MUDFLOW HAZARD IN THE ARGUN RIVER BASIN: ASSESSMENT AND MAPPING

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Abstract

Mudslides, as well as the manifestation of landslides, rockfalls, desertification of the territory, seasonal floods, hail, are one of the negative natural processes that manifest themselves in the mountainous regions of the republic, damaging communications. Villages are also formed in parts of areas that economically represent only areas of mountain grazing, are poorly populated or not populated at all, but nevertheless do not lose their relevance and, like other inhabited areas, require studying the manifestations of natural processes. The amount of precipitation and the level of moisture in the mountainous part of the republic are the highest, so the influence of moisture on the surface shapes is the most significant here. The territory of the Argun River basin is located in a zone of 5-7-point seismicity, which increases from north to south. The most populated Chechen inclined plain and the northern slopes of the Greater Caucasus are located in a zone of increased seismic activity. An assessment of the possible activation of mudflow processes as a result of climate change is given. The conducted qualitative analysis of changes in meteorological factors influencing the formation of mudflows (precipitation, temperature regime) in the region according to data from various weather stations. An increase in air temperature and an increase in the amount of precipitation — both average annual values and values for the warm and cold period - have been revealed; the tendency of glaciers to retreat is clearly observed. A study of climate change over a long period shows that mudflow activity in the Argun River basin has increased significantly.

Keywords: mudflow processes, climatic changes, precipitation, temperature regime.

I. Introduction

The borderline natural and geographical position of the republic at the junction of the large European plains and the powerful mountain system of the Greater Caucasus determines many of its features. All elements of the natural landscapes here are formed under the influence, on the one hand, of the barrier role of the mountain system from the south, as a result, subtropical warm air masses do not penetrate into the territory of the republic, moisture intake to the flat part from the air basins of the Black and Mediterranean Seas decreases. On the other hand, the complete openness from the north, north—west and east to the penetration of Arctic, Atlantic and continental Siberian, Central Asian air masses in different periods of the year determines the aridity of the northern and moisture-sufficiency of the foothill plains of the republic with a generally high level of solar insolation.

The combination of all these factors determines the vegetation cover and fauna and, with their participation, the formation of landscapes over the previous millennia, which we see in the republic from north to south today. The variety of natural landscapes and, accordingly, soil-climatic, orographic and other conditions in the republic, from the northern lowlands to the snow-

covered highlands in the south, create favorable conditions for human activity. Within the republic, he can choose a place of residence in a wide variety of natural conditions, which in many places have unique properties that contribute to health, its restoration and longevity. Tectonically— it is a large monocline complicated by anticline folds, the largest of which are the Benoy in the east and the Dattykh between the Fortanga and Assa rivers in the west. Reaching a width of up to 30 km in the western part, the Black Mountains noticeably narrow to the east, where their width does not exceed 12-15 km. The system of low-mountain ranges of the Black Mountains is composed of Cretaceous and Paleogene limestones, marls and sandstones, which are easily exposed to surface (exogenous) destruction. As a result, the Black Mountains have soft, rounded outlines. The ridges are low, the prevailing heights are 1000-1100 meters, they represent a series of mountain folds gradually descending to the north. Transverse valleys formed by numerous rivers and longitudinal depressions divide the Black Mountains into a number of separate mountain ranges. River valleys often expand, and the mountains surrounding them seem to recede, forming vast basins in places. The largest of these basins in the Black Mountains is located at the confluence of the Chanta-Argun and Sharo-Argun rivers, near the village of Chishki. From the foot to the peaks, the Black Mountains are covered with forest, which gives them a dark color from afar. Hence their name. The Black Mountains represent a zone of foothills. The actual mountainous part of the republic is located on the northern slope of the Greater Caucasus.

