

AZERBAIJAN REPUBLIC

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ABSTRACT

of the dissertation for the degree of Doctor of Philosophy

**LANDSCAPE-ECOLOGICAL DIAGNOSTICS AND ZONING
OF THE GANIKH-AYRICHAY VALLEY AND ADJACENT
MOUNTAINOUS AREAS**

Speciality: 5408.01 – Physical geography and
biogeography, soil geography, geophysics and
geochemistry of landscapes

Scientific field: Geography

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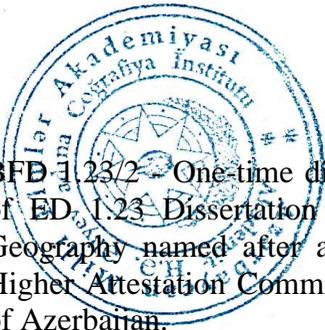
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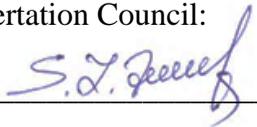
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GENERAL CHARACTERISTICS OF WORK

Actuality and development of the subject. The current state of the landscapes of the Ganikh-Ayrichay valley and adjacent mountainous areas, their change and degradation as a result of anthropogenic impact pose very serious geocological problems for the study region. Violation of the stability of geosystems of the area, loss of initial functional characteristics, intensification of exodynamic processes caused by technogenic processes, excessive load on landscapes, etc. require optimization and effective management of natural and anthropogenic impacts. To do this, it is necessary to conduct research based on landscape-ecological diagnostics in the region under study.

2700 km² out of 4500 km² of the territory of the study region are agrocomplexes that have undergone erosion and degradation. It should be noted as a sad fact that the landscapes of the Ganikh-Ayrichay valley and adjacent mountainous areas consist of approximately 80% of ecologically weak and unstable complexes. That is why the study of the stability of natural geosystems in the complex landscape-ecological diagnostics of the region under study can contribute to the effective solution of a number of persistent economic, social, environmental and military problems.

Proper management of environmental threats caused by anthropogenic transformation in the region where we conducted our study is extremely important for the sustainable development of the natural landscapes of the area. For many years, the irrational use of the natural resource potential of the region, the mistakes made in their management have led to a weakening of environmental security in landscapes, and the increase of dangers and risks. The correct solution of the problem, the regulation of anthropogenic loads on natural complexes, prevention of landslide, erosion and flood risks, landscape degradation as a whole and development of their ecological assessment methods are one of the main tasks facing modern landscape science.

Exodynamic processes created and activated by anthropogenic transformation of natural complexes in mountainous regions,

degradation and disturbance of landscapes have always attracted the attention of scientists as an object of scientific research. Especially in recent decades, the sharp increase of anthropogenic loads in natural complexes, the fundamental change of landscapes, the degradation of natural complexes as a result of the creation of re-derivative complexes with different contents in their place, and the intense increase in damages caused by landscape disturbances have increased the urgency of the current problem.

Research object and subject. The object of the study is the modern natural and anthropogenic landscapes of the Ganikh-Ayrichay valley and adjacent mountainous areas. The subject of the study is the study and assessment of modern environmental complications, degradation, exodynamic processes and threats in geosystems as a result of centuries-old anthropogenic impact in this region using the method of landscape-ecological diagnostics.

Research aims and tasks. The goal of the study is to determine the current state of natural geosystems, anthropogenic transformation, the environmental consequences caused by them, and the preparation of necessary measures to reduce the environmental load using landscape-ecological diagnostic methods in modern geosystems of Ganikh-Ayrichay valley and adjacent to mountainous areas. To achieve the goal, the following tasks are to be solved:

- study of the historical evolution of vertical differentiation and anthropogenic transformation of natural-anthropogenic landscapes;

- analysis of the formation and development of modern landscapes, taking into account the influence of natural-environmental factors on the landscape structure;

- assessment of landscape-ecological conditions by comparison of elevation, inclination, hypsometric level, etc. maps and transformation maps of natural landscapes developed on the basis of ArcGIS software;

- mapping "Diagnostic assessment of landscapes" and "Ecological zoning of landscapes" for the region under study by analyzing the structure, differentiation and transformation of modern landscapes using the method of ecological diagnostics of landscapes.

Research methods. Although the main research method is

landscape diagnostic analysis, also took into account a number of research methods that are widely used in the study of regions in landscape science. In particular, when compiling modern landscape maps were widely used aerospace, landscape-indicator, cartographic, mathematical-statistical, software methods of ArcGIS. An important role in our studies is also played by stationary and semi-stationary methods carried out at separate observation sites in various landscapes of the region. In addition, the landscapes of the region were studied by methods of systematic analysis and comparison.

In the research work, information obtained from route, semi-stationary, field, expedition, comparison methods and decoding of space images ("Landsat" ETM-7,8, "SPOT", "Google Earth") is almost reflected in all sections.

The main provisions of the defense:

1. Ecological assessment of natural landscapes based on the diagnosis of landscape-ecological conditions of the Ganikh-Ayrichay valley and adjacent mountain areas.
2. Anthropogenic transformation of vertical differentiation of natural-anthropogenic landscapes.
3. Environmental zoning of landscapes based on analysis of landscape structure.

