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ABSTRACT

of the dissertation for the degree of Doctor of Philosophy

LANDSCAPE-ECOLOGICAL POTENTIAL AND ITS OPTIMIZATION OF LANGABIZ RANGE AND SURROUNDING AREAS

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

Field of science: Geography

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GENERAL CHARACTERISTICS OF THE WORK

The actuality and the investigation level of the topic. From the coast of the Caspian Sea to the landscape complexes of the highlands, human intervention in natural complexes is observed in all areas. The thinning of forest massifs and the change of species composition in the mountainous areas, the intensification of the processes of desertification and aridification due to anthropogenic reasons in the plains, and the loss of pastures, which are the fodder base of livestock, have become typical for our republic. The development of tourism and the expansion of the recreation industry from year to year have intensified human interference with nature.

Observations show that the massive and irregular use of forest areas does not play a small role in the degradation of forest ecosystems. Under the influence of these and other negative processes, the transformation of historically formed natural landscape complexes (especially forest biogeocenoses) intensified, in some places they were transformed into landscapes with a simple structure of little importance, and in some places they were the derivatives of human economic activity - anthropogenic and man-made landscapes (agricultural fields, orchards, settlements and infrastructures, etc.), and at the same time, the ecological potential of existing landscape complexes has decreased.

The production of material goods is the basis of human society, but this process should not lead to the aggravation of "human-nature" relations. Legal, administrative, economic, social, etc. implemented by the state and society. The system of measures should serve to optimize these relations without reducing the pace of economic growth, protect natural complexes, and maintain the ecological potential of landscapes at the appropriate level.

The Langabiz range and the surrounding areas, located in the southeastern part of the Greater Caucasus, attract attention with the transformation, degradation and reduction of ecological potential of landscape complexes, as in other regions of our Republic. This geographical unit is characterized by a unique relief structure, partially preserved plant formations and complex land cover, natural and anthropogenic (transformed) landscapes. The transformation of landscape complexes in Langabiz and surrounding areas manifests itself in the complete or partial destruction of natural vegetation or its replacement by others, the emergence of elements of desertification and aridization in pastures and hayfields (thinning of plants, reduction of biomass and loss of biodiversity, etc.). From this point of view, it is of both scientific-theoretical and practical importance to prevent the damage that can be caused by the transformation processes observed with the decrease of their ecological potential in landscape complexes, to predict the current trends, to evaluate their ecological potential, as well as to restore and increase it.

N.A. Gvozdetsky, A.G. Isachenko, F.N. Milkov, G.P. Miller, et al. from foreign scientists in the field of development of research in the field of analysis, assessment and optimization of the ecological potential of landscape complexes as a modern and promising direction of natural sciences, and in Azerbaijan, B.A. Budagov, M.A. Museyibov, A.A. Mikayilov, M.J. Ismayilov, Y.A. Garibov, K.Sh.Allahverdiyev and others conducted research and obtained relevant results.

Purpose and objectives of the research. The main goal of the dissertation is to evaluate the ecological potential of the landscape complexes of the Langabiz range and the surrounding areas and determine ways of optimization. To achieve the goal, the following tasks were set and fulfilled:

- to map (on a scale of 1:100,000) by, studying the modern state of landscape complexes, to study their evolution and trends;
- justify the impact of anthropogenic factors on the ecological potential of landscape complexes;
- to carry out bonitation of landscape complexes and draw up bonitation map;
- assess the ecological conditions and potential of landscapes and draw up relevant maps;
- to investigate ways and possibilities of optimizing the ecological potential of landscape complexes within the research object.

Research methods. While collecting the empirical data that make up the information base of the research, cartographic, landscape and geomorphological, soil research (field and laboratory), aerospace methods, etc. has been used. When determining the ecological potential of landscapes, the approaches of A.G.Isachenko, N.F.Reimers, M.J. Ismayilov, G.Sh. Mammadov and other researchers were referred to.

The main provisions of the defense:

1. Assessment of the role of anthropogenic factors in the degradation of landscape complexes and their constituent components and changes in their ecological potential:

2. Application of the proposed step-by-step approach to assess the ecological potential of landscape complexes:

3. Ecopotential grouping of landscape complexes:

4. Conceptual bases of optimization of landscape complexes based on indicators of ecological potential and the importance of their application.

Scientific novelty of the research: The scientific innovations obtained as a result of the work analysis are the following:

- the boundaries of landscape complexes in the Langabiz range and surrounding areas were clarified, their areas were measured, and development trends were determined and analyzed;
- the factors affecting natural landscape complexes and causing their transformation, and their degree of influence and field indicators were determined;
- for the first time, a system of criteria was chosen to assess the ecological potential of landscapes, and based on it, the assessment of landscape complexes was carried out, ecological assessment was carried out, and corresponding maps were drawn up by determining the ecological potential.

Theoretical and practical significance of the research. The obtained results can be important in the implementation of measures aimed at ensuring the sustainable development of the Langabiz range and surrounding areas, in revealing economic and recreational opportunities, and also in maintaining the ratio (balance) between natural and anthropogenic landscapes.

