

ORIGINAL RESEARCH ARTICLE

Ecosystems conservation and analysis of the representativeness of protected areas of the Kyrgyz Republic in a climate change

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ABSTRACT

The most valuable natural complexes and objects should be represented in the State protected areas (PA) system. In order to preserve biodiversity, it is necessary to expand protected lands to 10% of the total country area and create an ecological network that includes various categories of ecosystems. Each protected area can represent one or a number of ecosystems, depending on the height above sea level, landform, climate and other factors. In a perfect scenario, PA system of Kyrgyz Republic must represent all categories of ecosystems including mountain, steppe, semi-desert and desert. In this research the analysis of the representativeness of protected areas in Kyrgyz Republic was performed for the first time. For this purpose, GIS data sets for PAs and classification of ecosystems were used. According to the results, forest ecosystems have the highest coverage, whereas low mountain meadows and wetlands have the lowest coverage in PA system of Kyrgyz Republic. This research suggests that this type of analysis is an important tool for biodiversity conservation and evaluation of an ecological vulnerability.

Keywords: Protected Areas (PA); ecosystems; climate change; biodiversity; representativeness of PA; ecological framework

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1. Introduction

In the context of climate change, protected areas, as the ecological framework of the country, play a crucial role in the adaptation of species and ecosystems. In order to protect the snow leopard (*Panthera uncia*), argali (*Ovis Ammon*) and ibex (*Capra sibirica*), brown bear (*Ursus arctos isabellinus*), lynx (*Lynx lynx*), manul (*Felis manul*), stone marten (*Martes foina*) and saker falcon (*Falco cherrug*), lammergeier (*Gypaetus barbatus*), himalayan griffin (*Gyps Himalayensis*), griffon vulture (*Gyps fulvus*), black vulture (*Aegypius Monachus*), golden eagle (*Aquila chrysaetos*) and other species there have been created 10 reserves and 13 natural parks. The protected area's (PA) cluster cover only some parts of the ecosystems. Other biodiversity hotspots are not covered by the PA system. In this regard, the task is to analyze the representativeness of ecosystems in the system of PAs.

At the state level, the major tool for conserving biodiversity under changing climatic conditions is the establishment of an effective PA system. This in itself is an adaptation measure for the conservation of rare species and ecosystems. The removal of anthropogenic pressure from protected areas allows biota to respond flexibly and adapt to new conditions, reducing the risk of extinction

of the most vulnerable species.

2. Protected areas of the Kyrgyz Republic

One of the leading focuses in the national policy, aiming to mitigate the effects of climate change, preserve biodiversity is the expansion of the network of specially protected natural areas up to 10% of the total area of the country, is provided for by the National Development Strategy of the Kyrgyz Republic until 2040^[1] and Priority Directions of Adaptation to Climate Change in the Kyrgyz Republic until 2017.

Almost the entire territory of the Kyrgyz Republic is included in the area of one of the 36 global "hot spots of biodiversity" called "Mountains of Central Asia"^[2]. The Tien Shan ecosystems are included in the list of 200 priority ecoregions of the planet by the World Wildlife Fund^[3]. In Kyrgyzstan, there are three wetlands of world importance under the Ramsar Convention: Issyk-Kul, Son-Kul and Chatyr-Kul^[4]. There are also 11 important bird areas (IBAs)^[5] and two objects included in the UNESCO program as international biosphere territories—Issyk-Kul Biosphere Territory and Sary-Chelek National Reserve^[6].

The country's environmental sustainability is determined by the national system of PAs (**Figure 1**), aimed at improving, protecting and rational use of land and water resources. The wetlands, ensure the preservation and restoration of biodiversity and the provision of ecosystem services. The interaction, mutual influence between biodiversity and climate change are two-way: climate change threatens biodiversity, and biodiversity can reduce the effects of climate change. The creation of protected areas for more than a hundred years has been one of the main effective approaches to the conservation of biological diversity, both at the global, national and regional levels. They form the ecological framework of the country and the region as a whole.

