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TÍTULO: Análisis del paisaje del territorio al evaluar los peligros naturales de la República de Kabardin-Balkar (Cáucaso Central).

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RESUMEN: El artículo aborda los peligros naturales sobre la base del análisis del paisaje del territorio. Se han utilizado métodos como el mapeo y zonificación, el análisis de la literatura científica, el estudio de mapas de varias escalas, fotos e imágenes satelitales, datos de GPS y estudios de paisaje de áreas montañosas de la región sur de Elbrus. Como resultado se han identificado paisajes con ciertos tipos de uso de la tierra y procesos de peligros naturales en la cuenca del río Baksan, que permitirán ajustar el grado de peligro natural según el tipo de uso de la tierra, y determinar recomendaciones para un desarrollo potencialmente seguro y sostenible del territorio investigado para cada tipo de paisaje.

PALABRAS CLAVES: riesgos naturales, tipos de uso del suelo, paisaje, geosistema natural y antropogénico, pistas de avalanchas.

TITLE: Analysis of the landscape of the territory when assessing the natural hazards of the Republic of Kabardin-Balkar (Central Caucasus).

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ABSTRACT: The article addresses natural hazards based on the analysis of the landscape of the territory. Methods such as mapping and zoning, the analysis of scientific literature, the study of maps of various scales, satellite photos and images, GPS data and landscape studies of mountainous areas of the southern Elbrus region have been used. As a result, landscapes have been identified with certain types of land use and natural hazard processes in the Baksan river basin, which will allow adjusting the degree of natural hazard according to the type of land use, and determining recommendations for potential development. safe and sustainable of the territory investigated for each type of landscape.

KEY WORDS: natural risks, types of land use, landscape, natural and anthropogenic geosystem, avalanche tracks.

INTRODUCTION.

Dangerous natural processes (DNP) are an important component of mountain landscapes, affecting almost all of their components. In some works, some aspects of the problem were considered, but integrated studies, evaluating the full impacts of natural hazards on the sum of the main DNP on the basis of landscape analysis, haven’t been performed (Andreev et al, 2012; Apazhev et al, 2015; Kyul, 2015a; Kyul, 2015b). In connection with the recreational and economic development of the mountain regions of the Greater Caucasus, the task of assessing the natural hazard, taking into account the anthropogenic component, becomes an urgent and priority task.

Along with the existing recreational centers such as Dombay, Karachay-Cherkess Republic or Elbrus, Kabardin-Balkar Republic, a number of new, mainly ski clusters are being built and designed here. In this case, there is an activation of DNP, and in particular, avalanches, which, in turn, lead to the formation of natural and anthropogenic geosystems, characterized by the transformation of landscapes to varying degrees up to the creation of the so-called “natural mudslides, landslides, avalanches, etc. complexes” with almost completely changed natural environment. In this regard, the southern Elbrus region as an *object of research* was chosen as the most intensively studied and underdeveloped. It is located in the basin of Baksan river, the right tributary of Malka river, the left tributary of Terek river (The concept of anti-avalanche protection of the territory from Terskol village to the Meadow Azau in Kabardin-Balkar Republic, 2009).

Snow-avalanche studies have been conducted here since the 30s-40s of the last century. At the same time, it can be stated that these studies are isolated and fragmented. Therefore, the priority direction is a year-round, detailed, field, component-by-component landscape survey of the territory using GPS-shooting. *The subject of research*: landscapes with the type of land use and a complex of DNP, in particular, avalanches. *The scientific novelty* of the research is of the highest value, as the summary data are new and derived from the field surveys over the past 10 years. The results are of practical importance, because against the background of increasing anthropogenic load on the landscape it is especially important to determine the degree of natural hazard and geoecological stability of geosystems to the effects of DNP. *Research objectives*: to identify natural and anthropogenic geosystems on the basis of natural hazard assessment; to develop recommendations for potentially safe development of territories based on DNP.

DEVELOPMENT.

Materials and methods.

To solve the problem of research, scientific and stock literature for the 10-year period (from 2005 to 2015) has been analyzed (Andreev et al, 2012; Razumov et al, 2001). Furthermore, the results of interpretation of satellite images of different years of aerial as well as private photos and video of landscape surveys in high-mountain regions of the southern Elbrus region over the last decade have been used. The problem is solved in several stages using a certain system of principles, methods and techniques. During the landscape studies, an integrated geoecological approach to the study of geographical and environmental aspects of the interaction of DNP with landscapes is used (Abdullin, 1998; Abulkhanova-Slavskaya, 1991).

