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GEOSYSTEM ANALYSIS OF DEVELOPMENT OF LANDSLIDE LANDSCAPES OF THE SOUTH-EASTERN SLOPE OF GREATER CAUCASUS

Abstract. The southeast tip of Greater Caucasus which is entering borders of Azerbaijan and being part of the Alpine and Himalaya geosynclinal belt, is characterized by high dynamism exogenous the relief forming the processes having essential impact on development of a landscape situation. In this regard there is a need of development of various methods for creation of scenarios of possible changes of a geoecological situation in various massif having harmful consequences, by identification of relationships of cause and effect. For this purpose, in this work possibilities of forecasting of landslides in natural area of Greater Caucasus with use of available geological and geomorphological, climatic and landscape data, and also visual supervision were analysed. These data allowed to reveal the main distinctions of factors of a relief situation, hydroweather conditions in certain physiographic areas in which landslides, character and intensity of the land use, to some extent influencing a descent of landslides and subject to their destructive influence are shown.

Keywords: processes, slope, exodynamic, landscapes, erosion, factor, sub district, Caucasus.

1. Introduction. Questions of identification of the reasons of geodynamic processes – taluses, scatterings and landslides are many years in the center of attention of the geographical public of the country because of harmful consequences of these phenomena for the social sphere and economic activity of all mountain regions [14].

The southern and Northeast slope of Greater Caucasus differ the complex geomorphological structure, being shown in difficult structure of alternation of water-permeable layers of breeds, an interlacing of tectonic violations, and also the high seismicity which quite often is hardly noticeable, but a decisive factor of slipping and a collapse of mass of breeds.

The inclination of a terrestrial surface saving in considerable energy of all mass of breeds of a slope has essential impact on development of landslide processes. But, as we know, big biases of slopes not always lead to landslides, even on sites close located to landslide massifs. So, slopes with strong maternal breeds are steady, slopes with alternation of layers of friable breeds and clays are the most subject to influence of geodynamic factors. Big biases of slopes, especially characteristic for the Southern slope of Greater Caucasus Range lead to landslides of landslide character, in a root changing shape of a landscape of this site [12, 13].

On degree of stability to impact of landslide processes of the territory of a massif active and active sites are differentiated on rather steady, so-so. Within a mountain meadow zone steady sites in the landslide relation are characterized by existence of clearly expressed subalpine and Alpine landscapes. Such sites can be subject to influence of others exodynamic processes – to a soil erosion, accumulation and movement of taluses and the scatterings constituting not smaller danger to a landscape and all ecological situation (figure 1).

