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ABSTRACT

of the dissertation for the degree of Doctor of Philosophy

"MANAGEMENT OF ENVIRONMENTAL RISKS AND HAZARDS CAUSED BY ANTHROPOGENIC TRANSFORMATION OF THE MOUNTAIN GEOSISTEMS OF THE NORTH- EAST Slope OF THE LITTLE CAUCASUS"

Speciality:	5408.01 - "Physical geography and biogeography, soil geography, geophysics and geochemistry of landscapes"
Field of Science:	Geography
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GENERAL CHARACTERISTIC OF THE WORK

Relevance of the topic and degree of development. Changes in the natural environment as a result of economic activities have affected most parts of the earth. At all levels of territorial organization of the landscape crust - local, regional and even global - a deep transformation of the landscape structure and natural processes has occurred as a result of anthropogenic intervention. Under the influence of human activity, the natural landscape has caused various changes, which has led landscape scientists to have an unequivocal approach to this process and a difference of opinion. As a result of these ideas, anthropogenic landscapes are complexes that are both consciously and purposefully created by humans to fulfill certain socio-economic functions and result from the deliberate alteration of natural landscapes.

In our republic, in the countries of the former USSR and in some European countries, numerous studies of landscape scientists investigated the problem of interaction between natural landscapes and the economy, studied topics such as classification of anthropogenic modifications of natural complexes, landscape and ecological assessment of territories, etc. They also analyzed the direction and intensity of various anthropogenic changes occurring in natural conditions, learned to predict the environmental problems they will create and optimize landscapes. Isachenko A.H. (1980)[1] and Milkov N.F. (1997)[2] are foreign scientists conducting research in this field, and Budagov B.A., Mikayilov A.A. (1996)[3], Garibov Y.A. (2012)[4] and others are local researchers.

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[1] Исаченко, А.Г. Оптимизация природной среды / А.Г. Исаченко. – Москва: Мысль, − 1980, − 264 с.

[2]Мильков, Н.Ф. Человек и ландшафты. Очерки антропогенного ландшафтоведения. / Н.Ф.Мильков. − Москва, − 1997, − 222 с.

[3] Budaqov, B.Ə., Mikayılov, A.A. Təbii landşaftların formalaşması və inkişafının əsas qanunauyğunluqları // Bakı:Azərbaycan Respublikasının konstruktiv coğrafiyası, − 1996, − 153-173 s.

[4] Qəribov, Y.Ə. Azərbaycan Respublikasının təbii landşaftlarının optimallaşdırılması / − Y.Ə. Qəribov. – Bakı: AzTU, − 2012, − 216 s.

In the north-eastern slope of the Lesser Caucasus, the population has recently increased, the area of settlements has expanded, the implementation of new infrastructure projects, the development of the mining industry, etc. intensified the use of natural resources of the area for various economic purposes. Intensive and diversely oriented anthropogenic transformation of the natural environment of the studied area is manifested in the structure of natural landscapes, their components, the course and development of natural processes. The study of these complex, still insufficiently studied processes is relevant for solving many theoretical, methodological and applied problems aimed at improving the system of nature use and optimizing the geoecological situation in the region.

The object and subject of the research. The research object of the dissertation covers the modern landscapes of the slope of the north-eastern part of the Lesser Caucasus - post-forest forest-steppe, meadow-steppe and forest-meadow, steppe, mountain-forest, mountain-meadow of the middle and low highlands. As a result of anthropogenic modifications, those landscapes have become much more complex, their differentiation and diversity have increased.

Research goals and objectives. The main purpose of the research is to determine the degree of anthropogenic loading of modern landscapes of the northeastern slope of the Lesser Caucasus mountains, to study the risks and dangers caused by exodynamic processes in the region, and to optimize geosystems. To achieve this goal, the following tasks have been set:

- Study of the natural-geographical factors influencing the differentiation of the modern landscapes of the north-eastern slopes of the Lesser Caucasus Mountains;
- GIS analysis of the impact of anthropogenic modification of geosystems on modern landscapes;
- Investigating the risks and dangers caused by exodynamic processes and anthropogenic loading;
- Determining ways to improve and optimize the ecological situation of the region.

Research methods Systematic analysis, historical-geographical, mathematical-statistical, observation, comparison, cartographic, as well as Geographical Information Systems were used in the implementation of the research work. Using GIS technologies, the morphometric indicators of the territory of the Republic of Azerbaijan, digital maps of the degree of vegetation cover from the decoding of Landsat 4-5 and 8-9 space images were analyzed in the form of tables and mathematical-statistical comparisons were made.

The main provisions defended:

- The influence of the natural-geographical components of the north-eastern slope of the Lesser Caucasus on the formation of natural landscapes;
- The impact of various anthropogenic influences on the transformation of natural landscapes;
- Risks and dangers caused by anthropogenic effects on geosystems.
- Forecasting the formation and development of modern sustainable landscapes.

Scientific novelty of the research. As a result of the conducted research, we have succeeded in the following scientific innovations:

- Using the decoding of space materials, the influence of natural-geographical conditions on the creation of landscapes was determined;
- The modern condition of the landscapes of the north-eastern slope of the Lesser Caucasus was studied;
- Risks and threats caused by exodynamic processes and anthropogenic modifications existing in the region were assessed;
- Ways to optimize the geosystems of the studied area have been determined.

Theoretical and practical significance of research. The practical importance of the work is determined by the possibility of applying the results of the dissertation research by scientific-research organizations, educational institutions, environmental services and project organizations in the implementation of

territorial planning and efficient use of nature measures. they can use in the course of work.

