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Transformation of High-Mountain Landscapes (Study of Lagonaki, North-West Caucasus)

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***Abstract*—At the present time, in different regions of the world the problem of reducing the area and fragmentation of natural ecosystems is extremely important. The characteristic of the specially protected Lagonaki territory is given. It is noted that the decline in landscape diversity is often accompanied by the loss of species at different levels. Most natural communities are changed by man. The intensity of anthropogenic impact on different natural communities in the region varies significantly. The characteristic of the highlands Lagonaki is given. There is a decrease in productivity of meadows from 34 to 4.1 t/ha. The Lagonaki highland has vast resources for the development of various types of tourist activities. Among these resources, there are allocated relief and geological structures, defining a significant variety of landscapes, the presence of attractive and picturesque recreational facilities.**

Keywords*— *permanent preservation area; Lagonaki, Caucasus mountains; diversity ecosystems

I. INTRODUCTION

Due to a unique scenic landscape, the Caucasus mountains attract tourists. However, even with 30% of the territory designated as Permanent Preservation Area, the diversity of ecosystems and natural heritage is being degraded due to tourist development, which has led to the loss of geodiversity, still under-recognized by the society. Geodiversity refers to the variety of botanical, geological and geomorphological elements of a territory, which are the product and record of Earth's evolution. In order to justify the need for its management, this paper aims to identify the geodiversity of Caucasus [1-4].

Maikop district belongs to the foothills and mountains of the North-West Caucasus. The main recreational resources are concentrated here. The area of the district is 366743 hectares. Maikop district is mainly agricultural. Crop, seed, potato, vegetable, horticulture and cattle are the main areas of agriculture in the region.

Relatively small islands of forest vegetation are a reminder of the oak forests that have grown here. The forests of the mid-mountain and high-mountain parts of the North-West Caucasus have been preserved thanks to the organization of protected areas. Oak forests of the lower mountain zone were almost completely destroyed. These territories belonged to rural and collective-farm forests and were actively exploited [5-8].

One of the key elements is the Lagonaki highland. The Lagonaki highland has vast resources for the development of various types of tourist activities [1,2]. Lagonaki is a part of the Caucasian natural protected areas from 1924 to 1951 and was in the condition of limited use. This mode had only mountain-meadow, mountain-forest were in the mode of absolute reserve.

The protected system survived the crisis in 1950-1956. During this period, the area of the reserve was reduced 3 times. This led to the unsystematic use of forests and pastures, the decline in the productivity of biological communities and their complete destruction. Forests (135,2 thousand hectares), mountain meadows (50,7 thousand hectares) are withdrawn. High-mountain part of the Lagonaki was in the regime of intensive exploitation of pastures and forests from 1951 to 1990.

Fig. 1. Location of the area.

The consequences were catastrophic. The systematic destruction of forests and pastures has led to a decline in the productivity of biological communities, and in some areas to complete destruction. Lagonaki was closed for grazing in 1990. Recently, however, attempts have been made to turn protected areas into a center of tourism.

II. STUDY AREA

Lagonaki is an isolated high-mountain limestone region of the Western Caucasus. Lagonaki is a part of the Western Caucasus mountains. Rocky mountains and glaciers are combined with wooded ridges in a small area (650 km^2). The orographic center of the highlands is the mountain group of the Fisht massif. It is the highest part of the highlands and

consists of mountains Fisht (2868 m), Oshten (2804 m), and Psheha-Su (2744 m). The territory is composed of rocks of Jurassic and Cretaceous age. The territory is composed of rocks of Jurassic and Cretaceous age. Upper Jurassic rocks consist of dolomitized limestones. They are exposed on the ridges of the Kamennoe more, Asishtau and others.

Fig. 2. Oshten, Lagonaki

Fig. 3. Kamennoe more, Lagonaki

Geomorphosites are often important elements of natural protected areas and may be valued both as structural and functional elements of the natural system and for their social values in relation to their location. Natural protected areas are designated as a result of a wide range of natural and cultural values that define a landscape, a natural environment, an ecosystem or a habitat [9-11].

