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The role of morphometric indicators of relief in the assessment of ecogeomorphological conditions in the Fuzuli administrative region

Samira Abushova

PhD (Geomorphology), Senior Researcher at Department of Geomorphology and Paleogeography, Ministry of Science and Education RA, Institute of Geography named after Academician Hasan Aliyev, Baku, Azerbaijan,
e-mail: abushova.samira88@gmail.com,  <https://orcid.org/0000-0002-2567-8876>

ABSTRACT

In the assessment of ecogeomorphological conditions, morphometric indicators of relief (such as slope, elevation differences, horizontal and vertical fragmentation, exposure etc.) make it possible to determine the intensity of natural processes and the characteristics of ecological risk formation within the area. The article analyzes the morphometric indicators and ecogeomorphological assessment of the relief of the Fuzuli administrative region. The characteristics of the morphometric parameters of the relief include quantitative indicators of the degree of complexity of the formation of the relief of the earth's surface. Morphometric indicators which determine the complexity coefficient of the earth's surface relief play an important role in the implementation of engineering works, as well as territorial planning. Quantities of morphometric indicators were calculated based on the digital elevation model of the relief (Aster DEM) of Azerbaijan and interpolated in the Arcmap 10.8 software to determine the degree of tension of the territory. According to the ecogeomorphological tension, the study area was divided into 3 zones and the morphometric values of each zone were given. It was determined that 36.98% of the Fuzuli administrative region has favorable conditions for the construction of infrastructure.

The aim of this study. To determine the degree of ecogeomorphological tension of the area based on the morphometric indicators of the relief. This allows for identifying areas with high susceptibility to natural processes and assessing potential ecological risks.

Research Methodology. The research maps, created using the Mercator projection system, have been georeferenced and aligned with the WGS 1984 UTM Zone 38N coordinate system. Based on the digital model of the relief, the morphometric indicators of the relief (horizontal and vertical fragmentation, slope, exposure) were analyzed, quantified, and the degree of ecogeomorphological tension was determined using the interpolation method in the ArcMap program.

Results. The study area consists of 501.13 km² of low-voltage, 696.66 km² of medium-voltage, and 157.36 km² of high-voltage areas, which are mainly suitable for land use. Only 11.61 percent of the area has high voltage, which allows these areas to be used as pastures, as well as for tourism purposes. It is possible to carry out various tourism and recreational activities in these areas, including hiking, mountaineering, and other outdoor pursuits, taking advantage of the natural landscape and scenic relief features.

Keywords: horizontal fragmentation, vertical fragmentation, slope, exposition, ecogeomorphological tension, territorial planning, exodynamic and endodynamic processes, morphometric indicators.

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Introduction. Global changes on Earth, as well as processes occurring in the climate, and further increase in the impact of anthropogenic factors on the environment increase the disruption of ecological balance. These changes lead to the intensification of exodynamic processes (erosion, gravity, karst, etc.) and, as a consequence, to the growth of ecogeomorphological tension. Since the end of the 20th century, the widespread development of ecological thinking in the world, the rapid "greening" of sciences, the transformation of environmental problems raised by the scientific community into the most important problems of humanity have created a great need for the development of a new scientific direction in the system of Earth sciences - geomor-

phology, as well as in other areas of science - ecological geomorphology [10, 11, 12, 13].

Recently, in Azerbaijan and its individual regions, certain research work has been carried out in the field of ecological geomorphology, which has developed as the most modern and promising direction of general geomorphology, and the corresponding results have been obtained [2].

As we know, the main natural factors determining the degree of territorial tension include endodynamic and exodynamic processes. The intensity of exodynamic and endodynamic processes, tectonic activity, in addition to affecting ecogeomorphological conditions, have a significant impact on population distribution and economic activity [21]. In addi-

tion, the morphometric quantities of the relief formed under the influence of endodynamic and exodynamic processes are also among the main factors determining the ecogeomorphological tension of the territory [6].

Relief elements and morphometric parameters affect soil fertility, uneven distribution of precipitation, redistribution of moisture in the soil after precipitation, intensity of surface runoff, susceptibility to water erosion, as well as solar insolation. Morphometry is currently one of the main methods of geomorphology, as a mathematical analysis of the configuration of the earth's surface and the shapes and sizes of its relief forms. We can sometimes evaluate morphometric indicators as a result or a primary indicator of relative tectonic activity [18, 19]. Exogenous processes, in turn, change the relief over time, thus playing an important role in changing the quantitative indicators of the morphometric parameters of the relief. The study of quantitative indicators of the relief (the intensity of vertical and horizontal fragmentation, the inclination of the surface, the orientation of the slopes, the geometric dimensions of the relief forms, etc.) plays an important role in assessing the ecogeomorphological environment of the territory, and therefore in the territorial organization of the economy [9].

Morphometric indicators are mainly obtained on the basis of topographic maps and aerospace materials, as well as modern GIS technologies, and appropriate maps are compiled. Morphometric data is of great importance in the correct orientation of human settlement, construction of communication systems, production facilities, placement of agricultural areas, efficient use of natural resources, etc., as well as in the study of geomorphological regularities. The quantities of morphometric indicators depend on the processes that form the relief, the dynamics of relief forms, the lithological composition of rocks, tectonic conditions, etc. Analysis of morphometric indicators of the relief determines a number of its important characteristics and plays an important role in solving various practical problems, as well as in assessing environmental stress [1]. This, in turn, is of great importance in the construction of economic facilities, laying canals, laying roads, in short, in terms of land use.

Materials and methods. Today, science is faced with the task of creating technologies aimed at modern land use, infrastructure construction, and the formation of agricultural systems. In our modern era, obtaining scientifically-intensive, high-intensity data based on Geographic Information Systems (GIS) and precise technical means greatly facilitates both research work in various fields and our daily lives. In the stage before the emergence of GIS technology, people performed morphometric indica-

tors of relief and cartometric work in general manually with certain auxiliary tools. Naturally, these studies required a lot of time and effort and, in some cases, were characterized by low quality when the area was large. In the stage after the emergence of Geographic Information Systems technology, cartometric and morphometric work began to be performed with the help of computer programs. Maps drawn up with computers, especially those prepared with ArcMap software, are distinguished by their accuracy, attractiveness, quick preparation, the ability to display individual content elements in the form of layers, and help researchers in conducting more accurate analyses [6].

Morphometry is currently one of the main methods of geomorphology, as the mathematical analysis of the configuration of the earth's surface and the shapes and dimensions of its landforms [4]. The increasing development of Geographic Information Systems, with the significant application of mapping software tools, allows for various spatial and topographic analyses based on digital elevation models of the terrain, as well as the analysis of hazardous exodynamic processes [16]. The main sources of information for morphometric analysis are largescale topographic maps, materials of field surveys, as well as data obtained from remote sensing of the earth. The use of GIS technologies and digital relief models allows creating thematic maps of the most important morphometric relief indicators. The preparation and analysis of maps were carried out on the basis of base maps of the Arcmap 10.8 software and the digital elevation model (Aster DEM) of Fuzuli.

