Debrisflow Hazard Assessment in Georgia

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Abstract:

Geological Hazards have always caused and still creates a threat to the important part of the population, also causes damage/destroy of existing infrastructure facilities. In the last decades, protection of the population from debrisflow hazards and safe operation of infrastructure objects became significant social-economic and geoecological problem for the most countries in the word. These problems are more in countries with the complicated geology, relief, climate, seismicity, human activities (Gaprindashvili M. et. al 2021; Fourth National Communication of Georgia 2021).

Georgia belongs to the most complicated region among the world's mountainous countries with development scale of debrisflow hazard, recurrence of these processes, and with negative impacts to the population, infrastructural objects, agricultural lands and environment, and the most tragically, it causes human casualties (Fig 1).

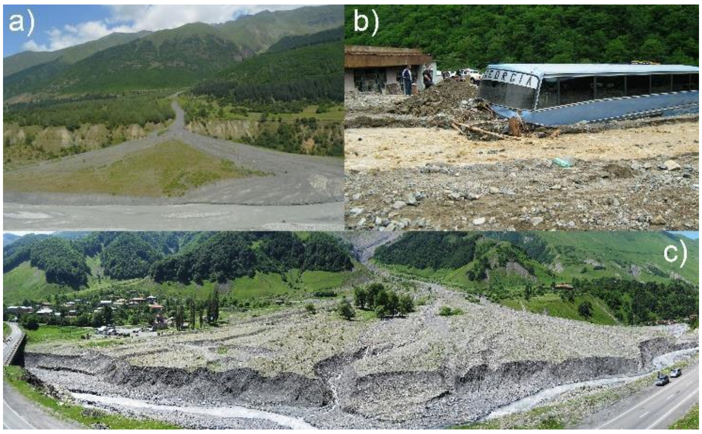

Fig. 1. Debrisflow hazards in Georgia: a) Mestia Municipality, Samegrelo-Zemo svaneti region; b) Rikoti pass – Shida Kartli region; c) Dusheti municipality, Mtskheta-Mtianeti region.

Hundreds of settlements, infrastructure objects are periodically affected by debrisflow disaster (Tsereteli E. et. al 2022). Annually the cases of debrisflow processes increase significantly. During the period of 2011-2023 the activity of debrisflows has been recorded in 2973 river gorges/ravines throughout the country (Fig. 2).

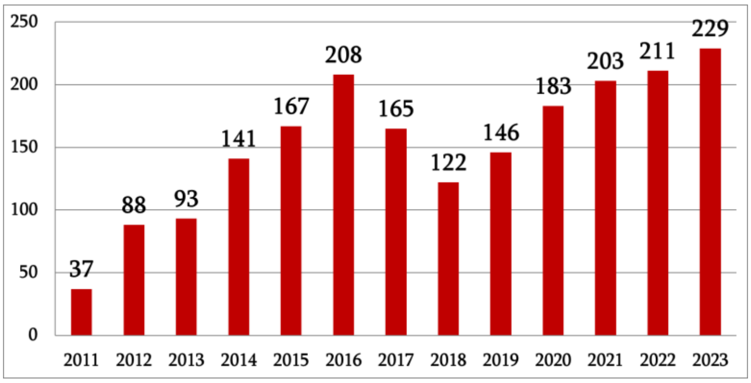

Fig. 2. Debrisflow hazards recorded in the territory of Georgia in 2011-2023 (Source: Gaprindashvili M., et. al, 2024)

Activation of debrisflow hazards and their risk depends on the geological environment, such as lithological composition of the rocks of the territory, their physical and mechanical properties and energy potential of terrain, as it is known that development of hazards at high hypsometric levels is faster and more intense. Accordingly, the magnitudes of the slope of the relief surface and the erosive intrusion depths of the rivers/gorges, the coefficients of horizontal divisions and, most importantly, the tensions of the gravity fields increase, together with process-driven factors such as meteorological events, seismicity and anthropogenic pressure (Gaprindashvili M. 2022).

Different methods are used for debrisflow hazard asssessment, which is based on the data availability: Qualitative, Quantitave, Rapid Mass Movement Simulation/Modelling, Spatial Multi Criteria decision-making (SMCE) et al. In Georgia different researches were conducted for the purpose of debrsiflow Hazard Assessment (Gaprindashvili G., et al. 2018, Gaprindashvili M. 2022).

Based on the different studies the major triggering factors were identified. It has been used the debrisflow hazard ratio (Ks): Comparison of the total number of debrisflows in the given river basins with rivers in the same basin where no debrisflows have been recorded; Comparison of the debrisflow areas of the relevant geological environment with the total area of the river basin; In addition to the listed coefficients, the following shall be taken into account when determining the risk of debrisflows: Frequency of the debrisflows; Single maximum volumes of debrisflows; Number of elements at risks; Also debrisflow events that pose a direct threat to the population and strategic infrastructure objects. In this regard, Georgia was zoned by different hazard categories: high, moderate, low and not dangerous. High hazard debrsiflow areas were modelled, using RAMMS software (Christen M., et al. 2012, RAMMS:debrisflow User Manual 2024).

References

Christen, M., Bühler, Y., Bartelt, P., Leine, R., Glover, J., Schweizer, A., Graf, C., McArdell, B., Gerber, W., Deubelbeiss, Y., Feistl, T., Volkwein, A. (2012). Integral hazard management using a unified software environment. Numerical simulation tool "RAMMS" for gravitational natural hazards. In G. Koboltschnig, J. Hübl, & J. Braun (Eds.), 12th congress INTERPRAEVENT 2012, pp. 77-86

Fourth National Communication of Georgia Under the United Nations Framework Convention on Climate Change. Chapter 4.9 Geological Hazards in Georgia, Tbilisi, 2021, pp. 278-286

Gaprindashvili G., Tsereteli E., Gaprindashvili M. Landslide hazard assessment methodology in Georgia. // Special Issue: XVI DECGE Proceedings of the 16th Danube - European Conference on Geotechnical Engineering, 2018, vol. 2, N 2-3, pp. 217-222.

Gaprindashvili M., Kurtsikidze O., Gaprindashvili G., Rikadze Z., et. al, Informational Bulletin - The results of the development of natural geological processes in Georgia in 2023 and the forecast for 2024, Department of Geology, National Environmental Agency, Tbilisi, Georgia, 2024, 488 pages

Gaprindashvili M., Assessment of geo-ecological hazards caused by geodynamic processes on the territory of Tbilisi and their prevention. PhD dissertation, 2022, 168 pages.

Gaprindashvili, M., Tsereteli, E., Gaprindashvili, G., Kurtsikidze, O. (2021). Landslide and Mudflow Hazard Assessment in Georgia. In: Bonali, F.L., Pasquaré Mariotto, F., Tsereteli, N. (eds) Building Knowledge for Geohazard Assessment and Management in the Caucasus and other Orogenic Regions. NATO Science for Peace and Security Series C: Environmental Security. Springer, Dordrecht. https://doi.org/10.1007/978-94-024-2046-3_14

RAMMS::DEBRISFLOW User Manual (2024), A numerical model for debris flows in research and practice, https://ramms.ch/ramms-debrisflow/

Tsereteli E., Gaprindashvili G., Gaprindashvili M. Natural Disasters (Mudflow, Landslide, Etc.). In: Bolashvili, N., Neidze, V. (eds) The Physical Geography of Georgia. Geography of the Physical Environment. Springer, Cham., 2022 https://doi.org/10.1007/978-3-030-90753-2_7