Approbation of the research results:

- Abstracts of reports from the scientific and practical conference “Ecological problems of natural resource management in Uzbekistan”. Samarkand, 1989;
- VI Congress of the Geographical Society of the Azerbaijan SSR, Baku., 1990;
- “Rational environmental management of mountainous countries”, materials of a scientific conference, Bishkek, 1991;
- "Environment and ecology" scientific-methodical conference Baku., 1997;
- “Development of the science of geography in the years of independence” republican scientific conference, Baku, 2013;
- Scientific-practical conference “Directions of application of modern geography science”, Baku, 2014;
- “Human and environmental relations” scientific conference, Baku, 2017.
- “Land management in the market economy: Achievements and modern challenges”, conference, Baku, 2018;
- “Human Geography in Azerbaijan and Russia; The main ways of development in the XXI century” international scientific conference, Baku, 2019.
- “Modern problems of geography” republican scientific conference, Sumgayit, 2019.
- “Science and Education: Preserving the Past, Creating the Future”, the XIII International Scientific Symposium, Kars, Turkey., 2021.
- “Man and relief as the main part of evolution” scientific-practical conference, Baku, 2022.
- “The role of Heydar Aliyev in the development of Science and Education in Azerbaijan”, scientific-practical conference Baku, 2023.
- International scientific-practical conference "Impact of modern climate changes in Azerbaijan on natural complexes and economic system" in connection with the declaration of 2024 as the "Year of Solidarity for the Green World" in the Republic of Azerbaijan, Baku, 2024.

The name of the institution where the dissertation work was carried out: "Landscape science and landscape planning" department of the Institute of Geography named after academician H.A.Aliyev of the Ministry of Science and Education of the Azerbaijan Republic.

Structure and volume of the work: The dissertation consists of an introduction – 5 pages (7749 marks), four chapters, including Chapter I – 12 pages (21731 marks), Chapter II – 26 pages (39526 marks), Chapter III – 56 pages (79242 marks), Chapter IV – 49 pages (44789 marks), a conclusion – 2 pages, and 144 cited names of the bibliography and appendices. The total volume comprises 164 pages and 200,073 characters. There are nine maps, five diagrams, and 28 tables.

MAIN CONTENT OF RESEARCH

The first chapter of the dissertation work is dedicated to "**Scientific-theoretical and methodical foundations of the problem**". In this chapter, the results of the research conducted by D.L. Armand, N.A. Gvozdevski, A.G. Isachenko, B.A. Budagov, M.A. Museyibov, A.A. Mikayilov, M.J. Ismayilov, M.I. Yunusov, G.Sh. Mammadov and others in connection with the classification of landscape complexes, their anthropogenic transformation, validation (comparative assessment), study and evaluation of their ecological, recreation and ecological potential, were analyzed. In the evaluation of the ecological potential of the landscapes of the studied Langabiz range and surrounding areas, the methods proposed by the mentioned researchers were referred to.

In our modern times, disruption of the landscape-ecological balance of geosystems and other changes occurring in other areas of our republic can be observed in the Langabiz range and surrounding areas as well. The area located in the southeastern corner of the Greater Caucasus is characterized by the complexity of the relief, colorful soil and vegetation, and the structure of unique landscape complexes, which play an important role in the formation of the ecological potential of landscape complexes in the studied area. The first chapter shows the implementation of the research in 3 stages, such as cameral, field-laboratory and concluding. At the cameral stage, as its most important result, it is mentioned that the preliminary version of the landscape map of the area is drawn up based on topographical and aerospace materials.

At the field-laboratory stage, landscape (geobotanical and geomorphological) studies were carried out in different seasons of the year, soil profiles were placed, and a description of the area was provided. Here, the determination of granulometric composition of soil samples in laboratory conditions is explained.by the pipette method according to N.A. Kachinsky; hygroscopic moisture - by thermal method; full water weight - by the method of D.I. Ivanov; total humus and nitrogen - by the method of I.V. Tyurin; total phosphorus by X ray spectral method; absorbed Ca and Mg by D.I.Ivanov's method; carbonation by a calcimeter; and determination of the reaction of the environment with a potentiometer.

At the final stage, information is provided on the calculating the areas of landscape contours, drawing up a landscape map of the area on a scale of 1:100000, carrying out the assessment and ecological assessment of landscape complexes, preparing the evaluation scale of ecological potential, calculating the final points of landscape types using correction coefficients, and drawing up “The final evaluation of ecological potential of landscape complexes” map (1:100000 scale) and on ways to restore, increase and optimize ecological potential of landscape complexes.

The second chapter is dedicated to **“Description of natural factors shaping the ecological potential of landscape complexes in the Langabiz range and surrounding areas”.** The studied area is located between the Girdiman and Pirsaat rivers on the southern slope of the southeastern part of the Greater Caucasus. The area rising to 100-150 m from the surface of the Gurjuvan and Shamakhi plateaus in the north, and 500-800 m from the northern edge of the Shirvan plain in the south, covers an area of 215202.06 hectares. In addition to the geographical location of the area, its physical-geographical conditions and natural components play an important role in the formation of the landscape-ecological potential of the geosystems of the Langabiz range and surrounding areas. The Langabiz range has a complex geological structure. The disseminated rocks consist of soft sediments of the Upper Cretaceous, Tertiary and Quaternary periods (sandstone, limestone, conglomerate, clay, and siltstones) and deluvial-proluvial sediments formed from their weathering products.

Relief and its indicators (height, horizontal and vertical fragmentation) play an important role in the formation of ecological potential of landscape complexes. The height factor determines the supply of heat and moisture, the aspect determines the amount of precipitation and insolation, the slope determines erosion processes, the density and composition of vegetation, which in themselves affect the formation of the ecological potential of landscape complexes. Those factors shape the ecological potential of both natural and anthropogenic landscapes (agricultural fields, orchards, etc.) by affecting soil fertility. For this purpose, on the basis of GIS technologies, geomorphological, slope, aspect, horizontal and vertical fragmentation maps of the Langabiz range and surrounding areas were drawn up.

