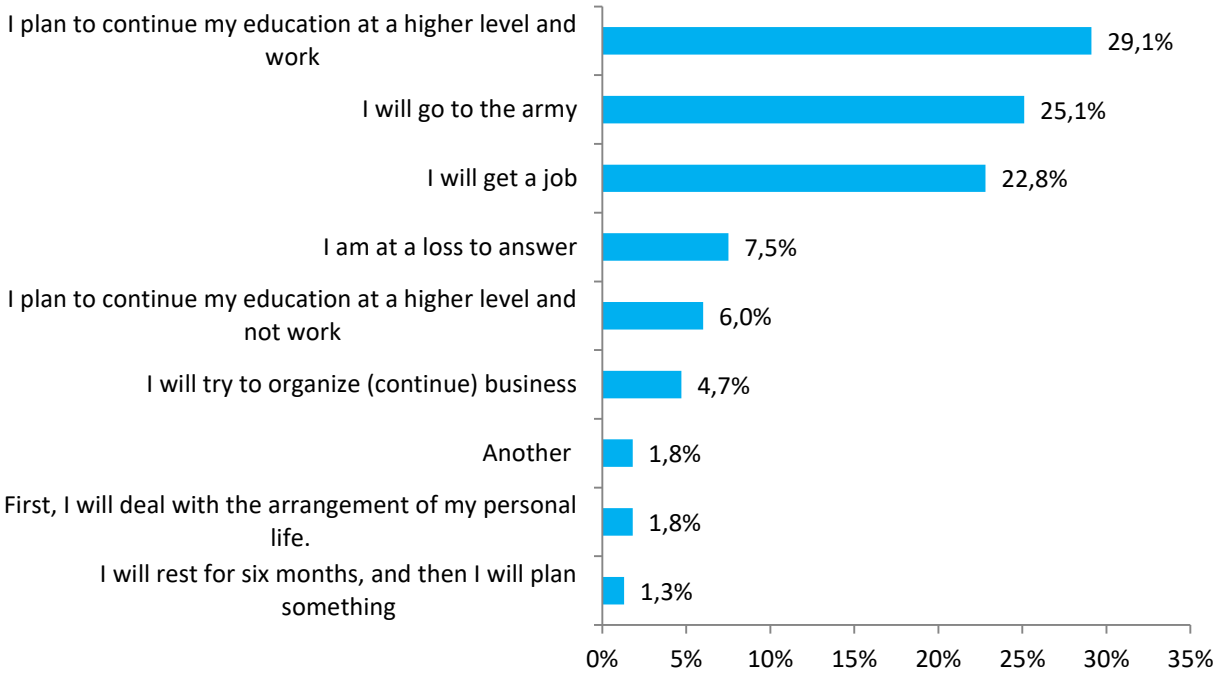

Fig. 3. Plans of students of AZRF subjects after receiving SVE diploma, (N = 686, questionnaire before the lesson).

[8] Srednee professional'noe obrazovanie: sostoyanie i vyzovy. Monitoring ekonomiki obrazovaniya. Informatsionno-analiticheskie materialy po rezul'tatam sotsiologicheskikh issledovaniy [Secondary vocational education: state and challenges. Monitoring the economics of education. Information and analytical materials based on the results of sociological research]. Vysshaya shkola ekonomiki [Higher School of Economics], 2016. Iss. 26. https://www.hse.ru/data/2016/07/06/1116716354/Выпуск%2026.%20Среднее%20профессиональное%20образование%20_состояние%20и%20вызовы.pdf (accessed 17 December 2020).

Successful employment of graduates is an indicator of the effectiveness of training and the relevance of training to labour market demand. However, the employment of graduates not in their specialty leads to the devaluation of the diploma and to negative consequences in the education system, the labor market and society as a whole. As the all-Russian studies show: “About 40% of SVE graduates do not work in the profession they have received and occupy mainly jobs that require a lower qualification level than they acquired as a result of training, and with a lower salary than was expected” [14, Dudyrev F.F. et al, p. 122].

Among SVE students of the AZRF subjects, 54% of the respondents plan to work in the future in their specialty, every third one (34.2%) has not yet decided on their choice, and approximately every tenth student (11.8%) does not associate their studies with further employment in the received specialty. If we consider the situation in the context of specific EGST, the most alarming are the data on the EGST “38.00.00 — Economics and Management”, where 23.3% of the surveyed students do not plan to implement the acquired knowledge and skills in the labor market, and every third one has not made the choice (Fig. 4). According to the EGST “09.00.00 — Informatics and Computer Engineering”, approximately every fifth student (17.1% of the respondents) does not plan to work in the specialty they receive, and 46.3% have not decided on their professional future. The intentions of SVE students of the AZRF subjects to find a job in their specialty look more optimistic in the EGST “44.00.00 — Education and Pedagogical Sciences” and “08.00.00 — Engineering and Construction Technologies”: 55.7% and 65.6%, respectively.

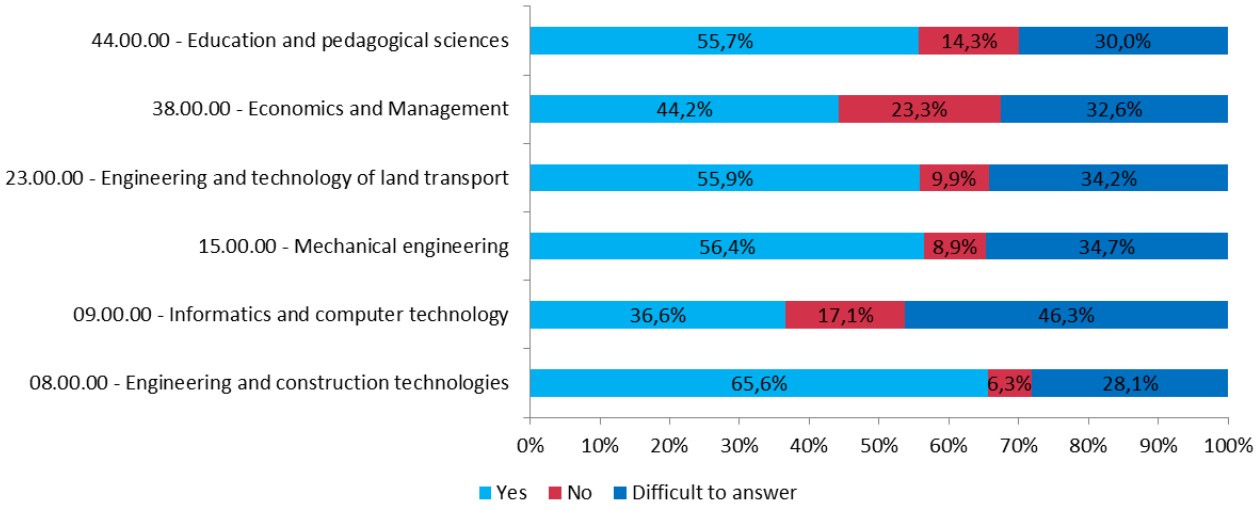

Fig. 4. “Do you intend to work according to the received speciality?”, in % according to EGST (N = 509, questionnaire after the lesson).

According to the research, most often, SVE graduates in the group of professions “health care” (94.1% of graduates), “education and pedagogy” (75.4% of graduates) and “service industry” (73% of graduates) find a job according to their profession [15, Klyachko T.L., Semionova E.A., p. 119–120].

Choosing one or another career trajectory, SVE graduates rely on their own preferences, values and motives. More than half of the graduates care about professional and career growth prospects (66.4% of respondents), a high salary (57.9%), financial stability and reliability of the

employing company (51.1%), and acquisition of new experience and knowledge (45.9%). Only for every third student, when choosing a place of work, along with the importance of the working regime (29.4%) and the team atmosphere (26.6%), the main requirement is the correspondence of the proposed place to the profession obtained (28.6%).

Within the framework of the study, after a career guidance lesson, SVE students of the AZRF subjects were asked to evaluate the possibility of building a successful career in the Arctic (identifying a subjective assessment based on their own ideas) and to express their preferences about starting a labor activity in the Arctic territories (identifying personal desires and interests of students). Every third SVE students of the AZRF subjects considers that it is definitely possible to build a successful career in the Arctic zone of Russia, another 58.8% are not so sure, but positively assess such opportunity, almost every tenth student (12.7%) doubts this success (Fig. 5).

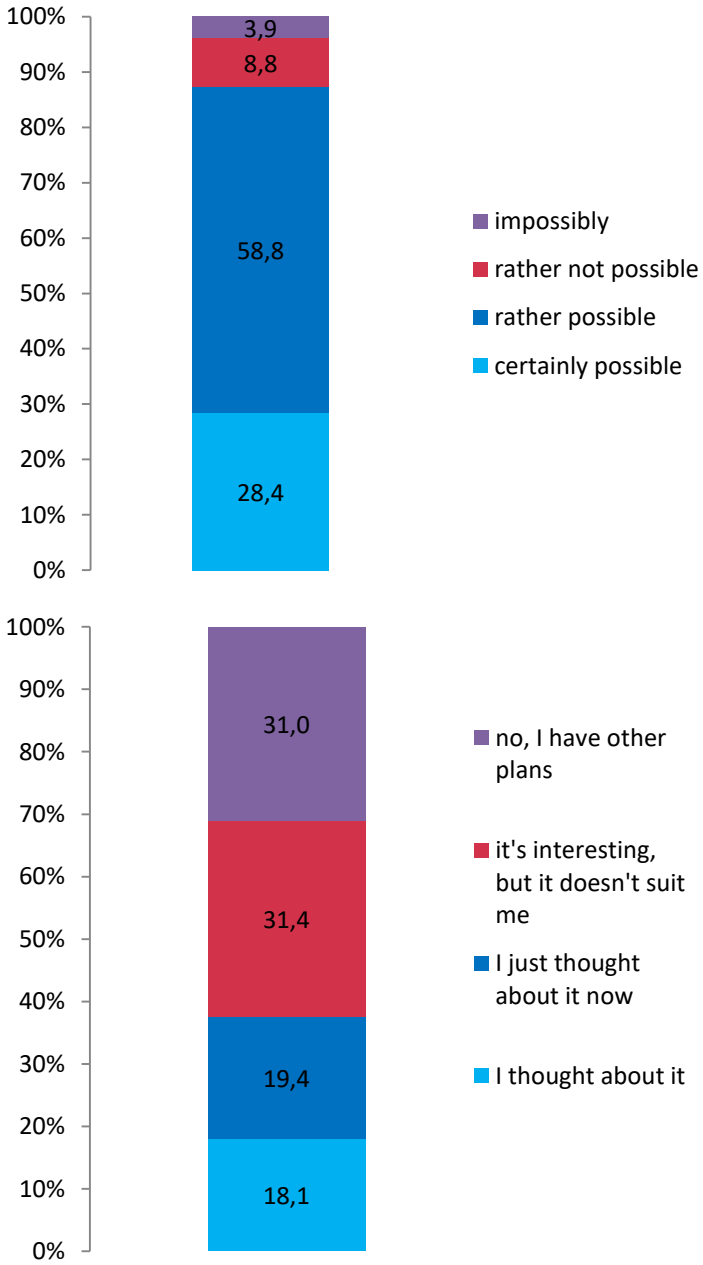

Fig. 5. SVE students' assessment of the opportunities for building a successful career in the Arctic and their desire to start a career in the Arctic, in % by column (N = 509, questionnaire after the lesson).

Every fifth SVE students of the AZRF subjects was going to start the career in the Arctic even before participating in a career guidance lesson (18.1%), every fourth student thought about this precisely after participating in the lesson (19.4%), every third student got interested in working in the Arctic, but there is a lack of confidence that this is suitable for him (31.4%). Every third student answered unequivocally that he has other plans (31%), which may also include employment, continuing education and military service. After one career guidance lesson, the share of students who have decided on their choice of profession and career path increased by 3%, the share of those who have a general idea of what they will do in the future increased by 3%, and the proportion of those who are not sure whether they will work in their specialty decreased by 5% (Fig. 6).

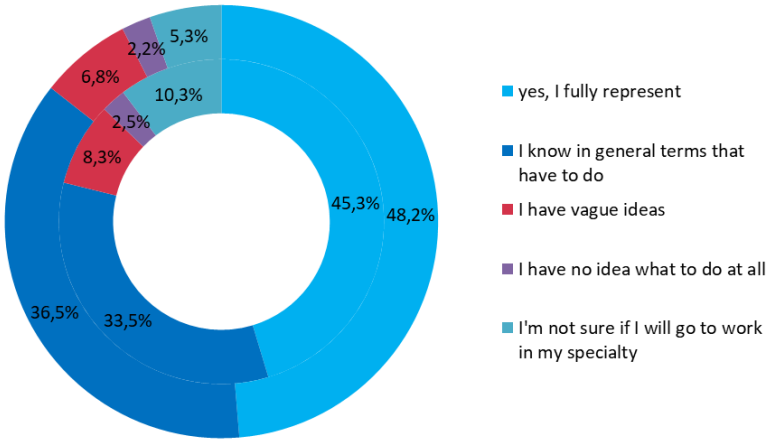

Fig. 6. Students' perception of the nature and content of future professional activity “before” and “after” the career guidance lesson (N = 686 before the lesson and N = 509 after the lesson).

Students who have expressed their direct or potential interest in professional implementation in the Arctic are the target audience for providing additional information about the labor market, career opportunities, living conditions and other social and economic effects [3]. Construction of a “sustainable future” in the Arctic (based on the concept of sustainable development) begins with education [16].

Conclusion

Half of the interviewed SVE students of the AZRF subjects did not decide on their future profession, and, as a result, they still do not think about building a future career path. For the second half of the students, it is important to work in the professional field in which they receive their education. When forming a career path, students, on the one hand, rely on their own interests, ideas and motives, and on the other hand, pay attention to the situation in the labor market. In this regard, it is important to conduct systematic work with students within the framework of professional self-determination both in existing practical approaches (internships, professional skills competitions, master classes, etc.), and as part of educational activities aimed at informing

students about “benefits” of the acquired professions and career opportunities in the AZRF and expanding of educational opportunities in the territories native to young people [17].

Professional self-determination of SVE students of the AZRF subjects is a topical issue of the vocational education system in the context of timely staffing of the Arctic regions’ economy, especially the existing labor shortage. It is also a “challenge to the non-standard and large-scale labor market of the AZRF” for the development of labor resources and human capital reproduction [18]. At the same time, it is important to monitor the features of professional self-determination and career trajectories of students.

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Problems and Trends in the Development of Mass and Elitist Systems of General Education in the Far North *

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Abstract. The Far North is the most important territory for Russia, which largely determines the pace and prospects of socio-economic development. This means that its development requires special attention. One of the main drivers for the development of the Far North is the system of general education, which meets the needs of the society and the economy of the macro region. The article considers it in two ways. First, a comparison is made between the Far North and the rest of the country of the dynamics of indicators that characterize the training of the most talented and motivated children. For this purpose, the number of winners and prize-winners of the all-Russian subject Olympiads since the academic year 2011/2012 is analyzed. It is shown that their number is significantly lower than the national average. Second, the dynamics of number of educational institutions, children attending them, and teachers working there are considered. The conclusion is made about the significant deterioration of the indicators, which is associated primarily with unfavorable demographic dynamics. The problems faced by the education system are considered and measures aimed at improving the situation are proposed. The most important of them are the concentration of efforts on the development of the mass system of general education, preparing children for work and living in rural areas, and improving the information support of the implemented policy.
Keywords: *the Far North, general education, all-Russian subject Olympiad, education system, educational policy.*

Introduction

The quality of education is one of the most important issues in modern conditions, since the rate of economic progress depends on the quality of the workforce at all levels of the education system. There are special expectations of general education, as it provides the basis for higher education. The system of higher professional education only polishes what comes from lower levels and is practically unable to correct shortcomings and fill gaps in knowledge, especially if people are unwilling and unaccustomed to work. Consequently, the general education system is one of the tools of spatial development that have been much discussed recently [1, Kudryashova E.V. et al].

A quality education system has three main elements. The first one is the infrastructure that allows entering the education system at the moment when it is necessary (availability of places), is located close to the place of residence and has the necessary equipment to carry out the educational process in accordance with the current curricula. The second element is a decent salary for well-trained teachers and other personnel of educational organizations. If this requirement is not met, less talented teachers go into teaching, who are less likely to be employed elsewhere. However, the love of the profession cannot completely outweigh the low wages, since teachers have to

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support non-working members of their families. This applies primarily to children. The third element is the availability of educational programs that allow teaching the material in the most assimilable way, and which express the innermost attributes of individuals in the best possible way. These three elements are interrelated and the low quality of one of them negatively affects the system as a whole.

Discussions about the quality of school education in Russia and individual regions have been going on for a long time, and much has already been said [2, Krylova N.B.; 3, Chevtaeva N.G., Strebkova N.V.; 4, Shafranov-Kutsev G.F., Efimova G.Z.]. However, there are still quite a few issues that require additional study, since they are not considered in sufficient detail. First of all, they concern the achievement of formal synthetic quality assessment criteria, which are most often understood as the final USE score, the number of applicants to vocational and higher education institutions and the achievement of high places at the final stage of the All-Russian subject Olympiads.

The last indicator deserves special attention. It assesses the extent to which regional education systems are able to set and achieve ambitious goals. Nevertheless, the elite education system alone, which is associated with the education of the most talented and interested students, is not able to create a basis for the socio-economic development of the region and the country as a whole. A mass education system is also needed, that teaches the majority of children and trains and raises the human capital of the bulk of the future workforce.

Research subject and method

For these reasons, we have analysed the education system in the High North in two directions. Both of them are important and allow us to characterize the education system from our point of view.

Firstly, we consider the number of winners and prize-winners of the final stage of all-Russian subject Olympiads in the Far North regions, compare the results of students from the Far North regions with the results of students from other regions and determine the share of the Far North regions among all winners and prize-winners in general and in separate subject groups. The data source is the orders of the Ministry of Education and Science of the Russian Federation or the Ministry of Education of the Russian Federation. The period from the 2001/2012 academic year to the 2019/2020 academic year was considered. We are primarily interested in the regional distribution, so we did not conduct additional analysis by grade.

Secondly, we consider indicators that characterize the development of the general education system. The data source is the statistical bulletin “Economic and social indicators of the Far North and regions equated to it”. For the period since 2000, data on the number of educational institutions, the number of children attending them and the number of teaching staff working in them have been analyzed.

By the Far North we mean the territories specified in the Decree of the USSR Council of Ministers dated November 10, 1967 No. 1029 "On the procedure for applying the Decree of the Presidium of the USSR Supreme Soviet of September 26, 1967 'On the expansion of benefits for persons working in the Far North and in the areas equated to the regions of the Far North'" and Resolution of the Council of Ministers of the USSR dated 03.01.1983 No. 12 "On amendments and additions to the List of regions of the Far North and localities equated to the regions of the Far North, approved by the Resolution of the Council of Ministers USSR dated November 10, 1967 No. 1029" (in current edition) in accordance with the administrative-territorial division of 2020. This means that we are considering all 24 regions in which there are regions of the Far North and equivalent areas. The basis is 18 regions of the Russian Federation: Arkhangelsk, Irkutsk, Magadan, Murmansk, Sakhalin, Tomsk Oblasts, the Republics of Buryatia, Karelia, Komi, Sakha (Yakutia), Tyva, Kamchatka, Krasnoyarsk, Khabarovsk Krais, Nenets, Khanty-Mansi, Chukotka, Yamalo-Nenets Autonomous Okrugs (AO). There are also six more regions with small populations in these areas: Amur, Tyumen (without Autonomous Okrugs) oblasts, the Altai Republic, Zabaykalsky, Perm, Primorsky Krais. We also consider them, but distinguish them separately.

For executive authorities, the object of management is the Arctic zone of the Russian Federation, the boundaries of which are approved by the Decree of the President of the Russian Federation dated 02.05.2014 No. 296 "On the land territories of the Arctic zone of the Russian Federation" with subsequent additions. Nevertheless, it is worth considering the larger region, which is the Far North. There are several reasons for this.

Firstly, the Far North occupies more than 70% of the country's area, and after the collapse of the USSR and the loss of western and southern territories, Russia became an even more northern country. At the same time, about 10% of the country's inhabitants live in the North, which means that it is important for development because migrants have difficulty adapting to living in such harsh natural and climatic conditions.

Secondly, most or all of the mineral and biological resources are concentrated in the Far North. Without the development of territories, it is more difficult to attract employees to develop them.

Thirdly, temporary migrants, who will be attracted in increasing numbers as the High North becomes more and more depopulated, treat the environment less carefully than permanent residents do, because they almost never consider it as their place of residence. This would have an extremely negative impact on the fragile ecosystem of the northern territories.

Fourthly, authorities and large commercial organizations are nowadays guided by the focal development of territories [5, Pilyasov A.N., Zamyatina N.Yu.]. This means that the depopulation of the Far North will continue. Whether this is consistent with the plans for the long-term development of the High North is up for debate, but we have doubts that this approach will reveal the natural, economic and social potential. Only integrated territorial development, where significant

efforts are made for social development, can slow down population decline and increase various forms of local capital.

Olympiad results as an indicator of quality of the Far North education system

Currently, the Olympiads for schoolchildren are considered as an element of continuous education, which allows linking secondary and higher schools and creating conditions that are more favourable for talented youth. However, the Olympiad system covers the contingent of students unevenly. There are more participants in more economically and socially prosperous regions. The share of participants from wealthy families is higher. Meanwhile, there is no evidence that participants from less favored regions and families are less talented. As a result, their potential is not revealed, and the socializing function of the Olympiads is not used to the full extent, which negatively affects the rate of human capital accumulation of these children.

The Olympiad preparation system includes school curricula on basic and higher levels, work in the supplementary education system, time-consuming self-preparation and targeted preparation for the Olympiad by an experienced teacher. Such an integrated approach allows the selection of more prepared and motivated students. Nevertheless, involving students in the Olympiad depends not only on them, but also on the resources that the region and the family have. Their availability is an important condition for achieving high results, since the cost of training children is constantly increasing.

The key difference between the tasks of the Olympiads and ordinary school tasks is not so much their increased complexity, but their unconventional character. This means that the Olympiads is aimed less at checking the students' knowledge, but is rather a test of their personal qualities (will, self-training, ability to understand what is written and think non-standardly, behavior under stressful conditions, etc.). As modern pedagogical practice shows, the formation of these qualities is accompanied by significant difficulties [6, Zhdanova L.A., Galaktionova I.V.; 7, Krasnoshchekova S.V.; 8, Ryabinina L.A., Chaban T.Yu.]. Another disadvantage is the fragmentation of knowledge acquired at school by most students, which has to be corrected in higher education [9, Shchegoleva L.V., Svetova N.Yu., Surovtsova T.G.]. Extending the approach aimed at developing students' skills of independent thinking and correct work with the text, not only to Olympiad students, but to all students, will significantly improve the quality of learning at school.

Participation in the Olympiads provides positive social and educational results. It also serves as a form of a school-leaving examination before the Unified State Exam, helping to popularize scientific knowledge. Winning prizes at the final stage of the All-Russian School Olympiad or the Olympiad in the list of the Ministry of Education and Science gives great advantages for admission to a university or a college of higher education. However, participation in lower stages or other olympiads can also be considered an additional admission advantage. The sense of balance gained by preferring the next steps in the education system is another incentive to participate in the Olympiad.

An important positive result is the broadening of horizons. Participation in the Olympiads allows not only to gain additional knowledge on the subject and to test one's strength against others, but also to make new acquaintances and to expand social circle, as well as to see other cities and even countries.

Finally, participation in Olympiads is an important tool for overcoming one's own fears. Taking part in the Olympiad at an early stage helps to gain experience that can be used later in examinations and other stressful situations. For a discussion of why participation in Olympiads is important for students, see [10, Ekimova N.A.].

Nevertheless, the Olympiads are accompanied by a number of difficulties. Three groups of problems can be distinguished. Firstly, the Olympiad tasks differ from the USE tasks, as they are more unique and cannot be used repeatedly for the next years. Besides, tasks are worked out for the different stages of Olympiads by different groups of specialists with heterogeneous professional competence and training level. As a result, subjects and complexity of the tasks in different regions are different, which means unequal conditions for the students. Secondly, financial and material-technical capabilities of the regions differ, as a result of which there is a differentiation of the regions with respect to the procedure for financing and holding the Olympiads. Thirdly, there is no unified approach to assessing the results and training of jury members and experts. As a result, the regions differ greatly in the level of expertise, which may cause misunderstanding of the rules of Olympiad and evaluation of participants' works. A significant number of difficulties at school and municipal levels are described by E. Yu. Rivkin, who shows considerable organizational and ideological problems [11, Rivkin E.Yu.]. Finally, successful participation in Olympiads does not always mean a high quality of the education system in the region as a whole. Nevertheless, due to the positive aspects described above, the popularity of Olympiads at all levels is only increasing.

In order to minimize these disadvantages, we limit ourselves to considering only the final stage of the All-Russian subject Olympiads, which allows us to provide homogeneous approach to the Olympiads and the assessment of participants. Besides, to unify the regions, we consider the number of winners and prize-winners not per 100 thousand people, but per 100 thousand children aged 7–18 years. This allows us to eliminate differences in the age structure and to compare the regions with each other.

Are there significant differences between the educational systems of the Far North regions and the rest of the country in terms of the results of the Olympiads? The answer to this question will make it possible to assess the quality of preparation of the most motivated students.

Figure 1 shows the distribution of final stage winners of all All-Russian subject Olympiads for 2011/2012 — 2018/2019 academic years by regions of Russia. It shows certain regularities, some of which make it possible to pose the question of whether the differences between regions are related to objective or subjective factors of their development.

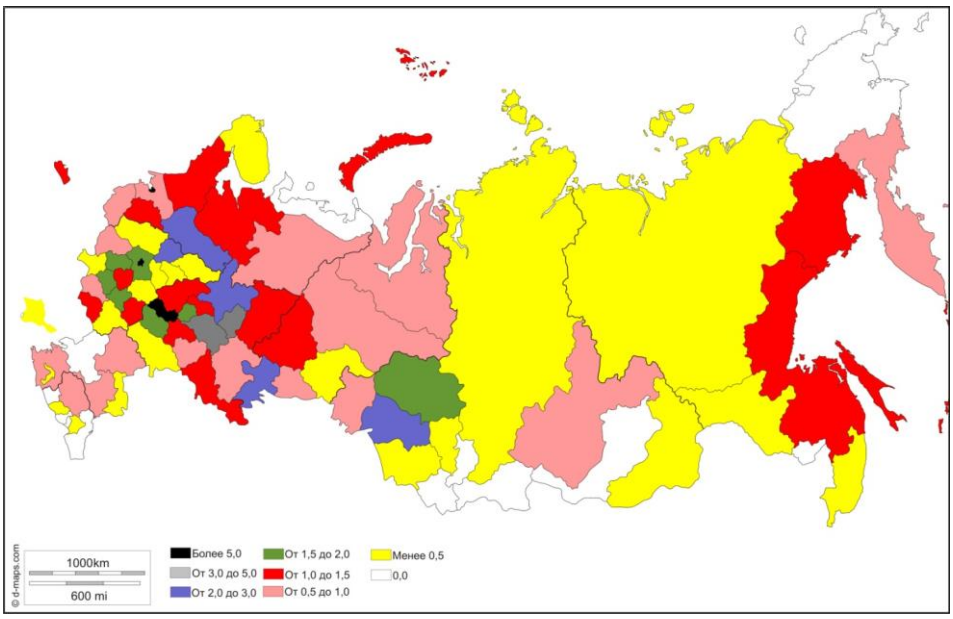

Fig. 1. Distribution of Russian regions by the number of winners of All-Russian subject Olympiads per 100 thousand children aged 7-18 years for the 2011/2012 — 2018/2019 academic years.

According to this indicator, the regions of Russia are heterogeneous, since the coefficient of variation significantly exceeds 33%. This is confirmed by considerable differences between the average and median values and applies to both the country as a whole and the distribution within federal districts. South of Russia (South and North Caucasus Federal Okrugs) is represented by the regions with the lowest number of winners among students. There are also many regions with a low number of winners in Siberia and the Far East. The Volga Federal Okrug, on the contrary, has the most regions with high values of indicators. Generally speaking, regions with smaller populations have fewer winners. In relation to the level of economic development, the relationship is less obvious. We can say not that economic indicators and economic specialization affect the number of winners, but how much the regional authorities are interested in high results, how the work to identify talented children is structured and what incentives are used for this.

The regions of the Far North showed lower results in comparison with the country as a whole. While in Russia the average number of winners was 1.8 per 100 thousand children (2.1 with the exclusion of the regions of the Far North), in the Far North it was only 0.7. This is due to the large number of regions, where the number of winners was less than four during the whole period under consideration (including those regions that had no winners at all). This group included 50% of the Far North regions (45% if we consider only 18 regions) versus 34% for the country as a whole (30% if the Far North regions are excluded). However, the statistical differences according to the Mann-Whitney criterion between the High North and the rest of the country are not significant. For 18 regions, the differences are not significant at all, while for 24 regions, the differences are also insignificant, but close to accepting the hypothesis about the significance of the differences.

In the Republics of Buryatia, Tyva, Altai, Nenets Autonomous Okrug, Chukotka Autonomous Okrug had no Olympiad winners at all. This is primarily due to the small size of the population.

Economic reasons, in our opinion, also contributed, but they are less noticeable. Thus, these regions showed the worst dynamics. Very low numbers of winners were in Amur Oblast, Zabaikalsky, Primorsky krais, where schoolchildren won only in two years out of the eight under review. High values were observed in more socially developed regions: Arkhangelsk, Tomsk Oblasts, Perm, and Khabarovsk Krais. Magadan Oblast is the only exception, and its position in this group is due to the successes of 2018–2019. The highest number of winners was observed in the Tomsk Oblast (1.7), but its value was also below the average for Russia. More than one winner per 100 thousand children aged 7–18 were in Sakhalin Oblast and the Republic of Karelia. The values were higher than the average for the Far North in Irkutsk Oblast and the Komi Republic. Among the remaining regions, the most interesting are the low values in the developed Krasnoyarsk Krai, where the number of winners turned out to be unexpectedly low.

If we consider the dynamics, we can say that the number of winners per 100 thousand children in most regions of the Far North has decreased since 2011/2012 academic year. Some growth was observed only in Arkhangelsk and Tyumen (without Autonomous Okrugs) Oblasts, the Komi Republic and Krasnoyarsk Krai. The share of 18 regions of the Far North decreased from 11.5% of the total number of all winners to 2.7%, and the share of 24 regions decreased from 15.4% to 4.3%. While the total number of winners increased, the number of winners in the Far North regions decreased.

In order to understand in which branches of knowledge the regions of the Far North had advantages, all the Olympiads were divided into four groups. The social sciences included history, social studies, law, and economics. The natural and exact sciences included astronomy, biology, geography, computer science, mathematics, physics, chemistry, and ecology. The humanities included world art culture (WAC), literature, English, Spanish, Italian, Chinese, German, Russian and French. Finally, other sciences consisted of technology, physical culture and the basics of life safety (BLS).

Over the entire period under consideration, the winners of the Olympiads from the Far North constituted 4.7% of all winners (6.5% in the analysis of 24 regions). At the same time, 18–19% of all school age children lived in the Far North (12–13%, if we consider only 18 regions). This means that the general education system in the Far North lags behind the leading regional general education systems in preparing the most gifted children.

The most noticeable successes among students from the Far North were in other disciplines. This is due to the large number of winners of the basics of life safety Olympiads from Irkutsk Oblast and the Khabarovsk Krai. They accounted for 11.9% of all winners in 18 regions and 13.3% in 24 regions. The social sciences scores were slightly above the average. The greatest contribution was made by Arkhangelsk and Irkutsk Oblasts. In total, there were 5.4% winners from these regions (7.3% taking into account 24 regions). The number of winners in natural and exact sciences was low, although this group includes a large number of academic disciplines. The number of prize-winners was low even in those regions where there are strong university schools. This

is probably due to the large number of small rural schools, where the technical base for such subjects is less developed, although schools outside the Far North face this problem as well. The share of winners from the Far North regions was 3.6% (5.4% in the analysis of 24 regions). The lowest rates, however, were for the humanities, which do not require the same significant facilities as the natural and exact sciences. Low rates are observed for all the humanities, even German language, for which higher results could be hoped for. Some regions of the Far East have achieved relatively high results in Chinese language, due to the presence of Chinese children and children from mixed families. Probably, teachers outside Moscow have less opportunities to prepare students for high-level competitions, since all regions were noticeably inferior to Moscow in language Olympiads.

Figure 2 shows the distribution of Russian regions by the number of prize-winners of the final stage of the All-Russian subject Olympiads for 2011/2012 — 2019/2020 academic years. In 2020, due to the coronavirus epidemic, all participants in the final stage became winners. This violates the established series of data, so in this paper we refer them to prize-winners rather than winners.

