environmental sciences proceedings

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Proceeding Paper

Protected Areas as Nature-Based Solutions for Climate Change Adaptation †

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† Presented at the 6th International Electronic Conference on Atmospheric Sciences, 15–30 October 2023; Available online: https://ecas2023.sciforum.net/.

Abstract: Protected Areas can play an important role in climate change adaptation as nature-based solutions. With the huge adaptation deficit, which results in an average loss of RUB 60 billion from extreme weather events annually, the importance of protective ecosystem services is being underestimated. The conservation of intact vegetation enables the maintenance of the stability in a territory that is several times larger, than within a Protected Area. In mountainous regions, forests and grasslands prevent mudflows. In tundra and high mountains, vegetation slows down the fast degradation of permafrost in a warming climate. Forests work to increase the minimum river low flow during droughts and to decrease the magnitude and pace of floods. Protected Areas provide territory and natural resources to indigenous people; thus, they can maintain their traditional lifestyle. It is of utmost importance to emphasize the value of Protected Areas as nature-based solutions by estimating the costs of the ecosystem services they provide and the amount of damage they help to avoid.

Keywords: climate change; Protected Areas; nature-based solutions; ecosystem services; ecosystem-based adaptation

Citation: Lipka, O.N.; Andreeva, A.P.; Shishkina, T.B. Protected Areas as Nature-Based Solutions for Climate Change Adaptation. *Environ. Sci. Proc.* **2023**, *27*, 34. https://doi.org/10.3390/ecas2023-15659

Academic Editor: Anthony Lupo

Published: 1 November 2023

1. Introduction

In the 2020s, there is not a spot in the territory of Russia where climate change has not manifested in one way or another. The rate of increase in the average annual temperature averages 0.6 °C/10 years, and in the Arctic, it amounts to 1 °C/10 years [1]. In the northern regions, the warming effect has favourable implications for agriculture and forestry, as well as for people's health. However, as the climate is becoming increasingly extreme, it is causing damage to every sector of the economy across the whole country [1–3]. Hazardous hydrometeorological events have grown in number from 150-200 to 300-450 per year in the late last century [1]. They annually cause a damage of more than RUB 60 billion to the Russian economy [4].

Indigenous peoples are considered to be the most vulnerable to climate change, since their traditional lifestyle heavily relies on the environment and ecosystem services: hunting, fishing, reindeer husbandry, and the use of non-timber forest resources [2,5,6].

The global experience demonstrates the benefits of using ecosystem services and nature-based solutions as adaptation measures [2,7,8]. Protected Areas' intact ecosystems are the stabilization core and ensure protection from climatic risks. Thus, PAs contribute to the adaptation of the adjacent territories and can be viewed as nature-based solutions.

2. Methods

According to IUCN, nature-based solutions (NbS) are actions to protect, sustainably manage, and restore natural and modified ecosystems that address societal challenges effectively and adaptively, simultaneously benefiting people and nature. Nature-based solutions address societal challenges through the protection, sustainable management, and restoration of both natural and modified ecosystems, benefiting both biodiversity and human well-being. They target major challenges, like climate change, disaster risk reduction, food and water security, biodiversity loss, and people's health and are critical for sustainable economic development [9,10].

Ecosystem-based adaptation (EbA) is the use of biodiversity and ecosystem services as a part of an overall adaptation strategy to help people adapt to the adverse effects of climate change. EbA aims to maintain and increase the resilience and reduce the vulnerability of people and the ecosystems they rely upon in the face of the adverse effects of climate change [11]. It is viewed as one possible type of nature-based solutions.

For the purposes of adaptation to climate change, it is convenient to use the classification of ecosystem services as developed by TEEB [12]. In Russia, this system was adapted, and ecosystem services were assessed using three indicators: provided, required, and used volumes [13].

General information about PAs and their distribution across the territory of Russia is provided based on Rosstat's data for 2022 [14]. The "Biomes of Russia" map [15] was used to obtain general information about the ecosystems, their biodiversity due to the key systematic groups, and geographical distribution. Information about hazardous hydrometeorological events, to which the territory of a particular biome is exposed, was obtained from the database [16].

3. Adverse Impacts of Climate Change

According to the observations, since the mid-1970s, the warming rate in Russia has been about 2.5 times faster than the global average. Throughout most of the country, there is a trend towards an increase in annual precipitation at a rate of 2.2%/10 years (on average for 1976–2022); however, some areas (north of West Siberia and north of Chukotka) show a decline in annual precipitation. The evolution of precipitation by season in some Russian regions is even more variable. In addition, climate change manifests through the increasing climate "nervousness", i.e., 1.5–2 times increase in the number of extreme (anomalous) weather events and their consequences (such as heat waves, droughts, floods, and wildfires) compared to the end of the last century [1,3,17].