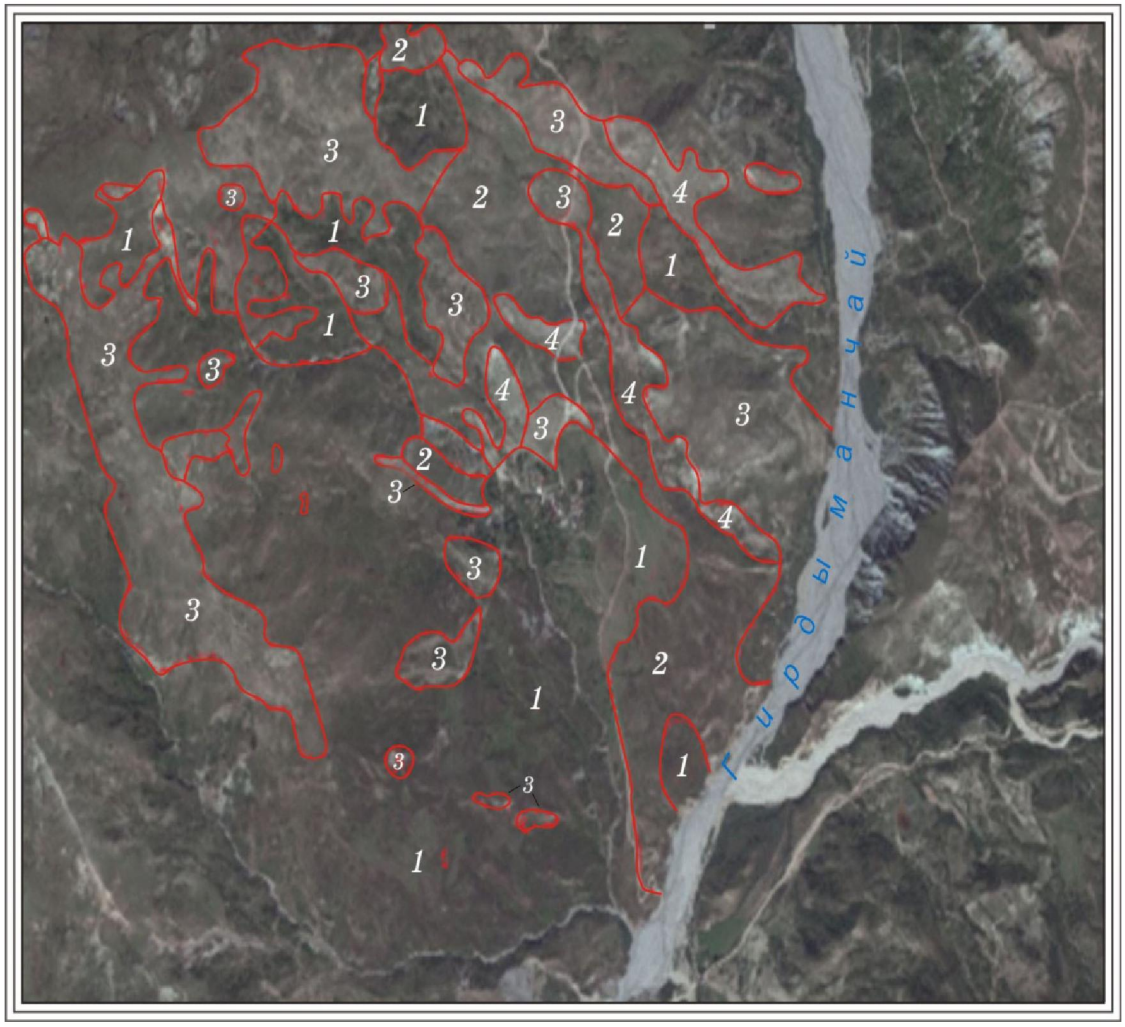

Figure 1 – Space image of part of the studied territory of a river basin of Girdymanchay of the 2010 with the allocated contours of the soils, different degree of erodibility. Scale 1 : 25 000; 1 - not bald-headed sites; 2 - slightly eroded sites; 3 - moderately eroded sites; 4 - severely eroded sites

It is known that an important element of development of landscapes is transfer of chemical particles as part of circulation of substances. In this regard mountain landscapes of Greater Caucasus are low-studied and demand the analysis of impact of exogenous processes on changes of quantity and a ratio of various chemical elements and their connections in soils and vegetation depending on intensity of various natural phenomena. For these purposes experts of various profile – geographers, soil scientists, botanists, the chemists which common efforts can help to reveal an overall picture of occurring geochemical changes can be attracted [17-19].

The geodynamic situation in Apsheron peninsula substantially becomes complicated the intensive town planning, being accompanied development of social and industrial infrastructure that leads to change of an initial relief and strengthening of factors of an landslide forming.

2. Objects and methods of researches. The southeast tip of Greater Caucasus which is active from the point of view of a descent of landslides, always drew attention of researchers of various disciplines – geologists, geomorphologists, landscape scientists, soil scientists, etc. trying to establish the reasons of this destructive process, to give an assessment of extent of influence of this or that factor on this phenomenon. The main landslide massifs, lithologic structure of breeds of landslide slopes, the basic landscape elements of separate large landslides were during this time defined [1-3].

These works were performed during field visual researches, and also the cameral researches meaning measurements on topographic maps, revealing the biases of a surface stimulating slipping of mountain masses.

Measurements of the cracks formed as a result of landslides on different massifs and definitions of their temporary dynamics allow to carry out in a certain degree territory division into districts on activity of breeds for the purpose of identification most of the landslide territories. The description of a landscape situation, its separate components promotes detection of the distinctions which were showed through a certain time occurring also under the influence of geodynamic processes.