Approval and investigation. Important maps of the research work, recommendations made in the work, etc. It can be used in the teaching of "Landscape studies" and "Ecology" subjects of the Ministry of Agriculture, Ecology and Natural Resources of the Republic of Azerbaijan, as well as in higher schools specializing in geography.

The main results and terms of the dissertation were presented at the following important international and republican conferences.

III International scientific conference on "Ecology: problems of nature and society" dedicated to the 110th anniversary of Academician Hasan Aliyev (Baku, 2017), International scientific conference on "Actual problems of modern natural and economic sciences" dedicated to the 95th anniversary of national leader Heydar Aliyev . (Ganja, 2018.), "Modern problems of water management, environmental protection, architecture and construction" IX international scientific-practical conference (Tbilisi, 2019.), "Innovation and global issues" V international scientific-practical conference (Ankara, 2019 .) III International scientific conference on "The role of tourism in ensuring sustainable development" (Baku, 2019).

The name of the institution where the dissertation work was performed. It was performed at the "Geography" department of the Faculty of History and Geography of Ganja State University.

The structure of the dissertation. Dissertation work consists of introduction, 4 chapters, conclusion and list of used literature. The volume of the work is 140 pages. 8 maps, 3 pictures, 8 tables, 1 scheme and a 126-name literature list were used in the work to increase the visibility of the research. Introduction-4-7 pages, Chapter I-8-43 pages, II chapter-44-73 pages, III chapter-74-105 pages, IV chapter-106-124 pages, conclusion-125-126, suggestions-127, literature the list is 128-140 pages. It consists of 210105 symbols without tables, graphs, pictures and bibliography.

SUMMARY OF THE STUDY

In the introduction, the relevance of the topic, the purpose, tasks, theoretical and methodological bases of the research are determined, and the scientific novelty and practical importance are explained.

Chapter I of the dissertation work is dedicated to **"Modern landscape zones of the north-eastern part of the Lesser Caucasus and their differentiating features".** The basis of the horizontal differentiation of the landscape complex is the horizontal invariance of the climate zone depending on the geographical latitude.

Since our republic is not located in a large range of geographical latitude, the horizontal change of landscapes from north to south (or vice versa) is weakly evident. These changes can also be found on the north-eastern slope of the Lesser Caucasus.

The main reason why landscapes are subject to periodic changes in both vertical and horizontal direction is the location in an active orogenic belt. Another reason for the diversity of the vertical belt of the differentiation of landscapes, that is, the change of the natural landscape complexes in a wide area towards the height, is the hypsometric height of the area.

As can be seen from the hypsometric height map of the northeastern slope of the Lesser Caucasus, the absolute height of the area fluctuates between 500-3724 m above sea level. Thus, 17% of the area is 500-1000 m, 30% is 1000-1500 m, 33% is 1500-2000 m, 11% is 2000-2500 m, 7% is 2500-3000 m and only 2% -i has an absolute height of 3000 m. In the mentioned region, these differences had a very serious impact on the vertical differentiation of landscapes and led to the emergence of different structural types in the vertical distribution of landscapes.

The differentiation of landscapes is influenced by the hypsometric height of the slopes, as well as their visibility. In the slope map we prepared based on the ArcGis software, the slopes of the mountain slopes on 4 main and 4 transit azimuths (north-00, northeast-450, east-900, southeast-1350, south-1800, southwest-2250, west -2700, northwest-3150) landscape types formed were analyzed.

Most of the landscapes spread in the area are concentrated in the

north-eastern (144797 ha or 17%), eastern (127653 ha or 15%), north-western (115795 ha or 14%) exposed slopes. In this region, the slopes with less steepness are in the south (9%), south-west (8%), and west (9%) exposed slopes.

The hydrographic network of the northeastern slope of the Lesser Caucasus also had an impact on the vertical and horizontal differentiation of landscapes. The rivers of the northeastern slope of the Lesser Caucasus are the right tributaries of the Kura River. The longest and wateriest rivers of the area are Zayam, Tovuz, Akhinca, Agstafa and Esrik rivers.

The flow process of the hydrographic network of the studied area is significantly influenced by physical and geographical conditions and climatic factors. The annual flow of these rivers, fed mainly by rain, ground and snow water, is unevenly distributed.

The influence of the terrain on environmental conditions is multi-factorial and highly dynamic. The stage of new tectonic movements for its north-eastern slope of the Lesser Caucasus took place from the Oligocene[5].

The formation of the Goyrushlu, Agdag plateaus and the Alibeyli depression is closely related to the processes that took place during the Oligocene. The foundations of the valleys of Cogaz, Incesu, Hasansu, Tovuz and partly Akhinca rivers were laid in the Oligocene[6].

All types of erosion are widespread in our research area. Depending on the height, depth erosion prevails in the mountainous part, depth and lateral erosion prevails in the middle highlands, and lateral erosion prevails in the low highlands. Since the high mountainous part of the area (Shahdag Murguz, Chingılli ridges) rose rapidly during the neotectonic stage, depth erosion developed and formed a network of deep valleys with different morphological characteristics.

The distribution of temperature in the region is different. The

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[5] Şirinov, N.Ş. İnsan və relyef / N.Ş. Şirinov – Bakı: Azərbaycan Dövlət Nəşriyyatı; − 1991, − 115 s.

[6] Məmmədov, Ə.V. Böyük Qafqazın cənub şərq qurtaracağında antropogen aridləşmənin torpaqların mikromorfoloji göstəricilərinə təsiri // Bakı: Coğrafiyanın müasir problemləri, ACC əsərləri, −2008, − 142-147 s.

average annual temperature changes from north to south and also from west to east: in Gazakh-11.80C, in Shamkir-12.90C, in Gadabay-7.30C, in Ganja-12.60C.

