Characteristic of the scree formation process and influence on the development of floods in Nakchivan Autonomous Republic

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Abstract. The territory of the Nakchivan Autonomous Republic has complex geological-geomorphological and other natural features. The large amount of fall in a very short distance, the diversity in geological conditions and climate elements cause the wide spread of slope processes, including slaking and screen materials. The analysis of researched literature materials, as well as field expedition materials conducted and collected in 2018-2023 shows that the mass of scree materials, as well as their geomorphological characteristics, differ sharply from lowland to highland and from northwest to southeast. For example, while the most erosion was observed on the southwestern slopes of the Kapicik, Gamigaya, Gazangoldag, Yaglidara, Ayichingil, Demirlidag peaks, Esishkekeydani pass, Kukudag, Kecheldag, Agdaban peaks, avalanche activity was weakly developed on the northern slopes of these peaks. Despite the accumulation of a large amount of alluvial materials in the upper part of the highlands, they hardly participate in the formation of floods. However, in the middle and low mountainous belt, they act as a catalyst for floods. Such danger exists for all river basins of the autonomous republic. However, the fact that the slopes of the northwestern part are less inclined compared to the slopes of the southeastern part significantly reduces this danger. Catastrophic floods in Ordubad, Ganza, and Kotamchay basins have become commonplace every 3-5 years. The activity of slaking and scree formation process and flood formation because of this makes the study of the cause of it an important issue. A geomorphological stress map of the area was drawn up with the joint analysis of the horizontal and vertical division of the terrain, as well as surface inclination angles. At this time, the results of the studies carried out in previous years were analyzed. The square of weak stress area is (1) 1262.622 km²; square of moderately stressed area (2) 1514.791 km²; square of tense territory (3) 1319.102 km²; square of high voltage area (4) 778.4616 km²; The area of the anomalously stressed area (5) is 627.034 km². The analysis of the map allows us to show the main distribution areas of debris-fall materials, as well as to determine the areas that lead to the development of other dangerous exo dynamic processes such as avalanches, rock falls, landslides, floods, etc.

Keywords: slope, physical erosion, erosion, inclination, fragmentation, cone.

Характеристика процесу формування осипів та їх вплив на розвиток паводків у Нахічеванській Автономній Республіці

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Анотація. Територія Нахічеванської Автономної Республіки має складні геолого-геоморфологічні та інші природні особливості. Великий обсяг падіння на дуже короткій відстані, різноманітність геологічних умов та елементів клімату зумовлюють значне поширення схилових процесів, у тому числі здрибніння і оспання матеріалів. Аналіз досліджених літературних матеріалів, а також матеріалів польових експедицій, проведених та зібраних у 2018-2023 рр., показує, що маса осипних матеріалів, а також їх геоморфологічні характеристики різко відрізняються від низовини до височин та від північного заходу на південний схід. Наприклад, якщо найбільша ерозія спостерігалася на південно-заходніх схилах піків Капічік, Гамігая, Газангодаг, Ялідара, Айчінгіль, Демірлідаг, перевал Ешшекмейдані, Кукудаг, Кечельдаг, Аглабан, то на північних схилах
Introduction

The mountainous areas of the Nakhchivan Autonomous Republic, located in the southwestern corner of the Minor Caucasus, are characterized by high dynamics and intensity of slaking and scree formation processes. In comparison with other regions of Azerbaijan, this process is clearly noticeable in almost all vertical zones, on the slopes of river valleys, on mountainous plateaus, as well as on the slopes of depressions in the territory of the autonomous republic. The main reason for this is that there are favorable geological, geographical, and especially climatic conditions for the formation of erosion and its various types everywhere in the area. In the Ordubadchay, the volume of scree material transported during a flood is more than 1-1.5 million m$^3$ (Geology of Azerbaijan, 2015).

