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Issue Article

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WHAT SYSTEMIC PROBLEMS, NEW RISKS AND OPPORTUNITIES FOR SUSTAINABLE DEVELOPMENT ARE CHARACTERISTIC OF THE RUSSIAN ARCTIC?

Abstract: *In this article, the authors examine the systemic and emerging challenges, risks, and opportunities for economic development, including sustainable development, in the Russian Arctic. An analysis of the characteristics, trends, and prospects for industrial production in the Russian Arctic is provided, revealing the challenges and specific features of single-industry towns. The readiness of Russian Arctic regions to overcome current economic instability from a labor market perspective is established. The problems and prospects for creating conditions for the integrated use of raw materials in Arctic regions are examined and substantiated. The conditions and prospects for shift work transformation are identified as a reserve for changing migration trends and developing the Arctic labor market.*

Key words: *Current issues, investment projects, global recessions, geopolitical processes, problems of increased costs, socio-economic processes, Arctic zones, economy of the Arctic Zone of the Russian Federation regions.*

Language: *English*

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Introduction

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The presented article is a continuation of the results of scientific- research papers confirming the relevance of the problem under consideration, clarifying the current specifics and prospects for socio-economic processes in the Arctic Zone of the Russian Federation (AZRF). Identifying the causes of this problem confirmed the relevance of the specific objective of the work—uncovering, through a range of problematic tools, the systemic and prospective dynamics of the socio-economic space of the Russian Arctic, taking into account geopolitical, macroeconomic, environmental, and mineral resource factors. Current reality confirms that the contradiction remains, and the unique nature of the current transformation conditions in the AZRF enhances the relevance of the problem. Thus, in 2024, amid extreme uncertainty, based on analogies to the behavior of Arctic regions during previous crises, a number of Arctic economic researchers expected the COVID-19 pandemic to lead to changes in the Arctic, including:

the solution to the problem of increased costs and lost profits for a number of industrial sector enterprises using unpopular methods and the suspension of a number of large investment projects due not so much to the decline in external demand for the main Arctic export items and restrictions on oil production under the OPEC+ agreement, but rather to the uncertainty of their duration;

the depth of the subsequent global recession and associated geopolitical processes.

However, at the 2024 stage of work, we are faced with a different situation, different from the behavior of the Arctic Zone regions in previous crises, which is rapidly changing the conditions for the development of the Arctic, namely:

Firstly, it was revealed that the conditions of the COVID-19 pandemic and a number of major environmental disasters in the Arctic Zone of the Russian Federation have significantly strengthened the provision of oil and gas, mining and metallurgical enterprises with factors for the sustainable development of the territory of their presence, including the greening of production, support for the economic growth of the territory, and the social responsibility of business (which is consistent with global processes);

secondly, the accelerated implementation by the state of an investment mechanism for the development of the Arctic Zone of the Russian Federation has been identified, which contributes to the intensification of a number of large investment projects of private business for the development of new fields, the development of processing, and infrastructure (which corresponds to the fundamental reasons for the entry of the global economy into the growth phase of the raw materials cycle);

Thirdly, the accelerated stabilization of economic processes in the Arctic Zone of the Russian Federation was identified and explained in comparison with the overall Russian situation, but at the same time, the acceleration of demographic losses in the regions of the Arctic Zone of the Russian Federation was also explained, including due to the more negative impact of the COVID-19 pandemic (due to low medical and demographic reserves and insufficient medical care, which could not compensate for the significantly higher costs of combating the pandemic).

In fact, the COVID-19 pandemic, the implementation of a new mechanism for managing the development of the Arctic Zone of the Russian Federation, and the fundamental causes of the growth phase of the global commodity cycle have accelerated the systemic processes of development of the Russian Arctic to such an extent that noticeable changes in the socio-economic dynamics are expected in the very near future. For example, already at the 2024 stage, we substantiated the accelerated achievement of a number of economic, environmental, and innovative strategic development targets for the Arctic Zone of the Russian Federation, but at the same time, the low probability of achieving demographic indicators. For example, the increase in the migration growth rate planned in the "Strategy for the Development of the Arctic Zone of the Russian Federation and Ensuring National Security through 2035" (here in after referred to as the Arctic Zone Development Strategy) is limited by accelerated growth in labor productivity, digitalization, automation and robotics, and increased use of shift work and remote work in the Arctic Zone of the Russian Federation; The planned increase in life expectancy is limited by the extremely negative impact of the COVID-19 pandemic on the population of the Arctic Zone of the Russian Federation, which is reflected in higher mortality rates in 2021–2022 and a greater reduction in life expectancy compared to the national average.

Thus, a unique opportunity is now emerging to study, in real time, a research problem that is evolving before our eyes so rapidly and so differently from what experts expected that objectively, we are not talking about maintaining the relevance of the problem, but, on the contrary, about its strengthening.

New conditions and opportunities for Arctic development require an in-depth examination of aspects that, on the one hand, best reflect the specific impact of geopolitical, macroeconomic, environmental, and mineral resource factors, and, on the other, will significantly determine the socioeconomic dynamics and development prospects of the Russian Arctic. To identify these aspects and substantiate these objectives, the following facts, which we relied on in our research and the results of which are reflected in this article, are relevant:

First, the results of a review of the global and national impacts on the development prospects of the Arctic Zone of the Russian Federation regions confirmed the potential for economic and associated socioeconomic growth for the Arctic Zone of the Russian Federation regions, the development of industrial production, and the mitigation of risks to increasing the primary exports of the extractive regions. It should be noted that the current consequences of the implementation of the SVO in Ukraine have increased the risks of realizing these promising opportunities, but the "pivot to the East" and the implementation of a full-scale national economic policy by Russia support the preservation of the established potential.

secondly, the established preservation of the strategic goals for the development of the Arctic, the implementation of which is ensured by the accelerated implementation of a mechanism for increasing investment activity in the Arctic Zone of the Russian Federation;

Thirdly, an understanding of the nature of public and corporate governance policies and practices during the COVID-19 pandemic in the Russian Arctic regions revealed the primacy of environmental issues, social responsibility, and the associated climate change issues. This is fully consistent with the latest global trends in accelerating the implementation by enterprises of strategies to ensure sustainable development factors in the regions where they operate, including greening production, adhering to ethical standards, promoting regional economic growth, and corporate social responsibility.

These facts confirm the importance of our broad context for studying the development of the Russian Arctic, not only from the perspective of achieving the economic performance of specific enterprises and Arctic development targets established at the regional and national levels, but also within the context of moving forward within the global strategy for the development of the oil and gas, mining, and metallurgy industries, taking into account the risks, opportunities, and new roles in societal stabilization amid the COVID-19 pandemic and growing geopolitical tensions. This broad context naturally underscores the scale of new challenges that must be addressed, namely:

- on the one hand, updating the risks and opportunities for greening production and social responsibility for enterprises in the Arctic Zone of the Russian Federation;
- On the other hand, the fact that the supporting role of the state as a regulator of conditions for the development of business initiatives by the private sector in the Arctic strengthens the development opportunities and the influence of business on socio-economic processes, but at the same time creates restrictions on business development, the need to ensure a set of security measures - epidemiological and environmental,
- Thirdly, the need to achieve the strategic development goals of the Arctic Zone of the Russian Federation, enshrined in the set of strategic indicators for the development of the Arctic Zone of the Russian Federation, including demographic indicators, the likelihood of which we justified as low (the main target indicators are reflected in the Arctic Zone Development Strategy and the Russian Federation Program "Socio-Economic Development of the Arctic Zone of the Russian Federation"). Given the above, we first had to decide: namely, to determine the conditions for the sustainable development of the Russian Arctic.