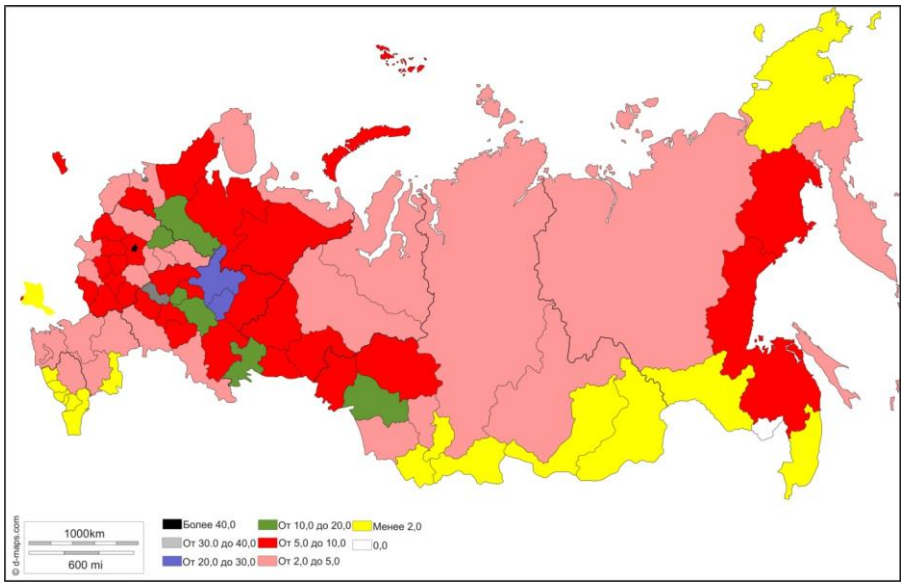

Fig. 2. Distribution of Russian regions by the number of prize-winners of All-Russian subject Olympiads per 100 thousand children aged 7–18 years for 2011/2012 — 2019/2020.

In terms of the number of prize-winners per 100 thousand children aged 7–18 years, the regions of Russia are also highly heterogeneous, since the coefficient of variation is noticeably greater than 33%, and the differences between the average and median values are large. Significant differences are observed both across the country as a whole and within the federal districts. As in the case of the winners, the lowest number of prize-winners was in the regions of southern Russia. The rest of the regions with a low number were located in the Siberian and Far Eastern Federal Okrugs. An important difference is that the prize-winners of the Olympiads were in almost all regions. The only exception is the Jewish Autonomous Oblast, which did not have a single prize-winner for the entire period starting from the 2011/2012 academic year. The Volga Federal Okrug can also be considered as a macro-region with the highest results, however, in terms of the number of prize-winners, the Central, North-West and Ural Federal okrugs showed much higher results

than in the case of the Olympiad winners. Probably, it can be argued that mass training of winners is available to a relatively small number of regional systems of general education, while due to a much larger number of winners, they appear in regions with less developed education systems.

In relation to the prize-winners of the Olympiads, the results in the Far North are worse, since in general in the macroregion their number was 4.1 against 9.0 in the country as a whole (10.1 excluding the Far North regions). A significant number of regions had less than 20 prize-winners for the entire period. Their share was 42% (39%, if we consider only 18 regions). This means that the differences between the 18 and 24 regions were slightly less noticeable. In the country as a whole, their share was 25% (18%, excluding the Far North regions). Statistical differences according to the Mann-Whitney test are also insignificant and are noticeably closer for 24 regions to the area of acceptance of the hypothesis about their significance.

The lowest number of winners was in the less developed regions of Siberia and the Far East with a high share of agriculture in the economy and the rural population. The "oil" regions (Sakhalin Oblast, Nenets Autonomous Okrug and Khanty-Mansi Autonomous Okrug), as well as Krasnoyarsk Krai, also showed low results, which is strange, given the significant financial resources at the disposal of regional authorities and a high proportion of the urban population. It can be assumed that the economic specialisation of the region and the share of the urban population have an impact, but their contribution is less significant in comparison with the development of the higher education system. Only Krasnoyarsk and Primorskiy Krais of the 14 regions with below average results had strong higher education systems. The Republic of Sakha (Yakutia) does not have a federal university, but under certain assumptions, it can also be considered to have a developed system of higher education. Among the leaders, the only exception is Magadan Oblast, which got into this group and was the leader in it due to local successes, when the results in it were at the level for Russia as a whole, but for the entire period, the number of prize-winners was significantly below the Russian average. Of the regions with high values, it is worth highlighting Kamchatka Krai, which got into this group due to the successes in 2011/2012 — 2012/2013.

If we consider the dynamics, the number of prize-winners of the Olympiads per 100 thousand children aged 7–18 years in the Far North regions in 2011/2018 — 2019/2020 has generally decreased. Nevertheless, an increase was observed in a much larger number of regions compared to the winners of the Olympiads. Therefore, their number has increased in the more economically developed Tyumen Oblast, with the exception of Yamalo-Nenets Autonomous Okrug. Regarding Irkutsk, Magadan Oblasts, the Republic of Buryatia and Zabaikalsky Krai, we can talk about an insignificant growth. An even dynamics was noted in Amur and Sakhalin Oblasts, Khabarovsk Krai and Yamalo-Nenets Autonomous Okrug. A slight decrease was noted in the Republics of Karelia and Komi. In the 2011/2012 and 2012/2013 academic years, the results of the regions of the Far North were higher than in subsequent years. The share of the Far North regions among all the prize-winners of the Olympiads decreased from 8.8% (11.8% in the analysis of 24 regions) to 4.9% (7.6%). If we limit ourselves only to the 2018/2019 academic year, when the data were compara-

ble to the 2011/2012 year, the decline will be even less: to 5.4% and 8.1%, respectively. However, with regard to prize-winners, the initial share was noticeably lower compared to winners.

For the entire period under consideration, the prize-winners of the Olympiads from the Far North regions accounted for 6.0% of all prize-winners (8.6% in the analysis of 24 regions). Consequently, the general education system in the regions of the Far North reveals the potential of a smaller number of children in comparison with other regions.

As in the case with the winners of the Olympiads, the greatest successes were achieved in other sciences. The share of winners was 11.8% (15.1% in the analysis of 24 regions). The main contribution was made by Arkhangelsk, Irkutsk, Magadan, Tomsk Oblasts, the Republic of Sakha (Yakutia), Khabarovsk Krai, Khanty-Mansi Autonomous Okrug. In this subject group, it is difficult to single out the only subject in which the Far North regions were in the lead. The distribution of regions in three other subject groups was equal and less different from the average, and there were no such noticeable differences as in the winners between them. In the humanities, the share of prize-winners was 5.3% (8.3% in 24 regions), in the social sciences — 5.0% (7.6%), in the natural and exact sciences — 5.2% (7.1 %). This confirms our thesis that additional efforts are required to prepare the Olympiad winners.

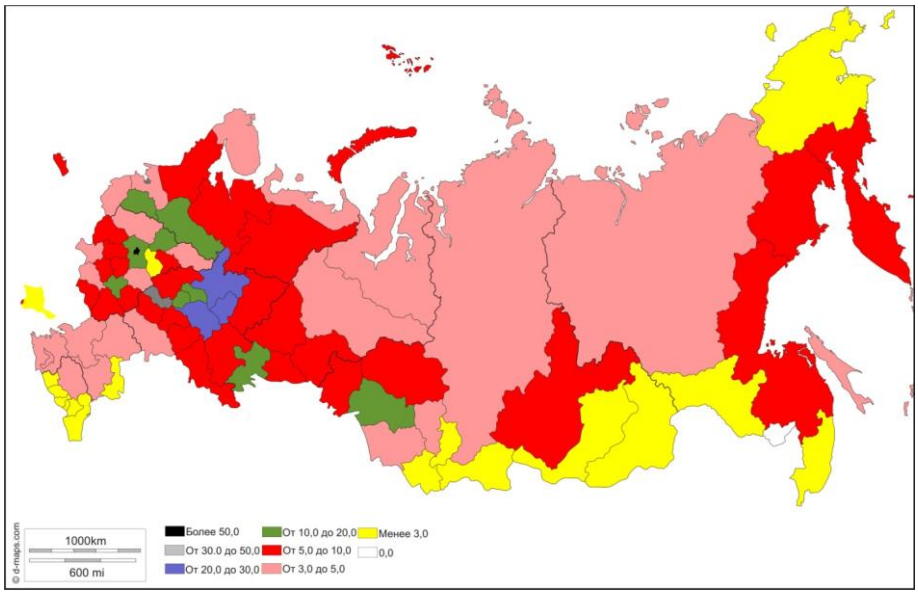

Fig. 3. Distribution of Russian regions by the number of winners and prize-winneers of All-Russian subject Olympiads per 100 thousand children aged 7–18 years for 2011/2012 — 2019/2020.

Several important conclusions can be drawn from Figure 3. Firstly, Moscow stands out among all the regions. Over the entire period under consideration, the number of winners and prize-winners in this region amounted to 51.7 per 100 thousand children aged 7–18 years. Moreover, their number increased from year to year. The next two regions (the Republic of Mordovia and St. Petersburg) had much lower values: 38.7 and 36.1, respectively. These two regions also stood out noticeably, since the following are the Udmurt Republic, Kirov Oblast and the Republic of Tatarstan, the values are much lower: 26.4, 24.3 and 23.2, respectively. They are at the bottom of the leading group. They are followed by the Chuvash Republic with a value of 15.9 and all other regions, which are further distributed without such significant gaps.

Secondly, among the regions of the Far North, the highest values (10.0) were in one of the least developed regions —Magadan Oblast. Nevertheless, it was still below the national average of 10.8 (12.2 when excluding the regions of the Far North from consideration). Values above the average for the Far North (4.8) were in more economically and socially developed regions or in regions located in the European part of Russia.

Thirdly, the leading regions are not necessarily the most financially secured and have a higher-income financial specialization: the desire of the regional leaders to achieve high performance is a much more important factor, since this, more accurately, ensures better work with children and the development of their abilities. The lowest results were shown by the regions of the South of Russia, Siberia and the Far East. They have many poor agricultural regions, but there are also many regions with extractive specialization, which have a large amount of material resources. In regions with a large share of the rural population, the results are lower, but in many regions with a high share of the urban population, they are also worse than the national average. In regions with a more developed system of higher education, the results are better, but this does not guarantee high results as, for example, in Krasnoyarsk Krai. Natural and climatic conditions are important, but also not a decisive factor. It can be assumed that the remoteness of settlements from each other and other factors, which can be estimated by spatial autocorrelation indices, are important. However, we have serious doubts about their significance for the country as a whole, although they may well be significant for the regions of the Far North.

The group of leading regions is also heterogeneous. It includes both very developed regions, which are financial, industrial and scientific centers, and regions with agricultural specialisation and a small amount of available financial resources. They are united by the fact that all of them (with the exception of Novosibirsk and Chelyabinsk Oblasts) are located in the Central, North-West and Volga Federal Okrugs. There is also not a single least developed region among them.

It can be assumed that of all the factors, the most important is the political will of the regional authorities and their desire to have a large number of winners and prize-winners of the final stage of the All-Russian subject Olympiads. As for the rest of the factors, it is difficult to single out one factor that could have a decisive influence, and we should talk about a complex of factors of socio-economic development that determine the interregional differences.

The number of winners and prize-winners of the Olympiads is influenced by the general trends in the development of general and additional education. Without schools setting high goals and a wide offer of extra-curricular activities, it is impossible to achieve high results. However, the development of the general education system plays a very important role, since it is difficult to achieve high results without the necessary basis.

Trends and problems in the development of the general education system in the Far North

Table 1 shows the dynamics of the number of educational institutions in the Far North and equivalent areas since the 2000/2001 academic year. We are not considering the entire region, but only the part that belongs to the Far North, but in most regions (except for six ones, considered separately), the conclusions will be valid for the entire region as a whole.

Table 1

Dynamics of the number of state and municipal educational institutions in the Far North in 2000/2001 — 2018/2019 academic years [1]

	2005 to 2000	2010 to 2005	2015 to 2010	2016 to 2015	2017 to 2016	2018 to 2017	2018 to 2015	2018 to 2000
Altai Republic	100.0	100.0	88.9	100.0	100.0	100.0	100.0	88.9
Republic of Buryatia	89.0	80.2	93.8	96.7	105.1	98.4	100.0	67.0
Republic of Karelia	86.2	83.6	93.0	99.1	96.7	99.0	94.9	63.6
Komi Republic	88.6	83.2	84.3	96.9	98.6	97.4	93.0	57.8
Republic of Sakha (Yakutia)	97.3	93.9	97.5	100.0	99.2	100.0	99.2	88.4
Tyva Republic	102.9	98.3	98.3	100.0	101.2	100.0	101.2	100.6
Zabaykalsky Krai	73.3	90.9	95.0	100.0	89.5	94.1	84.2	53.3
Kamchatka Krai	93.5	93.8	94.2	100.0	101.8	100.0	101.8	84.1
Krasnoyarsk Krai	93.3	75.5	96.7	98.5	100.0	99.0	97.5	66.4
Perm Krai	69.9	62.7	96.9	100.0	93.5	86.2	80.6	34.2
Primorskiy Krai	84.1	91.4	94.3	86.0	100.0	95.3	82.0	59.4
Khabarovsk Krai	93.1	88.3	94.1	99.5	101.0	100.5	101.0	78.2
Amurskaya Oblast	97.1	86.8	84.7	102.0	100.0	100.0	102.0	72.9
Arkhangelsk Oblast (without AO)	69.9	86.2	84.5	99.1	97.7	91.1	88.2	44.9
Nenets Autonomous Okrug	100.0	88.4	97.4	94.6	80.0	92.9	70.3	60.5
Irkutsk Oblast	96.2	93.7	84.1	100.0	100.0	98.0	98.0	74.3
Magadan Oblast	89.9	90.1	93.8	96.7	98.3	100.0	95.0	72.2
Murmansk Oblast	90.7	83.0	88.7	98.8	100.0	99.4	98.2	65.6
Sakhalin Oblast	88.6	89.3	94.6	98.7	98.7	100.0	97.5	73.0
Tomsk Oblast	81.9	88.3	86.1	98.4	95.9	95.7	90.3	56.3
Tyumen Oblast (without AO)	57.7	93.3	14.3	700.0	35.7	100.0	250.0	19.2
Khanty-Mansi Autonomous Okrug	94.3	94.5	88.6	101.9	98.8	98.4	99.1	78.2
Yamalo-Nenets Autonomous District	94.2	91.8	96.3	90.0	109.4	100.0	98.5	82.1
Chukotka Autonomous Okrug	87.5	85.7	97.6	102.4	100.0	97.6	100.0	73.2
Far North	88.8	88.2	91.0	99.1	99.0	98.8	97.0	69.2

During the period under review, the number of general education institutions increased only in the Republic of Tuva. If not for the closure of three schools in the 2011/2012 academic year, then in the Altai Republic it would have been possible to keep their number unchanged. A low decline was noted in the Republic of Sakha (Yakutia). Yamalo-Nenets Autonomous Okrug and Kamchatka Krai lagged behind them. In other regions, the number of educational institutions decreased by more than 20%.

If we exclude Tyumen Oblast with a small number of educational institutions in the Far North, which leads to significant fluctuations, the lowest retention was noted in Perm Krai, alt-

[1] Source: The number of state and municipal educational organizations (excluding evening (shift) general educational organizations). URL: https://rosstat.gov.ru/bgd/regl/b19_22/IssWWW.exe/Stg/04-03.doc (accessed 15 January 2021). The number of state and municipal educational organizations (excluding evening (shift) general educational organizations). URL: https://rosstat.gov.ru/bgd/regl/b16_22/IssWWW.exe/Stg/04-03.doc (accessed 15 January 2021).

hough the number of organizations in this region located in the Far North was also small. Of the regions with a large number of educational institutions, Arkhangelsk Oblast should be singled out, where the reduction was more than 50%. More than 40% of the initial number was lost by Tomsk Oblast, the Komi Republic, Zabaikalsky and Primorskiy Krais.

Both groups included both more and less financially secured regions. Therefore, we can assume that the dynamics of the number of general education institutions was influenced primarily by demographic dynamics. The dynamics of the number of settlements also contributed, since in the conditions of the Far North, many schools are rural. The geographical factor also played a certain role, since in all regions of the European part the decline was higher than the average value for the Far North.

After 2010, the rate of decline in the number of educational institutions in the regions of the Far North has slowed down, but there are some exceptions (Zabaikalsky Krai, Nenets Autonomous Okrug). Moreover, in some regions there was an increase in their number (Amur Oblast, the Republic of Buryatia, Khabarovsk Krai). Nevertheless, the process of reducing the network of educational institutions continues, and there are no reasons to change the trend.

In the conditions of the Far North, the educational institutions are the cultural centres of the settlements [12, Cost D.S.; 13, Herrmann V.] [2], therefore, further closure of general education organizations will lead to further depopulation of the Far North regions. If the state plans the integrated development of these territories, measures are needed to preserve schools, especially small ones, and to improve the quality of education there.

The dynamics of number of children at school age has already been considered by us [14, Sinitsa A.V.], therefore, table 2 shows the dynamics of the number of students of general education organizations. As in the case of table 1, we limited ourselves to the Far North and equivalent areas.

Table 2

Dynamics of the number of students in state and municipal educational institutions in the Far North in 2000/2001 — 2018/2019 academic years [3]

	2005 to 2000	2010 to 2005	2015 to 2010	2016 to 2015	2017 to 2016	2018 to 2017	2019 to 2018	2019 to 2000	2019 to 2000
Altai Republic	85.9	85.2	103.8	103.7	103.6	103.4	105.0	116.7	88.7
Republic of Buryatia	71.1	80.6	97.2	99.3	101.5	99.3	99.3	99.3	55.3
Republic of Karelia	68.6	84.8	103.2	102.9	102.1	101.6	101.0	107.8	64.7

[2] See also: Neustroev N.D., Neustroeva A.N., Sakerdonova A.S., Sleptsov Y.A., Rufov V.A. Small schools as a sociocultural center in rural settlements of the North-East of Russia: Search for the ways to preserve and develop. Espacios. 2018, vol. 39, no. 23, p. 16. URL: https://www.revistaespacios.com/a18v39n23/a18v39n23p16.pdf (accessed 15 January 2021).

[3] Source: The number of students in state and municipal educational institutions (excluding evening (shift) general educational institutions). URL: https://rosstat.gov.ru/bgd/regl/b19_22/IssWWW.exe/Stg/04-06.doc (accessed 15 January 2021). The number of students in state and municipal educational institutions (excluding evening (shift) general educational institutions). URL: https://rosstat.gov.ru/bgd/regl/b20_22/IssWWW.exe/Stg/04-04.docx (accessed 15 January 2021). The number of students in state and municipal educational institutions (excluding evening (shift) general educational institutions). URL: https://rosstat.gov.ru/bgd/regl/b16_22/IssWWW.exe/Stg/04-06.doc (accessed 15 January 2021).

Komi Republic	70.3	81.4	101.2	102.1	101.1	100.6	100.2	104.1	60.4
Republic of Sakha (Yakutia)	86.0	86.4	98.8	102.0	102.2	101.8	101.2	107.5	78.8
Tyva Republic	89.1	88.9	107.0	104.3	105.4	104.2	102.5	117.5	99.6
Zabaykalsky Krai	70.0	85.7	93.3	100.0	100.0	100.0	96.4	96.4	54.0
Kamchatka Krai	74.0	87.5	104.0	100.9	102.6	101.4	100.8	105.8	71.3
Krasnoyarsk Krai	74.8	81.9	101.5	103.0	101.2	101.2	100.0	105.5	65.6
Perm Krai	72.6	86.8	87.0	97.5	100.0	94.9	97.3	90.0	49.3
Primorskiy Krai	69.3	81.9	99.1	69.6	98.7	98.7	97.4	66.1	37.2
Khabarovsk Krai	68.2	82.1	99.6	102.0	102.6	101.0	99.8	105.5	58.9
Amurskaya Oblast	70.0	83.4	96.7	101.7	100.8	99.2	99.2	100.9	57.0
Arkhangelsk Oblast (without AO)	67.8	87.2	104.5	102.7	101.9	100.7	95.5	100.6	62.1
Nenets Autonomous Okrug	81.1	95.0	105.3	103.3	101.6	101.6	98.4	105.0	85.1
Irkutsk Oblast	69.7	82.7	98.3	104.3	102.5	100.4	100.1	107.5	60.9
Magadan Oblast	65.4	82.5	103.2	100.6	100.6	100.0	99.4	100.6	56.1
Murmansk Oblast	66.1	82.4	102.4	101.2	103.1	101.1	100.9	106.4	59.3
Sakhalin Oblast	70.4	85.5	113.2	99.3	102.5	101.6	101.9	105.4	71.7
Tomsk Oblast	70.5	82.5	99.6	101.6	102.4	99.2	100.8	104.1	60.3
Tyumen Oblast (without AO)	65.1	85.7	12.5	900.0	103.7	103.6	103.4	1000.0	69.8
Khanty-Mansi Autonomous Okrug	76.9	92.4	111.7	103.8	103.7	103.0	103.0	114.2	90.7
Yamalo-Nenets Autonomous District	83.7	87.5	102.0	102.0	102.4	101.1	102.4	108.2	80.8
Chukotka Autonomous Okrug	73.8	93.4	102.8	102.7	100.0	98.7	100.0	101.4	71.8
Far North	73.7	85.8	103.4	102.3	102.5	101.5	101.2	107.7	70.4

During the period under review, the number of children studying in general education institutions decreased in all Far North regions. The smallest decline was in the Republic of Tuva. It was followed by the Altai Republic, Nenets Autonomous Okrug and Khanty-Mansi Autonomous Okrug, which are regions with high birth rates by Russian standards. Excluding Yamalo-Nenets Autonomous Okrug, all the other regions had a decline of more than 20%.

The regions with the greatest decline are those with different combinations of low birth rates and high migration outflows. In general, the link between birth rates and school closures is confirmed, but not always a direct one. For example, Arkhangelsk Oblast was a leader in the closure of general education institutions, but the decline in the number of students was much smaller. It is necessary to consider each region in more detail and analyze how the decline in the birth rate affected the process of optimizing the network of general education organisations, which is much better done by local experts who have access to municipal statistics.

Regions with smaller populations have had higher birth rates and, consequently, higher enrolment rates. This is due to the presence of a higher share of indigenous peoples of the North. With the exception of Nenets Autonomous Okrug, all of them are located in the Asian part. Regions with the greatest decline are also located there, but still the decline was higher in the European part, since all other regions of this part had a decline above the average in the Far North.

The number of students directly depends on the previous birth rate; therefore, until the 2005/2006 academic year, their number was decreasing. The decline has also continued to a lesser extent in the following years. From the 2010/2011 academic year, the number of

students in most regions began to increase. There are, however, a significant number of exceptions. Since the 2015/2016 academic year, a steady downward trend in the number of students has remained only in the Republic of Buryatia, Zabaikalsky, Perm and Primorsky Krais, that is, in the regions with the largest total decline over the entire period. The increase in the number of students will continue until about 2025, after which, due to the wave-like population dynamics, the regions of the Far North will again face a sharp and strong reduction in their number.

Table 3 shows the dynamics of the number of teaching staff in the Far North and equivalent areas. Our attention is focused on it, because this category is broader than just the category of teachers.

Table 3

Dynamics of the number of teaching staff in state and municipal educational institutions in the Far North in 2000/2001 — 2018/2019 academic years [4]

	2005 to 2000	2010 to 2005	2015 to 2010	2016 to 2015	2017 to 2016	2018 to 2017	2019 to 2018	2019 to 2000	2019 to 2000
Altai Republic	128.6	77.8	114.3	100.0	100.0	100.0	100.0	100.0	114.3
Republic of Buryatia	90.5	68.4	84.6	100.0	100.0	100.0	100.0	100.0	52.4
Republic of Karelia	82.1	73.1	119.3	95.6	98.5	100.0	98.4	92.6	66.3
Komi Republic	84.4	87.7	93.0	101.1	100.0	96.8	97.8	95.7	65.9
Republic of Sakha (Yakutia)	103.1	74.1	118.1	101.1	101.1	100.6	100.0	102.8	92.8
Tyva Republic	100.0	87.1	118.5	103.1	100.0	101.5	103.0	107.8	111.3
Zabaykalsky Krai	100.0	100.0	75.0	100.0	100.0	100.0	100.0	100.0	75.0
Kamchatka Krai	85.4	71.4	136.0	97.1	100.0	103.0	105.9	105.9	87.8
Krasnoyarsk Krai	88.8	62.0	122.7	100.0	100.0	101.9	98.2	100.0	67.5
Perm Krai	87.5	71.4	140.0	85.7	100.0	100.0	100.0	85.7	75.0
Primorskiy Krai	72.2	76.9	90.0	77.8	100.0	100.0	100.0	77.8	38.9
Khabarovsk Krai	80.8	72.9	114.0	102.0	100.0	100.0	102.0	104.1	69.9
Amurskaya Oblast	88.9	68.8	109.1	91.7	109.1	100.0	100.0	100.0	66.7
Arkhangelsk Oblast (without AO)	85.3	73.7	130.6	98.4	98.4	98.4	93.4	89.1	73.1
Nenets Autonomous Okrug	87.5	114.3	100.0	87.5	114.3	87.5	100.0	87.5	87.5
Irkutsk Oblast	85.2	69.3	98.1	105.9	96.3	100.0	98.1	100.0	58.0
Magadan Oblast	77.3	82.4	92.9	100.0	100.0	100.0	100.0	100.0	59.1
Murmansk Oblast	77.5	69.6	107.3	98.3	101.7	100.0	100.0	100.0	57.8
Sakhalin Oblast	77.8	73.5	119.4	100.0	97.7	104.8	104.5	107.0	73.0
Tomsk Oblast	80.5	84.8	89.3	100.0	100.0	100.0	100.0	100.0	61.0
Tyumen Oblast (without AO)	25.0	100.0	30.0	666.7	100.0	150.0	100.0	1000.0	75.0
Khanty-Mansi Autonomous Okrug	87.0	76.6	124.2	101.9	101.9	101.8	101.2	106.9	88.5
Yamalo-Nenets Autonomous District	93.2	71.0	128.6	101.6	101.6	101.5	101.5	106.3	90.5
Chukotka Autonomous Okrug	100.0	66.7	150.0	100.0	100.0	100.0	100.0	100.0	100.0
Far North	87.5	75.4	114.5	100.3	100.3	100.4	100.3	101.3	76.6

[4] Source: The number of teaching staff of state and municipal educational institutions (excluding evening (shift) general educational institutions). URL: https://rosstat.gov.ru/bgd/regl/b20_22/IssWWW.exe/Stg/04-02.docx (accessed 15 January 2021). The number of teaching staff of state and municipal educational institutions (excluding evening (shift) general educational institutions). URL: https://rosstat.gov.ru/bgd/regl/b16_22/IssWWW.exe/Stg/04-04.doc (accessed 15 January 2021).

During the period under review, the number of teaching staff decreased in 21 out of 24 regions of the Far North. In the Altai and Tyva Republics, the increase in their number can be associated with an increase or a slight decrease in the number of general education institutions and a high birth rate. In Chukotka Autonomous Okrug, the growth is probably associated with the adaptation of the educational system after the huge migration outflow in the 1990s. A relatively slight decrease was observed in the more economically prosperous the Republic of Sakha (Yakutia), Khanty-Mansi Autonomous Okrug and Yamalo-Nenets Autonomous Okrug. The list of regions with the largest decrease (over 40%) is similar to the previous one: Irkutsk, Magadan Oblasts, the Republic of Buryatia, Primorsky Krai. This group also included Murmansk Oblast, which had low results in previous cases, but not low enough to be included in a similar group. We can see that, despite some exceptions, the dynamics of the number of teaching staff is determined mainly by the dynamics of the birth rate and the number of educational institutions. Geographically, the features are similar to those of the number of educational organisations.

Of all the indicators under consideration, the number of teaching staff is characterized by the most contradictory dynamics. According to the enlarged time intervals, a decrease during each of them was observed only in the Komi Republic and Primorskiy Krai. In the 2000s, most regions had a decline, although in some regions local authorities were able to maintain (Zabaikalsky Krai, Chukotka Autonomous Okrug) or even increase (the Altai Republics, the Republic of Sakha (Yakutia), Nenets Autonomous Okrug) their number. In the 2010s, growth was observed in most regions, which followed the increase in fertility, but in all regions in which there was a decrease in the number of teaching staff in the 2015/2016 — 2019/2020 academic years (with the exception of the Republics of Karelia and Komi), it was more than 10%. In general, the decline in the Far North was about 25%, which is slightly lower than the total reduction in the number of general education organisations and children studying in them. This is probably due to the dynamics of the provision of teachers in rural small schools.

For a more complete description of the existing trends, it is necessary to describe the dynamics of salaries of pedagogical staff. We will not go into this question because it is discussed in detail in [15, Karaseva L.A., Okhrimenko A.O.; 16, Sinitsa A.L.; 17, Sinitsa A.L.; 18, Sinitsa A.L.].

The network of educational organisations in the Far North regions is facing a number of problems that determine the dynamics presented above. They can be divided into common for the whole country (closure of incomplete schools, a decrease in the number of students, a shortage of personnel, etc.) and specific to the regions of the Far North. Let us review the most important of them through the prism of the general education system in the Far North.

An important problem is physical accessibility of general education institutions. For example, in the Republic of Sakha (Yakutia), the average distance to the nearest school was 30.6 km. In the 2006/2007 academic year, 173 schools (26% of the total number) were located in places connected to the nearest settlement with a winter road or air/water ways [19, Gabysheva F.V., p. 55] (in the country as a whole, the average radius of accessibility of rural schools from

1990 to 2014 increased from 12.6 km to 17.3 km [20, Bondarenko L.V., p. 77]). The situation is better in the regions with less severe climatic conditions and higher population density, but even in these regions the long distances are an important factor limiting the development of the network of educational institutions, especially in the settlements remote from the centres of the region and transport routes.

At present, the problem of staffing has not been resolved. Remoteness means weak socio-economic infrastructure and low wages, as well as difficulties in employing teacher's family members. As a result, there is a shortage of staff, and many specialists teach several subjects, which almost always means less immersion of children in the material. In particular, there is a shortage of young teachers who are not ready to work in such conditions [21, Afanasyeva L.I., Porotova N.A.; 22, Kozhurova A.A., Safonova D.V.; 23, Martynenko O.O., et al.].

In conditions of remoteness, the quality of education largely depends on the technical maintenance of buildings and the provision of equipment and books for lessons. Most rural municipalities in the High North do not have sufficient resources to deal with this problem.

An important feature that must be taken into account is the shift in the teaching schedule due to the migration activity of students during the holidays. Climatic conditions mean that, due to illness and weather conditions, children often do not attend school, and a considerable amount of material is given to them remotely and for self-study. Natural conditions have a negative impact on the ability of students and teachers to work. It is also not always possible to explain certain phenomena to children, because in the conditions of the Far North they may not occur (for example, flowering of gardens). These specific problems cannot be completely eliminated; but it is possible to try to mitigate their negative effects.

Currently, the prestige of physical labor is low. For this reason, and due to the poor development of agroeconomics in rural areas after the collapse of the collective farm system, labor education of agrotechnical, forestry, environmental or other profile, which provides useful skills and knowledge for life in rural areas, is poorly represented [24, Eflova Z.B.]. This is one of the reasons for the outflow of the population, since the school cannot interest children in hard rural work, does not provide appropriate skills and does not prepare students for life and professional work in their small homeland.

Apart from problems common for the whole country and specific to the Far North, there are problems related to education of indigenous peoples of the North. Schools are not always able to meet the needs of people and to provide the education that would allow the indigenous peoples to integrate into the modern society. If they succeed in doing this, then they largely lose their national identity. These features are described in sufficient detail in [25, Balashov Yu.V.; 26, Indenbaum E.L.; 27, Sinitsa A.L.]. It should only be noted that significant financial costs are not required to eliminate most of the problems.

It is worth mentioning that difficulties with the development of the education system in rural or remote settlements are not a specific to Russia. Children from rural areas in foreign

countries are less likely to receive a complete secondary education [5]. This is especially noticeable in relation to the indigenous peoples of the North, whose education system requires additional financial resources [28, Doyle A., Kleinfeld J., Reyes M.], and whose educational level is lower [29, Bania E.V., Eckhoff C., Kvernmo S.]. The deep problems in the development of general education in the United States are described in great detail in the fundamental monograph by J. Goodlad [30, Goodlad J.], which shows that they apply to many other countries.

Recommendations for education system development

Due to large interregional differences, some authors argue that it is impossible to create a unified change management system and that only a general framework regulation is needed [31, Kasprzhak A.G., Bysik N.V.]. This means that for the Far North and equivalent areas, solutions that take into account the specifics of their educational systems are needed. Another important condition for the development of local education systems is participation of the local community itself, i.e. the presence of high social capital [32, Galindabaeva V.V., Karbainov N.I.].