The vertical distribution of landscapes in the mountainous areas of the north-eastern slope of the Lesser Caucasus and the emergence of various exodynamic processes in connection with them are closely related to inclination. For the north-eastern slope of the Lesser Caucasus, the areas with a slope of 5-100 cover a wider area. Only 4% of the total area has a slope higher than 300.

The nival and partly nival-glacial landscapes of the highlands cover the parts of the Lesser Caucasus mountains (i.e. Karabakh volcanic plateau, Zangezur ridges, Murovdag) at an altitude of approximately 3,000 m. A slightly wider area of the subnival rocky landscape is developed in the Camish pass (3724-m) and Omar pass (3295-m), as well as in the Korogludag ridge (3462-m). In the high mountain passes and watersheds subjected to continuous denudation, their area gradually decreased and was replaced by subalpine and alpine meadows in the high mountains.

Accumulation of coarse-grained products, unsorted avalanche and debris products of physical wear inside the complex is observed.

High mountain meadows have developed in the studied region between subnival and forest complexes, between 1700-1800 m and 3000-3200 m absolute altitudes. Subalpine-alpine meadows are divided into 3 classes in terms of change-disturbance characteristics: weakly, moderately and severely disturbed landscapes. According to our calculations, weakly and moderately disturbed pastures and meadows cover 300,000 ha, and severely disturbed pastures and meadows cover 149,000 ha.

Most of the high-quality, productive forests in the research area are in the mid-mountain zone. Destruction of bushes and forests in most parts of the researched region has led to the desiccation of soil covers and the washing of its upper layers. The shrub-forest and meadow complexes of the region, which come after the forest, are extremely different from each other in terms of the anthropogenic characteristics of the areas.

Chapter II of the dissertation is dedicated to the study of

"The main regularities of the anthropogenic transformation of the mountain geosystems of the northeastern slope of the Lesser Caucasus". These areas are one of the regions that have been mastered since ancient times and have undergone fundamental transformation as a result of the economic effects of people over many years. The urban type of Selitep complexes changes the natural landscapes more sharply and acts as one of the most important factors determining their fundamental transformation. In the Lesser Caucasus, the density of seliteb landscapes (per 1000 ha) is 2% in Gadabey, 0.6% in Dashkasan, 1.3% in Shamkir, and 1.8% in Tovuz. In the Lesser Caucasus region, the Ganja-Gazakh sloping plain is the part most exposed to human economic activity. 50% of the seliteb complexes of the entire territory, including 90% of large settlements (Ganja, Shamkir, Tovuz, Gazakh, Aghstafa, etc.), and 80% of irrigated crops, fruit and vineyards are concentrated here. As a result of this, intensive anthropogenic effects have caused drastic changes in natural landscapes. In most areas of the plains, the anthropogenic factor of landscapes is more than 0.8. The agrolandscapes formed on the north-eastern slope of the Lesser Caucasus have gone through a long historical-geographic development. All the complexes that exist here have been transformed in their own way. From agrolandscapes, farmlands, gardens, plantations, pastures and meadows cover larger areas. Until the 50s and 60s of the 20th century, more than 80% of anthropogenization was observed in the sloping plains, and the rest in the mountainous areas. One of the most important reasons for the rapid and fundamental transformation of this region is the development of industry here (Figure 1).

As man-made transformation is related to the mining industry, this process is more specific to the areas of the region with high natural resource potential. In particular, Gadabey copper-molybdenum complexes, Ganja-Dashkasan alunite complexes, Gazakh-Shamkir construction materials, etc. have variously disturbed mining landscape complexes. The anthropogenic factor of landscapes in man-made complexes is 0.7-0.8 and higher. Complexes of this type make up to 5% of the studied area. Their largest territorial units cover large areas in both settlements and industrial facilities in Dashkasan, Gadabey, Gazakh, Shamkir. Thus, the pollution occurs in the area of Dashkasan

iron ore combine and covers an area of 1200 ha. The adoption of the northeastern slope of the Lesser Caucasus by various economic sectors has had its effect on the formation of its modern landscapes. Thus, natural landscapes lost their original state over time due to anthropogenic effects and were replaced by new landscape types.

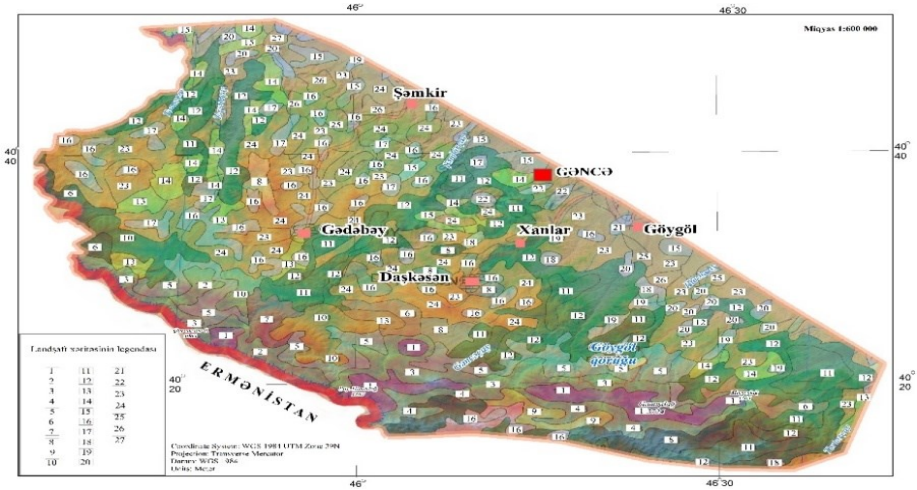


Figure 1. Transformation map of the landscapes of the northeastern slope of the Lesser Caucasus

The north-eastern region of the Lesser Caucasus is the largest and oldest tourist zone of our country. This region includes Ganja, Goygol, Dashkasan, Shamkir, Gadabey, Tovuz, Agstafa and Gazakh territories. Hajikand and Goygol recreation areas at an altitude of 1566 m above sea level are the richest areas of the zone with recreational potential.