Main part

This article presents a solution to the problem of finding out. The potential and limitations of ensuring sustainable development in the Arctic Zone of the Russian Federation are explored based on a comprehensive set of studies, including the impact of climate change on ecosystems, the specifics of nature management in the Russian and international Arctic, as well as a detailed examination of institutional conditions and promising areas for improvement. The importance of addressing this challenge stems from the established global trend of increasing public attention to the practical activities of enterprises and the environmental and social impacts of these industries in their territories. Furthermore, observational data indicate an acceleration in the rate of climate change at high latitudes, making it crucial to consider their impact on Arctic processes from the perspective of ensuring sustainable development and preventing potential environmental disasters during economic activity. For natural resource managers, climate change offers new opportunities, primarily related to the increased duration of the dynamically active period of water use for fishing, tourism, mineral exploration and extraction, and cargo transportation along the Northern Sea Route. On the other hand, it presents new challenges, primarily related to the threat of destruction of land-based and offshore infrastructure for industrial and social purposes. To ensure sustainable development, it is necessary to carefully plan economic activities in the Arctic and conduct environmental impact assessments as part of the mandatory state environmental review process. This requires taking into account the prospects of climate change, comprehensive monitoring, and integrated control, including an assessment of climatic and anthropogenic impacts on terrestrial and marine ecosystems.

The Arctic is a region that has received significant attention from many countries worldwide (Figure 1). This is due to a combination of factors. An analysis of numerous scientific papers, as well as the authors' own research, revealed the following characteristics common to virtually all Arctic regions:

- special natural and climatic conditions caused by a lack of oxygen and solar heat due to high latitudes, long, snowy and low-temperature winters, permafrost, and an ice sheet on land and in the waters of the Arctic seas;
- slow biological and chemical-biological

processes, which reduces the ability of ecosystems to self-purify and makes them particularly vulnerable to anthropogenic impacts;

- short growing season of plants and insufficient capacity of vegetation to absorb greenhouse gases;
- the formation of local industrial clusters that are significantly dependent on external supplies of various resources;
- the economy of territories based primarily on the extraction of natural resources;
- low population density of the territory and high population migration;
- with a small number of large settlements, the population is predominantly urban.

Since the described specific features are common to virtually all Arctic territories—both those belonging to Russia and those under the jurisdiction of other Arctic countries—they can be considered fundamental. These fundamental characteristics constrain the sustainable development of Arctic territories.

Figure 1. Arctic territory.

The mechanism for ensuring sustainable development in the Russian Arctic includes governance, economic, social, and environmental aspects (Figure 2). All of these aspects operate in a comprehensive manner, creating a synergistic effect that enhances the impact of each individual aspect on achieving the overall result.

Figure 2. Aspects of the mechanism for ensuring sustainable development of the Russian Arctic.

Historically, most of the Russian Arctic was sparsely populated and experienced little anthropogenic impact due to its underdeveloped industrial environment. However, increased interest in the Arctic's resource potential has led to the development of industrial and social infrastructure, the emergence of industrial enterprises, and the growth of settlements, including cities. The combination of these factors is disrupting the ecological balance of Arctic territories and increasing the risk of sustainable development due to environmental pollution. As our research has shown, major Russian corporations with production assets in the Arctic are rapidly modernizing equipment and developing technologies that reduce pollutants, including greenhouse gas emissions, into the environment. Consequently, over the period 2018–2024, A decrease in air pollutant emissions has been observed—from 3,356.5 to 3,284.6 thousand tons, wastewater discharge—from 638 to 619 million m³, and waste recycling has expanded—from 18.7 to 35.5 million tons. We previously noted the decoupling effect in the economic development of the Arctic Zone of the Russian Federation, whereby increased production volumes were accompanied by a reduced burden on the natural environment. On the other hand, the area of disturbed lands is growing as a result of hydrocarbon field development in the Arctic. Regular monitoring of greenhouse gas levels in the atmospheric air is organized at three stations in the Russian Arctic, located in the settlements of Teriberka, Tiksi, and Novy Port. The observation results from the Teriberka and Tiksi stations are of particular interest, as they are located in conditions close to natural ones (Table 1).

Table 1. Carbon dioxide and methane concentrations in the Russian Arctic

Year	Teriberka				Tiksi			
	SN_4, Billion–1	ΔCH_4, Billion–1	CO_2, Million–1	ΔCO_2, Million–1	SN_4, Billion–1	ΔCH_4, Billion–1	CO_2, Million–1	ΔCO_2, Million–1
2012	1910.2	4.0	396.6	2.3	1910.2	-3.0	396.1	1.9
2013	1907.8	-2.4	398.8	2.2	1915.1	4.9	399.1	3.0
2014	1913.5	5.7	400.7	1.9	1930.8	15.7	400.7	1.6
2015	1924.4	10.9	402.2	1.5	1940.1	9.3	403.2	2.5
2018	1946.7	22.3	405.7	3.4	1946.4	6.3	406.1	2.9
2020	1947.1	0.4	409.1	3.5	1956.7	10.3	408.7	2.6
2021	1950.4	3.3	411.4	2.2	1960.4	3.7	411.3	2.6
2022	1961.8	11.4	414.1	2.7	1983.7	23.3	414.3	3.0
2023	1980.4	18.6	415.8	1.8	1993.6	9.9	416.5	2.2
2024	1999.1	18.7	418.5	2.6	2014.1	20.5	419.1	2.6

A ten-year study (2014–2024) showed a nearly constant increase in carbon dioxide and methane concentrations. Over the ten years, CO_2 concentrations increased by 6%, reaching a maximum (418.5 ppm in Teriberka and 419.1 ppm in Tiksi) in 2024; CH_4 concentrations increased by 5%, also reaching a maximum (1999.1 ppm in Teriberka and 2014.1 ppm in Tiksi) in 2024. These values are close to data from the Barrow Arctic Research Center in Alaska. In 2023, the rate of CO_2 concentration growth slowed to 1.8–2.2 ppm per year. This was likely due to reduced production caused by the COVID-19 pandemic. In 2024, greenhouse gas emissions increased again, reaching 2.6 million tons per year. At the same time, a significant increase in atmospheric CH_4 concentrations was observed: 18.7 billion tons in Teriberka and 20.5 billion tons in Tiksi. The energy crisis in circumpolar (or near-Arctic) countries, caused by a reduction in energy consumption from Russia due to political and economic factors, is leading to an increase in the share of coal, fuel oil, and wood among energy sources. The use of such energy resources leads to increased greenhouse gas emissions and a weakening of decarbonization policies. Risks to sustainable development in the Arctic are increasing exponentially.

The proposed outcome of Arctic sustainable development management is a reduction in the negative anthropogenic impact on the natural environment. In this study, the negative anthropogenic impact is assessed based on the volume of emissions from stationary sources into the atmosphere, wastewater discharges, and waste generated. The effectiveness of Arctic sustainable development management was assessed using a set of indicators (Figure 3). A dynamic analysis of the indicators reflecting the effectiveness of Arctic sustainable development management is presented in Figure 4.

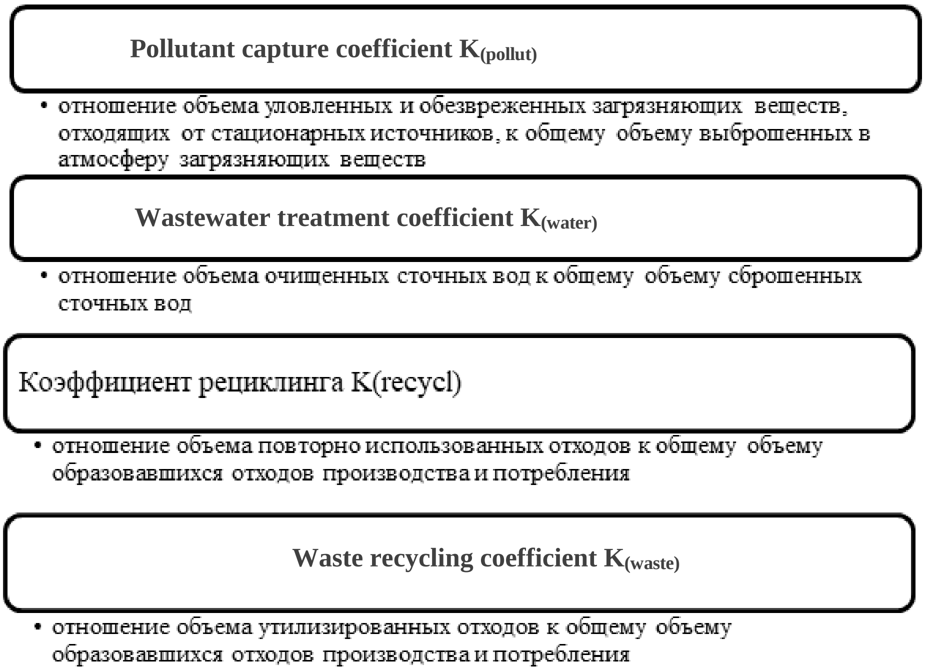
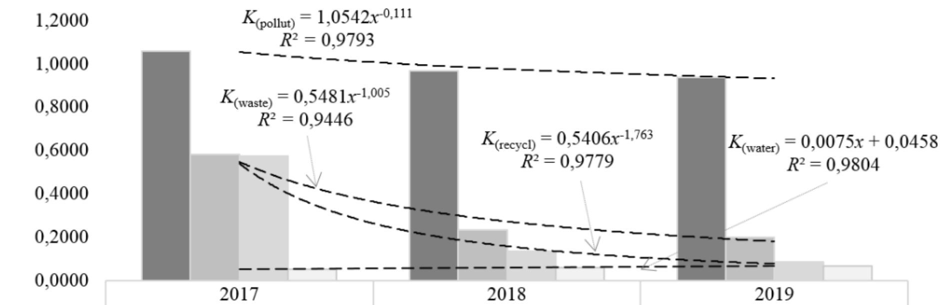