The Langabiz range and surrounding areas are characterized by semi-desert, dry steppes and mild hot climate types with dry summers. The annual number of sunny hours here is 2000-2400 hours/year, and the total of active temperatures is 3000-4500^{0}C. The annual amount of total solar radiation is 124-132 kcal/cm^2, and the annual radiation balance is 45-50 kcal/cm^2. The amount of precipitation is 200-400 mm in the southeast and 500-600 mm in the northwest[1]. The distribution of solar radiation in the study area depends on vegetation cover, amount of cloudiness, altitude, etc. And varies depending on the reasons. The complexity of the physical and geographical conditions affects the flow distribution in the Langabiz range and nearby areas.

Rainwater plays the main role in feeding rivers in the area. Most rivers usually dry up in summer.

The following forms of plants are distributed in the study area: forest and forest thickets of the lowland; plants of the xerophytic dry steppes and semi-desert zone of the mountain plains. Due to the formation of zonal, regional and local characteristics, composition, properties and regimes of soils under the influence of soil-cultivating factors, the following soils are common here: mountain-brown forest (four subtypes: typical mountain-brown, carbonated mountain-brown, grayish mountain-brown, cultivated mountain-brown), mountain gray-brown soils (four subtypes: mountain dark gray-brown, mountain

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[1] Eyyubov, A.D. Bonitation of the climate of the Azerbaijan SSR / A.D. Eyyubov – Baku: – 1975, – 148 p.

ordinary gray-brown, mountain light gray-brown, underdeveloped mountain gray-brown), gray soils; gray-meadow lands; grassy-gray lands.[2].

The third chapter is devoted to the issue of **"Differentiating characteristics of the landscapes of the Langabiz range and the surrounding areas and the characteristics of the selected criteria for evaluating the ecological potential"**. Based on the topographical maps of the Greater Caucasus (1:100000 scale), landscape mapping was carried out under the guidance of A.A.Mikayilov and M.C.Ismayilov at the stage of cameral and field research. Based on the analysis of the prepared digital map with the GIS programme, the parameters of the landscape structure were calculated (Figure 1).

During the field studies, soil profiles were laid out according to landscape types, and the vegetation of the area was studied. The names of land contours have been amended according to the modern classification. Within the Langabiz range and the surrounding areas, 7 landscape types are distinguished: forests of low mountains; lowland forest thickets; lowland steppes; xerophytic dry steppes of mountain plains; lowland semi-deserts; dry steppes of accumulative plains; river-valley landscapes. In order to assess the ecological potential of landscape complexes, the climate (temperature, precipitation, sum of active temperatures), relief (slope), anthropogenic structures (roads, settlements, communication lines, planting, grazing, mowing fields) of the area were selected as criteria.

Below is a specification of ecological potential value criteria in an example of a lowland forest landscape (as an example).

The forest landscape type of the lowland includes historical areas of broad-leaved mountain-forest landscapes. Mountain-forest complexes start from 500-700 m absolute heights of the lowland in the studied area. Here, forests have been completely removed from the altitudinal landscape spectrum due to the agricultural activities of

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[2] Abdullayev, R.A. Ways to prevent and degrade the soil cover of the south-eastern slope of the Great Caucasus (in the example of the Langebiz ridge and the Great Harami ridge) [Text]: The abstract of the dissertation submitted to receive the degree of Ph.D. in Agricultural Sciences: 2511.01. R.A.Abdullayev; ANAS, Institute of Soil Science and Agrochemistry, 2014.-166 p.

people, and fragmented forests and thickets, cultivation, mowing and grazing have formed in their place.

Ecological potential indicators of the forest landscape of the lowland (example).

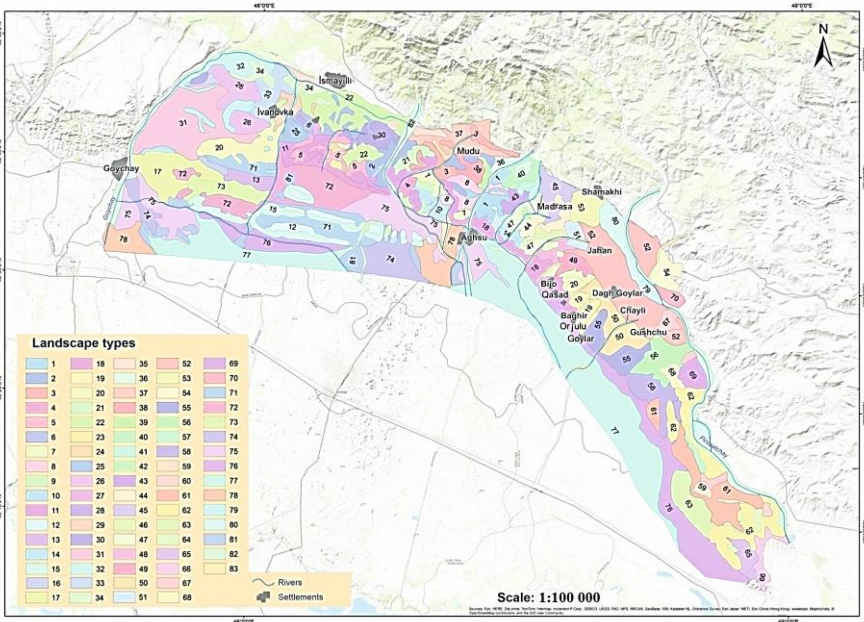

Figure 1. Landscape map of the Langabiz range and surrounding areas (A.A. Mikayilov, M.J. Ismayilov and G.A. Imanova)

The following climatic indicators are characterized for the forest landscapes of the lowland with a mild-warm climate: the average annual temperature is 10.9-11.9^{0}C, the average temperature of the hottest month (July) is 20^{0}C, and the average monthly temperature of the coldest month (January) is 0-3^{0}C. Atmospheric precipitation fluctuates between 700-800 mm. The total of temperatures above 10^{0}C in the area is 3300-3400^{0}C. Annual relative humidity is 70%. The amount of sunny hours is not more than 2200 hours/year. Different types of lowland forests are located in areas with different degrees of slope. This landscape type is 1560.34 hectares on slopes with >40^0 - 17.0% inclination; 1796.13 hectares on slopes with 35^0 - 19.6% inclination; 4448.33 hectares on slopes with 25^0 – 48.6% inclination;

It covers an area of 1352.78 hectares on slopes with an inclination of 17^0-14.8% (table 1).

