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ABSTRACT

of the dissertation for the degree of Doctor of Philosophy

**NATURAL CONDITION OF THE SHAMAKHI-ISMAYILLI
ZONE, ASSESSMENT OF THE NATURAL RESOURCES,
AND PROBLEMS OF THEIR PRESERVATION**

Speciality: 2508.01 – Geoecology

Field of Science: Geography

Applicant: **Hayat Fikret Shakiliyeva**

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The dissertation work was performed at the department of “Geographical ecology” of the Baku State University.

Scientific supervisor: Doctor of geographical sciences, professor
Shovgi Yusifziya Goychayli

Official opponents: Doctor of geographical sciences, docent
Nariman Aziz Pashayev

Doctor of Philosophy in Geography, docent
Ilgar Baylar Khalilov

Doctor of Philosophy in Geography
Nasiba Niyaz Hajiyeva

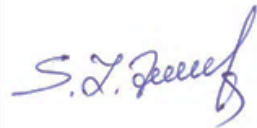
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Chairman of the Dissertation council: Corresponding member of ANAS,
Doctor of geological–mineralogical sciences,



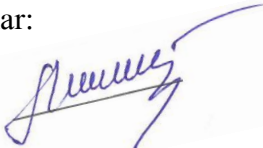
Talat Nasrulla Kangarli

Scientific secretary of the Dissertation council: Doctor of Philosophy in Geography,
docent



Samira Ogtay Alakbarova

Chairman of the scientific seminar: Doctor of geographical sciences, docent
Mehman Mohubbat Mehbaliyev



GENERAL CHARACTERISTIC OF THE WORK

Actuality and level of research on the topic. Since Azerbaijan has embarked on the path of contemporary development, novel requirements and approaches have arisen in studying its natural conditions and developing productive forces. These days, demands for the assessment of Azerbaijan's natural conditions and natural resources and their protection have increased. Particularly, it should be noted that the approval of the National Program for ecologically sustainable socio-economic development in the Republic of Azerbaijan (February 18, 2003), the State Programs of the socio-economic development of the regions of the Republic of Azerbaijan (2004-2008, 2009-2013, 2014-2018, 2019-2023) years) has created conditions for the effective management of the country and its regions, as well as the effective use of natural conditions, material and social resources, and the implementation of environmental protection on a scientific basis. What has been shown above is important in the study and management of mountainous regions. As the directions of socio-economic development of all regions are defined in the state programs and documents, new requirements are put forward in the field of efficient use of ecological conditions and natural resources.

It is important to create a balance and protect nature in relation to the achieved socio-economic development as well as multifaceted activities of the economy. Above all, what has been said creates the need to study the natural conditions and conduct large-scale scientific-research works in areas with complex conditions, such as the Shamakhi-Ismayilli zone.

In the evaluation of the environmental conditions and natural resources of the zone, taking into account the current local and global processes, the quantitative and qualitative changes in nature are brought to the fore. At present, there is a need to evaluate natural conditions and natural resources to reveal the differences between natural reproduction and reproduction of social production. One of the important aspects that determine the relevance of the topic is that the research region is located on the southeastern slope of the Greater

Caucasus Mountain and is subject to earthquakes, landslides, and erosion. The analysis of what has been said requires regulation of the use of nature in modern times, sustainable development, and research of nature-society relations.

The theoretical bases of the research are not only based on the foreign researchers, who conducted research in this field, namely T. Miller, R.G. Dzzokgman, N.F. Reymers, E.M. Nikolayevskaya, A.I. Perelman, and others, but also Azerbaijani scholars, such as H.A. Aliyev, B.A. Budagov, S.T. Rustamov, A.M. Shikhlinsky, A.J. Ayyubov, Sh.Y. Goychayli, T.A. Khalilov, Y.A. Garibov, M.A. Mammadov, A.S. Mammadov, Z.N. Eminov, N.A. Pashayev and others.

Purpose and missions of the investigation. The purpose of the **mission** consists of determining the availability of the complex ecological condition and natural resources, the ecological consequences of their usage, the regulation ways of the anthropogenic activity of the population, and developing protection measures. Implementing the specified provisions necessitates the fulfillment of the following tasks:

- Adopting the Shamakhi-Ismayilli zone and analyzing the essential stages of the development of the processes of the economic activity;
- Scrutinising the natural ecological systems and structure of the area;
- Determining the degree of optimality in the process of living and economic activity of the population in the research area;
- Evaluating the effective usage expedients of renewable resources, as well as, the land resources in the period of modern reforms;
- Mapping of the territorial differences of the geographical-ecological features by determining the internal landscape-ecological types of the region and developing the development model in order to toand restore it.

Methods of investigation. In the process of carrying out the research, methods of comparison, historical, mapping, and statistical approaches were used.

The primary provision of the defense:

- Assessment of geographical and ecological conditions of Shamakhi-Ismayilli zone;
- Investigation of modern forms of interactions between nature-population-production;
- Evaluation of the landscape units (divisions) of the territory for the purpose of efficient use of nature, restoration of nature;
- Methods of protection and mapping of natural and anthropogenic landscapes.

Scientific innovation of investigation:

- the modern state of the interactions between nature-population-production was analysed, and the ecological assessment was carried out;
- geographical-ecological conditions of the zone were evaluated in the system of nature-population-production relations;
- the issues of nature use and nature restoration were evaluated by the landscape units of the area, at the same time, depending on the degree of inclination of the terrain;
- protective measures were developed in accordance with the essential aspects of the dynamics occurring in the conditions of global climate changes;
- based on the study of anthropogenic landscapes, a Geographical Information database was created for the protection of natural conditions.

The theoretical and practical significance of the research. The results of the dissertation work are important for the Ministry of Ecology and Natural Resources, the executive authorities of the administrative districts of the zone, the Ministry of Agriculture of the Republic, and the relevant departments of the Ministry of Economy in implementing the necessary measures and preparing laws. The results of the research materials can be useful in the Department of Architecture and Urban Planning of the Republic and the educational process.