During the preparation of ecogeomorphological tension map, horizontal fragmentation, vertical fragmentation, slope inclination and exposure maps are superimposed in layers. The quantitative degree of each morphometric indicator is appropriately matched with each other and the corresponding stress zones are created.

The research maps developed in the Mercator projection system are coordinated with WGS_1984_UTM_Zone_38N.

The preparation of the maps was carried out in the following sequence (Figure 1).

Discussion and conclusions.

The area of the Fuzuli region, which is the study area, is 1386 km², and the population is approximately 144 thousand people. There are 2 cities (Horadiz and Fuzuli), 16 settlements, 82 villages and other settlements. Fuzuli region borders Jabrayil, Khojavand, Agjabadi, Beylagan regions and Iran along the Araz River (Figure 2).

Agriculture, which has been the basis of the region's economy throughout history, is characterized by its high development here. This is explained by

the presence of gray, chestnut, gray-brown soils suitable for agriculture in terms of productivity. The geomorphological structure, physical-geographical conditions of the research area have been extensively studied in their research works by A.A. Mikayilov (1969), M. Suleymanov, B.A. Budagov (1981), E.K. Mikayilov (1969), M. Suleymanov, B.A. Budagov (1981), E.K. Alizadeh (1988), A.T. Hagverdiyev (1975), M.A. Museyibov (1981) and other Azerbaijani scientists. The Fuzuli administrative region is located in the southwest of the Lesser Caucasus

fold-orogenic zone, on the Araz-bearing plains. According to the orohypsometric map of Karabakh, the main part of the Fuzuli administrative region consists of low mountainous and foothill parts. For this reason, the morphometric indicators of the terrain are mainly characterized by low values. According to the ecogeomorphological tension zoning of Karabakh, Fuzuli region covers part of the low-grade Front Caucasus sloping plains and the southwestern slope of the medium-grade Lesser Caucasus [5, 7].

Gravity relief forms are relatively poorly deve-

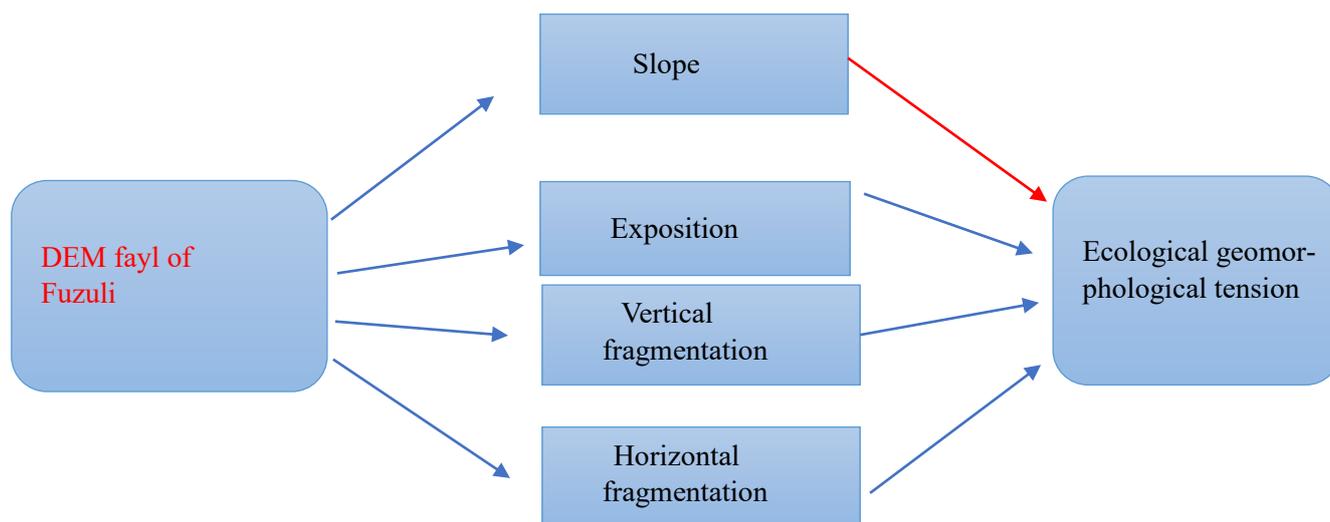


Fig. 1. Model used in the preparation of ecogeomorphological tension map

loped here. In its orographic structure, the Arazyan plains predominate, and the Ayidag, Khazar, Mangalenata, Agdash, and Jangulu mountains are located. These plains are mainly of denudation-accumulative origin, consisting mainly of proluvial and deluvial sediments. The Karabakh plain, one of the main orographic units, is covered with alluvial-proluvial sediments of rivers flowing from the eastern and northeastern slopes of the Small Gagaz. The plain, which has an undulating surface, is divided by a network of valleys and gorges, has an even more complex relief with numerous buried uplifts, and the conic formations of rivers flowing through the area. According to V.R. Volobuyev, the Karabakh plain was formed as a result of the transgression of the Caspian Sea in the IV period [15].

During the displacement of the river network, morphosculptures were formed on morphostructures formed as a result of endodynamic processes, further complicating the relief.

The rivers flowing through the Fuzuli region (Guruchay, Kondalanchay, Gozluchay, Charaken) are rivers of the Araz basin. Here, the Ashaghi Kondalanchay reservoir was built on the Kondalanchay and canals were laid, which is used to irrigate 24 thousand hectares of agricultural land.

As we know, the analysis of relief forms and geomorphological processes is of great importance

for the development of exodynamic processes such as landslides and avalanches, for territorial planning or human activity.

During the ecogeomorphological assessment of the study area, four main morphometric indicators - horizontal and vertical fragmentation, slope inclination and exposure - were analyzed (Figure 3). These morphometric parameters of the relief, in addition to determining the level of ecogeomorphological tension of the relief, have a fundamental impact on territorial planning, the organization of the tourism industry, the placement of infrastructure, settlement, etc. For example, when carrying out excavation work on a construction site, irrigating agricultural fields, and selecting the shortest trajectory with the least excavation costs, the inclination of the relief must be taken into account.

The main sources of information for morphometric analysis are large-scale topographic maps, materials from field surveys, as well as data obtained from remote sensing of the earth. In the article, the Digital Relief Model was taken as the main source of information during morphometric analysis.