The modern integrated approach to nature protection requires the expansion of the network of specially protected natural areas (SPNA), the protection of rare plant and animal species listed in the International Red Book (IUCN) and the Red Book of the Kyrgyz Republic.

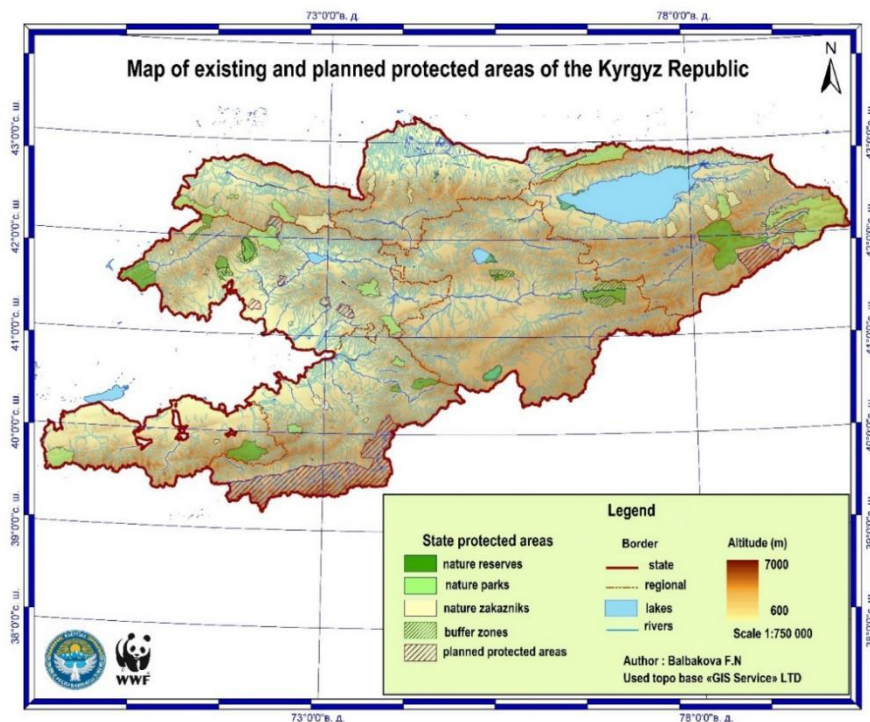


Figure 1. Map of specially protected natural areas of the Kyrgyz Republic^[7].

As shown on the **Figure 1**, existing and planned PAs in the Kyrgyz Republic has all categories of protected areas forming a network of specially protected natural areas with a total area of 1,463,242 hectares, which is 7.37% of the country’s territory^[7].

Table 1. Area development by each PA category.

PA	Increase of the Area by each PA category (hectare)					
	1995	2000	2005	2010	2015	2023
Reserves	164,857	236,937	354,760	460,887	509,952.7	509,952.7
Nature and national parks	11,172	238,697	259,197	294,801	392,029.6	724,570
Natural monuments	100	100	100	100	100	100
Sanctuaries/ nature reserves	288,900	36,176	291,017	287,192.8	123,170	229,019
Total PA area	465,179	512,060	905,224	1,182,717.5	1,076,395	1,463,242
% of the total country’s area	2.30	2.50	4.50	5.95	5.38	7.37