The allocation of the geosystem as a unit of zoning occurs within the boundaries of morphostructures (altitude-exposure principle) and river basins of different orders (the so-called basin principle). In field surveys, the main methods and techniques are the inventory and certification of landscapes and landforms associated with the formation of DNP – avalanches with a complex of anti-avalanche structures (Asmolov et al, 1979; Bodalev, 2001).

The cartographic basis for the natural and anthropogenic geosystem maps is a map of the area affected by avalanches of scale 1:200000 (Kyul, 2015b; Razumov et al, 2001). Avalanche hazard assessment is carried out in the following way. First, based on the analysis of special maps, a working cartographic basis is drawn up, where regional taxa – province, regions and areas of avalanche formation with different degrees of avalanche danger are allocated successively in the study area;

then the areas of avalanche formation are determined by the average avalanche damage (the number of avalanche landforms per 1 linear km of the valley bottom).

During the geoecological monitoring at the time of inventory and certification of landscapes and avalanches, the classification of landscapes by the leading type of land use is carried out; the parameters of landscapes and avalanches are specified. Classes and types of landscapes are identified (on types of land use and DNP). On the basis of monitoring data on the map of the area affected by avalanches M 1:200000 (Kyul, 2015b; Razumov et al, 2001), within the river basins are determined individual natural and anthropogenic geosystems with the leading types of land use and DNP. According to the results of zoning, the areas of avalanche formations (within the river basin) are ranked according to the degree of avalanche danger and a set of anti-avalanche measures is developed for each of them.

In assessing, the range of theoretical questions is addressed: the landscape classifications by type of land use, structures, avalanche, and avalanche topography have been developed. The terminological support is formed. Here are some definitions (in the author's edition). Natural-anthropogenic geosystem for example, avalanche is "a set of avalanche forms of the relief with avalanches accompanying DNP + landscapes with certain types of land use)". Avalanche basin is "the totality of the avalanche catchments with a total area of transit or accumulation due to their overlap with the formation of a single snowfield avalanche". A complex avalanche catchment is "an avalanche catchment with several avalanche centers or trays, where a single avalanche flow is formed in the confluence or overlap zone".

Results.

In the first phase, the assessment of avalanche danger of the southern Elbrus region, located in the main basin of the avalanche formation, Baksan river avalanche activity was estimated according to the results of the analysis of maps of scale 1:200000, based on the zoning of avalanche risk areas of Kabardin-Balkar Republic (Kyul, 2015b; Razumov et al, 2001). Moreover, the zoning data are adjusted including the snow-avalanche situation at the moment. The southern Elbrus region within the province of avalanche formation – first-order morphostructure, orogenic morphostructure of the Greater Caucasus is divided into 4 areas (second-order morphostructures) and 6 areas of avalanche formation (within the third-order morphostructures) with varying degrees of avalanche danger. In assessing the infestation of the territory by avalanches (indicator-number of catchment 1 km of the bottom of the valley) it is determined that, of the 125 areas of avalanche formations on the territory of Kabardin-Balkar Republic (Razumov et al, 2001), 72 is in the basin of Baksan river. According to new data from avalanche field observations, areas are combined into 25 pools of avalanche formations.

An example of the basin No. 12, avalanche area 2-42 (according to the Cadastre ... (Razumov et al, 2001)) with a high avalanche danger level has been considered. There are different types of elementary avalanche formation units: from simple and complex avalanches to avalanche basins (25 in total) with a complex of anti-avalanche measures. There are 25 catchments. The numbering of avalanches is given by the numbering adopted in the Cadastre of the Moscow State University and is specified in the course of inventory (in brackets – the numbering, Runich) (Kyul, 2015a). The main part of the area is 6 avalanches, No. 62(9)-58(14), which generate huge catastrophic avalanches, overlooking the valley and blocking the road Terskol-Azau.

The table gives the characteristics of the main part of the area 2-42.

Table. The data on snow avalanches in the avalanche catchments No. 62(9)-58(14).