Scientific novelty of the research:

–for the first time, the geoecological conditions were studied in the Ganikh-Ayrichay valley and adjacent mountainous areas with the method of systematic landscape-ecological diagnostics. During the formation and regional differentiation of landscapes, the regularities of landscape differentiation and the main directions of anthropogenic transformation were assessed based on the analysis of hypsometric gradation, inclination, horizontal and vertical division, maps of the density of the river network;

–based on the method of landscape-ecological diagnostics, the changes occurring in the modern natural-anthropogenic landscapes of the region under study over historical periods were systematically studied, and for the first time the map "Landscape-diagnostic assessment" was prepared for the study. Development trends that may occur in regional landscapes are diagnosed on the map and

given in the form of landscape groups;

–for the first time, on the basis of landscape-ecological diagnostics and anthropogenic transformation of natural landscapes for the research region, a map "Ecological zoning of landscapes" was compiled. Based on the analysis of space images, landscapes on the map are divided into groups – ecological zones, which differ from each other in vertical and regional differences;

–on the basis of landscape-ecological diagnostics, an ecological assessment of natural landscapes was carried out and, on its basis, trends in the further development of regional landscapes were predicted;

–an analysis of the ecological stability of landscapes was carried out and a map "Landscape stability" was compiled according to the degree of disturbance of the region. On the map, taking into account the complex physical and geographical features of the region, including the continuous development of the productivity of natural landscapes, the degree of change, and resistance to anthropogenic impacts, all territorial units were grouped according to their degree of stability.

Theoretical and practical significance of the research. In solving the theoretical and methodological foundations of the problem, world landscape scientists N.A.Gvozdetsky, A.G.Isachenko, F.N.Milkov, N.A.Solnchev, K.I.Gerenchuk, A.A.Grigoryev, D.L.Armand, V.B.Sochava, I.I.Mamay, B.I.Kochurova, among republican landscape scientists B.A.Budagov, M.A.Museyibov, E.K.Alizade, A.A.Mikayilov, Y.A.Garibov, M.I.Yunusov, M.C.Ismayilov, E.Sh.Mammadbayov and others widely used scientific, theoretical and practical research of scientists.

The obtained scientific results can be applied in solving landscape-ecological problems of the region under study, ecological optimization of landscapes, and ensuring sustainable socio-economic development.

Approbation and application. Important maps of research work, results of soil analysis, recommendations, data in the work, etc. It can be used in teaching the subjects "Landscape" and "Ecology" in the relevant departments of the Ministry of Agriculture,

Ecology and Natural Resources of the Republic of Azerbaijan, the Tourism Agency, as well as in higher educational institutions in the specialty "geography". The research results were presented at the following conferences and symposiums:

Materials of the Republican scientific conference "Development of geographical science in the years of independence" (Baku, 2013), "Heydar Aliyev and the development of geographical science", Republican scientific conference (Baku, 2013), "Doctoral students and young researchers", materials of the XVIII Republican scientific conference (Baku, 2013), "Young scientists, graduate students and students" , XX scientific and practical conference (Saransk, 2016), "Theory and practice of harmonization of interaction of natural, social and production systems of the region", International scientific-practical conference (Saransk, 2017), "Modern problems of water management, environmental protection, architecture and construction", International scientific and technical conference (Tbilisi, 2018), "International highlands and plateau culture", symposium, (Giresun, 2019).

14 scientific articles have been published on the topic of the dissertation.

Name of the organization where the dissertation was prepared. The dissertation work was carried out at the Department of "Physical Geography" of the Faculty of Geography, Baku State University.

The total volume of the dissertation with a sign, indicating the volume of the structural sections of the dissertation separately. The dissertation work consists of an introduction, 4 chapters, a conclusion, and a list of references. The volume of work is 143 pages. The work consists of 23 figures, 8 tables, 2 schemes and diagrams, and a bibliography of 117 titles. Introduction - 5 pages (9028 symbols), Chapter I - 28 pages (43015 symbols), Chapter II - 29 pages (47408 symbols), Chapter III - 27 pages (48127 symbols), Chapter IV - 38 pages (57657 symbols), conclusion - 2 pages (2642 symbols), bibliography - 10 pages (16015 symbols), without tables, graphs, figures and references, consists of 212058 conventional symbols.

RESEARCH MAIN CONTENT

The introduction presents actuality and development of the subject, aims and tasks, methods, main provisions of the defense, scientific novelties, theoretical and practical significance of the research, approbation and application.

The first chapter of the dissertation work is devoted to the topic "**The influence of modern ecological and geographical conditions of the Ganikh-Ayrichay valley and adjacent mountainous areas on the formation of landscapes**". In this chapter, first of all, the relief and geological structure of the Ganikh-Ayrichay valley and the mountainous regions adjacent to it were analyzed, climatic characteristics were studied, surface and underground waters were studied, and the advantages of soil and vegetation were noted.

The Ganikh-Ayrichay valley chosen as the object of study (named Ganikh-Haftaran together with the part included in the territory of Georgia) is a subterranean tectonic depression located in the syncline of the same name in the north-west of the Azerbaijan Republic. The Ganikh-Ayrichay valley is an accumulative plain that has undergone a long geological development, was completely formed at the beginning of the Pleistocene in period IV and is covered with young alluvial and partly proluvial deposits of the modern period. About 85-90% of its territory is made up of alluvial deposits, consisting of sand, clay, river stones, especially river cones¹.

