

ANALYSIS OF THE POLICIES OF THE REGIONS OF THE ARCTIC ZONE OF THE RUSSIAN FEDERATION IN THE FIELD OF ADAPTATION TO CLIMATE CHANGE

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Annotation

This article examines the experience of developing climate change adaptation plans in the Russian Federation at the regional level. The authors analyze the regulatory framework, structure, and content of regional adaptation plans, as well as approaches to their development and implementation. Particular attention is paid to the methodological aspects of plan preparation and the identification of climate risks. Based on a review and analysis of pilot regional adaptation plans, key trends, challenges, and development prospects for this area in Russia are identified. This work may be useful for specialists in climate policy, public administration, and sustainable development.

Key words: Arctic zone of the Russian Federation, climate change, greenhouse gases (GHG), climate change adaptation plan, sustainable development climate policy, climate risks.

I. Introduction

The study of climate change mechanisms, forecasting its consequences and developing adaptation strategies is a pressing scientific task, attention to which has not diminished since the second half of the 20th century [1, 2].

Climate change has a significant impact on both the natural environment and socio-economic systems. Profound impacts on natural ecosystems are associated with permafrost thawing, desertification, destruction of marine ecosystems [3], increased frequency and scale of forest fires, deterioration of forest pathology [4], changes in species ranges, and reduction of biodiversity [5-7]. The socio-economic consequences of climate change, according to forecasts, can be expressed in a decrease in GDP [8, 9], increased poverty and social tensions, especially in developing countries where adaptive capacity is limited [10]. Droughts and extreme weather events lead to reduced crop yields, which poses threats to food security [11], excess mortality and morbidity of the population on a global scale [12]. For urban and coastal areas, long-term risks are associated with population migration due to sea level rise and an increase in the frequency of natural disasters [13].

Arctic ecosystems are among the most sensitive and vulnerable to the impacts of climate change [14, 15]. Accelerated melting of glaciers and permafrost in the Arctic zone contributes to greenhouse gas emissions, increasing global warming [16, 17]. In turn, these processes affect infrastructure: the destruction of permafrost threatens the integrity of roads, pipelines and settlements, which requires

monitoring the condition of existing structures and adapting construction technologies when implementing new infrastructure projects [18]. Climate change is accompanied by a reduction in the range of some Arctic species, such as polar bears and reindeer [16, 17, 19], the penetration of alien species into northern latitudes, and a shift in vegetation zones [20]. The consequences of these processes pose threats to the traditional way of life of indigenous peoples [19, 21].

Relevance of the study. The global impact of Arctic amplification, the presence of environmental risks, its high geopolitical role, and its socio-economic significance determine the relevance of studying climate change and developing adaptation plans to these changes in the Arctic zone of the Russian Federation. The rate of warming in the Arctic zone exceeds the global average by 2–2.5 times, which is called Arctic amplification [22–24]. The Arctic territories of Russia occupy an area of 4.8 million square kilometers, which is almost a third (28%) of the entire country. The Arctic Zone of the Russian Federation includes, in whole or in part, the territories of nine constituent entities: Murmansk and Arkhangelsk Oblasts, the Republic of Karelia, the Nenets Autonomous Okrug, the Komi Republic, the Yamalo-Nenets Autonomous Okrug, the Chukotka Autonomous Okrug, the Sakha Republic (Yakutia), and Krasnoyarsk Krai [25, 26].

The Arctic zone of the Russian Federation encompasses regions where sustainable development is associated with various risks: climatic, ethnic, and socioeconomic [17, 26, 27]. Currently, the climate change problem is shifting from scientific research to the development of management strategies and investment decisions.

The aim of this work is to analyze existing regional plans for adaptation to climate change in the subjects of the Arctic Zone of the Russian Federation, as well as to assess the degree of their compliance with scientific assessments of climate risks.

II . Methods

The methodological basis of the study consisted of an analysis of regulatory legal acts governing climate change adaptation policy, an analysis of information from the public procurement website on the implementation of the function of developing climate change adaptation plans by the subjects of the Arctic Zone of the Russian Federation, and an analysis of information contained in the Register of Climate Projects on the development and validation of climate projects in the regions of the Arctic Zone of the Russian Federation.

III . Results

Analysis of the legal framework for adaptation to climate change.

The priority task The National Action Plan for the first stage of adaptation to climate change for the period up to 2022, adopted in 2019, was “the definition of a system of target indicators for achieving federal, industry and regional adaptation goals and the approval of methodological recommendations for assessing climate risks and the formation of industry, regional and corporate plans for adaptation to climate change” [28].

In 2021, the Russian Government adopted a strategy for Russia's socioeconomic development with low greenhouse gas emissions through 2050. This strategy aims to reduce GHG emissions by 60% compared to 2019 levels and by 80% compared to 1990 levels, while maintaining positive economic growth . Carbon neutrality is to be achieved by 2060 [29]. According to calculations by the Ministry of Economic Development, implementing the 60% emissions reduction plan will require an investment of approximately 88.8 trillion rubles.