No.	No. of the avalanche catchment	Date of the avalanche	Max. amount of overflows, thousand cubic meters	Changes in landscape. Damage.	Frequency, years.
1	62(9)* **	20/12/67	350	2.3 hectares of forest	**-**
	62(9)	01/4/69	460	1.3 hectares of forest	2
	62(9)	20/1/94	-		25
	62(9)	**29/12/01**	**700**	**9** hectares of forest	**7**
	62(9)	09/12/05	-		4
2	**62(9)-61(10)** **2** avalanche catchments	**00/3/56**	**-**	**-**	**-**
	62(9)-61(10)	**20/12/67**	**600**	**2.7** hectares of forest	**11**
	62(9)-61(10)	**06/12/73**	**1200**	**14.5** hectares of forest	**6**
	62(9)-61(10)	**05 and 09/1/87**	**-**		**19**
3	***62(9)-60(11)*** ***3*** avalanche catchments	***04/1/79***	***By analogy with 06/12/73 (more than 1200)***	***About 20*** *hectares of forest*	-
4	**60(11), 59 (12-13)**** **3** avalanche catchments	**18/1/76**	**600**	**26** hectares of forest**.** 2 men died.	-
5	58(14) *	11/3/71		**2** hectares of forest	-

Notes: * the catchment with PDA; ** the catchment with anti-avalanche structures.
Catastrophic avalanches are in bold; the data that need to be clarified are in italics.

In the course of field survey, landscape analysis of the territory is carried out.

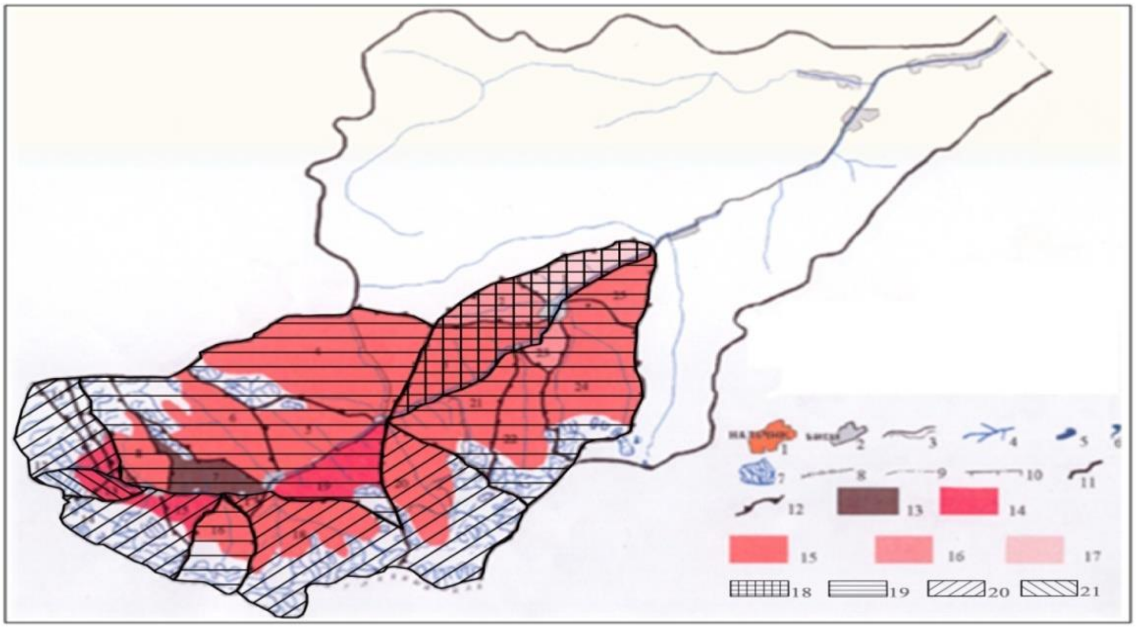
Landscape zone 1. The lower part of the slope is a zone of unloading and accumulation with removal cones. The absolute height is 1400-1700-1900-2000 m. In addition to the agricultural type with pasture and hay-bearing subtypes, an anti-avalanche protective subtype of the avalanche landscape on the site of the complex of anti-avalanche structures is prevalent (Andreev et al, 2012).