Figure 3. Performance indicators for sustainable development management in the Arctic

It was revealed that, despite active innovation and increased investment in environmental protection, declining trends in pollutant capture, waste disposal, and recycling prevailed in the Russian Arctic zone from 2018 to 2024. The opposite trend is characteristic of water resource management, the trend line of which is described by a linear function (the approximation reliability R2 was 0.98). Thus, the burden on the environment is increasing. The effectiveness of sustainable development management in the Arctic for the period from 2018 to 2024 cannot be considered satisfactory, while current (operating) costs for environmental protection in the Russian Arctic zone increased from RUB 32,133 million in 2018 to RUB 38,146 million. in 2022, but decreased to 36,577 million rubles in 2024. The structure of current (operating) costs for environmental protection in the Arctic zone of Russia in 2022 and 2024 is presented in Figure 5.



	2017	2018	2019
K(pollut)	1,0582	0,9658	0,9387
K(waste)	0,5802	0,2340	0,2003
K(recycl)	0,5752	0,1346	0,0866
K(water)	0,0539	0,0596	0,0690

Figure 4. Evaluation of the effectiveness of sustainable development management in the Arctic

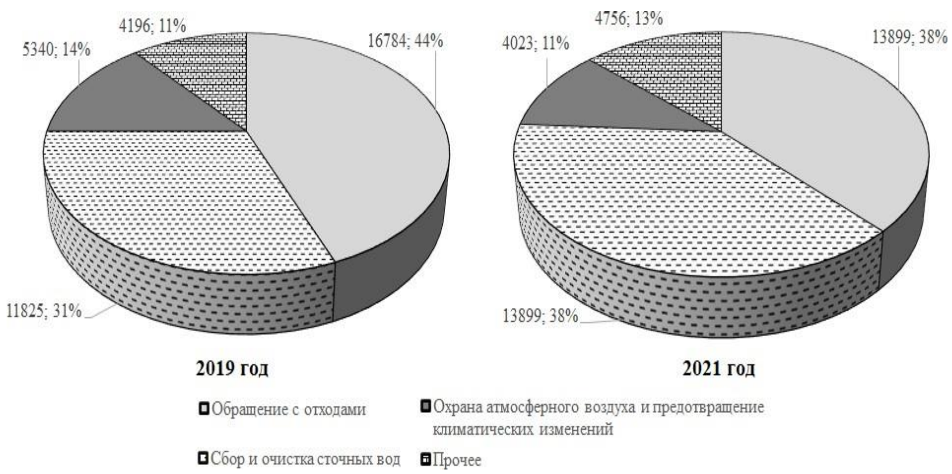


Figure 5. Structure of current environmental protection expenditures in Russia's Arctic zone. Source: Authors' calculations based on data from the Federal State Statistics Service

The largest share of expenses was allocated for waste management (44 and 38% in 2022 and 2024, respectively), wastewater collection and treatment (31 and 38% in 2022 and 2024), and air protection and climate change mitigation (14 and 11% in 2022 and 2024). Waste management expenses decreased by RUB 2,885 million in 2024, and air protection and climate change mitigation expenses decreased by RUB 584 million. At the same time, wastewater collection and treatment expenses increased by RUB 2,074 million, taking into account that in 2024, compared to 2022, total environmental protection expenses in the Arctic Zone of the Russian Federation decreased by RUB 1,569 million, or 4.1%.

Next, the indicators of specific costs for managing sustainable development in the Arctic were determined, for which the volume of investments per unit of environmental pollution was calculated (Figures 6, 7).

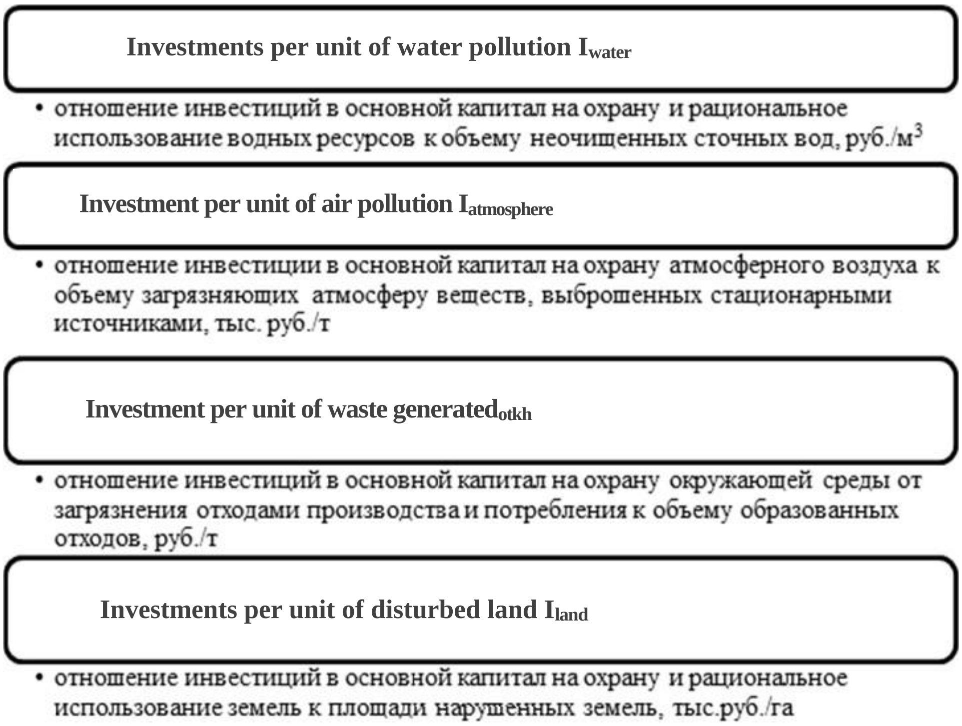


Figure 6. Indicators of unit costs for managing sustainable development in the Arctic.

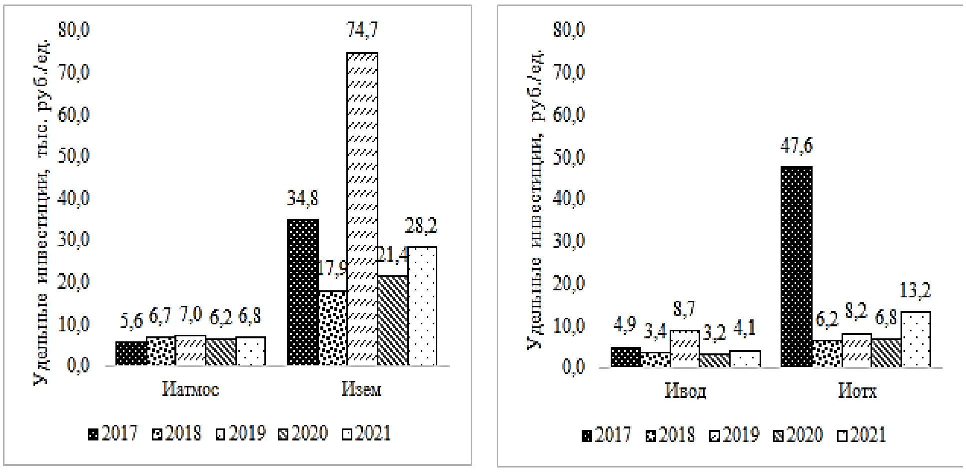


Figure 7. The volume of investment per unit of environmental pollution in the Russian Arctic.