In order to protect the riches of nature, a large number of national parks, reserves and sanctuaries have been created in the zone. The first Goygol State Nature Reserve, established in Azerbaijan in 1925, is located in this zone. The main purpose of creating the reserve is to protect mountain-forest and mountain-meadow biocenoses, mountain lakes, flora and fauna of the north-eastern slope of the Lesser Caucasus zone, which are of resort-climate importance. The development of ecotourism in order to protect natural recreational resources in this region is also appropriate. Goyazan mountain, Damjili, Koroglu

constellation, Goshagaya, etc. are examples of natural monuments that are considered as tourism objects. In terms of area and economic importance, Ganja, the second largest city of the country, has interesting and ancient tourist facilities (Nizami Ganjavi Mausoleum, Shah Abbas (Juma) Mosque, Imamzade complex, Sheikh Ibrahim Mausoleum, etc.). The oil of Naftala, 48 km southeast of Ganja, which is important for medical treatment, as well as significant historical-architectural buildings in the territory of Goygol and Gazakh, 25 km south, increase the recreation of the region from the point of view of tourism.

In the north-eastern slope of the Lesser Caucasus mountain, the characteristics of agriculture and related anthropogenic transformations also change according to the change of landscape belt types towards the height. The semi-desert and dry steppe landscapes of the foothills and sloping plains have undergone a higher anthropogenic transformation, mainly the superior development of irrigation agriculture, horticulture, winter pastures, irrigation and road-communication systems, as well as various types of anthropogenic changes. Mountain-steppe landscapes are distinguished mainly by the type of pasture-pasture animal husbandry, ruminant farming, partly low-fertilization, road-communication lines and recreational activities. In the mountain-forest landscape belt type, mainly paddy farming, partly hay, forestry and recreation farming have improved (table 1). Mountain meadow landscape types are used in the form of summer pastures, mowing sites, unsystematic and irregular grassland tourism area. The mentioned types of anthropogenic activities create unique transformations in the corresponding natural landscape zones.

In the north-eastern slope of the Lesser Caucasus mountains, steppe landscapes cover the sloping plains at the foot of the mountains, and wide areas of the low highlands up to 700-800 m high. The modern desert landscapes in the studied area are mainly re-derivatives formed in their place as a result of deforestation that existed here in the past. These are proven by the presence of an illuvial layer in the structure of black loam-like and brown soils scattered in mountain desert landscape types, chemically close to forest soils.

Table 1.

Anthropogenic destruction of the forest in sample areas on the north-western slope of Sariyal mountain

№	The name of the forest landscape	Number of trees		Damage to trees, %		Degree of anthropogenic disturbance	Averages of trees	
		Total	Repetitive derivation	Undamaged	Damaged		Density	Height m
I	Oak-stemmed forest on a poorly fragmented	352	171	26	74	Strong	0,4	18
II	Oak-hornbeam forest on a relatively smooth	214	184	32	68	Strong	0,4	20
III	Deciduous oak forest on a moderately fragmented mountain slope	454	78	70	30	Weak	0,8	28

During the comparison of the area ratio of natural and anthropogenic landscapes in the plain dry-desert landscape, it was determined that the anthropogenic level is more than 90%. The plasticity of the terrain on the north-eastern slope of the Lesser Caucasus Mountains, the fact that the bottoms are smooth, wide, and the depressions between the valleys are useful and efficient in terms of livestock and agriculture have led to the increase of settlements in the mountain-forest landscape zones.

The presence of rich minerals in the north-eastern part of the Lesser Caucasus has led to the development of industry in the region since ancient times. The development of industry, especially the construction of the Transcaucasian railway, has led to massive deforestation in the region. In four years, instead of 3,000 cubic meters of wood, 15,000 cubic meters of wood were cut[7]

The following stages of anthropogenic transformation of the forest landscape are distinguished (table 2). As mentioned in the table, the recreation potential of the mountain-meadow-steppe landscape is changing in a negative direction due to the existing anthropogenic influences. Anthropogenic interventions have seriously reduced the density of plant grasses, the level of cover and natural biological diversity in the mountain-meadow landscape type. The change of surface cover conditions the change of microclimate (table 2).

Chapter III of the thesis work is dedicated to the study of **"Risks and dangers caused by anthropogenic transformation in the north-eastern part of the Lesser Caucasus".**

Scientists divide environmental risks and threats caused by anthropogenic transformation into four main categories, and each of them has evaluation criteria. First of all, it is determined by the sources that created it (slide, avalanche, erosion, desertification, etc.) and the areas they occupy in landscape types. Each of these categories can be found in varying degrees in the study area. 36.4% of the land cover of our republic has been eroded at different levels.

[7] Məmmədova L.A. Azərbaycan təbiəti. Sözün qüdrəti / L Məmmədova − Bakı: Elm və Təhsil, − 2015, − 342.

Table 2.