The relief of Lagonaki is complex and diverse. Fluvial, sloping and karst processes play an important role. They determine the availability of specific forms of terrain. In this place there are all the forms of glacial (glacier valleys, cirques, moraines) and types of karst topography (wells, caves, underground rivers).

Fig. 4. Lagonaki

Fig. 5. Bolshaya Azishskaya Cave, Lagonaki

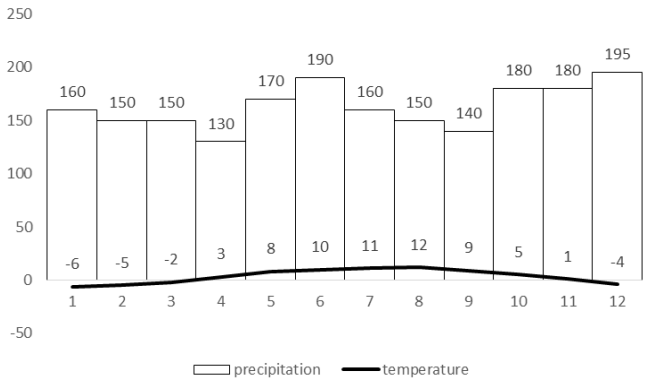

Fig. 6. Annual precipitation and temperature, Lagonaki

According to climatic conditions, the territory belongs to the wet subdomain climatic region of the Western Caucasus. The climate of the mountainous region is formed under the increasing influence of western winds.

The main part of precipitation is represented by snow. The distribution of snow cover on the territory is extremely uneven

and depends on the combined influence of many factors: the height above the sea level, exposure and steepness of the slopes, the features of the relief, the vegetation cover of the area. Snow cover on the slopes of the southern exposure in the forest and meadow zones is not significant.

III. RESULTS AND DISCUSSIONS

Complex geological history, highly dissected relief and high-altitude zoning caused high landscape and species diversity of the territory. The territory covers the full profile of high-altitude natural landscapes typical for the Western Caucasus (Table I).

TABLE I. ALTITUDINAL ZONALITY

Region	Zone	Height
Alpine	Snowfields, glaciers	2800
	Alpine meadows	2400
	Subalpine meadows	2000
Medium mountain	Fir forests	1500
	Beech and fir forests	1000
Low Mountain	Beech and hornbeam forests	700
	Oak and hornbeam forests	500
Foothill	Oak forest-steppe	

The Alpine landscape is characterized by a combination of steep rocky slopes, rocks, scree, glaciers and snowfields with significant areas with closed soil and vegetation cover. Snow cover melts in July, in September it snows. Characterized by sharp temperature fluctuations. The soil cover is represented mainly by mountain-meadow Alpine sod-carbonate leached soils.

Alpine low-grass meadows and lichen wasteland are characterized by relatively high local species richness. Phytocenoses with domination of Carex tristis, C. hutiana, Kobresia persica are confined to the slopes of different steepness and exposure and having a different degree of stoniness. The lichen cover varies from 15% to 35%, mosses 5% to 15%. The phytocoenoses with dominance of Festuca ovina are located mostly on the plateau-like ridges and slopes of lesser steepness. Almost all of them have a closed cover and a significant projective cover of lichens (up to 60%). The species richness of these communities is relatively low.

Geranium meadows are confined to small depressions of mesorelief with significant accumulation of snow in winter. The growing season usually begins in late June-early July. The projective cover varies from 50 to 97%. Dominant species are Geranium gymnocaulon, Hedysarum caucasicum, Pedicularis condensate.

Alpine communities of western and circus bottoms are with abundant (more than 4 m) snow accumulation. Species diversity is low. Dominant species are Ranunculus brachylobus, Sibbaldia parviflora, Taraxacum stevenii.