Typical and carbonate subtypes of brown mountain-forest soils are typical for the forest landscapes of the lowlands. The amount of clay in the top layer of typical brown mountain-forest soils ranges from 50.8-66.0%, and the amount of humus decreases from 3.67-4.41% to 0.88% in the lower layers of the profile.

It is typical for these soils that carbonates leached in the top layer of the soil increase towards the lower layers and the carbonate content in the profile is 0.87-26.95%. The pH is 6.98-7.95. The total amount of absorbed bases varies between 34.0-46.0 mg.eq along the profile.[3].

Another soil subtype is carbonated brown mountain-forest soils. The thickness of the humus layers in this soil is 0-50 cm, and the amount of humus decreases towards the lower layers. The structure of the soil is granular in the upper layer and nut-like towards the depth.

The amount of total humus is 1.4-1.5% in the planting layer, and 0.64-1.30% in the sub-planting layers. According to the humus, the amount of total nitrogen in the upper layers is 0.12-0.43%. The amount of carbonates in the soil profile is 12.88-18.83%. In carbonate mountain-brown soils, the amount of absorbed Ca cations was high in most cases, ranging from 8.56 to 33.2% along the profile. The C:N ratio is between 3.1 and 7.1, and the pH is between 7.8 and 8.3[4] .

Among the anthropogenic factors, the influence of settlements, roads, communication lines, and other man-made facilities, as well as agricultural places, especially farmlands, on landscape complexes is more noticeable. The total area of the territories under settlements and man-made facilities is 76.19 hectares, which covers 0.83% of the landscape area. The total area of

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[3] Imanova, G.A. Physico-chemical characteristics of soils of the Langebiz range and the surrounding area //– Baku: Geography and natural resources, Proceedings of the Azerbaijan Geographical Society, -2018. No. 2 (8), – p. 61-66.

[4] Imanova, G.A. Diagnostic indicators of the ecological state of chestnut (gray-brown) soils of the Langabiz ridge of the Greater Caucasus // - Kemereva: Bulletin of the Kemerevsky State University series, Biological, technical sciences and Earth science -2017. No. 2(2) - p. 51-53.

land suitable for agricultural activity is 2102.9 hectares, which is 22.96% of the territory. Of these lands, 134.7 hectares or 1.47% of the research object are cultivated, and 1925.2 hectares or 21.02% are mowed and grazing areas.

As can be seen from Figure (2), within this type of landscape, the partially transformed oak-ash-tree forest landscape type has a larger area (2243.18 ha or 24.49%) in the carbonated brown mountain-forest soils of poorly fragmented watersheds. The other two landscape types − partially transformed oak-beech forest (19.62%) on typical brown montain-forest soils of moderately fragmented relatively inclined mountain slopes and partially transformed oak-beech forest on typical brown montain-forest soils on weakly fragmented lowlands (19.58%) also have a high specific gravity in the area.

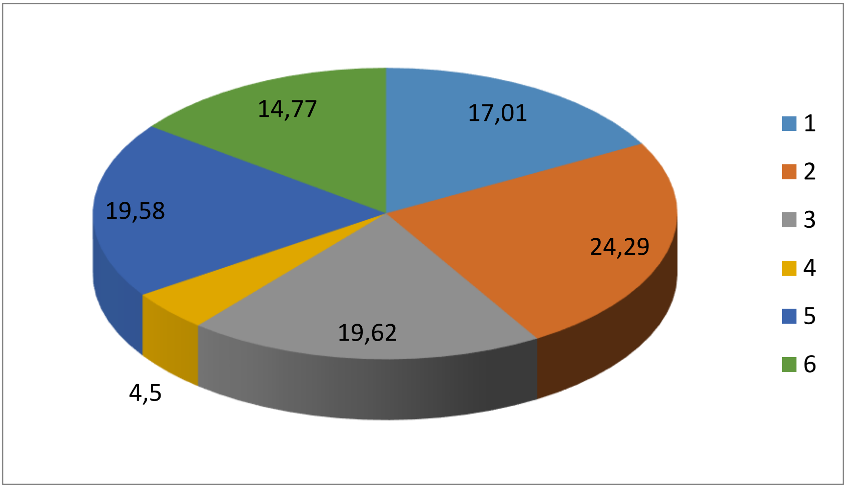

Image. 2. Forests of the lowland: *1- partially transformed oak-beech forest in typical brown high mountain-forest soils on intensively fragmented mountain slopes with active landslides; 2-partially transformed oak-ash-tree forest in thick carbonated brown mountain-forest soils of poorly fragmented watersheds; 3- partially transformed oak, hornbeam forest in medium-thickness typical brown mountain-forest soils of moderately fragmented relatively inclined mountain slopes; 4- partially transformed oak, hornbeam forest in thick typical brown forest soils of mountain slopes in weakly fragmented low mountain watersheds; 5- partly transformed oak, hornbeam forest in thick typical brown mountain-forest soils in poorly fragmented lowlands; 6 - partially transformed oak, hornbeam, ash-tree, hawthorn, etc. forest in well-developed thick carbonate brown mountain-forest soils in poorly fragmented smooth watersheds.*

Thus, when evaluating the ecological potential of landscape complexes, two groups of criteria were used:

- Natural indicators of the landscape (climate – T^0, $\sum T>10^0$, precipitation; relief – slope);
- Anthropogenic indicators a). Residential settlements, roads, trails, communication lines, etc. b). Agricultural sites.