In the sedimentary thickness of the Caucasian Ridge, strong and easily destructible rocks alternate, which led to their division into a number of longitudinal ridges. Ridges were formed where resistant rocks were exposed, and valleys separating them arose in places where less durable rocks spread. The pasture Ridge (next to the south of the Black Mountains) has a complex structure. In the western part, it forms two, and in some places three parallel ridges. Strata of Upper Cretaceous limestones, dolomites, marls are exposed to the south by a steep cliff, and in the north they fall gently at a slight angle (up to 140). Many peaks of the Pasture Range rise to a height above 2000 meters. The next one to the south is a Rocky ridge, which is especially distinguished by its asymmetry: the southern slopes are steep, almost vertical in many areas, and the northern ones are gentle. In the valleys of the rivers crossing the limestone ridges, narrow and extended sections alternate.

In places where the river cuts into the solid limestone rocks composing the ridges, its valley has the appearance of a deep narrow gorge with steep rocky slopes. Even on a hot, sunny day, twilight and coolness reign in the gloomy gorges of such a gorge. The river valleys in the gaps between the ridges are completely transformed. Here, the mountains form vast light basins, elongated, as a rule, along the course of the river. Mountain villages and villages are usually located in such places convenient for settlement. Along the southern border of the republic stretches a chain of silvery-white snow-capped peaks of the Lateral Ridge, which in this area is a thousand meters higher than the Main Caucasian Ridge.

Between the Lateral Ridge and the Rocky One (to the north) is the North Jurassic intermountain basin, which reaches its greatest width to the west, within the Central Caucasus (up to 35 km) and within the republic is manifested by a number of separate basins: Galanchozhskaya, Itum-Kalinskaya, Sharoyskaya, Makazhoyevskaya. The lateral and Watershed (Main) ridges are composed of lower — Middle Jurassic Mesozoic clay shales. In the Chechen Republic, the links of the Lateral Ridge are the Pirikitelsky ridge with the peaks of Tembolt-Lam (Tebulos-Mta), Kamito-Dattakh-Kort (4271m), Donos-Mta (4178m) and the Snow Ridge, the highest point of which is Mount Diklos—Mta (4274 meters). Eleven peaks in Chechnya have a height of more than 4,000 meters. Tembolt Lam peak (4494 m above sea level) is the highest not only in Chechnya, but also in the entire Eastern Caucasus. Exogenous (external) factors that form the morphological appearance of the relief include: water, climate, fauna and flora, human activity, and the nature of rocks on the surface. Their influence is complex, zonal or altitudinal. In the Chechen Republic, the relief of the highest mountains in the south is directly determined by eternal snow and ice. The formation of mudflows in the Chechen Republic is due to a combination of geological, climatic and geomorphological conditions: the presence of seleforming soils, sources of intensive watering

of these soils, as well as geological forms contributing to the formation of sufficiently steep slopes and channels.

II. Methods and material

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III. Results and discussion

The Argun River basin is characterized by the complexity of the surface structure, which is associated with the tectonic structure and geological history of development. This has a decisive effect on orohydrography, climatic conditions, in particular precipitation and temperature conditions, which naturally contributes to a high probability of mudflow processes. The abundance of precipitation contributes to an increase in the moisture content of rocks, significantly increasing their mass and increasing the effects of gravitational forces on soil masses, this leads to the rupture of strong structural bonds in rocks, changing the consistency of soils to plastic and even fluid. Reduction of structural bonds in rocks on slopes, forming dynamic changes in slope landscapes.

In various regions of the republic, with abundant precipitation, only a small part of the moisture is infiltrated, and most of it quickly flows down the slope. In the areas of permafrost, rapid and deep thawing of frozen rocks in spring and summer favours the development of mudflows: on the slopes of the northern exposure to solifluction phenomena, on the southern ones — outflows, which, with abundant precipitation, can turn into active mudflows. Argun Gorge is one of the most dangerous mudslides in the Chechen Republic. The zone of occurrence of mudflow processes here are both the channels of numerous tributaries of the Argun themselves, as well as the channels of temporary watercourses, which, with prolonged precipitation, often turn into violent water-mud flows (Figure 1).