The model-based estimates of potential damages incurred due to wind, frost, and strong precipitation during the cold and warm periods amount on average to RUB 200–235 billion per year. The most affected sectors include housing and communal (up to RUB 70 billion or more) and energy sector (RUB 64 billion), followed by road transport (RUB 33–34 billion). The estimate of the potential damage to agriculture is lower (RUB 20–22 billion), which is explained by a lower cost of assets, i.e., agricultural crops, in territories prone to droughts, including those also exhibiting high temperatures [18].

4. Nature-Based Solutions, Ecosystem Services, and Protected Areas

Nature-based solutions use certain ecosystem services for climate change adaptation. PAs are one method of biodiversity conservation and the maintenance of the effective performance of ecosystem services, on the one hand, and one type of land use, on the other. By preserving intact landscapes, Protected Areas help regulate ecosystem services, which have an important role in climate change adaptation and help reduce the risk of disasters (Figure 1).

The classification of terrestrial ecosystem services in Russia [12] includes the following types that can be used for climate change adaptation and to reduce the risk of disasters: the use of plants to reduce the wind strength and the damage caused by hurricanes and storms; the regulation of moisture flows between the earth surface and the atmosphere; the

maintenance of the volume of water runoff; the regulation of variability (i.e., stabilization) of water runoff; reduction in the intensity of, and damage from, floods; the protection of soils from water and wind erosion; the prevention of dust storms; the prevention of damage from landslides and mudflows; and the regulation of cryogenic processes [19].

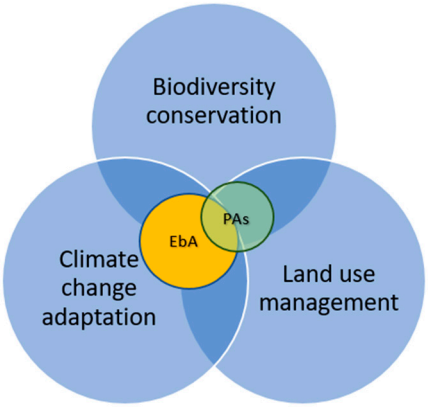

Figure 1. A conceptual model for integrating PAs into land use system, nature-based solutions, and climate change adaptation.

The range and scale of ecosystem services substantially differ across natural zones. The considerable extent of the country from north to south determines the wide range of successive ecosystems. More than 46% of Russia's territory is covered with forest, and around 65% is permafrost, and 21.6% is wetlands [20]. According to the "Biomes of Russia" map [15], more than 40% of the territory is occupied with mountain biomes.

In permafrost areas, the removal of, and damage to, the vegetation provokes thermokarst processes, which then speed up through feedback loop and result in, inter alia, the destruction of buildings and infrastructure in the Arctic region [21]. With well-developed vegetation and warming-propelled increase in peat and mosses, which are known for their cooling properties, the soil temperature remains stable [22].

Today, the preservation, restoration, and adaptation of forests to climate change are viewed as an adaptation mechanism that can help reduce the damage caused by natural disasters to large areas, such as landscapes, river basins, etc. In this regard, forests form the backbone of these areas' environmental sustainability [23].

The ability of forest plantations to favourably influence the hydrological regime and temperatures has been long used in arid regions, primarily through creating forest shelterbelts. In Russia, these were first used in the late 19th century [24] and are still used now to reduce wind speed and increase snow reserves in the fields [25]. Typically, the wind speed reduction effect is 20 times the height of a shelterbelt on the downwind side and 5 times its height of the upwind side [26].

The records show that 10–15% more precipitation falls annually over forested areas and adjacent parts of open spaces than over the neighbouring bare areas [27].

Protection from heat waves, especially in urban heat islands, is an important challenge. Research shows that air temperatures in urban residential neighbourhoods are 2.4–2.6 °C higher than in urban parks. Parks also help mitigate excessive air dryness (relative air humidity in parks is 1.9–3.7% higher) [28]. Reducing the thermal impact of the road-topping materials by planting high-shade trees along the pavements is one measure included in the draft climate change adaptation plan for Moscow [29].

In the northern regions, the warming effect of ecosystems is important to ensure comfortable living conditions. For example, the warming effect of swamps for Leningradskaya Oblast is estimated at 10% of the regional heat supply [30].

The impact of forests on the hydrological regime of rivers has three different dimensions: the effect on the water evaporation amount, the effect on the surface and internal runoff, and the effect on the water balance as a whole. In the bare areas in the middle of the

East European Plain, up to 65% of annual precipitation reaches rivers through the surface runoff. A 20% afforestation of the territory can reduce the surface runoff to 14%, and full afforestation can bring it down to 5% [31].

