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Editorial

Landslides and Geophysical Investigations: Advantages and Limitations

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Geohazards processes can damage or increase the risk of human beings, properties, critical infrastructures, and environment itself. They also could involve the interruption of human activities with serious socioeconomic consequences. Among all the natural occurrences, landslides are regarded as one of the most destructive types of geohazards. Landslides are a type of "mass wasting," which denotes any down-slope movement of soil and rock under the direct influence of gravity, which can occur and develop in a large variety of volumes and shapes. Even though the catastrophic impact of landslides is not totally unavoidable, it can be significantly reduced by increasing the capacity to assess and predict the risks and using different mitigation methods. In the past decades, many 2D and 3D numerical modelling methods have been designed and developed to assess slope stability, to predict slope response to various triggers, to evaluate the slope deformation and evolution pattern, and to perform back-analysis simulations. Nevertheless, such models still require access to detailed knowledge of the geological, mechanical, and hydrological properties of landslides and boundary conditions. Therefore, accurate geological field surveys have to be integrated by means of low-cost and noninvasive techniques, like the geophysical ones, to collect widespread data with the aim of reconstructing a suitable geological and hydrogeological model of the area, improving the reliability of deterministic model.

This special issue is dedicated to the geophysical methods applied to investigate, characterize, and monitor landslides. Over the years, both the advantages and limitations of these techniques have been highlighted, and some drawbacks are still open. Some papers were submitted to this special issue, and, after a thorough peer review process, only five articles were selected to be included in this special issue. This relatively small number is probably caused by the difficulty in applying geophysical techniques on slope movements given hard-operating conditions (e.g., high slopes, distance from access roads, and lack of security for the technical operator) and not because the methods limitations are greater than the advantages.

The review carried out by V. Pazzi et al. on geophysical techniques applied in landslides studies analyses the international efforts toward overcoming the geophysical technique limitations highlighted by the 2007 geophysics and landslide review, focusing on works of the last twelve years (2007-2018). The authors carried out the review analysis using a "material landslide approach" on the basis of the more recent landslides classification. The most studied landslides are those of the flow type for "soil" landslide typology and those of the fall type for the "rock" category. From the "employed method" point of view, active and passive seismic methods are the most employed in landslide characterization and monitoring. To quantify the efforts performed to overcome the limitations highlighted in 2007, a three-level scale was employed (from many/some efforts to non-discussed). The limits inherent in each technique and the need to still develop multisource data integration methods were clear; very often the main drawbacks depend on the operator who carries out the survey, the analysis of data, and the interpretation and the presentation of the results. Finally, independently of the applied technique/s, a very accurate and high-resolution survey could be performed only on a small landslide portion, as it is costly and time-consuming.

V. H. G. Monroy et al. describe the preliminary results of an integrated geological and geophysical study carried out to demonstrate that the city of Mitla (Mexico) was covered by the deposits of a dry landslide. It is a collapsed body composed of ignimbrite blocks and matrix from the Sierra La Calavera, and according to its morphology, the geotechnical characteristics, and the geophysical data interpretation, the landslide was provoked by an earthquake of a magnitude in the range from 6.2 to 7.3 Mw. Unfortunately, until now there is no a precise age established for the landslide occurrence. However, the event presumably damaged the pyramids of Mitla in historical times, and large parts of the pyramids are probably still located under the avalanche deposit as evidenced by the outcomes of this preliminary investigation. This paper highlights how geophysical exploration, in particular electrical resistivity tomographies, the study of earthquakes, and the environmental seismic noise carried out in synergy with other survey techniques are good and promising tools in the geoarchaeology field of research.

The paper by H.-B. Havenith et al. presents the results of an integrated survey and the 3D geomodel generated for an ancient mass movement located immediately downstream from the Rogun Dam construction site (Tajikistan). The geophysical survey includes electrical resistivity tomographies, seismic profiles, and ambient vibration measurements, as well as earthquake recordings. The integrated interpretation of all results reveals that probably only a relatively small part of the ancient giant mass movement is really exposed to slope instability phenomena. Nevertheless, authors highlight how all the geophysical measurements are affected by a great variability that affects the final estimated unstable volume.

Implementing an early warning system (EWS) is a challenging issue in landslide monitoring. To verify the usefulness of seismic noise analysis as part of an EWS, A. Lotti et al. describe the results of the HV analysis of a 7-month period of passive seismic data collected by a pilot scale passive seismic network arranged to monitor an unstable rock mass. Possible connection between rainfall/temperature/displacement and rockslide seismic activity is evaluated, and the hypothesis that the HV amplitude value is directly related to meteorological factors can be excluded. On the contrary, the observed variations potentially reveal changes of subsoil site conditions and have also implications for the assessment of site response to seismic shaking.

Finally, S. Nguiya et al., based on the analysis and the gravity inversion constrained by seismic information, show the geodynamic implication of the intracrustal mafic discontinuity in the north-western portion of the Congo Craton and its implication for the occurrence of landslides across the area. Faults, earthquake, volcanism, and geomorphology are known as potential triggers of landslides. According to the authors, by correlating the location of some observed landslides and the gravity data, new insights into the regional tectonic can be inferred.

Conflicts of Interest

The authors declare that there are no conflicts of interest regarding the publication of this paper.

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