The abundance of the solid phase of the debris product in the flood flow leads to an increase in its destructive activity, which causes considerable damage to various areas of the farm (Qashqai, Bababeyli, 2017). One of such devastating flood events was observed by us on June 13, 2020, in Akhurachay Valley in Sharur district. The floodwaters moved debris of different sizes along the river bed at great speed, as a result, several private houses were destroyed in the villages of Akhura, Hamzali, and Diza, the roads connecting the villages became unusable, as well as many backyards and grain fields covered with scrap materials.

The activity of scree formation processes and the formation of floods as a result determine that the investigation of the causes of their occurrence is one of the most urgent issues. Natural-destructive processes in the research object, including avalanches, have not been studied separately. Analysis of some slope processes can be found at studies by S.A. Azizbeyov (1961), M.A. Abasov (1970, 1989), B. Antanov (1959), B.A. Budagov (1960, 1995), M.A. Museyibov (1962, 1965), S.Y. Babayev (1999) and recently it can be found to some extent in the works of N.S. Bababeyli, G.H. Garbanov and N.N. Bababeyli (2018, 2019, 2020, 2021). The results of these studies, providing a certain amount of factual material, play a key role in the selection of characteristic territories and are also important in decoding of the aerospace photography materials used.

During remote sensing, we can not only distinguish the genetic type of rocks, bedding conditions, color, vegetation cover, etc. However, we can also identify rock types with different genetic characteristics based on our ground observations for experimental sites. Therefore, we have tried to analyze the dynamics of erosion, especially landslides and scree, as well as the ecogeographic consequences caused by it, based on GIS technology. This, in turn, can create conditions for assessing land resources, determining the nature of land protection measures, and the direction of reforms in the economic structure.

Studied area

The Nakhchivan Autonomous Republic is in the southern and southeastern parts of the Caucasus. Its territory lies between 38°51'-39°47' north latitude and 44°46'-46°10' east longitude. The republic is bordered by Armenia to the north and northeast, the Islamic Republic of Iran to the south and southwest, and the Republic of Turkey at a short distance. Almost 66% of the area is 1000 m above sea level. In the north, Darelaez, and in the east, the Zangezur range of mountains. The southern and southwestern parts of the territory, along the Araz River, are plains of Tertiary and Quaternary sediments located at an altitude of 600-1400 m.

Methodology of the Research

Mainly aerospace materials were used to determine the formation mechanism of scree centers, their development intensity, as well as their manifestation.
in various landscape complexes. For the accuracy of the results, routes were made along different river valleys, and ground observations and photographs were taken in areas with different hypsometric conditions and relief conditions. However, literature, large-scale topographic maps, as well as computer technologies were used during the study.

**Analysis and Discussion**

In some cases, screes, which are not significantly different from avalanches due to their formation mechanism, accumulate at the foot of steep and inclined slopes and create unique morphological forms (Museyibov, Budagov, Shirinov, 2012). The steepness of the slope determines not only the driving force of the scree product but also its movement characteristics, speed, and where it will stop (Okura, Kitahara, Sammori, Kawanami, 2000). Depending on the inclination, scrap materials exhibit different movements such as sliding, overturning, falling, bouncing and rolling. Free fall usually occurs in parts where the inclination of the slope is above 70° (Deparis, Jongmans, Cotton, Baillet, Thouvenot, Hantz, 2008). The falling block bounces by hitting the slope surface. When the inclination angle is less than 45°, the blocks go from jumping to rolling (Dorren, 2002; Heidenreich, 2004). During rolling, scrap materials gain or lose speed depending on the surface morphology and its mechanical composition. Thus, while the small-sized particles do not roll very far down the slope, relatively large-grained sediments move hundreds of meters due to their large kinetic energy. In some cases, this process results in rock fall.

In contrast to rock-fall materials, they are much more varied, giving the landscape a specific appearance with distinct layers parallel to the slope (Fig. 1).

Depending on the volume of scree materials and the initial morphology of the area where they were collected, they have different thicknesses in different areas. Although such cones are often used interchangeably with the term colluvium, they are actually quite different from it.