With considerable distances between settlements and a large number of small rural schools and not always high living standards, in our opinion, betting on increasing the number of winners and prize-winners of the subject Olympiads, is wrong, because significant resources are spent on students' preparation, but they move to other regions to enter the universities. Consequently, there is a "brain drain", which is irrevocable, since almost all of these children, after graduation from the university, stay in the new place of residence. From a long-term strategy point of view, a much better approach is to develop the education system in such a way as to increase the average USE score. This will improve the quality of the incoming flow of applicants to local universities, whose activities are largely aimed at developing the regions of the Far North and equivalent areas and will favorably affect the development of these territories, and will allow to obtain more noticeable results on the final stage of the All-Russian subject Olympiads in the long term. This approach will also help to slow down the outflow of the population, since the poor quality of mass schooling is a significant reason for a change of residence.

It may be tempting to use the experience of some regions. There, the overwhelming majority of winners and awardees are in the same general education system, and they receive special support. This allows children to develop and show great success at the Olympiads. However, in this case, the educational system does not work for the alignment of the results, but for their concentration. Consequently, indicators of other secondary schools are worse, since the most talented children are withdrawn from them, and, as a result, their financing is worse, which is a great negative impetus that affects all the regional system of general education. It is necessary to develop it comprehensively and evenly, avoiding such distortions that hinder this process.

[5] Bania E.V., Lydersen S., Kvernmo S. Non-completion of upper secondary school among female and male young adults in an Arctic sociocultural context; the NAAHS study. BMC Public Health. 2016, 16 (960). URL: https://bmcpublichealth.biomedcentral.com/articles/10.1186/s12889-016-3644-2 (accessed 15 January 2021). DOI: 10.1186/s12889-016-3644-2

The major difference between elite and mass general education is less about the quality of the curriculum. It is necessary to strengthen those components of schooling that are aimed at developing children's ability to think independently, understand what has been written, evaluate it critically and argue for their point of view, as well as develop the desire for self-education within and beyond the school curriculum. These skills are essential not only in later stages of the education system, but also in everyday life. The need to improve the quality of these components applies to all schools, but it is especially important for the Far North, as it would allow the development of these areas more diversified, reducing the share of the mining sector and increasing the sustainability of socio-economic development. Improving these skills will contribute to a fuller and better knowledge of the school curriculum.

It is also important for schools in the Far North to return labour education to the curriculum in order to give children real life skills. Perhaps, such schools need other, not massive, unified criteria for assessing the quality of education. It is also important for them to have material support from regional and municipal authorities and support the efforts of schools to have the proceeds from the sale of their products as an additional source of funding. The examples suggest that there is a demand for agricultural and other schools with a similar profile [33, Bozhedonova Z.N.; 34, Nemirich T.N.].

In conditions of dispersed settlement and poor transport accessibility, schools in the Far North, which are often the only state institutions involved in cultural and educational activities for both children and adults, are in great need of high-speed Internet. First of all, this concerns rural schools, since children and teachers often lack access to modern and more advanced knowledge, which greatly limits development and reduces the quality of education. In rural schools, the cost of educating children is higher than in urban ones, and in small schools, it is even higher. Nevertheless, it is necessary to provide Internet access to every general education organisation.

It is necessary to strengthen the information support of the current policy, which can be supported by international experience. This requires research to determine the problems facing the education system more comprehensively. It is particularly important for rural areas, because the education system does not prepare for rural life and abroad [35, Bæck U.-D.K.]. Such studies are usually conducted on sufficiently large samples to be representative, if not for the whole country, then at least for the northern territories [6] [29, Bania E.V., Eckhoff C., Kvernmo S.].

A number of other measures can also be identified. As additional support measures for rural teachers, it may be proposed to provide young specialists who plan to work in rural areas with a set of equipment at the expense of the regional budget. It may include, for example, a laptop

[6] See also: Bania E.V., Lydersen S., Kvernmo S. Non-completion of upper secondary school among female and male young adults in an Arctic sociocultural context; the NAAHS study. BMC Public Health. 2016, 16 (960). URL: https://bmcpublichealth.biomedcentral.com/articles/10.1186/s12889-016-3644-2 (accessed 15 January 2021). DOI: 10.1186/s12889-016-3644-2; Rapp S., Aktas V., Ståhlkrantz, K. Schoolboards' expectations of the superintendent – a Swedish national survey. Educational Review. N.d. URL: https://www.tandfonline.com/doi/full/10.1080/00131911.2020.1837740 (accessed 15 January 2021). DOI: 10.1080/00131911.2020.1837740

and a projector. In regional institutes for advanced training and retraining of educators, a subdivision is needed that would work only with rural schools. It is also necessary to organise regular advanced training on issues that are relevant for the teacher themselves, not only within the framework of the subjects they read, but also in psychology and pedagogy. This is especially important for young teachers. More active involvement of children in research activities is needed. This will require additional funding, but will improve the quality of education and provide new data that will be based on long-term observations. This experience has been implemented abroad [36, Klene A.E., et al.].

Finally, it is necessary to develop the general education system in order to minimize the negative impact on children's health. It has been noted in publications that the already poor health of children at school age in the regions of the Far North is even worse [37, Buzinov R.V., Amerina E.A., Unguryanu T.N.]. The school could have a positive effect on the shortcomings of family education, but it faces problems that negatively affect the health of children, and, therefore, their academic performance [37, Buzinov R.V., Amerina E.A., Unguryanu T.N.; 38, Shemetova E.V., Boytsova T.M.]. It is therefore necessary to make efforts on the part of the federal and regional authorities to enable the institution to become a centre of health promotion [39, Ulanova S.A.], which is especially important in conditions of dispersed settlement of the Far North, and to develop and implement an appropriate long-term state policy.

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The Role of Self-Education in Preservation and Development of Human Capital in the Republic of Karelia: Socio-Cultural Aspect *

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Abstract. The problem of preserving human capital in the context of globalization is due to processes in the economic, social and cultural spheres. The search for a solution to this problem in the field of humanities is associated with aspects of personality self-development. Among the most important components of personality self-development, the majority of researchers in the humanities note self-education as a motivator for labor and social activity. Therefore, the identification of socio-cultural factors affecting the level and need for self-education requires a comprehensive interdisciplinary approach with regional specifics taken into account. Objective **is** to identify the factors influencing the level of self-education of residents in the modern economic and socio-cultural conditions of the Republic of Karelia. The material for cultural analysis was the results of field studies obtained during a scientific expedition to the Karelian Arctic, northern and southern border regions of Karelia. As a research methodology, an integrated cultural approach was used. Among the effective methods were focus groups on thematic cases, standard and non-standard questionnaires, interviews, polls, factor analysis, statistical and normative methods. For the first time in scientific practice possible sources, channels and preferences of the population of Karelia in self-educational activities have been researched. As a result, it was concluded that the combination of economic indicators is the determining socio-cultural factor for self-educational activity of the residents of the investigated areas and geographical indicator, which allows the inhabitants of Karelia to realize their spiritual and material needs at a high level and to preserve human capital as the main value of society in the unstable situation of a globalizing world.

Keywords: *human capital, self-education, migratory process, socio-economic development, adult education, complex expedition.*

Introduction

The preservation of human capital is one of the main problems of the socio-economic development of the Republic of Karelia. According to statistics [1], the migration loss in 2019 started to decline, but still shows negative values. In this regard, the situation requires a comprehensive analysis and identification of the reasons for the negative migration balance. From the generally accepted point of view, the reason for the migration loss in Karelia is associated with economic and social aspects. However, from a scientific standpoint, such a vision is considered one-sided, since only a comprehensive interdisciplinary study is able to identify cause-and-effect relationships and, as a result, determine ways to solve the problem.

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[1] General results of migration of the population of the Republic of Karelia for January–August, 2019. URL: https://krl.gks.ru/storage/mediabank/73284_08.pdf (accessed 18 June 2019).

The concept of human capital, rooted in science of the 20th century thanks to T. Schultz, G. Becker, L. Turov, J. Kendrick and others, has a multifactor structure. The positivist approach is used by economists [1, Gvozdeva M.A., Kazakova M.V., Kiblitskaya T.R., p. 46] and is a convenient tool for scientific analytics [2, Buranshina N.A.]. However, "the solution to the problem in the form of identifying methods for preserving human capital is largely associated with intangible culture, which is diverse, spontaneous, local and requires a special approach" [3, Smirnov A.K., p. 19].

Similar practice is carried out by scientists of different directions: I.A. Krutiy and O.V. Krasina in the field of sociology [4, p. 127–130], Ya.M. Roshchina [5], J.B. Avey, F. Luthans, S.M. Jensen [6, p. 678], F. Luthans, J.B. Avey, J.L. Patera [7] in economic psychology, A.J. Elliot and M.V. Covington [8], I.N. Semenov [2], A.L. Zhuravlev, D.V. Ushakov in psychology, A.I. Yuriev, A.V. Selezneva, E.P. Dobrynina, I.S. Burikova [3] in political psychology. But since the concept of human capital is multifactorial [9, Korchagin Yu.A., p. 61], its study should be not only interdisciplinary, but also complex.

An important aspect is the understanding of human capital as a volume of investments in education and self-education [10, Armstrong M.], education, health care [11, Vidal-Salazar M., Hurtardo-Torres N., Mathias-Reche F.], security [12, Zacharatos A., Barling J., Iverson R.D.], vocational guidance, culture, as well as consumer needs of the population.

Regional problems of preserving human capital are actively studied in modern Russian science [13, Grachev S., Donichev O., Malkova T., p. 68]. Meanwhile, Karelia has only once become an object of socio-cultural scientific research [14, Pivoev V.M. et al.].

In the modern world, self-education is given priority. "The key to professional success is not knowledge acquired once in a lifetime. The ability of people to find their way through a vast field of information, the ability to find solutions independently and to implement them successfully comes to the forefront" [4].

The essence of self-education is reduced to the possible self-realization of a person in different areas, taking into account his individual characteristics and abilities. In modern information society, a free and wide selection of interactive courses, projects and self-education programs can satisfy any cognitive interests of both professional and non-professional orientation.

The cognitive subject of self-education forms all these skills and abilities in the process and under the influence of the socio-cultural situation to which a person belongs.

The analysis of real socio-cultural situation allows us to identify the main factor that determines the demand for self-educational activities of our contemporaries.

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[2] Semenov I.N. Ekonomicheskoe povedenie cheloveka kak kapitala i razvitie ego refleksivno-tvorcheskogo potentsiala v polikul'turnom biznes-obrazovanii [Economic behavior of a person as capital and the development of his reflective and creative potential in multicultural business education], 2019. URL: http://fs.nashaucheba.ru/docs/45/index-2576108.html (accessed 18 August 2019).

[3] Burikova I., Konovalova M., Pushkina M., Yuryev A. Opyt psikhologicheskogo izmereniya chelovecheskogo kapitala [Experience of psychological measurement of human capital]. URL: https://gtmarket.ru/laboratory/expertize/3251 (accessed 22 August 2019).

[4] Konovodova Yu.A. Samoobrazovanie — eto vazhneyshiy priznak kachestva obrazovatel'nogo protsessa [Self-education is the most important sign of the quality of the educational process]. URL: https://moluch.ru/conf/ped/archive/98/4555/ (accessed 22 August 2019).

The purpose of the work is to identify the factors influencing the level of self-education in modern economic and socio-cultural conditions. The analysis of factors influencing the self-education of the inhabitants of the Ladoga region, the Karelian Arctic and the inhabitants of the northern borderlands is among the tasks.

The theoretical significance of the study lies in the possibility of identifying the leading factors of the modern socio-cultural situation, influencing the level and need for self-education of inhabitants of the region, using an interdisciplinary humanitarian approach. The practical significance of the study lies in the possibility of approbation of various humanitarian methods, including self-education questionnaires.

Materials and methods

The article presents the results of a comprehensive research expedition "Ways of preserving human capital as an urgent problem of Karelia", conducted in 2019 in some regions of the Republic of Karelia.

The empirical data were obtained by applying an integrated methodology of cultural research, sociology, economics, history, linguistics, psychology and axiology. The following methods were used when working with the adult population of the Karelian Arctic (Kemskiy and Lokhskiy districts), the northern outskirts (Kostomuksha urban district) and the Karelian Priladozhie (Sortavalskiy, Lakhdenpohskiy and Pitkyaranta districts):

- focus groups on thematic cases (history and sociological research),
- standard and non-standard questionnaires (sociological, psychological and economic research);
- description and interpretation of ideas, reactions and assessments of a person on a problematic topic (linguistics and psychological research);
- interviews (historical and sociological research);
- surveys (sociological and economic research);
- factor analysis, statistical and normative methods (economic research).

In the course of processing the obtained empirical data, it turned out to be possible to verify the proposed hypothesis about the main factor that determines the level of self-education of the inhabitants of the republic.

Results

Opportunities for self-education are undoubtedly greatest in cities. The larger the city is, the more opportunities it has. So, the capital of Karelia, the city of Petrozavodsk, has concentrated most of the offers on the market of Karelian educational services. According to the Internet portal Kareljob.ru [5], there are 27 adult education centres and educational institutions, all of them are lo-

[5] Kareljob.ru: Internet portal. Courses for adults. URL: https://www.kareljob.ru/education/index.php?id_rub=1 (accessed 22 February 2020).

cated in Petrozavodsk. The vast majority of further education offers are in professional fields: accounting, computer skills, IT training, management. Foreign language courses (mainly English and Finnish) are always popular. It is noteworthy that all these offers are of a commercial and practical nature, being a kind of advanced training or professional retraining courses.

However, there are non-commercial offers, represented primarily by non-profit public organisations and state budgetary institutions (museums, libraries, cultural centres) that conduct various educational activities and general culture courses.

It should be noted that according to Kareliastat [6], in 2019, the educational and cultural systems occupy the third place (after transport and communication services and housing and communal services) in the structure of paid services to the population, amounting to 8.6%. One of the conclusions that can be drawn from the statistics is that the solvent part of the population is ready to invest in education.

Petrozavodsk State University occupies a special place in the market of educational services in Karelia. In 2017, it became the pivotal university of the region and undertook a number of commitments, the most important of which was the preparation of the socio-economic strategy of the region [7]. The development strategy is aimed not only at the introduction of new technologies in all areas of development (Internet, agro-industrial complex, tourist cluster, mechanical engineering, high medical technologies, etc.), but also at the development of human potential in both professional and general cultural aspects. The university contributes to the implementation of projects promoting science and introducing global and traditional culture. The target audience of the projects is primarily schoolchildren who are potential applicants. However, there are a number of educational projects for adults, two examples of which are given below.

Since 2010, the social service “Open University” has been a part of Petrozavodsk University. For more than 10 years of its existence, about 30 courses have been developed and implemented, many of them continue for years. The topics are diverse: world and local history, world and traditional culture, psychology, medicine, plant growing, computer literacy, and so on. Lecturers and teachers of the courses are leading scientists of Petrozavodsk University and the Academy of Sciences. The example of the Open University is interesting, first of all, for its elderly audience. So, according to a survey conducted in 2016 [8], the percentage of students is as follows: under 25 years old — 6.3%, 25–40 years old — 14.9%, 40–55 years old — 23.1%, over 55 years old — 53.5%. As for the social status of students, it is estimated at 41% of non-working people, 24% of working

[6] Respublika Kareliya v tsifrakh’2019: kratkiy statisticheskiy sbornik [The Republic of Karelia in figures'2019: a short statistical collection]. Petrozavodsk: Kareliastat, 2019. 65 p. URL: https://krl.gks.ru/storage/mediabank/02471(1).pdf (accessed 22 February 2020).

[7] Opornyy vuz: 10 plyusov [Flagship university: 10 pluses]. Informatsionnoe agentstvo «Respublika» [nformation Agency "Respublika"], 2017. URL: http://rk.karelia.ru/social/opornyj-vuz-10-plyusov/ (accessed 22 February 2020).

[8] Babakova T.A., Levina O.R. Otkrytyy universitet kak fenomen obrazovaniya vzroslykh [The open university as a phenomenon of adult education]. Nepreryvnoe obrazovanie: XXI vek, 2016, no. 2 (14), p. 26–38. URL: https://cyberleninka.ru/article/n/otkrytyy-universitet-kak-fenomen-obrazovaniya-vzroslyh (accessed 28 February 2020).

pensioners, 28.6% of working adults, 6.4% of students. It is noteworthy that 44.8% of the respondents were not previously associated with Petrozavodsk State University (that is, they did not study or work in it). This parameter indicates the attractiveness of the scientific and educational atmosphere of the university, which is open to everyone who wants to acquire knowledge. This is evidenced by the constantly growing audience of the Open University, which amounted to more than 3 thousand people in 2019.

Another unique example of creating scientific and cultural space is the Humanitarian Innovation Park, which began functioning at the end of 2018. The system of innovation parks declared in the program of the supporting university [9] included not only IT and engineering areas, tested by many universities, but also humanities. Thus, for the first time in Russia, the Humanitarian Innovation Park (HIP) was created, which unites scientists from different humanitarian fields: historians, philosophers, philologists, cultural scientists, sociologists, political scientists, lawyers and economists. The purpose of the association is to identify metasubject connections in the humanities and conduct complex scientific research in the humanitarian sphere of the Republic of Karelia. The park also has a scientific and educational function. Spatially, the HIP has been embodied in several sites where scientific, educational and awareness-raising projects are being implemented. In 2019, number of these projects totalled 14 and attracted several hundred participants of different age categories (schoolchildren, students, scientists, adult volunteers). The thematic projects of the HIP relate to the basics of genealogy (building a family tree, searching for ancestors, working with archives), studying foreign languages (Greek or Swedish), philosophy and culturology (the essence of philosophical knowledge and its application in all types of human activity) , local history (study of the intangible culture of the Russian North, work with field research data, work with archives). The most ambitious educational project “Karelia to the present day”, implemented jointly with the State TV and Radio Company “Karelia”, was embodied in a series of TV programs dedicated to the history, culture and nature of the republic. TV shows are broadcast on the federal channel (Russia24) in prime time and have good ratings [10]. The interest of the public can be explained by the need of Karelians to learn more about their region from scientists, which, in turn, can be called an element of self-education.

As noted above, the functions of the HIP include scientific research. Their practical implementation was a complex research expedition “Ways of preserving human capital as a topical problem in Karelia”. One of the objects of research was the socio-cultural situation and its influence on the self-education of the inhabitants of the republic. The study was carried out in three territorial areas; a total of 661 respondents took part in it. The analysis of the socio-cultural situation in the studied territories was carried out taking into account geographical, demographic, economic, historical and cultural factors.

[9] Development program of the flagship Petrozavodsk State University for 2017–2021. URL: https://petrsu.ru/docs/counter/6328 (accessed 18 August 2019).

[10] Karelia to the present day. URL: http://tv-karelia.ru/category/karelia-do-nashih-dney/ (accessed 25 February 2020).

Geographic factor

The geographical position of Karelia is unique. Firstly, the republic has the longest border in the Russian Federation with the European Union (Finland), and, secondly, it is located in relative proximity to the federal centers: first of all, Moscow and St. Petersburg. Both of these factors are especially relevant for the Ladoga area. In addition, this area is the closest to the capital of Karelia, Petrozavodsk city (220 km). The northern regions are the farthest from St. Petersburg and Petrozavodsk, but at the same time, the western regions (Kostomuksha, Loukhi) border Finland.

Economic factor

The territories under study differ in terms of their production development, economic activity and level of wages. The latest figure for 2019 is: 37.810 rubles in the Sortavala municipal district, 36.567 rubles in the Pitkyaranta municipal district and 52.641 rubles in the Kemskiy municipal district.

Demographic factor

The demographic factor is to some extent related to the geographic one, since the proximity of the Ladoga area to St. Petersburg affects the outflow of the population due to labor migration. The statistical data for 5 years (as of January 2019), collected from the local authorities during the expedition, are as follows: Sortavala district — 30914 residents (1286 people left), Pitkyaranta municipal district — 17390 residents (1498 people left). Positive dynamics is observed in the Kostomuksha urban district: a total of 29871 residents, of whom 295 have moved.

Historical and cultural factor

All district centres have numerous objects of cultural heritage, reflecting the centuries-old history of coexistence of Karelians, Finns, Russians and Sami. With the total number of such objects (1023), the largest number of them is located in the Sortavala region (548) [11]. The uneven distribution of cultural objects is combined with their typical diversity. Thus, in Ladoga and Kemskiy districts, the main sights, attracting a large flow of tourists (Valaam and Solovetskiy monastery), are of historical and cultural nature and reflect the milestones of Russian history. Meanwhile, the lack of ancient historical monuments in Kostomuksha is compensated by popularization of the ethno-cultural heritage of Karelians and Finns (Karelian language, Karelian-Finnish epic, traditional crafts) and Kostomuksha itself (the youngest city of Karelia, 41 years old), which is an example of urban architecture, created according to the advanced Finnish technologies.

It is important to note that social and cultural institutions (museums, libraries, cultural centers, etc.) are active in all areas studied. Their activities are aimed not only at preserving historical memory, but also at stimulating the cognitive needs of the population. In total, 450 cultural insti-

[11] Statistical information on the location of cultural heritage sites of the Republic of Karelia. URL: http://monuments.karelia.ru/ob-ekty-kul-turnogo-nasledija/statisticheskie-svedenija-po-dislokacii-ob-ektov-kul-turnogo-nasledija-respubliki-karelija/ (accessed 18 June 2019).

tutions operate on the territory of Karelia [12], and about 4 thousand people work there. The optimal functioning of these institutions is ensured by the State Program of the Republic of Karelia "Development of Culture", which takes into account one of the priority tasks of state policy on the preservation of historical and cultural heritage and its use for upbringing and education [13].

It can be assumed that the main condition for self-education is a developed cultural infrastructure. This assumption was tested during a research expedition by interviewing residents of all these areas, working in the public sector, industry, management and agriculture. As a possible option, a questionnaire on self-education of adults was proposed, developed by the Department of Personal Psychology, St. Petersburg State University. The survey had 3 questions about biographical facts and 17 questions about the respondents' activities in various forms of self-education: reading various kinds of literature, visiting libraries and lecture halls, watching popular science and documentary films, visiting exhibitions and museums, participating in cultural events of local centers, professional development, watching theatrical performances and concerts, participating in amateur performances, attending online courses.

In accordance with the instructions, points were awarded for each answer, then the points were summed up, and the total score was calculated. The higher the score was, the more participants were expected to be involved in self-education and self-development activities. Further, the results of the questionnaire were subjected to statistical processing, on the basis of which a level grading of marks was applied. A high level of self-educational activity — from 17 to 23 points — indicated that person was actively involved in self-educational activity and was largely involved in the process of self-development. The average level — from 11 to 16 points — indicated that person's involvement in the process of self-development and self-education is at the average level necessary for the implementation of the process. The low level of this activity — below 10 points — indicates a low degree of involvement in the process of self-development.

The survey involved 661 respondents aged 18 to 72 years, 70% of whom were women, 30% — men. Of the respondents, 72% in Kostomuksha, 67% in the Arctic, and 66% in Ladoga had higher education. A positive fact is 100% coverage of the surveyed respondents with one or another form of self-education, which indicates such a trait as a constant striving for new knowledge, skills and abilities in completely different spheres of human activity.

According to the results of the questionnaire, it can be concluded that the largest number of adults with a high level of self-education is in Kostomuksha (19% of the total number of respondents), which is twice more than the number of respondents with a high level of self-education in the other two areas (9% in the Arctic and 10% in Ladoga area). If the relationship be-

[12] Respublika Kareliya v tsifrakh'2019: kratkiy statisticheskiy sbornik [The Republic of Karelia in figures'2019: a short statistical collection]. Petrozavodsk: Kareliastat, 2019. 65 p. URL: https://krl.gks.ru/storage/mediabank/02471(1).pdf (accessed 22 February 2020).

[13] Ob utverzhdenii gosudarstvennoy programmy Respubliki Kareliya «Razvitie kul'tury» [On the approval of the state program of the Republic of Karelia "Development of culture"]. URL: http://docs.cntd.ru/document/919511963 (accessed 22 February 2020).

tween the level of formal education and self-education is identified, the data indicate that the vast majority of respondents with a high level of self-education have higher education. It can be concluded that people with a higher level of higher education have a greater motivation for self-education and self-development. The study showed that the vast majority of respondents in Kostomuksha had a higher education, that is, the general level of formal education was quite high (72%).

In comparison with other districts, the number of respondents with an average level of self-education prevails in Kostomuksha (52% of the total number). In Ladoga, the number of respondents with an average level of self-education is about half (49%), most of them have higher education (84%). In the Karelian Arctic and Ladoga area, the same indicator of respondents (40%) with a low level of self-education was revealed, and the number of people with higher education there does not exceed 36%.

Discussion and conclusions

The results of the survey show that the highest level of self-education and formal education is observed among the residents of Kostomuksha urban district. Linking the socio-cultural factors of this area with the results of the study, we can conclude that

- the place of birth does not determine the preservation of human capital in the territory and is not a determining factor in the demographic situation (the lowest birth rate in Karelia refers to Kostomuksha urban district, where, unlike other regions, a demographic increase in the labor force was recorded);
- the highest level of wages in Karelia provides Kostomuksha residents with sufficient opportunities for self-education through participation in domestic and international programmes, courses and projects;
- proximity to the border provides Kostomuksha residents with a high level of international mobility, which also expands the possibilities for self-education;
- cultural and historical factors are not decisive factors in motivating residents to self-education in the studied territories.

Thus, the main factor determining the high level of inhabitants' self-education in the studied regions of Karelia is a combination of economic and geographic indicators that allow Karelians to fulfill their spiritual and material needs at a high level and maintain the growth of human capital.

The main directions of research in future are related to the possibility of expanding the research activities of scientists of the supporting university through expeditionary activities throughout the territory of the Republic of Karelia.

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Doctrine on Food Security of Russia: Socio-Economic and Socio-Biological Aspects of Its Implementation in the Arctic *

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Abstract. The article considers socio-economic and socio-biological aspects of the Russian Food Security Doctrine, approved on January 21, 2020. The need to monitor Russia's food security is due to significant changes in "the country's socio-economic development, the emergence of new risks and threats to food security caused by economic sanctions imposed in 2014 by a number of Western countries against our country, the openness of the national food market" in connection with the accession to the World Trade Organization, and the deepening integration within the EAEU. The article examines modern approaches to the definition of state food security. Certain provisions of the Doctrine of Food Security of the Russian Federation are assessed, the analysis of food security in Russia in terms of self-sufficiency, economic and physical availability of food was carried out on the basis of statistical data. Food security in Russia has been achieved for the main items of food products, which is confirmed by the results of the analysis performed. A similar positive trend in the development of our country is confirmed by the estimates of foreign researchers based on the results of the Global Food Security Index monitoring. A comparative analysis of the diet of the population of Russia and the Arkhangelsk and Murmansk Oblasts is given. The work focuses on socio-biological risk factors for food security in the Arctic region of Russia.
Keywords: *Doctrine of food security, monitoring, diet, economic accessibility, social and biological risks*.

Introduction

A new Doctrine of food security of the state was approved by the Decree of the President of the Russian Federation dated January 21, 2020 No. 20 [1]. The need to approve a new Doctrine is associated with significant changes in the conditions of socio-economic development of Russia in recent years, the emergence of new risks and threats to food security caused by economic sanctions introduced in 2014 by a number of Western countries, the openness of the national agri-food market in connection with the accession to the World Trade Organization and deepening integration within the EAEU.

The Doctrine establishes definitions and indicators of Russia's food security at the legislative level. The food security of Russia is characterized as "the state of socio-economic development of the country, which ensures food independence of the Russian Federation, guarantees physical and economic accessibility for each citizen of the country of food products that meet

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[1] Ukaz Prezidenta Rossiyskoy Federatsii ot 21.01.2020 № 20 "Ob utverzhdenii Doktriny prodovol'stvennoy bezopasnosti Rossiyskoy Federatsii" [Decree of the President of the Russian Federation dated January 21, 2020 No. 20 "On approval of the Food Security Doctrine of the Russian Federation"]. URL: http://publication.pravo.gov.ru/Document/View/0001202001210021 (accessed 20 June 2021).

mandatory requirements, in amounts not less than rational standards of food consumption necessary for an active and healthy lifestyle". Innovations and issues of implementation of the new Doctrine of food security of Russia are considered in detail in the works of Anishchenko A.N., Shutkov A.A. [1], Shagaida N.I. [2], Yarkova T.M. [3]. These works consider the main risks and identify the main causes that hamper Russia's food supply, justify the mechanisms and conditions for the implementation of the Doctrine of food security of the state. It should be noted that the presented studies do not pay attention to the regional aspects of the Doctrine implementation.

The purpose of this study is to consider the socio-economic and medico-biological aspects of the implementation of the Doctrine of food security in the Arctic on the example of the Arkhangelsk Oblast.

Assessment of food security in Russia

The main indicator of food security is the self-sufficiency threshold in percentage calculated as the ratio of the volume of domestic production of agricultural products, raw materials and foodstuffs to the volume of their domestic consumption. Table 1 presents the results of Russia's food security indicator for 2019.

Table 1

The level of self-sufficiency in food products in accordance with the "Doctrine of food security of Russia" [2]

Products	Doctrine threshold, %	Produced in 2019 [3] of need, %	Deviation from the threshold, %
corn	not less than 95	155	+60
sugar	not less than 90	128	+38
vegetable oil	not less than 90	175	+85
meat and meat products	not less than 85	97	+12
milk and dairy products	not less than 90	84	-6
fish and fish products	not less than 85	82.2	-2.8
potato	not less than 95	95	0
vegetables	not less than 90	84	-6
fruits and berries	not less than 60	40	-20
food salt	not less than 85	64	-21

The above data show that for the main types of food products, such as grain, potatoes, meat and meat products, sugar, vegetable oil, the threshold values of the Doctrine in 2019 were achieved. According to the Minister of Agroindustrial Complex and Trade, I.B. Bazhanova [4], Arkhangelsk Oblast produces the amount of potatoes, vegetables, milk and dairy products, fish and seafood necessary for self-sufficiency. Apart from the traditional ones, prospective directions for the development of the region's agro-industrial complex can include the production of seed potatoes, the development of livestock breeding, aquaculture, as well as the collection and processing of forest mushrooms and berries and their cultivation, which fully corresponds to the tasks set in the Doctrine. Reindeer husbandry is developed in the Nenets Autonomous Okrug, which makes it

[2] Ibid.

[3] Rosstat. URL: https://www.gks.ru (accessed 04 July 2021).

[4] Interview of the Minister of Agroindustrial Complex and Trade of the Arkhangelsk Region, I.B. Bazhanova. URL: https://youtu.be/4vbb7oxchjc (accessed 04 July 2021).

possible not only to cover the needs of indigenous peoples, but also to supply reindeer meat products to the markets of the region. The main risks affecting the development of agriculture in the Arkhangelsk Oblast are the underdeveloped infrastructure, which complicates the logistics of products, the unsatisfactory financial condition of many agricultural enterprises, the lack of labor and climatic conditions. The majority of support measures for agricultural producers at the federal and regional levels are aimed at achieving the indicator of food independence, which will allow obtaining the desired result in problem areas.

It should be noted that food security, in addition to the criterion of self-sufficiency, includes a wider range of socio-economic and medico-biological aspects of the life. The Economist Intelligence Unit examines food security in the context of income and economic inequality, gender inequality, as well as environmental and natural resource differentials across countries [5]. In 2021, this company published another report on the Global Food Security Index [6]. The study assessed food security trends in 113 countries. The final index value was based on factors of food availability and accessibility, food quality and safety, as well as natural resources and sustainability in the region. Russia ranked 24th in terms of food security and made a significant step forward compared to 2014, when it was in 43rd place. In terms of the food availability to the population, Russia is ranked 20th in the index, and 34th in terms of food availability. Russia received high marks for food security programs, level of access to markets and agricultural financial services. Finland is the leader of the Global Food Security Index, and the rest of the countries of the Arctic Council are also ahead of Russia in this indicator. Researchers from The Economist Intelligence Unit highly assess the sufficiency of food supply in Russia (86 out of 100 points) and note that the diet meets nutritional standards (84.1 points out of 100 possible).

An important indicator of the country's food security is dietary intake. Recommendations for rational norms of food consumption that meet modern requirements for a healthy diet were approved by Order of the Ministry of Health of the Russian Federation of August 19, 2016 No. 614 [7]. These recommendations can be used to assess the achieved level of food security. Table 2 presents comparative data on food consumption in the Russian Federation, the Arkhangelsk Oblast, including the Nenets Autonomous Okrug, and the Murmansk Oblast for 2019. Statistical data on the food balances of Russia were used in the comparative analysis.

[5] Rossiya zanyala 24-e mesto v Global'nom indekse prodovol'stvennoy bezopasnosti 2020 [Russia ranked 24th in the Global Food Security Index 2020]. URL: https://agbz.ru/news/rossiya-zanyala-24-e-mesto-v-globalnom-indekse-prodovolstvennoy-bezopasnosti-2020/ (accessed 04 July 2021).

[6] Global Food Security Index. URL: https://foodsecurityindex.eiu.com/Index (accessed 04 July 2021).