Horizontal fragmentation. As is known, the horizontal fragmentation of the relief is determined by the length of the erosion-ravine, ravine and ravine network [3]. In most cases, an increase in the amount of horizontal fragmentation indicators is ob-

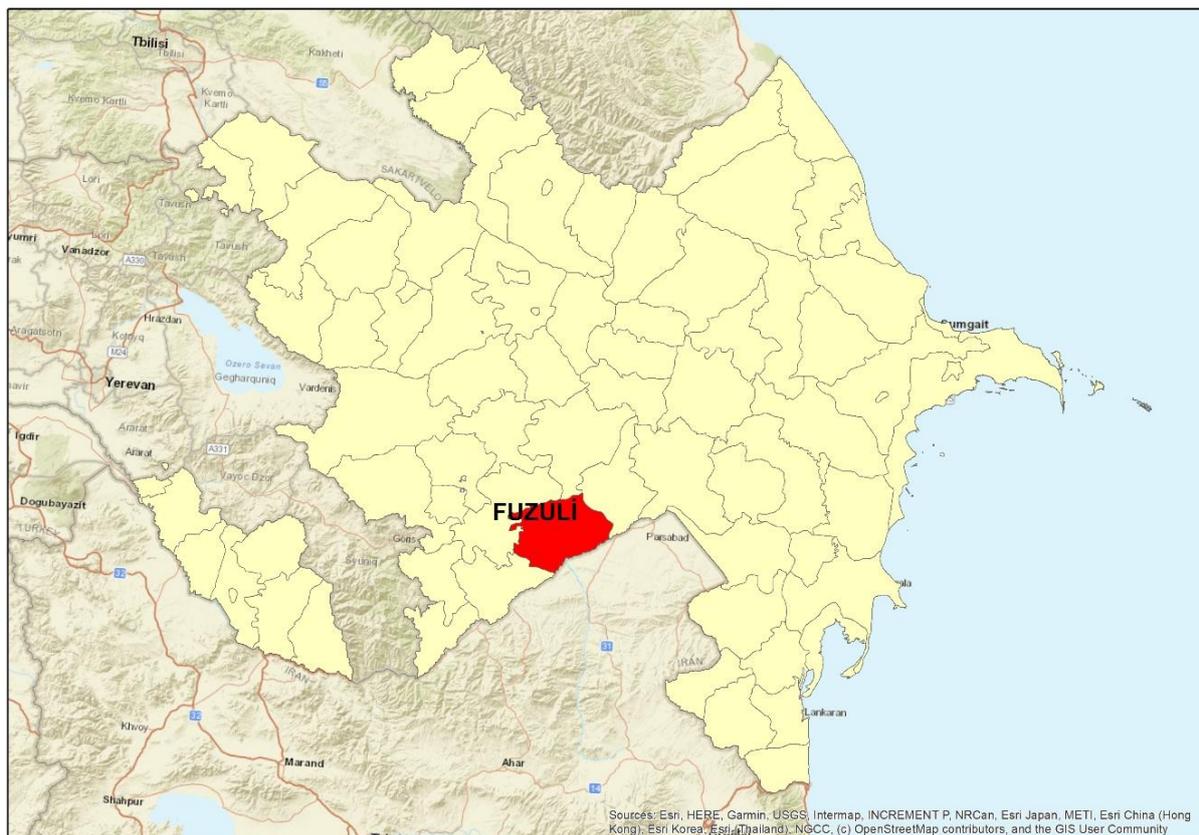


Fig. 2. Geographical location of Fuzuli district

served from the plain to the center of the mountainous area. For a long time, many scientists have resorted to traditional methods when analyzing the characteristics of watersheds, which can include measurements made on topographic maps with some tools (for example, curvimeters).

Thus, the horizontal fragmentation map was mainly compiled on the basis of a topographic map at a scale of 1:100,000. For this, the lengths of the valley network falling on a single area were measured on the map and divided by the area of that area [17]:

$$K = \frac{L \text{ (km)}}{S \text{ (km}^2\text{)}}$$

Here L is the length of the river-valley-ravine-gobu complex, S is the area of the square, K is the amount of fragmentation.

After determining the value of fragmentation, isolines were drawn at a certain interval covering the same quantitative indicators and maps were compiled. However, nowadays, remote sensing and GIS tools are widely used for watershed analysis. The horizontal fragmentation of the area was prepared based on Aster DEM in the Arcgis 10.8 program. First, the river and ravine-ravine network of the area, as well as irrigation canals, was extracted, then a 1 km² grid of the area was created and the hydrographic network per square was calculated (Figure 3):

SRTM DEM → Processing over DEM → Fill → Flow direction → Flow accumulation → Stream definition → Stream to features → Defining sub-watershed → Stream order → Stream number → Stream length → → Drainage density

Analysis of the compiled map shows that the high value of fragmentation coincides with the areas of the positive morphostructures of the territory corresponding to the mid-mountain belt. Here, the density of the valley-ravine network increases, and the energy of erosion processes reaches a high level.

The values of horizontal fragmentation mainly vary between 0.1 and 2.05 km/km². In general, the horizontal fragmentation indicator in the territory is observed in high values due to the density of the river network and the canals built for irrigation of agricultural lands. Thus, approximately 46% of the territory has a fragmentation value of 0.8-1.2 km/km² (Table 1). The highest indicator is 1.6-2.05 km/km², which covers 2.12% of the territory and is observed in the basins of the Kondalanchay, Guruchay and Araz rivers, as well as in areas where irrigation canals spread in agricultural lands (Graphic 1).

The main rivers affecting the quantitative indicators of horizontal fragmentation in the study area:

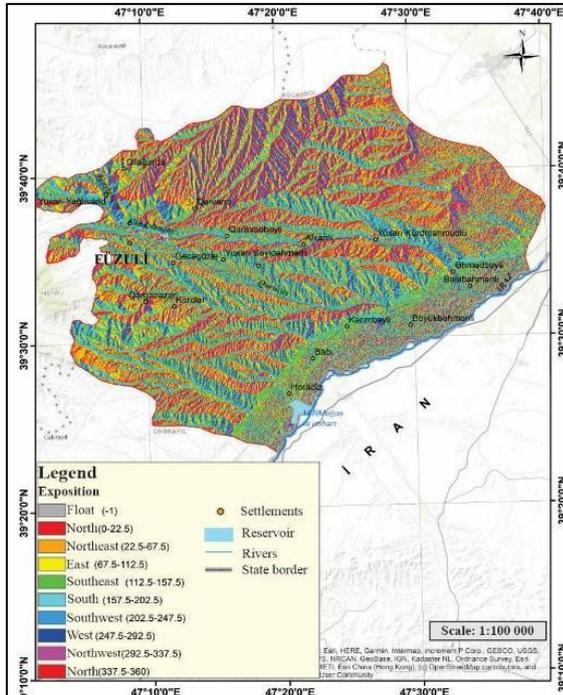
Araz – The rivers of the study area mainly flow into the Araz River. The Araz River, one of the main transit rivers of Azerbaijan and originating at an

altitude of 2,900 m from the Bingol peak in the Republic of Turkey is one of the basic river with affecting the quantitative horizontal fragmentation of the surrounding areas. It plays an important role in irrigation of agricultural fields and household use.