According to their morphogenetic features, one can distinguish here bring cones, intercone depressions, inclined, slightly inclined alluvial, alluvial-proluvial plains. These plains and other landforms form the basis of the modern landscapes of the valley. Depending on the lithology of rocks and morphogenetic types of relief, small individual landscapes are formed. The highlands of the region, consisting mainly of clayey shales and partly of sandy, sandstone sediments of the Jurassic period, and the central ridge of the Main Suayiridji Range are accompanied by narrow valleys, avalanches, swollen, sometimes bare-rock peaks, and watersheds. Modern landforms and the geological structure of the region, where

¹ Geography of the Republic of Azerbaijan / Chairman of the editorial board R. M. Mammadov. – Baku: Europe, – T. 1: – 2014. – 530 p.

extreme processes are intense, create the basis for the formation of nival and subnival landscapes.

The vertical distribution of the climate and its elements in the region under study plays an important role in the vertical differentiation of its landscapes. In this region, four of the vertical types of climate formed in our republic arise: 1) the mountain-tundra climate type is typical for absolute heights exceeding 2700-3000 m, is characterized by extreme humidity, cold, mostly frosty passage of all seasons. In the formation of various morphogenetic types of nival and subnival landscapes are an important landscape-forming factor; 2) a cold climate type with abundant precipitation in all seasons is observed at absolute altitudes of 1500-2700 m, it is characterized by extreme humidity, cold and snowy winter, as well as a very long duration. The upper boundaries are predominantly alpine and subalpine meadows, the lower boundaries one determines the areas where high mountain forests are widespread; 3) a moderately warm climate type, with precipitation evenly distributed over all seasons, is mainly spread in the form of a narrow strip at absolute altitudes of 600-1500 m, characterized by mild, humid winters and moderately warm, relatively humid summers. Even distribution of moisture throughout the year creates a favorable basis for the development of different types and subtypes of the forest landscape, and in some areas, mountain forests of secondary origin; 4) a moderately hot climate type with dry winters is formed mainly in the Ganikh-Ayrichay valley and in the surrounding low-mountain and partly mid-mountain belts at absolute heights of 400-1000 m, summers are relatively warm and moderately hot, and winters are mild and less frosty².

The Ganikh-Ayrichay valley is the area where all the rivers flowing from the southern slope of the Greater Caucasus are concentrated, and where both surface and underground waters are very rich. The role of underground and surface water supply in the formation of landscapes and their morphogenetic characteristics, territorial differentiation is unparalleled. Although the plain-forest, forest-meadow, meadow-marsh, tugay forest complexes in the study area are associated with relief and climate, they are mainly a product of underground and seepage water from rivers.

²Climate of Azerbaijan / Ed. A.A. Madatzade. – Baku: Science, – 1968. – 342 p.

The population living in the Ganikh-Ayrichay valley makes extensive use of its groundwater, especially artesian and sub-artesian ones. According to the information provided by the Ministry of Ecology and Natural Resources of the Republic of Azerbaijan, the operational groundwater reserves of the Ganikh-Ayrichay valley are 2 million m³. The population uses dug wells and artesian water for both irrigation and domestic needs. An exceptional role in the water supply of the city of Baku is played by water from the sub-artesian wells of Oghuz-Gabala.

Various morphogenetic types and species of both plain and mountain soils are common in the Ganikh-Ayrichay valley and adjacent mountainous regions. On these lands, vegetables, fruits, orchards, cereals, fodder plants that are important for our country and are highly productive are grown. Plain forest-meadow, alluvial-meadow, meadow-marsh, brown-forest ordinary and light gray-brown (ordinary and light chestnut) soils were formed in the Ganikh-Ayrichay valley.

According to the results of field soil studies of and laboratory analyzes carried out in the mountain steppes of the studied region, it was established that the following types and subtypes of soils are common here: 1) washed primitive mountain meadow lands 1893.0 ha or 0.76% of the total area; 2) washed, grassy mountain-meadow lands, 6781.6 ha or 2.73% of the total area; 3) washed mountain-meadow soils make up 4033.9 ha or 1.62% of the total area. The relief of the area where these lands are distributed is dissected by valleys in different directions, the rocks that make up the soil are proluvial-alluvial. The territory is used only as a pasture.

The vegetation of the Ganikh-Ayrichay valley and the adjacent mountainous areas is colorful, aesthetic, diverse in species, etc. in terms of its characteristics, it differs sharply from other regions of the country. In the southern part of the Balakan, Zagatala and Gakh regions, plant species are common from the remains of lowland forests (alder, linden, white poplar, long-stemmed oak) to highland meadows. In the southern foothills of the region, degraded lowland forests were replaced by agricultural lands, thickets of a derived type (shibleks) and residential areas. The remains of juniper, eucalyptus and partially Iberian oak forests can be

found in the steppe plateaus of the Gakh, Shaki, Oghuz, Gabala regions³.