The fourth chapter is devoted to **"Evaluation and optimization of the ecological potential of the landscapes of the Langabiz range and surrounding areas"**. Based on the approach proposed in the dissertation, the evaluation of the landscape-ecological potential of the Langabiz range and surrounding areas was carried out in the following stages: *first stage* - bonitation of landscape complexes; *second stage* - environmental assessment of landscapes; *third stage* - assessment of ecological potential of landscapes.

In the first stage (bonitation of landscape complexes), a rating scale of quality of soils distributed in separate landscape types in the Langabiz range and surrounding areas was drawn up, and by applying correction coefficients reflecting the thickness of soil profiles (table 1), quality of soil points were determined based on their stable diagnostic indicators and final quality of soil points were found (table 2).

Table 1

Correction coefficient for soil profile thickness
(G.Sh. Mammadov, A.B. Jafarov, A.S. Oruclu, 2015)

Thickness	Correction factor
Thick	1,0
Medium thickness	0,8
Sleep	0,6

At the next stage, based on the obtained quality of soil points, the open quality of soil scales of landscape complexes were compiled, average values of landscape types and, comparative value coefficients were found (table 3), and a bonitation map was drawn up (Figure 3).

A number of soil factors (granulometric composition, thickness of soil profile, salinization, etc.) during soil assessment through correction coefficients, were taken into account according, to the methodology. Because of the calculations made with the application of correction coefficients, the soils distributed within the landscape types received the following values: thick typical mountain brown, 100 points; thick typical brown mountain forest, 70 points; typical brown mountain forest of medium thickness, 65 points; thick carbonated brown mountain forest, 69 points; thick steppe brown mountain forest, 59 points; medium-thick grayish brown mountain forest, 44 points; medium thick typical mountain brown, 82 points; upper typical mountain brown, 47 points; thick carbonate mountain black soil, 100 points; medium thickness carbonated mountain black soil - 65 points; thick mountain dark gray-brown - 81 points; medium thick mountain dark gray-brown - 57 points; thick mountain ordinary gray-brown (chestnut) - 67 points; medium thickness ordinary gray-brown (chestnut) - 58 points; thick mountain light gray-brown (chestnut) - 46 points; medium thickness light gray-brown (chestnut) - 40 points; upper light gray-brown (chestnut) - 26 points; thick gray – 38 points; medium thickness gray – 37 points; thick gray-brown - 31 points; upper gray-brown - 20 points.

Using soil value indicators, open soil quality scales of landscape complexes were compiled, and the average values of landscape types, comparative value coefficients, and final soil qaulity points of landscape types were determined. For this purpose, the following formula was used (G. Mammadov, A. B. Jafarov, et al.):

$$LB = [(lb1X\ S1)+ (lb2\ X\ b2)+ ...+(lbn\ X\ Sn)]: (S1+S2+....Sn) \quad (1)$$

Here, lb1, lb2,...lbn are soil quality points found based on the internal properties of the lands distributed within the landscape; S1, S2,....Sn- area of landscapes.

The soil quality points (SQP) and the comparative value coefficient (CVC) of the landscape types of the Langabiz range and surrounding areas were determined as follows: lowland forests SQP - 42-70, CVC 0.65-1.09; xerophytic dry steppes of mountainous plains

Table 2[5]

Land of Langabiz range and surrounding areas
the main bonitation scale

The name of the lands	Thickness correction factor	Hummus				Nitrogen	UAC		Average score			Final credit score
		0-20	0-50	0-100	0-20	0-50	0-20	0-50	0-20	0-50	0-100	
Forest and undergrowth landscape complexes												
Thick typical brown mountain-forest	1,0	50/58	116/66	185/69	3,8/61	9,4/71	31,3/87	28,3/86	68	74	69	70
Typical brown mountain forest of medium thickness	0,8	104/122	259/148	-	7,3/118	18,1/136	32,3/90	32,6/99	110	127	-	95
Upper typical brown montane forest*	0,6	-	-	-	-	-	-	-	-	-	-	42
Thick carbonaceous brown mountain forest	1,0	34/40	84/48	160/59	7,6/122	12,5/94	25,2/70	24,9/76	77	73	59	69
Thick steppe brown mountain forest	1,0	51/60	94/53	174/65	2,4/39	5,6/42	24,2/68	24,2/74	56	56	65	59
Medium-thick steppe brown mountain forest	0,8	42/49	92/53	-	2,1/43	5,0/38	25,9/72	25,3/77	54	56	-	44
High steppe brown mountain forest	0,6											35
Thick typical mountain brown	1,0	85/100	175/100	269/100	6,2/100	13,3/100	35,8/100	32,8/100	100	100	100	100
A typical mountain brown of medium thickness	0,8	70/82	176/100	-	6,9/111	16,3/122	35,1/98	34,8/106	97	109	-	82
The top is typical mountain brown	0,6	59/69	-	-	4,7/75	-	32,4/91	-	78	-	-	47

5 Note: Estimated by G.A.Imanova.

Table 3[6]

Bonitation of lowland forest landscapes (sample) in the Langabiz range and surrounding areas

Landscape species	bonitet point	Area, acr	CVC
Partially transformed oak-beech forest in typical brown mountain forest soils on intensively fragmented mountain slopes with active landslides	42	1560,34	0,65
Partially transformed oak, beech forest on moderately thick typical brown montane-forest soils of moderately fragmented relatively inclined mountain slopes	65	1796,13	1,01
Partially transformed oak, hemlock forest poorly fragmented low mountain watersheds − thick typical brown forest soils of mountain slopes	70	411,6	1,09
Partially transformed oak, hornbeam forest on thick typical brown montane-forest soils in weakly fragmented lowlands	70	1793,55	1,09
In weakly fragmented smooth watersheds, well-developed thick Table 4 continuation of partially transformed oak, hemlock, hemlock, hawthorn, etc. in carbonate brown mountain-forest soils. forest	69	1352,78	1,07
Partially transformed oak-brown forest in thick carbonate brown montane forest soils of poorly fragmented watersheds	69	2243,18	1,07
Average credit score of the landscape:	64	9157,58	1,0

[6] Note: Estimated by G. A. Imanova.