The development stages of scree materials also have an important influence on the formation of the physical properties described above. Sanders, Ostermann, and Kramers note that in glaciated areas, the scree cones developed in three stages. After the glaciation process, detrital materials begin to accumulate in the first stage at the bottom of the slope, without showing good sorting, usually as a result of direct fall or jump action. With the continuation of the rock fall, both the slope in the source area recedes and with the accumulation of scree at the foot of the slope, the slope begins to widen. As a result of the larger blocks being rolled over longer distances in this way, the scree piles show a well-sorted accumulation of finer grains at the top and coarser grains at the bottom. At the last stage, when the scree materials that were previously accumulated and formed the screes begin to flow, it causes the formation of erosion furrows inside the cone, as well as the formation of a secondary accumulation zone. The inclination of the cone that has completed the development stage varies between 35-45° in the areas near the source point and between 5-20° in the skirt parts (Sanders D.G., Ostermann and Kramers, 2010).

As indicated above, the first of several basic conditions for the development of the scree process and the creation of its corresponding landforms is mechanical fragmentation. Almost no forest cover in the region, dry and hot weather, and cold winter causes widespread physical erosion. It should be noted that the area of 3.88 thousand km², which is 70.7% of all

![Fig. 1. Scree on the slopes of the Havushchay basin](image-url)
landscape complexes of the autonomous republic, has been eroded to one degree or another (Bababeyli, Guluzadeh, 2021). The degree of intensity of these processes is more clearly reflected in the magmatogenic intrusive and volcanic rocks of the high mountain belt of the Zengezur range. Thus, through erosion processes, the initial relief of the watershed part of the Megri-Ordubad batholith and the branches close to it have completely changed their shape (Alizade, Hagverdiyev, Tarikhazar, Bababeyli, 2017; Alizade, Khalilov, Tarikhazar, Hamidova, 2017; Abbasov, 1970). Despite the fact that the area is composed of these solid rocks, which are extremely resistant to erosion, hard and durable, erosion is almost equal to the intensity of the southern slopes of the Greater Caucasus. On the one hand, the magnitude of the daily temperature amplitude, and on the other hand, the inclination of the slopes (Fig 2), and their degree of bareness create conditions for this. Slopes with an inclination higher than 30° occupy almost half of the total zone (48.28%) due to the large area occupied by sharply divided landforms. This situation becomes even more acute in the steep, precipitous slopes surrounding Goy-Gol, where the Trogvari valley of the Sakgarsu River and the peak of Gamigaya meet.

The poor development of soil cover, as well as the lack of cover by plants, is one of the factors that increase continentality. The heating and cooling of bare rocks with high heat capacity creates temperature conditions and amplitudes that differ from the environment in different periods of the year. Due to the transparency of the atmosphere and low cloudiness, the solar radiation here is 150-160 kcal/cm². This quantity is the maximum indicator not only for Azerbaijan but also for the South Caucasus as a whole. For comparison, it should be said that the amount of annual radiation in the Gizilgum desert of Central Asia is 155 kcal/cm². It is interesting that the number of sunny hours (2200-2400 hours) observed in the highlands of the autonomous republic is equal to the amount observed in plain areas such as Kur-Araz lowland, Gobustan and Absheron. Under the influence of intense solar rays, the volume of rocks consisting of different minerals is constantly changing, which creates internal pressures in different directions and sizes. Although the coefficients of expansion and compression are very small (table 1.), the repeated and long-term continuation of this event cracks them, and disrupts the relationship between the mineral itself and the formed rock. Therefore, one part of the slope is quickly eroded, and the other is more resistant to erosion. A relatively large rock particle breaks down into smaller pieces as a result of physical wear. However, one important point should be noted the process of rock fragmentation is not only related to the intensity of thermal weathering. Undoubtedly, during tectonic movements, rock masses exposed to high stress are subjected to numerous micro-cracks. This is due to this zone is considered the most active area of tectonic uplift in the Minor Caucasus.

