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Prospects for restoring ecosystems in the Pasvik River basin reconstruction of climate change, biodiversity, history of nature management and conservation practices

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ABSTRACT

The paper is devoted to discussing the effectiveness of measures to restore degraded lands and preserve biodiversity in the north-west of the Murmansk Region in the Pechenga Municipal District (Russian Federation). The purpose of the study was to study climate change, biodiversity, the history of nature management and environmental practices in the basin of the Paz River. Published and archived data from climatic, soil-geobotanical, archaeological, and historical studies were collected and systematized, as well as their own field geoecological studies (2021-2024). The use of reconstruction and forecasting methods made it possible to recreate an objective picture of climatic changes in the basin of the Paz River over the past 9.5 thousand years and to identify a multiple change of vegetation (from Arctic tundra to forest) after the melting of the glacier. The study of archaeological and historical materials allowed us to identify five stages of economic development of the territory, which led to a reduction in biodiversity and land degradation (with a maximum in the 70s of the XX century at the peak of the development of copper-nickel production). Three main factors hindering the restoration of degraded lands in the Paz River basin have been identified: large areas of man-made wastelands with a high content of heavy metals, long-range irradiation of microparticles of pollutants, and low rates of natural restoration of Arctic ecosystems. To accelerate the processes of natural restoration, it is proposed to replace expensive methods of reclamation of man-made wastelands with the creation of a set of conditions for the formation of biological soil crusts (communities of cryptogamous organisms).

KEYWORDS

Degraded lands, Biodiversity, Ecosystem restoration, Climate change, History of nature management, Pasvik River basin, Pasvik nature reserve

1. INTRODUCTION

Restoration of degraded lands, protection of rare species of flora and fauna, and conservation of ecosystems are part of the global international agenda and the development strategies of countries and regions [1]. The United Nations Decade on Ecosystem Restoration (2021–2030) is intended to consolidate the efforts of business, government, scientific and environmental institutions, and the public, and to move towards concrete action [2]. However, to include effective ecosystem restoration practices in regional socio-economic development programs, in addition to political will, material-technical and human resources, it is necessary to consider the following factors:

(1) the availability of objective spatial data on the actual state of ecosystems;

(2) the presence of information on natural and technogenic hazards and risks, including descriptions of sources of negative impact (nature, duration, scale, degree of ecosystem degradation);

(3) analysis of previously undertaken measures (positive and negative restoration experience);

(4) determination of the planning horizon (short-term or long-term);

(5) analysis of data on the dynamics of natural processes and the history of nature management.

The last factor is of particular importance, yet it is extremely rarely present in analytical reports and regional development programs [3]. This paper presents the results of a study conducted by us in 2021–2024 in the Pechenga municipal district of the Murmansk region (Russia). It discusses the prospects for applying retrospective analysis for effective ecosystem restoration and regional management.

The aim of the study was to reconstruct changes in climate, biodiversity, the history of nature management, and conservation practices in the Pasvik River basin in order to develop recommendations for ecosystem restoration and their inclusion in the region's socio-economic development plan.

2. RESEARCH METHODS

The object of the study was the ecosystems of the right bank of the Pasvik River basin at the border of Russia, Norway, and Finland (Figure 1).

Figure 1. Russian part of the Pasvik River basin

The selected model area covers 2,573.83 km² (1.75% of the total area of the Murmansk region) and is characterized by high species richness for the Arctic (about 3,500 species)-this is two-thirds of the biodiversity of the Murmansk region. Here are preserved the northernmost coniferous forests in Europe, indigenous birch sparse forests, tundras, and internationally significant wetlands. They are adjacent to technogenic wastelands near copper-nickel production centers. The Pasvik River basin is a meeting point for western Scandinavian and eastern European flora and fauna, as well as arctic and northern taiga species. Immediately after the glacier retreated, the first settlers arrived here (about 9 thousand years ago), which can be considered the beginning of the economic development of the territory.