The bulk of the vegetation of the Ganikh-Ayrichay valley and the mountainous regions adjacent to it is concentrated in mountain forests. The area covered by forest in the area of forestry is 218,047 ha, and on the territory of reserves (Zagatala reserve 15,509 ha, Ilisu reserve 8,684 ha) - 25,193 ha. This means 28.3% of the total area of the region⁴. Practically on the entire territory of the region (excluding Reserve areas), the natural vegetation cover is severely disturbed as a result of spontaneous human activities, the species composition has changed, vegetation has been replaced by derived type groups in many places. As a result of illegal cutting of special valuable tree species and cattle intensive grazing have been replaced by xerophilic, sometimes freegan sedges and semi-desert plant groups in the region.

Chapter II of the dissertation work is devoted to **"Regularities of transformation of natural and anthropogenic landscapes of the Ganikh-Ayrichay valley and adjacent mountainous areas"**. The anthropogenic transformation of the landscapes of the studied region and the patterns of their differentiation are analyzed, and the environmental problems caused by this are investigated. Using GIS technologies and mathematical cartographic methods, space images were deciphered and a modern landscape map, anthropogenic transformation of landscapes, as well as inclination, elevation, and hypsometric grade maps were compiled. At the same time, the natural complexes of the area were grouped according to the degree of change as a result of anthropogenic impact.

As a result of studying the problems caused by the anthropogenic transformation of the natural landscapes of the study area, it was found that the risks and dangers caused by landscape changes, floods and landslides are constantly activated in accordance with the increase in human economic influence and accelerate the process of landscape degradation. As the anthropogenic transformation of the natural landscapes of the territories intensifies, the landscapes of settlements,

³Agro-climatic atlas of the Azerbaijan Republic. / A. Ayyubov, Kh. Rahimov [and others]. – Baku: Science, – 1993. – 193 p.

⁴Hajiyev, V.D. Alpine vegetation of the Greater Caucasus and its economic importance. / V.D. Hajiyev. – Baku: Science, – 1970. – 282 p.

agro-complexes, pastures and meadows of the region also suffer to varying degrees. This is reflected in the table that we compiled on the basis of statistical data (table).

Table

Distribution of the settlements and population located in the Ganikh-Ayrichay valley and adjacent mountainous to it by administrative districts (2020).

Administrative districts	Number of settlements			Population (people)		
	City	Settlement	Village municipalities	Urban population	Settlement population	Rural population
Balakan	1	1	17	9317	999	79511
Zagatala	1	2	16	19772	11266	87190
Gakh	1	-	16	12328	-	40931
Shaki	1	2	16	62965	2320	105448
Oghuz	1	-	14	6891	-	33393
Gabala	1	3	17	12415	19649	61588
Ismayilly	1	2	15	15004	2317	62009
Including,						
Total:	7	10	111	138692	36551	470070

Source: ARSSC data, 2020, based on statistical data.

Analysis of the data of the table prepared by us shows that the urban population of the region is 138.7 thousand people, the population living in settlements is 36.6 thousand people, and the population living in rural settlements is 470.1 thousand people. As can be seen, the vast majority of the population living in the region is concentrated in rural settlements. The share of the population living in rural settlements reaches 60-89% on average. This indicator has a significant regional difference in the area. Thus, 88.5% of the Balakan population, 76.8% of the Gakh population, 73.6% of the Zagatala population, 65.8% of the Gabala population and 61.7% of the Shaki population live in village-type dwellings.

In accordance with the increase in the population and the number of settlements in the region, agricultural areas, especially irrigation farming, are developing, and grazing and grazing areas are being expanded. This results in the increase of anthropogenic load in the study area.

An analysis of the distribution of settlements and the population of the study region by landscape complexes shows that most of the population settled in complexes with fertile soil, more suitable for agriculture, with favorable relief and climatic characteristics. More than 70% of the population and settlements are located in the plain-forest, mountain-meadow, foothill and low-mountain steppes, forest-steppe, brown, chestnut-black-soil forests of gentle plains and desertified complexes, intermountain plains, in mountain steppes, on widened river terraces, in valleys, etc. concentrated.

An analysis of the materials given in the compiled map "Anthropogenic transformation of the Ganikh-Eyrichay valley and adjacent mountainous areas landscapes" shows that about 20% of the settlements and population are concentrated in the hornbeam-beech and oak-forest belt of the low and middle mountains of the region. However, this indicator has very serious regional differences in the territory we study. If more than 30-40% of the population of the region is concentrated in the forest belts of Zagatala, Balakan and Ismayilly regions, then in Oghuz, Gabala and Shaki regions this figure is no more than 10-15%. All this is connected with the natural and systematic transformation of the natural landscapes of the region in historical periods.

Settlements in the forest zone of the region we study have a greater influence on the change of natural complexes. On satellite images, these complexes are deciphered by large scattered areas, chain structures along the river, and in some cases ring structures.

Although rocky nival and subnival landscapes, typical of the highlands of the region under study, occupy a relatively small area, due to unfavorable environmental conditions, the level of population settlement in these zones is low, and anthropogenic impacts are episodic.

An analysis of the distribution of the region's population by landscape zones shows that the population density decreases from east to west. Thus, with a population density of 101 people/km² in the Balakan region, 92 people/km² in the Zagatala region, 39 people/km² in the Oghuz region, and 41 people/km² in the Ismayilli region⁵.

⁵ The population of Azerbaijan. – Baku: SSC, – 2020. – 514 p.