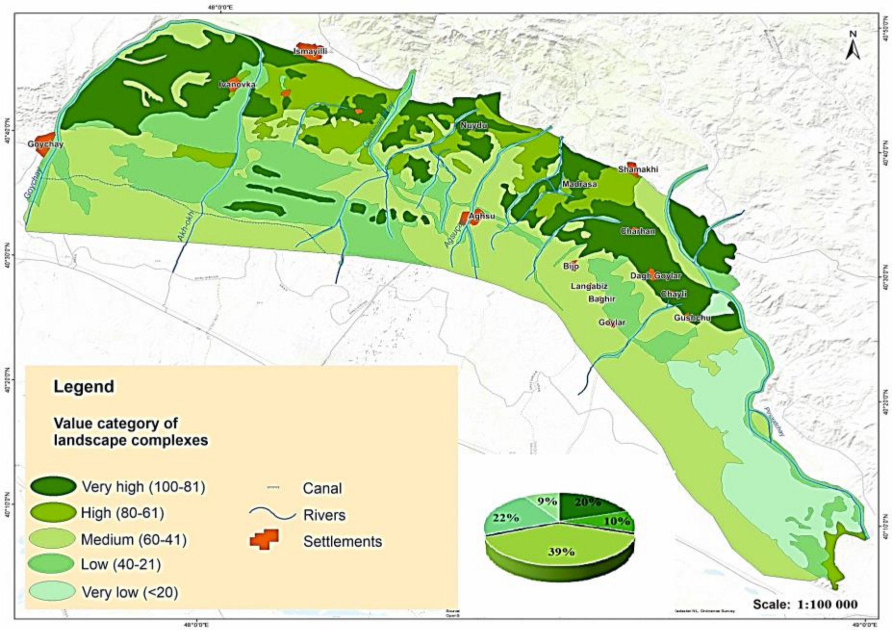

Figure 3. Bonitation map of the Langabiz range and surrounding areas

– SQP - 42-100, CVC - 0.49-1.25; arid sparse forests and thickets – SQP - 35-59, CVC - 0.71-1.20; desert (steppe) landscape – SQP - 26-81, CVC - 0.52-1.62; semi-deserts of the lowlands – SQP - <20-38, CVC <0.83-1.58, dry deserts of the accumulative plains – SQP - 38-55, CVC - 0.84-1.22, river-valley landscape – SQP - 31-51, CVC - 0.86-1.47.

As a result of the final calculations, the final average values and comparative value coefficients (CVC) of the existing landscape types in the Langabiz range and surrounding areas were determined as follows: forests of the lowland – 64 points (1.06); xerophytic dry steppes of mountainous plains – 85 points (1.42); arid sparse forests and bushes – 49 points (0.82); steppe (desert) landscape – 50 points (0.83); semi-deserts of the low highlands – 24 (0.40); dry steppes of accumulative plains – 45 (0.84); river-valley landscape 36 (0.68). The average value of the studied area as a whole was estimated at 53 points.

In the second stage (ecological assessment of landscape types), while conducting ecological assessment of landscape types in the Langabiz range and surrounding areas, research was conducted in the following order:

1) according to the methodology, special assessment scales of individual environmental indicators of landscapes in the area (altitude of the area, precipitation, $\sum t>10^0C$, slope) were compiled;

2) ecological assessment scales of landscape complexes were compiled, ecological assessment was carried out, and value points - were determined; According to the methodology of S.Z. Mammadova, the ecological value of specific landscapes was determined by the following formula (2):

$$Lb= (m1+m2+m3+....+mn)+ Bl:Sn \quad (2)$$

Here, Lb is the ecological value of the landscape type; m1, m2, m3,... mn - an indicator of the environmental factors involved in the assessment, expressed as a score; Bl – soil quality point of the landscape; Sn – the number of ecological value criteria involved in the evaluation.

Because of the final calculations, the environmental value indicators of landscape types in the Langabiz range and surrounding areas received the following values: forests of the lowland - 59-81 points (70 points); xerophytic dry steppes of mountainous plains – 64-90 points (81 points); arid sparse forests and bushes – 62-74 points (71 points); steppe (desert) landscape – 68-88 points (76 points); semi-desert landscape – 72-82 points (75 points), dry steppes of accumulative plains – 79; river-valley landscapes - 76. The average environmental value of the Langabiz range and surrounding areas were 77 points.

In the third stage (estimation of the ecological potential of the landscapes), the last stage of the evaluation of the landscapes and the ecological potential of the Langabiz range and the surrounding areas, anthropogenic factors – the percentage of areas occupied by crops, perennial crops, and grazing and mowing areas in the landscape complexes – were taken as value criteria and expressed through a correction factor. During the ecological evaluation of landscape types, the variability of value criteria was taken into account using correction coefficients. Note that the correction coefficients used can be divided into two groups according to their value-forming functions:

potentiator (correction coefficients of areas under man-made objects)

potential raiser (correction coefficients of crops, perennial crops, mowing and grazing areas)

Belonged to the first group (correction coefficient under man-made objects) was developed based on the methodology of Y. Guliyeva. (table 4). Using this method, we worked out correction coefficients of the areas under man-made objects for the Langabiz range and surrounding areas. Correction coefficient = indicator of the landscape subjected to man-made pressures (in %) / indicator of the landscape not exposed to man-made pressures (in %).