Primary source data containing information about the model territory has been collected and systematized: (1) climate – dynamics of average temperatures in January, July, annual; dynamics of annual precipitation; change in the spectrum of paleoregativity; (2) Biodiversity – the current species richness of plants, animals, and fungi by systematic groups; biotopic distribution and abundance dynamics for background and rare species; (3) Archaeology – monuments of the Mesolithic, Neolithic, and Middle Ages; traditions of restoring natural resources in the practice of local peoples; (4) the history of nature management – the composition and density of the population, types of economic activity, the use of natural resources, the dynamics of the number of economically significant species of fauna and flora, examples of man-made digressions and restorative successions).

The created electronic database of materials includes 527 publications: chronicles – 3; documents of state power and management – 45; international treaties – 10; accounting and statistical materials – 23; notes, memoirs, diaries – 22; geographical toponyms, maps, dictionaries – 148; articles and monographs – 261; cadastres – 12; databases data – 3. It also includes 72 reports (1990-2025) from 265 items of the archive of scientific research documentation of the Pasvik State Nature Reserve (located in the central part of the studied territory). During several expeditions (July 2021, September 2022, August 2023, August 2024), geobotanical and soil studies were conducted to compare reference plots of the Pasvik River basin ecosystems and degraded land plots. Descriptions were made of 37 plots (each 500 m²), 7 transects were established (about 5 km each), more than 8,000 unmanned aerial vehicles images were taken, 144 soil samples and 83 samples of plants, fungi, and lichens were collected for analysis of heavy metals, selenium, and other elements.

The integration of data on the Russian part of the Pasvik River basin made it possible to construct curves of changes in climatic indicators and vegetation spectra after the glacier retreat, correlate them with the main stages of territory development, and assess the current cumulative (accumulated) effect of nature management.

3. RESULT AND DISCUSSION

The results of the reconstruction of climatic indicators for the Pasvik River basin over the past 9.5 thousand years were obtained taking into account data from various sources [3]. They are presented in graphs (Figure 2). The available data indicate a wide range of differences in temperatures and precipitation, as well as alternation of warm and cold, dry and wet periods.

The results of vegetation reconstruction based on previously published data [4; 5] show that over the past 9.5 thousand years, following climate change, the spectra and dominants of zonal vegetation changed in the following sequence (Figure 3): (1) arctic tundra, (2) forest-tundra with birch dominance, (3) forest with pine dominance, (4) tundra–forest-tundra–forest (with coniferous and deciduous species), (5) pine-birch forest, (6) forest-tundra–forest, (7) vegetation dominated on uplands by shrub tundra and birch sparse forests, on slopes and depressions-by pine forests (modern and near-future).

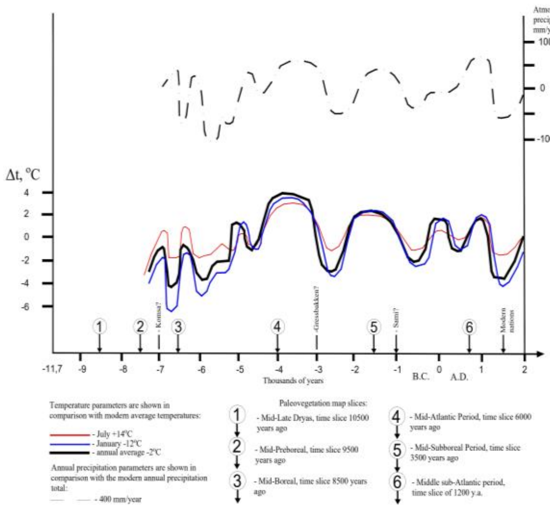

Figure 2. Climate change in the Pasvik River basin over the past 9.5 thousand years

Available data confirm the existence of 12 zonal vegetation variants (excluding wetland and floodplain ecosystems).

he analysis of archaeological research results indicates the possible penetration here of representatives of the Komsa phase, Gressbakken phase, and Saami [7]. Over the past five centuries, the territory has been actively developed by Slavic, North Germanic, and Finno-Ugric peoples [8]. As can be seen from the provided graph **(**Figure 2**)**, the peoples of the Pasvik River basin lived here during both warming and cooling periods, supporting ecosystems by observing special rules and technologies of nature management [9]. A characteristic example is the annual economic cycle of a nomadic Saami family [10].