The effect of anthropogenic change of mountain-meadow-steppe landscapes on the recreation potential of the area

Sample area and landscape type	Absolute height and inclination of the slope	Characteristic of anthropogenic change			Changing landscape components					Changing the recreational potential of the landscape
		Farm area	Intensity of anthropogenic impact	The rate of anthropogenicity, with a coefficient, in %	Relief	Land	Vegetation change			
							Species	Elevation and height 100%, m	Productivity g/m2	

Table 2 follows

1. Mountain-meadow soils and subalpine meadows of the Sarıyal mountain watershed of the weakly fragmented smooth watershed	2800 m watershed	Mowing and partial grazing	Irregular	$\frac{0,2}{20}$	Weak	Weak	29	$\frac{100}{38}$	920	Landscapes that have sufficiently retained their existing recreational potential
2. Saryyal mountain south-eastern slope, subalpine meadow on the thick mountain-meadow soils of the smooth slope	2550 m 15–20°	Mowing and partial grazing	Seasonally irregular	$\frac{0,3}{30}$	Weak disruption	Weak disruption	31	$\frac{100}{28}$	830	“——”
3. 1.5-2 km north-east of Versiyal mountain	1700 m south-eastern slope with an inclination of 20-25°	Mowing, intensive grazing	Seasonally irregular	$\frac{0,7}{90}$	The terraced slope, the relief has changed strongly	Recycled grass lands	28	$\frac{100}{29}$	950	Landscapes with sufficient recreational potential

										Table 2 follows
4. Gravel mountain range, strongly degraded grassland with grass-meadow soils of the smooth north-eastern slope	The inclination of the slope is 15–20°, the absolute height is 2100m	Grazing	Seasonally irregular	0,5 50	Strongly modified, man-made ravines, groves and roads	Trampled, degraded, exposed 30–35%				Landscapes that have largely lost their recreational potential
5. Koshgar mountain slope. Disturbed grassland with grassy mountain meadow soils of the flattened plateau surface of a flat mountain slope	North-eastern slope, inclination 15-20°, absolute height 2300m	Grazing meadows	Seasonally irregular	0,6 60	Strongly altered, man-made ravine, etc	Strong tread, special weight 13g/m3, degradation, stripping 15%	16	85 grass 3cm, weeds 30cm	140	Mountain-meadow landscapes that have lost their recreational potential
6. Left bank of Shamkirchay, 5km southeast of Miskinli village: Bushy steppe consisting of heavily degraded secondary bushes and weeds.	Inclination 25–30°, 2300m	Grazing	Regular	0,5 50	Sharp change, man-made ravine, gobo, paths, roads	Sharp tread, specific gravity 14.2g/cm2, stripping	18	70 grass 5cm, weeds 25cm		It has largely lost its recreational potential

14.1% of it is weakly, 10.7% moderately, and 11.6% severely washed soils.[8] One of the main reasons for the wide spread of erosion processes in the mountainous areas of the Lesser Caucasus, which we have studied, is the continuous grazing of grazing and pasture zones due to the excessive loading of pasture in those zones.

Deforestation and destruction of forests and forest-shrubs in the plains and low-mountainous areas of the region and unsystematic plowing of certain areas, as well as the acceleration of erosion in the cultivated lands of the region, have resulted.

In Goygol National Park, located in the north-eastern direction of the Lesser Caucasus, due to the improper observance of grazing rules in the mountain-meadow belt, the process of pasture erosion is widespread. As a result of unsystematic and excessive grazing of large and small-horned animals, the condition of mowing and grazing areas has deteriorated significantly.

Desertification is an important natural-historical process occurring in the landscape, and it has its own role in its transformation and territorial differentiation. As in other regions of Azerbaijan, the process of desertification in the studied area is mainly due to the influence of anthropogenic factors in the plains and foothills. Fundamental changes in the region's ecogeographical conditions and the increase of anthropogenic loads play a major role in the formation of desertification and the risk of desertification. In the creation of this process, the destruction of grazing forest and bush plants in connection with the life activity of people acts as an important anthropogenic factor.

The desertification-desertification process is more dynamic in the eroded arid mountain slopes, and often the bare areas become sources of desertification and their area expands year by year. Such desertification centers can be found at the lower border of the former forest - around the villages of Seyfali, Sarikhan, Narimanli, Chovdar, Yenikend, Chaikend, and Tatarli. Reforestation in desertification centers is carried out by intensive, purposeful planting of forest trees.

[8] Qəribov Y.Ə, Əsgərova H.H. Azərbaycanın arid landşaftlarında səhralaşmanın bəzi təzahür məsələləri // − Dağlıq ölkələrdə təbiətdən səmərəli istifadə üzrə elmi konfransın materialları, − Bişkek, − 1991, − 30-31s.

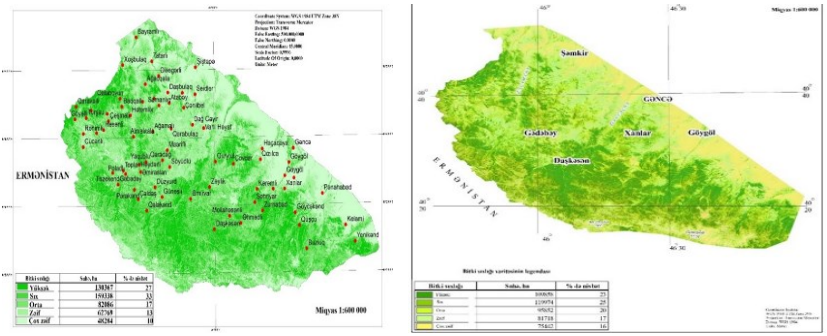
The rich fodder base of the summer pastures of the north-eastern slope of the Lesser Caucasus has been drastically changed and its natural potential has decreased significantly due to unsystematic use for many years.