Table 1. The coefficient of volume expansion of some minerals, according to Clark

<table>
<thead>
<tr>
<th>Name of mineral</th>
<th>coefficient of volume expansion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quartz</td>
<td>0.000310</td>
</tr>
<tr>
<td>Orthoclase</td>
<td>0.000170</td>
</tr>
<tr>
<td>Hornblende</td>
<td>0.000284</td>
</tr>
<tr>
<td>Calcite</td>
<td>0.000280</td>
</tr>
</tbody>
</table>

When the daily temperature fluctuates around the freezing point of water and snowmelt creates enough free water, it gives them an extra boost and acceler-
ates their disintegration. Because the frozen water exerts a pressure of several hundred kilograms per cm$^2$ on the walls of the cracks in the rock. Similar work is performed by the salts that are filled in the cracks and crystallized there. For example, anhydrite combines with water and becomes gypsum, increasing its volume by 33 percent.

The number of cracks in the soil, in turn, causes the diversity of the mechanical composition of wear materials. Usually, when the number of cracks is small, the broken part is divided into larger pieces, and on the contrary, in different directions and when there are many of them, it breaks into smaller pieces.

Due to the fact that the area is made up of rocks with different characteristics, it is exposed to different degrees of physical erosion. Observations show that these processes occur more strongly in crystalline coarse-grained rocks than in homogeneous small-grained rocks (Bababeyli, Guluzadeh, 2021; Alizade, Hagverdiyev, Tarikhazar, Bababeyli, 2017). In some places, for example, in the central part of the area, especially on the slopes of Kapicik (3904 m), Gamigaya (3726 m) and Gagangoldag (3829 m), the color of the rocks (blackish gray) plays an important role in the occurrence and intensity of erosion (Fig. 3). Therefore, in the mentioned area, the foothills of the mountains, sometimes even the slopes of the hills, are covered with a large number of stone fragments and various debris materials. Because the erosion processes on these slopes are so intense denudation does not always manage to remove all the prepared material. Similar scree slopes are also manifested in the high inclination and sharply divided slopes of Yaglıdara (3825 m), Ayıchingıl (3707 m), Demirlidag (3368 m) and Eshshekmeysani (2862 m) passes. By the way, let’s note that these slopes have a high index in terms of erosion risk and are considered particularly dangerous areas within the autonomous republic.

As a whole, the rocky, scree belt formed on separate peaks in Zengezur covers a height of about 2900-3400 m. In the scree belt, where more than 50% of the annual precipitation is in solid form, the detrital materials are composed of larger particles than in the lower belts. The size of the materials is also affected by the type and chemical composition of the rocks that make them up. Andesitic rocks are no larger than 10-50 cm, while individual clastic materials reach 0.5-2 m in diameter. This also applies to clay-shales (Bababeyli, Gurbanov, Hajiyeva, 2019).

South of the Cold Mountain (3161 m), the hypsometric differentiation of the relief is weak, but the amount of depth or vertical fragmentation is on the contrary high (Fig. 4; 5). Here Paleocene cyanite-diorites, depending on the features of the geomorphological conditions and the nature of the weathering, are widely developed as lumps of coarse debris masses (Geology of Azerbaijan, 2015). As a result, the described area has become a real dynamically developing floodplain. This fact is also reflected in the flood hazard map in Nakhchivan Autonomous Republic prepared by K. Asadov and N. Bababayli (Bababeyli, Asadov, Askerov, 2017).

Although the watershed part of the southeastern part of the Deraleyez ridge, especially at the peaks of Kukudag (3120 m), Kecheldag (3118 m) and Agdaban (3093 m), the relief fragmentation, lithology and intensive displacement of erosion materials are completely similar to the Zengezur ridge, the decrease in the height of the slopes and the relative inclination of the slopes towards the northwest of Kukuchay leads to a lower intensity of the transport of debris materials and a more active accumulation of soil-cultivating derivatives. Presently, most of the territory has soil-vegetation cover and is relatively little fragmented, including the watershed of the ridge. Therefore, scree-debris materials are weaker compared to the Zengezur range.