Approbation and application of the research. The scientific results and provisions of the dissertation were reported and published in the international scientific conference on the topic of “Ecology:

nature and society problems” (Baku, 2007), “XIV Republic scientific conference of the doctorates and young researchers” organised by the Ministry of Education of the Republic of Azerbaijan (Baku, 2010), “XVI Republic scientific conference of the doctorates and young researchers” organised by the Ministry of Education of the Republic of Azerbaijan (Baku, 2012), the conference dedicated to the National leader H. Aliyev’s 90th anniversary (Baku, 2013), the conference dedicated to the National leader H. Aliyev’s 95th anniversary (Baku, 2018), the Republic scientific-practical conference of the topic of “The strategic roadmap and geographical research” (Baku, 2018) and the International scientific-practical conference on the topic of “Theoretical and applied problems of geographical science: demographic, social, legal, economic and environmental aspects” (Voronezh, 2019). 18 scientific works, including 11 scientific articles and 7 theses were published related to the dissertation topic.

The name of the organisation where the dissertation was implemented. The dissertation work was performed at the department of “Geographical ecology” of the Baku State University.

The volume, structure, and primary content of the dissertation. The total volume of the dissertation is 143 pages consisting of 3 chapters, conclusions and suggestions, 179 references, 27 tables, 4 figures, 2 maps, and 2 map schemes. The introduction is 4 pages, I chapter 42 pages, II chapter 45 pages, III chapter 30 pages, the conclusion 5 pages, and the references 16 pages. It consists of 229554 characters without tables, graphs, pictures, and bibliography.

PRIMARY CONTENT OF THE RESEARCH

The introduction defines the actuality and level of research on the topic, mission and objectives, methods, the main provisions defended, scientific innovations, the theoretical and practical importance of the research, approbation, and application.

The Shamakhi-Ismayilli zone is one of the most complex areas among the mountainous regions of Azerbaijan. That area has been studied by the country's geologists, geomorphologists, geographers, soil scientists, hydrologists, and other fields of science. The role of

the natural condition and natural resources in the development of the industry and agriculture, the evaluation, and the use in the population settlement were studied by H.A. Aliyev, B.A. Budagov, M.A. Museyibov, N.A. Nabiyeu, S.G. Rustamov. M.A. Mammadov, A.M. Hajizade, B.T. Nazirova, Sh.Y. Goychayli, N.A. Pashayev.

The studies conducted are devoted to the geological and geomorphological conditions, the genesis and dynamics of the landscapes, and the morphometry of the relief. They are important in the adopting of the territory, reflect the territorial systems of natural complexes, and have scientific and practical bases.

The first chapter of the dissertation work is devoted to **“Ecological evaluation of the natural conditions of the research area”**. Here, studies on the relief, geomorphological conditions, landscapes, and other researches of the area were conducted, summarized and ecosystems were analysed.

The conducted researches commenced from the Main Watershed (Babadag) and continued towards the descent at a height of 200-300 metres in the south and southeast. The complexity of the territory creates great difficulties in the field of organization of industry and agriculture here. Generally speaking, only up to 60% of the research area in the field of using modern scientific and technical achievements is considered suitable for adoption. The research object has an area of 5977.59 km² having a complex relief. The average inclination of the relief was studied on the basis of a topographic map with a scale of 1:100000.

In our research work, using M. Mehbaliyev’s cartographic materials, the ecological conditions for all slopes were evaluated on the topographic map of the studied area, and recommendations were made for the appropriate nature protection and nature restoration measures ¹(Table 1).

¹Mehbaliyev, M.M. Applied morphometry //Materials of the III International scientific conference, Youth and Science: Reality and Future. 5 vol. and 4 vol., Natural and applied sciences. - Nevinnomyssk: 2011, - p. 400-404. (In Russ.)

Table 1
Distribution of the inclined areas in the Shamakhi-Ismayilli zone and their suitability for the agricultural use

Number	Inclination α^0	Area, A		Suitability for the agricultural use
		Absolute (km ²)	%	
1	2	3	4	5
1	0-3 ⁰ (less inclined)	1141,65	19,1	It is feasible to engage in all kinds of agricultural activities in the areas which have the inclination up to 1,5 ⁰ . The application of agrucultural technology does not cause wide erosion. There is almost no surface erosion. It is possible to experience weak surface erosion the areas inclined up to 1,5-3 ⁰ . Agrotechnical and soil protection works should be implemented.
2	3-6 ⁰ (moderately inclined)	597,98	10,0	The productivity of the agricultural machinery decreases. The erosion process is more experienced in the southern expositions. It should be taken measures against erosion.
3	6-12 ⁰ (very inclined)	2712,88	45,4	The areas with the erosion threat cannot be used for farming. The special agricultural machinery should be implemented where plowing is possible.
4	12-20 ⁰ (steep)	1146,81	19,2	The usage of these kinds of areas requires the application of the special agricultural machinery.
5	20-45 ⁰ (very steep)	378,27	6,3	These areas cannot be used for farming. It is suitable for summer pastures. It is important to plant meadows and a forest in the areas where erosion develops strongly.
Total:		5977,59	100,0	

On the basis of the research conducted in the area, a map of the construction of appropriate terraces in accordance with the mountain slopes was drawn up in many parts of the area. Its analysis indicates that the area of the study zone varies on 5 gradations, ranging from 0⁰ to 45⁰. Environmental measures have been determined by us depending on the degree of inclination of the region (Figure 1).

At the same time, a new map was prepared using GIS technologies. Based on the analysis of the map, it can be said that, unlike in previous years, the relief of the area has undergone significant changes in modern times. In the study region, new areas inclined from 45⁰ to 70⁰ (40 km² in total) were formed (Figure 2).

The progress of all processes in the soil (including the formation of erosion processes, the volume, and quality of productivity), as well as ecological processes, depends on climate indicators. *“The amount of solar radiation falling on the territory of the study region varies depending on the diversity of the relief. Its total amount varies between 120-135 kcal/cm² during the year. The amount of annual total radiation on the highest peaks of the Greater Caucasus Mountains is equal to 140-145 kcal/cm². ”*².

The average annual air temperature in the low mountainous part of the area ranges from 10,5⁰C to 14,5⁰C. The January temperature is – 0,6-1⁰C, and the average July temperature rises to 22,4-23,2⁰C. The coldest month is January, with a temperature of 1,4⁰C. The average annual precipitation in the area fluctuates between 522-527 mm. The most precipitation is observed in March, April, and early May and is 32-63 mm per month. The predominance of humid weather in some areas of the research zone (Ismayilli, the mountainous areas of the Shamakhi) has a positive effect on the provision of moisture in the fields of the rainfed crop (non-irrigated crop), the formation of grass cover, the collection, and growth of water resources. Since the areas of the study area are bare in many places (Gobustan, lowlands of the Aghsu district), rains cause intensive soil washing, and at the same time, the fertile layer of the soil is washed away.