The present expansion of PA area from 5.38% in 2015 to 7.37% is the country’s contribution into implementation of Achi Target 11 (**Table 1**)^[8]. Aiming at fulfilling the tasks included in the Action Plan to Implement Biodiversity Conservation Priorities in the Kyrgyz Republic for 2014–2024, 10 specific activities were identified, and 80% are completed. In general, Kyrgyzstan shows a positive trend regarding the expansion of PA area, and there is a plan to increase this area to 10% by 2024 through the establishment of several PA in Batken province the projected Arks National Park of 80 thousand hectares to preserve low mountain steps and desert ecosystems—Goitered gazelle (*Gazella subgutturosa*) habitats. Another project in Osh province is the projected Chon-Alay National Park to preserve high alpine steppe and meadows ecosystems—argali (*Ovis ammon Severtsov*), snow leopards (*Panthera uncia*), manul (*Felis manul*) habitats. It is also planned to establish a number of zoological reserves in Talas, Jalal-Abad, Batken provinces. All these efforts are necessary, as protected areas play a crucial role in climate change adaptation since they provide “nature solutions” to climate change. Besides providing refugial habitats for rare and endangered species, protected areas also significantly contribute to carbon sequestration and storage, and overall strengthening of ecosystem services. PAs networks should include sufficiently representative areas of landscapes and ecosystems, typical for each natural subdivision of the geographical provinces.

In order to prevent the consequences of climate change, the conservation of biodiversity - it is necessary to create an ecological network that includes various categories of protected areas and migration corridors—in mountain, forest, steppe, semi-desert and desert ecosystems^[9].

Natural plant and animal communities play a crucial role in the formation of an environment suitable for life in difficult mountainous conditions. On the plains, ecosystem boundaries may extend for hundreds of kilometers and fluctuations in biological communities caused by climate change occur over vast areas. However, in the mountainous Kyrgyz Republic, desert, steppe, alpine meadow, and forest ecosystems occur in close proximity to each other and ecosystem patches are sometimes only several kilometers across. This high degree of biodiversity across such small areas can only continue to survive if these contrasting ecosystems are covered by a system of protected areas. The formation and preservation of soils, retention of rainfall, continuous surface water flows and purification, and even gas composition of the atmosphere depend on the functioning of natural ecosystems. Once highland ecosystems are lost, they cannot be effectively replaced by other ecosystems. Thus, preserving the heterogeneity of mountain ecosystems will need to be a critical part of the response to climate variability.

Typically, species that are already endangered are particularly vulnerable to the impacts of climate change, as natural conditions are altered and habitats degraded. One such species is the snow leopard

(*Panthera uncia*). The high mountain ecosystems of the Kyrgyz Republic form extensive snow leopard habitat. Projected increases in temperature and the melting of glaciers may reduce the extent and quality of the snow leopard’s alpine habitat as lower elevation ecosystems shift upward. Snow leopards (*Panthera uncia*) could also be threatened by increasing aridity in this region, which will threaten the survival of prey species such as argali (*Ovis ammon*) and ibex (*Capra sibirica*). Another climatic threat to snow leopards (*Panthera uncia*) could be increasing snowfall in winter, which would contribute to the die-off of prey species and hinder the snow leopard’s (*Panthera uncia*) ability to hunt^[10].

In Kyrgyzstan, 20 classes of ecosystems (**Table 2**) are identified based on natural complexes synthesis according to classification proposed by Shukurov^[11]. Difficult high mountain terrain in the south temperate zone in Kyrgyzstan creates favorable conditions for all basic types of natural ecosystems ranging from deserts to high mountain tundra (**Figure 2**).