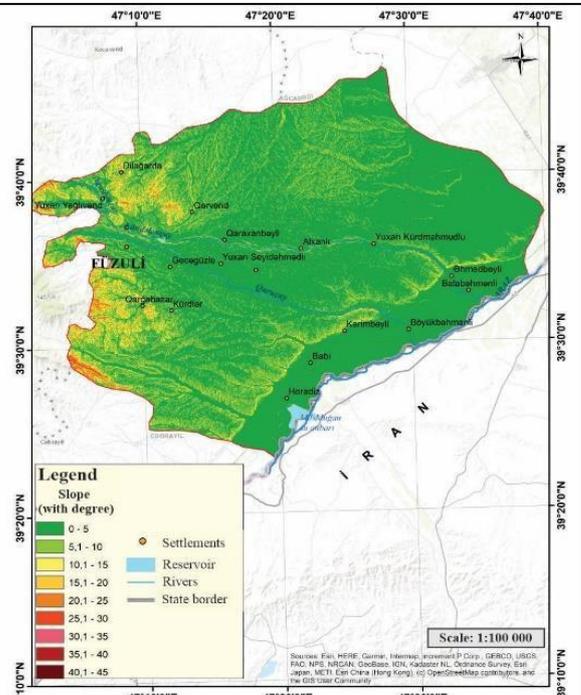
Kondalanchay – The main source of nutrition of this river, which takes its source from springs

emerging from the surface in the Chakhmag range of the Lesser Caucasus, is rainwater. Floods occur in the river during the spring-summer period when there is a lot of precipitation. Its basin covers an area of 536 km².

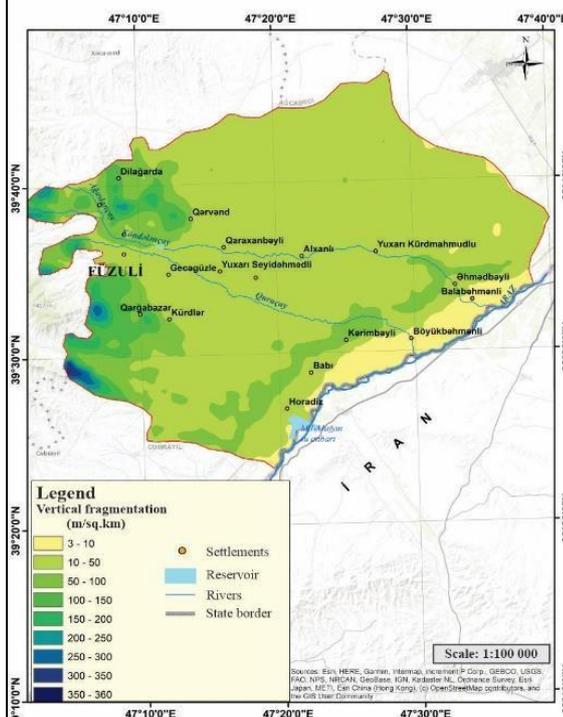
Guruchay – formed by the confluence of the Ishkhan and Ikah rivers, which take their source from



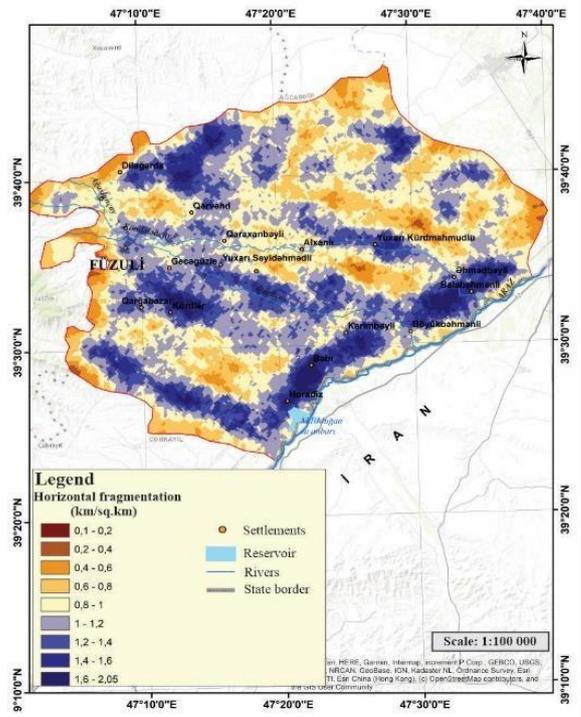
Exposition of the relief of the Fuzuli region



Slope of the relief of the Fuzuli region



Vertical fragmentation of the relief of the Fuzuli region

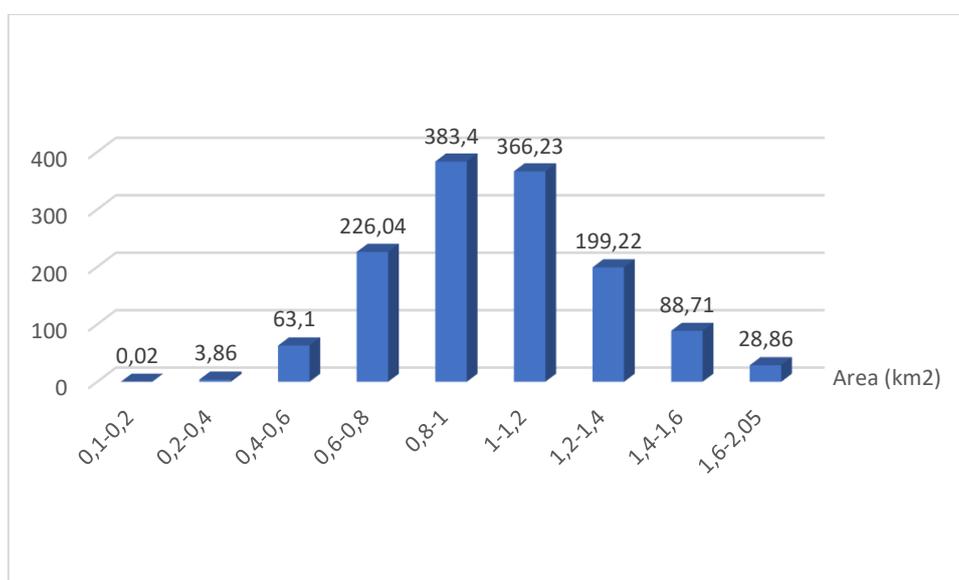


Horizontal fragmentation of the relief of the Fuzuli region

Fig. 3. Morphometric indicators (exposition of the relief, slope of the relief, vertical fragmentation of the relief, horizontal fragmentation of the relief) of the relief of the Fuzuli region (Source: The maps were prepared based on a digital model of the relief of the Fuzuli)