The interpretation of space images gives the chance of them to interpretation for detection of geomorphological and landscape features of consequences of landslides both their spatial and temporary dynamics in the presence of pictures of different years. In Azerbaijan many years were spent works on creation and improvement of various means and methods of interpretation of space data for definition of the directions of development of the harmful natural phenomena [10-12].

3. The received results. Materials of numerous researches of an environment of Greater Caucasus available in existence can give the chance to reveal prerequisites of emergence and development of landslide processes and to create a certain group of landslide massifs for the purpose of development of protective measures on prevention of their harmful consequences. The material on physiographic and synoptic division into districts of natural area of Greater Caucasus within Azerbaijan was for this purpose processed and a number of the factors causing a descent of landslide masses is defined.

Divaryan landslide stream, beginning on a northwest slope of the mountain Matur, on the left coast of Girdymanchay, at the absolute height of 2200 m, it is stretched at distance of 2,9 km to the course of Girdymanchay and finishes the activity at the absolute height of 1400 m. In an amphitheater and a transitional zone width of a landslide stream reaches 10-15 m, and on a carrying out cone more than 2,5 km. Its landslide materials narrowed the course of Girdymanchay to 3-5 m. The modern landscape of a landslide difficult also is characterized by existence of cracks, ridges, shaft, bushes, hollows, pools, boggy sites and fresh landslide materials.

As the digital model of a relief of the Divaryan landslide, created on the basis of the GIS technology shows, wavy character of a surface causes diversity of landscape structure of landslide weight. Namely, camber of a middle part of a landslide with the best conditions of moisture accumulation, most likely, is the reason of development of shrubby and wood vegetation on relatively weak inclined sites, including, sites of a cone of carrying out (figure 2).

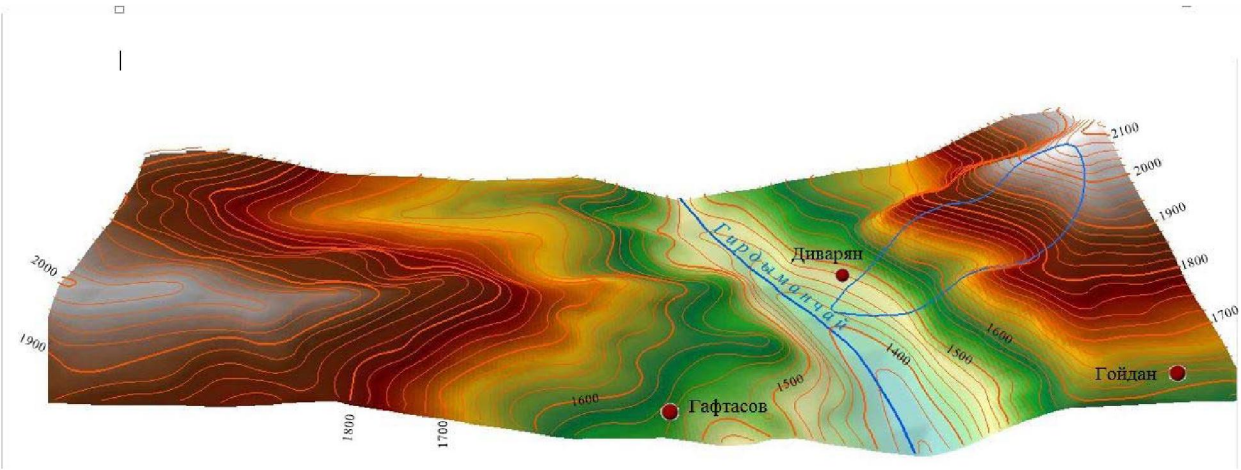

Figure 2 – Digital model of a relief of the Divaryan landslide located on the left river bank Girdymanchay. This model is received on the basis of processing of a space picture of high resolution of 2012 and 2013. Continuous horizontals are carried out through each 20 meters

The similar model is created and for the Demirchi landslide which has been also located on the Southeast slope of Greater Caucasus Range, which development down can influence changes of the bed of the river (figure 3). Unlike the Divaryan landslide the surface of this landslide has a hollow form. Demirchi landslide stream, beginning to the East from the Lagich pass in river Demirchichay headwaters (a river basin Pirsaat) at the absolute height of 2000 m, proceeds to 1700 m. Its length is 25 km, width is 100-500 m. It develops within mountain meadow and mountain-steppe landscape types.