²Shykhlinisky, A.M. Climate of Azerbaijan / A.M. Shykhlinisky. - Baku: Elm, - 1968, - 152 p. (In Russ.)

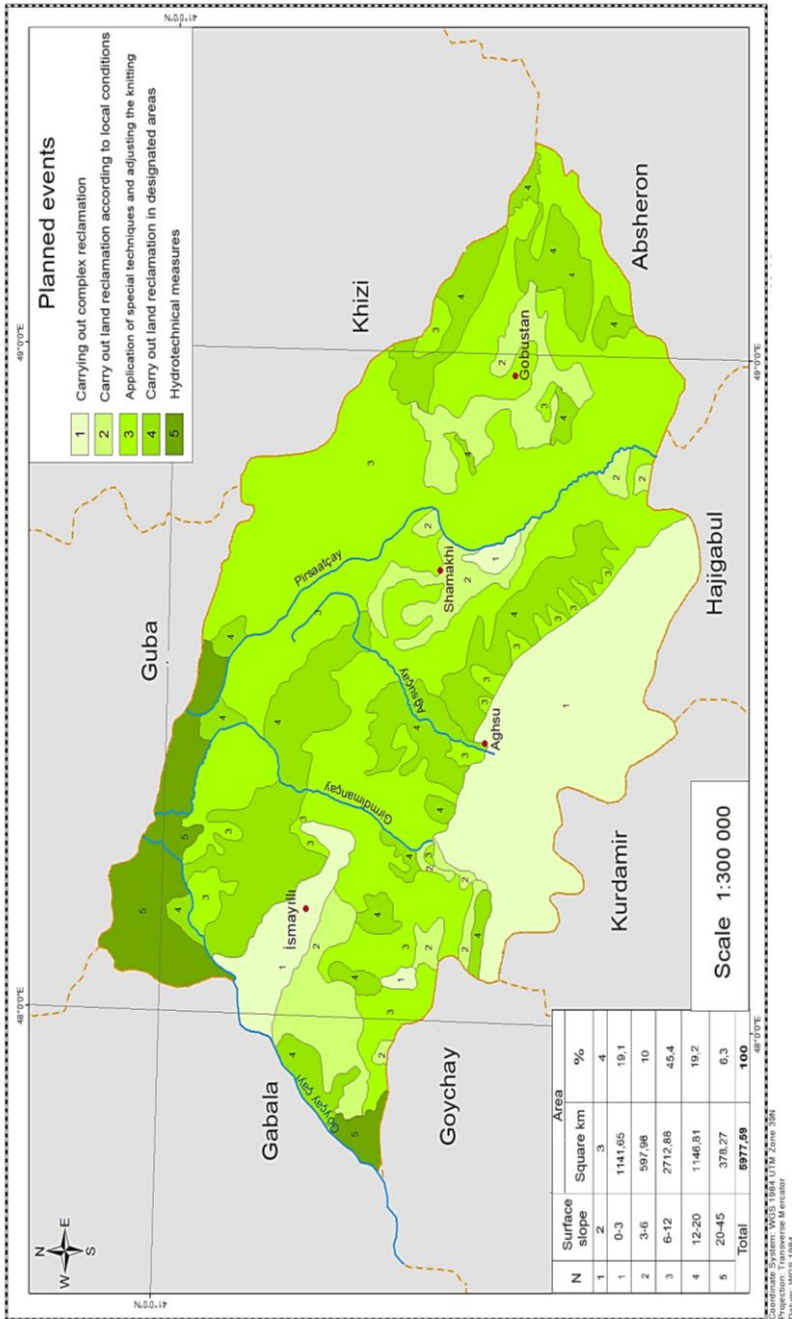


Figure 1. Actions to be taken in connection with inclination in the Shamakhi-Ismayilli zone

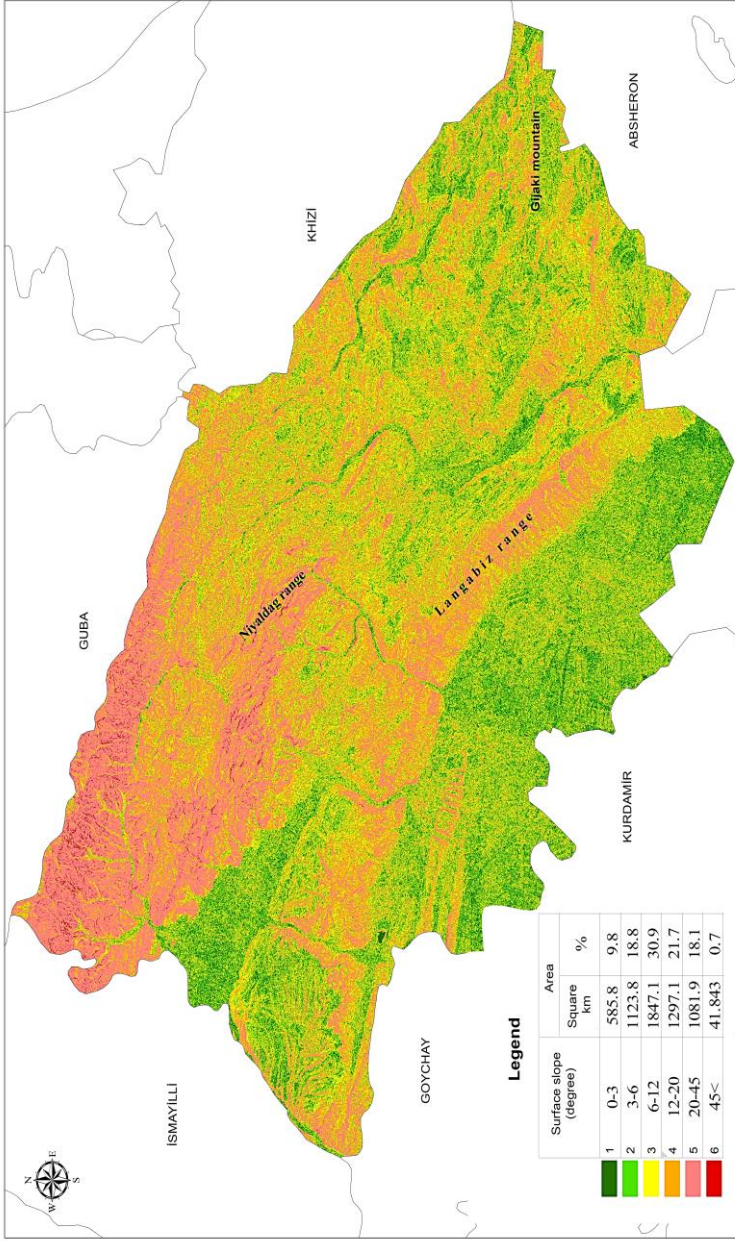


Figure 2. Inclination map of the Shamakhi-Ismayilli zone based on the digital elevation model