By Order No. 221 of the Ministry for the Development of the Russian Far East dated November 26, 2021, the Arctic Zone of the Russian Federation (AZRF) approved a climate change adaptation plan aimed at mitigating the negative impacts of global warming on the region. The document defines a set of measures to monitor climate change, protect infrastructure, preserve ecosystems and the traditional way of life of indigenous peoples, and enhance economic and social resilience. The plan calls for the coordination of federal, regional, and local authorities, the use of modern forecasting technologies, and the attraction of investment to implement measures within the established timeframe [30].

Methodological recommendations for assessing climate risks, ranking adaptation measures according to their degree of priority, forming industry, regional and corporate plans for adaptation to climate change, as well as indicators for achieving adaptation goals were approved by Order No. 267 of the Ministry of Economic Development of Russia dated May 13, 2021 [31].

The main goals and principles of climate policy are defined in the Climate Doctrine of the Russian Federation until 2030, approved by Decree of the President of the Russian Federation of October 26, 2023 No. 812 [32], which, according to the document, should ensure safe and sustainable institutional, economic, environmental and social, including demographic, development of the Russian Federation in the context of climate change and the emergence of associated threats.

The National Action Plan for the Second Stage of Adaptation to Climate Change through 2025 [33] contains a list of measures aimed at providing organizational, regulatory, scientific, methodological, and informational support for adaptation processes. The procedure for working with adaptation plans includes climate risk assessment; assessment of possible damage from the impact of climate risks, including the formation of a list of climate-vulnerable objects (CVO); determination of adaptation needs and target indicators (TI) for them; selection of ongoing activities that can satisfy adaptation needs through achieving the TI; formation of a climate change adaptation plan; monitoring and evaluation of the effectiveness and efficiency of adaptation measures in the updated plan. By the end of 2025, it is planned to prepare an action plan for the third stage of adaptation to climate change through 2028.

Comparative analysis of regional climate change adaptation plans of the Arctic Zone of the Russian Federation

Regional climate change adaptation plans have been approved by regional governments [34-40]. The plans contain information on climate risk assessment results , classifying risks by hazard level as catastrophic, highly hazardous, hazardous, and moderately hazardous (Table 1). In the Murmansk Region, the adaptation plan is currently being updated. Therefore, the risk assessment and priority action data presented in the work cannot be considered as characteristics of the region's approved climate adaptation policy. The regulatory legal acts in question are not publicly available for the Chukotka and Nenets Autonomous Okrugs.

Table 1. Climate risks in the territories of the constituent entities of the Arctic Zone of the Russian Federation.

A constituent entity of the Russian Arctic*	Characteristic climate risks
Murmansk Oblast	Catastrophic: hurricanes, tornadoes, strong winds. Very dangerous: mudflows, avalanches. Moderately hazardous: floods.
Yamal -Nenets Autonomous Okrug	Risks of hazardous level: heavy precipitation and return of cold weather during the growing season; lowering of the permafrost roof to a depth below the foundations; thermokarst; heaving; flooding of the territory; landslides; solifluction; suffusion; erosion and thermal erosion; abrasion and thermal abrasion; floods; avalanches of dangerous size; mudflows with a volume of up to 50,000 cubic meters
Republic of Karelia (RK)	Risks of a dangerous level: forest and peat fires, flooding during the passage of flood waters, squalls, coastal ice breakaways.
Komi Republic	Risks of hazardous level: risks of heat, flooding and flooding, ice formation, frost, hail, strong winds and forest fires.
Republic of Sakha (Yakutia)	Risks of high severity include forest fires, exposure to extreme weather events, forest pests and diseases, habitat loss and biodiversity loss.
Krasnoyarsk Krai	Catastrophic: strong wind with a maximum speed of 40 m/s. Very dangerous: floods and high water on the Yenisei and its tributaries, heavy precipitation, fire hazard in forests. Risks of dangerous level: landslides, karst, frost.
Arkhangelsk Oblast	The assessment data is not provided.

*The following subjects are partially included in the Arctic Zone of the Russian Federation: the Republic of Karelia (RK) (6 municipalities: Belomorsky District, Kalevalsky District, Kemsy District, Kostomuksha Urban Okrug, Loukhsky District, Segezha District); the Komi Republic (4 municipalities: Vorkuta Urban Okrug, Inta Urban Okrug, Usinsk Urban Okrug, Ust-Tsilemsky District); the Sakha (Yakutia) Republic (13 municipalities: Abyysky Ulus, Allaikhovsky Ulus, Anabarsky Ulus, Bulunsky Ulus, Verkhnekolymsky Ulus, Verkhoyansky District, Zhigansky District, Momsky District, Nizhnekolymsky District, Olenyoksky District, Srednekolymsky Ulus, Ust-Yansky Ulus, Eveno-Bytantaysky National Ulus); Krasnoyarsk Krai (4 municipalities: the city of Norilsk, Taimyr Dolgano-Nenets District, Turukhansky District, and part of the Evenki District (10 rural settlements)); Arkhangelsk Region (9 municipalities: the city of Arkhangelsk, Mezensky District, Novaya Zemlya Urban Okrug, the city of Novodvinsk, Onega District, Primorsky District, Severodvinsk Urban Okrug, Leshukonsky District, and Pinezhsky District).