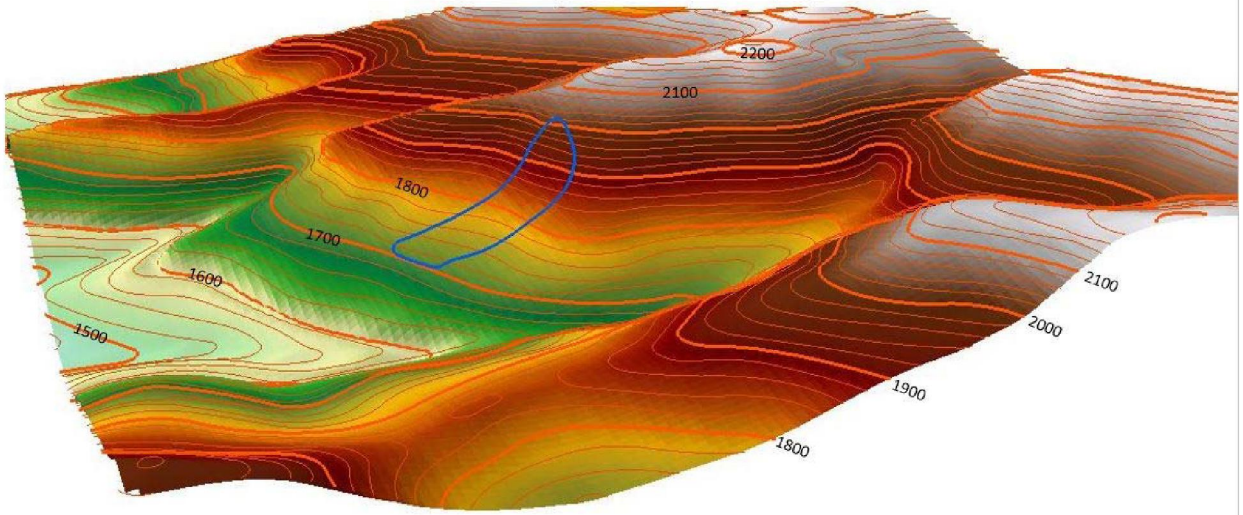

Figure 3 – Digital model of a relief of the Demirchi landslide located in a river basin Pirsaat.
This model is received on the basis of processing of a space picture of high resolution of 2012 and 2013.
Continuous horizontals are carried out through each 20 meters

Mountain territories of Greater Caucasus are included in limits of several physiographic areas. The Gonagkend area covers in the structural relation the Tufan anticlinorium, the Shakhdag-Hyzisynclinorium, the Tengi-Beshbarmag anticlinorium, east suburb of the Zagatalo-Govdagsynclinorium and Hussarmono-cline. Due to the formation at various absolute heights of a number of intermountain hollows conditions for development of settlements, agriculture and cattle breeding which however, can serve as the reason erosive, but not landslide process are created. The landslide phenomena here have the natural character connected, apparently, with fluctuations of seismic activity, nature of the spreading breeds, washing-away activity of the rivers, especially, during high waters and an atmospheric precipitation, including, storm rains. The intermountain hollow of Shakhdyuzu (2400-2700 m) is used as a summer pasture. The relief of the area possesses the big range of heights (200-4460 m) and therefore altitudinal zonality is presented here in a full range. Due to the fall in the southeast direction of absolute height of a relief and aridity strengthening in hillsides reduction of a river drain and disappearance of mountain landscape belts, an aridization of the woods, expansion of areas of dry steppes and semi-deserts towards low-mountainous is observed.