Ecosystems map of the Kyrgyz Republic

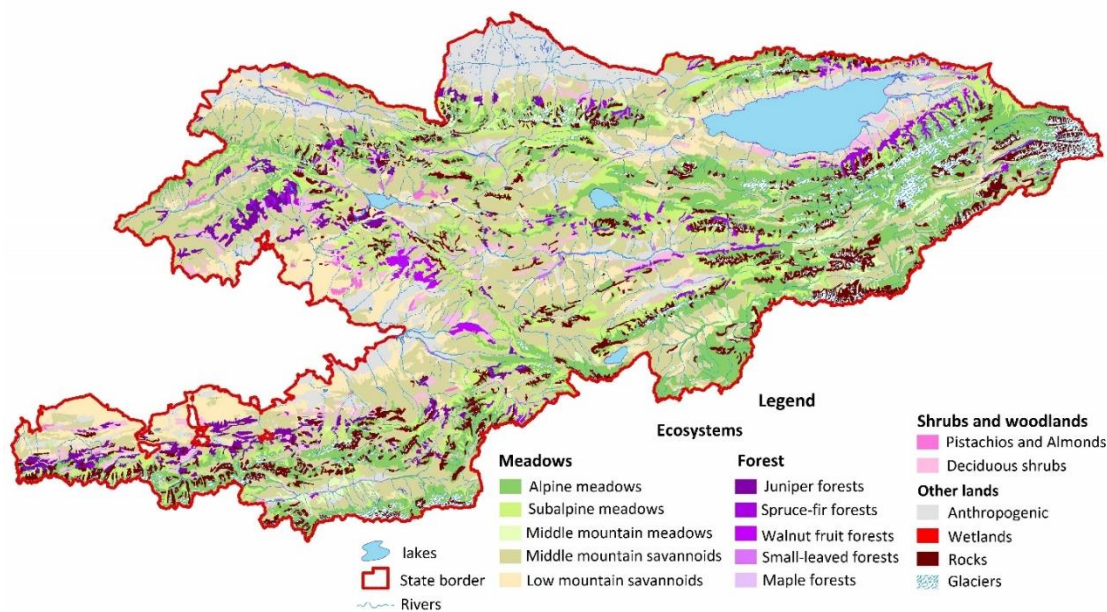


Figure 2. Map of ecosystems of the Kyrgyz Republic^[11].

Concentration of wide variety of ecosystems and landscapes in a limited area, as well as hard surface irregularity constitute relatively small total area of each ecosystem class, create extreme conditions for them and high degree of their clusterization; these characteristics increase mountain ecosystems vulnerability to anthropogenic pressures at the local level and climate change at the global level.

Table 2. Ecosystems and their disturbance degree.

Ecosystem classes	Area, km ²	Disturbance		
		severe	medium	weak
Spruce-fir forests***	3017.00		X	X
Juniper forests and open forests***	2548.32		X	
Small-leaved forests***	1040.64	X	X	
Walnut fruit forests	928.75		X	
Broad-leaved forests***	83.67		X	X
Pistachios and Almonds	458.47	X		
Middle mountain deciduous shrubs	3871.96			X

Table 2. (Continued).

Ecosystem classes	Area, km ²	Disturbance		
		severe	medium	weak
Cryophyte (alpine) deserts	1953.44	X		
Cryophyte (alpine) meadows	17,263.49		X	
Cryophyte (alpine) steppes	22,474.57		X	
Subalpine meadows	13,207.99		X	
Middle mountain deserts	1384.34	X		
Middle mountain steppes	24,803.53		X	
Middle mountain meadows	8898.19		X	
Middle mountain savannoids	2361.89		X	
Middle mountain open forests	231.51	X		
Low mountain and foot steppes	192.70	X		
Low mountain deserts	5571.61	X		
Wetlands***	8086.02	X	X	
Anthropogenic*	32,111.71			
Other lands*				
Glaciers and snow patches	5773.74			
Nival-subnival	13,909.04			
Rocks, rock slides and streams	9150.67			
Total:	178, 313.38			

Note:

*—anthropogenic ecosystems are not assessed as they are 100% disturbed as natural ecosystems;

**—other lands are not assessed as they practically lack biodiversity;

***—different comparable areas have different level of conservation.

As can be seen from **Table 2**, out of 20 ecosystem classes 8—severe disturbed, 2—the same are severe and medium disturbed, 9—medium disturbed and 3—weak disturbed. Ecosystems are especially severely damaged in foothill valleys, middle basins and mountain ejections up to 1500–2000 m above sea level. Part of a significant replacement of the ecosystem has taken place here. Artificial ecosystems (arable land, settlements, industrial zones, communications, etc.), the remaining natural ecosystems are likely to be highly under anthropogenic press.

Foundation from the foundations of sustainable development is the area of protected ecosystems. For stable development, it is necessary pre-reserve transition areas to ensure the preservation of all types of ecosystems when their boundaries change due to climate change. The representativeness ecosystem diversity in a network of protected areas can only be assessed for the entire territory of the country. The natural ecosystem can develop only from natural ecosystems^[12].