In the rivers in the study area, *floods occur in May and June, and water scarcity occurs in December and January. Girdimanchay, the largest river artery in the area, causes floods*³. In addition to these, there are several reservoirs in the zone (Yekakhana, Javanshir, Shirvanhol, Jeyrankechmez), which also play an important role in irrigation. The study area is rich in several mineral waters, most of which have medicinal value. (Bado, Varna, Namazgah, Lahij, Zargaran and others.) Moreover, this zone is rich in underground water and artesian water.

Generally, flood events that occur intensively at certain times of the year in the rivers in this area cause considerable destruction and soil erosion. As a result of the erosion process, the amount of humus, nitrogen, and basic nutrients in the soil decreases, the fertility of the soil deteriorates, and its productivity decreases significantly.

The second chapter of the dissertation work is devoted to **“Evaluation of natural and social resources”**. Here, natural resources and the areas of the economy were assessed, and population settlement, and their anthropogenic effects on environmental conditions were analysed.

The Shamakhi-Ismaili zone is not very rich in natural resources. Since the Greater Caucasus is composed of sedimentary rocks, there are almost no ore minerals. Nevertheless, oil, natural gas, and oil shale are the main resources. Stone, gravel, sand, lime, and other building materials are mainly available here. The clay deposits of the Shamakhi, Aghsu, and Ismayilli regions have important construction importance.

The total land fund in the Shamakhi region, which is included in the research zone, is 161,9 thousand hectares, which is 1,62 hectares of land per person. In the area, perennial crops are 2,42 thousand hectares, cultivated land is 3,48 thousand hectares, hayfields are 1,63 thousand hectares, and meadows are 66,2 thousand hectares. In the Shamakhi district, 7,38 thousand hectares of homesteads and 11,4

³Rustamov, S.G., Qashqai, R.M. Water resources of the Azerbaijan SSR / S.G. Rustamov, R.M. Qashqai - Baku: Elm, - 1989, -184 p. (In Russ.)

thousand hectares are forests. The forest area per person in the region is 0,11 hectares (Table 2).

In the Ismayilli district, which is included in the Shamakhi-Ismayilli zone, the area of the total land fund is 194,4 thousand hectares, of which 83,4 thousand hectares are suitable for agriculture. The total amount of cultivated land in the region is 31,3 thousand hectares and this amount for per person is 0,36 hectares. However, this figure for the forest land is 66,9 thousand hectares and the amount of area per person is 0,80 hectares. Turning to the perennial crops, this figure per person is 0,02 hectares. Finally, the amount of the rest of the land with 4,7 thousand hectares is 0,05 hectares per person. Accordingly, hayfields per capita are 0,03 hectares, meadows are 0,46 hectares, and yard areas are 0,03 hectares.

The Gobustan district included in the study zone varies in different values according to the indicated gradations, unlike the two previously mentioned districts. Thus, only 92,4 thousand hectares of the total land area of 153,2 thousand hectares are considered suitable for agriculture. This composes 60% of the total area. Regarding the separate indicators - cultivated areas are 37,0 thousand hectares, perennial crops are 3,7 thousand hectares, and 2,49 thousand hectares are rest areas. There is no hay field area in the Gobustan district. Yard areas in this region are 0,55 thousand hectares as opposed to the meadows are 48,7 thousand hectares. In contrast to the Shamakhi and Ismayilli districts, while forest areas in the Gobustan district make up 1,6% of the area, the figure for per person is 0,05 hectares.

Aghsu district is the smallest territorially in this zone, its area is 108,4 thousand hectares. 77,9 thousand hectares of the territory are considered suitable for agriculture. 30,8 thousand hectares of the region's territory are cultivated, including 0,38 hectares per person, 3,47 thousand hectares are perennial crops, including 0,04 hectares per person, 2,41 thousand hectares are non-cultivated lands, including 0,03 hectares per person, 37,4 thousand hectares are pasture, including 0,46 hectares per person, 2,88 thousand hectares are homesteads, including 0,04 hectares per person. Right after the Shamakhi and Ismayilli districts, the Aghsu district ranks third in

terms of forest area, and the total forest area is 3,11 thousand hectares, of which 0,04 hectares per person (Table 2).

*“Generally, 58,9% of the total area in the study area is suitable for agriculture. As a result of our analysis, it was determined that 13,5% of the territory is covered by forests, 37,0% by arable land, 2,40% by perennial crops, 6,0% by non-cultivated land, and 2,51% by hayfields, 48,3% by pastures and 3,15% by backyards.”*⁴(Figure 3).

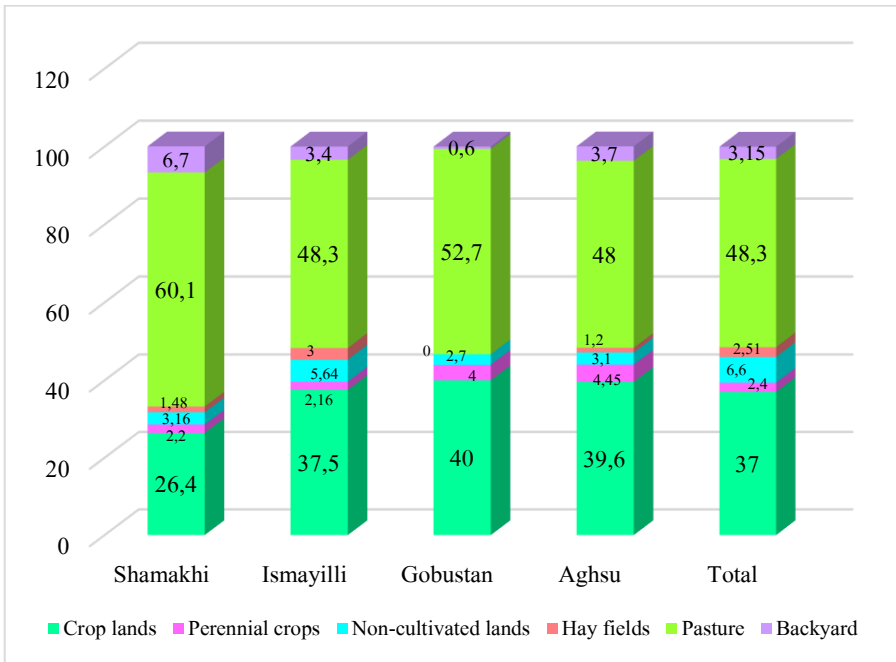


Figure 3. General indicators of suitable lands for agriculture in the research area (%).

