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## ECOLOGICAL ASPECTS OF STUDYING OF NATURAL-RECREATION POTENTIAL OF MOUNTAIN GEOSYSTEMS (on example of southern slope of the greater caucasus)

*In this article the relief, climatic parameters and landscape differentiation of the territory has been explained for precise evaluation of the recreation potential within Demirapanchay basin and adjacent areas. On the basis of derived data the schematic maps of the shown area that reveal some climatic parameters have been plotted for the first time in GIS environment and a big-scale (M 1 : 100 000) map of recreation potential according to the landscape belt of the study area has been plotted in GIS environment.*

*During evaluation of the recreational potential of the landscapes special attention was given to geological, geomorphologic characteristics of the area, to comfort degree of the climate (temperature, relative humidity, number of sunny days, solar radiation, etc), to forest cover of the area (forest density, composition of trees, level of humidity, fruit maintenance, etc) and to aesthetics view of landscapes (attractiveness, waterfalls, canyons and etc.) Besides, the elements (floods, landslides, soil erosion, snow falls, soil erosion, the number of cloudy day in recreation days etc.) that make risk and hazard for tourism activities and decrease the level of comfort in landscape have been studied.*

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*The analysis of the mountain geosystems in a world and tourism complexes with advanced geographical location and huge recreation potential are in focus of interest in last years as a scientific-practical priority problem. At the time of estimation of the recreation potential the relief of the territory diversity of the plants, existence of the water basins, especially rivers, variety of the natural landscape, antropogenic change of the region and possibilities of the road infrastructure setting are taken into account). In this article, we presented some climate indicators for an accurate assessment of the recreational potential for Demirapanchay basin and surrounding areas, based on the information gathered in GIS.*

**Keywords:** relief, climatic parameters, tourism, river, environmental risks.

**Introduction.** The rapid development in terms of recreation of mountainous in recent years areas increased interest in the study of mountains that characterized by high dynamism and sensitivity to anthropogenic factors.

The complexity of geological structure, sharp crush of the relief, horizontal and vertical differentiation of the slope incline, exposition, absolute altitude and periodic change of mezo-micro climate conditions within mountainous areas has formed geosystems with complex structure – functional characteristics. Wrong anthropogenesis interference influences to this type of mountain structures causes sharp ecological disbalance within landscapes that results in rapid activation hazardous natural processes such as floods, landslides, collapse, erosion etc.

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antropogenic change of the region and possibilities of the road infrastructure setting are taken into account [1, p.69].

**Study Area.** The intense development in terms of the recreation of mountain geosystems in last 10 yaers is observed also in Azerbaijan part of the Grater Caucasus. So that, a big Shahdag winter-summer tourism complex in a territory of Shahdag national park and building up of another big winter-summer tourism complex within Demirapanchay basin of the Gabala region are bright evidences for aforesaid development.

Demirapanchay basin was chosen as an example area for research purposes. Floody Demirapanchay basins' area is 596 km<sup>2</sup>, length 69 km and starts from the 3850 m height on the southern slope of the Greater Caucasus range. The water flow rate of the river 40–60 % supported by ground waters. Annual average water debit is 3–10 m<sup>3</sup>/sec. Flow of the river comes 26 % in spring, 23 % in autumn, 35 % in summer and 16 % in winter.

The main part of the Shahdag tourism complex is located within elevation of 1440–1640 m, whereas Gabala winter-summer tourism complex is setting up at the region with height of 1828 m above the sea in summer cottages area, with awesome view and rich landscape cover areas [17, p. 88].

The study area is situated on the 41°9' north latitude and 47°44' east longitude. The territory area makes up 2097, 82 hectares (Fig. 1).

