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ANALYSIS OF THE PRECIPITATION REGIME THAT TRIGGERED THE LANDSLIDE IN NERGEETI (IMERETI, GEORGIA) ON FEBRUARY 7, 2024

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Abstract. *The results of the analysis of the precipitation regime that caused the landslide in Nergeeti (Imereti, Georgia) on February 7, 2024 are presented (day with landslide and 3, 5, 7, 10, 20 and 30 days before its onset for meteorologycal stations Kutaisi and Zestaponi). These data were compared with similar generalized data for 75 landslide cases in Imereti. In particular, it was found that the heavy precipitation regime that triggered the landslide in Nergeeti was observed quite rarely in the Imereti region – in 12% of cases out of 75 for the amount of precipitation on the day with the landslide and only in 8% of cases for the accumulated amount of precipitation over 30 days.*

Key Words: *landslides, atmospheric precipitation, rainfall triggering, Imereti, Georgia.*

Introduction

Existing landslide maps in Georgia mainly take into account time-independent spatial factors (slope steepness, lithology, soil and vegetation cover, etc.) and ignore or give very little weight to precipitation [1]. However, recent publications indicate that intense or extreme precipitation may be one of the main causes of landslide activation [2, 3]. Recently, a number of studies have been conducted in Georgia to assess the short-term (days, months) and long-term (century-long) effects of precipitation on landslide occurrence [4-9].

In particular, in the work [7], based on data on 174 landslides with known coordinates and the time of their descent, data are presented on the accumulated amount of precipitation on the day of the landslide and for 3, 5, 7, 10, 20 and 30 days before their activation for 11 regions of Georgia (including Imereti with 25 cases of landslides). Based on these data, average threshold values of precipitation amounts (level, mm) were obtained depending on their duration in hours before landslide activation for Georgia and its individual regions.

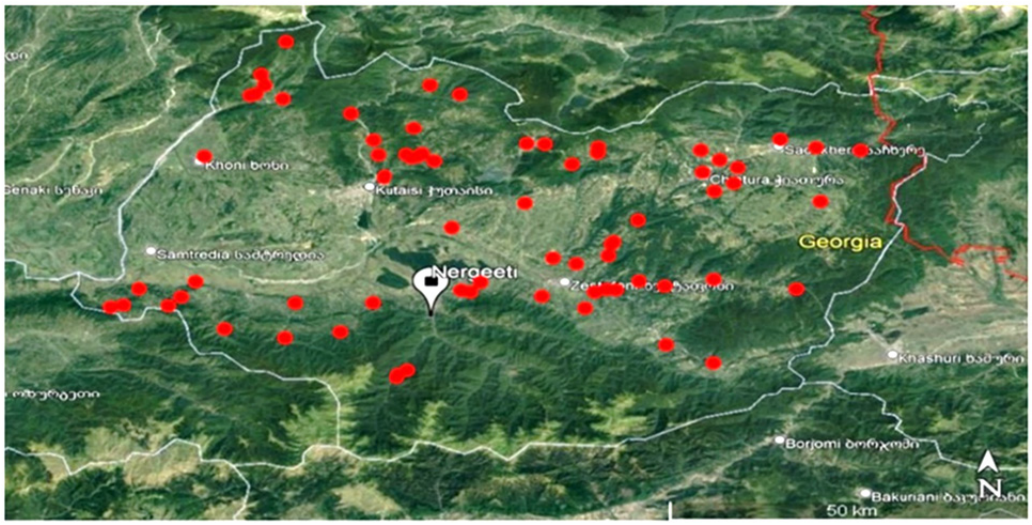

Fig. 1. Distribution of landslides on the territory of Imereti.

Currently, taking into account the information from the first created catalogue [10], there are data on 537 landslides in Georgia with known coordinates and activation time up to 2022 (including 75 landslides for Imereti, Fig. 1). Accordingly, we have already created an updated database on the precipitation regime, compared to the work [7]. This database allows for a more detailed analysis of the role of precipitation in landslide activation both in the past and present, as well as forecasting this activation.

In 2024, there were several cases of landslides with severe consequences in Georgia.

On the night of February 6-7 (around 1-2 am) in Western Georgia in the village of Nergeeti in the Baghdati municipality on the right slope of the Khanistskali River valley a rock landslide process was activated (Fig. 1, 2). The landslide developed in the lower part of the slope, on a very steep inclined surface (60-65°), in highly depleted sandstones, tuffs and argillites. The height of the landslide canopy is 30 meters, the width of the landslide in the upper part is 20-25 meters, in the lower part 90-100 meters. The approximate volume of the landslide mass that entered the dynamics is 150000 m^3. Along with complex tectonic and morphological conditions, the origin and activation of the landslide process were mainly associated with heavy precipitation that fell on February 5-6-7.

Fig. 2. Landslide in Nergeeti [https://www.radiotavisupleba.ge/a/32895673.html].