Fig. 7. Alpine meadows, Lagonaki

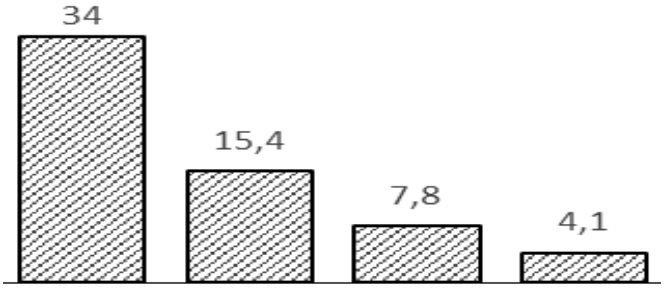

Fig. 8. Reducion of productivity of alpine meadows, Lagonaki

Subalpine mountain-meadow landscape corresponds to the height of 1800-2400 m. It is characterized by wide flat slopes, interspersed with stone placers and rock outcrops. Vegetation is represented by areas of thickets of Rhododendron caucasicum, middle grass meadows and subalpine tall grass.

Tourism has a significant negative impact on the nature of the reserve. Minimal digression was observed on steep slopes of forest and meadow. Meadows with high grassy vegetation are presented here. Therefore, tourists are forced to move along the trail. The width of the trail is 0.4-1.8 m. There is a complete lack of vegetation on it. Trees and shrubs that grow along the trail have severe damage. The main changes in meadow biocenoses are represented by the following types:

soil trampling, complete destruction of vegetation. There is a violation of subalpine herbs and the emergence of weed species. Motor transport is a real disaster for the meadows. It leads to the destruction of vegetation and increased erosion.

One form of exposure is the introduction of foreign species. The results of studies have shown that the main danger is the spread of Erigeron annuus and Ambrosia artemisifolia. The construction of tourist infrastructure contributes to the penetration of foreign species in the mountain landscapes.

Fig. 9. Alpine meadows, Lagonaki

IV. Conclusions

Analysis of the dynamics of the load on tourist routes revealed uneven distribution over the years and routes. The maximum number of Amateur campaigns in 1992 and 1993 in the subsequent time has decreased. Since 2000, there has been an increase in the load.

In the zone of upper mountains, beech and beech-fir forests recreation has virtually no effect on trees, and their biological damage to trees, their technical value and sanitary condition. Recreation has a significant impact on the level of mechanical damage caused to trees of most species, except fir trees.

Agricultural impacts on natural complexes Lagonaki are associated with the development of high-mountain livestock. The impact of grazing is expressed in the oppression of vegetation, in feed competition and displacement of wild animal species by domestic ones, in violation of daily and seasonal migration of wild animals, in their infection with diseases and parasites from domestic.

Grazing on Lagonaki was carried out constantly with varying degrees of intensity. From 1924 to 1951 the high-mountain part of Lagonaki was a part of the Caucasian reserve and was in the mode of limited economic use. In 1951, when the area of the reserve was reduced three times, this area was removed from its composition and transferred to intensive operation. Thus rules and norms of a pasture weren't met. In some years, the load was more than 50 thousand heads of cattle, widely used vehicles. Unsystematic and uncontrolled use of pastures has led to widespread soil erosion, transformation of grass and reduced its productivity. During this time, the yield fell from 34 t/ha to 4 t/ha.

As a result of long-term impact, the upper border of the forest on Lagonaki is reduced. The greatest damage to the forest on its upper limit was caused by cutting down of pasture economy for various needs.

Contamination with poisonous and non-edible herbs in some areas reached 60-80%. In the places of paddocks, artificial Solonets, on cattle-driving trails, plant communities were completely destroyed. Among the most affected zones by grazing were small lakes and marshes. Most of the lakes were contaminated with nutrients, aquatic vegetation was completely destroyed in 15% and significantly transformed in 60% of cases. The biggest changes occurred on the Hiking trails and Parking lots. Minimal digression was observed in areas with high grassy cover, dense undergrowth and undergrowth. The composition of the plants of the subalpine meadow is significantly changed - presented weed species, unusual for this zone. In areas of tourist routes trampled soil, cover and litter, there were natural landfills. Construction of camp leads to the emergence of weed species, such as Ambrosia artemisifolia, Matricaria matricarioides, Erigeron annuus that are significantly distributed throughout the territory.

Analysis of the distribution of weed species in mountain areas showed that the most widespread species are Ambrosia artemisifolia, Erigeron annuus. The main role in the distribution of weed species belongs to building materials used in the construction of roads and the construction of tourist infrastructure.

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