An analysis of specific investments per unit of environmental pollution reveals an increase in the financial resources attracted to ensure sustainable development of the Arctic. In 2024 (compared to 2023), specific investments in Ivod per unit of water pollution increased by 76.15%, reaching 8.7 rubles/m3. The increase in specific investments in the protection, rational use, and reclamation of Izym lands amounted to 114.73%, reaching 74.7 thousand rubles/ha, in measures to protect atmospheric air Iatmos — 24.76%, reaching 7.0 thousand rubles/t; the increase in specific investments in fixed assets intended for the disposal and recycling of production and consumption waste Iotkh amounted to 30.9%, reaching 8.2 rubles/t. In 2023, the size of all specific investments per unit of environmental pollution decreased: specific investments per unit of water pollution in Ivod decreased by 63.22%, reaching 3.2 rubles/m3; specific investments in the protection, rational use and reclamation of land in Izem decreased by 71.35%, reaching 21.4 thousand rubles/ha; investments in measures to protect atmospheric air in Iatmos decreased by 11.43%, reaching 6.2 thousand rubles/t; the drop in specific investments in fixed assets intended for the disposal and recycling of production and consumption waste in Iotkh amounted to 17.07%, reaching 6.2 rubles/t. In 2024, on the contrary, an increase in the indicators is noted: Ivod - 4.1 rubles/m3 (28.12%); Izem - 28.2 thousand rubles/ha (31.78%); Iatmos - 6.8 thousand rubles/t (9.68%); Ioth - 13.2 rubles/t (112.90%).

An assessment of the effectiveness of sustainable development management in the Arctic was conducted based on a comparison of environmental protection expenditures and pollutant emissions. Sustainable development management in the Arctic can be considered effective if investments in environmental protection measures contribute to improved environmental performance and a reduction in negative environmental impacts. Calculation of correlation coefficients revealed a direct relationship between current (operating) environmental protection expenditures in the Arctic zone and the volume of treated wastewater (k = 0.68), as well as between the volumes of reused and recycled waste (k = 0.77). Thus, the effectiveness of sustainable development management in the Russian Arctic is evident here. A significant negative correlation coefficient between current environmental protection expenditures and the volume of captured and neutralized pollutants emanating from stationary sources (k = –0.92) indicates ineffective spending on air protection. Risk is a key concept in sustainable development. Risk is a combination of the probability of a hazardous event occurring and the severity of the consequences of this event for the economy, population, and ecosystems of the Arctic.

Decision-making processes in managing sustainable territorial development typically occur under conditions of varying degrees of uncertainty. The effects of industrial development in the Arctic territories can increase or decrease the risk of sustainable development in the Arctic Zone of the Russian Federation. In our understanding, this refers to a complex of factors caused by industrial development that significantly impact the development of the Russian Arctic's manufacturing sector, the livelihoods of the local population, and the environment.

It is common practice to distinguish between positive and negative externalities, and we therefore adhere to this classification. Positive externalities from industrial development in the Arctic reduce the risk of sustainable development, while negative ones, conversely, increase it. Based on scientific research, we have systematized the externalities of industrial development in the Arctic (Table 2).

In addition to the positive effects noted, the potential for sustainable development in the Russian Arctic is enhanced by international cooperation in environmental protection and sustainable resource management, strengthening national security globally, and the progressive development of industrial and logistics corporations operating in the Arctic. The risk of natural and man-made accidents increases. And, of course, climate change presents new risks and opportunities for sustainable development in the Russian Arctic. In recent years, Arctic researchers have pointed to a dramatic shift in the Arctic climate. This is due, on the one hand, to the accumulation of greenhouse gases in the atmosphere, largely produced by anthropogenic activity, and on the other, to natural cyclical temperature fluctuations. While the causes may differ, the result is the same. While the Arctic remained one of the most inaccessible places on the planet, scientific theories about its geopolitical and economic importance were perceived as pure abstraction. However, the situation has now changed: over the past half-century, Arctic territories have warmed three times faster than the Earth's surface as a whole. And the rate of these changes is accelerating. The Arctic Council's Arctic Climate Change (AMAP) research group, which studies Arctic climate change, has predicted that by 2035, the average annual surface temperature in the Arctic will increase by 3.3–10°C compared to the 1995–2018 average. Melting of permafrost and glaciers is already noticeable, as well as a larger and earlier clearing of ice from water surfaces and snow cover from land. According to the AMAP report, "Arctic Climate Change: Key Trends and Impacts," significant, and in many cases critical, climate changes have occurred in the Arctic between 1971 and 2024 (Figure 8).

Table 2. External effects of industrial development of Arctic territories that determine the risk of sustainable development

Positive effects that mitigate risks	Negative effects that increase risks
Ecological	
Capture of pollutants, disposal of production and consumption waste, treatment of discharged wastewater, etc.	Pollution of the atmosphere, water bodies, land destruction, increased incidence of disease, etc.
Innovative	

Research and development; high-tech technologies that benefit multiple stakeholders; investment inflow	A "brain drain" to countries that offer decent rewards for intellectual capital; automation of processes, accompanied by the replacement of manual labor with machines, and, as a result, rising unemployment
Investment	
When investing in production - growth of productivity, quality of manufactured products; when investing in environmental protection measures - environmental externalities; when investing in human capital - scientific and technological development of the economic system	Corruption, inefficient use of funds
Infrastructure	
Developing transport infrastructure that is accessible to the local population; industrial development requires expanding social infrastructure (in healthcare, education, etc.)	Destruction of natural objects
Social	
Improving the quality of life, increasing wages, and increasing the number of jobs	Unemployment and morbidity in industrial areas