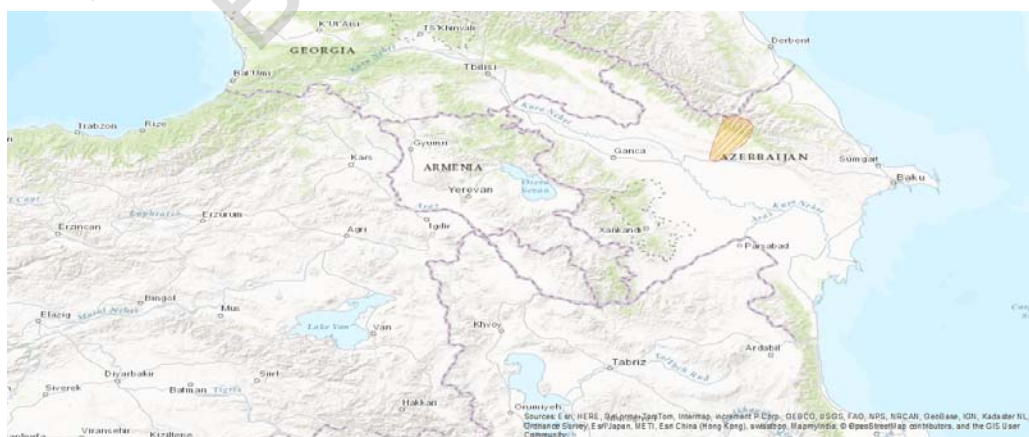


Figure 1. Location of the study area

**Methodological approaches.** The study in GIS environment of the modern landscapes of the area between Filfilichay-Girdimanchay area of high flood hazardous Demiraparanchay's basin will make more efficient use of the areas that are rich in recreational potential and will allow develop tourism complexes on the basis of the landscape planning.

GISs allow for more ecology-based identification of flora and fauna in order to determine the nature of protection required based on application availability. In this study, GISs were used to characterize the habitats and create spatial data that form the basis of planning and managing the use and protection of land. Nature conservation and landscape ecology are carried out via practical applications in different areas, which require interdisciplinary study. Using GIS provides support for these applications and helps researchers solve their problems and achieve their goals [9, p. 195].

Landscape scenery quality is of fundamental importance for nature-based recreation. Landscape recreation potential is determined by biophysical attributes including, among others, climatic conditions, landforms, hydrography and vegetation [3, p. 560]. Landuse is also important for determining the scenic quality of the landscape.

In this article, we presented some climate indicators for an accurate assessment of the recreational potential for Demiraparanchay basin and surrounding areas, based on the information gathered in GIS. In addition, for the first time, the modern landscape map of research area has been gridded in a large-scale (M 1 : 100 000) [4, p. 499].

**Results.** Our field studies and climate data analysis in Demiraparanchay basin and surrounding areas show that this area is very suitable for winter and summer recreation-tourism development. A big complex that is under construction in Demiraparanchay river basin is the proof of existence for winter and summer tourism opportunities. The "Tufan" winter and summer tourism complex is situated on the awesome landscape zone and setting up in rich landscape areas at an altitude of 1828 m.

As a result of our analysis, it is evident that there exist snow covers in this area from November to the end of February. The climate is fully compatible for ski tourism. However there are also big opportunities for summer tourism. So that, land cover, colorful landscape, cool summer climate, rich plant species, development of national handicraft, inherited around the territory, existence of the historical monuments of different cultures (Gabala tower, Sheykh Badraddin sepulcher, Sheykh Mahammad sepulcher, Alban church) give the opportunities for development of ecological tourism, rural tourism, adventure tourism, etc.

The data that have been registered as elements of tourism-recreation potential were analyzed in Geographic information system and evaluated by five point scale system. Here, 1<sup>st</sup> point scale was accepted as very favorable, 2<sup>nd</sup> as favorable, 3<sup>rd</sup> as middle favorable, 4<sup>th</sup> as less favorable, 5<sup>th</sup> as very small favorable. During evaluation of recreational potential of landscapes, the special attention has been given to development opportunities of tourism potential in this area.

For example, 1<sup>st</sup> point scale zone of foothills and low mountains with forest and scrub forestst, meadow and forest landscape is very profitable for different types of tourism and recreation opportunities [18, p. 304].