As a result of the analysis of the distribution of the population of the studied region by vertical zones, it was found that 11.4% of the population at absolute heights of 0-200 m, 43.3% - at absolute heights of 200-500 m, 47.3% - at absolute heights of 500-1000 m, 3.4% is concentrated at altitudes of 1000-2000 m and 0.1% in areas above 2000 m⁶.

As a result of the decoding of space images, it was determined that forests and meadows are depicted on a green and light green background, and flood source are depicted on a light gray with a granular-scattering structure. Like a serious ecological hazardous flood source area, cardinal preventive measures should be taken in accordance with the correct diagnosis of the causes of their occurrence. These measures include various engineering projects, forest greening, forest reclamation, etc. can be attributed. Controlling and managing the creation and development of floodplains at the state level is one of the most important issues.

In order to determine the degree of anthropogenization of landscapes in the region, the influence of economy areas, settlements and natural destructive processes on landscape complexes was carefully analyzed and mapped. Thus, as a result of the analysis of environmental problems caused by the anthropogenic transformation of the landscapes of the Ganikh-Ayrichay valley and adjacent mountain areas, we determined that as the anthropogenic transformation of landscapes accelerates, the activity of exodynamic processes also increases. As a result, the damages to economy areas and the population caused by various consequences of floods, landslides, degradation increases accordingly. In recent years, the rapid growth of the population and the number of settlements has increased the anthropogenicity of landscapes, created conditions for disturbing the ecological balance and accelerating the degradation of landscapes that are more subject to anthropogenic pressure.

The natural landscapes of modern agricultural and horticultural areas of the Ganikh-Ayrichay valley have changed dramatically as a result of the long-term effects of humans, species diversity has arisen in

⁶ Geography of the Azerbaijan Republic. / Chairman of the editorial board R. M. Mammadov. – Baku: Europe, – T 2: - 2015. – p. 111–112.

natural landscapes, and they have been replaced by repeated or new anthropogenic units.

As a result of the transformation of natural landscapes in the Ganikh-Ayrichay valley, the main anthropogenic landscapes formed in their place were agrocomplexes. Most of them were artificially created on the site of lowland-forests, forest-steppe and meadow-marsh complexes.

Agrolandscapes in the region are divided into the most common types of non-irrigated farming, irrigated agriculture (agroirrigation landscapes), garden plantation, pasture and hayfield. Historically, the development of livestock, horticulture and agriculture in the area has increased the agricultural potential of the district and the level of exploitation.

Based on Y.A.Garibov's classification, we divided the natural landscapes of the study region into 5 categories according to the anthropogenic transformation, deciphering space pictures using ArcGIS program (with data from Landsat 7-8 orbital stations), and the degree of landscape change:

1. Landscapes that are practically unchanged, maintaining their natural structure and stability ($Af < 0.1$). These complexes occupy up to 12% of the territory of the region studied by us. This includes nival, subnival landscapes, thickets of bearing cones, natural swamps, lakes in depressions. Here, anthropogenic impact is not permanent.

2. Weakly changed, mainly landscapes exposed to irregular anthropogenic influences that retain their natural structure and stability ($Af < 0.2$). These complexes occupy more than 15% of the territory of the region, covering a significant part of subalpine and alpine-meadow and forest landscapes. Against the general background of these landscapes, anthropogenic modifications are formed with small scattered areas in space images reflected in the form of waves.

3. It refers to landscape units that are moderately altered, partially retaining their natural structure and stability, and subject to predominantly uneven anthropogenic impact ($Af = 0.2 - 0.5$). These complexes occupy more than 25% of the territory of the region. This includes eroded forest and meadow landscapes but part of self-restoring meadows and steppes of regenerative origin.

4. It includes landscapes subjected to regular anthropogenic impacts ($Af=0.5-0.8$) that have been drastically changed, have largely lost their natural structure and stability. These complexes occupy approximately 33% of the region. Territorial units of the garden plantation, agro-irrigation, non-irrigated sown, residential-garden etc. formed on landscapes the foothills and low mountainous and Ganikh-Ayrichay valley's former forest, forest-meadow, forest-steppe, plain-forest, steppe covers agrocomplexes. Most of them are anthropogenic modifications that have lost their natural structural and functional properties.

5. Majorly transformed ($Af>0.8$) landscape units. Such landscape complexes include large urban and rural-urban complexes, artificial reservoirs (canals, collectors, hydraulic structures), communications, industry, mining enterprises, processing enterprises, roads, etc. include. These landscapes have almost completely lost their natural structural and functional characteristics and have a serious ecological impact on the environment.

Chapter III of the dissertation is devoted to **"Differentiation regularities of the landscapes of the Ganikh-Ayrichay valley and the mountainous territories adjacent to it according to the degree of stability."** In this chapter, the degree of stability of natural landscapes is studied, and a structural and diagnostic assessment of the vertical and horizontal differentiation of modern landscapes is carried out.

Along with other methods, mathematical cartographic methods were used, providing the correct mechanism for vertical and horizontal differentiation of landscapes. In the study of the distribution and transformation of landscapes, drawing up maps of inclination, elevation, surface and deep fragmentation helps to accurately determine the structural and functional characteristics of each landscape. In this regard, based on the ArcGIS 10.3 version GIS software, we determined Ganikh-Ayrichay valley and the mountainous territories adjacent to it the inclination, height, hypsometric steps, river network density, vegetation cover, etc. have been compiled maps. These maps helped to carry out landscape-ecological diagnostics of the region.