Table 4

Correction coefficients for man-made devices (according to Y. Guliyeva)

indicator in percentage in landscape	Coefficients
0,1 -0,5	1,00
0,5-1,0	0,95
1,0-1,6	0,90
1,6-2,2	0,80
2,2- 3,5	0,70
3,5-4,0	0,60

When calculating the correction coefficients (K), it was calculated by the following formula based on the ratio of the percentage expression of the pressured landscape area indicator (TL%) to the percentage expression of the pressured landscape area indicator (FL%).

$$K = \frac{TL}{FL} \qquad (3)$$

Using the same rule, correction coefficients were found for cropland, perennial plantings, and mowing and grazing areas. In contrast to the correction coefficients of the areas under man-made objects, the correction coefficients for planting, multiple plantings, and mowing and grazing areas strengthened the ecological potential (table 5).

Table 5[7]

Correction coefficients for the planting areas

indicator in percentage in the landscape	Coefficients
0,0-0,2	0,60
0,2-0,5	0,70
0,5-1,5	0,80
1,5-2,0	0,90
2,0-4,0	0,95
4,0-6,0	1,00
6,0-8,0	1,05
8,0-10,0	1,10
10,0-13,0	1,15
13,0-16,0	1,20
16,0-20,0	1,25
20,0-23,0	1,30
23,0-25,0	1,35
>25,0	1,40

After applying correction coefficients, the ecological potential of landscape types in the Langabiz range and surrounding areas received the following values: forests of the lowland – 40 points; xerophytic dry steppes of mountainous plains –70 points; arid sparse forests and thickets – 48 points; steppe (desert) landscape – 72 points; semi-desert – 34 points, dry steppes of accumulative plains - 37 points, river valley – 42 points. The average score of the ecological potential of the area was 50 points. According to the evaluation stages, the landscape types spread over the Langabiz range and surrounding areas received the following values (table 6).

[7] Note: Estimated by G.A.Imanova.

Table 6[8]

Evaluation results

Landscape types	Assessment of the landscape types			Area, hectares
	bonitation	environmental assessment	Ecopotential assessment	
Lowland forests	64	70	40	9157,58
Xerophytic dry steppes of the highlands	85	81	70	57807,61
Arid sparse forests and thickets	49	71	48	4918,86
Desert (steppe)	50	76	72	24216,55
Lowland semi-deserts	24	75	34	32309,02
Dry steppes of accumulative plains	45	79	37	66017,92
River valley	36	76	42	20774,52
Average value:	53	77	50	215202,06

According to the ecological potential, the landscapes of the Langabiz range and surrounding areas are grouped as follows (in 5 groups) (Figure 4): very high ecological potential (>100-81 points) – 96 points, area 21275.59 hectares (9.89%); high ecological potential (80-61 points) – 68 points, area 40601.38 hectares (18.87%); medium ecological potential (60-41 points) – 52 points, area 75607.13 hectares

[8] Note: Estimated by G. A. Imanova.

(35.13%); low ecological potential (40-21 points) – 30 points, area 75300.64 hectares (34.99%); very low ecological potential (<20 points) – 16 points, area 2417.32 hectares (1.12%).

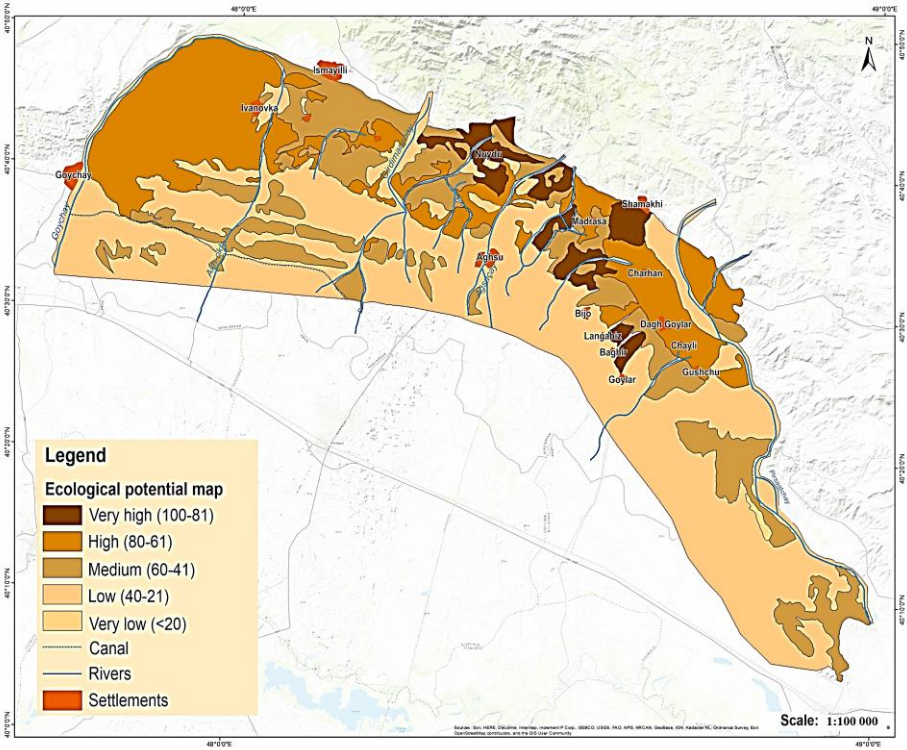

Figure 4. Ecopotential grouping of landscapes of Langabiz range and surrounding areas (G.Imanova)

Depending on the ecological potential indicators (grouping) of the landscape complexes of the Langabiz range and surrounding areas, the development of ways to optimize their use is of both scientific-theoretical and practical importance. Taking into account all this, ways (models) of optimization of use for value groups have been developed based on ecological potential indicators.