⁴Shakiliyeva, H.F. Ecological evaluation of the soil-climate conditions of the southern slope of the Greater Caucasus. // Scientific news of Baku State University. Series of natural sciences, - Baku: - 2015, - №2, - p. 171-179. (In Aze.)

Table 2

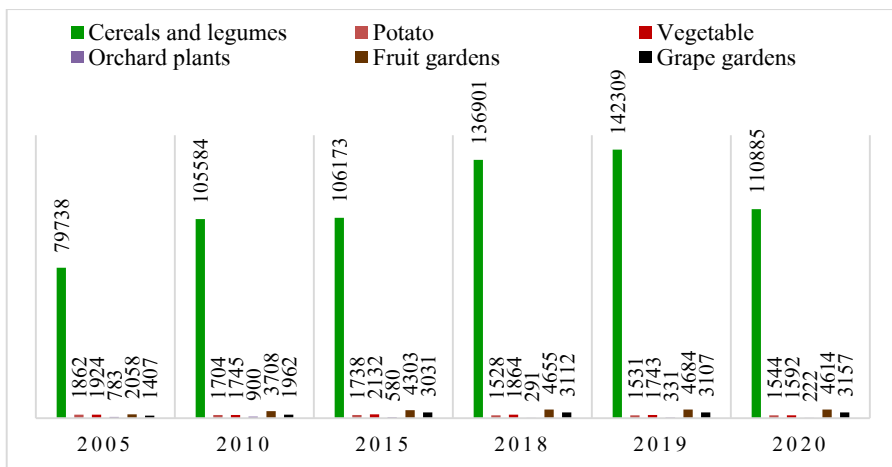
Structure of land use in the Shamakh-Ismayilli zone

Administrative districts	Area, thousand hectares		Including the total of the lands that are suitable for agriculture (thousand)		From them																	
	Hectares	%	Hectares	%	Crop		Perennial crops		Non-cultivated lands		Hayfields		Pasture		Backyard		Forest					
					Total	Per person	Total	Per person	Total	Per person	Total	Per person	Total	Per person	Total	Per person	Total	Per person				
Shamakhi	161,9	110,1	68,0	29,0	26,4	0,27	2,42	2,20	0,003	3,48	3,16	0,03	1,63	1,48	0,02	66,2	60,1	7,38	6,70	11,4	7,07	0,11
Ismayilli	194,4	83,4	43,0	31,1	37,5	0,36	1,80	2,16	0,02	4,70	5,64	0,05	2,50	3,00	0,03	40,3	48,3	2,84	3,40	66,9	34,4	0,8
Gobustan	153,2	92,4	60,1	37,0	40,0	0,77	3,70	4,00	0,08	2,49	2,70	0,05				48,7	52,7	0,55	0,60	2,24	1,46	0,05
Aghsu	108,4	77,9	71,9	30,8	39,6	0,38	3,47	4,45	0,04	2,41	3,10	0,03	0,93	1,20	0,01	37,4	48,0	2,88	3,70	3,11	2,87	0,04
Total	617,9	363,8	58,9	128,1	37,0	0,39	11,4	2,40	0,04	13,1	6,60	0,04	5,07	2,51	0,02	192,5	48,3	0,15	3,15	83,7	13,5	0,3

Source: Environment in Azerbaijan, Baku: 2021, 140 p. (In Aze.)

For the study area, which is a mountainous area, the amount of agricultural land can be considered a good indicator. At the same time, it is not correct to consider all the remaining 40% of land in the area as unusable. It is possible to expand the area of useful land by carrying out various melioration measures (phyto, water, dry, etc.) on 30-35 thousand hectares of land on the mountain slopes, river valleys, and other places. The most important thing is that it is possible to prevent landslides, erosion processes, etc., along with improving the microclimate due to afforestation on those lands.

In the section “**Assessment of agricultural areas**” it is mentioned that the research zone is specialized in important grain production, animal husbandry, and viticulture-wine production of the republic. Although the leading field of agriculture in the region is viticulture, later this field has declined to some extent. This was mainly due to the strengthening of measures to combat alcoholism in the 80s of the 20th century.



Source: Agriculture of Azerbaijan - Baku, 2021, 75p.

Figure 4. Fields of crops (hectare).

The zone is characterized by an abundance of thermal resources, which is important for ensuring high productivity in conditions of abundant moisture and proper agrotechnical measures. In most of its territory, the total active temperatures exceed 4000°C.

This is enough thermal potential to grow rainfed wheat and corn or grow vegetables after harvesting the wheat and other plants from the same field twice during one agricultural year (Figure 4).

In the agro-production grouping of land, the land is grouped according to production value and its level of use on the farm, making land maps more agronomic and management-friendly to the farmer. The main purpose of an agro-production grouping of soils is to combine the genetically and productionally close soils, on the other hand, is to combine soils that are not genetically close to each other. Grouping the soils, which are productively different (if they form a complex and have common similarities) creates advantages to using them efficiently. In the Shamakhi-Ismayilli zone, 3 agro-production groupings are divided: 1) mountain-meadow and meadow-steppe; 2) mountain-forest; 3) mountain farming. Each grouping, in turn, is divided into 5 quality groups, dividing into the best soils, good, medium quality, low quality, and conditionally unsuitable soils.