It is clear from the research that the level of anthropogenic loading of the mountain-meadow landscape of the north-eastern slope of the Lesser Caucasus was 2-2.5 times higher than that of summer pastures in other mountainous regions of the Republic of Azerbaijan. The reason for this is that the mountain-grassland landscapes in the researched region have an optimal relief-climate and a large part of the summer pastures in the southeast of the Lesser Caucasus (Kalbajar, Lachin, Zangilan, Shusha, etc.) will be occupied by Armenians until 2020. After 1995, the loading of the summer pastures on the north-eastern slope of the Lesser Caucasus as pasture has increased by 1.5-2 times compared to the 1980s. Our observations and the analysis of statistical data show that the loading of the pasture area is increasing rapidly. This leads to extreme anthropogenic loading of mountain meadows, a sharp decrease in their irreplaceable recreation potential.

Detailed information about Azerbaijani forests was studied by G.Shmammadov, M.Y.Khalilov (2002) and other researchers[9]. The forest reserve of our republic is 11.8% of the territory of Azerbaijan. According to historical materials, the amount of forest reserves has decreased intensively due to the increase in the number and density of the population. As a result of the decoding of space images, we have compiled the degree of vegetation coverage of our research area for the years 1980 and 2021. We have determined that during this period, many changes occurred in the flora of the northeastern slope of the Lesser Caucasus. A decrease was observed mainly in areas with high (20 thousand ha) and dense (39 thousand ha) vegetation cover, and on the contrary, an increase in areas with medium (13 thousand ha), weak (18 thousand ha) and very weak (75 thousand ha) has been done. Currently, 16% of the total area is

[9]. Məmmədov, Q.Ş. Azərbaycan meşələri / Q.Ş.Məmmədov, M.Y.Xəlilov – Bakı: Elm, − 2006, − 314 s.

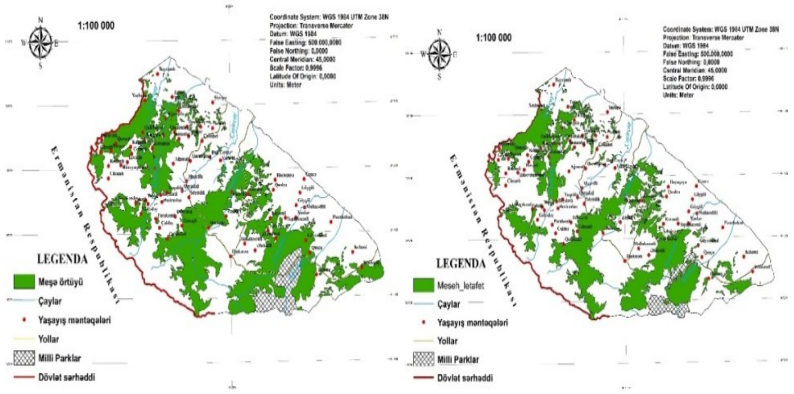
covered with very little vegetation, 17% is weak, 20% is medium, 25% is dense and 23% is high (Figure 2).



a)1980 b) 2021

Figure 2. Vegetation map of the northeastern slope of the Lesser Caucasus

As a result of the conducted research and interpretation of aero-space images, we found that the forest cover on the northeastern slope of the Lesser Caucasus has decreased to 2.5% in the last 60 years (Figure 3).



a) b)

Figure 3. Forest cover map of the northeastern slope of the Lesser Caucasus (a) 1960; b) 2021)

Serious measures should be taken to preserve and increase forest resources, felling should be carried out in accordance with the relevant natural conditions, the condition of existing forests, serious measures should be taken against fire and grazing, and plans for planting new forests should be further expanded. If the illegal cutting of forests is not prevented in time, our republic may face severe environmental disasters. Thus, it can lead to the expansion of erosion, the increase of steppe areas, the intensification of landslides, floods, and avalanches in mountain areas, and the drying up of springs and rivers. However, we consider it appropriate to create and efficiently use new reserves or national parks in the area.

Chapter IV is dedicated to the issues of **"Combating and managing risks and dangers caused by anthropogenic transformations".**

At present, sustainable development of natural landscapes, effective use, protection, and their evaluation are among the most important problems of landscape science and at the same time physical geography. In the area selected as a research object, there are plain and mountainous landscape classifications, which in themselves group a number of types:

1. Mountain landscape class;
2. High mountain-meadow;
3. Low and medium mountainous mountain-steppe.
4. Mountain-forest complex or mountain-forest;
5. Mountain-forest-steppe meadow-bush complexes.

This research area includes nival-subnival and alpine-subalpine landscapes. Nival and subnival landscapes cover 10.2% of the northeastern slope of the Lesser Caucasus. In a number of areas on the mountain tops here, the snow is above the snow line. This type can be found on the top of Goshgar and Kepaz. This complex has very unfavorable conditions due to the morphometric and climatic indicators of the terrain. Here, vertical fragmentation (higher than 1000 m/m2), horizontal fragmentation (higher than 2 km/km2), inclination (above 350) gets the highest value. Buda causes the ecogeomorphological situation in those areas to become tense. Also, subnival-nival-glacial complexes cover a wide area in these

landscapes. Alpine and subalpine high mountain-meadow complexes cover most of the high mountain-meadow landscapes in the northern and northeastern directions of the Lesser Caucasus. The high mountain-meadow region has a considerable geological and geomorphological structure. These landscape units are sharply divided horizontally and vertically depending on environmental conditions. Here, the vertical fragmentation is 800-1000 m/m2, the horizontal fragmentation is 1.5-2 km/km2, and the slope is 300-350. Buda causes the ecogeomorphological situation in those areas to be highly stressed.