Both in Zengezur and in the Dereleyez ranges, the scree materials are remarkably variable depending on the exposure. So, while the northern part of the peaks in the watershed is almost not eroded, while the southeastern part is moderately eroded, this indicator is severe in the southern exposure (Bababeyli, Gurbanov, Askerov, 2019; Bababeyli, Guluzadeh, 2021). This can be explained by several reasons. First of all, the inclination is relatively low on the northern
exposure slopes, and another fundamental reason is that the northern and western exposure slopes have the lowest, and the southern and eastern exposure slopes have the highest radiation balance. The expressions of southern and northern slope, which are popular among people, also confirm this idea. Along with physical erosion, the traces of erosion caused by ancient glaciers are clearly visible in the transformation of the screes into the dominant geomorphological process in the highlands. It is especially noticeable on the steep slopes between Kapicyk and Devaboynu (3563 m). It is fair enough that many researchers consider scree products important elements of the ancient climate (Blikra, and Nemec, 1998). Our field researches show that in some parts of the territory, the processes of sedimentation continue to develop on the same ancient cone structures. It should be noted that the ancient cones have a brownish-yellow-brown color as a result of oxidation and are relatively different from the surrounding rocks. Due to the harsh climatic conditions, there still needs to be complete vegetation on them, and individual plant species grow sparsely.

Despite the accumulation of a large amount of alluvial materials in the upper part of the highlands, they hardly participate in the formation of floods. Because the melting snow in the warm period cannot create active flows. Surface water usually moves along the bottom of these screes, causing surface erosion. At the same time, these waters reduce the friction force of screes and wear materials, and ensure the movement of the mass as a whole (Bababeyli, Gurbanov, Bababeyli, 2021; Mammadov, Hashimov, Verdiyev,

Since the transition zone from the highlands to the middle mountainous has more favorable landscape-ecological conditions, it slightly weakens the intensity of the scree process. In particular, the upper part of the Kukuchay basin and the northern part of the Bichenak forests are covered with tall subalpine forests, which’s length reaches 150-180 cm, and sometimes 2 m. Such a root system leads to the formation of a sod layer that protects the soil from erosion. While alpine meadows develop in the form of glades in the relatively humid central part of the research object, such meadows are not encountered in their southern and northern parts. It should be noted that in the areas of the mountain-meadow zone where they meet large rocky massifs, a large pile of scree materials is collected. In many cases, they move along the slope and disrupt the structure of mountain meadows. As such areas usually cover small areas, it is very difficult to identify them only with the help of aero-space photographs.

According to S.Y. Guliyeva’s calculations, about 20 thousand ha of the area of 97.56 thousand ha, which has an absolute height of more than 2000 m, is covered with stone piles and scree materials (Guliyeva, 2011).

The analysis of our research shows that in the mountain-meadow zone, the scree processes are weak compared to the nival-rocky zone, and develop more intensively than in the forest zone, weakening from top to bottom. As a result of global warming, the expansion of alpine and subalpine meadows does not occur or is very slow in many places, while the nival belt is moving upwards. That is, when the degradation is activated in the landscape, its recovery is very slow. This leads to an increase in the volume of scree. In such places, stone landfills are formed, where large frost erosion is widespread. Analysis of aerospace data shows that this process is faster on steep andesitic slopes (Bababeyli, Guluzadeh, 2021). The main reason for this is the intensification of physical wear as a result of the growth of the daily and annual amplitude in areas freed from snow. But another no less important reason is unsystematic grazing and overloading. According to some experts, especially Nazim Bababeyli, the protection of plants in the highlands, as well as in its parts close to the watershed, in recent years has led to a decrease in the development of erosion and an increase in the density of vegetation areas.