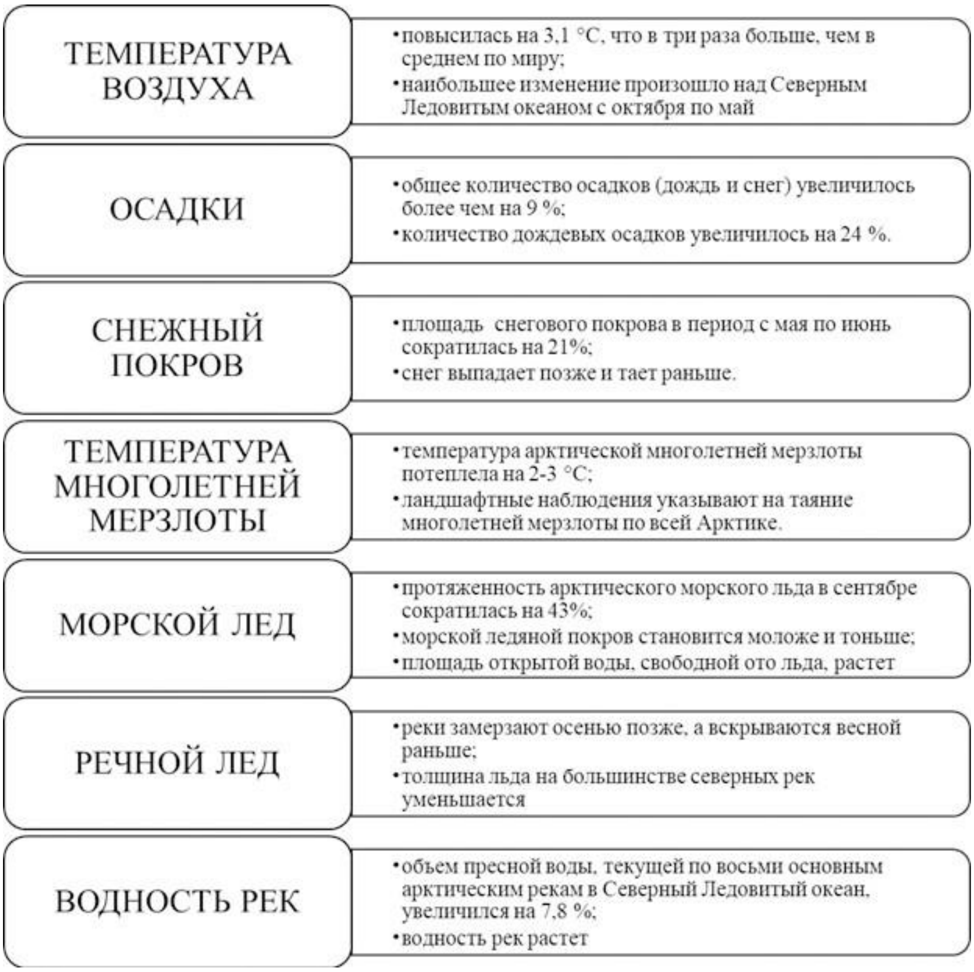


Figure 8. Climate change in the Arctic. Source: compiled from AMAP data

From 1995 to 2024, the average annual surface air temperature in the Arctic increased by 3.1°C, three times faster than the global average. This conclusion is based on AMAP instrumental data with interpolation applied over the Arctic Ocean, where observations are sparse. The largest air temperature change over this 49-year period occurred over the Arctic Ocean between October and May, averaging 4.6°C, with the peak warming of 10.6°C occurring in the northeastern Barents Sea. The situation was similar in the Arctic zone of the Russian Federation. Across all sectors of the Russian Arctic, the trend toward increasing average temperature began in the late 1970s and intensified sharply in the 21st century. In 2024 alone, the temperature increased by 1.9°C. Warming over the 45-year period from 1995 to 2024 across the Arctic Zone of the Russian Federation is 0.69°C/10 years (Figure 9). Based on observations and modeling, total annual precipitation in the Arctic (rain and snow combined) increased by more than 9% from 1995 to 2024, with rainfall increasing by 24%, and the greatest increase occurring during the cold season—from October to May.

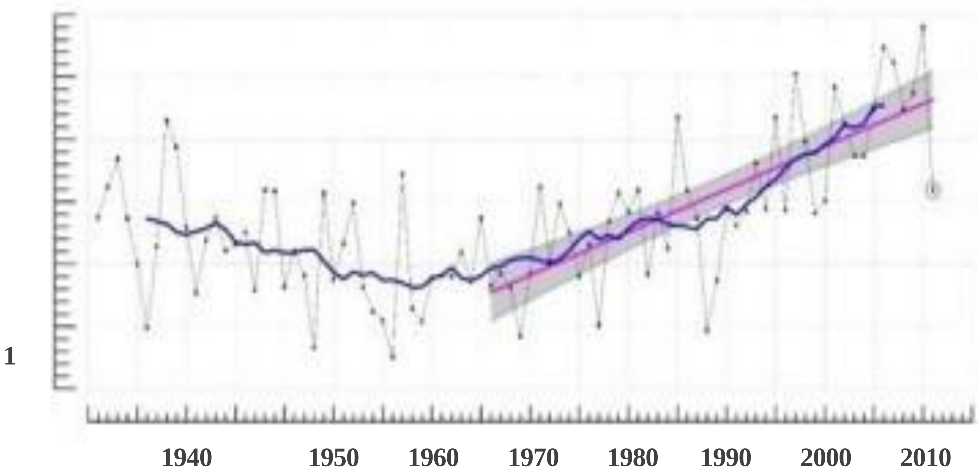


Figure 9. Dynamics of air temperature in the Arctic zone of the Russian Federation and the linear trend since 1995

Combined with disruption of glaciological processes in the Arctic, increasing precipitation is leading to increased river flow: the volume of freshwater flowing through eight major Arctic rivers into the Arctic Ocean has increased by 7.8%. A distinctive feature of the Arctic zone of the Russian Federation is a significant area of permafrost, characterized by low temperatures and a thin layer of seasonal thaw (Figure 10). The freezing depth of rock in some places reaches 1.5 km. Since the 1970s, Arctic permafrost has warmed by 2–3 °C. In many colder permafrost areas, the rate of warming over the past 20 years has been higher than at any time since 1979. The seasonally thawed layer has become deeper in many areas since the 1990s, and landscape observations indicate thawing of permafrost throughout the Arctic. Climate warming has had a significant impact on the ice cover of the Arctic seas. The area of Arctic sea ice at the end of summer has decreased by 43% over half a century; it has become younger and thinner. Strong, persistent winds over the ice-free sea surface generate severe storms and gales. The area of sea ice in the Siberian Arctic seas began to decrease especially rapidly after 1996 (Figure 11). The rapid melting of ice led to a sixfold reduction in the ice area of the Russian Arctic seas over ten years (1996–2015) (from 1,400 to 234 thousand km2), a further sixfold reduction from 2015 to 2018 (from 234 to 37 thousand km2), and a 1.4fold reduction from 2018 to 2024 (from 37 to 26.3 thousand km2). In 2024, the ice area increased by 26% compared to 2023.

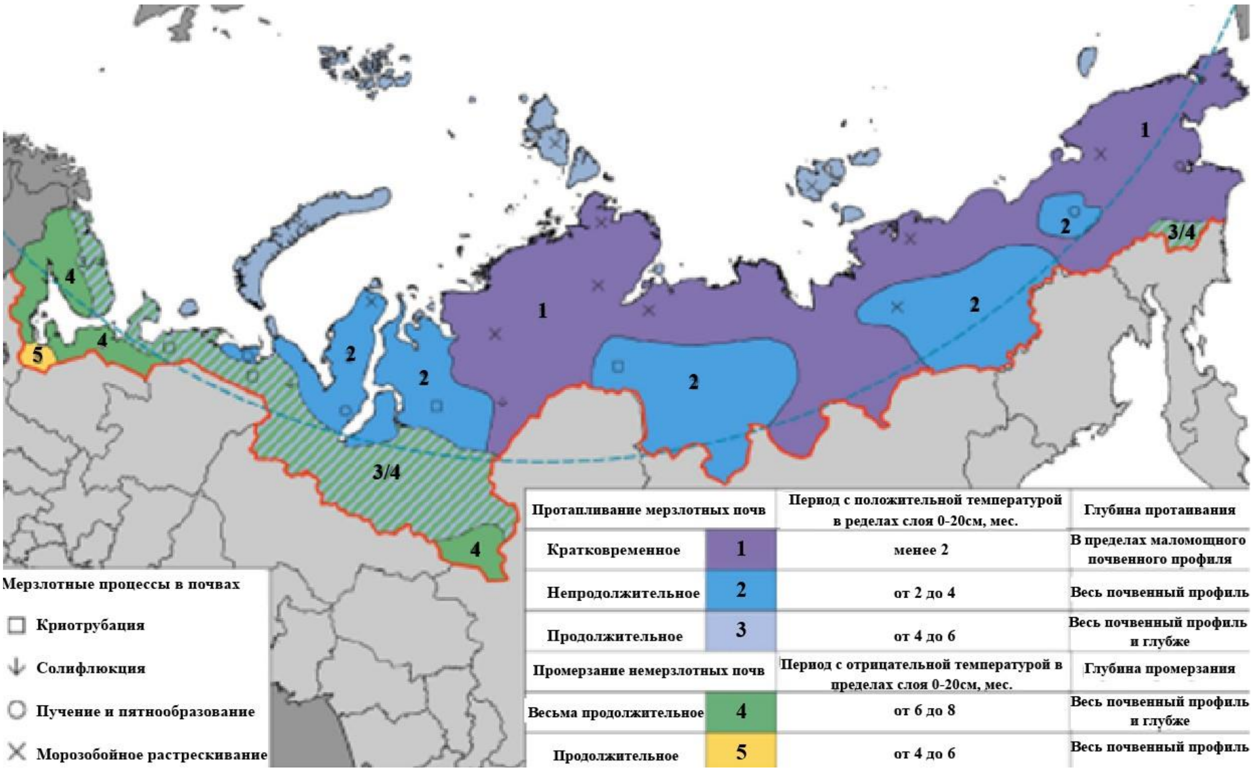


Figure 10. Map of permafrost processes in the Arctic zone of the Russian Federation

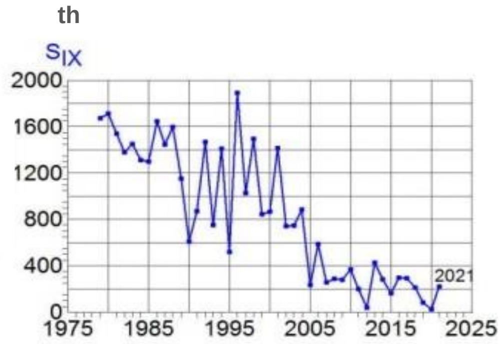


Figure 11. Dynamics of sea ice extent in the Siberian Arctic seas

The speed and scale of changes caused by global warming, as well as the limited capacity of Arctic nature to self-regenerate, are leading to the transformation and degradation of the unique ecological systems of circumpolar countries.