IV . Discussion

An assessment of the need for adaptation of Russian regions to various types of physical risks of climate change was given by I.A. Makarov and A.V. Chernokulsky [41], who showed the presence of risks associated with forest fires for the Arkhangelsk Region, the Komi Republic, and the Yamalo-Nenets Autonomous Okrug. Possible negative consequences of permafrost thawing are predicted for the Komi Republic, the Nenets Autonomous Okrug, the Yamalo-Nenets Autonomous Okrug (YNAO), Krasnoyarsk Krai, the Sakha Republic (Yakutia), and the Chukotka Autonomous Okrug.

The authors did not note any physical risks of climate change for the Murmansk Region and the Republic of Karelia.

Nevertheless, climate risks have been identified for these regions as part of the development of climate change adaptation plans. For the Republic of Karelia, the list of priority adaptation measures corresponds to the need to adapt to increased forest fires and extreme weather conditions.

The documentation for updating the Murmansk Region's climate change adaptation plan contains risk assessments for various hazard levels. Adaptation measures include those aimed at mitigating the impacts of permafrost thaw. However, the region is located outside the permafrost zone, and the risks associated with its degradation do not pose a systemic threat to the economy and infrastructure. The region's territory lies within the seasonal freezing zone; isolated or island permafrost may occur in some high-mountain areas [42].

The Yamalo-Nenets Autonomous Okrug is a region highly vulnerable to climate change due to extreme weather conditions and the characteristics of permafrost soils. The detailed risk description in the adaptation plan is consistent with the high risk assessment provided by the authors of the article. For the Republic of Sakha (Yakutia), a high risk assessment is given due to the rapid thawing of permafrost soils, landscape changes, and impacts on traditional economic activities, which is consistent with the list of threats outlined in the adaptation plan.

The Krasnoyarsk Territory faces high climate risks due to a combination of extreme atmospheric events and geographic features, resulting in a high degree of vulnerability requiring a comprehensive approach to adaptation.

For the Komi Republic, the risks are assessed as significant, but somewhat lower than in regions where Arctic climate challenges predominate. The priority adaptation measures presented in the plan correlate with the risk assessment and reflect the need for measures to protect both infrastructure and ecosystems.

The Arkhangelsk Region is a region with large forested areas, and therefore forest fires are recognized as a significant climate risk. However, the Arkhangelsk Region is not included in the top 25 regions for any of the risk types. The regional adaptation plan includes measures to ensure forest fire safety among its priority actions.

Thus, the regional plans for adaptation to climate change in most of the considered subjects of the Arctic Zone of the Russian Federation are consistent with scientific risk assessments.

The Arctic Zone of the Russian Federation (AZRF) regions exhibit significant differences in the types of climate risks. Permafrost-affected areas (Yamalo-Nenets Autonomous Okrug, Sakha) face specific challenges related to thawing, thermokarst, and heaving, while more forested and coastal zones (Karelia, Murmansk Oblast) face challenges related to flooding and extreme weather events.

Despite their differences, all plans include developing monitoring and forecasting systems, modernizing infrastructure, and enhancing emergency preparedness. Regions with extreme climates (such as Sakha and Krasnoyarsk Krai) emphasize energy modernization and measures to protect critical infrastructure, while regions such as the Komi Republic also focus on environmental monitoring and the transition to clean fuels.

The adaptation plans of the Arctic Zone of the Russian Federation's subjects demonstrate a general trend toward a comprehensive approach: from monitoring and forecasting to specific engineering, infrastructure, and social measures.

Conclusion

Climate change adaptation planning at the level of the Arctic Zone of the Russian Federation's constituent entities is demonstrating positive momentum, despite existing challenges and limitations. An analysis of currently approved adaptation plans shows that the regions have assessed climate risks and developed adaptation measures in accordance with regulatory requirements and

taking into account regional specificities. However, to ensure sustainable and scalable adaptation planning, further development of the methodological framework, strengthening of institutional mechanisms, interdepartmental cooperation, professional development, and the implementation of systems for monitoring and evaluating the effectiveness of adaptation measures are necessary. For the Arctic Zone of the Russian Federation's regions, prioritizing adaptation measures, taking into account their high vulnerability to various climate risks, is an important condition for increasing climate resilience.

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