According to the analysis of the representativeness of protected areas^[7] by ecosystems in **Figure 3**, spruce-fir, juniper and maple forests ecosystems have the highest coverage in PAs, the mountain meadows have the average coverage, whereas wetland, small-leaved forests, pistachios and almonds forests have the lowest coverage.

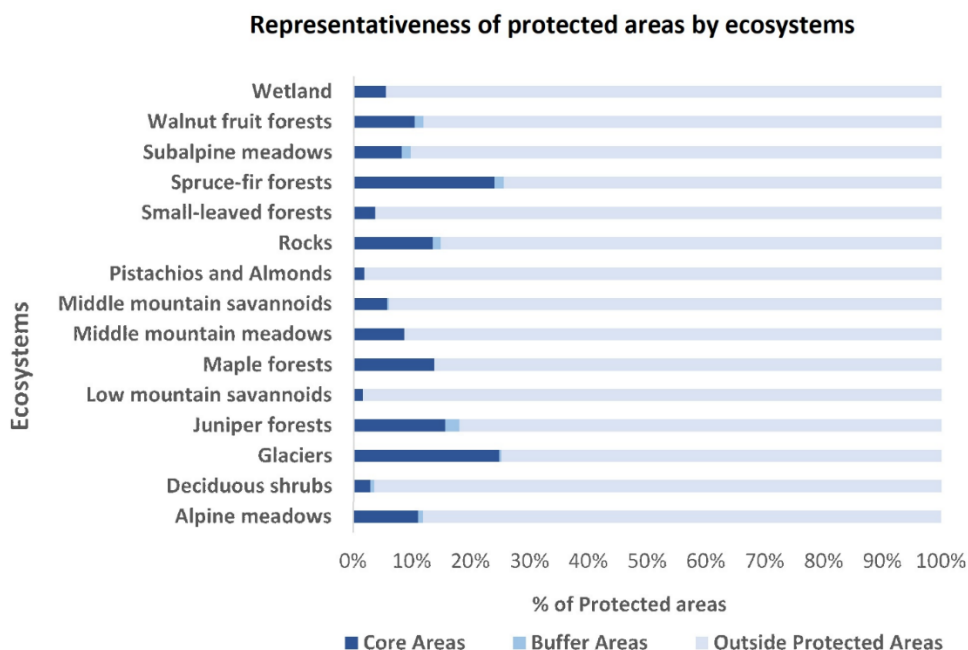


Figure 3. Compiled on the basis of the Balbakova’s GIS map of Pas Kyrgyz Republic^[7].

Herewith, the most important natural complexes and objects—both reference and unique ones—are included in the state PA system: spruce-fir, juniper and walnut fruit forests, high mountain alpine meadows and middle mountain meadows.

Due to anthropogenic pressures the majority of low mountain and middle mountain savannoids, deciduous shrubs that represent pastures have lost their self-regeneration capability, and large herbivorous animals have practically disappeared. This degradation leads to the loss of genetic resources and redistribution of ecological niches. In addition, faster climate change is increasing pressure on natural ecosystems. In this connection, it is necessary to strengthen activities aiming at ensuring primary coverage of ecosystems that preserved their natural condition, and develop methods to use reference ecosystems for regeneration of ecosystems that have lost the substantial part of their genetic viability and structure.

3. Conclusion

Thus, PA networks should include sufficiently representative areas of landscapes and ecosystems that are characteristic of each natural subdivision of the region (geographical provinces, districts, etc.). They should also include areas with high adaptive capacity and resistance to climate change. Climate-smart protected areas and their networks include areas of particular importance for the reproduction of biological resources and the provision of other ecosystem services. Protected area systems should also include rare and unique natural complexes and objects that ensure their maximum possible preservation in the present and future.

Conflict of interest

The author declares no conflict of interest.

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