[7] Prikaz Ministerstva zdravookhraneniya RF ot 19 avgusta 2016 g. № 614 "Ob utverzhdenii Rekomendatsiy po ratsional'nym normam potrebleniya pishchevykh produktov, otvechayushchikh sovremennym trebovaniyam zdorovogo pitaniya" [Order of the Ministry of Health of the Russian Federation of August 19, 2016 No. 614 "On approval of the Recommendations for rational norms of food consumption that meet modern requirements for a healthy diet"]. URL https://www.garant.ru/products/ipo/prime/doc/71385784/ (accessed 04 July 2021).

Table 2

Recommended rational norms and actual food consumption for 2019

No.	Products	Recommended rational norms kg / year / person	Household food consumption in 2019, kg / year / person [8]		
			Russian Federation	Arkhangelsk Oblast, incl. NAO	Murmansk Oblast
1.	Bread products	96	95.7	94.0	66.2
2.	Potato	90	58.4	47.8	49.2
3.	Vegetables, including:	140	104.1	94.9	90.7
4.	Fresh fruits, including:	100	75.4	80.6	87.0
5.	Sugar	24	31.2	40.5	30.0
6.	Meat products, including:	73	90.5	86.4	84.9
7.	Fish products	22	21.9	24.9	20.1
8.	Milk and dairy products, total in terms of milk	325	264.9	226	245
9.	Eggs	260	235	234	240
10.	Vegetable oil	12	10.6	11.4	8.5

Table 3

Composition of nutrients in consumed food products, on average per consumer per day [9]

	Norm	Russian Federation		2019		
		2014	2019	Arkhangelsk Oblast	Nenets Autonomous Okrug	Murmansk Oblast
proteins, g	82	78	80.5	78.4	77.7	71.3
fat, g	95	105	108.8	113.4	105.8	103.9
carbohydrates, g	417	333	332.7	351.5	339.0	278.1
kilocalories	2850	2603	2644.3	2 752.6	2 630.1	2 344.5

Analysis of the data presented shows that the diet of residents of the Arkhangelsk Oblast, the Nenets Autonomous Okrug and the Murmansk Oblast does not comply with the recommendations of the Ministry of Health of the Russian Federation. The northerners consume more meat, sugar and fish. The indicators for the consumption of eggs, bread and vegetable oil are close to the norm, while for the rest of the items there is a significant lag. The qualitative characteristics of the diet (Table 3) confirm this. In terms of the consumption of proteins, carbohydrates and caloric intake, the diet of the inhabitants of the Russian Federation and the Arctic regions of the Russian North corresponds to the standard characteristics of a healthy diet. A similar situation was noted by Karanina E. et al. [4].

Possible reasons for this situation may be food traditions, as well as a decrease in the purchasing power of the population due to high inflation rates in the country. Khairullina O.I. [5] notes that “there was a decrease in purchasing power of the most consumed by the Russians categories of products, in particular butter, bread, wheat flour, noodles, rice, cereals. There was also a significant increase in the consumer price index. The biggest increase affected sugar — 164.54%, potatoes — 134.06%, sunflower oil — 125.91%, pasta and cereals — 117.41%”.

[8] Household food consumption in 2019. URL: https://gks.ru/bgd/regl/b20_101/Main.htm (accessed 04 July 2021).
[9] Rosstat. URL: https://www.gks.ru (accessed 04 July 2021).

The decline in real incomes has a direct impact on the affordability of food and the quality of human life. The Doctrine defines economic affordability of food as "the ability to purchase food of proper quality at prevailing prices, in volumes and assortments that meet the recommended rational consumption standards" [10]. One of the indicators characterizing the economic affordability of food can be the share of spending on food in the household budget. At the end of 2019 [11], they averaged 29.7% in the Russian Federation, 28.1% in the Arkhangelsk Oblast, 27.5% in the Nenets Autonomous Okrug, and 25.3% in the Murmansk Oblast. It should be noted that in the northern regions the share of expenses for the purchase of food is slightly lower than the average for the Russian Federation. Average indicators do not always reflect the availability of food for all categories of the population. Khairullina O.I. [5] notes that "there is a significant differentiation in the level of expenditure on food among the population by income level, which is reflected in the affordability of food and, consequently, its quality". She also cites data that in the group with minimum incomes, the share of spending on food purchases in consumer spending of households by 31.1 percentage points higher than in the group with the maximum income. In the Russian Federation, according to Rosstat [12], in 2019 the share of households spending more than half of their income on food is 21.3%. In the Arkhangelsk Oblast, this figure was fixed at 17.1%, in the Nenets Autonomous Okrug — 13.2%, and in the Murmansk Oblast — 8.1%. The given data show that the successful implementation of the Food Security Doctrine requires the development of special measures to support households with low average per capita income, such as large families, pensioners and persons with disabilities.

One of the main directions of state policy in the field of ensuring food security in the Doctrine is fundamental and applied scientific research into the medical and biological evaluation of the safety of food products. An assessment of socio-biological risk factors for food security is part of such studies.

Socio-biological risk factors for food security in the Arctic region of Russia (on the example of the Arkhangelsk Oblast)

Living in the extreme climatic and geographic conditions of the Arctic leads to an increase in the degree of stress of adaptation processes in the human body, which causes functional shifts in various physiological systems. Attempts to understand the essence and significance of the influence of environmental factors of high latitudes on human health have been made before, but the interpretation of data in this area is rather complicated [6–11]. Today, reliable information of a comprehensive nature is extremely scarce due to objective and subjective reasons.

[10] Ukaz Prezidenta Rossiyskoy Federatsii ot 21.01.2020 № 20 "Ob utverzhdenii Doktriny prodovol'stvennoy bezopasnosti Rossiyskoy Federatsii" [Decree of the President of the Russian Federation dated January 21, 2020 No. 20 "On approval of the Food Security Doctrine of the Russian Federation"]. URL: http://publication.pravo.gov.ru/Document/View/0001202001210021 (accessed 20 June 2021).
[11] Rosstat. URL: https://www.gks.ru (accessed 04 July 2021).
[12] Rosstat. URL: https://www.gks.ru (accessed 04 July 2021).

Panin L.E. and Kaznacheev V.P. [6, 7] and a number of other polar medicine specialists [14, 15] characterize the unfavorable factors of human living in the North and identify the reasons for the formation of the so-called phenomenon of “polar stress syndrome” or “northern stress”. The “polar stress syndrome” determines the restructuring and mobilization of psychophysiological parameters with the activation of hypothalamic-pituitary-adrenal system and metabolic processes [6, 15]. Currently, there is evidence of genetically determined response programs of the neuroendocrine system to the effects of environmental factors of the North [15]. Khasnullina A.V. emphasizes that “the action of unfavorable social factors aggravates the negative effects of natural influences, which requires additional energy expenditure by the body and, accordingly, increases the severity of the state of chronic stress” [14] and notes that metabolic adaptation prevails at the basis of the biological adaptation system to extreme environmental conditions. The “standard” of adaptation to local geoclimatic conditions is a group of the aboriginal population of the North. The centuries-old contact of the aborigines with the harsh geographical factors of the North, the peculiarities of the way of life and nutrition affected the state of metabolism, which made it possible to distinguish a special “polar” (northern) metabolic type. Panin L.E. [6] formulated the “Concept of formation of the “polar metabolic type””. The main provisions of this concept have been confirmed by other researchers.

Sukhanov S.G., Alikberova M.N. [19] concluded that the rejection of the traditional diet — a decrease in the amount of proteins and fats in the diet of the indigenous population with a simultaneous increase in the consumption of carbohydrates (bread, sugar) and alcohol — “influenced metabolism and caused the development of maladaptive and pathological disorders digestive organs, respiration, urinary system, ENT organs, immune and endocrine systems” [19].

According to Nikiforova N.A. [20], nutrition should be considered as a preventive factor of long-term impact on the health preservation of the inhabitants of the North. Kozlov A.I. and a number of other researchers note that a high level of energy metabolism is accompanied by a significant consumption of proteins and lipids [21].

Summing up the assessment of the socio-biological risks of the implementation of the Food Security Doctrine in the Arctic, it can be concluded that it is necessary to conduct comprehensive studies of the problem of developing rational nutritional standards for various groups of the population of the Far North, paying special attention to indigenous and small peoples.

Conclusion

1. Food security is one of the most important indicators of a country's sustainable development. Russian researchers confirm the achievement of the required level of food security for half of the Doctrine's indicators. In order to solve the problems of agriculture in the Far North, joint efforts of the state and private investors are required to build the infrastructure of the agro-industrial complex, to attract investments in the organization of production in the promising areas of agricultural development in the Arctic region.

2. The diet of the population of the Arctic zone of Russia does not meet the recommendations of the Ministry of Health. In developing the food safety doctrine for the population of the Arctic regions, it is necessary to take into account the duration of the historical residence of various groups of the population (newcomers, indigenous Russians, small peoples of the Far North) in these territories. The structure of basic food products for the population of high latitudes should take into account the peculiarities of their metabolism, age, occupation, and other socio-biological factors.
3. At present, many aspects of metabolic regulation from the standpoint of assessing the functional reserves of hormonal and metabolic supply depending on the period of the year, the degree of risk of developing borderline prenosological states and the degree of adaptation to unfavorable environmental factors (environmental, climatogeographic and professionally determined extreme factors) are not completely disclosed and require further study and understanding.

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Small and Medium-Sized Towns in the Settlement System of the Russian North: 1939–2020 *

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Abstract. The article examines the settlement system of the Russian North, which was previously determined by decisions of ministries and departments, and now it is changing under the influence of resource corporations' activities. The focus is on small and medium-sized towns that are part of the supporting framework of settlement, ensuring connectivity of the northern territories. The authors analyze the dynamics of population, including urban one, and the population of small and medium-sized cities. The study identifies periods of upward and downward dynamics for each population group and settlements. If the country is drawing the population to the west, then in the North it is concentrated in the Asian part. The article shows that urban settlements were created multifunctional, with the monopoly of a city-forming enterprise, which, on the one hand, made them economically vulnerable, and on the other hand — more adaptable to external conditions. According to the author's methodology, small and medium towns are ranked according to the share of the population of these cities in the total population of the region. The authors have identified four groups of regions that have an insufficient, medium, high and excessive share of the population of small and medium towns; the optimal boundaries of this share are proposed. The authors have identified four groups of regions that have an insufficient, medium, high and excess share of the population of small and medium towns; the optimal boundaries of this share are proposed. The study revealed the similarity (concentration of the population in large cities) and the difference in the structure of settlements in the North (the share of the population living in small and medium urban settlements, is lower in the countryside). The research results will be applied in the development of strategic documents for the development of northern towns.
Keywords: *Russian North, population, settlement system, small and medium towns, ranking of cities.*

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Introduction

The majority of the world's population now lives in cities. In 2020, the global population was 7.8 billion people, of which 56% live in cities [1]. According to forecasts, in 2050 it is projected that approximately 68% of total population will be urban [2]. However, despite the fact that the rapid growth of cities is observed in almost all countries of the world, the levels of urbanization varies greatly by geography. While most of the countries of Latin America are urbanized to the same extent as the countries of Europe, the countries of South and East Asia, Central Africa remain predominantly agricultural. The Nordic countries have a very high level of urbanization: Denmark — 88%, Sweden — 88%, Norway — 82%, Canada — 81% and Russia — 74% [3].

The Russian North is just as urbanised as the Nordic countries — 81.3%. The number of urban settlements is 290, of which 6 are large cities, 9 are big cities, 10 are medium-sized cities, 92 are small towns and 173 are small villages. The share of the urban population in the Arctic is even higher — 88.0% (2020).

Large and big cities provide fertile ground for innovation and contribute to job creation and economic growth, they “have the resources of the agglomeration economy and the benefits of economies of scale” [1, Duranton G., Puga D., p. 2063–2117]. In small and medium-sized cities, on the contrary, “other things being equal, the probability of their socio-demographic depression is higher, the relative population losses in the course of outflow and depopulation are greater. And according to a number of features (unprofitability of city-forming enterprises, unemployment of able-bodied citizens, low wages or their absence, etc.) in the early 2010s, 2/3 of small towns and 1/5 of medium towns could be referred to depressed ones” [2, Nefedova T.G., Treyvish A.I., p. 17].

Small and medium-sized towns of the Russian North are mainly new resource towns created in the 20th century. Quite often, their life cycle depends on explored reserves of raw materials and consumer demand. The example of problematic towns in the Komi Republic is a vivid confirmation of this: Vuktyl (1984) is on the verge of closure due to the depletion of gas reserves, Inta (1954) is no longer a coal mining town after the liquidation of the last Intinskaya Mine in 2018. The future of many single-industry settlements is unpromising [3, Fauzer V.V., Klimashevskaya E.V.].

The increased interest in small and medium-sized towns is also due to the fact that if large and big cities, megalopolises received significant bonuses during the transition to new socio-economic conditions, “then small towns located far from the regional or federal capital turned out to be abandoned periphery with lots of economic and social problems among residents” [4, Korchagina I.I., Migranova L.A., p. 66]. The market economy gave an impetus to the development of large cities, but at the same time caused the stagnation of small and single-industry towns [5,

[1] Demoscope Weekly. № 879-880. URL: http://www.demoscope.ru/weekly/app/world2020_0.php (accessed 10 December 2020).
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Rastvortseva S.N., Manaeva I.V., p. 24–25]. A significant part of the enterprises put into operation during the Soviet era became economically unstable [6, Gavrilyeva T.N., Arkhangelskaya E.A., p. 76]. While the cities, economies of which were built on such enterprises, turned out to be uncompetitive. However, "unlike a non-competitive company, a non-competitive town cannot leave the market and cease to exist" [7, Korotich M.V., p. 130].

Small and medium-sized towns are also important for the North because in 2020 they contained 37.5% of urban residents (in Russia — 23.9%). They, along with the urban settlements, form the main settlement framework, contribute to the settlement of the territory. In general, it can be noted that the proportions of urban systems were determined by the history of development of territories, their sectoral specialization and the network of transport infrastructure [8, Kolomak E.A., p. 61].

The goal is to assess the extent to which the North of Russia is "saturated and provided" with small and medium-sized cities that constitute the supporting framework of settlement, providing connectivity and population density of the northern territories.

The focus is on 13 regions of Russia, the territory of which fully belongs to the Far North and equated areas.

Settlement system of the Russian North

The development of the settlement system in the Russian North was determined by the peculiarities of industrial development and was characterized by bringing production closer to the sources of raw materials, giving a special role to small towns and stimulating their development outside the influence of large cities, creation of urban-type settlements [9, Kuznetsova T.E., p. 106].

Historically, two forms of settlement have been developed: belt and focal. In the belt type, settlements are located along rivers or transport arteries. During the period of industrial development, the settlement system is predominantly of a local nature, settlements arise in the area of mineral deposits. In the case of focal settlement, cities and rural communities are separated by hundreds and thousands of kilometers of uninhabited space, and objects of the economy and social sphere are concentrated in very limited areas of an exclusively local level [10, Glezer O.B., Vainberg E.I., p. 23, 25].

The formation of the settlement system in the North of Russia proceeded in two ways. *Natural way*: when the functioning of existing settlements and the creation of new ones, as well as the establishment of inter-settlement ties became the result of the action of more or less "objective economic laws". *Regulatory way*: it was determined by administrative decisions on the implementation of large state-organized and supported projects for the economic development of new territories [11, Leksin V.N., p. 62].

The specificity of the settlement network being formed, mainly by cities in the North and Siberia, is due to the fact that the formed urban settlements performed many functions, but the

main idea was that the creation of a network of supporting cities secured Russia's right to these lands [12, Okladnikov A.P., p. 6–23; 13, Fauzer V.V., Smirnov A.V.]. In addition, the North was of interest as a source of various minerals, agriculture and reindeer husbandries were not priorities. Therefore, the main direction of settlement policy was the creation of multifunctional cities [14, Smidovich S.G., p. 35].

Still, the Northern cities, all other things being equal, have a wider specialization: being remote from the main economic centres, they have to develop the whole range of basic services they need. This circumstance can be considered as a factor that increases the cost of living in the northern regions [15, Huskey L.; 16, Berman M., Howe L.], but it can also be considered as the basis of vitality, resistance to economic cataclysms [17, Zamyatina N.Yu., Goncharov R.V., p. 169].

In Soviet times, the centers of urban development were enterprises that provide a variety of life benefits: apartments, furniture, scarce food, children's institutions, vacation packages and much more. Enterprises became centers of social development of cities: they planned, created and operated social infrastructure. Settlements were created — conglomerates “factory - person - city”, in which the factory played a major role in people's lives. Big cities differed from small ones only in the fact that they were divided into factory microdistricts [18, Matovykh Ye.A., p. 188]. In 1930–1950, in the country and especially in the North, with the involvement of significant financial, material and human resources, large enterprises were built, and urban settlements, a kind of city-factories, arose around them. Some of the previously created cities also changed their profile and became industrial [11, Leksin V.N., p. 63].

Until the 1990s, the main economic effects in new development areas were ensured by economies of scale in the activities of giant plants. Today, an increasing return is provided by the ultimate compactness, island isolation of new development objects, which mitigate the effect of northern increases in prices, transport and energy costs [19, Pilyasov A.N., Zamyatina N.Yu., p. 62].

The new thing in the settlement system is that if earlier the specific territorial configuration of the new development process was determined by the decisions of metropolitan departments, regional super-organizations, now it is formed as a part of the spatial structure of resource corporations. Its style is created under the influence of the internal institutional and organizational structure of the company [20, Dunning J.H.].

In the early 1990s, foreign studies predicted significant changes in the spatial model of Russia's development as a result of the abandonment of state regulation of the institution of “residence permit” and northern subsidies, the absence of a migration policy in the regulation of migration flows [21, Clayton E., Richardson T.; 22, Hill F., Gaddy C.]. Based on the idea of a plurality of spatial equilibrium, an increase in long-term socio-economic and demographic problems in the industrial regions of the peripheral parts of the country was predicted [23, Combes P.-P., Mayer T., Thisse J.-F.].

For the Russian North, the vector of population settlement in the long-term perspective is determined by the “General Scheme of Settlement”. It proposes “not to form permanent settle-

ments in places with unfavorable medico-geographic conditions, in this connection *it is offered to pass from a policy of residence to a policy of stay of non-indigenous people*, to develop large urban settlements — basic centers of population residence, to concentrate the population in promising settlements with a stable socio-economic base, not to create new small settlements, to introduce more broadly the rotational method of organizing labor; it is recommended to limit the growth of cities as much as possible; the growing stagnation of small and medium-sized urban settlements, which determine the economic and social life of the surrounding rural areas, has to be overcome" [4].

Today there is no "uniform view of the settlement model. However, the majority of experts agree that Russia should develop and colonize the northern territories. Otherwise, it is possible to lose access to resources and political advantage, that huge scientific, military-technical, human and infrastructural potential, which was accumulated throughout the last century" [24, Blagodeteleva O.M., p. 6]. It is also necessary to take into account that Russia is a huge space, in the organization of which an acute shortage of human and financial resources is experienced, and the compression of the inhabited and economic space that is taking place against the background of depopulation is typical for the country. Consequently, the models of economic compression are urgently needed today [25, Vainberg E.I., p. 38].

The preservation of the network of small and medium-sized towns is possible with the transition to the principles of sustainable development, this should become a universal task and be implemented at an accelerated pace [26, Lokken G., Haggarde M.; 27, Pressman N.; 28, Puga D.]. Sustainable development predetermines the formation of settlement according to the principle of "base city — intraregional shift", when there is an interaction of stationary base cities with a full-value infrastructure and multifunctional purpose, where the working contingent with families permanently resides, and small mobile settlements at the fields [29, Storey K., Shrimpton M.]. In order to preserve small and medium-sized cities, an alternative version of their development is proposed, based on the implementation of the concept of "slow cities" ("Cittaslow"), which is actively being introduced in many countries of the world [30, Wirth P., Elis V., Mueller B. et al , p. 62–75].

The resettlement of the population as a process can be quantitatively measured by a number of indicators: the dynamics of the population, the proportion of the urban population, the number of urban settlements, the population density of urban settlements, the population density [31, Fauzer V.V., Lytkina T.S., Fauzer G.N., p. 43]. Let us consider the settlement system of the Russian North for 1939–2020.

In 1939, there were 71 urban settlements in the North, of which large and big cities accounted for 2.8%, medium — 2.8%, small — 39.4%, urban settlement — 55.0%. The number of settlements reached its peak in 1989 — 460, mainly due to urban settlements, their share was

[4] General scheme of settlement on the territory of the Russian Federation (approved by the Government of the Russian Federation, minutes of December 15, 1994 No. 31).

77.2%, the share of small towns decreased to 16.7%, large and big cities — remained at the level of 1939, and medium — increased to 3.3%. Small towns showed growth until 2002 — 96, by 2020 their number decreased to 92. As one can see, the backbone of the settlement system was formed by urban settlements and small towns, which "remain among the entire mass of urban settlements precisely because production conditions often do not require a higher concentration of population" [32, Pokshishevskiy V.V., p. 103].

In 1939, the North was relatively agrarian, the share of rural residents was 64.5%; by 2020 it dropped to 18.7%. Most of the population in 2020 was living in towns: in large — 24.3, big — 17.6, medium — 8.2, and small — 22.0%. The residents of the urban-type settlement accounted for 9.2%. (Table 1).

Table 1

Main indicators of the settlement system of the Russian North, 1939-2020[5]

Indicators	1939 [6]	1959	1970	1979	1989	2002	2010	2020
The number of urban settlements, units								
large cities	1	1	2	2	6	4	6	6
big cities	1	2	6	10	7	9	8	9
middle cities	2	8	6	9	15	12	10	10
small towns	28	61	70	69	77	96	94	92
urban-type settlement	39	245	295	336	355	261	185	173
Population, people								
whole population	3 121 519	5 253 270	6 380 935	7 618 100	9 692 919	8 300 687	7 916 951	7 822 685
urban population	1 107 301	3 290 617	4 349 189	5 657 325	7 654 695	6 588 364	6 314 228	6 360 921
large cities	284 570	391 565	835 713	999 948	1 936 097	1 243 375	1 745 997	1 897 136
big cities	117 069	221 874	637 102	1 312 961	1 200 158	1 569 636	1 236 367	1 379 718
middle cities	122 605	559 041	402 292	538 065	1 067 266	835 807	691 384	643 928
small towns	394 340	940 722	1 193 495	1 245 849	1 641 009	1 911 214	1 853 625	1 722 916
urban-type settlement	188 717	1 177 415	1 280 587	1 560 502	1 810 165	1 028 332	786 855	717 223
rural population	2 014 218	1 962 653	2 031 746	1 960 775	2 038 224	1 712 323	1 602 723	1 461 764
Average population of settlements, people								
large cities	284 570	391 565	417 857	499 974	322 683	310 844	291 000	316 189
big cities	117 069	110 937	106 184	131 296	171 451	174 404	154 546	153 302
middle cities	61 303	69 880	67 049	59 785	71 151	69 651	69 138	64 393
small towns	14 084	15 422	17 050	18 056	21 312	19 908	19 719	18 727
urban-type settlement	4 839	4 806	4 341	4 644	5 099	3 940	4 253	4 146
Population density, people per 1 sq. km	0.41	0.69	0.84	1.00	1.27	1.09	1.04	1.03
The measure of territorial concentration of the population	-	1.186	1.099	0.994	0.939	0.985	0.971	0.962

The density of the population can be used to determine whether an area is populated or developed. Population growth until 1989 increased the density from 0.41 to 1.27 people per sq. km, the population decline reduced it to 1.03. It can also be noted that the density of urban set-

[5] According to the censuses: 1939–1979 — the actual population, 1989–2010 — the permanent population; 2020 — at the beginning of the year.

[6] The data for 1939 does not include territories that were not part of the USSR.

tlements per 1 million sq. km in the North is 3.5 times lower than the national average: 38.0 and 133.9, respectively. For comparison: in the Moscow Oblast, it is 3182.8; in the Northwestern Federal Okrug — 168.9 and in the Far Eastern Federal Okrug — 39.8. Another informative indicator, used to assess the degree of uniformity of the population distribution, is the measure of territorial concentration of population [33, Venetskiy I.G., p. 141]. It shows that from 1959 to 1989, it was decreasing in the process of population dispersal as a result of the development of the Far North. The value of the indicator varied from a decrease in the specific weight of the Arkhangelsk Oblast, and then the growth of the Khanty-Mansi Autonomous Okrug and a high migration loss in the Magadan Oblast. According to the scale, proposed by Yu.V. Porosenkov [34, p. 27–28], the distribution of the urban population in the North of Russia is sharply uneven (1.003). However, for small and medium-sized towns, the value of the indicator is lower, which makes it possible to classify their location as significantly uneven (0.98). The distribution of the rural population of the North (0.78) also belongs to this category (Fig. 1).

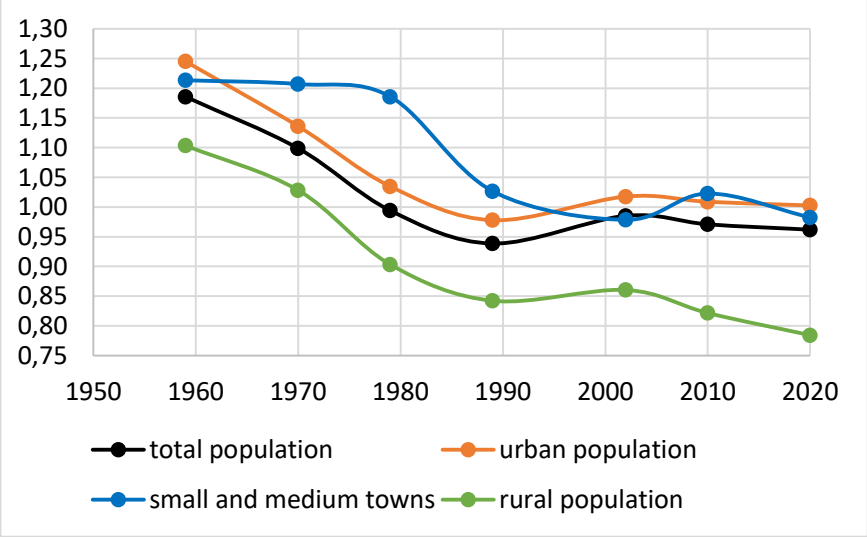

Fig. 1. Measure of spatial concentration of the population in the Russian North, 1959–2020.

Concluding the section on the resettlement of the population of the Russian North and determining its future, it is necessary to give some explanations. In the practice of Russian zoning, for the first time in 1886, the “List of remote areas” was defined [7]. In 1932, the Far North was separated from remote areas. In 1945, two concepts appeared: “Far North” and “areas equated to the Far North”. The northern borders have changed several times, significantly — between 1983 and 2012. The beginning of a new stage in the zoning of the Russian North can be considered on May 2, 2014, when the Decree of the President of the Russian Federation “On the land territories of the Arctic zone of the Russian Federation” No. 296 was issued, which determined the List of land territories of the Russian Arctic. The composition of the Arctic territories has also changed several

[7] Polozhenie ob osobykh preimushchestvakh grazhdanskoy sluzhby v otdalennykh mestnostyakh, a takzhe v guberniyakh Zapadnykh i Tsarstva Pol'skogo (1886 god) [Regulations on the special advantages of civil service in remote areas, as well as in the Western provinces and the Kingdom of Poland (1886)]. Svod zakonov Rossiyskoy imperii v 16-ti tomakh [Code of laws of the Russian Empire in 16 volumes]. SPb., Russian Book Association "Deyatel", 1912, vol. 3, p. 330–343.

times [8]. If one looks at the map of the North, one can see that the Arctic covers the North with its "blanket" and divides it into two parts (Fig. 2). This trend can be expected to continue in the future. Regional leaders are tempted to include most of their territories in the Arctic. This is also facilitated by the course of state policy towards the development of the Arctic. In the Strategy for the Spatial Development of Russia up to 2025, the Arctic zone of the Russian Federation is assigned to the priority geostrategic territories [9], while the other parts of the Russian North are given little attention in the document.

[8] Ukaz Prezidenta RF «O sukhoputnykh territoriyakh Arkticheskoy zony Rossiyskoy Federatsii» ot 2 maya 2014 g. № 296 (red. ot 5 marta 2020 g.) [Decree of the President of the Russian Federation "On the land territories of the Arctic zone of the Russian Federation" dated May 2, 2014 No. 296 (as amended on March 5, 2020)].

[9] Rasporyazhenie Pravitel'stva Rossiyskoy Federatsii ot 13 fevralya 2019 g. № 207-r «Ob utverzhdenii Strategii prostranstvennogo razvitiya Rossiyskoy Federatsii na period do 2025 goda» [Order of the Government of the Russian Federation of February 13, 2019 No. 207-r "On approval of the Strategy for the spatial development of the Russian Federation for the period up to 2025"].

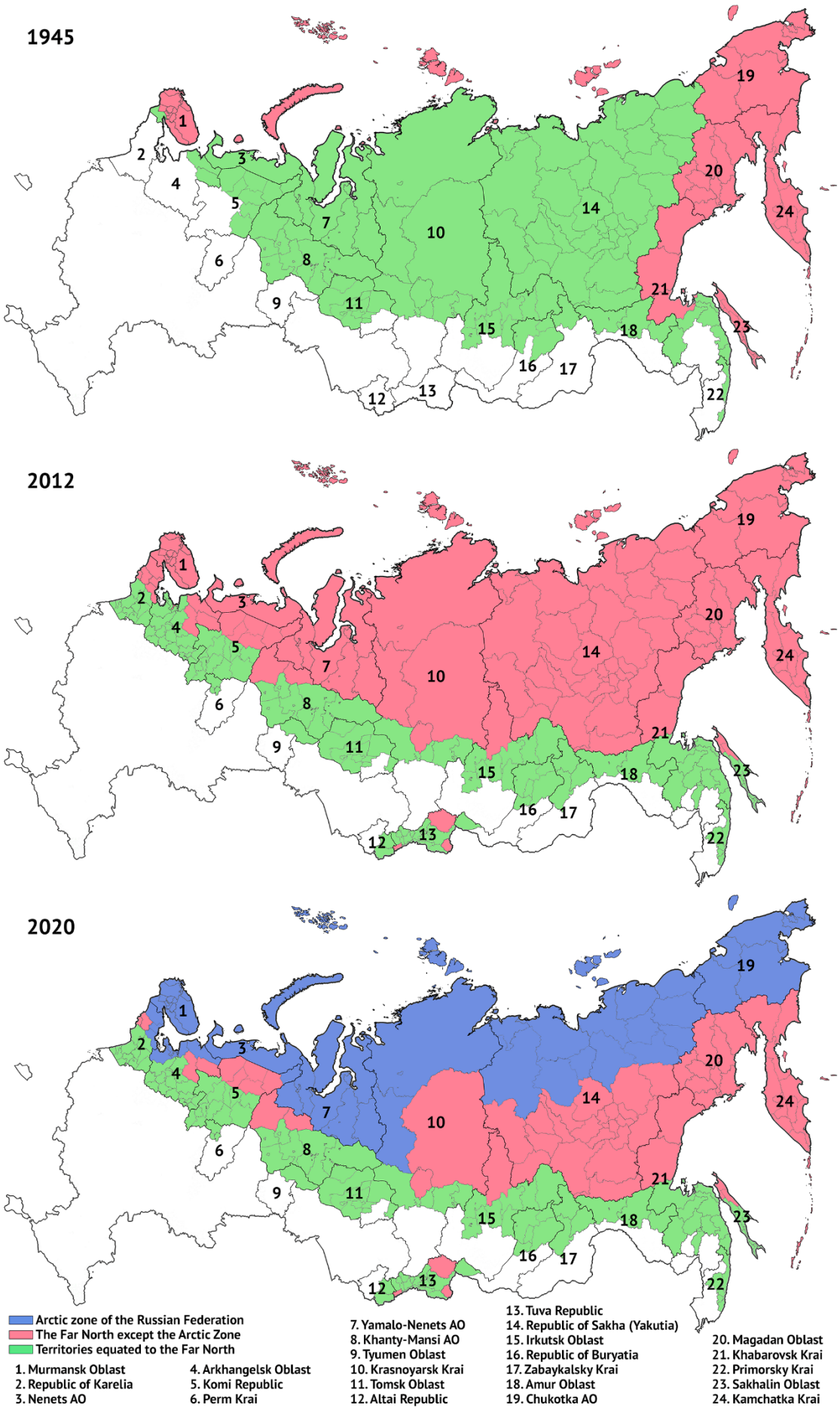

Fig. 2. Zoning of the Russian North and the Arctic, 1945, 2012, 2020.