Researchers are already noting the disappearance of ecosystems on some glaciers, including shelf glaciers, which are retreating under the influence of high temperatures. The number of epi shelf lakes, each with its own unique ecosystem, is shrinking. Arctic freshwater bodies are becoming polluted and acidified, negatively impacting the reproduction of zoobenthos and fish. The combined effects of long-term warming (rising water temperatures, longer ice-free seasons, melting permafrost) and extreme events (storm waves and swells) are increasing erosion. Coastal erosion is accelerating in many parts of the Arctic, where some of the highest erosion rates on Earth are observed.

Thus, climate change is a pressing issue in the

Arctic, where temperatures are rising much faster than the global average, and widespread changes in precipitation, snow cover, permafrost, and sea and land ice are transforming the Arctic environment, with long-term impacts on sustainable development. These changes have long-term consequences for the Arctic. While warming in these areas offers new development opportunities, it also brings new risks to sustainable development. This has intensified the struggle for the Arctic, which is taking place on several fronts, namely:

First and foremost, new opportunities for mineral development. The Russian Arctic is extremely rich in mineral resources (Figure 12); however, most deposits are located in hard-to-reach areas with harsh climates, above the Arctic Circle. Due to melting glaciers and a generally milder climate, extracting and transporting natural resources in the Arctic will become much easier, simpler, and cheaper. Deposits that were previously impractical to exploit are becoming accessible and are moving from the off-balance to the balanced category. Global warming also opens up new opportunities for geological exploration and the search for new deposits. Experts estimate that the Arctic contains 13% of the world's undiscovered reserves.

The Arctic contains oil reserves, 30% of which are gas reserves, rich deposits of uranium and rare earth minerals, as well as gold and diamonds. However, the majority—84% of the world's most significant energy minerals—are located offshore. The Arctic is of interest to industrialists from many countries as a region for industrial mineral development due to the value of the natural resources found there.

Figure 12. Mineral deposits in the Russian Arctic

The importance of the Arctic as a source of resources for Russia is obvious.

In the Arctic zone of Russia there is, %:

- All-Russian reserves: gold - 40, oil - 80, gas, nickel, copper, antimony, cobalt, tin, tungsten, mercury, apatite, phlogopite - 50-90, chromium and manganese - 90, platinum metals - 99, local diamonds and vermiculite - 100;
- World reserves: diamonds and natural gas - 30, nickel - 20, apatite - 50, niobium - 35, copper, platinum group metals and tin - 15, oil (excluding shelf) and cobalt - 10, tungsten and mercury 6-8.

Of the expected 90 billion barrels of oil and 50 trillion cubic meters of gas, the Russian Arctic zone accounts for approximately 30 billion barrels of oil and 33 trillion cubic meters of gas. American experts have estimated 11 billion barrels of oil in the Barents Sea alone, equivalent to $1.25 trillion at current prices. Regarding gas, 11 trillion cubic meters have been discovered in the Russian Arctic zone. The region is also rich in biological resources, including fur-bearing animals (arctic fox, sable, mink, etc.). The number of reindeer is estimated in the millions. The Arctic and subarctic seas are home to the largest populations of commercial fish. Based on this, it can be concluded that the Arctic is an important component of the Russian economy. This territory is of strategic importance to our country, securing its geo-economic position in the world and influencing the domestic development of industries related to the use of natural resources extracted in the Arctic. The total value of Arctic resources could reach trillions of dollars. It is precisely because of such significant potential revenues that attention to the Arctic is growing. Every country wants to improve its economic situation through sustainable development, including through rational use of natural resources during the extraction and processing of minerals and the exploitation of other natural resources, and climate change is opening up new opportunities for this.

Secondly, new logistical opportunities have predetermined the struggle for trade routes. What is the Arctic in this context? The Arctic represents billions of dollars, the opening of new zones of influence, and, of course, new trade routes. Melting glaciers are opening up previously inaccessible trans-Arctic shipping routes, which, in turn, has a huge impact on economic rivalry in the Northern Hemisphere. The main countries involved in this rivalry are Russia, China, and the United States. The release of ice from the water surface makes the Northern Sea Route navigable along its entire length, increasing navigation times. Climate change will alter global logistics routes: transporting sea cargo between the Western and Eastern Hemispheres via the Arctic will become easier, safer, faster, and therefore commercially viable. However, using the Northern Sea Route also brings new risks, primarily those of natural origin: ice-free Arctic waters are exposed to strong winds; As a result, storm waves and swells arise, significantly impeding navigation.

Furthermore, there are risks associated with the creation and development of infrastructure. Operation of the Northern Sea Route requires high-tech ports and cargo hubs capable of receiving, sorting, and shipping cargo. Most of these facilities are under construction, but under the sanctions imposed on Russia by unfriendly countries, this is becoming increasingly difficult. While it was planned to use foreign technologies, equipment, and machinery in the construction and operation of port and warehouse facilities, the delivery of many of these has been suspended or even cancelled. Global warming is also leading to the thawing of permafrost, forcing a change in Arctic construction technologies and significantly increasing the cost of infrastructure projects. The expansion of the icebreaker fleet is a particular concern. The Russian Federation is currently focusing on the construction of powerful icebreakers: they are essential for the operation of the Northern Sea Route, but under the sanctions, these plans could be disrupted. Moreover, icebreakers built with great difficulty and significant financial costs may not be in demand due to both political restrictions and further global warming and accelerated melting of ice;

Third, the development of Arctic territories plays a huge role in the development of the mining and processing industries. The Arctic accounts for approximately 11% of Russia's national income and 22% of all Russian exports. Russia extracts virtually all of its diamonds, apatite-nepheline and copper ores, phlogopite, vermiculite, 97% of its platinum, 90% of its nickel, 95% of its gas, 60-80% of its oil, rare and rare earth metals, and antimony in these regions. Climate warming will expand access to minerals. Technological advances and improved accessibility will likely reduce the costs of extracting and processing Arctic resources. At the same time, it is worth noting that decarbonization of production, aimed at reducing greenhouse gas emissions, is essential. The Russian Federation has committed to sequestering CO_2 emissions, reaching complete carbon neutrality, which limits the potential for expansion of the mining and processing industries in the Arctic. It should also be taken into account that, due to the weak protection and low self-cleaning capacity of Arctic ecosystems, the consequences of major man-made disasters and accidents will be particularly significant. Therefore, Arctic industrial facilities and technologies for the extraction, transportation, and processing of minerals must have an increased "safety margin" in environmental terms. Furthermore, materials and technologies used in the construction of industrial buildings and structures must have special characteristics capable of withstanding extreme natural and climatic conditions. All this leads to increased costs for economic activity in the Arctic. Melting permafrost negatively impacts the development of industrial enterprises in the Arctic, resulting in ground subsidence and the formation of swamps. This leads to damage to buildings and structures and disruption of industrial and social infrastructure. Over the past fifty years, the resilience of buildings and infrastructure constructed in permafrost zones has significantly decreased. Particularly negative consequences of global warming have been observed on the Taimyr Peninsula, where almost all industrial buildings and structures, as well as transport lines, including pipelines, have been damaged. Furthermore, as with the construction and operation of port infrastructure, geopolitical factors associated with sanctions against Russia exacerbate the risk.