Height differences on the Southern slope of Greater Caucasus Range which generally covers the Zagatalo-Lagich physio geographic area which is stretching from the West, from the Georgian border to a river Girdimanchay valley in the east on 220 kilometers, with cool slopes are made by 2800-2900 meters. Biases of a surface change in limits 30º-45º that probably is a leading factor of development of landslide processes, along with showers, characteristic and for the Northeast slope of Greater Caucasus and high seismicity. Number of the rivers (Mazymchay, Belokanchay, Kurmukhchay, Dashagilchay, etc.) crosses the Southern slope across, forming valleys with cool slopes. In the territory the broad-leaved woods which however can't serve fixing from breed sliding by a factor, mountain meadows and subnival landscapes dominate.

Shemakhi (Mountain Shirvan) the physio geographic area surrounded from the West Akhsu's river, from the North a watershed of Greater Caucasus Range, from the East the Gobustan low-mountainous, and from the South the Shirvan steppe is characterized by high seismicity (8-9 points) which probably plays the leading role in coupling violation between the mass of breeds and a descent of landslides. In the territory of the area where unlike previous, with more humid climate, mountain-steppe, forest-steppe, mountain and forest and mountain meadow landscape complexes prevail.

Studying of a geodynamic situation in Apsheron which is part of Greater Caucasus becomes an actual scientific and practical problem for life support of the most part of the population of the country which has concentrated on the territory of the Baku agglomeration, enduring construction boom which is capable to aggravate earlier existing problems and to create new in connection with intensive high-rise construction in the Baku amphitheater. Today the main landslide massifs in city boundaries are known and the most probable causes of a descent of landslides on these sites are established. However with expansion of city boundaries and advance of housing construction, including, elite, for example, to the South from the downtown towards the Bail ledge there are new dangers to life of people on once weak-populated site of Apsheron.

The territory of Apsheron and the city of Baku is included in limits of the Gobustan-Apsheron physio geographic region of natural area of the Southeast tip of Greater Caucasus which is the landslide dangerous territory for all South Caucasus [4]. The most part of the area consists of low-mountainous with a wide circulation arid denudation processes and in the tectonic relation enters limits of the Shamakhi-Gobustan synclinorium and a southeast extremity of the mega anticlinorium of Greater Caucasus [11]. Owing to a relief of low-mountainous and plains, and also high aridity of climate in the territory landscapes of semi-deserts and dry steppes dominate. Here the halophytic plants is most of all developed.

The territory of Greater Caucasus is included in limits of several synoptic areas.

The Oguz-Ismailli area is exposed to influence of the centers of the cold air located over the Kara Sea, Scandinavia, the South of Eastern Europe and Kazakhstan, getting in the territory through the Caspian Sea and the Azor maximum. Seldom air masses get through the territory of Georgia. Sometimes warm air of a subtropical anti-cyclone gets. Three subdistricts are allocated.

In a high-mountain subdistrict average annual temperatures make 0°-7°C, middle January temperature -5°-10°C (frost), and middle July +5+17°C, an average annual amount of precipitation of 1000-1300 mm. The most damp period – the end of spring beginning of summer. During this period there can be an activization of a role of ground waters in development of landslides.

The Guba-Shamakhi area more than other areas is affected by cold air masses Arctic and middle latitudes and the Central Asian anti-cyclone. On the contrary, influence of a tropical anti-cyclone is shown here poorly, and the Azor maximum in comparison with other areas – is strong.

Mountain subdistrict – average annual temperature reaches +5+7°C, middle January +4°+6°C, middle July +14°+15°C less. The average annual amount of precipitation makes 400-600 mm that says that the role of an amount of precipitation in an landslide forming is less, than their quality in comparison with the previous area though the maximum of a precipitation here is observed, as well as in the Oguz-Ismailli area at the end of spring beginning of summer.

The territory of the Apsheron peninsula and the city of Baku is included in limits of the Apsheron-Gobustan synoptic area differing from others by strong North southern air streams. Influence of area of a high pressure formed Kara, Scandinavian and Azor maximum over Southeast Europe is the main reasons of it. Within this area two subdistricts are allocated: subdistrict of Apsheron and Gobustan subdistrict.

In a subdistrict of Apsheron average annual temperature makes +14+15°C, middle January +3+4 °C, middle July +24+26°C, the average annual sum of a precipitation of 100-250 mm, the greatest number of a precipitation drops out in the fall, the winds of the northern direction which are called “xazri” (or the Baku north), often being accompanied a storm dominate. Storms, fogs and phenomenon snowfalls seldom repeating.