Although the valleys of Nakchivanchay and its tributaries have denser forests and bushes in the middle mountainous zone, presently, a large part of this altitude zone forms a wide strip of sharply divided, almost precipitous slopes, as in the highlands. The main factor of fragmentation is river erosion and other destructive denudation processes. Thus, the total density of river valleys increases as it goes down from the rocky zone. These, in turn, regularly increase the morphometric tension in the terrain and, as a result, strengthen the slope processes in those areas. Especially in the south-eastern part, the degree of erosion is high because the inclination, fragmentation, erosion base, and depth of the slopes are greater than in other places. For example, more than 80% of the southern slopes of the Kotamdagh range with an absolute height of 1300-2000 m are covered with stones, rubble, and 10-12% of plant groups form a cover on the surface (Guliyeva, 2011).

Since the surface is strongly divided, the appearance of the slopes here is also distinguished by its complexity. This complexity causes the balance of solar radiation, which in turn leads to different intensities of weathering. In addition to physical weathering, rock breakdown is partly chemical. Because the water temperature is higher than in the highlands, the intensity of chemical erosion increases. Regarding this, 1800-2600 are typical absolute heights. In general, the occurrence of physical and chemical weathering in the middle highlands is characterized by moderate intensity. In addition, it is worth noting that in some cases, the erosions caused by hooves of wild animals, especially mouflon and bezoar goats, which have recently been strictly protected, create conditions for the creation of small scree areas. Such areas are constantly expanding as a source of erosion. Because the natural regeneration of exposed slopes is impossible in dry conditions.

The comparative characteristics of the distribution of rubble-scare materials in separate areas in the middle highlands show that they are intensively developed, covering large areas in the Gilanchay, Vanandchay, Aylischay, Ordubadchay, Gazanchay, Kotamchay, and Jahrichay basins. The physical erosion is in severe because the slope where they flow has the south and south-west directions. From large rock fragments to pebbles, gravel, and sand particles of different sizes collected in the conveying cones, it enables obtaining some information about the erosion processes along with the hydrological and geological characteristics of the basins. Thus, the presence of river terraces and thick cones at the foot of the mountains confirms that the erosion processes in the basin have a strong and ancient history.

Since the valleys of the above-mentioned rivers have a large inclination and sharply divided moun-
tainous relief in many places, erosion materials are actively transported toward the river bed, creating a light-colored granular strip in aerial photographs. The linear movement of these debris materials gradually forms numerous shallow furrows that are visible on the slopes. Due to the frequency and intensity of such events, the process of creating dominant landscapes is completely slow, and as a result, a complex alternation of erosion, denudation, and accumulation processes is observed on the slopes.

Alluvial products accumulated in river terraces and ravines expand over time, merge, and form plumes similar to proluvial cones. On the foothills of the southern and near exposure slopes, the thick scree cones are usually devoid of vegetation (Fig. 6), while on the more favorable northern exposure slopes, they are covered with shrubs and perennial grasses (Fig. 7).

The cones located at the bottom of the flood-lands act as a catalyst for floods. Such a danger exists for all river basins of the autonomous republic, but the fact that the slopes of the northwestern part are less inclined compared to the slopes of the southeastern part significantly reduces this danger. Catastrophic floods in Ordubad, Ganza, and Kotamchay basins have become commonplace every 3-5 years.

In the central part of the middle mountainous belt, numerous small river valleys between the separate ridges of the Dereleyez and Zengezur ridges are also rich in sedimentary materials. Mainly, around the village of Kuku, the volcanic rocks, especially the sandstones, scree attract more attention. This is proven by the solid materials and suspended particles carried by the rivers during the rainy season or during the floods that occur from time to time.