Systematization of available data allows us to distinguish five stages of nature management in the Pasvik River basin: they are characterized by a specific combination of types of economic activity, degree of impact on biodiversity, and forms of nature management [11]. For many millennia (from the Mesolithic to the mid-16th century), nature management remained resource-conserving and dispersed. During the period of active colonization (from 1565 to the end of the 19th century), there was a sharp transition to resource-consuming focal nature management. In 1900–1945, economic activity and the scale of negative impacts on all components of the natural environment expanded rapidly. In 1945–1991, nature management became large-scale and focal, with peak loads exceeding the ecological capacity in terms of impact on ecosystems (mainly due to the development of copper-nickel production and rapid population growth) [12]. Since 1991, against the backdrop of a sharp decline in production, population outflow, the formation of the Pasvik Nature Reserve, and other protected areas in the Pasvik River basin, in addition to resource-consuming focal nature management, resource-conserving dispersed (mainly environmental and recreational) activities have begun to develop. Aerotechnogenic pollution and degradation of the soil-vegetation cover continue after the cessation of

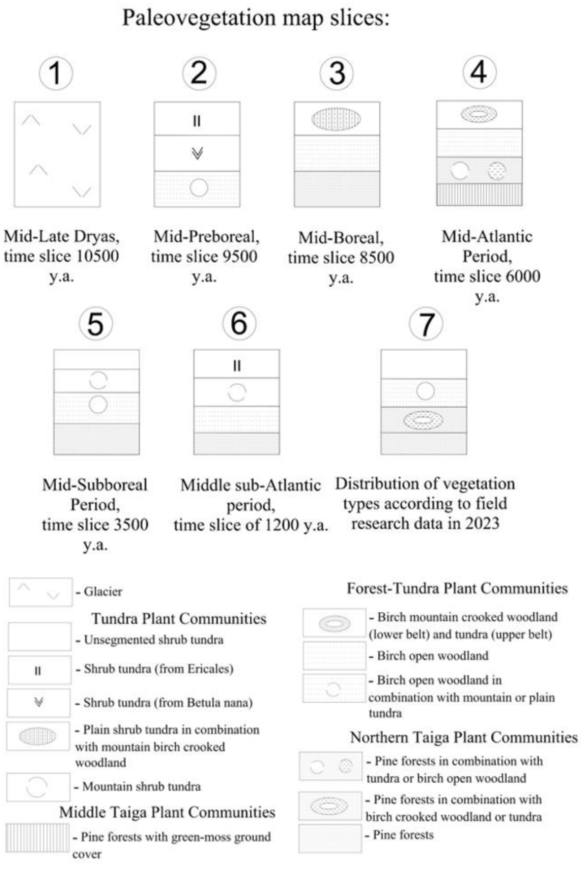

Figure 3. Spectra of zonal vegetation types in the Pasvik River basin over the past 9.5 thousand years

copper-nickel production in 2020 due to the transfer of contaminated dust particles from technogenic wastelands (about 10,000 m²) to neighboring areas, necessitating the creation of special scientific research sites [13].

The data from the conducted environmental studies indicate a high degree of degradation of tundra and birch woodlands ecosystems at a distance of 1-3 km from industrial areas, maximum development of disturbed lands in the northeast direction from the smelter, high content of heavy metals in the soil and living organisms (the results are being processed and published) [14].