This area we studied includes mountain-forest and mountain-steppe complexes. Within this complex, a wide slope (22-250) and fragmentation of relief (vertical fragmentation (400-600 m/m2), horizontal fragmentation (1-1.5 km/km2)) are characterized, which leads to a tense ecogeomorphological situation in those areas. Most of the slopes of our study area are north and northeast facing. Such a situation led to the formation of up to 80% of the humid landscapes formed in the region on these exposed slopes. From the ecological change of the landscapes, we conclude that the main reason for the active development of exodynamic processes here is that the anthropogenic loading has a value of 0.8-0.9.

Semi-deserts of foothill plains – this type of landscape has a large area, it covers arid areas of foothill plains, wide river valleys. Here, the availability of morphometric indicators of the relief (inclination (0-220) and fragmentation of the relief (vertical fragmentation (0-400 m/m2), horizontal fragmentation (0-1 km/km2)) has led to greater appropriation of the area. Formation of agro-irrigation landscapes and development has a longer history. There were favorable natural conditions for the creation of irrigated anthropogenic complexes in the studied area. Studies show that the thickness of agro-irrigation sediments in the inter-conical depressions of the Ganja-Gazakh sloping plain reaches 0.5-1.0 m. In the studied dry-desert and partially Kurboy semi-desert landscapes, signs of ancient irrigation are small dashes, buried soil layers, waterless valleys, etc. preserved as important genetic indicators in modern anthropogenic landscapes. These signs are clearly

distinguished in the modern relief in the form of Ganjachay, Goshgarchay, Shamkirchay, Tovuzchay and ancient canals, low dashes, and elongated depressions drawn from their tributaries. These are relic structural elements of modern landscapes.[1010] The second way of forming irrigated agro-landscapes in the studied area is the use of kahriz waters. Due to the high degree of mineralization of Kahriz waters, the use of Kahriz waters for irrigation over the years has affected the salinization of agro-landscapes. It should be noted that in the following years, as a result of melioration measures, in addition to increasing the productivity of agrolandscapes, certain measures were taken to prevent soil salinization and it is appropriate to take them.

We prioritized the optimization of 1364 km2 of the northeastern slope of the Lesser Caucasus by evaluating the natural-ecological balance and organizing environmental control in a systematic way.

Keeping in mind the research works, we have distinguished 3 main directions of optimization of the landscapes of the north-eastern part of the Lesser Caucasus for recreation purposes, which we give below:

I. Evaluation of natural-ecological balance and organization of environmental control in a systematic way.

II. Normalization of anthropogenic loading of landscape species.

III. Succeed in maintaining natural components or complexes by turning privately protected areas into national parks, reserves, and sanctuaries (Figure 4).

The implementation of measures in the given directions will allow to optimize the future development trends of anthropogenic landscape types, to increase the ecological diversity and recreation potential of the area. The majority of the area, i.e. 3357.9 thousand km2, i.e. 65.9%, was considered appropriate to normalize the anthropogenic loading of landscape species. Basically, these areas

[10] Мусеибов, М.А. Ландшафты Азербайджанской Республики (Пространственное диффенренциация и эволюция ландшафтов). / М.А.Мусеибов. − Баку: БГУ, − 2013, − 137 с.

include settlements, arable fields, summer and winter pastures, hayfields, tourism-recreational facilities, in short, areas that are currently being used by various farms. If the correct balancing of anthropogenic load in the mentioned zones, regular and systematic use is taken into account, the process of degradation of landscapes will be slowed down, and it will lead to their continuous appropriation.

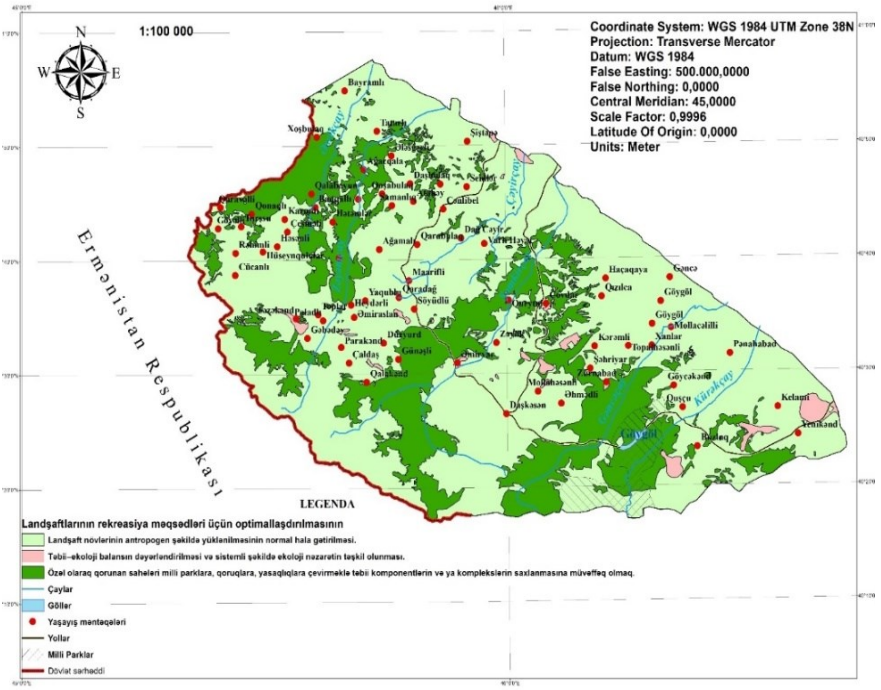


Figure 4. Map of the optimization of the landscapes of the northeastern slopes of the Lesser Caucasus for recreational purposes.