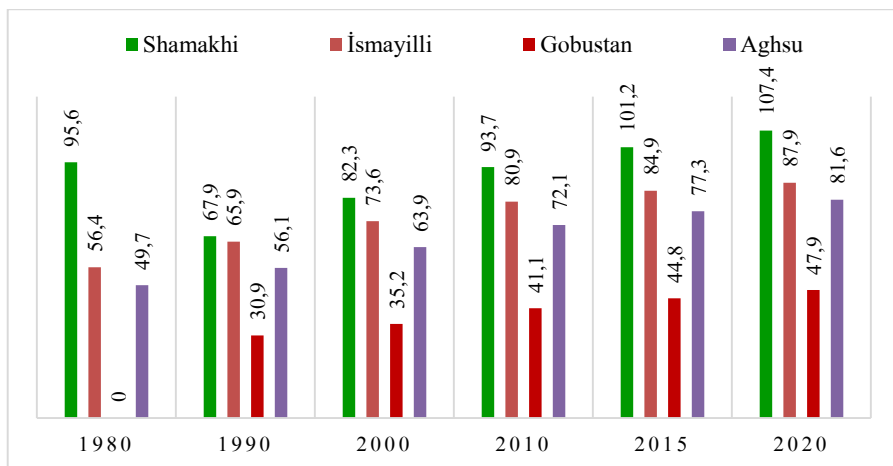
324,8 thousand people settle in the study area. *The region is distinguished by its high growth rate compared to the indicators of the republic according to the indicators of population renewal*⁵. In the last 40 years, the population growth in the area was 62%. The indicated growth is an average of 1.54% over the years.

The mortality rates of the population in the Shamakhi-Ismayilli zone are different. In the last 4 decades (1980-2021) in the zone, the fewest deaths were witnessed in the Gobustan district. Thus, the analysis indicates that in 1995, the death of 235 people was recorded, which was 13,0% of the population of the zone, and in 2020, the number of deaths in the entire region was 14,3%.

In the Shamakhi-Ismayilli zone, Ismayilli and Agsu districts differ from other districts in terms of population settlement. It should also be noted that in the Ismayilli district, the birth rate decreased during the 20 years. *Thus, 1609 people were born in the Ismayilli district in 1995, which made up 29,5% of the population of that zone.*

⁵. Population of Azerbaijan 2020 –Baku:- State Statistical Committee of the Republic of Azerbaijan, 2021, - 140 p. (In Azc.)

In 2015, 25,6% of the births of the zone's population fell to the Ismayilli district. Accordingly, in 1995, among the total population of the zone, the number of deaths in the Aghsu district was 32% (611 people), this indicator was 26,7% in 2015 (442 people) and 28,0% in 2020 (643 people)⁶ (Figure 5). Among the reasons for the increase in death, we should mention the impact of the Covid-19 pandemic.



Source: Demographic indicators of Azerbaijan./ 2021. p. Baku: Sada, - AR DSK, -2021. - 560 p.

Figure 5. Population growth over the years (%)

In general, the relative increase in population in the Shamakhi-Ismayilli zone in recent years is the result of the suburbanization process, and the area is favourable from an ecological point of view. The migration of the population is mainly directed to the regional centres and Baku city. It should be noted that the implementation of economic and social reforms in the Shamakhi-Ismayilli zone, especially the successful completion of land reforms, made it possible for the population to stay in their ancestral homes, and the number of people leaving the area decreased. In this regard, the population's anthropogenic impact on the environment and its

⁶Demographic indicators of Azerbaijan - 2021. Baku: Sada,- State Statistical Committee of the Republic of Azerbaijan, -2021. – 560 p. (In Azc.)

settlement, in addition to having an ecological content, creates conditions for the expansion of employment issues of the population at the expense of local resources.

Ecologically disturbed areas are also common in the study area. It is a known fact that environmental risks are increasing as the fields of science, technology and economy develop. As ecological risks increase, the environment in the area becomes tense, and the natural balance is disturbed.

The natural terrain systems disturbed by anthropogenic influences cover the lower and middle parts of the Agsuchay and Girdimanchay basins, the southern slopes of the Langebiz mountains, as well as the middle flow of the Pirsatchay. The structure of forest-shrub and mountain xerophyte landscapes has been disturbed as a result of long-term, unregulated agriculture, partly due to deforestation. In these landscapes, biogenic components have undergone fundamental changes. 50-60% of natural landscapes have been transformed by various cultural landscapes. Up to 40% of the areas covered by this group of landscapes are plowed and used for grain farming (grains, potatoes). The conducted studies indicate that the forests in the Agsuchay and Girdimanchay basins have also been disturbed in the areas marked as high credit areas. Completely modified natural terrain systems are suitable for areas where settlements, reservoirs, power lines, pipelines, and roads are built. As a result of the influence of long-term, multi-field, partially selective, and industrial-technogenic forms of use, all-natural components here have undergone radical changes.

In the studied area, this group of landscapes is found in the form of ribbon-shaped and hearth-shaped areas within separate landscape types. The geological foundation, which is considered the most conservative component of the landscape, is also subject to change as a result of human economic activity. As a result of road construction works in the mountainous terrain, anthropogenic cuts were created in the area. Construction of the Mingachevir-Baku electric line, Hajigabul-Grozny, and Meysari gas pipelines created linear changes in lithogeomorphological conditions. In the western and northwestern parts of the territory, mainly forested and closed

settlements were formed, and in the southeastern part, garden and non-garden type seliteb landscapes were formed.

Optimized natural landscape systems cover the central part of the studied area - the Shamakhi plateau and surrounding areas. *“Along with anthropogenic effects, the role of natural events and processes in changing the ecological state of landscapes is great. Of these processes and events, landslides, avalanches, floods, erosion, and arid-denudation processes have a greater impact on landscape degradation and ecological status.”*⁷. *“In the high mountain belt, where exogenous processes are active, the areas where stress is caused by landslides, avalanches, scattering, intensive erosion, and other effects are wider. In these areas, as a result of the influence of these factors, the lithomorphism of landscapes becomes stronger.”*⁸.