Morphometric indicators of the relief

Horizontal fragmentation (km/km ²)	Area (km ²)	Vertical fragmentation (m/km ²)	Area (km ²)	Slope (with degree)	Area (km ²)	Exposition	Area (km ²)
0.1-0.2	0.02	3-10	83.46	0-5	1047,08	Flat	52.44
0.2-0.4	3.86	10-50	971.85	5.1-10	235,01	North	165.05
0.4-0.6	63.1	50-100	197.61	10.1-15	51,82	North-east	203.63
0.6-0.8	226.04	100-150	68.01	15.1-20	17,21	East	219.37
0.8-1	383.4	150-200	24.76	20.1-25	6,61	South-east	186.66
1-1.2	366.23	200-250	9.19	25.1-30	2,60	South	163.82
1.2-1.4	199.22	250-300	3.14	30.1-35	0,85	South-west	133.67
1.4-1.6	88.71	300-350	1.45	35.1-40	0,14	West	118.67
1.6-2.05	28.86	350-360	0.02	40.1-45	0.1	North-west	118.06

Graph. 1. Quantitative indicators of horizontal fragmentation (km/km²)

the Karabakh range. The Guruchay River, which is 82 km long and has a basin area of 512 km², plays an important role in irrigating agricultural fields in the study area and therefore cannot deliver its water to the Araz River. It is mainly fed by groundwater and its flood period is observed in April-May. Together with its two main branches and small branches, it significantly affects the increase in the amount of horizontal fragmentation of the area [14].

Gozluchay – It takes its source from the south-eastern slope of the Lesser Caucasus at an altitude of 1520 m. This river, which does not have a constant flow, is partially used for irrigation during periods of heavy rainfall [14].

Analysis of the distribution of horizontal fragmentation over the territory shows that their quantitative changes are related to the lithomorphologic base of the territory, the lithological composition of sediments and rocks, endodynamic factors, as well as climatic conditions of the territory, characteristics of precipitation distribution, inclination and orientation

of slopes, changes in hypsometry over a large interval, etc. factors. Low fragmentation values correspond mainly to mountainous areas and areas with weak river network distribution, and are 0.1-0.6 km/km², covering 4.93% of the administrative region.

Vertical fragmentation. Among the morphometric characteristics of the relief, the indicators of vertical fragmentation (depth of fragmentation) are the most important, since they allow us to judge the general erosional fragmentation of the surface. Vertical fragmentation indicators are used in the study of erosion and other exodynamic processes, specific ecogeomorphological zoning, genetic reconstruction, and prediction of the state of the natural environment.

Vertical fragmentation is calculated according to the hypsometric differences of the area and the amount of fragmentation increases from plain to mountainous according to the relief of the administrative region. The amount of fragmentation is determined by the ratio of the difference between the

absolute height of the lowest point of a ravine, ravine, valley, etc. relief element falling on a unit area and the highest absolute value within that area.

As with horizontal fragmentation, there is a traditional method for calculating vertical fragmentation quantities. The fragmentation quantity is calculated according to the ratio of the difference between the absolute height of the lowest point of an erosional relief element such as a ravine, gully, valley, etc. falling on a single area on a topographic map and the highest absolute value within that area [17]:

$$\Delta H = H_{\max} - H_{\min}$$

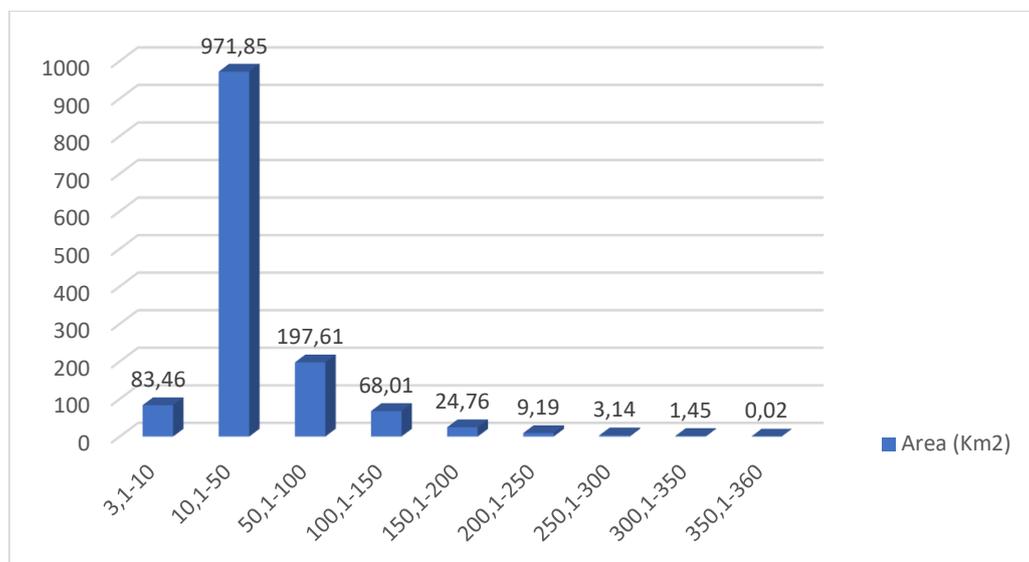
Here H_{\max} is the highest value within the square, H_{\min} is the lowest value, ΔH is a quantitative indicator characterizing the depth of vertical fragmentation.

The vertical fragmentation map was prepared in Arcgis 10.8 based on Aster DEM. First, the heights of the area were calculated and divided into a 1 km² grid, and as a next step, the difference be-

tween the maximum and minimum heights per square was calculated. Analysis of the prepared map shows that the quantities are distributed regularly according to the positive and negative morphostructural elements of the area.

As a result of the measurement work, the amount of vertical fragmentation in the area was conditionally divided into 9 categories. High values of fragmentation and the distribution of isolines allow us to distinguish morphometrically tense areas. Since the hypsometric values of the studied area are low, vertical fragmentation is observed here in low values. Thus, the highest value of vertical fragmentation is 350-360 m/km² in the lowlands of the Karabakh ridge falling within the administrative region, and the lowest values are observed in the Araz-bound plains (3-10 m/km²) (Graphic 2).