The physical and mechanical properties of the constituent territories of the Argun Gorge determine the features of their destruction during the active regime of atmospheric precipitation, the nature of which undergoes significant changes under the influence of ongoing changes in the planet's climate. Geological and geomorphological processes of exogenous origin depend on the resistance of rocks with different strengths to external influences. Our research has shown that over the past decade, there has been a significant intensification of mudflow processes in the study area due to ongoing climate changes.

The study area is composed of loose rocks of Neogene age that are easily susceptible to destruction, therefore even slopes and hollows with a small slope are potential zones of mudflow generation. The Argun River basin belongs to the zone of significant waterlogging, where the annual amount of precipitation is 700-1100 mm or more. Mudflows arising in the upper reaches of

the Argun River basin consist of a mixture of water, clay and pebbles.

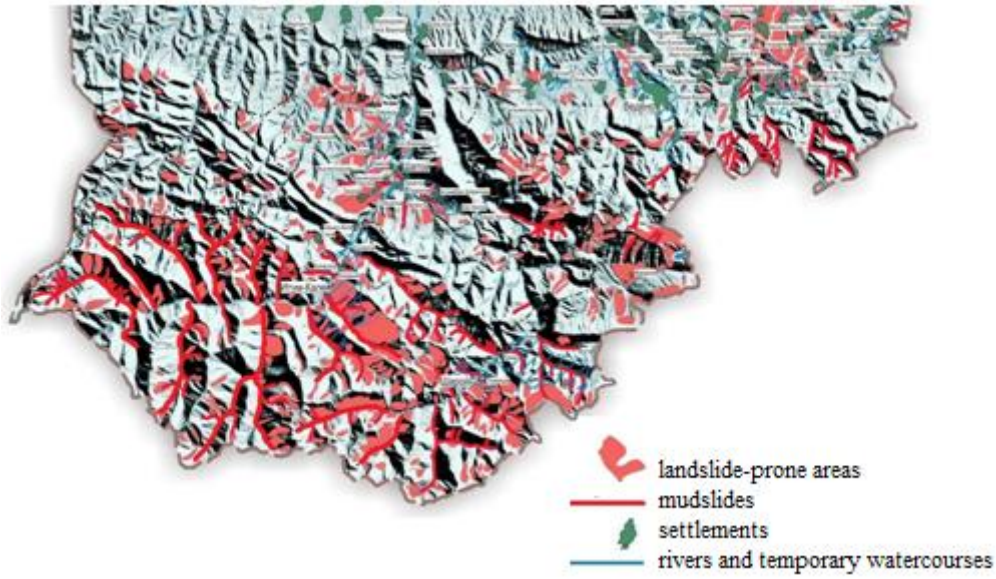

Figure 1: Map of catastrophic natural processes in the Chechen Republic

The ongoing mudflow processes in the Argun River basin belong to the rain by their genesis. The snow and glacial type of mudflow processes in the basin are manifested in the high-altitude part.

Sources of solid nutrition of mudflows can be: glacial moraines with or without loose filling; riverbed blockages and clutter formed by previous mudflows; woody and vegetative material. Sources of water supply for mudslides are: rains and downpours; glaciers and seasonal snow cover (during the melting period); waters of mountain lakes. Glacial mudflows are also characteristic of high-altitude basins with developed modern glaciers and glacial deposits, such as the upper part of the Sharo-Argun and Chanta-Argun rivers and their tributaries.