Population of the Russian North

From 1939 to 1989, the population of the Russian North increased 3.1 times, including the European — 2.2 times and the Asian North — 5.3 times. Significant growth was recorded in the Khanty-Mansiysk (13.7), Yamalo-Nenets (10.8) and Chukotka (7.6) Autonomous Okrugs, Sakhalin Oblast (7.1 times) [35, Fauzer V.V., p. 7–28]. In the following years, up to 2020, the population was constantly decreasing. The exceptions are the Khanty-Mansi and Yamalo-Nenets Autonomous Okrugs, which have been demonstrating positive dynamics throughout the years, as well as the Nenets Autonomous Okrug and the Sakha (Yakutia) and Tyva republics since 2002. Until the end of 1970, the European North dominated in terms of population, in 1979 this advantage was 955.8 thousand people. Starting in 1989, the population of the Asian North began to exceed the European part, at first by 142.4 thousand people, and in 2020 by 1 million 197.7 thousand people. It can be noted that, while at the national level, the population was pulled westwards and concentrated in half a dozen regions [25, Vainberg E.I., p. 32], in the North the population was concentrated in the Asian part.

In 1939, the only northern region with the population of over 1 million people was the Arkhangelsk Oblast, in 1979 the Republic of Komi became the "millionaire", in 1989 — the Murmansk Region, the Republic of Sakha (Yakutia), and the Khanty-Mansi Autonomous Okrug. Then the reverse process began. By 2002, Murmansk Oblast and the Republic of Sakha (Yakutia) lost this status, by 2010 — the Republic of Komi. Today, five regions have a population of 500 thousand to one million people: the republics of Karelia, Komi and Sakha (Yakutia), Murmansk Oblast and Yamalo-Nenets Autonomous Okrug (Table 2).

Table 2

Population of northern regions, 1939–2020, people [10]

Region	1939	1959	1970	1979	1989	2002	2010	2020
Russian Federation (thousand people)	**108 378.8**	**117 534.3**	**130 079.2**	**137 551.0**	**147 021.9**	**145 166.7**	**142 856.5**	**146 748.6**
Russian North	**3 121 519**	**5 253 270**	**6 380 935**	**7 618 100**	**9 692 919**	**8 300 687**	**7 916 951**	**7 822 685**
European part	**2 186 771**	**3 302 003**	**3 879 069**	**4 286 974**	**4 775 262**	**3 964 028**	**3 567 772**	**3 312 476**
Republic of Karelia	468 898	651 346	713 451	736 022	790 150	716 281	643 548	614 064
Komi Republic	318 996	815 799	964 802	1 118 421	1 250 847	1 018 674	901 189	820 473
Arkhangelsk Oblast	1 107 699	1 267 186	1 401 289	1 467 069	1 569 679	1 336 539	1 227 626	1 136 535
Nenets AO	47 617	36 881	39 119	47 001	53 912	41 546	42 090	44 111
Murmansk Oblast	291 178	567 672	799 527	965 462	1 164 586	892 534	795 409	741 404
Asian part	**934 748**	**1 951 267**	**2 501 866**	**3 331 126**	**4 917 657**	**4 336 659**	**4 349 179**	**4 510 209**
Republic of Sakha (Yakutia)	413 198	487 343	664 123	838 808	1 094 065	949 280	958 528	971 996
Tuva Republic	0	171 928	230 864	266 453	308 557	305 510	307 930	327 383
Kamchatka Krai	111 275	220 753	287 612	378 491	471 932	358 801	322 079	313 016
Magadan Oblast	149 712	188 889	251 297	332 845	391 687	182 726	156 996	140 149
Sakhalin Oblast	99 925	649 405	615 652	654 915	710 242	546 695	497 973	488 257
Khanty-Mansi AO –	93 274	123 926	271 157	569 139	1 282 396	1 432 817	1 532 243	1 674 676

[10] Census data: 1939–1979 — current population, 1989–2010 — permanent population; 2020 — at the beginning of the year.

Yugra								
Yamalo-Nenets AO	45 840	62 334	79 977	157 616	494 844	507 006	522 904	544 444
Chukotka AO	21 524	46 689	101 184	132 859	163 934	53 824	50 526	50 288

Urban population of the Russian North

Industrialization gave a strong impetus to the urbanisation of the northern territories. The agrarian economy was actively replaced by the industrial one. The construction of factories, mines and the harvesting and processing of timber in the periphery territories required a large workforce. The local population, being too small, could not satisfy the growing needs of the nascent industry. In order to solve the personnel problem, the country's leaders put forward the idea of colonization and development of natural resources of the North, Siberia and the Far East by creating a system of correctional labor camps and special settlements, for the management of which the Main Administration of Camps (GULAG) was created in 1930 [36, Zherebtsov I.L.; 37, Lytkina T.S., Fauzer V.V., p. 92–93; 38, Fauzer V.V., Lytkina T.S., Fauzer G.N., p. 154].

The development of natural resources was accompanied by the construction of workers' settlements near the places of employment, which quickly turned into small cities. From the second half of the 1930s, the construction of full-fledged cities in the North began. Along with the objective processes of the urban settlements formation, there was a political motive: to turn the country from an agrarian into an industrial one [9, Kuznetsova T.E., p. 107] by relocating industrial enterprises to the North and Siberia during the Great Patriotic War. In subsequent years, the model of urbanization of the North was maintained, based on the predominance of stationary cities with a permanent population, which were provided with various kinds of preferences [24, Blagodeteleva O.M., p. 17; 39, Fauzer V.V., Lytkina T.S., Fauzer G.N.]. The formation of permanent settlements solved a number of problems: the formation of permanent staff required for labor-intensive technologies; the arriving population considered themselves “conquerors of the North”, involved in grandiose construction projects; the North gave many people the opportunity to improve social conditions and make a career; due to the poor development of the transport system, the rotational method was extremely costly; many cities have become symbols of the country's development (Vorkuta, Norilsk, Magadan) [40, Trunova N., p. 34].

The extensive economic development of the Russian North has led to a rapid increase in the urban population. From 1939 to 1959, it increased from 1 million 107.3 thousand people to 3 million 290.6 thousand people. The urbanization of the North proceeded at a faster pace: while the number of urban residents in Russia increased 1.7 times, it increased 3.0 times in the North, including 2.5 times in the European North and 4.8 times in the Asian North. The leaders in urban population growth were: the Komi Republic — 16.6 times, the Sakhalin region — 9.8, Chukotka Autonomous Okrug — 8.7, Magadan Oblast — 6.0 and Khanty-Mansi Autonomous Okrug — 5.0 times.

In the intercensal periods from 1959 to 1989, the population increased steadily by 1.3 times in the first two decades and by 1.4 times in the next 10 years, the absolute increase over 30

years amounted to 4 million 364.1 thousand people. From 1989 to 2002, there was a noticeable decrease in the urban population by 1 million 66.3 thousand people. Along with migration, to a large extent, this is due to the administrative-territorial transformations of urban settlements into rural settlements. Out of 355 northern towns, 78 became rural (22.0%). Large-scale reductions affected the Republic of Karelia, where 33 out of 44 urban settlements were transferred to the category of rural ones (75.0%), which reduced the share of the urban population by 6.4 percentage points. From 2002 to 2010, the population continued to decline, but not so significantly — by 274.1 thousand people. The next 10 years gave an increase of 46.7 thousand people. In terms of constituent entities, it can be noted that the Republic of Tyva, Khanty-Mansi and Yamalo-Nenets Autonomous Okrug had a positive population growth all years, the Republic of Sakha (Yakutia) and Nenets Autonomous Okrug — since 2002, Chukotka Autonomous Okrug — since 2010.

Until the early 1980s, the old-inhabited European North exceeded the assimilated Asian North in terms of urban population; in 1979, the excess was 918.1 thousand people. The development of oil and gas fields in Western Siberia led to the Asian North having a population of 33.8 thousand people in 1989, and in 2020 the difference increased 27.5 times (the entire population — 8.4 times) and amounted to 929.4 thousand people. This trend is likely to continue in the coming years.

More than 1 million urban residents have been living in the Khanty-Mansi Autonomous Okrug since 1989. In four other regions the urban population exceeds 500 thousand people: Arkhangelsk and Murmansk oblasts, the republics of Komi and Sakha (Yakutia) (Table 3).

Table 3

Urban population of the northern regions, 1939–2020, people [11]

Region	1939	1959	1970	1979	1989	2002	2010	2020
Russian Federation (thousand people)	**36 295.6**	**61 611.1**	**80 981.1**	**95 373.9**	**107 959.0**	**106 429.0**	**105 313.8**	**109 562.5**
Russian North	**1 107 301**	**3 290 617**	**4 349 189**	**5 657 325**	**7 654 695**	**6 588 364**	**6 314 228**	**6 360 921**
European part	**859 296**	**2 112 197**	**2 717 240**	**3 287 708**	**3 810 448**	**3 126 788**	**2 863 008**	**2 715 771**
Republic of Karelia	150 335	415 918	490 516	573 172	643 496	537 395	502 217	497 337
Komi Republic	29 159	484 039	597 416	793 441	944 423	766 587	693 436	641 721
Arkhangelsk Oblast	434 438	680 654	920 743	1 057 818	1 151 559	999 591	928 973	893 306
Nenets AO	13 670	16 820	21 380	27 656	34 336	26 242	28 539	32 538
Murmansk Oblast	245 364	531 586	708 565	863 277	1 070 970	823 215	738 382	683 407
Asian part	**248 005**	**1 178 420**	**1 631 949**	**2 369 617**	**3 844 247**	**3 461 576**	**3 451 220**	**3 645 150**
Republic of Sakha (Yakutia)	111 548	239 411	374 533	514 212	731 963	609 999	614 545	642 708
Tuva Republic	0	56 759	86 991	113 265	144 310	157 299	163 402	177 765
Kamchatka Krai	35 373	140 515	218 986	312 671	384 469	290 811	249 150	245 607
Magadan Oblast	27 313	164 176	193 540	271 578	328 293	168 725	149 811	134 641
Sakhalin Oblast	50 175	489 429	483 059	539 707	584 273	474 123	397 106	402 063
Khanty-Mansi AO – Yugra	7 488	37 298	170 625	445 675	1 166 339	1 301 924	1 401 429	1 549 313
Yamalo-Nenets AO	12 764	21 787	34 247	79 708	385 614	422 826	443 043	457 079

[11] Census data: 1939–1979 — current population, 1989–2010 — permanent population; 2020 — at the beginning of the year.

Chukotka AO	3 344	29 045	69 968	92 801	118 986	35 869	32 734	35 974

In 1939, the share of the urban population of the North was 35.5%, slightly higher than the Russian figure of 33.5%. The Murmansk Oblast was characterized by a high share of urban residents — 84.3%, but this share was low in the Khanty-Mansi Autonomous Okrug — 8.0% and the Komi Republic — 9.1%. By 2020, the urban population increased to 81.3%, the growth amounted to 45.8 percentage points. The following regions were highly urbanized: Magadan Oblast — 96.1%, Khanty-Mansi Autonomous Okrug — 92.5%, Yamalo-Nenets Autonomous Okrug — 84.0% and Sakhalin Oblast — 82.3%; Murmansk Oblast maintained a high level of urbanization — 92.2%. The republics of Tuva and Sakha (Yakutia) remain low urbanised at 54.3% and 66.1%, where agriculture is successfully developing. Speaking about the maximum share of the urban population, it is limited by the size of the entire population [41, Khorev B.S., p. 5], and in the northern regions — by the number of indigenous peoples of the North.

Cities of the Russian North

Despite the constant growth in the number of cities (574 in 1939, 1116 in 2020), Russia is experiencing a shortage of them. Currently, there are not enough cities to serve even the inhabited territory of the country, in terms of neither quantity, nor population size, nor location. A particular problem is the inaccessibility of settlements in the North and in the eastern regions of the country [10, Glezer O.B., Vainberg E.I., p. 26–27]. At the same time, cities play the role of nodal elements of the supporting frame of the territory, centers of development and service of the surrounding territory [25, Vainberg E.I., p. 31].

Northern cities have peculiarities: remoteness from the main settlement zone and the largest cities of the country; strong seasonal fluctuations in weather conditions (snowy frosty winters) and a short growing season, which impedes the development of agriculture in the city vicinity; close relationship between the history of development and modern economic activity with the development of the surrounding area resources [42, Zamyatina N.Yu., p. 5–6].

According to the set of rules “Urban planning. Planning and development of urban and rural settlements” of the Ministry of Construction of the Russian Federation, cities are classified as follows: *small* — up to 50 thousand people; *medium* — from 50 to 100 thousand people; *big* — from 100 to 250 thousand people; *large* — from 250 thousand to 1 million people; *major* — with a population of over 1 million people [12].

The existing settlement network in the Russian North includes the first four groups of cities, there are no major ones. In 1939, there was one large city — Arkhangelsk, one big — Murmansk, two medium —Petrozavodsk and Yakutsk and 28 small cities. In the pre-Soviet period, 19 cities were created, in the Soviet period — 13. Of the cities’ structure of 1939, by 2020, there were

[12] Svod pravil «Gradostroitel'stvo. Planirovka i zastroyka gorodskikh i sel'skikh poseleniy». SP 42.13330.2016. Aktualizirovannaya redaktsiya SNiP 2.07.01-89 [The set of rules “Urban planning. Planning and development of urban and rural settlements”. SP 42.13330.2016. Updated edition of Building Codes and Regulations 2.07.01-89]. URL: http://docs.cntd.ru/document/456054209

4 large, 3 big, 3 medium and 22 small cities. It can also be noted that in different years 12 cities from the above list crossed the border of medium-sized ones (Table 4).

Table 4

Year of formation and population of towns and cities in the Russian North as of January 17, 1939 [13]

City / town	Year of formation	Population	City / town	Year of formation	Population
Arkhangelsk	1584	284 570	Aldan	1932	14 022
Murmansk	1916	117 069	Naryan-Mar	1929	13 670
Petrozavodsk	1777	69 723	Kondopoga	1938	13 374
Yakutsk	1643	52 882	Salekhard	1938	12 764
Petropavlovsk-Kamchatskiy	1812	35 373	Belomorsk	1938	12 238
Monchegorsk	1937	28 450	Medvezhyegorsk	1938	12 108
Magadan	1939	27 313	Velsk	1780	6 712
Syktyvkar	1780	25 281	Kargopol	1784	6 338
Alexandrovsk-Sakhalinskiy	1917	24 905	Olyokminsk	1783	5 182
Kirovsk	1931	22 542	Shenkursk	1780	4 878
Kandalaksha	1938	22 172	Mezen	1780	3 874
Severodvinsk	1938	21 304	Vilyuysk	1783	3 147
Okha	1938	19 601	Solvychegodsk	1796	3 018
Kotlas	1917	17 265	Tommot	1923	2 804
Kem	1785	16 624	Srednekolymsk	1775	2 029
Onega	1780	15 783	Verkhoyansk	1817	1 569

In Russian practice, a special place is occupied by 173 cities with a population of over 100 thousand people and regional “capitals”, in which the majority of the population lives. These cities concentrate the resource potential of the territories: financial, industrial, intellectual, demographic, infrastructural and administrative. Such cities perform a number of specific functions: most of them are transit transport hubs, trade and service centers, centers of medicine, education and culture [43, Belkina T.D., Minchenko M.M., Nozdrina N.N. et al, p. 85]. This fully applies to nine northern regional centers: Arkhangelsk, Yakutsk, Murmansk and Petrozavodsk have a population of over 250 thousand people; Syktyvkar, Yuzhno-Sakhalinsk, Petropavlovsk-Kamchatskiy, Kyzyl and Khanty-Mansiysk — from 100 to 250 thousand. Four centers have a smaller population: Magadan and Salekhard — from 50 to 100 thousand, Anadyr and Naryan-Mar — less than 50 thousand people.

In total, there are 15 cities in the North with a population over 100 thousand people. Only three regions have more than one of such cities: the Khanty-Mansi Autonomous Okrug — 4, the Yamalo-Nenets Autonomous Okrug — 2 and the Arkhangelsk Oblast — 2. Therefore, it is so important for the Russian North to preserve and develop a network of small and medium-sized cities (SMC). In 2020, there were 10 medium and 92 small towns in the North (Fig. 3).

[13] Ranked by population.

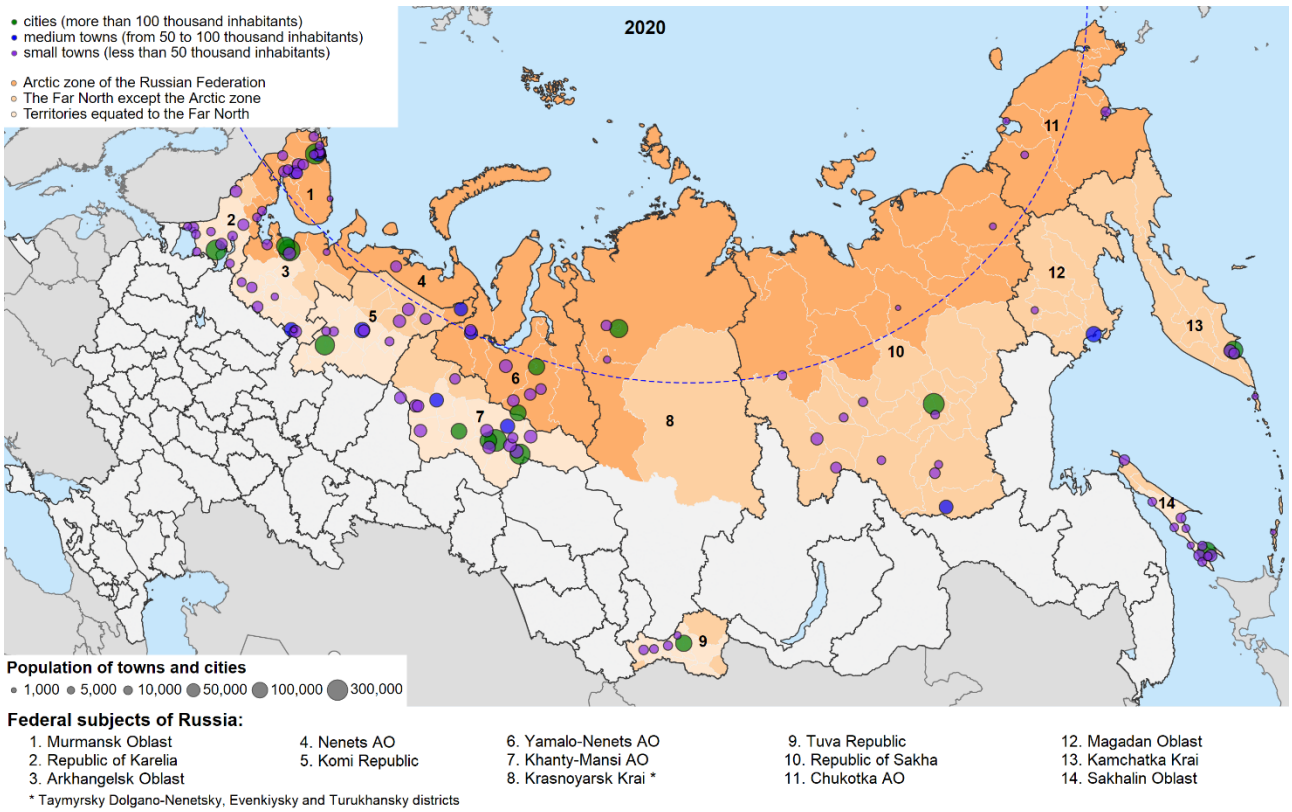

Fig. 3. Towns and cities of the Russian North at the beginning of 2020.

Let us consider the cities that had the status of "medium" in different years. There are only 16 such cities, 10 of them remained medium-sized and 6 — have become small-sized. From the moment of formation to 2020, in 2 cities — in Salekhard and Kogalym — a constant population growth was noted, in 14 cities there was an increase in population until 1989 and its decline (excluding Nadym, there was a population growth in 2010). At the same time, from 2010 to 2020, the population increased in three cities: Kotlas, Nyagan, Severomorsk. In 1989–2020 six medium-sized cities moved into the category of small towns: Nadym, Monchegorsk, Pechora, Kandalaksha, Kholmsk and Inta; two small towns became medium-sized: Salekhard and Kogalym (Table 5).

Table 5

Population of towns and cities in the Russian North with a population of 50-100 thousand people, 1939–2020, people [14]

City / town	Year of formation	1939	1959	1970	1979	1989	2002	2010	2020
Ukhta	1943	-	36 154	62 923	87 467	112 876	103 340	99 591	93 716
Magadan	1939	27 313	62 225	92 105	121 250	151 520	99 399	95 982	92 052
Kogalym	1985	-	-	-	-	44 606	55 367	58 181	67 727
Kotlas	1917	17 265	52 608	55 661	61 454	67 899	60 647	60 562	61 990
Nyagan	1985	-	-	-	-	55 029	52 610	54 890	58 565
Neryungri	1975	-	-	-	22 647	74 201	66 269	61 747	57 934
Apatity	1966	-	-	45 627	62 010	88 066	64 405	59 672	54 667
Severomorsk	1951	-	28 116	40 919	50 090	63 495	55 102	50 060	53 525
Vorkuta	1943	-	55 668	89 742	100 210	115 329	84 917	70 548	52 776
Salekhard	1938	12 764	16 567	21 929	24 935	33 207	36 827	42 544	50 976
Nadym	1972	-	-	-	26 058	53 659	45 943	46 611	44 830

[14] Census data: 1939–1979 — current population, 1989–2010 — permanent population; 2020 — at the beginning of the year.

Monchegorsk	1937	28 450	45 523	45 980	51 401	70 856	52 242	45 361	41 145
Pechora	1949	-	30 586	37 803	56 361	65 666	48 700	43 105	38 229
Kandalaksha	1938	22 172	38 222	42 656	45 430	54 246	40 564	35 654	30 379
Kholmsk	1922	- [15]	31 541	37 412	45 158	51 553	35 141	30 937	27 148
Inta	1954	-	45 136	50 178	50 862	61 798	41 217	32 080	24 121

Small and medium-sized cities of the Russian North

Small and medium-sized towns occupy a special place in the settlement network of the North because they are the most numerous. In 1939, 30 out of 32 cities were small and medium-sized, 18 of which were in the European North and 12 — in the Asian North. These settlements reached their peak in 2002, with 108 settlements (47 in the European North and 61 in the Asian North). By 2020, their number decreased to 102. In 2020, the number of SMCs was the largest in Murmansk — 15, Sakhalin Oblast — 13, in the Arkhangelsk region, in the republics of Karelia and Sakha (Yakutia), in the Khanty-Mansi Autonomous Okrug – Yugra — 12 in each entity.

In contrast to the dynamics of the population in general and urban in particular (growth until 1989), the population of small and medium-sized cities increased until 2002 (Fig. 4). The population growth since 1939 amounted to 2 million 230.1 thousand people, followed by a decrease in the population by 380.2 thousand people. The population decline occurred everywhere, except for the Nenets and Chukotka Autonomous Okrugs. This can be explained by the fact that "due to the decline in the well-being of the population, the reduction in employment, the lack of favorable conditions for doing business and other negative socio-economic processes, small towns are becoming more and more unattractive not only for investors, but also for the population" [7, Korotich M.V., p. 131]. In most regions, the dynamics of the urban population corresponds to the dynamics of the entire population, according to the SMCs, it remains only in two regions — the Republic of Karelia and the Murmansk Oblast, the multidirectionality is explained by fluctuations in the size of cities with a subsequent change in their status.

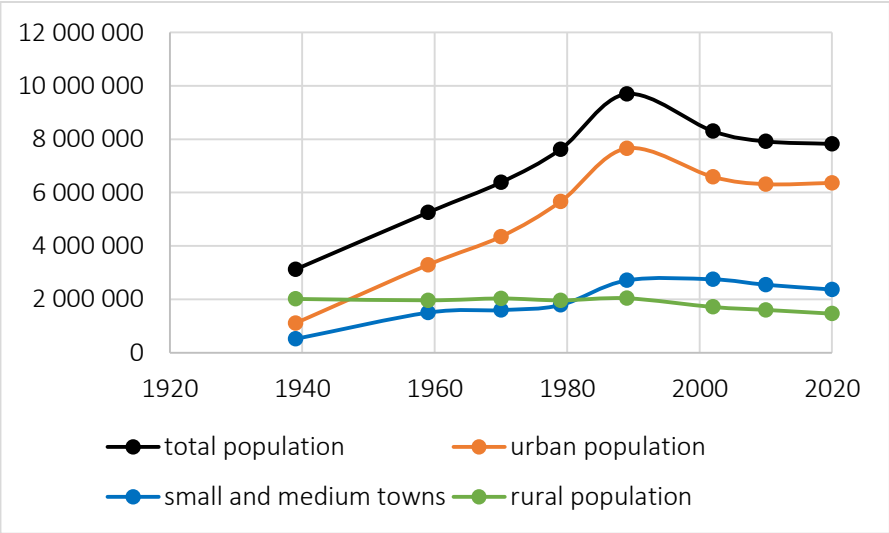

Fig. 4. Distribution of the population of the Russian North by types of settlements, 1939–2020.

[15] In 1905–1945 — as part of Japan, received the USSR city status in 1946.

In 1939, the Republic of Karelia alone had a population of over 100 thousand of small and medium-sized towns. By 2020, there were eight of them, and in six subjects the population began to exceed 200 thousand people: in the Khanty-Mansi Autonomous Okrug – Yugra — 487.5, in the Murmansk Oblast — 335.3, in Komi Republic — 303.7, in Arkhangelsk Oblast — 273.1, in the Yamalo-Nenets Autonomous Okrug — 204.3 and in the Republic of Sakha (Yakutia) — 200.1 thousand people (Table 6).

Table 6

Population of towns (less than 100 thousand people) in the northern regions, 1939–2020 [16]

Region	1939	1959	1970	1979	1989	2002	2010	2020
Russian Federation (thousand people)	**12 638.1**	**20 479.6**	**23 451.7**	**24 504.1**	**27 088.8**	**27 705.8**	**27 298.4**	**26 244.5**
Russian North	**516 945**	**1 499 763**	**1 595 787**	**1 783 914**	**2 708 275**	**2 747 021**	**2 545 009**	**2 366 844**
European part	**315 354**	**794 493**	**918 873**	**1 024 587**	**1 238 749**	**1 201 230**	**1 188 759**	**1 092 269**
Republic of Karelia	124 067	134 868	177 337	205 552	241 448	219 530	197 852	180 165
Komi Republic	25 281	259 151	275 723	233 037	255 221	292 670	351 564	303 654
Arkhangelsk Oblast	92 842	226 102	168 785	231 478	284 705	292 293	282 307	273 122
Nenets AO	13 670	13 222	16 864	23 435	20 012	18 611	21 658	25 151
Murmansk Oblast	73 164	174 372	297 028	354 520	457 375	396 737	357 036	335 328
Asian part	**201 591**	**705 270**	**676 914**	**759 327**	**1 469 526**	**1 545 791**	**1 356 250**	**1 274 575**
Republic of Sakha (Yakutia)	81 635	113 980	87 720	126 289	227 302	225 454	210 062	200 060
Tuva Republic	0	48 972	77 936	98 822	125 371	39 025	38 440	39 045
Kamchatka Krai	35 373	85 582	0	36 210	58 465	72 772	62 474	61 568
Magadan Oblast	27 313	62 225	104 748	16 025	16 895	107 232	101 837	96 407
Sakhalin Oblast	44 506	357 267	270 525	287 842	310 437	225 893	181 816	159 834
Khanty-Mansi AO – Yugra	0	20 677	95 825	102 178	398 502	495 687	545 693	487 508
Yamalo-Nenets AO	12 764	16 567	21 929	68 660	301 595	357 303	193 215	204 324
Chukotka AO	0	0	18 231	23 301	30 959	22 425	22 713	25 829

The population of small and medium-sized cities is extremely unevenly distributed in the northern regions. In 1939, the share of the population living in small and medium-sized cities of the constituent entities in the total population of small and medium-sized cities of the Russian North (over 10%) was equal to 24.0% in the Republic of Karelia, 18.0% in the Arkhangelsk Oblast, 18.0% in the Republic of Sakha (Yakutia), 14.2% in the Murmansk Oblast. In 1989, there were already five such subjects: the Murmansk Oblast — 16.9%, the Khanty-Mansi Autonomous Okrug — 14.7%, the Sakhalin Oblast — 11.5%, the Yamalo-Nenets Autonomous Okrug — 11.1% and the Arkhangelsk Oblast — 10.5%. By 2020, due to the extensive development of oil and gas fields in Siberia, the Khanty-Mansi Autonomous Okrug came out on top — 20.6%, followed by the Murmansk Oblast — 14.2%, the Komi Republic — 12.8%; the Arkhangelsk Oblast retained its position — 11.5%.

Ranking of northern subjects by the share of the population of small and medium-sized cities in the total population of the region

The analysis of the population dynamics was conducted in the following sequence: the settlement system of the Russian North — the entire population — the urban population — cities —

[16] Census data: 1939–1979 — current population, 1989–2010 — permanent population; 2020 — at the beginning of the year.

small and medium-sized cities of the Russian North. It led us to the need to answer the main question posed or the stated goal — to what extent the North Russia is "saturated and provided" with small and medium-sized cities, which constitute the backbone of settlement, providing connectivity and population of the northern territories. In order to answer this question, it was necessary to propose a methodological tools to assess the degree of "saturation and provision" of the northern territories with small and medium-sized cities. Using the experience of similar work [44, Fauzer V.V., Lytkina T.S., Smirnov A.V.; 45, Fauzer V.V., Smirnov A.V., Lytkina T.S., Fauzer G.N.], we have put forward our own vision of the solution to this problem.

Let us describe the sequence of solving the problem. In order to rank the northern subjects by the share of the population of small and medium-sized cities in the total population of the region, the following iterations were performed. The first step involved selecting the boundaries of the development of the Russian North: 1939 — the "Gulag" period of the development of the North, 1959 — the transition from various forms of coercion to economic incentives, 1989 — changes in the social system and state paradigm in relation to the northern territories: settlement to habitation, and 2020 — the result of the development of small and medium-sized cities in the urban space of the North.

The second step identifies the minimum and maximum value of the share of small and medium-sized cities in the total population of the region. The range of their variation was determined as the difference between the largest and the smallest value of the indicator in the studied population for four years. The difference between the polar values (0.0–68.8) was divided into four equal intervals, which gave a variation step of 17. It was used to identify four groups of territories. At the third step, all Northern regions were ranked in terms of the proportion of population in small and medium-sized cities into groups that had insufficient (0–17), medium (18–34), high (35–51) and excess (52–69) share of the population of small and medium-sized cities.

According to the proposed scale, in 1939–1959, Russia had an insufficient share of the population living in small and medium-sized cities; in subsequent years, this share increased to an average value. The North of Russia started with an insufficient share of the population of small and medium-sized cities, in subsequent years (1959–2020) it remained in the middle group. In terms of regions, the Republics of Karelia and Sakha were consistently in the middle group. A stable increase in the share of SMC's population was shown by 6 regions: the Republic of Komi, the Arkhangelsk and Murmansk oblasts, the Nenets, Khanty-Mansi and Chukotka autonomous okrugs. In the Republic of Tyva and the Yamalo-Nenets Autonomous Okrug, there was an increase until 1989, and then there was a transition to lower groups. Kamchatka Territory and Magadan Oblast moved from a higher group to an insufficient one in 1989, but later improved their position. Sakhalin Oblast, which had high indicator in 1939–1959, lost its position. The movement of each subject over the years when changing the group is shown by arrows (Table 7).

Table 7

Grouping of northern regions by the share of the population of towns (less than 100 thousand people) in the total population, 1939, 1959, 1989, 2020

Share of the population, %	1939	1959	1989	2020
Excessive from 52 to 69		↑ Sakhalin Oblast	↑↑ Yamalo-Nenets AO	↑↑↑ Magadan Oblast ↑ Nenets AO
High from 35 to 51	Sakhalin Oblast	↑ Kamchatka Krai ↑ Nenets AO	Nenets AO ↑ Tuva Republic ↑ Murmansk Oblast ↓ Sakhalin Oblast	Murmansk Oblast ↑ Komi Republic ↑ Chukotka AO ↓ Yamalo-Nenets AO
Middle from 18 to 34	Republic of Karelia Republic of Sakha Kamchatka Krai Magadan Oblast Murmansk Oblast Nenets AO Yamalo-Nenets AO	Republic of Karelia Republic of Sakha Tu-va Republic Magadan Oblast Murmansk Oblast Yamalo-Nenets AO **↑ Russian North** ↑ Komi Republic ↑ Arkhangelsk Oblast	**Russian North** Republic of Karelia Komi Republic Republic of Sakha Arkhangelsk Oblast **↑ Russian Federation** ↑ Chukotka AO ↑ Khanty-Mansi AO	**Russian Federation** **Russian North** Republic of Karelia Republic of Sakha Arkhangelsk Oblast Khanty-Mansi AO ↑ Kamchatka Krai ↓ Sakhalin Oblast
Insufficient from 0 to 17	**Russian Federation** **Russian North** Komi Republic Arkhangelsk Oblast Khanty-Mansi AO Chukotka AO	**Russian Federation** Khanty-Mansi AO Chukotka AO	↓↓ Kamchatka Krai ↓ Magadan Oblast	↓↓ Tuva Republic

After analyzing the distribution of the northern regions from 1939 to 2020 by groups of "saturation and provision" with small and medium-sized cities, we have obtained an assessment of the contribution of small and medium-sized cities to the settlement systems of the northern regions. This information only indicates the place of the region in a certain historical period, but it was not enough to develop and optimize the settlement system of the regions. This led to the decision to quantify the acceptable / sufficient share of the population of small and medium-sized cities in the total population of the region. The following algorithm was proposed. The median value of the share of the population of small and medium-sized cities — 34.4 — is superimposed with a variation step of 17, 8.5 in each direction. The result is a "corridor" equal to 25.9–42.9%. Although it's worth mentioning that "golden middles, like beautiful extremes, do not exist at all" [2, Nefedova T.G., Treyvish A.I., p. 22]. The practical significance of the "corridor" is that if the share of the population of small and medium-sized cities is insignificant, then the territory has low connectivity and population density, and its surplus shows that there are few large and big cities with innovative potential in the region, which are the points of economic growth. Location of regions by acceptable / sufficient share of the population of small and medium-sized cities for 1939–2020 is presented in table 8.