In general, the amount of vertical fragmentation in 71.47% of the area varies between 10-50 m/km², which has a positive impact on the ecogeomorphological tension of the area.



Graph. 2. Quantitative indicators of vertical fragmentation (m/km²)

The surface slopes. One of the most important indicators of the relief is the inclination angles or slope of the slopes. The intensity and speed of the movement of soil masses, exogenous processes, surface and groundwater largely depend on the magnitude of the slope angles of the earth's surface. Depending on a number of features of the areas where the inclination of the slopes is observed, the spread of various types of slope processes can be observed here. Thus, at small inclination angles, as a rule, a slow mass displacement of the cover of destructive material is observed, which indicates the stability of the slopes; with increasing steepness, moving blocks and active deluvial washing processes begin to appear; in conditions of steep slopes, the main processes are essentially gravitational in nature (landslides, rock falls).

Slope is a quantitative indicator of the ratio of the height difference between the lowest and highest points of a slope to the distance between these points. The inclination of slopes, like topography and hypsometry, also plays an important role in the distribution of the relief and its elements. Information on the inclination of slopes is widely used in slope processes, engineering-geological surveys, earthworks, etc. Slope is mainly formed as a result of endodynamic processes, as well as denudation processes. Slope, one of the main morphometric indicators of the relief, is related to its height, degree of fragmentation, and the morphological characteristics of the tectonic and magmatic structures that make up the morphostructures.

The slope degree, which is considered one of the main indicators for all sectors of the economy,

like other morphometric indicators of the relief, determines the intensity of slope processes, the energy of the relief, the amount of solar energy, and the infiltration of atmospheric sediments.

Inclination maps are traditionally prepared using various methods - the method of squares, the method of sliding circles, the method of morphographic surfaces. The inclination angles on the map are calculated using the following formula [17]:

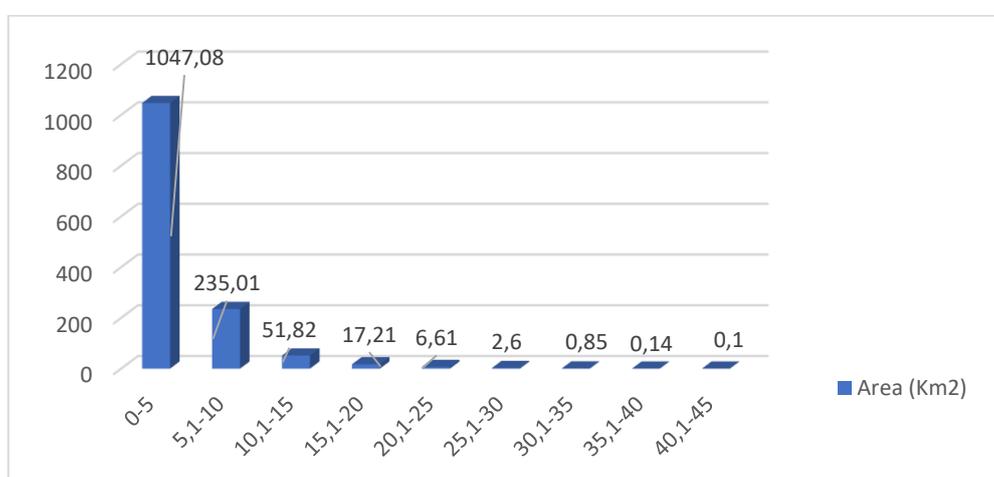
$$i(\text{tg}\alpha) = \frac{h}{L}$$

Where h is the cutting height (the maximum and minimum hypsometric difference of the slope), L is the distance between two horizontals. The larger the scale of the map to be prepared, the more accurate the value of the inclination angle will be. The prepara-

tion of inclination maps using the traditional method is very difficult, tedious and time-consuming.

The slope map of the area was prepared based on the Aster DEM model of the relief in the ArcMap 10.8 program.

Based on the conducted analyses, we can note that the values of the slope indicators of the territory mainly vary between 0° - 10° , which indicates that there are favorable conditions for the use of the territory and the organization of the economy here. Thus, in areas with a slope of up to 10° (94.1%), irrigated agriculture and partially livestock breeding have developed (Graphic 3). In areas with a slope of 30° - 45° (0.1%), intensive erosion, denudation, a dense network of ravines and gorges are characteristic, and they are suitable for livestock breeding, pasture-meadow, and terrace farming (2-3 m wide).



Graph. 3. Quantitative indicators of slope (with degree)

Generally, the indicated quantities are generalized indicators of the surface inclination in the altitude zones, in which high tension slopes are observed in mountainous areas with a high angle of inclination, and low tension slopes characterized by small indicators of the same quantity in the lowlands and plains. Undoubtedly, sometimes this regularity is violated.

Exposition. Exposition one of the main morphometric indicators, is of great importance in the formation of the plasticity of the relief and is considered one of the main factors affecting the bioclimatic characteristics of the area. Climatic indicators on the slopes, the uneven distribution of temperature, evaporation, solar radiation, precipitation and wind regimes, and changes in soil and plant cover depend on the exposure.

Thus, the uneven heating of slopes, depending on their exposition, affects the thermal regime of the soil cover, the species composition of plants, and indirectly, the increase or decrease in productivity.

Due to the diversity of solar radiation and moisture, the vegetation cover on northern and western-

facing slopes is dense and rich, while on southern and eastern slopes, on the contrary, it is sparse and characterized by a poor species composition.

The factor determining the exposition is related to the orientation of morphostructures that complicate the relief, their morphological and also fragmentation characteristics, where rivers and their flow direction play an important role. The density of the river network in the area significantly increases the fragmentation of slopes, and in connection with this, the orientation of the slopes also increases. A number of exodynamic processes also occur with varying intensity depending on the orientation of the slopes, mainly developing relatively strongly on the slopes facing south, so such slopes also have relatively high stress.

