International Journal of Mining Science (IJMS)
Volume 9, Issue 2, 2024, PP 9-12
ISSN 2454-9460 (Online)
DOI: http://doi.org/10.20431/2454-9460.0902002
www.arcjournals.org

Main Factors of Mudflows Formation and Tracking of Movement of Mountain Rock Fragments

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Abstract: *The article discusses the issues of mudflow formation. Particular emphasis is placed on taking into account two main indicators of mudflows: water flow and the content of rock fragments.*

It is recommended to organize a mode network for quantitative assessment of the intensity of denudation processes (weathering and washing); dynamics of soil and subsoil moisture in cross-sections of slope and channel sediments, soil surface temperature, any solid material carried out of this catchment (nano-separators, silt-separators).

Control of the movement of debris and soil on the surface of the catchment is possible by means of 1) research on the gravitational movement of debris material on the slopes (monitoring the movement of fixed objects (marked stones) along profiles and with the help of aerospace methods, etc.), 2) monitoring the washing of fine soil from the surface slopes according to the established profiles, 3) continuation of the analysis of changes in the cross-sections of the links of the hydrographic network of various orders to determine the movement of sediments through the channel network and the calculation of the balance of deformations in the sections.

In the future, there is a possibility of creating a mobile block of "surface condition" information for forecasting mudslides during other mudslide-hazardous manifestations (rains, intense snowmelt, etc.).

Keywords: *Mudflows, rock fragments, slopes, weathering, showers, observations*

1. Introduction

The study of mudflows has been carried out for a long time [1-11, etc.]. On the territory of Ukraine, the oldest studies of villages date back to the end of the 19th century in the Crimea [1]. This is due to their destructive effect, leading to significant economic losses in economically developed areas and retarding the development of other areas where such phenomena are also observed [5, 11, etc.]. Flooding has become especially active since the 40s of the 20th century in connection with deforestation [8-9]. The occurrence of mudslides is usually periodic (9-10, 14-19 years, etc.) depending on the accumulation of friable debris in areas prone to mudslides and the occurrence of dangerous meteorological conditions (long rains, heavy downpours, etc.) [9, 11, and others].

Most often, mudslides are formed by rains of 50-100 mm/day - 53% of cases, and 20-50 mm/day - 30% of cases. Precipitation of more than 100 mm/day is relatively rare and occurred in 14% of cases of mudslides. Light rains of 10-20 mm/day formed only 3% of the observed villages [13]. It should be noted that not only intense rains lead to the formation of mudslides, but also long-term precipitation of low intensity leads to the emergence of mudslides due to the flooding of rocks by the surface of the slopes [14]. Moreover, in this case, mudflows are longer than during intense precipitation [14].

2. Materials and Methods

According to [8], when studying mudslides caused by rains and downpours, it is important to know the layer of precipitation during the rain, the intensity, duration, frequency and area of distribution of these rains, as well as the conditions necessary for their precipitation. Indicators of the possible fall of heavy rain include [8] the vertical stability of the atmosphere, an indirect indicator of which is first of all the surface air temperature.

According to the data of the Carpathian Selestok Station [15], the formation of mudslides in the study area occurs during intense torrential rainfall. The removal of friable material occurs due to the disruption of the self-removal of the channel, intensive reworking of the banks and undercutting of the slopes in the landslide areas. The mudflows observed in this case are nanowater.

The main research method was the analysis of literary sources and the list of observations on the hydrometeorological network.

The presence of observations on the state hydrometeorological network of the components of the mud formation process was subject to analysis.

According to M.M. Aisenberg and others. [5, 13, etc.] in the Ukrainian Carpathians, water-stone villages of mostly torrential origin, originating mainly in the middle mountains, prevail. The most destructive villages are in the Prut river basin, followed by the Dniester river and less destructive ones in the Tisza river basin. The main sediment-forming factors are the catchment area, the length of the watercourse, the longitudinal slope, the runoff coefficient, and the amount of precipitation. The methods of studying villages are expeditionary studies of the consequences of villages, observation of atmospheric precipitation and cartographic methods, etc.