Table 8

Grouping of northern regions by the share of the population of towns (less than 100 thousand people) in the total population (25.9-42.9%), 1939–2020

1939	1959	1989	2002	2020
	Russian North	**Russian North**	**Russian North**	**Russian North**
Republic of Karelia		*Republic of Karelia*	Republic of Karelia	Republic of Karelia

	Komi Republic		*Komi Republic*	Komi Republic
	Tuva Republic	Tuva Republic		
Kamchatka Krai	Kamchatka Krai			
	Magadan Oblast			
	Murmansk Oblast	Murmansk Oblast		
			Sakhalin Oblast	Sakhalin Oblast
Nenets AO	Nenets AO	Nenets AO		
		Khanty-Mansi AO	Khanty-Mansi AO	Khanty-Mansi AO
			Chukotka AO	
Yamalo-Nenets AO	Yamalo-Nenets AO			*Yamalo-Nenets AO*

Italics indicate subjects that were not included in the interval in the previous year.

The results of the evaluation of the "saturation and provision" of the northern territories with small and medium-sized cities for 1939–2020 allow to study this process both statically and dynamically (Tables 7–8). The proposed methodological tool for assessing the "saturation and provision" of the northern territories with small and medium-sized cities can be used in other territorial entities.

Conclusion

The territory of Russia is 17 125.2 thousand square km, its northern regions — 7 623.7 km (44.5%). There are 2293 urban settlements in Russia, of which 290 (12.7%) are located in the North. The urban network of the Russian North is represented mainly by small and medium-sized cities, of 117 cities they account for 102 (87.2%). The average population size of small towns is 18.727, of medium-sized cities — 64.393 people, which is higher than in the Russian Arctic, but lower than Russian indicators. The low population density of northern settlements reduces their competitiveness, provokes an outflow of the population, which aggravates an already difficult situation. Density of urban settlements per 1 million sq. km in the North is 3.5 times lower than the national average, 38.0 and 133.9, respectively.

Each period of development of the economy and society has its own distribution system. From 1959 to 2020, there was a tendency for the concentration of the urban population in large and big cities, their share increased from 12.5 to 51.5%. The share of the population of small and medium-sized cities varied from the maximum (46.7%) in 1939 to the minimum (31.5%) in 1979 and amounted to 37.2% in 2020, which is significantly higher than the Russian indicators (34.8, 25.7 and 23.9% respectively). The number of the urban population changed the most: in 1939 — 188.7 thousand people, in 1989 — 1810.2 thousand people (increase of 9.6 times) and in 2020 — 717.2 thousand people (decrease — 1 million 93 thousand people). In terms of number, small and medium-sized cities show relative stability, which indicates good adaptation to external environmental conditions. Consequently, the preservation and development of small and medium-sized towns, urban settlements is relevant today and in the foreseeable future, since they constitute the supporting frame of settlement, ensure the connectivity and population of the northern territories.

The ranking of northern subjects by the share of the population of small and medium-sized cities in the total population of the region made it possible to determine the optimal boundaries — the lower and upper values of this share (25.9–42.9). In 2020, the North of Russia as a whole, the Republics of Karelia and Komi, the Sakhalin Oblast, the Khanty-Mansiysk and Yamalo-Nenets Autonomous Okrugs had an acceptable / sufficient share of the population of small and medium-sized cities. The proposed "corridor" indicates an insufficient or excessive share of the population of small and medium-sized cities in the Russian North.

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Yurak-Samoyeds: Problems of Ethnic Identification *

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Abstract. The article is devoted to the poorly studied problem of the origin of the name Yuraki, which the Russians, as well as the Enets and Nganasans, called the group of the Samoed-speaking population that wandered along the northern outskirts of Western Siberia in the 17th — first half of the 20th century. On the basis of published and unpublished archival materials, information from the works of Russian and foreign scientists, as well as dictionaries of the peoples of the North, we attempted to identify the ethnic composition of the Yuraks, the boundaries of their settlement, determine the chronological framework for the emergence and existence of this name and clarify its origin. The research has resulted in a number of reasonable conclusions and assumptions. The name Yuraki appeared in the 17th century, when the tax policy of the tsarist administration in the north of Western Siberia provoked active resistance of certain groups of the nomadic Samoyed population. Russians called the Yoraks / Yuraks nomadic in the deep tundra, who did not pay a permanent tax, tundra and forest Nenets and Enets, as well as a mixed Nenets-Enets group. This name comes from the Nenets word *Yor* meaning "depth". By the 19th century, the Nenets of the Yenisei province began to be called Yuraks, regardless of the tax system. In the Soviet household documents of the Dolgan-Nenets National District, this name appeared until the middle of the 20th century.
Keywords: *Yuraks, Nenets, Enets, tax policy, Berezovskiy Uezd, Mangazeyskiy Uezd, Taz, Yenisei, tundra.*

Introduction

The history of the ethnographic study of the Samoyed peoples dates back about three centuries. However, among historians, ethnographers and linguists, there is still no consensus on the origin of the ethnonyms Samoyeds and Yuraks, referring to the Nenets. Questions related to the name of the Samoyeds require a separate work to be written, therefore, in our article, only the name of the Yuraks has been investigated [1].

The Russians, as well as the Enets and Nganasans, named the Yuraks a group of the self-speaking population that roamed the northern outskirts of Western Siberia in the 17th — first half of the 20th centuries. The article attempts to identify the ethnic composition of the Yuraks, the boundaries of their settlement, to determine the chronological framework of the emergence and existence of this name and to clarify its origin. In order to achieve the objectives of the research, published and unpublished archival materials of the 17th — early 20th centuries, information from the works of Russian and foreign scientists of the 18th – 20th centuries, as well as dictionaries of the peoples of the North were identified and analyzed.

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[1] This article is a revised and supplemented version of the report read at the conference "You are the only one with my tunes, a cold, but alive country..." to the 100th anniversary of the birth of I.S. Gurvich (Moscow, October 24-25, 2019).

The most of the materials that we relied on when writing this article are not unique. At the end of the 20th century, the Japanese geographer and ethnographer A. Yoshida attempted to search for the ancestors of the Yuraks using almost the same data [1, p. 140–170]. Using linguistic data, rather coherent hypothesis on origin of Yuraks and their name was put forward by the Soviet and Russian linguist E.A. Khelimskiy [2, p. 27–31] and his Finnish colleague J. Janhunen [3, p. 8, 50]. From the standpoint of comparative linguistics, the genesis of the ethnonym Yuraks was considered by the Russian philologist V.Yu. Gusev [4, p. 60–64].

Unlike our respected colleagues, we relied more on historical and ethnographic sources and literature, on the basis of which we tried to substantiate our assumptions about who the Yuraks were, why they were called that and what happened to them. Our article is clearly structured, each section has its own meaning. First, an overview of the sources and literature is presented. The movement of Russians into the Trans-Urals region and their relationship with the aborigines is shown to understand the ethnic processes that influenced the formation of the Yuraks as a relatively isolated ethnic community. The description of the historical events that took place in the Berezovskiy and Mangazey districts made it possible to localize the territory of the nomadic Yuraks. The description of marriage relations showed the ethnic components of the Yuraks. In conclusion, it was possible to clarify to whom exactly the definition of “Yuraks” referred and to put forward a reasonable assumption about the origin of this ethnonym.

From source to source

The main sources on the history and ethnography of Western Siberia in the 17th century are various documents that reflect the uneasy relationship of Russians with the aborigines during the active development of tundra and taiga lands east of the Ob. Information about the Yuraks can be found in the formal replies of the Tobolsk, Beryozov, Mangazei governors and petitions of service people. Some of them were identified and published in the 19th century, others — at the beginning of the 21st century [5, DAI, p. 161–165; 6, Vershinin E.V., Vizgalov G.P., p. 19, 34, 113, 152].

The first mentions of Yuraks in scientific works can be found in the work of the Russian historiographer G.F. Miller’s “Description of the Peoples of Siberia”, written in the middle of the 18th century on the basis of materials from the Second Kamchatka Expedition. The name Yurak is like beads scattered throughout the work, when the author presents clothes, food, reindeer husbandry, and fishing of the Nenets in comparison with other peoples [7]. The Yenisei Samoyeds are called Yuraks by student V.F. Zuev, who carried out expedition to the Berezovskiy Uezd of the Siberian Gubernia in 1771–1772 on the instructions of academician P.S. Pallas [8, p. 53, 94]. In the capital work of Academician I.G. Georgi about the peoples “inhabiting the Russian state”, in the description of the “Semoyadi” it is briefly written: “starting from Mangazeya, the most populous Yuryaks” [9, p. 4].

Purposeful study of the peoples of the Yenisei North began in the second quarter of the 19th century. The first ethnographic description of "Samoyeds with the inclusion of Yuraks" based on the materials of the expedition of 1842–1845 in Northern and Eastern Siberia made by Russian traveller, geographer and naturalist A.F. Middendorf. Published in 1878, supplemented by scientific and statistical materials of the 1850s–60s, it contains information about the tribal composition of the Samoyeds and Yuraks, about the peculiarities of their life, about traditional beliefs, etc. [10, Middendorf A. F., p. 660–688]. A large-scale study of the Yenisei foreigners was carried out in 1845–1849 by the founder of comparative Ural studies, M.A. Kastren. On the way of his expedition to the Taz–Yenisei interfluve, he identified the boundaries of the settlement of the Yuraks, described their traditional crafts, types of dwellings and clothing, food, determined the features of the Yurak–Samoyed dialect [11, Kastren M.A., p. 336, 337, 350–355, 359–361, 472–474, 479–482].

The peculiarities of the Yuraks' clothing (similar to that of the Entsy) were shown by a doctor, ethnographer and folklorist M.F. Krivoshapkin in his essay about the Yenisei district [12, p. 151–152]. The first Russian professor of geography, anthropologist, archaeologist and ethnographer D.N. Anuchin tried to correlate the Yuraks with the Molgonzeya tribe, the name of which appears in various sources of the 15th–17th centuries [13, p. 35–37]. The historian-archivist P.N. Butsinskiy wrote about the Samoyeds of Mangazeisk Uezd without distinguishing between Nenets, Enets and Nganasans [14, p. 33–98]. Traditional beliefs of the Taz tundra and Purva forest Nenets people were investigated in the expeditions of 1911 and 1914 by a Finnish ethnographer and folklorist T. Lehtisalo. According to the tradition established by that time, he calls them Yurak–Samoyeds [15].

The number and settlements of the Yuraks in the 1920s were presented in works by ethnographer, historian L.N. Dobrova-Yadrintseva [16, p. 8–9, 65–66; 17, p. 22, 33–34, 36]. Historical information about the Samoyeds and Yuraks of the 17th century can be found in the works of the historian S.V. Bakhrushin [18, p. 85–94]. The literature on the Yenisei Nenets, which was available to scholars by the 1940s, was described by the Leningrad ethnographer A.A. Popov as scarce and unsatisfactory in content, having published his essay on the social structure and religion of the Yuraks [19].

In addition to scientific writings about the Yenisei province in the 19th–early 20th centuries, a large number of local history works were published, the authors of which described the life and household of the Yuraks or briefly mentioned them. Among the authors were representatives of different professions and estates: provincial officials, members of the Siberian branch of the Imperial Russian Geographical Society, writers and journalists, exiled revolutionaries, gold miners, fishing specialists, hydrographers, geographers and geobotanists, ornithologists, archaeologists, art historians. These works are not of particular interest to our study.

A qualitatively new stage in the study of the Samoyed peoples (including the Yuraks) began in the second half of the 1940s with the research of the ethnographer B.O. Dolgikh, who later became one of the largest Siberian scholars of the 20th century. In particular, a comparison of field

ethnographic materials with archival data allowed B.O. Dolgikh to trace the ethnic history of peoples who roamed between the Taz and Yenisei rivers for several centuries, to clarify the origin of ethnic groups, large and small clans [20, p. 109–124; 21]. The work in this direction was continued by his students, outstanding ethnographers Yu.B. Simchenko [22] and V.I. Vasilyev [23].

Several works of the author of this article are devoted to the history of the tribal structure formation of the Nenets on the Gydan Peninsula and interethnic interactions between the peoples of the interfluve of the Taz and Yenisei [24, Kvashnin Yu.N.; 25, Kvashnin Yu.N.].

Separately, the scientists who studied the Nenets and other Samoyedic languages should be mentioned. The first grammar of the Samoyedic languages, where Yurak is singled out as a separate branch, was written by M.A. Castren [26]. The first large Yurak–Samoyed dictionary was compiled by T. Lehtisalo [27]. In their writings, these researchers called all the Nenets living from the White Sea in the west to the Yenisei in the east as Yuraks.

In the first half of the 20th century, the famous Soviet linguist and ethnographer G.N. Prokofyev in his essay “The Nenets (Yurak–Samoyed) language” wrote that the Yuraks were the Nenets people “from the river Taz and further eastwards within the entire Taimyr National Okrug and the Turukhansk District of the Krasnoyarsk Krai”. At the same time, he did not distinguish them from the general Nenets population either by language or by culture [28, p. 6, 7].

Examining archival documents, the linguist E.A. Khelimskiy paid attention to a small list of Yurak words recorded in the middle of the 18th century by G.F. Miller and published in abridged form in the works of Academician P.S. Pallas and the German orientalist J. Klaproth. Comparison with modern words from the Samoyed languages, according to the scientist, showed that the Yurak dialect differed from both the tundra and forest Nenets dialects, but had features that brought it closer to the Enets language [2, Khelimskiy E.A., p. 28].

Concluding the review of sources and literature, it should be said that they can only provide a general and not always clear picture of the Yuraks. In addition, most of the above authors did not even try to find out the origin of the name of this population group.

AB ORIGINE

According to E.A. Khelimskiy, the Yuraks were a separate group of the Samoyed population, which emerged in the course of a gradual, not abrupt, disintegration of the pre-North Samoyed linguistic community. The Yurak dialect of the Nenets language, called by the scientist “Old Eastern”, became a transitional one between the Nenets and Enets languages, and its speakers maintained “a fairly high level of mutual understanding with both western and eastern neighbours” for a long time. The dialect disappeared no later than the middle of the 19th century “due to the absorption of its carriers by waves of new migrations of the Yamal Nenets to the east” [2, Khelimskiy E.A., p. 31].

Generally agreeing with the conclusions of E.A. Khelimsky, J. Janhunen ventured to derive the name Yuraks from the Nenets tundra word Yura (s), translating it *ver-lorengehen — to disap-*

pear (to get lost, to vanish) [3, Janhunen J., p. 8, 50]. So, the Yuraks are a kind of tribe that disappeared or got lost in the vastness of tundra. However, it is far from true.

As is known from the chronicles, the northern territories of the Urals and Trans-Urals were the first to be explored by the Novgorodians. Reliable information about the Russian campaigns to the east of the Urals is available in the Novgorod fourth chronicle of 1364 [29, PSRL, p. 64–65]. Later, in 1483 and 1499, military men under the leadership of the Moscow governors made campaigns to Siberia. By the end of the 15th century, Russians already had a certain idea of the peoples who lived far to the east of the Ural Mountains [30, Magidovich I.P., Magidovich V.I., p. 220–223].

In 1525, the "Samoyed Yugorskaya", who lived along the river Ob, was admitted to Russian citizenship, which was secured by the diploma of tsar Vasiliy III and later confirmed by the letter of tsar Fyodor Ivanovich of 1597 [6, Vershinin E.V., Vizgalov G.P., p. 10–11]. The movement of Russians from the Ob to the Yenisei began at the end of the 16th century, along the routes explored by the industrialists of the Stroganov family. Several "successive and well-prepared campaigns to the Yenisei banks" were made between 1584 and 1605 [30, Markov S., p. 273–275].

The foundation of Mangazeya on the Taz in 1601 and Turukhansk on the Yenisei in 1607 allowed the Russians to settle down in the vast territory of Western Siberia and establish contacts with the peoples who lived there. According to the data of the Mangazeya tribute books of 1607, "not only Samoyeds who lived along the Taz river, but also many Samoyeds and Ostyaks along the Yenisei river, as well as some Tunguses on the Lower Tunguska river, paid tribute (yasak) to Mangazeya at that time". In 1610, merchants, the Dvinyans, went from Turukhansk to the mouths of the Yenisei and Pyasina and found out that "*...the Yenisei is deep and boats can sail along it, the river is convenient, there are pine forests and arable lands, and fish in that river is the same as in Volga, and your sovereign's officials and industrialists live along that river*". Since 1614, the Russians began to collect yasak from the "Pyasid Samoyeds" (living along the Pyasina river) [32, Miller GF, p. 27, 30–31; 6, Vershinin E.V., Vizgalov G.P., p. 75–76].

Thus, the space from the Ob to the Yenisei was already well known to the Russians in the early years of the 17th century, and any peoples (clans, tribes) simply could not get lost there or disappear without a trace.

In the 17th century, the territory of the Nenets and Enets settlement was part of the Berezovskiy and Mangazeyskiy uezds. There are conflicting views on the border between the uezds. For example, B.O. Dolgikh wrote that the Samoyeds (Nenets) of the Berezovskiy district lived "in the lower reaches of the Ob, along the Pur, on the Yamal peninsula, in the region of the Ob and Taz gubbs", and "the territory of the Mangazey district ... in general, more or less corresponded to the territory of the present-day Turukhansk krai" [33, Dolgikh B.O., p. 64, 120]. Yekaterinburg historian E.V. Vershinin believes that "there were no clear boundaries between these uezds, in fact the tundra and forest-tundra between Obdorsk and Pur was a 'nobody's' territory" [6, Vershinin E.V., Vizgalov G.P., p. 5].

In our opinion, the points of view of both researchers are not entirely correct. Compared to the neighboring uezds, the Mangazeya uezd was sparsely populated, but this does not mean that it did not have certain boundaries. On the maps of the early 17th–early 18th centuries, from Isaac Massa to S.U. Remezov, the administrative boundaries of uezds and volosts were not marked. Only in the academic "Atlas of Russia" (1745) on a sheet with the inscription: "Parts of the Pechora, Ob and Yenisei rivers with their mouths flowing into the Northern Ocean", a clear border between the Berezovskiy and Mangazey uezds, passing along the right bank of the river Nadym (No. 14), can be seen. Perhaps, a similar distinction existed in the 17th century. It may be indirectly confirmed by the record in one of the letters of 1679 to the Berezovskiy province governor: "*...and that thief Maulka and Igonka with his fellows, having heard a message of the servicemen from Berezovo, ran to their former dwelling, where they came from, from the Mangazeya side from Nadym…*" [5, DAI, p. 166].

The yasak population of the Mangazey Uezd in the 17th century included Enets, Forest Nenets and Nganasans, as well as Khanty, Selkups, Kets, Evenks. The Enets were divided into tundra and forest. The tundra Enents wandered from the Khantayskiy yasak wintering on the right bank of the Yenisei to the Ledenkin Shar wintering on the river Messo-Yakha (along the 68th parallel), at times moving along the Taz up to Mangazeya and along the Yenisei down along its tributaries Bolshaya and Malaya Kheta and Solyonaya. The forest Enets wandered in the forest and forest-tundra zone, mainly between Mangazeya on the Taz and Turukhanskiy on the Yenisei, moving to the Khudoseya river in the south and reaching the Upper and Lower Baiha rivers in the east. Forest Nenets roamed in the interfluve of Pur and Taz, in the upper and middle reaches of these rivers, to Mangazeya [33, Dolgikh B.O., p. 72, 136, 142; 23, Vasilyev V.I., p. 100–101, 107].

The tundra Nenets, part of the forest Nenets and Khanty were taxed with yasak in Beryozovskiy Uyezd. At the beginning of the 17th century, the tundra Nenets reached the middle of the Yamal peninsula in the north, near the rivers Mutnaya and Zelenaya. They roamed on the right side of the Urals in the meridian direction from the Baydaratskaya Bay of the Barents Sea to the Voikar, Lyapin and Kunovat rivers, moved along the southern part of the Ob Bay to the banks of the Tazovskaya Bay. Forest Nenets roamed on the left bank of the river Nadym, in its upper and middle reaches, near the lake Num-To, and in the upper reaches of the river Kazym [33, Dolgikh B.O., p. 74–75; 23, Vasilyev V.I., p. 85–86].

Already at the beginning of the 17th century, there was difficult situation with the yasak collection on the territory of both uezds. While the semi-rural Khanty population was taxed almost completely, the nomadic Samoyeds actively resisted it. It should be added that the unauthorised trade with Samoyeds, organised by the Russian "walking people", tremendously impeded yasak collection. Resisting pressure of the Russian administration, the Samoyeds throughout the century periodically attacked Pustozersk and Obdorsk, robbed grain stocks, took away goods from ships wrecked by a storm, killed Russian people, fled to neighboring uezds [32, Miller G.F., p. 234–236; 6, Vershinin E.V., Vizgalov G.P., p. 23–25, 29–30, 33–35, 43, 46–48].

The Nizhneobsk and Yamal Samoyeds, trying to find new hunting grounds, so that there was something to trade with the Russians, and, if possible, to avoid the yasak tax, began to migrate between the Taz and Yenisei rivers.

"Yuratskaya Samoyed Nemirnaya"

In the 17th century, the names "yuraki" and "yuratskaya samoyad" began to appear in the yasak documents of the Berezovskiy and Mangazeya uezds. Cartographic materials of the early 18th century made it possible to determine the places where the yuraks roamed. For example, on the Semyon Remezov's "Drawing of the land of the Turukhansk city" (1701), representing the lands of the Mangazeya uezd and the nearest districts, it is written "*Nemirnaya samoyed yuratskaya*" in the interfluve of the Ob and Pur rivers. The area between the tributary of the Yenisei, Lower Kheta river, and the sea bays is marked as "*Yuratskaya land nemirnaya*", and on the left bank of the Lower Kheta river a postscript can be seen: "*And along it the Yuratskaya samoyed nemirnaya comes through Taz and from Pur*" [34, Remezov S., p. 143].

Archival data analysis, conducted by B.O. Dolgikh, showed that a certain number of Nenets-Yuraks were paying yasak in the Mangazeya uezd almost every year, starting from the 1630s to the beginning of the 18th century. The first mentions of Yuraks can be found in the yasak books of the Verkhotaz yasak wintering in 1634 and 1636, where five people of the "yuratsk kamennaya [2] samoyad" were recorded. In addition to the Verkhotaz wintering, located below the Khudoseya river, Yuraks reached the city of Mangazeya in the 1630s–50s, and in 1657 they roamed at the mouth of the Taz river. On the Yenisei, individual Nenets-Yuraks were noted by yasak collectors in 1636, and from 1658 they began to pay yasak regularly in the Khantai wintering together with the Samoyed Enets [33, Dolgikh B.O., p. 69, 136].

According to B.O. Dolgikh, by the middle of the 17th century, a meridional border was established between the nomads of the Nenets and Enets in the tundra zone, passing along the Krovavaya river. In our opinion, at that time, the Russians gave that name to the modern Messo river [3], which originates in the far north and flows into the Taz Bay [33, p. 134, 136; 21, p. 159; 25, Kvashnin Yu.N., p. 165]. The delimitation of the territory was very conditional, therefore, both the Nenets and the Enets often roamed far beyond the boundaries of their estates, guided by economic benefits. For example, a provincial dispatch of 1644 mentions the Obdorsk Samoyadin of the Ivasida family [4], who roamed in the area of the Nadym river and fished periodically "*on the Taz below the Mangazeya city*". The charter of 1657 reported about the Mangazeya Samoyeds, met by the Russians on the Nadym river [6, Vershinin E.V., Vizgalov G.P., p. 32, 46].

The Russian administration, which tried to establish a timely full collection of yasak from the taxable population and resorted to taking hostages-amanats for this, forced the Samoyeds to

[2] Priuralskaya.
[3] From the enets messi(s') — to wander.
[4] Ivasids, Evasids — this was the name of the Ngevasiada clan (modern Aivaseda) in the documents, one part of which roamed in the forest zone with the Kazym Nenets, and the other in the tundra between Nadym and Taz.

move to remote tundra. In the report extract of 1652, it is said that after the capture of the best Samoyed people to amanats, "*the Karachai Samoyads of the Yevasida clan from Berezovskiy Uyezd left for the Mangazeya Uyezd, fifty people or more*". Together with them, Hena Khuleyev left the clan of Karachey (Kharyuchi) with lots of people "*and started to pay yasak to the tsar in Mangazeia*" [6, Vershinin E.V., Vizgalov G.P., p. 43, 166].

In 1695, members of the Aseda family of forest Enets helped the Nenets from the Ayvaseda clan to take revenge on the Mangazeya servicemen for the campaign of voivode Andrey Zabolotskiy against the Yuraks on the river Pur, during which many people were killed. After that, Aseda migrated to the left bank of the Taz Bay, and from 1696 to 1700 they paid yasak in Obdorsk [18, Bakhrushin S.V., p. 90; 21, Dolgikh B.O., p. 185, 190].

The invasion of the Nenets and Enets into each other's territory often led to armed bloody feuds. For example, in 1638 the tundra Enets Idepedey from the Soyta clan was killed by "*Yuratsk samoyad on the Verkhotaz mountains*". In the same year, the forest Enets of the clans Aseda and Yuchi were "*beaten on Pur by the Purovskaya yasak samoyad*" [23, Vasilyev V.I., p. 128].

The inhabitants of the Mangazeya Uezd suffered greatly in 1679. In February, the son of Hena Khuleyev, "*the Yuratsk prince of Koryuch Khinin ... with many people*", came to the Khantai yasak wintering and wanted to attack and plunder it. Having received a rebuff from the servicemen, he moved away from the wintering and began to kill and plunder the Russian people who lived nearby, and then — the "*yasash people, the Khantai and Tavgitskiy samoyad*", that is, the Enets and Nganasans. In June of the same year, the Samoyed "*Prince Nyla of the Asitskiy family with twenty people*" came to the old Mangazeya city and wanted to kill the yasak collectors. Nyla himself was killed in the battle, and his people, having recovered, took the city in besiege and did not recede from it for three days and three nights. The Samoyed (Enets) princes of the Yaryg of the Selir clan and the Marobanko of the Yugut clan came to the aid of the besieged "*with their families and fought off those thieves from the city*" [5, DAI, p. 161–166; 6, Vershinin E.V., Vizgalov G.P., p. 166].

According to some sources, wars between Nenets and Enets ended with reconciliation and payment of ransom. For example, at the end of the 17th century, Yuratsk Samoyadin Voloma asked the Verkhotaz Samoyadin Sanarayka Soloneev to give Yurak "*golovshchina, consisted of two girls, for previous killings*" [5] [18, Bakhrushin S.V., p. 91].

Based on the above, we can state the following. Despite occasional conflicts, the free or forced migrations of the Nenets and Enets from the Berezovskiy district to Mangazeya and back created conditions for the formation of a mixed Nenets-Enets population in the Taz-Yenisei interfluve in the 17th century. It developed gradually as a result of marriages between the Nenets and Ents and partly of the golovshchina payments.

[5] The payment for the murder, levied in favor of the relatives of the murdered.

Matchmakers

As mentioned above, members of the Aivaseda (Evasida) clan, as well as the Kharyuchi (Karacheya) clan, were among the first to wander in the Mangazeya Uezd territory [6, Vershinin E.V., Vizgalov G.P., p. 43]. They were the main eastern non-ethnic marriage partners of the Enets. Information about the Nenets-Enets marriages in the 17th century is very scarce. However, it is possible to note the mention in some documents of the Nenets of the Aivaseda clan, who were related to the Aseda Enets. For example, in the dispatch from the Berezovskiy governor of 1645, it is written, "... *killed that Sava Ondreev Syrapteyko of Asidtskov's family, the Mangazey Yasak Samoyadin, with his son-in-law, Evasidin and our family*" [6, Vershinin E.V., Vizgalov G.P., p. 34]. Another document tells about Michutka Eteev from the Aseda clan, the son-in-law of the head of the Aivaseda clan, who beat the Mangazeya archers in 1695 [21, Dolgikh B.O., p. 190].

Other matchmakers of Ased were the representatives of the Lambai family of the Entsy family (Lobbeo, Lombuev, Lampai). From the archival data, collected by B.O. Dolgikh and V.I. Vasiliev, an attempt can be made to reconstruct the history of this family. For the first time, 26 Samoyed people of the Lombuev clan were noted in the yasak books of the Khantai wintering in 1614. By the early 1630's, the number of yasak payers in this clan was reduced to one person. Further information about him is lost, until the end of the century. Scientists suggest that at this time members of the Lombuev clan paid yasak along with the Obdor Samoyeds, as well as intermarried with them. In the yasak book of 1695, Naka and Lave Ikiny were recorded among the Nenets of the Kharyuchi clan. In 1700, the Nenets of "Ikin clan", headed by Lovitsa (Lave) Ikin, roamed to the Khantayskiy wintering of the Mangazey district, together with the aforementioned Michutka Eteev from the Aseda clan. This was the beginning of the formation of the administrative-territorial group of coastal Yuraks in the lower reaches of the Yenisei, the main clans of which were the clans Lampai and Aseda. Members of the Lampai clan figured the surname Ikin in archival documents throughout the 19th century. [21, Dolgikh B.O., p. 150–152; 23, Vasilyev V.I., p. 50, 177]. According to A.F. Middendorf, Karasin Enets and Avam Nganasans called coastal Yuraks Lobbö, and Khantai Enets — Lowwöo [10, Middendorf A.F., p. 663–666].

The Lampai and Aseda clans were apparently intermarried as early as the beginning of the 18th century. In the second half of the 18th–early 19th centuries, the circle of marriage ties of the Yenisei Yuraks expanded due to new settlers from the Ob and Nadym. The documents of that period record, among the marriage partners of Aseda and Lampai, the Nenets of the clans Karachey (Kharyuchi), Tazu-Karachey (Tazu-Kharyuchi), Sigunei (Syugney), Yar, Ader. In the first half of the 20th century, Evay, Togoy, Taseda, Yadne, Ter, Nenyang, Saba, Yamkiny were added to them. In addition, the coastal Yuraks Lampai and Aseda themselves continued to actively intermarry with each other [6].

[6] SITO SAT, f. И-154, ser. 8, file 72, sh. 175-218back. Revizskie skazki o yasachnykh inorodtsakh Obdorskoy volosti [Revision tales about the yasak foreigners of the Obdorsk volost], 1782; SAKK, f. 239, ser. 1, file 1, sh. 57. Ispovednye rospisi Tazovskoy Nikolaevskoy tserkvi [Confessional murals of the Taz Nicholas Church], 1801; SAKK, f. P-769, ser. 1,

In the lower reaches of the Taz, at the turn of the 17th–18th centuries, there were also changes in the ethnic and tribal composition. Forest Enets of the clans Yuchi, Bai and part of the Muggadi went down the Yenisei and formed new Samoyed Yasak volosts — Karasinskaya and Podgorodnaya. Part of the Aseda clan, together with their division Selirta and clans of Nenets–Entsy origin, Parava, Maryik and Ter (part of Muggadi) formed the Taz volost. From the middle of the 18th century, the Taz and Beregovaya volosts began to be officially called Yurats, and the non-living Enets living there were called Yuraks, in contrast to the Khantai and Karassian Samoyed Ents [33, Dolgikh B.O., p. 143; 21, Dolgikh B.O., p. 76, 121].

It would seem that we can conclude that in the 17th–19th centuries, Yuraks was the name of the mixed group of the population, formed in the interfluve of the Taz and Yenisei as a result of contacts of the tundra Nenets with the tundra and forest Enets. However, this is not true.

The Aivaseda clan, in addition to the "Taz matchmakers" from the Aseda clan, also had "Purov matchmakers" from the forest Nenets clan Pyak, who are repeatedly referred to in yasak documents as Yuraks. For example, in the Mangazeya yasak book of 1636 it is spoken of "*the Purovskaya Yuratsk Samoyad of the Peki clan*". In 1641, in Mangezeya, the "*Yuratsk self-unification of the Pekiev family of Yuvaga*" was caught. In the governor's report of 1645, it is said about the wife of the murdered archer, who, after the collapse of the karbas, walked along the coast on foot "*and found her Yurak relatives named Peks*" [33, Dolgikh B.O., p. 71; 6, Vershinin E.V., Vizgalov G.P., p. 34]. G. D. Verbov wrote about the prohibitions on marriage between the Pyak and Aseda clans in the 1930s. [35, p. 59].