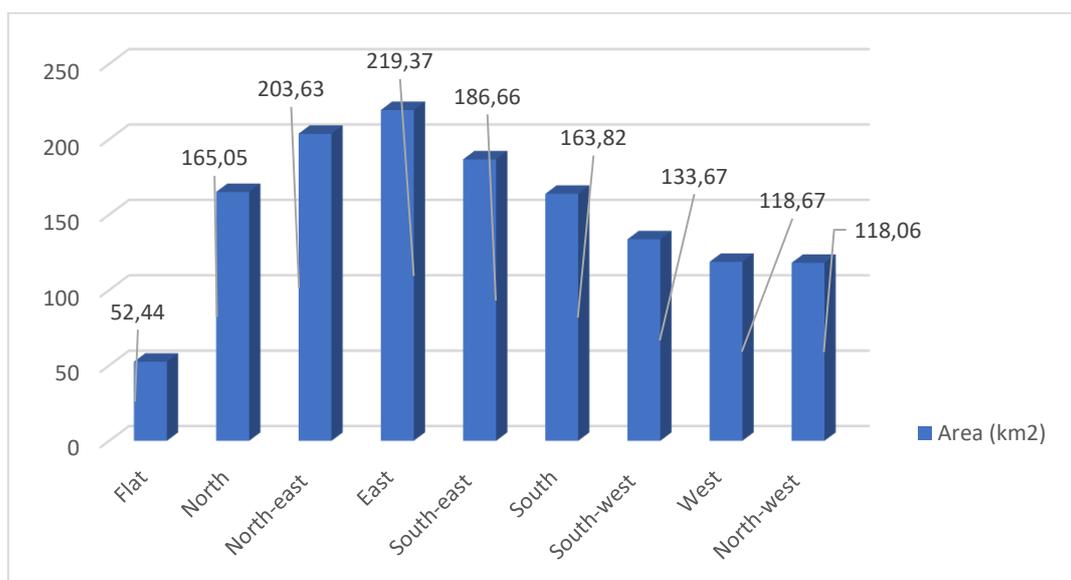
When measuring the slope using the classical method, the following steps are performed: the boundary of the slopes (watershed and valley-ravine network) is marked on a 1:100.000 scale topographic map; within each slope, perpendicular lines are drawn from the watershed to the river valley, their azimuth or rhumb are measured with a protractor,

and a map is drawn based on the results obtained [17]. A comprehensive study of slope is of great practical importance, as it affects all areas of the national economy. In the research work, slope was developed in the ArcMap 10.8 program. Analysis of the measurement work shows that the north-east and east-facing slopes dominate in the area and cover 31% of the area. On the contrary, the north-west-facing slopes cover a very small area, only 8.7%, that is, 118.06 km² of the area (Graphic 4).

The northern-facing slope of the area is characterized by a decrease in solar radiation and dense vegetation in the low-mid-mountainous areas, while

the northeastern and eastern slopes are characterized by a relative decrease in solar radiation and relatively dense vegetation. The southeastern and southern-facing slopes are characterized by intense solar radiation, erosion, and the resulting weak vegetation, and bare rocks. For the western and northwestern-facing slopes, a significant decrease in solar radiation, dense vegetation, and weak erosion are typical.

The south-southwest-southeast slopes of the area are more exposed to the influence of dry air currents than the other slopes, and in this regard, the ecogeomorphological tension is assessed with a higher score.



Graph. 4. Quantitative indicators of exposition

Thus, the analysis of morphometric indicators plays a key role in the ecogeomorphological assessment and zoning of the relief, being of great importance in assessing the geodynamic stress of the area and identifying the factors that cause it.

The morphometric indicators (slope inclination and exposure, degree of horizontal and vertical fragmentation), which play a key role in the formation of the ecogeomorphological characteristics of the relief of the Fuzuli administrative region, have a significantly different nature. Each of them individually affects the ecogeomorphological tension in different ways. Thus, the amount of horizontal and vertical fragmentation affects the stability and dynamics of the relief, the exposure of the slopes affects the distribution of solar radiation, humidity, and consequently the density and productivity of the vegetation cover, the intensity of the slope processes, the diversity of the physical and chemical properties of the soil cover, and thus the ecogeomorphological conditions, etc.

Conclusion. Thus, based on morphometric data, along with the study of the regularities of the development of the relief, the features of the manifestation of endogenous and exogenous morphogenesis pro-

cesses, ecogeomorphological tension areas were determined. The use of these data in the study of endo- and exodynamic stress of the relief, and thus in the determination of territorial planning, was shown.

During the preparation of the ecogeomorphological tension, as indicated in the methodology, the maps of horizontal fragmentation, vertical fragmentation, slope inclination and exposure were superimposed and high values were matched with low values, appropriate zones were separated, and the area of each zone was calculated.

A map was compiled to assess the relief based on morphometric indicators and the area was divided into 3 tension zones: low tension, medium tension and high tension. In the compiled map, low tension areas correspond to low tension areas and high tension areas correspond to high tension areas, and are evaluated with appropriate scores. On the map, low tension areas are shown in green, medium tension and high tension areas are shown in yellow and orange tones (Figure 4).

Assessment of ecogeomorphological conditions is extremely important for determining areas suitable for human settlement, the use of the land surface