Demiraparanchay river is the most dangerous flood risk river in the Southern slope of the Greater Caucasus after Shinchay and Kischay rivers.

The intensity of exo-dynamic processes within rivers' basin, regular floods and landslides here has strongly influenced formation of the surrounding areas and landscapes, strongly affected landscape inner differentiation and increased landscape-ecological tension here. Geological structure, lithology composition of the rocks strongly affected formation of modern landscapes of the Demiraparanchay basin. The prevalence of gravitational – tectonic ruptures in this area has intensively influenced formation of landslides, sets of valley-ravines and rock falls in this area. The slopes between peaks of Bazaryurd, Rustambaz, Peygambarbulag, Tufan and Gotur have strongly been influenced to exertion and denudation process. Under influence of mentioned and other factors the alpine and subalpine peaks were smoothed. The main origins of the floods are located in a high and partly meadow mountain zone. The rocks collected here come from different origination, and dominantly belong to avalanches and moraine sediments.

The landslides and flood foci are widespread in the bared timberland of the eastern slopes of Rustambaz-salavat ridge. Main flood foci are concentrated within basin of the left inflows of Demiraparanchay river beginning in water separated part of the Main Caucasian range, around peak of Tufan. On extent of the flood development of Demiraparanchay river inflows can be divided into two groups – very dangerous and not dangerous. During selection of tourist routes and recreational areas, the danger of floods should be taken into account.

The vertical decomposition increases of relief from 600–700 m grows up to 1300–1500 m to the north in the area. The slopes around watershed areas are complicated by rocks and cracks. Increase of relief decomposition is making subnival and mountain meadow landscapes more attractive for tourists.

The areas relief characteristics and hypsometric height, led in contrast change the climate coefficient in short distances. Those climatic conditions are allow the development of various types of recreation and tourism in this area.

The average temperature of the warmest month of July in area of 800 m altitude 23° C, at 1600 m is 16° C, at 2000 m is 14° C, at 2400 m is 12° C, at 2800 m is less than 10° C. The average temperature of the coldest month in January is 0, -1° C at altitude of 800 m, at 1200 m is -2, -1° C, at 1600 m is -3, -4° C, at 2000 m is -5, -6° C, at 2400 m is -7, -8° C, at 2800 is -10, -11° C. The air temperature analysis show that establishment of the recreation systems are more favorable in 1200–1300 meters height.

Atmospheric precipitation has distributed irregularly depending on the height and slope of research area. The amount of precipitation is 600-800 mm in low mountains and foothills of the eastern part, and increase to more than 900–1000 mm on westward. According to the humidity index, the forest's lowest border begins at 600 m, upper border goes through 2000–2200 m.

Amount of annual atmospheric precipitation in Demiraparanchay basin located at the altitude of 1200–2400 m is 100–1200 mm or more. Seasonal distribution of annual atmospheric precipitation is one of the main factors that influence on recreational tourist activity (Table 1, 2). Main part of the atmospheric precipitation is falling at the end of autumn, winter and the beginning of spring. In autumn and winter months falling precipitation come on form of rain, in areas higher than 1500 m there observed snow.

Depending on hypsometry and slopes of exposition covered by snow, number of these days is 78–210, an average cover thickness of snow for 10 days is 50–100 cm.

Table 1. Estimation of climate indicators of landscape zones in Filfilichay-Girdimanchay area

Land-landscape zone	The solar radiation, Kkal/cm <sup>2</sup>	Number of sunny days	Number of days of precipitation, mm	The average daily temperature total higher of 0°C over the number of days	The average temperature in July, °C	The average temperature in January, °C	Which is lower than the 0°C length of the period, days	Absolute max. temperature higher 35°C – the number of days	The degree of accessibility for tourism, with point scale
Foothill's forest and forest-shrubs	120-125	330-350	400-600	300-330	24-26	1; 2	40 -55	5-10	V
Low upland's forests	125-130	340-350	600-1000	250-300	22-24	0; 1	60-75	5 and less than	V
Average upland's forests	130-135	280-320	1000-1200	200-250	20-22	0; -2,5	80-120	-	IV
Subalpine meadows	135-140	240-280	1200-1400	200-150	15-20	-2,5; -5	130-145	-	III
Alpine meadows	140-145	200-240	1000-1200	130-100	10-15	-5; -10	150-170	-	II
Subnival	145-150	150-200	600-800	80-50	5-10	-10; -12	180-200	-	I
Nival-rocky	150 and more than	100 and less than	600 and less than	50 and less than	5 and less than	-12	200 and more than	-	I

