

# Features of Landslide Manifestations in the Mountainous Parts of the Chechen Republic

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**Abstract.** In the distribution of landslides on the territory of the North Caucasus, there is a regularity associated with the latitudinal zonality of the climatic and geological conditions of landslide formation. On the territory of the North Caucasus, landslides of sliding, squeezing out, upflow of the current, subsidence and complex, distinguished by the mechanism of mixing, are developed. General factors - the processes of formation of landslides in all types: causing a change in the configuration of slopes (an increase in their height and steepness to values exceeding the critical ones for this type of rock; bottom and side erosion); causing a regressive change in the physical and mechanical properties of rocks (weathering, moistening of surface and ground waters); causing additional pressure on rock masses (hydrodynamic and hydrostatic pressure, seismic shocks); anthropogenic, causing changes in slopes and slopes (undercutting, and artificial watering, overloading with dumps and earthworks, vibrodynamic loads).

## 1 Introduction

Landslides are among the most dangerous geological processes and pose a threat not only to engineering structures, but can also lead to significant human casualties. Landslides can occur along the sides of quarries during the development of minerals in an open way. Landslides are encountered quite often along the banks of rivers, lakes, seas, as well as in mountainous areas. Analysis of the results of complex engineering surveys will allow characterizing the structure of landslide massifs, identifying zones of weakening associated with the main elements of the landslide, assessing the stability of landslide massifs, preventing their development and, if necessary, localizing the further movement of the landslide. A landslide is a mass of rock that slides or slides down a slope or escarpment. The formation of a landslide is a geological exogenous process, manifested in the displacement of rock masses due to a violation of their stability, under the influence of gravity, when shear stresses become greater than shear resistance. A landslide is also referred to as an area of displaced rock, including separation, transit, and accumulation zones. The construction of structures and their operation in areas of distribution or possible formation of gravitational phenomena, which include landslides, is a complex problem. In some areas, they significantly change the relief of the earth's surface, destroy the lands located on them, violate the stability of structures, buildings, roads, pipelines, entire complexes of structures, cities, destroy them, causing catastrophes with human casualties.

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According to R. Schuster, landslides cause much more total damage than floods, hurricanes, volcanic eruptions and earthquakes. All this leads to the need to constantly carry out land reclamation work to improve such areas and build a variety of anti-landslide structures. [3]

The territories are difficult to access, with absolute marks from 2800-4000 m above sea level. The composition of the first group of landslides formed in homogeneous cohesive rocks includes structural, subsidence, plastic (consistent) and landslides-landslides (Fig.1).



**Fig 1.** Landslide-flow near the village of Dachu-Borzoy

## 2 Research Methodology

Geophysical studies of landslide and landslide-prone slopes are part of engineering and logical surveys and are used to solve general geological and special tasks. The possibility of using geophysical methods is determined by the degree of differentiation of the geological section by specific electrical resistance, electrical permeability, polarizability of rocks, velocity of elastic waves in them, magnetic thermal characteristics, the ability to slow down fast neutrons and absorb gamma rays, etc.

On the territory of the Chechen Republic, the activity of the landslide process was average. Most of the manifestations were found in the region of the middle-low-mountain relief of the meganticlinorium of the Greater Caucasus. In total, 24 active landslides were identified, which destroy the roads of the republic to varying degrees. 0.031 km of paved roads and 0.081 km of unpaved roads were affected by the landslide process. The activity of landslide-scrree processes on the territory of the republic was low. A total of 4 active manifestations were identified in the high and mid-mountain areas of the meganticlinorium of the Greater Caucasus. Manifestations are developed within the sections of roads with. Kharachoy - s. Vedeno (3 manifestations) and p. Yarysh-Mardy - with. Zones (1 manifestation). No manifestations had a negative impact on the roadbed. The main factor in the activation of dangerous EGPs on the territory of the Chechen Republic remains meteorological in combination with technogenic load [8].

Observations of landslides and slips are carried out in order to determine the presence (or absence) of landslide displacement; studying the patterns of variability of slips in time and evaluating their connection with different s m and factors and; study of the spatial variability of landslide deformations on the slope; determining the location of the surface (zone) of displacement of a landslide and studying the patterns of development of deep landslides deformations; forecasting the development of a landslide (determination of the beginning of activation or attenuation of the process, etc.); evaluating the effectiveness of the implemented anti-landslide measures. The achievement of the listed goals is carried out

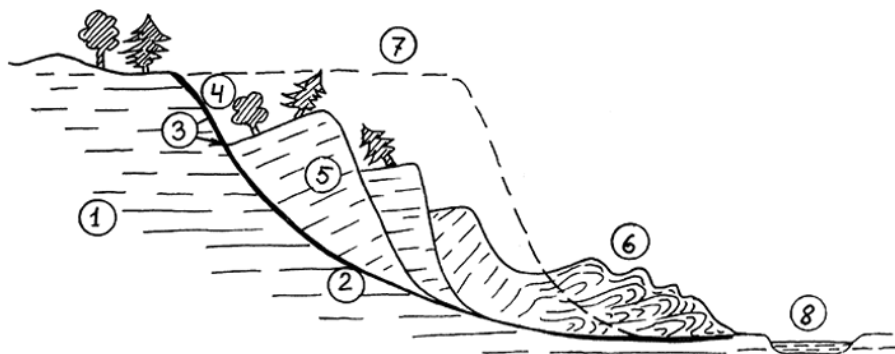
with the help of geodetic observations of the planned high-altitude the position of the benchmarks installed on the surface of the slope, the deformograph-cracks and gauges and the depth benchmarks. To provide geodetic reference points and all major landslide morphoelements, it is purposeful to carry out variously according to the result of fissure-morphological survey, carried out taking into account the genetic classification cracks. The reference and orientation benchmarks should be located outside the landslide displacement area. Benchmarks on the slope should not provide mutual visibility from the nearest observed benchmarks.