The above examples convincingly prove that not only the Nenets and Enets, who were marriage partners, but also the Purovskiy Forest Nenets, who did not marry the Enets, were called Yuraks.

Who are the Yuraks?

The answer to this question is, surprisingly, simple. One has only to carefully examine the archival documents and understand their analysis by ethnographers. Attention should be paid to the clear division of "samoyad" in the documents of the 17th century on "yasachnaya" and "yuratskaya". For example, in the formal reply of the Mangazeya governor of 1636 it is written "...*Vaska Kolmogor was beaten by a non-Yasak Samoyad, Yuraks*". In the formal letter of the Tobolsk governors of 1643, the "thieves' Yuratsk Samoyad" is mentioned. And, finally, in the governor's report of 1645 there is a record that "...*in Mangazeya, the foreigners Yuratsk and Yasak Samoyad are stealing, your sovereign Russian people are robbed and beaten*" [6, Vershinin E.V., Vizgalov G.P., p. 152].

The notes of the participant of the Second Kamchatka expedition of 1734–1742, Lieutenant H.P. Laptev, contain a valuable remark that was pointed out by N.K. Auerbach and V.I. Vasyliev:

file 448, sh. 1-160. Kartochki brachnykh par zhiteley Dudinskogo rayona Turukhanskogo kraya [Cards of married couples of residents of the Dudinskiy district of the Turukhansk region], 1926–1927.

"*…as these Yuraks, when they came, robbed and killed a lot, not only the inhabitants, but also the service collectors of the yasak, and these Yuraks, some are in yasak, but only in free one, and they pays what and how much they want with animals*" [36, Zapiski..., p. 53].

In one of the documents of 1755, a certain Ika, 73 years old, and his large family are noted as "*the Lampayevsk family of Yuratsk Samoyads, living downstream along the Yenisei, non-taxed*" [7].

B.O. Dolgikh was the first to draw attention to the opposition between the Yasan and Yuratsk Samoyeds. In particular, in one of his works, understanding the possible reasons for the decline in the number of Entsy in the yasak books of the 1630s, he wrote about the departure of "*a part of the tundra Enets to the Obdorsk Nenets (Yurak) who did not pay the tax yasak*" [21, Dolgikh B.O., p. 140]. Unfortunately, B.O. Dolgikh did not develop this thesis further.

Based on the thought of B.O. Dolgikh and on the above facts, it can be stated that in the 17th century, Russians began to name representatives of the nomadic Samodian population who avoided a permanent yasak tax as Yuraks. Some Yuraks paid yasak, but occasionally, in those winterings, near which they were caught by yasak collectors.

Only name remains

The origin of the name Yuraki remained unclear during all its existence. In our opinion, most of the travelers and researchers of the 18th–19th centuries and the beginning of the 20th centuries did not try to guess its meaning because they did not know the Nenets language. However, we do not find decoding in the works of specialists either. For example, A. Shifner, editor of M.A. Castren's reports, in one of his comments to the "Grammar of Samoyed Languages" wrote: "*The Yuraks, who gave the name to the entire branch, are just one tribe, and Castren believes that their name may be associated with Yugra*" [26, Castren M.A., p. 7].

G.D. Verbov stated categorically about the name Yurak: "*The origin of the word "yurak" is known quite accurately and does not cause the slightest doubt. The fact is that "Jurak" in the language of the Enets, formerly known under the name "Yenisei Samoyeds", and the Nganasans (Tavgians), adjacent to the Nenets in the east, means "Nenets" (in general)*" [37, Verbov G.D., p. 18].

According to the Hungarian linguist P. Khaydu, the name Yurak may come from the Khanty and Mansi jor**n** (jor**aŋ**), which was adapted in Russian using the suffix of ethnonyms -ak [38, Khaydu P., p. 125]. In the Khanty-Russian and Mansi-Russian dictionaries one can find the corresponding words: Khant. yora**ӈ**, yara**ӈ**; Mans. yery**ӈ,** yorə**ӈ** — important, proud, from the word yer, yor — pride, conceit, arrogance [39, Balandin A.N., Vakhrusheva M.P., p. 31; 40, Skameiko R.R., Syazi

[7] SITO SAT, f. И-156, ser. 1, file 1978, sh. 6. O vosprinyavshikh svyatoe kreshchenie Mangazeyskogo vedomstva o zhivushchikh v Tazovskoy storone vnizu Taza reki i bliz morskoy guby raznykh rodov samoyadtsakh [About those who received holy baptism of the Mangazeya department about samoyadts living in the Taz side at the bottom of the Taz river and near the sea bay], 1755.

Z.I., p. 26]. In our opinion, these words are not related to the name of Yuraks. They simply reflected the peculiarities of interethnic relations between the Khanty and Mansi and the Nenets.

As is known, reindeer husbandry in Western Siberia began to develop intensively earlier than that of the tundra Nenets. In the 17th century, possession of a sufficient number of deer allowed them to migrate over long distances, catching a fur-bearing animal to pay tribute, or, conversely, to avoid paying. At the same time, the Khanty and Mansi were mainly engaged in hunting and fishing, which often depended on external and internal factors, such as excessive hunting by Russian "nomads" or climatic changes. Here is just one example, taken from the petition of Ostyaks of the Berezovsky Uezd with a request to postpone the payment of tribute, dated 1643: "*…big water made the fishing industry redundant and we have suffered hunger and starvation for all the years, and many Kazym Ostyaks with their wives and children died of hunger, while others, our Sovereign, our brothers, Ostyaks, wives and children, sold them to work because of hunger. And your sovereign yasak has nothing to hunt. And in the previous years, Sovereign, in summer they were catching more fish, and for that dry fish and fat they bought from the tundra Samoyad some stuff and fulfilled that need, and with that stuff they paid your sovereign yasak for all the years*" [6, Vershinin E.V., Vizgalov G.P., p. 25–26]. It can be assumed that the Nenets were so proud of their wealth and independence that this gave the poor Khanty and Mansi a reason to call them "proud", "important", "arrogant".

P. Khaydu connects his other hypothesis with the Nenets clan Yar, from which, according to him, the ethnonym jaran ~ jorn and, accordingly, the name Yurak, may be derived [38, Khaydu P., p. 125]. It is also impossible to agree with this explanation, since the Yar clan just began to stand out from the Vanuito maternal clan in the first half of the 17th century. An indirect confirmation of this can be the record in the petition of the merchant Mikhail Kondakov, dated 1641, where he complains about the Nenets of different clans, mentioning, among others, "*Vanyutin of the Yar family with comrades*" [6, Vershinin E.V., Vizgalov G.P., p. 20, 22]. Throughout the 17th century, Yar was a small clan and did not play the same significant role in the life of nomadic and semi-sedentary communities between the Ob and Yenisei rivers, as, for example, the Kharyuchi clan (Karachei, Karachey samoyad). By the end of the century, the main nomadic places of the Yar clan were located on the right bank of the Taz Bay, and its marriage contacts with the Aseda clan began only in the 18th century. [33, Dolgikh B.O., p. 75–76; 24, Kvashnin Yu.N., p. 47–51].

In our opinion, the origin of the name Yuraks should be sought in the Nenets language, starting from the thesis about the Yasak and Yurak Samoyad. The above-mentioned work by A.F. Middendorf has a very interesting note, which researchers have never paid attention to, although it can serve as a starting point for decoding: "*The coastal Yuraks call themselves Jöndjör*" [10, Middendorf A.F., p. 665]. This name consists of two parts: *yond*, from the Nenets tundra yondas — to wander, migrate, and *yor* — depth, deep-rooted [41, Tereshchenko N.M., p. 121, 123]. Accordingly, it can be translated as "*wandering in the depths*" or "*migrating into the depth*", i.e. to remote

tundra. Here it is worth paying attention to the entry in the Nenets-Russian dictionary of G.D. Verbov: "*yondas* — to migrate to a new, unknown place" [42, Verbov G.D., p. 21].

Based on the above, we can assume that in the 17th century the Nenets who did not want to pay yasak, migrated to the deep tundra, for what the Russians called them *yorak / yurak* (from Nenets *yor* — depth + Russian suff. *-ak*; compare: permyak, sibiryak, kerzhak). In the Russian script of that time, there was no separate graphic sign for displaying the sound Yo (along with the sounds Ye and E, it was written with the letter Є), but the letter Yu existed. The Yuraks adopted the nickname of the Nenets from the Russians in their own vocalization: the Enets in the form of *durak* and the Nganasans in the form of *durake / duriake*.

It is interesting that uncertainty in the record *Yo / Yu* in the word Yuratskiy was reflected in some official documents of the 17th century. For example, in one of the petitions, dated 1679, it is written three times "*Yeratskaya* (read as Yoratskaya — Yu.K.) *Samoyad*", three times — "*Yaratskaya*", and three times — "*Yuratskaya*" [5, DAI, p. 161-162].

Let us clarify that the change of the letter and sound *Yo* to *Yu* does not contradict the norms of the Nenets language (Nenets. *vad**yo**das* / *vad**yu**das* — to grow; *me**yo*** / *me**yu*** — reliable, strong; *n**yo**rakultsi* / *n**yu**rakultsi* — to chase a beast or man) [43, Burkova S.I. et al., p. 11, 69, 71, 85, 93]. In addition, in colloquial speech, when the Nenets pronounce some words, the sounds Yo and Yu are often difficult to distinguish.

Conclusion

To summarize, a number of well-founded conclusions and assumptions can be made. The name Yuraks originated in the 17th century. The yasak policy of the tsarist administration in the north of Western Siberia provoked active resistance at that time from certain groups of the nomadic Samodian population. This led to uncontrolled movements of some Nenets and Enets clans across the territory of Berezovskiy and Mangazeya uezds. In the 17th–18th centuries, in the interfluve of the Taz and Yenisei rivers, a mixed Nenets-Entsy group of the population was formed as a result of intensive processes of interethnic interaction, where the Nenets language and culture became predominant. The Russians began to call the Nenets and Enets nomads wandering in the deep tundra, not tributed by a constant yasak, Yoraks / Yuraks. In the 18th—early 19th centuries, this name, regardless of the taxation system, extended to the tundra and forest Nenets, and by the middle of the 19th century, it was used mainly for the Nenets of the Yenisei gubernias. In the Soviet administrative records of the Dolgano-Nenets National Okrug, it appeared until the middle of the 20th century.

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Abbreviations

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The 50th Anniversary of the Start of Drilling the Kola Superdeep Well *

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Abstract. The Kola Superdeep Well (SG-3) is an outstanding achievement of Soviet science and technology, drilled in Precambrian crystalline rocks and reached a depth of 12262 m. It was one of a series of super deep wells planned within the framework of the program "Earth's Interior Exploration and Superdeep Drilling". In order to achieve record depths, unique domestic drilling equipment and materials capable of working at high temperatures and pressures were created. A fundamentally new technology for drilling wells using hydraulic downhole motors was developed. Despite difficult drilling conditions and repeated accidents, SG-3 has fulfilled almost all the tasks assigned to it. The well was penetrated with full core sampling, which was subjected to comprehensive study. This made it possible to study the deep structure of the Earth's crust and to revise the interpretation of depth seismic data. It was found that changes in the physical properties of rocks at great depths had been erroneously interpreted as a change in their composition. It made it possible to assess the prospects of deep horizons of the Pechenga structure for copper-nickel mineralisation by uncovering a previously unknown body of ore-bearing hyperbasites. New information was obtained on the temperature gradient, which turned out to be significantly higher than expected, as well as on the vertical metamorphic zoning along the borehole section. The composition and physical properties of rocks in deep horizons were investigated. Tectonic fault zones and six types of ore mineralisation were identified in the borehole section. New data on ore formation processes at great depths have been obtained, which is an important contribution to the theory of mineral deposit formation
Keywords: *Kola superdeep well, new drilling technology, deep structure of the Earth's crust, ore mineralization.*

Introduction

On May 24, 2020, Russian and global geological science celebrated a significant date — 50 years since the beginning of drilling the Kola superdeep well in the Pechenga district of the Murmansk Oblast, the world's deepest scientific well, which reached a record depth of 12.262 m. Drilling the SG-3 by Soviet explorers and geologists is comparable only to space flight and is the greatest achievement of world geological science in the 20th century.

The problem of studying the continental crust using superdeep drilling arose and was discussed in the USSR in the late 1950s – early 1960s. The main task was considered as "the opportunity to obtain factual material, which is extremely necessary for understanding of endogenous processes and associated mineral deposits, directly from great depths" [1].

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The scientific foundations of the superdeep continental drilling program were determined at a joint meeting of the Presidium of the USSR Academy of Sciences and the board of the USSR Ministry of Geology and Mineral Protection, chaired by Academician M.V. Keldysh. The program itself was approved by N.S. Khrushchev, the Chairman of the Council of Ministers of the USSR, on the basis of a decision on the report of D.I. Shcherbakov, Academician-Secretary of the Department of Geological and Geographical Sciences of the USSR Academy of Sciences, in 1962. The USSR Superdeep Drilling Program was a response to the US Ocean Drilling Program.

US Ocean Drilling Program

The development of science and technology in the second half of the 20th century was largely determined by the rivalry between the geopolitical blocs led by the USSR and the USA. While achievements in space were widely publicised, the race in superdeep drilling was less reported, but no less intense.

In 1958, the Mohol superdeep drilling program appeared in the United States. It was one of the most ambitious postwar projects. The program was designed to overtake the USSR in scientific rivalry, setting a world record in ultra-deep drilling. The project takes its name from the word “Mohorovićić” — the name of the Croatian scientist who identified the interface between the Earth's crust and the mantle — the border of Moho. The creators of the program decided to drill wells in the ocean, where, according to geophysicists, the Earth's crust is much thinner than on the continents. From 1961 to 1966, at an ocean depth of 3500 m, near the island of Guadeloupe in the Caribbean Sea, geologists drilled five wells from the CUSS1 drilling barge, the deepest of which was 183 meters. At this location, under the sedimentary rocks, they expected to find the upper layer of the Earth's crust — “granite”, but the core contained oceanic basalts. It was not possible to penetrate the crust and reach the mantle. It was necessary to lower the pipes several kilometers into the water, pass 5 km of the ocean floor and reach the upper mantle. Scientists believed that the upper crust contained young rocks and the lower crust — ancient rocks. However, only superdeep drilling could give a true picture of the structure and composition of the Earth's outer shell and upper mantle [2, 3].

In 1968, the vessel Glomar Challenger, specially built for realization of the deep-water drilling program, was launched in the USA. It was planned to drill the entire Earth's crust and obtain samples of the upper mantle rocks. The concept of the mantle was based on indirect data — the velocity of propagation of seismic waves in the subsurface, the change in which was interpreted as the boundary of layers of rocks of different ages and compositions.

The result of drilling discouraged and inspired the scientists; they began to prepare a new phase of drilling. But when the cost of the project exceeded $ 100 million, the US Congress stopped funding. The Mohol project did not answer any of the questions posed, but it showed that the superdeep ocean drilling is possible. The United States has prepared a new program for the study of the ocean floor (Deep Sea Drilling Project). The Glomar Challenger, built specifically for

this project, and the Joydes Resolution, which replaced it in 1985, have drilled nearly 800 wells in the bottom of various oceans and seas since 1968, reaching a maximum depth of 1741 meters below the ocean floor. By the mid-1980s, offshore drilling results confirmed plate tectonics theory.

USSR Superdeep Drilling Program

The Soviet Union created the program “Exploration of the Earth's interior and superdeep drilling”, but on the continent, not in the ocean. Despite the centuries-old history of drilling, continental ultra-deep drilling was a completely new business, since the work was planned at previously unattainable depths — more than 7 kilometers. The Chairman of the Council of Ministers of the USSR, Khrushchev N.S., approved this program, being guided more by political than scientific reasons, since he did not want to lag behind the United States.

In 1963, the Interdepartmental Scientific Council on the program "Exploration of the Earth's interior and superdeep drilling" was formed for the organization, coordination and practical management of the work on the deep study of the earth's interior. It consisted of about 200 scientists and specialists from scientific and industrial organizations of various ministries and departments. The first chairman of this council was the USSR Minister of Geology, Academician of the USSR Academy of Sciences, A.V. Sidorenko. Then it was headed by Doctor of Technical Sciences, N.S. Timofeev, and in 1974 — by the Minister of Geology of the USSR, E.A. Kozlovskiy. From 1965 to 1971, the head of the Department of Scientific Research Organizations of Mingeo was G.I. Gorbunov, and his deputy from 1966 was N.P. Laverov, who headed this department from 1972 to 1983. He supervised the sectoral geological work of the USSR Ministry of Geology and actively participated in the program “Exploration of the Earth's interior and superdeep drilling” and the selection of locations for superdeep wells.

The work program for the 1970's was to develop a model of the structure of the Earth's crust and upper mantle, as well as new methods for predicting mineral deposits, produce forecast maps with a quantitative assessment of natural resources and reserves, and identify the direction of prospecting and exploration for the main types of minerals in promising regions of the country.

A fundamentally new technical and methodological approach to solving the regional deep structure of the Earth's crust and upper mantle was developed, based on the integration of superdeep and deep drilling data (according to the existing classification, wells with a depth of 3000–6000 m are considered to be deep, and with a depth of more than 6000 m — superdeep), as well as seismic deep sounding and other geophysical and geochemical methods. A system of interconnection of geophysical profile data based on superdeep reference wells was developed for the territory of the USSR. According to the program, the Kola (SG-3) and Saatlinskaya (SG-1) superdeep wells were planned first of all [2, 3].

The superdeep drilling program developed simultaneously with the space exploration program of the USSR and was like a space flight into the bowels of the Earth, which is comparable in volume of scientific research, development of new equipment and funding. The program “Explora-

tion of the Earth's interior and superdeep drilling" on the continent seemed to be a completely new experience. The results of scientific drilling turned out to be unexpected in many ways and forced a revision of theoretical concepts that had seemed obvious and immutable before. The aim of the program was to understand the cross-section of the Earth's crust from the sedimentary cover to the "basalt" layer and the Mokhorovichich boundary [4, 5]. The depth of the planned wells was estimated at 15 km. The locations of the wells were chosen so that each well would fully penetrate some seismic layer most developed at the drilling site; all wells in total would provide an idea of the different layers and types of continental crust.

The sedimentary layer was supposed to be drilled by wells in the Caspian region, where its thickness is maximal. The well in the Urals was intended to study the structure of the sedimentary layer in the geosynclinal trough, where it has been altered by volcanism, metamorphism and hydrothermal activity. The well on the Kola Peninsula was planned to penetrate the "basalt" layer. Two more wells were planned to study the composition of the "basalt" layer in two zones of different tectonic history (intermontane Kura trough and Kuril ridge). In case of successful drilling, the well in the South Kuriles was supposed to reach the Mokhorovichich section.

An important step towards the study of the deep structure of the subsoil was the creation at the All-Union Scientific Research Institute of Drilling Technology a laboratory for mantle drilling in 1964, which was headed by N.S. Timofeev. During 1964–1966, a scientific analysis of technical problems in construction of superdeep wells was carried out and strategic ways of solving the problems were outlined. All types of geological conditions characteristic of the Earth's crust have been analyzed: igneous rocks, sedimentary deposits, combinations of sedimentary and igneous rocks, conditions of the minimum thickness of the Earth's crust [1].

For consecutive increase of technical potential, in accordance with the principle "from simple to complex", it is advisable to solve the problem with observance of an order of wells drilling, namely in the sequence of the named sections of the Earth crust. It was decided to start drilling the Kola well (SG-3) in the crystalline rocks of the Baltic Shield.

VNIIBT developed a technical design for the first stage of drilling (up to 7000 m) of the Kola well. The Uralmash-15000 drilling rig was developed by the specialists of the Uralmash plant. The drilling technology with hydraulic downhole motors was substantiated. It was the technology, which for the first time in the world, in the field of technics and technology of ultra-deep wells drilling, used drill pipes made of light aluminum alloys, which were manufactured at the defense enterprises of the aviation industry. A fundamentally new technological approach has been developed, in which the well structure was formed directly during its construction on the basis of current information about the geological section.

The USSR Ministry of Geology and Mineral Resources was appointed as the head organization in the implementation of the planned tasks, and more than 150 scientific and industrial organizations of this ministry, the USSR Academy of Sciences, the academies of the union republics, the USSR Ministry of Higher Education and the RSFSR Ministry of Higher Education, branch minis-

tries and departments were involved in the implementation of the program. After discussion at the interdepartmental scientific council on the problem of “Exploration of the Earth's interior and superdeep drilling”, the technical requirements were transferred to the Research Institute of Heavy Engineering for the development of technical documentation and subsequent production of two prototypes of the drilling rig for ultra-deep depths at the Uralmash plant.

Kola Superdeep Well

The Kola Superdeep Well (SG-3) was conceived as a fundamental research project aimed at studying the interior of the Earth and the processes taking place within it. One of the main tasks of drilling the well was to achieve a hypothetical “basalt” layer of the Earth's crust. The assumption that the continental crust consists of the upper “granite” and lower “basalt” layers was based on seismic data, indicating an increase in the density of rocks with depth.

The location of the SG-3 was chosen in 1968 by the Interdepartmental Commission headed by Academician V.I. Smirnov (Fig. 1). Initially it was supposed to be drilled in Archean gneisses near the village of Liinakhamari on the Barents Sea coast, but then another option was adopted, solving the practical problem of determining the prospects of the lower horizons of the Pechenga ore field in relation to sulfide copper-nickel ores. SG-3 was started in the northwestern part of the Kola Peninsula, 10 km west of the city of Zapolyarniy (69°25 N, 30°44 E). The area has some of the oldest ore-bearing tectonic structures on Earth from the Early Proterozoic and Archean periods. With a design depth of 15 km, the well was supposed to reach a depth of 13 km by 1990 [2].

Fig. 1. Interdepartmental State Commission for the selection of the SG-3 location. From right to left: Head of the Kola State Geological Survey, D.M. Guberman, at the site of the SG-3, Academician V.I. Smirnov, Head of the Department of Scientific Research Organizations of the USSR Ministry of Geology, G.I. Gorbunov, his deputy N.P. Laverov. Photo by D.F. Saburova, Kola State Geological Survey, 1968.

Drilling of the Kola well was entrusted to the specially organized Kola geological exploration expedition of the Volgokamskgeologia association (since 1986 — the Nedra association) of the USSR Ministry of Geology and Mineral Resources. Up to 3000 specialists and 16 research laboratories worked at the well at the same time. D.M. Guberman became the head of the Kola geological exploration expedition, and the geologist team included V.S. Lanev, Yu.P. Smirnov, and others [2]. Drilling was started on May 24, 1970 not only to study the most ancient rocks of our planet, but also to discover new deposits of copper-nickel ores of the Pechenga ore field [5, 2, 3].

The purpose of drilling SG-3 was to study the deep structure of the Precambrian structures of the Baltic Shield, typical for the basement of ancient platforms, and to assess their ore-bearing capacity. The main tasks of the works were as follows:

- To study the deep structure of the nickel-bearing Pechenga complex and the Archean crystalline basement of the Baltic Shield, to find out the features of geological processes at great depths, including ore-forming processes.
- To clarify the geological nature of seismic boundaries in the continental crust and to obtain new data on the thermal regime of the subsoil, deep water solutions and gases.
- To obtain fullest possible information on the material composition of rocks and their physical state, to discover and study the border zone between the “granite” and “basalt” layers of the Earth's crust.
- To improve the existing and to create new technologies and technical means for drilling and complex geophysical surveys of ultra-deep wells.

The solution of these issues should be based on the results of core examination by geological, petrographic, mineralogical, geochemical methods using optical, X-ray, microprobe, thermal, chemical-analytical, spectroscopic, and other methods of analysis. An important task was to develop technical and technological solutions for drilling wells to ultra-low depths.

The choice of the SG-3 well location was determined by the results of deep seismic sounding along the Barents Sea — Pechenga — Lovno, performed in 1958–1962 [6]. It has been determined that beneath the central and northeastern parts of the Pechenga structure, the upper boundary of the “basalt” layer is at the smallest depth. This part of the Baltic Shield has been studied by deep seismic sounding. Detailed magnetic and gravimetric maps as well as well drilling results are available. It was assumed that there is a granite stratum to a depth of 5 km, after which it was expected to find stronger and more ancient basalt rocks. The geothermal gradient there is lower than in other geological regions and amounts to 1.0–1.2°C per 100 m depth, which greatly facilitated the conditions for well drilling. In addition, crystalline rocks have high strength, which implies the use of a simplified well design.

At the beginning, drilling was carried out with the Uralmash-4E serial drilling rig, which was used for oil and gas exploration and production. It took 4 years to drill to a depth of 7263 metres (Fig. 2).


a


b

Fig. 2. Drilling rigs of SG-3 — "Uralmash-4E" 1970 (a), "Uralmash-15000" 1984 (b). Photo by D.F. Saburov, Kola State Geological Survey, 1972 and 1977.

The first stage of drilling was completed in May 1975, when the well reached a depth of 7263 m. By this time, the section of the Early Proterozoic North Pechengian volcanic-sedimentary rock series was intersected, and the well entered the underlying Archean gneisses. The successful implementation of the first stage of drilling had a decisive influence on the development of the optimal way to develop ultra-deep drilling. One of the most important technical achievements of the first stage of drilling was the development of the technology for drilling wells in crystalline rocks up to 7 km using drilling equipment and tools of domestic production [2]. Then there was a break for almost a year to replace the drilling rig. The Uralmash-4E drilling rig was dismantled, and a specially designed set of Uralmash 15000 drilling equipment with a lifting capacity of 400 tons was installed with maximum automation and stepless regulation of the main technical processes.

In 1976, after the installation of the drilling complex, the second stage of drilling began. The Chairman of the Presidium of the Kola Scientific Center of the USSR Academy of Sciences, G.I. Gorbunov, and the Head of the Department of Scientific Research Organizations of the USSR Ministry of Geology, N.P. Laverov, came to SG-3 to evaluate its readiness to continue drilling (Fig. 3). This installation was used for further drilling, and it made it possible to penetrate 12262 meters deep into the Earth's crust. In June 1979, the well broke the record of 9583 meters held by the US well, reaching a depth of 9584 meters. In 1983, the well reached a depth of 12066 m. As of 05/01/1991, the well depth was 12262 m [3].

Fig. 3. G.I. Gorbunov, the Chairman of the Presidium of the Kola Branch of the USSR Academy of Sciences, N.P. Laverov, the Head of the Department of Scientific Research Organizations of the USSR Mingeo at the SG-3 well in 1976. Photo by N.P. Laverov, 1973 and 1976.

During the second stage of SG-3 drilling, a number of complex technical problems were solved. So, at depths of more than 8 km, it turned out to be practically impossible to control the bit operation using ground sensors and instruments. The investigations revealed the promising of hydraulic communication channel for transmitting the information from downhole sensors to the surface by means of frequency modulation of pressure pulses in fluid [2]. The most important requirements were to ensure maximum core recovery and to maintain borehole verticality. On December 27, 1983, the well depth reached 12000 m, and the drillers were preparing to drill to the target depth (Fig. 4).

a b c

Fig. 4. Stages of SG-3 drilling, 10000 m (a), receiving and laying of core (b), 12000 m (c). Photo by D.F. Saburov, Kola Geological Survey, 1980, 1982, 1983.

After reaching a record depth of 12066 meters, drilling was suspended, as preparations were being made for the XXVII International Geological Congress to be held in Moscow in 1984. The outstanding achievements of the Soviet Union in the field of deep exploration of the Earth's interior attracted geologists, engineers, technologists and other specialists both in our country and abroad. It was decided to report the main results of the SG-3 study at a special session of the Congress and to show the participants the work of the well and the core samples raised from the depths. A special excursion of the ministers of geology of many countries to SG-3 was organized. The Kola superdeep well was recognized as the most outstanding achievement of world science in the 20th century [3]. It was included in the Guinness Book of Records as a world achievement [2, 7].

In 1990, the maximum depth was reached — 12262 m, which has not been surpassed so far. However, a drastic reduction in funding made it impossible to continue the work. Drilling was stopped in 1992. It was assumed that after completion of drilling the Kola superdeep well would be turned into a unique laboratory for the study of deep processes in the Earth's crust using special instruments. However, in 1995, all scientific work was terminated due to lack of funding, and the well itself was mothballed [7, 8].

The decision to dismantle the unique Uralmash 15000 drilling equipment was made in summer 2007 by a special expert commission of Rosnedra and Rosimushchestvo representatives.

Features of SG-3 drilling technology

Drilling of the Kola well was carried out using only domestic equipment and technology. All drilling equipment was made at the enterprises of the USSR defense industry, just as in the nuclear weapons and spacecraft projects. A unique drilling rig “Uralmash 15000” was created with a lifting capacity of 400 tons, with a drilling fluid injection pressure of 40 MPa, with maximum automation of drilling processes. The rig was designed for drilling wells to a depth of 15 km [2].

The industry has mastered the production of more than 30 new types of drilling equipment. For the first time in the world, automated equipment using turbine drilling was used in a drilling rig: when not the entire string rotates, but only the drill head. Drilling fluid was fed through the string under pressure to rotate a 46 m long multistage turbine at the bottom with a 214 mm drill bit. A pipe — a core receiver — passed through all sections of the turbine; it collected the core

samples of the drilled rock. In order to create a long drill string, several types of drill pipes made of light alloys based on aluminum have been developed, including those capable of operating at great depths and in high temperatures. A drill string of this length, assembled entirely from steel pipes, would simply break off under its own weight (Fig. 5). In total, more than 50 km of light-alloy pipes were used in the drilling process.

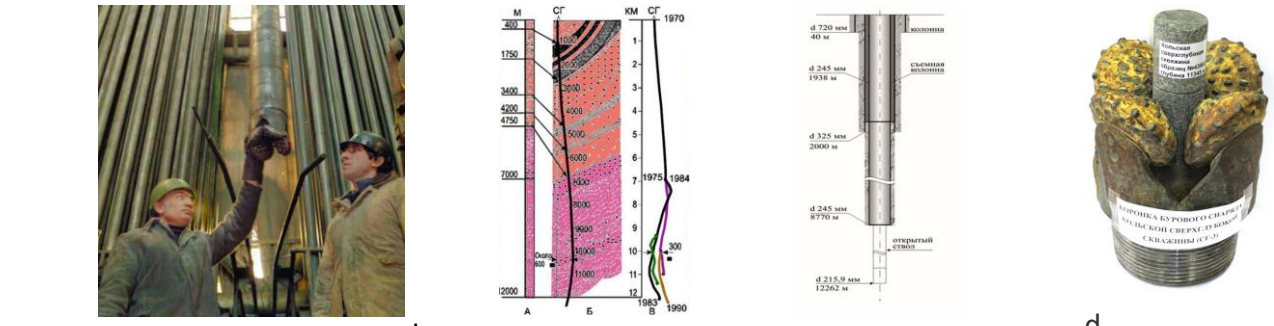

Fig. 5. SG-3, running the turbodrill (a), schematic section of the well (b), actual design of the well (c), drill bit with core (d). a — photo by D.F. Saburov, Kola Geological Survey, 1977, d — photo by K.V. Lobanov, 2019

To drill the well, rock cutting tools and downhole motors for deep conditions with hard-alloy drill bits were designed. One bit served about 4 hours with a 7–10 meter penetration. With a well depth of more than 8000 m, it took up to 18 hours to run the string in and out with its automatic disassembly into sections. The SG-3 was the first in the world to use a monitoring and control system for the drilling process. The information-measuring system included three main software and hardware subsystems: preparation for the trip, control of drilling, and the results. Taking into account the peculiarities of rock drilling, the main task of the system was to recognize critical technological situations [2–3, 6–8].

On September 27, 1984, drilling of SG-3 was continued. Another 9-meter interval was drilled, but the drill string broke off at a depth of more than 12 km. The drill string was stuck while being lifted. A turbodrill and 5 km of drill pipes remained in the well. Only 7 months later, drilling was resumed from a depth of 7000 m.

A lot of similar difficulties, completely unexpected, arose during the drilling and coring the Kola well. To a depth of about 7 km, the borehole intersected solid, relatively homogeneous Proterozoic volcanic-sedimentary rocks, and therefore the borehole was flat, almost corresponding to the diameter of the drill bit. However, less durable, fractured, interbedded Archean rocks — gneisses, amphibolites — went deeper than 7 km. Drilling became more difficult, and the borehole took on an oval shape, many caverns appeared, and accidents became more frequent. After the largest accident in 1984, it took 6 years to reach 12 km depth again.

A total of 12 by-pass bores were drilled in the well. Four of them had a length from 2200 m to 5000 m. The borehole branching frustrated the drillers, but delighted the geologists, who unexpectedly got a three-dimensional picture of an impressive array of ancient Archean rocks that formed more than 2.5 billion years ago. Below 7 km, the well is a multilateral mine, the first shaft

of which was completed at a depth of 11662 m, the second shaft, drilled from the first one at a depth of 9378 m, reached 12066 m, the third one, started at a depth of 7010 m, ended at 12 262 m, and, finally, the fourth shaft, drilled in the third one at a depth of 9649 m, reached11 882 m (Fig. 5, b) [9]. This was the reason for the duration of the last drilling phase, since up to 60 m were drilled in a month.