4. CONCLUSION

(1) The current interglacial period in the Pasvik River basin is characterized by significant climatic fluctuations against a background of relative stability in geological and geomorphological conditions. (2) Climate changes were accompanied by shifts in vegetation: during warming periods, forest vegetation predominated; during cooling periods-forest-tundra and tundra. (3) Throughout the long history of nature management, the peoples of the Pasvik River basin not only actively exploited natural resources, which led to species extinctions and degradation of the soil-vegetation cover, but also simultaneously tested technologies for their restoration. (4) Currently, the main obstacle to the restoration of degraded lands is the transfer of soil microparticles from technogenic wastelands to neighboring areas, as well as fires, the persistence of dumps and tailings storage. (5) It is proposed to include measures to support environmental and recreational nature management in the region’s socio-economic development program. The most promising is the creation of special scientific research sites with plots of technogenic digression, restorative succession, reference ecosystems, and experimental areas. (6) The considered climate change trends indicate the need to test a comprehensive regional biodiversity restoration program for the coming decades, focused on the rehabilitation of shrub tundra, birch sparse forests, and pine forests. To accelerate natural ecosystem restoration processes on technogenic wastelands, a set of conditions is proposed to ensure the rapid formation of biological soil crusts (communities of cryptogamic organisms).

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REFERENCES

[1] "Goal 15: Biodiversity, forests, desertification" Accessed on: May 08, 2025. [Online]. Available: https://www.un.org/sustainabledevelopment/biodiversity

[2] "UN Decade on Restoration" Assessed on: May 08, 2025. [Online]. Available: https://www.decadeonrestoration.org/

[3] V. A. Masloboev, "Zones of intensive nature management in the Russian Arctic under climate change: natural and social processes in the long term," *Kola Science Centre of RAS*, 2019.

[4] V. Y. Evzerov, "Consequences of climate changes of the Quaternary period in the Kola region (on the example of the Late Valdai glaciation and Holocene)," *Bull. Kola Sci*. Cent. RAS, vol. 25, no. 2, 2016.

[5] S. O. Grigorieva et al, Paleoclimatic reconstruction of the ranges of tree species in the North-West of Russia. Voronezh: VGLTU, 2018.

[6] G. A. Elina, A. D. Lukashov, and T. K. Yurkovskaya, "Late glacial and holocene palaeovegetation and palaeogeography of Eastern Fennoscandia," *The Finnish Environment;* 4/2010. Accessed on: May 08, 2025. [Online]. Available: http://hdl.handle.net/10138/37967

[7] E. M. Kolpakov, A. M. Kiseleva, A. I. Murashkin, and V. Y. Shumkin, "Archaeology of the Kola North: review for 2022," in Proceedings of the Kola Science Centre of RAS, *Natural and Humanitarian Sciences*, 2023, pp. 164–183.

[8] T. M. Krasovskaya and A. V. Evseev, Rational Nature Management on the Kola Peninsula. Moscow: Moscow University, 1990.

[9] T. Rankama and J. Kankaanpää, "First evidence of eastern Preboreal pioneers in arctic Finland and Norway," Quartär, pp. 183–209, 2011.

[10] I. L. Schaeffer and S. Johann, At Nikitsky Gate, Institute. Institute of Ethnology and Anthropology, RAS, 2008.

[11] O.A. Khlebosolova and E. I. Golubeva, "Evolution of nature management problems in the Pechenga district of the Murmansk region," in Rational Nature Management: Traditions and Innovations: Proceedings of the III International Conference, M. V. Slipenchuk, Ed., Moscow: Nauka Publishing House, 2022, pp. 321–327.

[12] Kola Mining and Metallurgical Company (industrial sites "Nikel" and "Zapolyarny"): impact on terrestrial ecosystems, under the general editorship of O.A. Khlebosolova. Ryazan: NP "Voice of the province, " 2012, pp 92.

[13] O. A. Khlebosolova and E. M. Sosna, "Prospects for the creation of a protected technogenically disturbed area 'Nikel-Zapolyarny,'" *Astrakhan Bull. Environ. Educ*., vol. 82, no. 4, pp. 28–36, 2024. Available: doi: 10.36698/2304-5957-2024-4-28-36

[14] Golubkina. N et al, "Nickel, Cu, Fe, Zn, and Se Accumulation, and the Antioxidant Status of Mushrooms Grown in the Arctic Under Ni, Cu Pollution and in Unpolluted Areas," *Stresses*, pp. 25, 2025. Available: doi: 10.3390/stresses5020025