### 3 Results and Discussions

The development of landslide processes is one of the main natural disasters in the Chechen Republic. On the territory of the republic, there are many landslide areas, which together represent landslide areas. The three landslide areas identified are characterized by the greatest landslide damage and the catastrophic manifestation of displacements: Benoysky, Shatoysky and Goragorsko-Grozny. The total area subject to landslide formation within the Chechen Republic is 2.1 thousand km<sup>2</sup>. The Goragorsko-Grozny landslide region occupies the central part and the adjacent northern and southern slopes of the Tersky and Sunzhensky ridges. The area of the landslide region is 110 km<sup>2</sup>. Anti-landslide measures should be developed, as a rule, for preventive purposes, taking into account the need to ensure long-term stability of slopes intended for economic development, as well as taking into account protection requirements not the environment. In this case, the optimal one should be applied, i. e. economically viable, necessary and sufficient set of anti-landslide protective structures and measures, justified by calculations and . The following preventive measures are recommended: prohibition of undercutting and overloading of slopes, unregulated water use , destruction of vegetation, laying in trenches of cables, pipelines, etc.; restriction or complete prohibition of plowing up slopes, operation of transport mechanisms - exciters of vibrations, production of explosions and so on .; anti-landslide protection of slopes by measures.

Landslides caused by changing natural conditions usually do not start suddenly. The initial sign of landslide movements is the appearance of cracks on the surface of the earth, ruptures of roads and coastal fortifications, displacement of trees, etc. Landslides move at a maximum speed (tens of km/h) in the initial period, over time their speed gradually slows down [3].

In the structure of a landslide, a sliding surface, a landslide body, a rear seam, and a sole are distinguished. The surface along which the masses of rocks move is called the sliding surface. Under the influence of groundwater, the sliding surface gets wet, becomes slippery, and the landslide body slides along it under the action of its own weight. The contact of the landslide body with the bedrock ledge above the landslide is called the rear seam of the landslide, and the place where the sliding surface emerges in the lower part of the slope is called the base of the landslide [9]. Often, landslides have a very complex structure and represent a series of blocks sliding down along slip planes with overturning layers of displaced rocks towards the primary undisplaced slope (Fig. 2). Such landslides, sliding under the influence of gravity, A.P. Pavlov called delipsive (lat. "delipsus. - fall, slip"). The lower part of such a landslide is represented by displaced rocks, significantly crushed, crushed as a result of the pressure of moving blocks located above. This part of the landslide is called detrusive (Latin "detrusio" - collision). In places, under the pressure of landslide masses on the adjacent parts of river valleys and various reservoirs, heaving mounds arise [8].



**Fig. 2.** Scheme of the landslide structure. 1 - bedrock of the undisturbed slope; 2 - sliding surface; 3 - rear seam; 4 - landslide ledge; 5 - landslide bodies; 6 - tubercle heaving; 7 - initial position of the slope; 8 - river

In the process of field work, a map of factual material is supplemented; engineering-geological columns of workings are being built with a preliminary selection of engineering-geological elements (IGE), geological and geophysical and engineering - geological sections; documentation on the study of soil properties in the field and laboratory methods is drawn up, are compiled by an auxiliary maps and sections reflecting and working out the “working hypothesis” of the formation of landslides and engineering and geological conditions that are important for the design and construction of elements in the geological environment (presence of weakened interlayers, sliding surfaces, weathering zones, aquifers, etc.). The results of this operational processing of materials are used to refine the program for organizing and conducting field and laboratory work, constantly on-site control over their quality, clarification of the boundaries of the IGE. [5]

For territories with a wide development of landslides, it is recommended to build a map of the development forecast using the landslide method tests and a la. For landslide-prone territories, within which there are no landslides at the time of the survey, but their mass development of economics is not excluded. In the early development, forecasting should be carried out taking into account both natural and anthropogenic factors and the slump of non-formation. The probability of development of natural-anthropogenic and anthropogenic landslides in different areas is different and is determined first of all about the different susceptibility of natural conditions to anthropogenic impact and the intensity of the anthropogenic factors themselves. Slopes of a certain steepness and height are usually exposed to anthropogenic impact; rocks constituting and more probable zones of landslide displacement; groundwater with a certain depth and surface slope; the surface from the zone of weakening of a certain configuration, etc. The receptivity of each component of natural conditions can be set to the first stage with the help of expert scoring. At the same time, the principle of commensurability must be observed, in connection with which, at first, it is necessary to assess the nature and directions in the interrelationships between the significant factors, and only after that proceed with the ranking within the significant factors themselves. The total assessment of the receptivity of the main components of the natural environment represents the potential of the landslide process, and what above, it is probably the process itself. Contents of the map-scheme of recommended anti-landslide measures, rational use and protection of geological environment is defined by its name. It is not allowed to distinguish taxonomic units on the basis of “suitability” or “unsuitability” for construction.

## 4 Conclusions

The study of landslides and landslide processes is very important at the present time, since landslides pose a threat to all types of engineering structures without exception, claim the lives of many people, damage the national economy, and render agricultural land unusable. In many cases, landslides make it extremely difficult to operate railway lines and roads. The analysis of the distribution of landslide objects over the territory showed that in the considered case of catastrophic landslide activation, the majority of landslide objects fall on slopes with a steepness of 10 to 15 degrees (26.7% in total) and a northeastern exposure (16.08% in total). The put forward assumption about the dependence of the length of erosion cuts and the number of landslide manifestations was not confirmed. The vast majority of landslide manifestations represented two main types in terms of soil displacement mechanics. These are landslides - streams and landslides of landslide - scree type.

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