Fourth, climate warming is opening up new opportunities for fishing and fish farming. More than a third of Russia's commercial fish and seafood are already harvested in the Arctic, and approximately 20% of canned fish is produced. Rising water temperatures and reduced thickness and duration of sea ice are leading to an increasing number of subarctic fish and marine mammal species migrating to Arctic seas that were previously unsuitable for their habitat. This is increasing the potential for commercial fishing in the Arctic parts of the Barents, Bering, and Okhotsk seas. Our research shows that the economic benefits of fisheries have a significant positive impact on the social development of coastal Arctic settlements. Aquaculture is also expanding further north, creating additional opportunities for economic development in Arctic territories. The social risk of artificial fish farming lies in potential competition with local fisheries, and the environmental risk lies in the spread of parasites among wild fish species.

Fifth, the opportunities of the tourism business in the Arctic, which gives rise to a competition for tourists. Tourism has become a part of the daily life of almost a third of the world's population, which is a huge number of people. In 2024, 10.2 million foreigners visited our country in the first 9 months of the year, a very large number of people that cannot but impact our country's economy. Arctic routes are attracting more and more tourists. Due to the shrinking ice area in the Arctic, new routes are emerging, and tourists are willing to pay a lot of money to see the northern lights and interact with the local population. Many researchers have noted a significant increase in cruise tourism in the Arctic. Here are just a few examples: the number of cruise ship passengers in Iceland increased from 265,935 in 2023 to 402,834 in 2024, which is more than 66%. In the ports of Northern Norway, the number of cruise passenger voyages increased by 33% between 2023 and 2024; The number of cruise ship passengers in Svalbard increased from 39,000 in 2018 to 63,000 in 2021; in Greenland, the number of passengers increased from 20,000 to 30,000 during the same period. The number of people visiting the Arctic increased from 67,752 in 2018 to 98,238 in 2024, an increase of over 57%. Interest in Arctic continental tourism, primarily ecotourism and nature tourism, has increased significantly among Russian residents and foreign visitors. For example, the Russian Arctic tourist park was visited by 1,306 people from 44 countries in the summer of 2022 (Figure 13). The "Chasing the Northern Lights," "Visiting the Polar Bear," and other programs developed by Russian tour operators are in steady demand.

Figure 13. Statistics of visits to the tourist park "Russian Arctic".

It should be noted, however, that the natural and climatic conditions, unique landscapes, and inaccessibility, which, among other things, make the Arctic attractive to tourists, ultimately impact the logistical, infrastructural, and economic aspects of organizing activities. Experts also note challenges in permitting visits to some Arctic territories and specially protected areas.

Despite this, Arctic tourism is beginning to have a noticeable impact on the Russian economy: new jobs are being created, the northern territories as a whole are developing, new educational and cultural programs are emerging that help retain young people in the northern territories, the economies of Arctic regions are diversifying, and increased revenues are flowing into budgets at various levels. The COVID-19 pandemic significantly altered these established trends in 2024, when most Arctic tourist trips were canceled or postponed. A little later, political factors led to Russia and the countries that joined the sanctions, including all circumpolar countries, virtually ceasing tourist exchanges. The deterioration of interstate relations and declining household incomes are the most significant risks to the development of Arctic tourism. In addition to political risks, sociocultural risks stemming from the impact of tourism on the livelihoods of local communities, as well as the exacerbation of environmental and economic risks accompanying the development of tourism infrastructure, can be identified.

Sixthly, global warming opens up new opportunities for strengthening. The military presence in the Arctic is intensifying the struggle for geopolitical influence. The Arctic's significant military potential cannot be ignored. The state borders of several circumpolar countries run through the Arctic Ocean. The Arctic is home to defense industry facilities, land, air, and naval military bases, airfields, and other military infrastructure facilities of circumpolar states. The Cold War ended many years ago, and it would seem that relations between Russia and the "collective West," comprising Europe and the United States, should have normalized. However, the military operation in Ukraine, which began in February 2024, led to a sharp increase in tensions between Russia and, above all, the United States.

Thus, the significance of Russia's military presence in such a vital region of the Earth as the Arctic has increased. Russia has long been building new military, land, and naval bases on northern continental territories and on islands in the Arctic seas, including Kotelny Island. The Russian army actively conducts military exercises in the Arctic, while the armies of other circumpolar countries, like Russia, regularly conduct their own exercises in Arctic territories. Furthermore, circumpolar countries are actively working to develop military equipment capable of operating in high Arctic latitudes, as logistics are crucial for increasing their military presence in the Arctic. Climate warming allows for an increased range of weapons capable of operating in Arctic temperatures, the expansion of military bases, and improved comfort for troops stationed there.

Several key areas of international cooperation among circumpolar countries necessary for ensuring sustainable development in the Arctic can be identified. First and foremost, it is essential to thoroughly study natural, anthropogenic, and socioeconomic processes in the Arctic to better understand the impacts of climate change. For various reasons, these processes are intensifying and accelerating. It is essential to thoroughly document the identified features of Arctic territories, with particular attention to endangered ecosystems and indigenous northern peoples whose traditional cultures are being lost.

The creation of a unified international open database reflecting the environmental, economic, and social status of Arctic territories, based on sustainable development requirements, is a long-standing need. Creating a unique, unified database to ensure sustainable development in the Arctic requires the joint efforts of national and international scientific organizations. Information sources can range from satellite data to local monitoring using autonomous vehicles, providing objective and reliable information about hard-to-reach areas of the Arctic. Most importantly, the creation of such a database must have common goals and objectives aligned with the requirements of sustainable development in the Arctic.

An important condition is the openness of such a database to researchers and policymakers in all circumpolar countries, which is necessary for the development and adoption of informed and well-founded management decisions at the international, national, and regional levels. Currently, there is a lack of global, cross-border, comprehensive studies assessing the impact of industrial development and climate change on coastal and offshore production infrastructure, mineral extraction and transportation systems, oil and gas pipelines, and so on. Understanding the consequences of such cumulative and complex impacts is important for mitigation, namely:

firstly, man-made risks of emergency situations;

and secondly, for financial risks associated with the economic activities of enterprises with production assets in the Arctic.

Adequate understanding of the impacts of climate change is essential for effective management and efficient responses to emerging risks. Significant gaps remain in the study and understanding of the social consequences of industrial development and climate change in the Arctic territories of circumpolar countries. This only confirms the urgent need for comprehensive monitoring and assessment of the social impacts of climate change in the Arctic. Moreover, research should be conducted not only in large cities and towns, but also in remote indigenous settlements, where ecosystem changes have the greatest impact on the livelihoods of the population. Ensuring sustainable development requires coordinated climate and ecosystem monitoring in key locations, combined with community-based monitoring that utilizes the knowledge and experience of Arctic indigenous peoples. A key area of international cooperation in sustainable development should be the identification of thresholds for the functioning of Arctic ecosystems. These include, for example, the maximum acidity of freshwater bodies for the development of juvenile fish, the maximum seawater temperatures for various phytoplankton species, or the minimum area and thickness of sea ice required to preserve the habitat of polar bears, seals, killer whales, and other Arctic animals. Such thresholds require more careful assessment, particularly with regard to potential ecosystem degradation. Forecasting the future of the global Arctic ecosystem and the Arctic Ocean requires a better understanding of its changing productivity, related to sea ice and open water, physicochemical processes, nutrient cycling, and the ability of primary producers to adapt to changing conditions. The impacts of climate change are transnational and transcontinental in nature and can interact, overlap, and mutually reinforce or weaken each other. Research costs can be reduced and the accuracy of predictive models can be improved by comparing the rate of climate change in the Arctic and other regions of the Earth. This requires joint research and data exchange not only between circumpolar countries but also with all other countries. A detailed analysis of policy documents from circumpolar countries, conducted by the authors, revealed the following. The key priority of Russia's Arctic policy is the development of Arctic territories and the advancement of transport logistics, as well as the exploitation of natural resources through the creation of an optimal configuration of the main factors of industrial production. In Sweden and Finland, the knowledge economy is the foundation of Arctic policy implementation, while in Denmark (a new Arctic development strategy for the period up to 2035 is currently under development) and Iceland, the green economy is the foundation.

These circumpolar European states are formulating their Arctic policy and strategy based on the EU's unified Arctic policy.15 In Norway, which is not a member of the EU, achieving sustainable development in the Arctic has been declared a national priority. Based on three principles—presence, activity, and knowledge—governments, businesses, and local communities collaborate to harmoniously address economic, environmental, and social challenges.16 The key Arctic policy priorities of Canada and the United States are based on four complementary principles.17 These principles encompass both domestic and international issues: security, climate change and environmental protection, sustainable economic development, international cooperation, and governance.