In the Gobustan subdistrict average annual temperature makes +11+13°C, middle January -1-3°C, middle July +22+25°C, the average annual sum of a precipitation of 150-300 mm, the greatest number of a precipitation drops out in the fall. Northern and northeast winds dominate, during the hair dryer the strong southwest wind blows. Storms, fogs and snowfalls are observed more often than in the Apsheronsubdistrict.

Apparently from the provided data, climatic conditions of these subdistricts strongly don't differ and can't be considered as a leading factor of emergence of landslides.

4. Conclusions. The numerous researches directed on development of actions for prevention of a descent of landslides are based on the purposes of reduction of biases of hillsides, the phytomeliorative works meaning restoration of a close vegetable cover on broken massifs. Such approach proceeds from insufficient understanding of an essence of the mechanism of this process covering not simply terrestrial surface, but rather powerful cover of sedimentary breeds with a certain stratification, sometimes some tens meters. Quite often in publications of various character expression "sliding of soils" that proceeds from misunderstanding of a geological and geomorphological essence of landslide process, the superficial relation to possible consequences of this phenomenon meets.

At the same time, attempts of melioration of landslide massifs which are ineffective are made. They, are generally directed on alignment of a surface and restoration of a close soil and vegetable cover, including, by implementation a forest plantation.

These measures lead to temporary stabilization of a geodynamic situation that actually, is the beginning of a new cycle in development of landslide process. Planting of trees improves soil and ecological, but not a geological and geomorphological situation as roots of trees aren't capable to constrain movement of mass of breeds sufficiently. Numerous landslides within a mountain and forest belt of Greater Caucasus within Azerbaijan, strongly changed all shape of a landscape can serve as an example, introducing before not meeting elements in its horizontal structure.

5. Alleged actions. In this regard there is an urgent need in the large-scale inventory of landslide massifs meaning drawing up detailed landscape, geological and geomorphological, soil and geobotanical sketch maps, including, with use of materials of space shooting [23-25]. Cartographic materials have to be added with the meteorological data including information on an annual course of air temperature, quantity, character and a mode of loss of a precipitation, average annual and average monthly air temperatures.

In the description of the landslide massif information on a humanitarian and economic situation of the landslide site, including data on number of settlements, number of their population, type of the settlement, features of their arrangement, quantity and character of the enterprises, the social objects located in this territory has to take an important place.

Accumulation and processing of large volume of data is able to afford to carry out comparison of the probable factors causing process of a descent of landslides and to reveal the key factor which hasn't been considered by initial consideration, for the purpose of search of opportunities of its neutralization [9, 12, 13, 20-22].

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ГЕОСИСТЕМНЫЙ АНАЛИЗ РАЗВИТИЯ ОПОЛЗНЕВЫХ ЛАНДШАФТОВ ЮГО-ВОСТОЧНОГО СКЛОНА БОЛЬШОГО КАВКАЗА

Аннотация. Юго-восточная оконечность Большого Кавказа, входящая в пределы Азербайджана и являющаяся частью Альпийско-Гималайского геосинклинального пояса, характеризуется высокой динамичностью экзогенных рельефообразующих процессов, имеющих существенное влияние на развитие ландшафтной ситуации. В этой связи необходимо разработать различные методы для создания сценариев возможных изменений геоэкологической ситуации в различных массивах, имеющих пагубные последствия, путем выявления причинно-следственных связей. С этой целью в этой работе были проанализированы возможности прогнозирования оползней в природной области Большого Кавказа с использованием имеющихся геологических и геоморфологических, климатических и ландшафтных данных, а также визуальных наблюдений. Эти данные позволили выявить основные особенности факторов условий рельефа, гидроклиматические условия в некоторых физико-географических районах, в которых проявляются оползни, характер и интенсивность землепользования, в какой-то мере влияющие на сход оползней и их разрушительное воздействие.

Ключевые слова: процессы, склон, экзодинамический, ландшафты, эрозия, фактор, подрайон, Кавказ.

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