In connection with the strengthening of human influence on nature and the aggravation of environmental problems, a new field of landscape science - landscape ecology - was born and began to develop rapidly as applied science. Landscape ecology provides a comprehensive study of environmental problems arising in connection with the use of natural landscapes and the preparation of scientific bases for their elimination. Ecologically optimal and extreme landscape zones are separated taking into account the landscape-climate characteristics. The optimal landscape is limited to the lower border of the ecological zone and the lower border of the upper highlands. The value of relative humidity, namely the ratio of precipitation to possible evaporation, equal to 0,8, was taken as the border of aridity. This number corresponds to the boundary between forest and steppe landscapes. In the optimal zone, relatively old (G₂-G₃) landscapes with relatively high productivity and natural stability - forest, forest-meadow-steppe, and partially mountain steppes have developed. This zone, where the ratio of heat and humidity is convenient, covers up to 20-25% of the territory.

Below the optimal zone is the extreme arid landscape-ecological

⁷Dashdiyev, R.H. Landscape ecology. The main features of mountainous country landscapes / R.H. Dashdiyev. - Baku: - 2009. - 131 p. (In Azc.)

⁸Garibov, Y.A. Optimization of natural landscapes of the Republic of Azerbaijan / Y.A. Garibov - Baku: AzTU, - 2012, - p. 138-145. (In Azc.)

zone. Arid geosystems - dry steppe, semi-desert and arid forest-shrub complexes have formed in this zone, which corresponds to the low mountains and the foothill plains, under the conditions of lack of humidity and scarcity of precipitation. Above the optimal landscape-ecological zone there is a high ecological zone with the extreme nature. The border of this zone passes through the absolute height of 2200 metres, corresponding to the lower border of the subalpine meadows. For this belt, in the conditions of heat limitation, mainly young age (G4) weakly stable and fragile geosystems - subalpine, alpine-meadow, subnival, nival landscapes are typical.

According to the degree of disturbance of the ecological situation and its natural stability, the landscapes of the area are grouped into the following groups: 1) stable landscapes that have not disturbed (conditionally disturbed) ecological balance well ($K_{ep} < 0,1$); 2) slightly disturbed ($K_{ep} = 0,1-0,4$) relatively stable landscapes; 3) moderately disturbed ($K_{ep} = 0,4-0,7$) poorly stable landscapes; 4) strongly disturbed ($K_{ep} > 0,7$) unstable and weakly stable landscapes in a stressful ecological situation⁹. Here, ecologically disturbed areas make up 10-15% and do not change the landscape structure.

Ecologically moderately disturbed landscapes are found in the form of glades in most of the studied area. Landscapes with a tense ecological situation in the studied area mainly have a point-hotbed area. This group includes dense roads around beds in summer and winter pastures, areas turned into a network of paths, strongly eroded meadows around villages, as well as badland areas of intensively fragmented arid-denudation areas. That region mainly covers the basins of the upper and middle flows of the Pirsaat, Aghsu, Girdiman rivers, and the left tributary of the Goychay. An analysis of natural terrain systems was carried out in the specified area.

The third chapter of the dissertation work is dedicated to **“Protection of natural conditions in the research area, ways of efficient use of natural resources”**. The expedient of optimisation

⁹Dashdiyev, R.H. The problem of optimizing mountainous landscapes of Azerbaijan // Works of the Geographical Society, - Baku: -2003. - Volume VIII, - p. 59-63 (In Azc.)

of nature-population relations and farm areas, being the natural-territorial complexes (landscapes) of the Shamakhi-Ismayilli zone, the subject of the research includes the aesthetics (attractiveness) of the landscapes as well as their functional purpose.

During the research, we analysed the following:

- a complex approach to the assessment of landscape-aesthetic resources of mountain landscapes;
- carrying out the territorial differentiation of typological and landscape-aesthetic resources of natural complexes;
- to determine the degree of optimality of nature use in territorial recreation systems (TRS).

The evaluation methodology of the aesthetic resources of mountain landscapes in the zone has been developed and approved. The landscape formation in the mountains is also taken into account here. *The high diversity of landscapes in the territory is defined by the mosaic of their structure and the variety of natural complexes*¹⁰.

The selection of the formation of geosystems as landscape-landscape complexes was justified, the features of the landscape complexes of the study area were analysed, and the regularities of the differentiation of mountain landscapes according to the landscape-aesthetic principle were revealed. This opens up the possibility of using landscape-analytical and extrapolation methods in the assessment of landscape-aesthetic resources. The regularity data show that the high-altitude plateau has the highest aesthetic potential, descending in the direction of the hills. The combination of different landscapes in the zone - (landscape - ecotone) has increased in aesthetic value. Namely, the beautiful views created by the landscapes are the main factor of the recreational value of the area. This fact is undeniable in the territorial organization of nature use.

In the section on *ecological assessment of landscapes*, it was revealed that poorly modified landscapes with anthropogenic modification cover more than 20% of the studied area.

¹⁰Dirin, D.A. Landscape and aesthetic resources of mountain territories: assessment, rational use, and protection. D.A. Dirin. - Barnaul: AzBuka, - 2005, - p.119. (Azec.)

This group of landscapes also includes grassland ecosystems of the arid-denudation low highlands of the Shamakhi-Gobustan region. In the eastern and southeastern part of the studied area, semi-desert and partially dry-desert landscapes are mainly used as winter pastures. Moderately modified, partially transformed landscapes cover 20-22% of the studied area, mainly covering the upper parts of the Pirsatchay, Gilgilchay, Valvalachay, and Gozluchay basins¹¹. Mountain-meadow and meadow-steppe landscapes have been changed as a result of long-term, sometimes unregulated pasture-mowing, and partly as a result of agriculture. Vegetation in these landscape complexes is rooted, and in some areas, the soil cover has been significantly degraded. Up to 8-10% of the area of landscapes belonging to this group is plowed.

Restoration protection methods of landscapes are carried out through especially protected areas, which include areas protected by the state, which are of exceptional importance for science, culture, and economy.

In the section on **the evaluation of the natural condition in terms of economic, ecological, and tourism**, a comprehensive evaluation of natural conditions and natural resources was carried out. The natural conditions of the Shamakhi-Ismayilli zone not only have a convenient natural condition but are also quite contrasting. *“The use of natural resources is mainly based on renewable resources. At the same time, the seismicity of the area and the occurrence of landslides pose a threat to living and affect the destruction of agricultural lands.”¹²* Anthropogenic influences also play a big role in the destruction of natural conditions and natural resources in many places. As a result, the reduction and thinning of the area of forests affect the destruction of wild plants. Furthermore, in the last 15-20 years, the land resources suitable for agriculture have decreased by 2-3% remaining under roads and construction.