According to the degree of stability, the grouping of natural landscape complexes of the Ganikh-Ayrichay valley and the mountainous territories adjacent to it plays a very important role in the

diagnostic assessment of the modern natural-anthropogenic landscape structure of the region. Therefore, through a systematic analysis of both natural and anthropogenic units of the region, an attempt was made to group them into a single prism. Taking into account the complex physical and geographical features of the region, including the productivity of natural landscapes, sustainable development, the degree of change, resistance to anthropogenic impacts, we have divided the modern landscapes of the region into 5 groups.

The Ganikh-Ayrichay valley and the mountainous areas adjacent to it are one of the areas with the most complex landscape structure, which has been developed since ancient times and has undergone a radical anthropogenic transformation. Here, all the landscape units spread in our republic, starting from the nival landscapes to the plain, forest, meadow, and plain steppe landscapes, were formed.

Chapter IV of the dissertation is devoted to **"Ecological diagnostics and zoning of modern landscapes of the Ganikh-Ayrichay valley and adjacent mountainous areas"**. In this chapter, the main criteria for the scientific and theoretical basis of the methodology for landscape diagnostics were outlined, and then the ecological diagnostics of nival-subnival, mountain-meadow, mountain-forest, foothill plain and cone bearing landscapes was carried out. At the same time, large-scale (1:100,000) maps "Ecological zoning", "Landscape-ecological diagnostics" and "Landscape-ecological potential assessment" were compiled in the chapter by studying the scientific and theoretical foundations of landscape-ecological zoning.

There are several aspects of landscape diagnostics. These include forecasting, planning, architecture, functional zoning of landscapes, territorial organization of the landscape, changes of individual components of the landscape (relief, vegetation, water bodies) by anthropogenic influences, etc. can be attributed.

In order to study the current state of landscape types, subtypes and smaller units of the Ganikh-Ayrichay valley and adjacent mountainous areas, as well as their unique structural and functional characteristics, we have selected 20 observation sites in different landscape units. They differ from each other according to their absolute height, morphological and typological characteristics. The landscapes of each site are

distinguished by unique productivity, natural and anthropogenic transformation, ecological and geographical characteristics. Here morphogenetic types of landscapes (alluvial plains, foothills, slope, river bed, terraces, and other complexes), landforms, lithological features of rocks, the nature of the soil and vegetation cover, species diversity, etc. were taken into account.

The selected sites are both landscape units and environmental observation monitoring typical for the region. In these observation sites, the unique features of the relief in field conditions, especially the degree of vertical and horizontal dissection of the surface, the inclination and exposition of the slopes, the depth of the source rocks, their lithological characteristics, occurrence conditions, and geological composition were systematically studied.

Based on the diagnostic assessment of landscapes on the observation sites, we have compiled an ecological and diagnostic map in order to determine promising directions for the development of modern landscapes of the region under study, anthropogenic transformation, the ecological situation, tension and degradation possibility. On this map, development trends that may arise in regional landscapes are diagnosed and are given in the form of landscape groups (figure).

1. Complexes, which are expected to change more sharply in the near future due to the intensive development of settlements, garden plantations, irrigation agriculture in plain-forest-meadow landscapes of intermountain synclinal depressions and smooth and inclined plains;

2. Complexes, which are expected to be more likely to undergo sharp transformations and re-derivative landscapes in the near future in variously modified units in forest, forest-bush, shrubland landscapes of foothills sloping plains and cones;

3. Complexes, which in the near future, the rise of anthropogenization of the forest, forest-shrub, forest-meadow landscapes of the middle and partial highlands and the decrease of the natural potential, the sharp increase of the landscapes of re-derivative origin are expected;

4. Complexes, which weakly and partially moderate change is expected in mountain-forest, mountain-meadow landscapes, protected in the form of nature reserves, national parks and wildlife sanctuaries in the middle and high mountains;

5. Complexes, which are expected to change weakly and partly moderately in the near future of mountain-meadow, subnival and nival landscapes, which are used weakly, irregularly and unsystematically.