Table 2. Assessment of snow cover on landscape zones in Filfilichay-Girdimanchay area

Landscape zone	The maximum thickness of snow cover during of the year for the ten-days, with cm	Beginning the snow cover (date)	The days of total with snow cover, days	Melting of snow cover dates
Foothill's forest and forest-shrubs	10-20	21 december	20-40	13. III
Low upland's forests	30-45	11 december	50-80	22. III
Average upland's forests	60-80	30 november	100-130	1. IV
Subalpine meadows	80-90	20 november	140-160	20. IV
Alpine meadows	90-100	31 october	160-180	15. V
Subnival	100-130	9 october	190-200	25. V
Nival-rocky	160 and more than	27 september	220 and more than	13. VI and late

In research area, on the heights of 1200–2800 m in mountains, different types of forest and meadow landscapes are expanded. Meadow mountain landscapes are spread in heights of 3000-3200 m above the forest zones (Fig. 2). The main part of the meadow landscapes are situated in Rustov plateau. The spread areas of the meadow landscapes are widely used for the cattle breeding, because of lower mountain inclines. In this zone steep mountain slopes relatively developed.

The bottom border of the mountain meadow landscape of the South Slope of the Greater Caucasus are in heights of 2000–2200 m, in the north-eastern slope of the Gusar region borders fall down to the height of 1800–1600 m. Downward progression here is associated with the lack of heat.

In Demiraparanchay basin and in surrounding areas mountain forest landscape types are more spread. Forest landscape mountain zone has evolved in altitudes of 700–2200 m and used more than the other natural complexes.

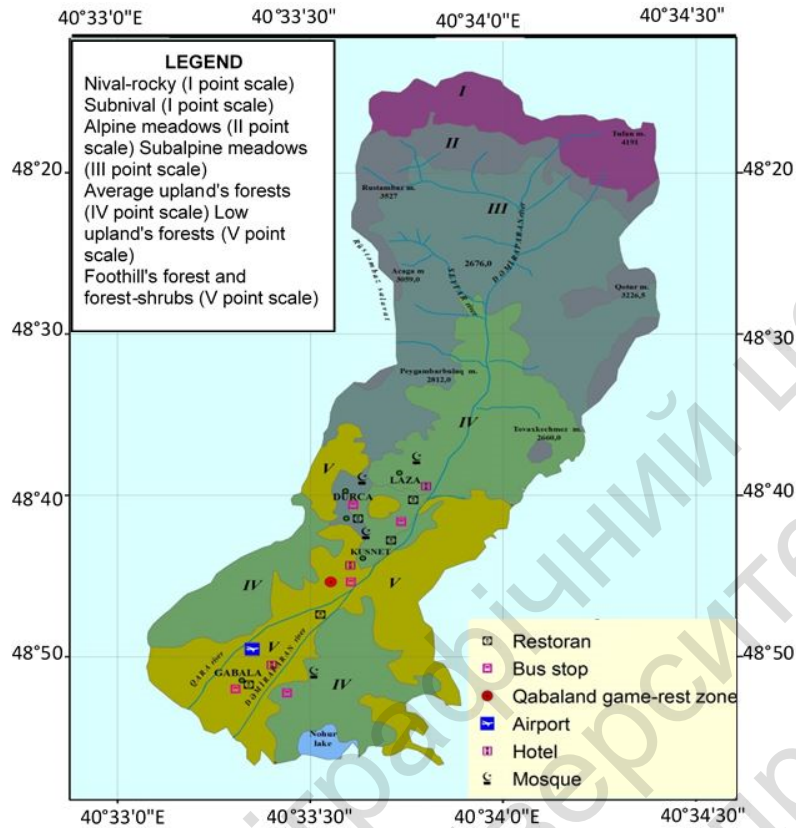
In low and middle mountains forest zone of surfaces inclinations are 5–15°, sometimes 25–30°, in river's network is 0,40–0,80 km/km<sup>2</sup>, the intensity of surface flow is 0,5–1 mm per year (Ismaylov et al., 2014).