Measures are divided into two groups depending on their nature:

- system of environmental measures;

- a system of economic measures.

The names are conditional because, both groups of measures ultimately serve to strengthen the ecological potential of landscape complexes, to protect biodiversity within landscapes, to optimize the efficient use of land and plant resources by improving economic forms (in agriculture and animal husbandry).

Environmental measures:

- protection of steppe (desert) landscape complexes: separation of “non-grazed and non-cultivated” areas in order to protect endemic plants and steppe ecosystems, optimization of grazing rate depending on the slope of the area, feed unit, and nature of vegetation;

- reforestation: establishment of xerophytic and dry subtropical forest areas in areas transformed into steppe (desert) areas;

- planned development of settlements: improvement of ways of efficient use of land resources for planned development of settlements and regulation of the density of communication lines;

Economic measures:

- organization of efficient use of agricultural land: planning of agricultural land in contour-ameliorative order, taking into account the plasticity of the relief in inclined and less inclined areas;

- planting of field-protecting forest strips and bushes around sown areas;

- application of organic and mineral fertilizers in optimized rates under agricultural lands;

- organization of efficient use of mowing and weaving areas: implementation of fundamental and surface improvement works in mowing areas; waiting for grazing norms in grazing areas, limiting the number of animals to be grazed to 3-5 heads/hectares;

- organization of effective use of the existing forest fund: the area of forest areas used in the natural reserve regime should not be less than 45%; the area of forest areas used for recreation should not exceed 35%; with the application of limited felling, the area reserved for forestry should not exceed 20%;

- measures against water erosion: planting fields and soil-protecting forest and bush areas in the territory, grass cover with soil-protecting properties; fixing the bottom of gorge and ravines;

conducting ploughing works in the opposite direction to the direction of the slope in sown areas; the use of soil-protecting crop rotation system, paying due attention to the establishment of field-protecting forest strips; systematic grazing of animals on slopes and anti-erosion measures in pastures; removal of landslide areas from economic circulation;

- measures against linear erosion: strengthening the bottom of ravines and gorges; systematic grazing of animals on slopes and anti-erosion measures in pastures; removal of landslide areas from economic circulation.

CONCLUSIONS

1. The boundaries of soil and landscape complexes in the Langabiz range and surrounding areas have been defined and their areas have been measured. It was determined that the forests of the low mountains cover an area of 9157.58 hectares (4.26%), the xerophytic dry steppes of the mountainous plains cover an area of 57807.61 hectares (26.86%), arid sparse forests and bushes cover an area of 4918.86 hectares (2.28%), steppe (desert) covers an area of 24216.55 hectares (11.25 %), semi-deserts of low mountains cover an area of 32309.02 hectares (15.0 %), dry steppes of accumulative plains cover an area of 66017.92 hectares (30.68 %), river-valley landscape type covers an area of 20774.52 hectares (9.65%);

2. Soil quality scales of soils and landscape complexes in the Langabiz range and surrounding areas were compiled, their comparative value coefficients were determined, and a map of landscape types on a scale of 1:100000 was drawn up. The soil qaulity points of the landscapes were as follows; forests of low mountains, 95 points, xerophytic dry steppes of mountainous plains, 85 points, arid sparse forests and bushes, 49 points, desert-steppe, 50 points, semi-deserts of low mountains, 24 points, dry steppes of accumulative plains, 45 points, rivers and streams landscape, 36 points;

3. Because of the final calculations, the environmental value indicators of landscape types in the Langabiz range and surrounding areas received the following values: forests of the lowland - 59-81 points (70 points); xerophytic dry steppes of mountainous plains – 64-

90 points (81 points); arid sparse forests and bushes – 62-74 points (71 points); steppe (desert) landscape – 68-88 points (76 points); semi-desert landscape – 72-82 points (75 points); dry steppes of accumulative plains, 79 points; river-valley landscapes, 76 points. The average environmental value of the Langabiz range and surrounding areas were 77 points and correction coefficients were found for planting areas within the landscapes.

4. Field indicators of man-made objects – planting, perennial plantings, grazing, and mowing places – were taken as value criteria, and the ecological potential of landscape types was evaluated with points as follows: forests of the lowland – 40 points; xerophytic dry steppes of mountainous plains – 70 points; arid sparse forests and thickets – 48 points; steppe (desert) landscape – 72 points; semi-desert – 34 points; dry steppes of accumulative plains – 37 points; river-valley landscape types – 42 points.

5. According to the ecological potential, the landscape of the Langabiz range and surrounding areas was mapped on a scale of 1:100000 and grouped: very high ecological potential (>100-81 points) - 96 points, covers the area of 21275.59 hectares (9.89%); high ecological potential (80-61 points) - 68 points, covers the area of 40601.38 hectares (18.87%); medium ecological potential (60-41 points) - 52 points, covers the area of 75607.13 hectares (35.13%); low ecological potential (40-21 points) -30 points, covers the area of 75300.64 hectares (34.99%); very low ecological potential (<20 points) - 16 points, covers the area of 2417.32 hectares (1.12%). Ways to optimize landscape complexes depending on the level of their ecological potential have been proposed.

PROPOSALS

1. A system of ecological and economic measures was proposed in order to optimize the ecological potential of landscape complexes in the studied area; it is important to take necessary measures to protect the steppe (desert) landscape complex, reforestation, planned implementation of settlements, protection of the existing forest resources, and restoration of species composition.

2. It is necessary to organize the efficient use of sown areas, mowing and grazing areas, water erosion control, and the use of mud volcanoes in the area for ecotourism purposes.

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