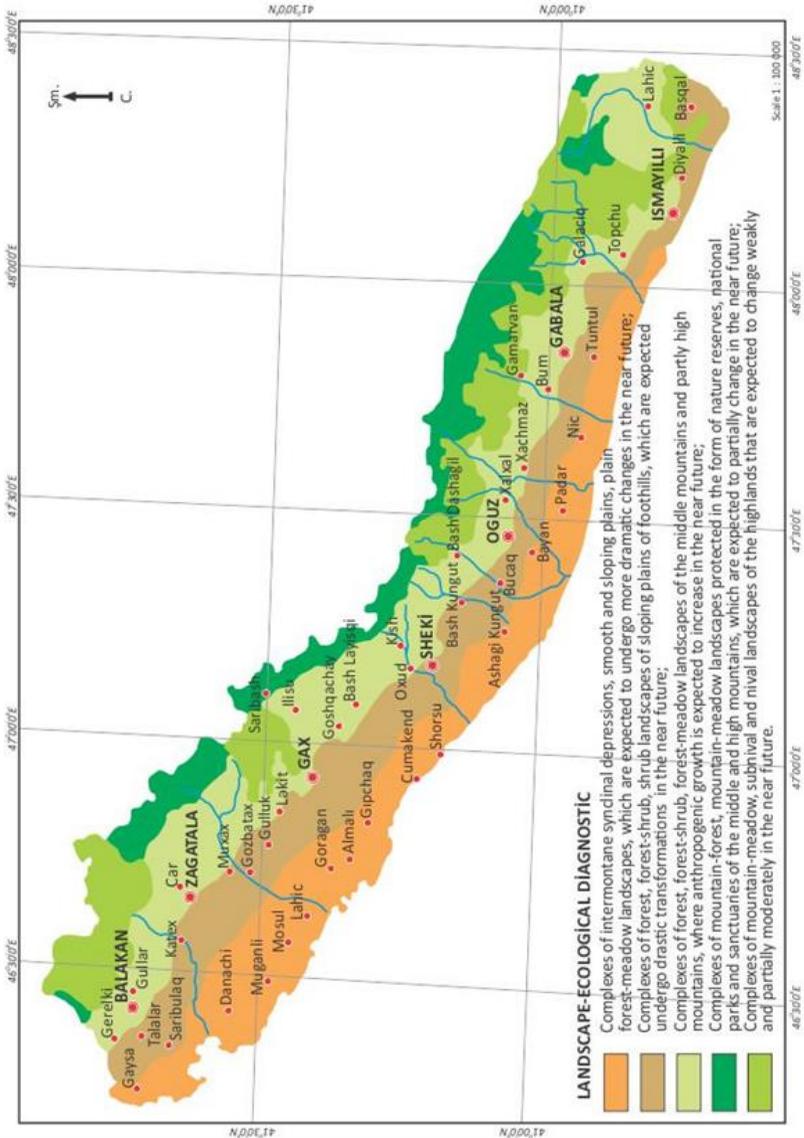


Figure. Landscape-ecological diagnostic map of the Ganikh-Ayrichay valley and adjacent mountainous areas

Landscape-ecological zoning is carried out at the final stages of landscape research. Usually, after analyzing all the parameters of the landscape, its modern structural and functional characteristics and directions for further development are determined. After all this, work is carried out on the zoning of landscapes in the study area and the allocation of their individual-regional units according to regional differences and individual characteristics.

The landscape zoning process is based on a number of principles and criteria. First of all, the vertical differentiation of natural landscapes, features of future development and anthropogenic transformation should be considered as the most important factors.

N.K.Karamov, B.A.Budagov, M.A.Museyibov, A.A.Mikayilov were the first to assess the regional differences in the vertical differentiation of landscape-ecological conditions of the Greater Caucasus.

The study of landscape zones shows that there are significant regional differences in the distribution of landscapes along river valleys from the northwest to the southeast. The reason for this is the diversity of climate, geological core, landforms and general ecological conditions in the river basins. Depending on the indicated features, exodynamic processes, floods, landslides, etc. in river basins differences arise when natural disasters occur. In order to manage each of them, to minimize damage to the economy, it is necessary to take into account regional characteristics.

The preparation of the landscape-ecological zoning map plays an important role in determining a number of aspects of landscape diagnostics and revealing the future development trends of individual landscape units. It should be noted that special studies in this aspect have not been conducted in our country. Considering the relevance and modernity of the problem, we tried to analyze a number of scientific, theoretical and methodological issues of the map of the landscape-ecological zoning of the region in which we conduct research on this issue.

An analysis of the scientific and theoretical concepts of landscape-ecological zoning shows that when conducting landscape-ecological studies for specific regions, the following criteria must be taken into account:

1. Vertical differentiation of natural landscapes, the degree of surface fragmentation and corresponding distribution of landscapes, types of vertical structure of landscapes;
2. Change of natural landscapes under anthropogenic influence, degree of anthropogenization;
3. Slopes inclination, exposition and their influence on landscape differentiation;
4. Exodynamic processes, their management, minimization of economic damage;
5. Vertical distribution of settlements and population by landscape types;
6. Correct assessment of the main development tendencies of landscapes, natural resource potential and their efficient use.

Taking into account the indicated criteria, a map of the landscape zoning of the Ganikh-Ayrichay valley and the mountainous territories adjacent to it was compiled. Such landscape-ecological zones include:

1. Balakan-Zagatala landscape-ecological zone covers the northwest of the region. It is a region territory has been mastered since ancient times and has undergone fundamental transformation.

2. Gakh landscape-ecological zone covers the widest sections of the Ganikh-Ayrichay valley. The southern part of the zone lies on the Dashuz plateau. This zone is characterized by a chain of numerous and close to each other village-type settlements, large agricultural lands, especially agro-irrigation landscapes, sparse stony-pebble shrubs, settlement plain, distribution in forest and mountain-meadow belts.

3. Shaki-Oghuz landscape-ecological zone covers a large area. Here you can find the entire range of landscapes from arid-denudation plateaus, arid-sparse forest-shrubs landscape of the lowlands to nival and subnival complexes.

4. Intensive transformation of the landscapes of the Gabala landscape-ecological zone took place to a greater extent on the low mountainous and foothill plains, especially in the Ganikh-Ayrichay valley. It covers densely populated river basins.

5. The natural forest and meadow landscapes of the Ismayilli landscape-ecological zone have relatively well preserved their structural and functional characteristics. The sparsely settlement of the population in

this zone determines the relatively weak transformation of landscapes.