The MAG 195/60 core barrel is a device that is attached to the turbodrill shaft and is equipped with a system for hydrotransporting the core through the receiving pipe to the core collector. These projectiles with a hydrotransport system are capable of holding up to 20 m of core with a diameter of 60 mm. More than 70% of the drilling interval was core-traversed with an average core recovery of 40.1% for the whole borehole. The duration of one running-in and pulling-out time at the depth of 12000 m was 21 hours [1].

The SG-3 trunk has a diameter and a circular cross-section only in the upper intervals — up to 6000 m. Cavernous zones in the trunk were only in the zones of tectonic faults, where it had a complex isometric shape. At depths of more than 7000 m, the wellbore had an elliptical section. Cavernous zones were associated with tectonic faults. In the upper intervals, the wellbore is generally resistant to hydrodynamic and mechanical influences, and in the Archean rocks, external influences led to collapse of the borehole walls and significant changes in its radial dimensions. In 1992, a unique operation was carried out to install a casing in the SG-3 borehole to continue drilling the well to a depth of 13 km. However, despite this, further drilling was abandoned.

Geological drilling results

The main task of drilling the Kola superdeep well was to study the deep structure and ore content of the ancient continental crust: obtaining a deep geological section; comprehensive study of the material composition of rocks and the nature of their change with depth; elucidation of the features of endogenous geological processes in the deep parts of the Earth's crust and their connection with ore formation processes; elucidation of the geological nature of deep geophysical boundaries and geophysical parameters of geological strata [3]. The basis for solving these issues was the data obtained during the study of the core, which was taken continuously along the well section and studied comprehensively by various methods. As a result, unique information was obtained, which often significantly changed ideas about the deep structure of the subsoil.

The SG-3 penetration disproved the previous views on the Earth crust structure in the vicinity of Pechenga structure. The design section of the well, based on seismic data, predicted that at a depth of 4 km, the well will emerge from the volcanic-sedimentary rocks of the Pechenga structure and enter the granite-gneisses of the Archean basement. After the drilled three-kilometer layer of granite-gneiss, the well was supposed to sink into the basalt layer. However, the rocks of the Pechenga structure extended to a depth of 6842 m, and only then were replaced by Archean granite-gneisses. The basalt layer was not found at all: up to the record depth, the drill penetrated through the Archean granitoid rocks.

When examining core samples during seismological studies, it was found that compacted granitoids were perceived by geophysicists to be denser than standard rocks. This is new geological information that allows for a different interpretation of the data of deep geophysical surveys (Fig. 6).

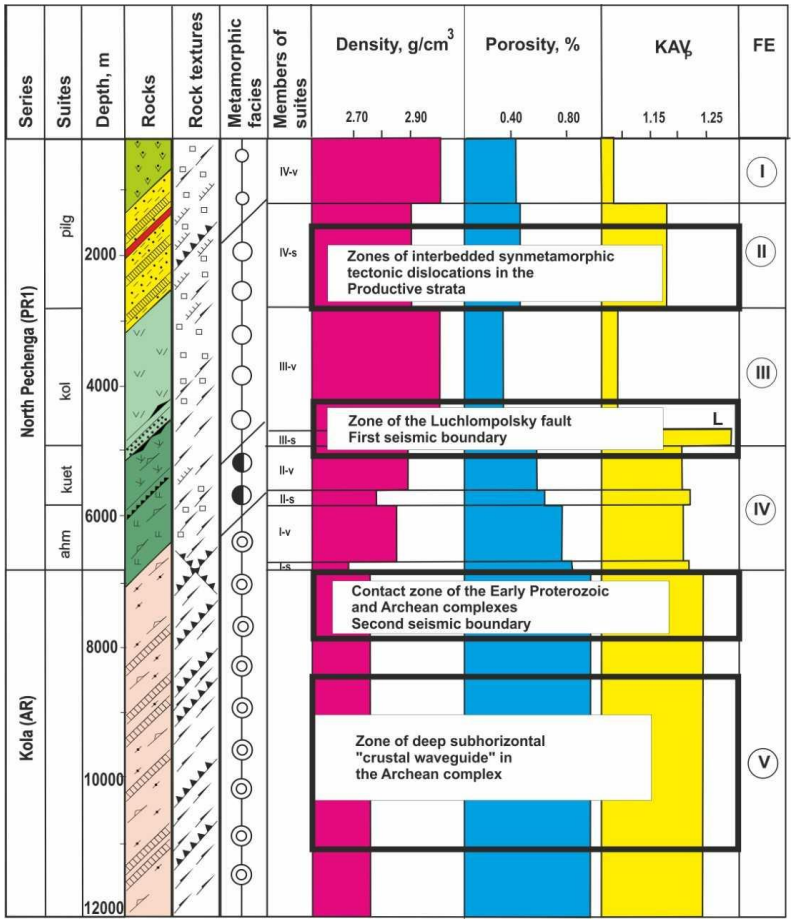

Fig. 6. Formalized section of the Kola superdeep well with tectonic faults zones [8].

The well is located on the northern flank of the Pechenga structure in order to assess the prospects of deep horizons in relation to copper-nickel mineralization, to cross the contact of the Early Proterozoic volcanics with Archean gneisses of the Kola series at the level of 4.7 km, and to penetrate into the “basalt” layer in the interval of 7.5–8.5 km to open Conrad's surface. As for the first task, it was successfully solved. At a depth of 1.5–1.7 km in the middle part of the productive strata, the well discovered a previously unknown body of nickel-bearing hyperbasites. However, the assumption about the presence of Konrad's surface at a depth of 7.5–8.5 km was not confirmed. The bottom of the North Pechenga Group was crossed at the 6.8 km, and up to a record depth of 12 km, the well passed through the gneisses and amphibolites of the Kola Group, i.e. along the “granite” layer of the Earth's crust. It was found that granitoids at great depths were perceived during seismological studies by geophysicists as denser than standard rocks [2, 3].

An important place in the structure of the Pechenga ore field is occupied by interstratal tectonic zones of synmetamorphic shearing, which led to the formation of flaky-block structures [4, 5, 7, 9, 10]. Four tectonic zones are identified in the SG-3 section and on the surface. The values

of the petrophysical parameters of rocks in interstratal tectonic zones are characterized by the highest density, porosity, and KAVp.

Petrological studies of the SG-3 core proved the synchronism of the Middle Proterozoic metamorphism and flake-thrust movements of rocks. Determination of the temperatures of metamorphism from the compositions of coexisting minerals and mineral associations confirms the general increase in the intensity of the process with depth. The average temperature of volcanic metamorphism in the upper part of the SG-3 section is 300°C (prenite-pumpellite facies), and the end of the greenschist facies (4900 m) is 450°C. In the epidote-amphibolite facies interval (4900–6000 m), it is 550°C, and within the amphibolite facies (the lower parts of the North Pechenga Group and the Archean Kola Series), metamorphism temperatures range from 550°C to 650°C (6000–12000 m). The section does not reveal a metamorphic break between the lowermost parts of the Severopechenga and Kola series: according to the mineral associations, both rocks correspond to the amphibolite facies and have crystalline-schisty textures. This suggests that granitization took place within the temperature boundaries of the amphibolite facies [11, 9, 10, 7].

Direct measurements of temperature at great depths were equally interesting and unexpected. It was assumed that in tectonically calm areas, to which the Baltic Shield belongs, the temperature increases insignificantly with depth (approximately 8–10°C per 1 km). However, the real temperature in the borehole at a depth of 10 km reached 180°C, and at a depth of about 12 km, the temperature values reached 212°C, instead of the assumed 120°C [12]. The role of mantle and radiogenic sources in the total depth heat flow was elucidated.

The Kola superdeep borehole provided extensive material on ore mineralization at various depths. The study showed the presence of mineralization in the ancient continental crust over the entire 12 km interval (Fig. 7).

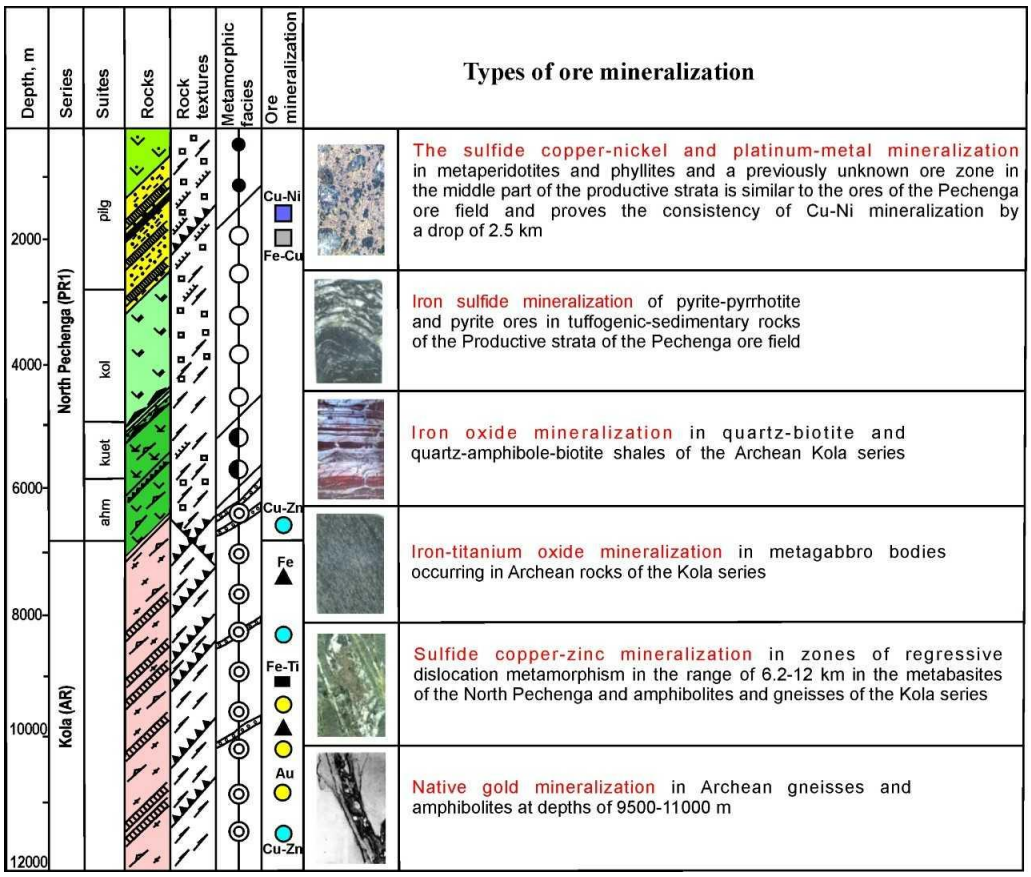

Fig. 7. Vertical ore zoning in the SG-3 section [8].

Six types of mineralization have been identified: sulfide copper-nickel and platinum-metal, sulfide iron, oxide iron, oxide iron-titanium, sulfide copper-zinc and gold-silver. At a depth of 1600–1900 m, an interval of commercial Cu-Ni ores was identified, the study of which made it possible to identify new deposits. The discovery of a previously unknown type of Au-Ag mineralization in the 9500–11000 m interval aroused great interest.

This may be due to increased tectonic activity in the deep horizons of the Earth's crust. Low-temperature hydrothermal mineralization (copper, copper-zinc, nickel) was deposited in the zones of groundwater circulation recorded at great depths (6.5–11.5 km and more).

The data on the processes of ore formation in the deep layers of the Earth's crust also turned out to be fundamentally new. Highly porous fractured rocks saturated with highly mineralized underground waters were encountered at depths of 9–12 km. These waters are one of the sources of ore formation. This was previously thought to be possible only at much shallower depths. The low-temperature ore minerals associations found in the well indicate the fundamental possibility of their industrial accumulations at these depths, not to mention high-temperature ore formations. This conclusion is of fundamental importance for the development of the theory of minerals and prospecting for ore deposits at great depths [4]. New data on ore formation at great depths was registered as scientific discovery No. 28 in the field of Earth Sciences.

Conclusion

The Kola superdeep well is an outstanding achievement of world and Russian geological science in the development of continental drilling. It was drilled within the framework of the "Exploration of the Earth's interior and superdeep drilling" program. All work under this program was carried out using only domestic equipment and technology. All drilling equipment was made at the enterprises of the USSR defense industry, as well as in nuclear weapons and spacecraft projects. The unique drilling rig Uralmash 15000 was created.

For the first time in the world, SG-3 was drilled using the latest domestic technical means, scientific study of the deep structure of the earth's interior. New materials and drilling technologies have been used, and unique drilling equipment has been created, which made it possible to reach previously inaccessible depths. This result has been unrivaled for 50 years. SG-3 is a breakthrough into the bowels of the Earth and can only be compared with a flight into space.

The joint work of about 200 scientists and specialists from scientific and industrial organizations of various ministries and departments made it possible to obtain material from such depths and to measure various parameters directly in the Earth's crust to a depth of 12262 m using new scientific equipment capable of operating in high temperatures and pressures. The obtained samples of rocks from great depths are comparable in value to samples from the Moon.

Geological and geophysical information on the deep structure of the Baltic Shield has significantly corrected the theoretical concepts that prevailed before drilling the well. Based on the study of the mineral-geochemical composition of the core rocks and a complex of studies in the SG-3 shaft, data on the material composition and physical state of deep rocks were obtained.

The geophysical boundary, which gives the greatest reflection during seismic sounding, where the rocks of the "granite" layer pass into a stronger "basalt layer", in the SG-3 section, indicates that there are less strong and less dense fractured rocks — Archean gneisses. Instead of the "Konrad surface" (the top of the basalt layer), a sub-horizontal "crustal waveguide" was identified, a kind of decompaction zone, the movement of tectonic blocks along these zones provided the flake-thrust structure of the entire Lapland-Pechenga block.

New data were obtained when assessing temperatures at great depths. It was assumed that in the granite-gneiss basement of the Baltic Shield, the temperature increases insignificantly with depth (by about 8–10°C per 1 km). The real temperature in SG-3 at a depth of 10 km reached 180°C, and at a depth of about 12 km — 212°C, instead of the expected 120°C.

The SG-3 study showed the presence of ore mineralization in the ancient continental crust over the entire 12 km interval. Six types of mineralization have been identified: sulfide copper-nickel and platinum-metal, sulfide iron, oxide iron, oxide iron-titanium, sulfide copper-zinc and gold-silver. The data on the process of ore formation in the deep layers of the Earth's crust also turned out to be fundamentally new. Thus, at depths of 9–12 km, highly porous fractured rocks saturated with highly mineralized underground waters were encountered. These waters are one

of the sources of ore formation. Previously, it was believed that this is possible only at much shallower depths.

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Northern Miniature in the Ecclesiastic Book of the Early 19th Century *

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Abstract. The article is devoted to the study of plots associated with different stages of the movement of the soul, presented in a manuscript book and on drawn sheets. The book was written at the beginning of the 19th century in the Russian North in the Old Believers' environment. The manuscript is interesting in composition, content and unique in design. The text of the book is written on fifty-five sheets, collected in a notebook and bound into a book. The manuscript includes three works: an excerpt from the eighteenth chapter of "The Flower Garden of Dorotheus of Gaza" about the spiritual ladder, the vision of Monk Gregory about the walk of Blessed Theodora, a story about a meal from the teachings of Saint Niphon.The text is attached by four folding miniatures and several illustrations - images on the themes of the works of the manuscript, which interpret the literary text more fully. As a result of the research, it was found that this collection is not the only list. Collections, similar in composition and decoration, are contained in the archives of museums and libraries of the country. This indicates the book wealth of the Russian North, the artistic and genre diversity of the northern book.
Keywords: *manuscript book, illustrated collection, northern miniature, Old Believer collection manuscript book.*

The book collection of the State Museum Association “Art Culture of the Russian North” contains a book of exceptional content and design. The manuscript is titled “Collection of texts on the ways of perfection and spiritual ordeals” [1, Nenasheva L.V., p. 210–218]. The book is written in one handwriting in ink on 55 sheets, collected in notebooks and bound in a book. The manuscript has plant-type headlines, initials, and capital letters in the text are spelled with cinnabar. The first page of the book is decorated with a rectangular headband in brown ink with floral ornaments. In addition to the main text, the manuscript contains several miniatures and long illustrations on paper, duplicated on fabric. The illustrations are in the form of strips, accordion-folded vertically or horizontally. The contours of the drawings are subtly traced with a pen in ink, the colors of the figures are green, yellow and red. The reader unfolds the panoramic drawings as they read the text. The images and the size of the inserts, drawn in detail on the sheets of the book, made a strong impression on the reader and viewer of the text.

The manuscript was written in the first quarter of the 19th century that is confirmed by a white date, 1816, which is visible against the light. In addition to the date, letters VM were found on the left side of the sheet, and M and B on the right side (Vologda (Velsk) manufactory of the Martyanovs and Bolozerskiys). In the table of alphabetic filigree, these signs are indicated under No. 138 — 1810, No. 139 — 1817–1818. [2, Klepikov S.A., p. 17].

The collection opens with the narration: “The ladder spiritual and ascent to heaven ...” (sheets 1–3back). This passage is taken from chapter 18 of the “Flower Garden of the holy monk

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Abba Dorotheus". The main idea of this passage is self-improvement and spiritual purification, a gradual ascent up the ladder of righteous life. The author encourages the reader to walk constantly up the spiritual and rising stairs to heaven. In the interpretation, the author explains that the steps of the spiritual ladder leading to heaven are the Lord's commandments and the virtues of the Father. Whoever goes along that staircase, one step at a time, ascends upward. Whoever steps in two or three ones — slips and falls to the ground again and crashes. So are the commandments and virtues: whoever bypasses the first commandments, will not summit the latter ones. The text is illustrated with a miniature in the form of a key to the gate from the Kingdom of Heaven (Fig. 1).

Fig. 1. The key to the gates of the kingdom of heaven (ladder of the 60 commandments).

The general view of the composition is represented by sheets glued back to back, forming the shape of a key, which consists of a bit, a rod and a grip. The bit of the key shows the foot of

the stairs, along which people who have chosen the path of spiritual ascent try to climb, but not everyone succeeds in doing this. Some of them manage to do it, and the person on the top of the ladder tries to climb up to the ladder of the sixty commandments. Winged demons, traditionally depicted with protruding bumps on their heads, try to drag people down the spiritual ladder with their hooks, and one demon succeeds: he pulls off a young man and drags him into the fiery abyss. Here, on the left side of the miniature, a group of people harnessed a demon as a symbol of a sinful life, which pulls them down into the fire of passions. In the lower central part of the sheet, the demon invites a doubting person to follow him (Fig. 2).

Fig. 2. The lower part of the key (bit).

The middle part of the key (rod) is a staircase of 60 numbered steps. The image of the ladder goes back to the famous vision in Jacob's dream from the book of Genesis, chapter 28. The image of the ladder is central to the work of John of Sinai, which was written as a guide to monastic life — “Lestvitsa” (“The Ladder”). “Lestvitsa” was a popular and beloved book in Russia, plots from it were drawn by Russian writers and poets, some chapters from it were published in pre-revolutionary magazines for home reading, for pedagogical education [3, Nenasheva L.V., p. 159]. As noted by R.V. Bagdasarov, “in Russia “Lestvitsa” of John of Sinai acquired special popularity during the ascetic rise of the 14th–15th centuries” [4, Bagdasarov R.V., p. 7]. In the “Lestvitsa”, before the beginning of the main text and in other early Russian manuscripts, a staircase of thirty steps was depicted according to the number of years of Jesus Christ’s life before baptism, “then the image of monks climbing the steps and demons interfering with them is increasingly spreading”. And the number of steps increases to sixty [4, Bagdasarov R.V., p. 7].

In our miniature, nine people climb the steps at different heights. To the right of the steps, the beginning of the New Testament commandment with its number is written in column. And here, on the steps, the struggle for human souls continues. Five people successfully climb the stairs of the commandments, their heads are raised, their eyes directed upward. The demons are trying to knock three companions down the stairs (two of them — with a stick, the third one is be-

ing poked in the back with sharp hooks), so those descending are drawn face down, uncertainly stepping onto the rung of the stairs. One of the climbers is trying to maintain balance and not to break down. This image most likely symbolizes a person insecure in himself and in his actions, weak to temptations and not always keeping the commandments, so his fall is inevitable (Fig. 3, 4).

Fig. 3. Ladder of the 60 commandments.

Fig. 4. Ladder of the 60 commandments (key rod).

The artist placed the Kingdom of Heaven in the grip of the key; the ladder of the commandments reaches up to the Lord's gates. The Lord on the throne rises in the center of the heavenly city. He holds an open Gospel with his left hand, the fingers of his right hand are folded in a two-fingered sign. Behind the back of the Savior is a shining hemisphere, behind which are the angelic figures on either side. On the right side of the throne are figures with beardless faces (young men and, possibly, women), on the left — bearded ones. The lower part of the miniature shows the city walls of houses that make up a single whole, with windows lined in a cage, with beautiful gates and figured columns on the sides — a characteristic image of the heavenly city in northern Old Believer manuscripts. A young man and an old man stand at the city gate. Five houses are drawn on the edges of the picture, figures of saints can be seen in four of them. "The symbolism and form of the picture are transparent. The kingdom of heaven opens with the key of God's commandments. <...> The key is intended for the door, and there is no doubt that the compilers of the plot were well aware of this "door" [4, Bagdasarov R.V., p. 10] (Fig. 5).

Fig. 5. Kingdom of heaven (key grip).

The handwritten sheets 7–29back contain a text from the hagiography of St. Basil the New on the tollhouse of Blessed Theodora. The text tells how Saint Theodora, after her death, underwent 21 aerial tollhouses and announced it in a dream vision to the disciple of the monk of Basil the New — Gregory. Theodora was a novice of the monk Gregory. After her death, he cared greatly for the novice and prayed for her soul, and in a dream, he succeeded to see Theodora's afterlife. The story of the monk Gregory about walking through the tollhouses of Blessed Theodora is included in the Hagiography of Basil the New, who lived in Byzantium in the 10th century. The translation of the Hagiography into the Slavic language was made in Russia at the end of the 11th century. From the second half of the 17th century, personal lists of the visions of the monk Gregory and the tollhouses of the Monk Theodora are widely circulated among the Old Believers, and since the 18th century, these plots are often found in Old Believer popular prints and drawn sheets, especially in the Russian North [5, Orthodox encyclopedia, p. 210–212].

Theodora's story begins with the fact that she dies of an illness, and at that moment many demons (in the text — Ethiopians) come to her bedside with a charter, in which Theodora's deeds from her youth are written. On the right side of the bed, there are two angels accompanying the soul of Theodora. Then death comes in the form of a skeleton with a scythe in his left hand and an ax in his right hand. It has various tools in the shoulder bag: swords, knives, saws, sickles, arrows. Death cuts off Theodora's legs with a small axe, then her hands, destroys her joints and nails, and finally cuts off her head. The miniature shows how the soul of Theodora moved away from the body and the young angels took it into their hands (Fig. 6).

Fig. 6. Moving of the Theodora's soul away from her body.

Further, in the text, Theodora tells the monk Gregory about the walking of her soul through the tollhouses, about the struggle of angels for the salvation of her soul. The tollhouses of Theodora are vividly described: they follow each other, from bottom to top, like the steps of a ladder and are located on clouds, where one or more demons are located with a box with rolled scrolls inside. The soul of the novice is placed in the hands of two angels who accompany her and try to protect her from evil demons. These chapters are illustrated with drawings for the walk of the Monk Theodora through the air tollhouses (Fig. 7). The reader was able to get acquainted visually with such tollhouses as slander, abuse, envy, lies, anger, pride, idle talk and foul language, recklessness and flattery, drunkenness, rancor, gluttony, fornication, etc. The text is illustrated with two folding miniatures. The soul of Theodora undergoes twenty-one tollhouses, which is described in detail in the book and depicted in the figures (Fig. 8, 9).

Fig. 7. The ladder of tollhouses.

Fig. 8. Tollhouses 18–21.

Fig. 9. Tollhouses 12–14.

Blessed Theodora's tollhouses end happily: the angels succeed in saving her soul from the demons, who could not find the grave sins she had committed while a novice. Further Theodora says: "We joyfully departed from the demons, approached the heavenly gates and entered them". She then describes in detail the heavenly kingdom and her joy in the heavenly abode. The miniature depicts habitats, typical for northern drawings. Saints look out the windows everywhere. Angels carry the soul of Theodora, and all the saints rejoice at her salvation, and the angels say to her: "You see, Theodora, from what torments the Lord delivered you through the prayers of Saint Basil". On the right side, the Monk Basil is depicted sitting on the throne. He meets the soul of Theodora forty days after her separation from the body (Fig. 10).

Fig. 10. Heavenly abode.

Another folding miniature shows drawings depicting souls held in tollhouses (a sequence of drawings from top to bottom), turning into an image of the entrance to hellfire and the throne of Satan (Fig. 11–14).

Fig. 11. Fragment of fig. 13.

Fig. 12. Fragment of fig. 13.

Fig. 13. Fall into hellfire.

Fig. 14. Hellfire.

On sheets 31–39 back, a story was written on behalf of the monk Gregory: “The saints enter the joy of the Lord”. All the ranks of the saints are shown in groups on a long ribbon. The enumeration of the ranks of the saints in the text and on the ribbon miniature begins with the Mother of God, ends with the immaculate wives. The list contains seventy disciples, twelve apostles, righteous Abraham, Isaac and Jacob, prophets, merciful and poor. The faces of the righteous were “red, white and blushing”, their clothes were white or colored with cheerful, bright colors — green, yellow and red. The groups of the righteous in the drawing are accompanied by inscriptions (Fig. 15–18).

Fig. 15. The saints enter the joy of the Lord.

Fig. 16. Fragment of fig. 15.

Fig. 17. Fragment of fig. 15.

Fig. 18. Fragment of fig. 15.

The beauty of the righteous is contrasted with the ugliness of sinners: robbers, thieves, adulterers, angry, ardent, vindictive, apostates, suicides. And, as the author writes in the book: “There were many of them all over the Earth, ‘like the sand of the sea from Adam’”. This is written in the book on sheets 41–52. The text is also illustrated by a folding ribbon miniature depicting groups of sinners who are captured and thrown into the river of fire by young angels (Fig. 19–21).

Fig. 19. The sea of fire.

Fig. 20. Fragment of fig. 19.

Fig. 21. Fragment of fig. 19.

The last two folios, pages 54-55, present a short edifying story about the meal of the pious and the wicked: “The lection of our holy father Niphont, as it is proper for Orthodox Christians to eat in silence”, which is read at the service on Saturday of the fourth week of Great Lent. This chapter is also illustrated. One sheet depicts a dinner, during which modest beggars are sitting at the table, they are honored with the presence of the angels themselves and therefore, in silence and humility, they have the meal. Another sheet depicts the rich sitting at the meal, at dinner they started idly talks, angry speeches, dissatisfaction with food, they behave violently, so the angel left them, anddark demons came instead of them and began to spread evil among the diners and pour “malicious smoke” on them (Fig. 22). The story of the meal, illustrated in miniature, is often found in northern Old Believer collections.

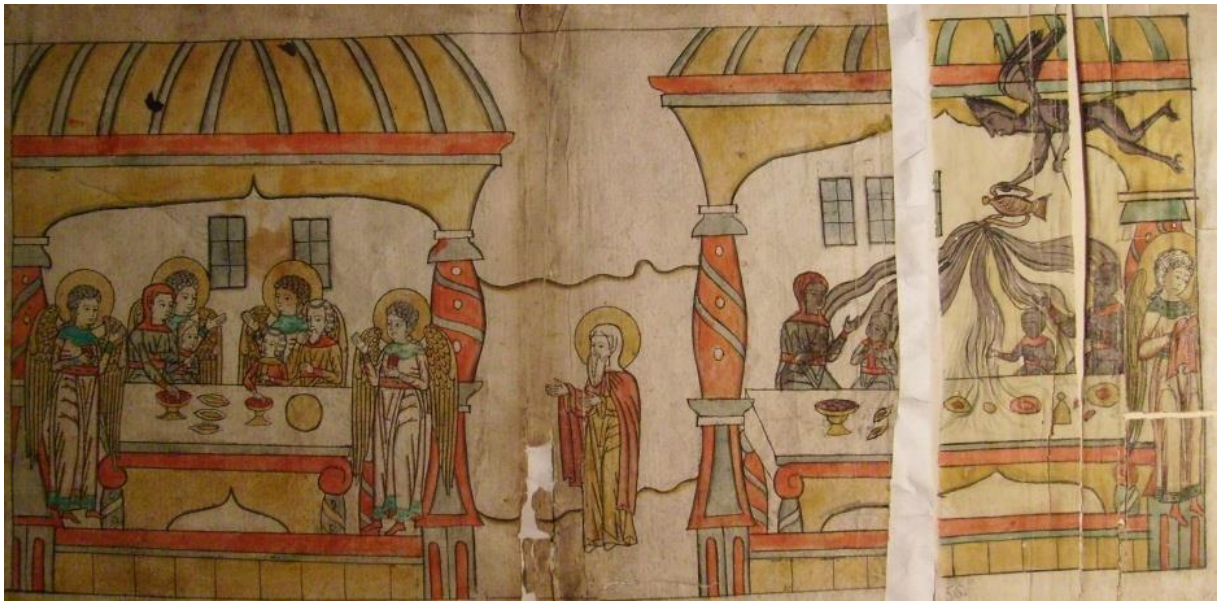

Fig. 22. The meal of the pious and the wicked.

This list is not the only one in the museum association “Artistic Culture of the Russian North”. The funds of the State Russian Museum contain a manuscript monument, which was acquired in 1967 by N.V. Taranovskaya in Nizhnyaya Toyma on the Northern Dvina, in the village of Velikiy Dvor. As noted by N.V. Taranovskaya, “the book is a collection of an eschatological nature, including four narratives on 52 pages, written in half-running hand”. The book also contains illustrations in the form of long folding strips. N.V. Taranovskaya calls this list the “Spiritual Ladder” after the name of the initial chapter, and dates it to the second half or the end of the 19th century, since the text and drawings were made on the paper of the Sumkin heritage factory No. 6 [6, Taranovskaya N.V., p. 118]. The so-called Spiritual Ladder from the Russian Museum is very similar to the manuscript created in the first quarter of the 19th century, kept in Arkhangelsk Museum, in composition, content, plots and manner of illustrations.

Copies of drawings, similar to the illustrations in our book, are also given in the article by R.V. Bagdasarov, where he explores the plots presented on the drawn sheets of the mid–late 19th century from the collection of Archpriest Vladislav Provotorov (Pavlovskaya Sloboda, Moscow Oblast) [4, Bagdasarov R.V., p. 3]. According to R.V. Bagdasarov, the plots of these pictures were cop-

ied from the drawn sheets that belonged to Nikolai Prokopyevich Shestakov, who lived in the village of Izosimovo, Belosludskiy camp (now it is Krasnoborskiy district of the Arkhangelsk Oblast) [4, Bagdasarov R.V., p. 4]. N.P. Shestakov is known as a scribe of books, one of the last icon painters on the Northern Dvina [7, Budaragin V.P., p. 404].

Perhaps the manuscript from the Russian Museum was copied from our literary monument. Then our list could not be fulfilled by N.P. Shestakov, since researchers know his works of the late 19th–first third of the 20th centuries. [7, Budaragin V.P., p. 404].

The manuscript from the Russian Museum also begins with the narrative "The Spiritual Ladder and Ascent to Heaven", and, as N.V. Taranovskaya writes, "the text of the first narrative of our manuscript gave it a name" [6, Taranovskaya NV, p. 118]. The collection also ends with a story about the meal of the pious and the wicked, "the plot, which is reflected in the Domostroy, in basten prints" [6, Taranovskaya N.V., p. 122]. A key to the gate to the kingdom of heaven is drawn to the sheets of text. The drawing of the key is very similar to the drawing from our book. It can be assumed that the pictures of miniatures that we discovered in scientific literature are very similar to the miniatures of the museum manuscript, which means that the miniatures presented in the museum book, as well as in the manuscripts in the collection of the Russian Museum and a private collection, are written in the same book workshop, in the north, in the Old Believer environment.

The miniatures in the three books show common features, "peculiar only to the manuscripts of Severodvinsk" [7, Budaragin V.P., p. 402]. "The Severodvinsk master, who is usually represented as a carpenter, woodcarver, ornamentalist-painter, turns out to be an excellent calligrapher, graphic artist, bibliophile, as well as an icon painter, that is, a master in the broad sense of the word and a spiritual mentor, a teacher of life" [6, Taranovskaya N.V., p. 117]. Therefore, the plots of miniatures, presented in these lists, are found on drawn sheets, on icons, in popular prints created in the Severodvinsk art workshops.

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