The purpose of the study is to identify ways of researching the ways of formation of one of the main components of mudflows - friable debris material on the slopes, its advancement along the slopes and links of the hydrographic network and its accumulation to the state of mudflow.

3. Results

At present, in our country, in the study of mudflows, quantitative information on the formation of mudflows is mainly collected. Catalogs with information about villages are being created, spatial identification of village basins is underway on paper (maps) and electronic media. But so far, the creation of an empirical model of the formation of mudflows is still a long way off. In order to predict mudflow processes, it is necessary to know the intensity of solid material entering the channel network and its dependence on such factors as the lithology of bedrock and cover deposits, morphometric characteristics of the catchment, and geo-botanical conditions. These factors are considered constant. Variable factors can be considered hydro meteorological conditions and the degree of preparedness of debris material to be involved in the mud flow. The analysis of the existing system of mudslide monitoring showed that it is more focused on recording the consequences of mudslides than on their forecasting. To reorient the system of observations of villages to their forecasting, the following are required: 1) maps of the distribution of rainfall in the landslide-prone area; 2) maps of water run-up time in the mud basin; 3) monitor the movement of friable debris and soil along the slopes of the rural catchment to the hydrographic network and along it.

Frost weathering and solefluction [16], which create loose material on treeless, often rocky slopes, are among the factors of the formation of brittle and detrital material. In the mid-mountains and low mountains, mud pockets are confined mainly to erosion processes and are associated with the erosion of un cemented rocks on unstable steep slopes covered with loose deposits of terraces, screes, landslides, etc.

The movement of debris on the slopes can occur not only due to the influence of rainwater, gravity and weathering processes play an important role here. Thus, in the movement of curums, 2 types of movement are distinguished [17]: 1) debris moves as a result of sliding or rolling on the surface of the slope, 2) the movement of debris is associated with temperature fluctuations as a result of changes in the volume of debris, freezing and melting of water in pores formed ice. Temperature movement is the reason for the reversal of debris in the area perpendicular to the surface of the slope.

When the fragment reaches the limit angle of inclination, it falls over the face and moves along the slope [17]. Stereo photogrammetric and geodetic methods for determining the mass flow on the slope are mentioned among the methods of studying the movement of debris on the slope [18, 19, etc.].

At the "Voron" observation point in Crimea, routine observations of the processes of formation of the solid component of mudflows were carried out. The amount of incoming solid material due to washing and weathering depends mainly on the lithology of the bedrock and the steepness of the slope [20, 21]. The most intensive processes of destruction and subsequent transportation of material occur on steep slopes and along thalwegs of streams and ravines with a steepness of more than 15°. In feeding villages, scree plays a significant role as a solid component [16, 22, etc.].

4. Conclusions

It is necessary to organize a mode network for quantitative assessment of the intensity of denudation processes (weathering and washing); dynamics of soil and subsoil moisture by cross-sections of slope and channel sediments, soil surface temperature, amount of solid material carried out of this catchment (nano-catchers, silt-catchers) [16]. Control of the movement of debris and soil on the surface of the catchment is possible by means of 1) research on the gravitational movement of debris material on the slopes (monitoring the movement of fixed objects (marked stones) along profiles and with the help of aerospace methods, etc.), 2) monitoring the washing of fine soil from the surface slopes according to the established profiles, 3) continuation of the analysis of changes in the cross-sections of the links of the hydrographic network of various orders to determine the movement of sediments through the channel network and the calculation of the balance of deformations in the sections.

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The author has no conflict of interests.

Work was performed during free time from work. Financing of this work was absent.

Statements & Declarations Funding

The author declares that no funds, grants, or other support were received during

the preparation of this manuscript.

Author Contributions

All the work presented in this paper was conducted by the author.

Conflicts of Interest

The author declares no conflicts of interest regarding the publication of this paper.

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Citation: *Budnik Svetlana., Main Factors of Mudflows Formation and Tracking of Movement of Mountain Rock Fragments“, International Journal of Mining Science (IJMS)”, 9(2) pp.9-12,*
DOI: http://doi.org/10.20431/2454-9460.0902002.