The Duruca village is located along Duruca River, which is right inflow of Demiraparanchay River. Attractive nature, ecological diversity of the natural landscape, densi-

ty of a forest cover and favorable geographical position of the mentioned areas give great opportunities for setting up tourism and recreation complexes here.

During estimation of recreation potential of the areas, the following criteria goes into consideration: relief of the area (relative height, incline, degree of decomposition of the area, watershed and river profile and so on), area's climate indicators, richness and species of vegetation, water resources, natural landscape diversity, anthropogenic changes within the area and possibilities of creation of transport infrastructures for the area [17, p. 91].

For the purpose of reduction of mountainous geosystems' degradation level, along with mitigation of the negative influences coming from anthropogenic activity and to prevent overweight of the landscapes we analyzed the sustainability of the landscapes from anthropogenic changes, and for the area that are subject for the recreation development we have plotted 1 : 100 000 scale maps of landscapes and recreation potential along with map of soils use on the basis of field works data and using GIS based pictures from several satellites (Landsat 7 ETM+, SPOT 1-4, OrbView-3 and others). In conclusion, it is outlined to compile a landscape planning program where the complex measures for this area will be highlighted (Fig. 2).



**Figure 2. Map of of estimation of recreation potential and torism opportunities of the Demiraparanchay river basin landscapes according to landscape zones (M 1: 100 000)**  
 I – very favorable, II – as favorable, III – as middle favorable, IV – as less favorable, V – as very small favorable

**Conclusions.**

1. The modern morphological properties, recent tectonic movements, interactions of exo-dynamic processes of relief of research area were studied and their relation to origination of new morphological units within landscape zones at the height have been analyzed.
2. For the first time we compounded temperature distribution and snow cover existence scheme-maps for January in GIS environment and we estimated starting and ending dates for winter tourism depending on height.
3. Demiraparanchay basin and surrounding areas' have wide tourism and recreation potential, as a result of the expansion of tourist centers in this area, anthropogenic influence loading increased and intensive cut-off of the forest areas resulted in landslide development here.
4. For the first time, for the purpose of reduction of the landscapes degradation level in Demiraparanchay basin and in surrounding areas, along with mitigation of the negative influences coming from anthropogenic activity and to prevent overweight of the landscapes we analyzed the sustainability of the landscapes from anthropogenic changes, and for the area that are subject for the recreation development we have plotted 1 : 100 000 scale maps of landscape zones and map of recreation potential, along with map of soils in use on the basis of field works data and using GIS based pictures from several satellites (Landsat 7 ETM+, SPOT 1-4, OrbView-3 and others)).
5. Taking into account the area wide range of tourism opportunities, was built ski in the winter and summer tourism complex, for the first time activities of devastating natural events for human life (floods, landslides, etc.) was assessed on environmental risks and hazards in landscape zones.

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## ЭКОЛОГИЧНІ АСПЕКТИ ВИВЧЕННЯ ПРИРОДНО-РЕКРЕАЦІЙНОГО ПОТЕНЦІАЛУ ГІРНИЧИХ ГЕОСИСТЕМ (на прикладі Південного схилу Великого Кавказу)

*На основі даних, отриманих нами в польових та інших дослідженнях, було вивчено рельєф, кліматичні показники території та диференціація ландшафтів території для подальшого точного оцінювання рекреаційного потенціалу басейну річки Дамирапаранчай і навколишніх територій. Уперше для зазначеної території складено картосхеми, на яких відображено деякі кліматичні показники території та великомасштабна (М 1 : 100 000) карта рекреаційного потенціалу за ландшафтними поясами досліджуваної території в середовищі ГІС.*