The main source of their solid nutrition are moraines, which are involved in the process of mudflow formation during the intensive melting of glaciers. The immediate causes of mudslides are also the intense melting of snow and ice, less often earthquakes. For the formation of mudflows, it is necessary to have: a sufficient number of products of rock destruction on the slopes of the basin; a sufficient volume of water to flush or demolish loose solid material from the slopes and its subsequent movement along the channels; a steep slope of the slopes and watercourse. The manifestation of mudflows forms the dynamics of the landscapes of the upper Chanta-Argun. The stability of subalpine and mountain-steppe landscapes is disrupted, the underlying rock is exposed, vegetation and a fertile layer flow down together with the mud mass, transferring subalpine and mountain-steppe landscapes into mudslides.

The prediction of glacial mudflow hazard is based on the identification of abnormal deviations in the characteristics of water and thermal regimes. For this purpose, information from hydrometeorological stations and posts located in this mountainous area is used. The forecast of glacial mudflow hazard consists in predicting in advance the possibility of a breakthrough of moraine and dammed lakes, as well as intraglacial reservoirs. According to the composition of the transferred solid material, mudflows are usually distinguished as follows: mudflows, which are a mixture of water and fine earth with a small concentration of stones (volume weight of the stream is 1.5–2.0 t/ m3); mudstone flows, which are a mixture of water, fine earth, pebbles, gravel, small stones; large stones are also found, but there are few of them, they sometimes fall out of the stream, then begin to move with it again (the volume weight of the stream is 2.1–2.5 t/m3); water-stone streams, which are a mixture of water with mostly large stones, including boulders and rock fragments.

The area of the upper reaches of the Sharo-Argun River basin is characterized by a fairly high mudflow activity. The area belongs to the waterlogging zones. Two factors affect the mode and amount of precipitation here: atmospheric circulation and the presence of high ridges of the Caucasus Mountains, which increase precipitation in its mountainous part.

Precipitation by season is characterized by great unevenness, due primarily to the intrusion of moist air masses into its limits, which are brought by the Atlantic cyclone. Since the influence of the Atlantic cyclone is manifested in the North Caucasus mainly in summer, the highest humidity and maximum precipitation are observed in May — July. At the same time, there is a sharp decrease in their annual number in the direction from south to north — from the mountains to the plains.

The amount of precipitation in the mudflow-prone zone of the Chechen Republic per year is 800-1000 mm or more. Mudflows arising in the upper reaches of the Sharo-Argun River basin consist of a mixture of water, clay and sand particles. The solution has the properties of a plastic substance. The stream seems to represent a single whole. Unlike a water stream, it does not follow the bends of the riverbed, but destroys and straightens them or passes over an obstacle. In places where there are significant riverbed slopes, the presence of loose material or clay, easily collapsing rocks, small sedimentary mudflows are formed caused by heavy rainfall of high intensity.

For the development of mudflow manifestations, in general, in the Argun River valley, hemorphological features contribute: a direct erosive-tectonic relief with a clear morphological reflection of the structural elements of the Montenegrin monocline, disturbed by the latest Neogene folding (anticline protrusions and flexures); the relief of the territory is relatively young, actively forming in the confrontation of intense modern uplifts and progressive erosion. increased precipitation from 800 to 1000 mm or more. per year. Moistening of rocks increases their mass and, accordingly, the effect of gravitational forces on them, which is accompanied by a weakening of the strength of structural bonds in them, a change in the consistency of soils to plastic and even fluid.

All this leads to a decrease in the strength (friction and adhesion) of rocks on the slope. With the stormy nature of precipitation, only a small part of the moisture is infiltrated, and most of it quickly flows down the slope. Also, the formation of mudflows is associated with anthropogenic activities in mountainous areas, construction and excessive grazing of livestock. According to the genesis, three main genetic types of mudflows are distinguished: rain, snow and glacial, which have a zonal distribution and significant differences in the mudflow regime.

The genetic type of mudflows characterizing the area means the dominance of this type of mudflows here and does not deny the presence of rare mudflows of a different genesis. In the mudflow basins of the Argun River, all three genetic types of mudflows are formed, but most of them belong to the rain type. Sedimentary mudflows are formed here with the transformation of mudstone flows as they move along the main channels. Spring activation of slope processes is possible during the cold autumn-winter season, when precipitation accumulates in the form of snow, initially falling on the unfrozen ground. In this case, during the spring snowmelt, almost all the meltwater will be filtered into the ground.