An analysis of the national strategies of circumpolar countries revealed a shared commitment to working closely with international partners to achieve the common goal of creating a peaceful, economically successful, and sustainable future for the Arctic. All these countries are members of the Arctic Council, within which most joint programs on sustainable Arctic development are implemented.[18] Russia, which chaired the Arctic Council in 2021, has prioritized responsible governance for the sustainable development of the Arctic. Currently, all official meetings of the Arctic Council, which it chairs until 2023, are suspended until further notice. All other cooperation between circumpolar countries and the Russian Federation on environmental protection, ecosystem conservation, detailed and in-depth study of natural, anthropogenic, and socioeconomic processes in the Arctic, expanded monitoring and documentation of changes (including climate change), and the development and implementation of mechanisms to limit further warming have also been suspended.

Cooperation between the Arctic regions of circumpolar countries and adjacent Russian Arctic regions has also been suspended, although in previous years it formed the basis of regional strategies. In Russia, cooperation with adjacent Arctic regions of other countries is enshrined in regional strategic documents, namely:

- "Strategy for the socio-economic development of the Nenets Autonomous districts until 2035";
- "Strategy for the socio-economic development of the Murmansk region until 2025 and until 2035";
- "Strategy socio-economic development of the Yamalo-Nenets Autonomous Okrug until 2035";
- "Strategy socio-economic development of the Chukotka Autonomous Okrug until 2035", etc.

More recent versions of regional socioeconomic development strategies for Russia's Arctic regions do not exclude international cooperation, but in practice, it is not implemented. The exclusion of the Russian Federation from decision-making processes is another, and crucial, risk to sustainable development in the Arctic. Thus, the current Arctic policies of European circumpolar countries, as well as Canada and the United States, greatly increase the risks to sustainable development in Arctic territories.

Conclusion

Taking into account the above, we had to decide first, namely: to determine the conditions for the sustainable development of the Russian Arctic.

New opportunities have been explored and new sustainability risks have been identified. The development of the Russian Arctic in modern conditions. The following has been established. Arctic climate change, caused by the accumulation of greenhouse gases in the atmosphere, largely produced by anthropogenic activity, on the one hand, and natural cyclical processes of temperature fluctuations on the other, combined with factors governing the Russian Arctic, offers new development opportunities, namely:

Firstly, due to the increase in extremely low temperatures, the reduction in the thickness of snow and ice cover, and the melting of permafrost, the extraction and transportation of natural resources is becoming much easier, simpler and cheaper, and the development of technology and better accessibility will lead to the fact that in the future the costs of extraction and processing of Arctic natural resources will only begin to fall;

secondly, climate change and increased interest in the development of the Arctic, accompanied by government support, provide impetus for the development of new industrial projects and social and production infrastructure;

thirdly, the reduction in the thickness and duration of ice cover in the Arctic waters opens up new logistical opportunities, and new national and transnational trade routes are being developed;

Fourthly, rising water temperatures are leading to more and more species of subarctic fish and marine animals migrating to Arctic seas that were previously not suitable for their life, which increases the possibilities for industrial fishing and farming of fish, edible mollusks and crustaceans in the Arctic parts of the Barents, Bering and Okhotsk seas;

fifthly, climate change opens up new tourist routes, which, together with government support programs, contributes to the development of the tourism business, which is beginning to have a significant impact on the socio-economic development of the Arctic territories;

Sixth, new opportunities are opening up for strengthening the military presence in the Arctic: climate warming makes it possible to increase the range of weapons capable of operating in Arctic temperatures, expand military bases, and make the contingent's stay there more comfortable.

At the same time, the current situation is giving rise to new risks to sustainable development. These include, first and foremost, natural risks associated with global warming: ice-free Arctic waters are exposed to strong winds, resulting in storm surges and swells that significantly impede navigation. Melting permafrost, resulting in ground subsidence and swamping, is forcing changes to Arctic construction technologies, leading to a dramatic increase in the cost of infrastructure projects. Increasing anthropogenic impact has highlighted a trend toward disrupting the fragile ecological balance of Arctic territories and increasing the risk of sustainable development due to environmental pollution. On the other hand, the commitments made by the Russian Federation to reduce CO_2 emissions to achieve complete carbon neutrality will to some extent mitigate the impact of negative anthropogenic pollution on Arctic ecosystems, but at the same time, the Arctic's productive development potential will be constrained.

Geopolitical risks are becoming increasingly significant: under the sanctions imposed on Russia by unfriendly countries, large-scale Arctic development projects are becoming increasingly difficult and expensive, as many foreign technologies, equipment, and transport routes are becoming less accessible or even unavailable. The decline in energy exports from Russia to European countries due to political and economic factors is leading to an increase in the share of coal, fuel oil, and wood as energy sources, resulting in increased greenhouse gas emissions and a weakening of decarbonization policies. Risks to sustainable Arctic development have been greatly increased by the suspension of the Arctic Council, as well as other cooperation between circumpolar countries and the Russian Federation on studying natural, anthropogenic, and socioeconomic processes in the Arctic, monitoring and documenting changes, and developing joint programs to limit further global warming, protect the environment, and ensure sustainable natural resource management.

The study showed that the effectiveness of sustainable development management in the Russian Arctic, assessed by comparing pollutant emissions and environmental protection expenditures, is largely dependent on foreign policy and socioeconomic conditions. Decision-making processes in managing sustainable development in Arctic territories occur in a climate of uncertainty, which is intensified by the emergence of new challenges.

References:

1. Abakumova, Yu. M. (2024). The concept and some features of tourism in the Arctic. *Forum of young scientists*. 2024. No. 4 (56) - pp. 34-40.
2. Avlasko, Z. A. (2025). Selecting a business model as a platform for successful implementation of the process approach. *Bulletin of Tomsk State University*, 2025, No. 399, pp. 170-174.
3. Arskaya, E. V. (2025). Global economic crisis: problems and prospects/ *Ekonomski pogledi*. 2025, no. 20 - pp. 19-26.
4. Bazhutova, E. A. (2025). Shift work as a reserve for the transformation of migration processes in the regions of the Arctic zone of the Russian Federation. *North and market: formation of economic order*. 2024, No. 4, pp. 148-166. DOI: 10.37614/2220-802X.4.2025.78.011.
5. Bazhutova, E. A. (2025). On the development of mechanisms for implementing business models for the integrated processing of mineral resources. *North and Market: Formation of Economic Order*, 2025, No. 4 (74) --- pp. 99-113.
6. Bazhutova, E. A. (1857). On the development of a regional strategy for managing entrepreneurial activity / *Society and Economy*. Issue 9, 2024, pp. 43-60. DOI: 10.31857/S020736760006415-5.
7. Bazhutova, E. A. (1857). Theoretical and methodological approaches to research entrepreneurial activity. *Society and Economy*. 2024 (b). No. 6 - pp. 19-24. DOI: 10.31857/S020736760005420-1.
8. Bazhutova, E. A. (2025). Economic activity in the Murmansk region: features of manifestation and conditions for optimization. *North and market: formation of economic order*. 2025, No. 2 (68) -- pp. 49-63. DOI:10.37614/2225-802X.2.2025.68.005.
9. Bandman, M.K. (2024). *Territorial production complexes: theory and practice of pre-planning studies*, Novosibirsk: Nauka, 2024, 256 p.
10. Baransky, G.G. (2025). A Convincing Path to Liquidation Restructuring/ *National Economy of the Komi Republic*. 2025. No. 4 (1-2). pp. 66-72.
11. Barasheva, T. I. (2024). Regional tax initiatives and economic effects from their implementation in the regions of the Far North / *North and market: formation of economic order*. 2024, No.

3 (73). pp. 40-51. DOI: 10.37614/2220-802X.3.2024.73.003.

12. Belov, M. I. (2025). *Scientific and economic development of the Soviet North*. 1933-1945. Moscow: Sea Transport, 2025, 616 p.
13. White, G.V. (2024). Methodology of the development of the Arctic region of Russia for economic purposes / *Transport business of Russia*. 2024. No. 1, pp. 228-231.