In areas where longitudinal and transverse fractures intersect, erosion processes are characterized by their intensity. From this point of view, the area from the upper course of Gabalichay and its confluence with Lizbirchay to Gunnut Village is of greater interest. Thus, a small area here is complicated by numerous faults and fault-displacement faults in different directions. Sharp broken slopes characterized by rock outcrops and scree are in the Ardych (2034.4 m), Tandirli (1649.6 m), Megridag (1869.1 m), Garagaya (1490.0 m), Ardagli (2230.4 m) massifs and covering large areas in several other areas. These areas are clearly distinguished from the surrounding areas by giving light, light-gray, and whitish color shades to the aerial photographs. In the south-eastern extension of this line, the steep slopes of the Karagush (2600 m) range, reminiscent of large quests, are characterized by the development of large-scale scree, consisting of coarse gravel and other rock fragments.

In addition to the large accumulations of avalanche materials on the slopes of the Payiz and Turkesh monoclinic ridges extending east from the village of Chalkhangala, as well as on the inclined slopes of the Daridag plain, there are also scree plumes and their separate cones (Bababeyli, Gurbanov, Bababeyli, 2021). Foothills of Ilanlidag (2415.8 m), Berdik (2053.6 m), Nahajir (1807.3 m), Ashabi-Kahf (1665.9 m) and Alinca (1821.4 m) laccoliths, which create unique shapes in the middle stream of Alinjachay and between it and Goynuku are distinguished by the relative size of the cones.

Such landscape conditions persist in the low mountain belt with less inclined, but rather sharply dissected slopes. The areas from the right bank of the Ordubad River to Daridag can be cited as a vivid example of the area where such areas are spread. However, unlike the previous belts, here the screes develop relatively little, mainly in the form of a narrow strip and separate spots on the slopes of monoclinal ridges and elevations. The porous clay-marl sediments
found on the steep slopes of the monoclines are covered with a surface-branched crack network at high temperatures after a small amount of precipitation in the summer. Especially during hot dry winds blowing in the hot season, the temperature in the area is higher than 30°C, and the relative humidity is lower than 30%. In such conditions, the winds have destructive effects on the vegetation, as a result, the degradation intensifies in large areas, the area of bare areas increases, and in other words, optimal conditions for the development of the active desert erosion process are created. The conducted research materials show that in some slopes the degree of surface covering with stone even reaches 85-95%.

From the right bank of Jahrichay to the north-west, low, intensively fragmented narrow mountain ranges, on the slopes of which the scree are widely developed (Fig. 8). In addition, the surface of low mountains with monocline structure, located between Selasuz and Jahrichay, consists of Eocene sedimentary rocks that are subject to easy decomposition. Unlike what we have shown, although the relief of the north-western part of the area is composed of high-density limestones (2.65-2.70 g/cm³), which are more resistant to erosion processes, even here, it is possible to find erosion materials at the foot of the monocline relief. At the same time, more scattering cones and rock layers eroded with pebbles can be observed on the steep slopes of the narrow valleys and narrows observed in the area. In particular, this process is more active in the Shahbulag River valley, which stands out for its magnificence and shape, and also on the right bank slope of Arpachay west of Gumuşlu village. Among the severely eroded areas are the island-like elevations of Dahne and Validag located in the western part of the Sharur basin. Argillites, which lose their mechanical strength quickly and sharply, are more prone to this process.

**Conclusion**

In the Autonomous Republic of Nakhchivan, a geomorphological stress map of the area was drawn up with a joint analysis of the horizontal and vertical division of the terrain, as well as surface inclination angles (Fig. 9). At this time, the results of the research carried out in previous years were analyzed (Tanriverdiyev, Safarov, 2014). The analysis of the map allows us to show the main distribution areas of scree-fall materials, as well as to determine the areas that lead to the development of other dangerous exodynamic processes such as avalanches, landslides, floods, etc. The area of weak stress territory is (1) 1262,622 km²; area of moderately stressed territory (2) 1514,791 km²; area of tense territory (3) 1319,102 km²; area of high voltage territory (4) 778.4616 km²; The area of the anomalously stressed territory (5) is 627,034 km².
References