The precipitation of snow on the frozen ground will cause the predominance of surface runoff over infiltration during its spring melting. The nature of the influence of waterlogging is largely determined by the physical and mechanical properties of rocks, the peculiarities of their change when changing the regime of climatic indicators. Thus, under the same weather, the development of exogenous geological processes occurs differently in rocks of different genesis, with different strength properties, weathering rate, water resistance, etc.

IV. Conclusion

Mudflow processes are widely developed in the territory of the Argun River basin in the Chechen Republic in the medium- low-mountain and high-mountain terrain. With active climate change, it

is possible to predict a high degree of mudflow activity in the high-mountain and medium-low-mountain parts of the Argun River basin.

The main factors of the predicted mudflow activity are climatic, to a lesser extent anthropogenic and technogenic. When abnormally heavy heavy rains fall, high activity of mudflow processes is possible in the middle-low mountains, in the middle and upper reaches of the Argun River and its tributaries. Mudflow activity is highly likely to occur in mudflow-prone areas in the middle and upper reaches of the rivers of the Argun River basin. Linear infrastructure objects (highways, communication lines, power lines, gas pipelines), parts of settlements fall into the impact zone of landslides. Climatic changes that have led to a change in meteorological indicators to an increase in atmospheric precipitation will lead to an increase in the number of mudflow processes in the Argun River basin.

References

[1] Bajrakov I. A., Gakaev R. A., Idrisova R. A. (2007) Vliyanie sovremennyj ehkzogennykh processov na landshafty Chechenskoj Respubliki. V sbornike: Materialy po izucheniyu Chechenskoj Respubliki Mezhvuzovskij sbornik nauchnykh trudov.. Bajrakov I. A., k.b.n., docent CHGU (otv. redaktor), Bolotkhanov EH. B., k.t.n., docent CHGU (zam. otv. redaktora), Avtaeva T. A., k.b.n., docent CHGPI, Idrisova R. A. st. prerod. kafedry fizicheskoj geografii CHGU. Nazran', 2007. S. 14–34.

[2] Gakaev R. A., Gacaeva L. S., Kerimov I. A. Geomorfologicheskie osobennosti vozniknoveniya selej v gornoj chasti Chechenskoj Respublike. V sbornike: Mezhdunarodnaya nauchnaya konferenciya, posvyashchennaya 500-letiyu armyanskogo knigopechataniya i 65-letiyu osnovaniya SNO EGU Materialy Mezhdunarodnoj nauchnoj konferencii, posvyashchennoj 500-letiyu armyanskogo knigopechataniya i 65-letiyu osnovaniya SNO EGU. 2013. S. 93–96.

[3] Kerimov I. A., Gakaev R. A., Daukaev A. A., Gacaeva L. S. Seli i ikh proyavlenie v Chechenskoj respublike. V sbornike: Sovremennye problemy geologii, geofiziki i geoehkologii Severnogo Kavkaza. Materialy Vserossijskoj nauchno-tekhnicheskoj konferencii. otvetstvennyj redaktor Matishov G. G.. Groznyj, 2011. S. 433–434.

[4] Perov V. F. Selevedenie : ucheb. pos. / V. F. Perov. – Moskva : MGU, 2012. – S. 274

[5] Panov V.D., Bazelyuk A.A., Lur'e P.M. Reka Terek. Gidrografiya i rezhim stoka. — Rostov-na-Donu: Donskoj izdatel'skij dom, 2015 607 s.

[6] Chernomorec S. S. Selevye ochagi do i posle katastrof : monografiya / S. S. Chernomorec. – Moskva : Nauchnyj mir, 2005. – 184 s.