Being a soil protection factor, forests prevent soil washout with snowmelt and rainwater, protect soils from being blown away, and stabilize moving sands [32].

The extent to which ecosystems can provide an ecosystem service can vary significantly. For example, a slowdown in permafrost degradation or a decrease in erosion rate in polar deserts or high mountains is detected only compared to human-disturbed habitats, whereas vegetation cover in the taiga and the tundra acts as insulation material that prevents heat exchange. The effectiveness of using plants to fix slopes in the highlands varies with plant species and the structure of their root systems. In this regard, a closed herbaceous-shrub canopy is as good as a closed tree canopy.

However, adaptation measures, including nature-based solutions, have their limits, for example, ecosystem services cannot reduce the damage from ice crust formation or tornadoes. In these cases, it is practical to choose from other adaptation measures.

Since PAs are territories with minimally disturbed natural vegetation cover, they regulate ecosystem services to the maximum degree compared to other types of land use. The set of ecosystem services depends on the PAs' landscapes and the adverse climate conditions that need adapting to. Although each PA has a certain specificity, the set of potential ecosystem services it provides can be presumed based on the natural zones and altitudinal belts to which it is confined. For all the large variety of adaptation ecosystem services, only two approaches are used to benefit from them: reducing the anthropogenic pressure and restoring the disturbed ecosystems. However, in each natural zone, there is quite a large variety of nature-based solutions.

In this context, PAs have an important role to play as they are intact areas where ecosystems are able to provide regulating services to the maximum degree for the purpose of climate change adaptation. According to Rosstat [17], in 2022, there were 11,931 PAs in Russia, totalling to 2,442,698.08 km^2, which is about 14% of the country's territory.

Although approaches for the valuation of ecosystem services, including those provided by PAs, have been developed for quite a long time [33,34], a comprehensive assessment for the whole Russian territory has not been accomplished even in the framework of the national report prototype on the ecosystem services in Russia [12]. Some researchers confirm that the entirety of the provided ecosystem services may be six or more times more valuable than the natural resources that can be harvested from 1 ha of Pas, i.e., timber, peat, etc. [35]. For example, the cost of pine stands in commercial forests amounts to 15,065 RUB/ha (production-based ecosystem functions) versus 124,640 RUB/ha in protection forests (regulatory ecosystem functions), i.e., is more than eight times lower For example, the cost of wood in commercial pine forests amounts to 15,065 RUB/ha (production-based ecosystem functions) versus cost of regulatory ecosystem functions 124,640 RUB/ha in protective forests (in accordance with the Forestry Code, protective forests are intended to protect various objects from undesirable natural (for example, precipitation, winds, avalanches) or anthropogenic impacts), i.e., is more than eight times lower [36].

5. Conclusions

The role of PAs in ecosystem-based adaptation and their potential as nature-based solutions are currently underestimated. One possible reason is the incomplete overall assessment of the ecosystem services of the country. In addition, the assessments of ecosystem services are typically made in compliance with the traditional TEEB system, which does not include many of the regulatory ecosystem services that are important for adaptation.

However, even the available fragmentary estimates of PAs' adaptation ecosystem services show that the ecosystem services they provide are at least six to eight times higher in value than the value of products that could be obtained from their territories. A

complete evaluation would require analysis based on the basin approach, which implies the evaluation of damage prevention or reduction for all objects located downstream.

In order to highlight the value of Protected Areas as nature-based solutions for adaptation plans, it is critically important to assess the costs of the ecosystem services and avoided losses.

Author Contributions: Conceptualization, O.N.L., T.B.S. and A.P.A.; methodology, O.N.L. and T.B.S.; formal analysis, O.N.L., T.B.S. and A.P.A.; investigation, O.N.L. and A.P.A.; resources, T.B.S. and A.P.A.; data curation, O.N.L.; writing—original draft preparation, O.N.L., T.B.S. and A.P.A.; writing—review and editing, O.N.L. and T.B.S.; visualization, O.N.L. and A.P.A.; supervision, O.N.L. All authors have read and agreed to the published version of the manuscript.

Funding: The research was accomplished under state assignment from Russian Hydrometeorological Service No. AAAA-A20-120070990079-6 to Yu. A. Izrael Institute of Global Climate and Ecology.

Institutional Review Board Statement: Approved by the Russian Hydrometeorological Service 10 October 2023.

Informed Consent Statement: Not applicable.

Data Availability Statement: Data are contained within the article.

Conflicts of Interest: The authors declare no conflicts of interest. The funders had no role in the design of the study; in the collection, analyses, or interpretation of data; in the writing of the manuscript; or in the decision to publish the results.

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