One of the most urgent problems of modern landscape science and physical geography in general is the determination of the ecological potential of regions and their individual parts and the preparation of its scientific and theoretical foundations.

Based on the ecological zoning of the landscapes of the region where research is being carried out, the correct assessment of their ecological potential and the preparation of the corresponding zones and belts are of great scientific and theoretical importance. To do this, we divided the natural landscapes of the region into 7 zones, taking into account the ecological and geographical potential and anthropogenic pressure.

1. Landscapes of intermountain depressions, smooth and flat plains, subject to drastic transformation with intensive and regular use;

2. Poorly fragmented used for irrigated and non-irrigated farms of foothill plains and bearing cones substantially transformed agrocomplexes;

3. Irregularly used, weakly and moderately transformed mountain-forest complexes of the low mountains and partly of the middle mountains;

4. Mountain-forest complexes that practically preserve the natural structure of low-mountain and mid-mountain territories;

5. Mountain-forest complexes that have been transformed, grassy, bushy, and degraded to varying degrees, exposed to the irregular economic impacts of medium and partly high mountains;

6. Pasture and hayfields complexes of irregular subalpine and alpine meadows of various degrees of fragmented, sharply and moderately transformed high mountains;

7. Sharply fragmented, having extreme conditions, practically unchanged and unassimilated subnival and nival complexes of the high mountains.

The landscapes of each zones that we have separated differ from others due to their vertical differentiation, anthropogenic transformation, inclination, vertical and horizontal division on hypsometric levels, population number and density in the region, and the main development trends of agricultural areas.

CONCLUSION

1. By use of processing of Landsat 7, Landsat 8 and ASTER GDEM3 format digital elevation models - DEM by means of ArcGIS software hypsometric steps, slope, elevation, rivers and density of rivers maps of Ganikh-Ayrichay valley and adjacent mountainous areas were prepared. As a result of the analysis of the obtained materials, it was determined that 12% of the studied area landscapes are practically unchanged, 15% are weakly changed and mainly retained their natural structure, 25% are moderately changed, 33% are sharply changed, and 15% are fundamentally transformed landscapes.

2. Modern ecogeographical conditions of the region we studied were analyzed with digital elevation models, satellite orthophotos, existing 1:600,000 scale landscape, soil, geomorphological and geological maps of the Azerbaijan Republic using GIS (ArcGIS) software. Based on landscape, geomorphological, geological, soil, plant materials and relevant maps of the region, an information base of landscape units of the area was prepared. Based on the mentioned software, it was determined that the plain-forest complexes occupy 24.2% of the territory (1089 km²), mountain-forest - 34.8% (1566 km²), mountain-meadow - 23% (807 km²) and rocky, subnival and nival high mountainous landscapes occupy 18% (810 km²).

3. Based on the interpretation of space images and the analysis of cartographic materials, the analysis of the large-scale (1:100000) anthropogenic transformation map we prepared for the region revealed that although 20% of the population of the region is located in forest complexes, there are serious regional differences. This number reaches 30-40% in Zagatala, Balakan and Ismayilli, and 10-15% in Oghuz, Gabala, Shaki.

4. For the first time, a landscape-ecological diagnostic map was drawn up for the region by the diagnostic evaluation method, taking into account the vertical differentiation regularities of landscapes, morphometric elements of relief, intensity of exodynamic processes, directions of anthropogenic transformation. From the analysis of the map, it was revealed that sharper structural changes in 12.5% of the 5 landscape categories identified in the research object in the near future, in

14.5% a moderate-level transformation, in 33.4% higher anthropogenic loading, in 8.5% weak and moderate changes, in 31.1% weak and partially moderate changes are expected to happen.

5. A map "Landscape zoning" was compiled for the study area based on the method of landscape diagnostic assessment. As a result of the analysis of this map, the Balakan-Zagatala, Gakh, Shaki-Oghuz, Gabala and Ismayilli landscape-ecological zones were identified, and the landscapes were grouped according to the degree of stability. As a result, the region is divided into practically unstable, weakly stable, moderately stable and stable landscapes.

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1. Aliyeva, R.A. Ecological consequences of anthropogenic transformation of the high mountain ecosystems of the South-Eastern Caucasus // Baku State University, National leader H.A. Republican scientific conference "Heydar Aliyev and the development of the science of geography" dedicated to the 90th anniversary of Aliyev's birth, – Baku, – 2013, – pp. 47–50 (together with Garibov Y.A., Zamanli L.E.). (In Azerbaijani).
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 10. Aliyeva, R.A. Ecological diagnostic assessment of the Ganikh-Ayrichay valley and surrounding mountainous landscapes of the Republic of Azerbaijan // Bulletin of the National Academy of Tourism. Russian scientific journal, St. Petersburg, – 2020, № 4(56), – pp. 45–48. (In English).

11. Aliyeva, R.A. Ecogeomorphological analysis of anthropogenic transformation of modern landscapes of Ganikh-Ayrichay valley with surrounding mountain slopes of the Republic of Azerbaijan// Scientific journal “Scientific Notes of the Crimean Federal University named after V.I. Vernadsky. Geography. Geology”, – Simferopol, –2021, –Vol.7(73). № 1, –pp. 203–211. (In English).
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