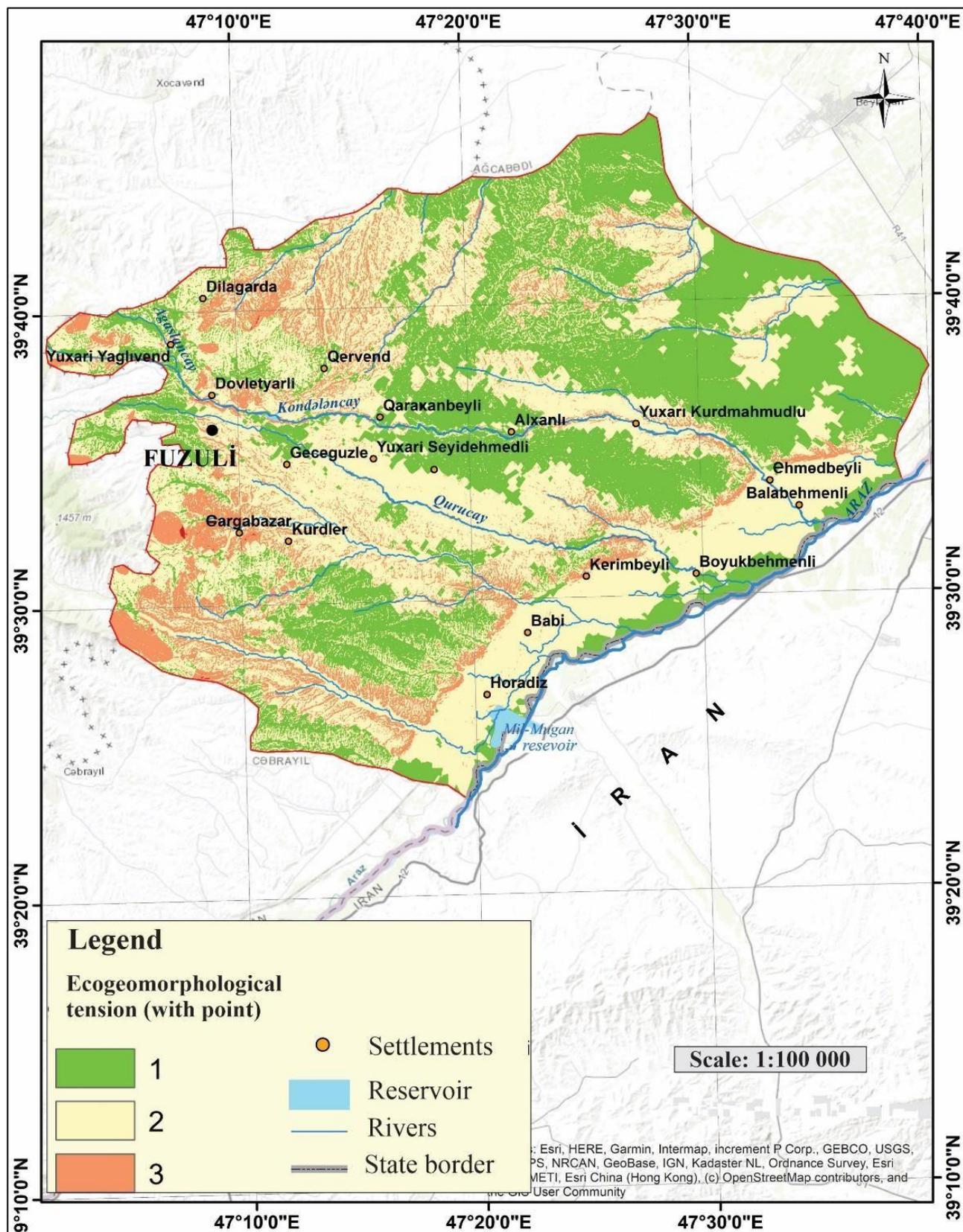


Fig. 4. Map of assessment of ecogeomorphological tension based on morphometric indicators of the relief of the Fuzuli administrative region

Assessment of ecogeomorphological tension of the Fuzuli administrative region based on morphometric indicators of its relief

Morphometric indicators of the relief				Ecogeomorphological tension zone (point)	Area	
Vertical fragmentatio	Horizontal fragmentation	Surface slope	Exposition		Km ²	%
3-10 m/km ²	0.1-0.2 km/km ²	0 ⁰ -5 ⁰	Flat	Weak (1)	501,13	36,98
10-50 m/km ²	0.2-0.4 km/km ²	5.1 ⁰ -10 ⁰	North			
50-100 m/km ²	0.4-0.6 km/km ²	10.1 ⁰ -15 ⁰	North-east			
100-150 m/km ²	0.6-0.8 km/km ²	15.1 ⁰ -20 ⁰	East			
150-200 m/km ²	0.8-1 km/km ²	20.1 ⁰ -25 ⁰	South-east	Mild (2)	696,66	51,41
200-250 m/km ²	1-1.2 km/km ²	25.1 ⁰ -30 ⁰	South			
250-300 m/km ²	1.2-1.4 km/km ²	30.1 ⁰ -35 ⁰	South-west	High (3)	157,36	11,61
300-350 m/km ²	1.4-1.6 km/km ²	35.1 ⁰ -40 ⁰	West			
350-360 m/km ²	1.6-2.05 km/km ²	40.1 ⁰ -45 ⁰	North-west			

relief for recreation and tourism, and the location of industrial enterprises.

Summarizing the conducted analyses, we can note that a high correlation was found between the horizontal and vertical distribution of the relief, as well as the inclination and exposure of the slopes, and the height of the relief obtained as a result of their interpolation, and the ecogeomorphological tension.

The measurements show that low-tension areas cover an area of 501.13 km², medium-tension areas cover an area of 696.66 km², and high-tension areas

cover an area of 157.36 km² (Table 2). Based on these indicators, it can be noted that the administrative region is ecogeomorphologically favorable and its vast territory is suitable for land use. Only 11.61% of the area has high tension, which makes it possible to use these areas as pastures.

Generally, the results of the assessment of ecogeomorphological tension based on the morphometric analysis of the relief and the compiled map data can be used in various fields of industry and agriculture, in the construction of economic facilities, communication systems, etc.

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Роль морфометричних показників рельєфу в оцінці екогеоморфологічних умов Фізулінського адміністративного району

Саміра Абушова

д. філософії (геоморфологія), ст. наук. співробітник
кафедри геоморфології та палеогеографії,
Міністерство науки і освіти РА, Інститут географії
ім. академіка Гасана Алієва, Баку, Азербайджан

При оцінці екогеоморфологічних умов морфометричні показники рельєфу (такі як нахил, перепади висот, горизонтальна та вертикальна фрагментація, експозиція тощо) дозволяють визначити інтенсивність природних процесів та особливості формування екологічного ризику в межах території. У статті аналізуються морфометричні показники та екогеоморфологічна оцінка рельєфу Фізулінського адміністративного району. Характеристика морфометричних параметрів рельєфу включає кількісні показники ступеня складності формування рельєфу земної поверхні. Морфометричні показники, що визначають коефіцієнт складності рельєфу земної поверхні, відіграють важливу роль у виконанні інженерних робіт, а також у територіальному плануванні. Величини морфометричних показників були розраховані на основі цифрової моделі рельєфу (Aster DEM) Азербайджану та інтерпольовані в програмному забезпеченні ArcStar 10.8 для визначення ступеня напруженості території. Відповідно до екогеоморфологічної напруженості, досліджувана територія була розділена на 3 зони та наведено морфометричні значення кожної зони. Було визначено, що 36,98% території Фізулінського адміністративного району має сприятливі умови для будівництва інфраструктури. Визначення ступеня екогеоморфологічної напруженості території на основі морфометричних показників рельєфу дозволяє виявити території з високою схильністю до природних процесів та оцінити потенційні екологічні ризики. Дослідницькі карти, створені за допомогою проекційної системи Меркатора, були геоприв'язані та вирівняні з системою координат WGS 1984 UTM Zone 38N. На основі цифрової моделі рельєфу було проаналізовано, кількісно визначено морфометричні показники рельєфу (горизонтальна та вертикальна фрагментація, нахил, експозиція) та визначено ступінь екогеоморфологічної напруженості за допомогою методу інтерполяції в програмі ArcMap. Досліджувана територія складається з 501,13 км² низьковольтної, 696,66 км² середньовольтної та 157,36 км² високовольтної територій, які переважно придатні для землекористування. Лише 11,61 відсотка площі має високу напругу, що дозволяє використовувати ці території як пасовища, а також для туристичних цілей. На цих територіях можна здійснювати різноманітну туристичну та рекреаційну діяльність, включаючи піші прогулянки, альпінізм та інші види активного відпочинку на природі, використовуючи переваги природного ландшафту та мальовничих особливостей рельєфу.

Ключові слова: горизонтальна фрагментація, вертикальна фрагментація, нахил, експозиція, екогеоморфологічна напруженість, територіальне планування, екзодинамічні та ендодинамічні процеси, морфометричні показники.

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