Landscape zone 2. The middle part of the slope is a transit zone with avalanche trays. Absolute height is 2000-2500-3000 m. Mountainous meadow zone. Subalpine, Alpine and subnival meadow belt with the subalpine, Alpine and subnival landscapes. A large number of avalanche trays (avalanche landscapes with avalanche-erosion subtype). Talus and Nival landscapes are prevalent. There are agricultural with pasture subtype and anti-avalanche protective landscapes (with avalanche-braking subtypes) in the lower part.

Landscape zone 3. The upper part of the slope is the zone of avalanche origin with avalanche centers. The absolute height is more than 3000-3500 m. Nival, less glacial and talus landscapes are developed.

As a result, a map of natural and anthropogenic geosystems of scale 1:200000 was developed on the territory of the southern Elbrus region (figure, the color shows the degree of damage of the territory).

Figure. The map fragment of natural - anthropogenic geosystems with the leading type of land use. The upper reaches of Baksan river. Southern Elbrus. Original scale 1: 200000.



Legend to the figure: Administrative settlements: 1 – the capitals of the republics; 2 – the centers of districts. Ways of communication: 3 – roads. Hydrography: 4 – rivers; 5 – lakes; 6 – springs. Terrain: 7 – glaciers. Borders: 8 – state; 9 – subjects of the Russian Federation; 10 – state reserves and national parks. Boundaries and numbers of taxonomic units of zoning: 11 – main basins of avalanche formation; 12 – basins of avalanche formation. The avalanche-hazard index is calculated as the ratio of avalanches per taxon length: 13 – very strong (>10); 14 – strong (5,0 – 10,0); 15 – medium (2,0 – 5,0); 16 – weak (1,0 - 2,0); 17 – very weak (<1,0). Natural and anthropogenic geosystems with land use type: 18 – mining; 19 –agricultural; 20 – recreational; 21 – communication.

DISCUSSION.

According to the results of avalanche activity assessment, based on the results of landscape analysis (see the figure), natural and anthropogenic geosystems are identified (by the leading types of land use and DNP):

1. With the mining land use type: a) debris-avalanche, No. 1 (mouth of the Gizhgit river); b) subsidence and landslide, No. 2 (the right side of Kamiksu); c) avalanche-mudflow, No. 3 (pools of the rivers Small and Big Mukulan).

2. Agricultural (pasture and hay) land use type: a) avalanche-mudflow, No. 4 (the pool of Kyrtyk with the influx of Siltransu), No. 8 (the basin of Terskol); b) avalanche-talus, No. 9 (between the rivers Garabashi and Terskol).
3. Recreational land use type: a) avalanche, No. 11 (from Garbashi river to Azau); b) avalanche-mudflow, No. 14 (the basin of Donguz-Orun – Baksan to Cheget), No. 18 (the Adyrsu river basin), No. 20 (the Adyrsu river basin).
4. With engineering and communication type of land use: a) avalanche, No. 13 (area on the right side of Baksan river between the Fields of Azau and Cheget); b) avalanche-mudflow, No. 21 (the area on the right side of Baksan river between Adyrsu and Tutusu rivers).

CONCLUSIONS.

The preliminary area assessment of the avalanche hazard made it possible to clarify the number, numbering and parameters of avalanches. Landscape analysis of the territory made it possible to carry out zoning according to the degree of landscape changes by avalanches, based on the anthropogenic component.

In the study area, avalanches create completely changed so-called avalanche landscapes – natural avalanche complexes. The degree of stability of the “landscape-avalanche” system is minimal.

On the basis of field surveys, recommendations on avalanche-safe development of the avalanche formation area 2-42 have been developed. It is necessary: a) to implement verification work on compliance of anti-avalanche structures draft. When identifying design flaws they need to be eliminated; b) to establish a permanent year-round snow-avalanche monitoring on protected areas, which will allow to record avalanches and their consequences, and, in the future, based on the analysis of monitoring data to assess the status and effectiveness of avalanche protection. Since the amount of avalanches since the beginning of construction (2009) did not reach critical values (0.6 and 1.6 million cubic meters), it is not possible to judge their effectiveness with a high degree of reliability; c) to conduct a complex of geomorphological, soil and other necessary specialized studies, which will make it possible to assess the degree of transformation and stability of landscapes.

In the future, recommendations on potentially safe and sustainable development should be developed for each of the 21 allocated natural-anthropogenic geosystems. For this purpose it is necessary to take into account the leading type of DNP and exclude or limit, in the future, from economic activities the use of those types of land use that can lead to the activation of DNP.

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