¹¹Aghayev, T.D., Garibov, Y.A., Eldarov N.S. et al. Environmental problems of world landscapes. / T.D. Aghayev, Y.A. Garibov, N.S. Eldarov. Book II. - Baku: Bilik, - 2014, - p. 242. (In Aze.)

¹²Dargahov, V.S. Recreation-tourism resources / V.S. Dargahov. - Baku: MBM, - 2008, - p. 174 (In Aze.)

Because of the increase in the number of cattle and sheep, the productivity of pastures decreases by 3-4%. In the total output of farms in the region, the volume of agricultural products was 60-62% compared to the industrial products was 3-4% of the total output. According to several reports, this indicator is 62-65%.

Several factors hinder climate comfort in the region, which are characterized by rainy summer months and gloomy weather in some years. In general, the repetition of comfort limits in the region reaches 70-75%, which creates appropriate conditions for the summer tourism season.

Balneological tourism resources. There are rich mineral and thermal waters in the Shamakhi-Ismayilli zone. More than 20 mineral and sulphurous waters are found in the region. The most famous of them are Basgal, Bado, Varna, Namazgah, Lahij, Zargaran, Galajig (Ismayili), Chukhuryurd, Asrakhanovka, Chanag, Avakhil (Shamakhi) and others. *The total flow of therapeutic waters in the region is more than 700 thousand litres per day. Healing mineral waters mainly consist of hydrocarbonate and carbon dioxide, cold and warm waters. Although the treatment facility does not operate at the base of the therapeutic waters, there are locally important treatment centres*¹³. The areas where healing waters are distributed in the region are surrounded by an exotic landscape, and the high flow rate of healing waters increases their possibilities of use in treatment and health tourism. In this regard, taking into account the decreasing level of the use of healing waters in the tourism industry of the region, it is appropriate to organize a mountain-climate and balneological treatment-health centre in the region in accordance with the state program on the development of resorts.

Tourism resources of the Shamakhi-Ismayilli zone, architectural monuments, and their tourism importance. In the Shirvan region, there are few pre-Islamic architectural monuments, but they stand out for their richness in terms of tourism. Such

¹³Babayev, A.M. Mineral waters of mountain regions of Azerbaijan / A.M.Babayev. - Baku: Chashioghlu, -2000, - p. 254. (In Russ.)

architectural examples are more common in the Ismayilli and Shamakhi districts. In general, there are 2 historical and cultural reserves (Lahij and Basgal) and 233 monuments of state importance in the Ismayilli district. Javanshir Castle and other monuments from ancient Albanian temples can also be encountered in the Ismayilli district. The analysis of monuments in the region shows that they mainly consist of examples of architecture dating back to the Middle Ages. Although many architectural examples stand out for their originality and can be presented to tourists, their small location and the collapse of some of them hurt their use in terms of tourism. Among the architectural monuments in the region, the seven domes, the medieval castles in Ismayilli, and the architectural examples in Lahij are considered more suitable for tourism. The location of other monuments at a distance from each other, and concentration in areas with poor road infrastructure are considered inconvenient for the organization of tourist routes. Taking into account the mentioned, it is possible to mention the possibility of joint use of architectural monuments and material-cultural samples in the region with other tourism resources.

Wood carving, pottery, blacksmithing, embroidery, silk weaving, and carpet weaving are widespread in the region. The art of wood carving consists of doors, windows, and other wooden patterns made in separate settlements of the Shamakhi and Ismayilli. In the towns of Basgal and Lahij in Ismayilli, craft shops related to local production that preserve traditional crafts, wood carving crafts, and silk weaving in the centre of Shamakhi have kept their traditional characteristics. Such traditions have an important role in promoting the tourism potential of the region and attracting foreign tourists.

RESULT AND SUGGESTIONS

1. Up to 55% of the territory of the Shamakhi-Ismayilli zone is convenient for agriculture and population settlement. 25-30% of the suitable land resources for agriculture were accounted for by cultivation. Suitable land resources for agriculture together with perennial crops constitute 59% of the region. Cultivated land and perennial crops per person are 10,65 hectares.

2. In the Shamakhi-Ismayilli zone, by summarizing the research in the field of an agro-production grouping of land, mountain-meadow, and meadow-steppe; mountain-forest; soils of mountain farming zones are classified into 3 to 5 groups according to their quality indicators.

3. The natural growth of the population of the Shamakhi-Ismayilli zone corresponds to the average natural growth level of the population of the republic. That is, during the last 41 years of observation in the research region, the annual natural growth of the population was 1,9% in relation to the natural growth of the republic's population. Taking into account the decrease and increase of the population due to migration, the minimum indicator of population growth increased from 0,16% (1990) to a maximum of 0,36% (2000); From 2010 to 2020, these numbers decreased by 0,26%, and 0,27% (respectively). Thus, the total increase is 0,31% on average in the area. Taking into account the 4% increase in the demand of each person in the general population growth, conditions have been created for the increase of environmental risks. In this respect, the population's anthropogenic impact on the environment and its settlement have an ecological content, and the expansion of the population's employment at the expense of local resources is one of the most necessary issues.

4. Having a different natural basis, natural productivity, and cases of disruption indicate the degree of ecosystem natural stability. In this regard, the stability levels of the territories were determined. Eco-meliorative measures are grouped in areas according to the degree of sustainability. The forest-meadow zone in the area is distinguished by keeping its natural stability at a relatively high level, which is between 0,1 and 0,4. Strongly disturbed areas (Ecological Distruption Index (EDI) $>0,7$) have a severe ecological situation. These areas cover the mountain-steppe landscapes of the Shamakhi plateau, which have changed by 90%. The forest-steppe landscapes of the Southeastern Caucasus have changed by 65-70%. Mountain-meadow landscapes have been changed by 30-40%. To reduce the impact of degradation rates related to the above, it is necessary to

increase the area of forests and greenery according to the presented map.

5. Assessment of nature-population relations and farm areas is related to landscape optimization issues. That is why landscapes should function with their full complexity. In such a case, landscapes become fully functional: 1. Natural reproduction is ensured; 2. It becomes aesthetically attractive; 3. The recreational importance increases; 4. Biological diversity is guaranteed.

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Address: Az 1143, Baku, 115th H. Javid avenue, ANAS, Institute of Geography named after academician H.A. Aliyev.

E-mail: cografiya_inst@mail.ru, institute@geograph.science.az.

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