The landslide completely destroyed 4 residential houses and blocked the central highway passing through the right slope near the Khanistskali River. The number of victims of landslides in the village of Nergeeti amounted to nine people [https://www.apsny.ge/2024/other/1707392803.php].

During these same days, in the highland Adjara, a mud mass covered four houses. Two people died, one was rescued and transported to a medical facility [https://www.ekhokavkaza.com/a/32809564.html].

At this stage of the research, an analysis of the precipitation regime that caused the landslide in Nergeeti on February 7, 2024 (the day with the landslide and 3, 5, 7, 10, 20 and 30 days before it began for the Kutaisi and Zestafoni meteorological stations) was carried out in comparison with similar generalized data on 75 cases of landslides in Imereti. The results of this analysis are presented below.

Study area, material and methods

Study area – Imereti region of Georgia. The data of Georgian National Environmental Agency about the daily sum of atmospheric precipitation are used. Data on landslides with known coordinates and time of their descent are taken from [7,10].

In the proposed work the analysis of data is carried out with the use of the standard statistical analysis methods.

Results

In Table statistical characteristics on the accumulated sum of precipitation data of meteorological stations in days with landslide and 3, 5, 7, 10, 20 and 30 days before their onset in Imereti for 75 landslides and also in Kutaisi and Zestaponi in day and before landslide in Nergeeti (mm) are presented.

Table. Statistical characteristics on the accumulated sum of precipitation data of meteorological stations in days with landslide and 3, 5, 7, 10, 20 and 30 days before their onset in Imereti for 75 landslides and also in Kutaisi and Zestaponi in day and before landslide in Nergeeti (mm).

Variable	Sum 1 day	Sum 3 days	Sum 5 days	Sum 7 days	Sum 10 days	Sum 20 days	Sum 30 days
	75 landslides in Imereti						
Mean	10.8	25.4	37.8	47.9	62.0	105.1	142.5
Min	0	0	0	0	0	23.2	32
Max	100.7	180.4	189.8	203.3	258.8	409.4	414.4
St Dev	21.5	38.9	42.1	45.8	52.0	78.0	79.6
St Err	2.5	4.5	4.9	5.3	6.0	9.0	9.2
99.99%(+/-)	9.7	17.5	18.9	20.6	23.3	35.1	35.8
CONF-L	1.1	7.9	18.9	27.4	38.7	70.0	106.7
CONF-U	20.4	42.8	56.7	68.5	85.4	140.1	178.3
	Landslide in Nergeeti						
Kutaisi	28.5	93.1	114.0	114.0	114.4	167.7	272.2
Zestaponi	24.0	103.0	122.0	122.0	122.0	192.0	262.0
	% from monthly mean of atmospheric precipitation in January in 1936-2024						
Kutaisi	18.6	60.8	74.5	74.5	74.8	109.6	177.9
Zestaponi	15.7	67.3	79.7	79.7	79.7	125.5	171.2

As follows from this Table, in Imereti the average accumulated precipitation amount associated with landslides varies from 10.8 ± 9.7 mm (day with landslides) to 142.5 ± 35.8 mm (30 days before landslides). In one case out of 75, the precipitation amount on the day with a landslide exceeded 100 mm (landslide in Khoni on July 8, 2016). Also, in one case out of 75, the accumulated precipitation amount for 30 days before landslides exceeded 414 mm (landslides in Samtredia on October 16, 2017).

Comparison of precipitation data at meteorological stations in Kutaisi and Zestaponi (25.6 and 19.3 km from Nergeeti, respectively, Fig. 1) with generalized data on landslide-related precipitation for Imereti as a whole shows that Nergeeti experienced an extreme precipitation regime. Thus, the accumulated precipitation amount for three days before the landslide and more at the indicated stations significantly exceeds the corresponding values of the 99.99% upper confidence interval of the average precipitation value for 75 landslide cases.

The average monthly precipitation in January in Kutaisi and Zestaponi in 1936-2024 is 153 mm. The precipitation amount for three days before the landslide was 61-67% of this climatic norm, and the precipitation amount for 30 days before the landslide exceeded this norm by 78% and 71%, respectively.

It should also be noted that for 75 cases of landslide triggering, the daily precipitation amount exceeding 30 mm was observed in 12.0% of cases, and the accumulated precipitation amount for 30 days exceeding 275 mm was observed in only 8.0% of cases.

Conclusion

In general, the settlement of Nergeeti is considered a landslide-hazardous area of Georgia (Fig. 1) and the Georgian National Environmental Agency issued a warning about the possible activation of landslide

processes here. In addition to Nergeeti, such a warning has also been issued for the settlements of Dimi, Obcha I, Obcha II, Tsitelkhevi, Persati, Shubani and Zegani.

However, the problem is to predict the location and time of activation of landslide processes relatively accurately, taking into account various factors, including precipitation regime (ground-based and satellite data on daily precipitation). We are currently working on solving this problem using all available information on landslides in Georgia and machine learning methods.

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