By turning 368.1 km2 of privately protected areas into national parks, reserves, and sanctuaries, we can succeed in maintaining natural components or complexes. Basically, these areas are covered by forest, forest-steppe and mountain-steppe landscapes. A massive occurrence in these regions, which are regularly broken for various

purposes, and the area of which is decreasing year by year, will lead to widespread problems such as soil degradation and erosion. At the same time, landslides, avalanches, floods, etc., will lead to the activation of exodynamic processes, which will result in the increase of environmental problems of these ecosystems.

We prioritized the optimization of 1364 km2 of the northeastern slope of the Lesser Caucasus by assessing the natural-ecological balance and organizing environmental control in a systematic manner. This includes areas where the mining industry is currently developing, where their waste is spread, where landslides, avalanches, erosion and other exodynamic processes are actively taking place. In order to protect the ecological balance of landscapes in this zone, there is a need for industrial areas to adopt waste-free technology, to use waste correctly, to carry out slope strengthening works in zones where various exodynamic processes often occur, and in general to have periodic monitoring. If these measures are implemented in time, we can return the land that we have lost to unusability back into circulation.

CONCLUSION

The following main results can be stated in the management of environmental risks and threats caused by the anthropogenic transformation of the mountain geosystems of the north-eastern slope of the Lesser Caucasus:

1. The natural-geographical conditions of the region, especially the morphometric indicators of the relief and the favorable climate factor, have led to the settlement of the population here since ancient times, the appropriation of the territory for various purposes, the constant increase of anthropogenic loading of natural geosystems, and as a result, the anthropogenic transformation of landscapes has covered a wide area.

2. It was determined that the type, intensity, and structure of anthropogenic activity usually change from the foothills to the

highlands according to vertical zones. According to the level of disturbance of the natural ecological structure, 8% severely disturbed, 45% moderately disturbed, 37% relatively weakly disturbed, and 9% intact natural landscapes were registered in the area. The strongest degree of anthropogenization was observed in the dry-desert landscapes of the foothill sloping plains, the forest, meadow-forest, meadow-steppe and desert landscapes of the low and partly medium highlands.

3. Modern and anthropogenic landscape maps of the region were prepared as a result of the decoding of aerial photographs, and the degree of change was determined for each landscape complex. Also, the degree of vegetation cover (1980-2021) and forest cover (1960-2021) of the studied area were compiled in the Geographical Information System, and their change dynamics were given. It was determined that currently 16% of the total area is very poorly covered with vegetation, 17% is poorly covered, 20% is moderately covered, 25% is densely covered, and 23% is covered to a high degree.

4. The risks and dangers caused by the exodynamic processes and anthropogenic transformation of geosystems occurring in the region were assessed, it was determined that these processes are more intense in the forest-steppe in the middle mountainous areas, and in the steppe landscapes of the low mountains, landslides and erosion cover a wider area.

5. In order to develop the landscapes of the studied area continuously, a map of their optimization was drawn up with the help of decoding of space images and the help of GIS. At this time, it was determined that 3357.9 thousand km2, i.e. 65.9% of the territory, was normalized by the anthropogenic loading of landscape species, 368.1 km2 of privately protected areas were transformed into national parks, nature reserves, and sanctuaries, and natural components and either the complexes should be maintained, and 1364 km2 should be prioritized for optimization such as evaluation of the natural-ecological balance and organization of environmental control in a systematic way.

6. Landslides, floods, avalanches, erosion, etc. caused by

exodynamic processes on the north-eastern slope of the Lesser Caucasus. the causes of the occurrence of the processes should be investigated and a system of measures should be prepared at the state level for their limitation and prevention. It is very necessary to achieve proper management and regulation of these processes by periodically conducting environmental monitoring in the studied region.

PROPOSALS

1. Identification and regular monitoring of all the main risk and danger factors in the area.
2. Landslides are the main risk and danger factor in the area. Preparation of the catalog of landslides and preparation of anti-slide measures.
3. Study and application of international experience in risk and threat management.
4. Preparation of large-scale (morphometric, plant, soil, etc.) thematic maps of risk and dangerous regions.
5. Organization of complex expeditions for the study of risk and dangerous regions.
6. Application of the most modern technology (electronic surveillance, creation of CIB of risks and threats) in the management of risks and threats.
7. Since population settlement and anthropogenic factors are the most important risk and dangerous factor, population settlement should be conducted on a scientific basis.
8. For the continuous, (sustainable) development of the studied area, a map was drawn up for the purpose of recreation with the help of decoding of space images and their optimization with the help of GIS. At this time, it was determined that 3357.9 thousand km2, i.e. 65.9% of the territory, was normalized by the anthropogenic loading of landscape species, and 368.1 km2 of privately protected areas were transformed into national parks, reserves, sanctuaries, and

natural components and either the complexes should be maintained, and 1364 km2 should be prioritized for optimization such as evaluation of the natural-ecological balance and organization of environmental control in a systematic way.

9. Landslides, floods, avalanches, erosion, etc. caused by exodynamic processes on the northeastern slope of the Lesser Caucasus. the causes of the occurrence of the processes should be investigated and a system of measures should be prepared at the state level for their limitation and prevention. It is very necessary to achieve proper management and regulation of these processes by periodically conducting environmental monitoring in the studied region.

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1. Cəfərova, L.H. Kiçik Qafqazın dağətəyi və alçaq dağlığı təbii landşaftlarının antropogen transformasiyasının yaratdığı problemlər // BDU -III Beynəlxalq Elmi konfransın materialları – Bakı: − 26−27 dekabr, − 2017, − s. 92-94. (Y.Ə.Qəribov, G.B.Əhmədova, T.V.Qasımova ilə birlikdə)
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