*Дослідження сучасних ландшафтів на території Південного схилу Великого Кавказу, у басейні річки Дамирапаранчай із підвищеною небезпечкою потоку в середовищі ГІС, дозволить ефективніше використовувати багатий потенціал рекреації території й розвивати туристичні комплекси не завдаючи шкоди навколишньому середовищу гірських геосистем.*

*Ключові слова: рельєф, кліматичні показники, туризм, селенебезпечні процеси, небезпека навколишньому середовищу.*

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## ЭКОЛОГИЧЕСКИЕ АСПЕКТЫ ИЗУЧЕНИЯ ПРИРОДНО-РЕКРЕАЦИОННОГО ПОТЕНЦИАЛА ГОРНЫХ ГЕОСИСТЕМ (на примере Южного склона Большого Кавказа)

*Для точного оценивания рекреационного потенциала бассейна реки Дамирапаранчай и окрестных территорий изучены рельеф, климатические показатели территории и дифференциация ландшафтов территории на основе данных, полученных нами в полевых и других исследованиях. Впервые для указанной территории составлены карты-схемы, отражающие некоторые климатические показатели территории и крупномасштабная (М 1 : 100 000) карта рекреационного потенциала по ландшафтным поясам исследуемой территории в среде ГИС.*

*Исследование современных ландшафтов на территории Южного склона Большого Кавказа, в бассейне реки Дамирапаранчай с повышенной опасностью потока в среде ГИС позволит более эффективно использовать богатый потенциал рекреации территории и развивать туристические комплексы, не нанося вреда на окружающую среду горных геосистем.*

*Ключевые слова: рельеф, климатические показатели, туризм, селопасные процессы, опасность окружающей среде.*

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## СИСТЕМНЫЙ АНАЛИЗ РЕЛЬЕФА ЮЖНОГО СКЛОНА БОЛЬШОГО КАВКАЗА КАК ИНДИКАТОРА ЭКОЛОГО-ЛАНДШАФТНОГО ПОТЕНЦИАЛА ТЕРРИТОРИИ

*Оценка эко-ландшафтного потенциала горных регионов требует системного исследования всех основных ландшафтообразующих компонентов, определяющих направление и тенденции развития. Одним из таких компонентов является рельеф, играющий большую и, нередко, ведущую и решающую роль. В связи с этим, одним из эффективных методов исследования естественных ландшафтов является системный анализ рельефа на основе морфометрических данных. Применение полученных в результате морфометрического анализа точных и дифференцированных количественных данных об изучаемой территории в ландшафтных исследованиях позволяет использовать эти морфометрические показатели, во-первых, как индикаторы выявления неустойчивых ландшафтов и с целью установления тенденций и динамики их развития, во-вторых, как данные для количественного обоснования уже выделенных ландшафтных единиц, в-третьих, в целях выявления их влияния на изменение и раздробленность ареалов современных геосистем. Предлагаемый нами системный анализ рельефа южного склона Большого Кавказа позволяет определить морфодинамическую напряженность территории.*

*Ключевые слова: рельеф, морфометрическая напряженность, горные геосистемы, ландшафтный потенциал*

**Введение.** В последние годы в Азербайджане, как и во всем мире возросла антропогенная нагрузка на естественные природные геосистемы. Одним из классических понятий эколого-географической теории корреляции человека и природы является экологический потенциал ландшафта: совокупность условий, необходимых для жизни и воспроизводства населяющих данную территорию организмов [6,13]. В настоящее время

соизмерение показателей антропогенной деятельности с потенциалом компонентов геокомплексов не дает возможность к самосохранению ландшафтов, и выживаемость их возможна лишь на основе изучения закономерностей формирования, функционирования и трансформации естественных и антропогенных ландшафтов, количественной оценки параметров, обеспечивающих их устойчивость, равновесие, стабильность и