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Editorial: Physics and modelling of landslides

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Editorial on the Research Topic
Physics and modelling of land slides

Disasters triggered by landslides cause life losses and substantial devastation to communities in terms of effects on the economy, livelihoods, and infrastructure every year across the world. However, the causative factors and mechanisms underlying landslide initiation and dynamics must be better understood, as accurate modelling of landslide risk is an essential prerequisite for developing reliable control and mitigation strategies [1]. Landslide susceptibility is influenced by a broad range of factors [2], such as soil physics and geochemistry, geological setting, climate, atmospheric dynamics, biogenic feedbacks, and anthropogenic influences, which have profound interlinkages with each other over a broad period- and length-scales. Moreover, landslide risk assessment further hinges on correctly understanding communities' local vulnerability and exposure [3].

This Research Topic of articles on the *Physics and Modelling of Landslides* presents leading-edge work into the quantitative understanding of landslide processes and dynamics.

A series of numerical simulations were carried out by Wang et al. for a better understanding of the dynamic response and failure modes of rock slopes containing weak interlayers subjected to earthquake excitation. They used the continuum-discontinuum element method considering the influence of seismic amplitude and weak interlayer inclination, to shed light on the formation mechanism of rock landslides with weak interlayers. Accordingly, the acceleration waveform and peak ground displacement amplification coefficient characteristics strongly contradict the landslide failure process. The combination of weak interlayers and seismic load causes multiple failure landslide modes.

Aiming at understanding the influence of water content on the characteristics of long-term deformations and stability of soil-rock mixtures of the Dahua landslide located on the right bank of Lancang River, China, Jiang et al., and Wang et al. performed multi-stage shear creep tests of SRM samples with different water contents. Based on their analysis, it was suggested that there are three stages of creep deformation: transient, steady-state, and accelerated. Moreover, shear-creep deformation is controlled by fractures of large particles at low water content but by large particles at high water content rotations.

By looking at the combined effects of the debris-flow impact force and lateral Earth pressure through finite element analysis, Eu et al. modelled internal stresses experienced during debris flow and sediment deposition from the 2011 Mt. Umyeon landslide, Seoul, the Republic of Korea. This approach provided valuable insights for the structural analysis and safety

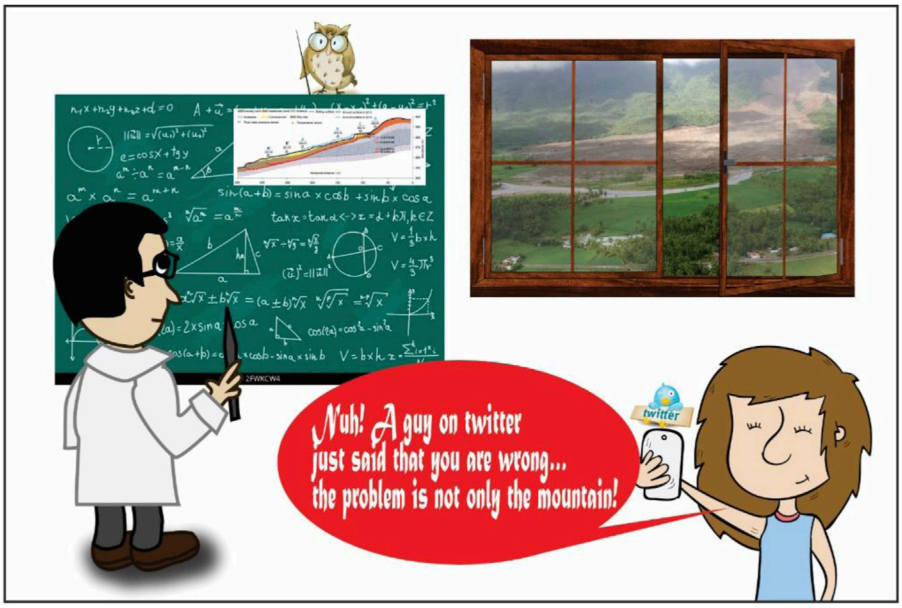

FIGURE 1
Landslide disaster risk reduction requires a sustained dialogue between the various disciplines on the physics of landslides, their causes and dynamics, and their socio-environmental interactions (Cartoon courtesy of Irasema Alcántara-Ayala).

assessment of check dams. It offered practical guidance for check-dam design and maintenance, considering sediment deposition and debris-flow impact force.

Zhang et al. used the Drucker–Prager model and the smooth particle hydrodynamics method to simulate soil slope failure and determine the slip surface with and without the effect of potential earthquakes. This study contributed to this growing area of research by exploring the relationships between sliding material volume, influence range, and slope angle. That being the case, the horizontal displacement of the slope under the effect of an earthquake increased non-linearly with the increase of slope incline angle.

He et al. and colleagues examined the mechanical property of typical residual soils from a landslide zone in Chenzhou city, China, by conducting direct shear tests. Mineral composition and microstructures of soil samples analysis through X-ray diffraction and scanning electron microscope tests showed rich clay minerals, including pyrophyllite, illite, kaolinite, and montmorillonite. The shear strength of soils gradually decreased with increasing water content under constant vertical load by a linear function, but the soil types influenced the trend of shear strength.

The fuzzy point estimation method and physical-based model were combined with the local factor of safety theory by Yang et al. to calculate the hillslope's internal local factor of safety for the hillslope of the Babaoliao collapse site in Chiayi County, Taiwan. The results indicated that the boundary flux controls the overall infiltration of water into the slope and affects the change in soil water content, which in turn causes slope instability. Moreover, delayed rainfall causes early slope instability; thus, evaluating shallow soils' hydraulic behavior and failure mechanisms is critical.

Li et al. used the fuzzy set assessment method to assess the risk level of landslide hazards in the Badong section of Three Georges in China. The stratigraphic lithology, degree of weathering, relationship between the structural plane and slope direction, cohesive force, angle of internal friction, severity, average slope degree, the height of slope, and type of landslide were considered as the assessment indices. Despite drawbacks, such as complicated calculation and necessary multiple variable parameters, results suggested that the variable fuzzy set model could offer an alternate route to evaluate the landslide hazards.

Conventional Machine Learning and Multi-Criteria Decision-Making techniques were used to compare performance for the development of susceptibility mapping of landslides in Muzaffarabad district, lower Himalayas of Northern Pakistan. Following this perspective, Khalil et al. found 85% accuracy when using Support Vector Machine, 83% with Linear Regression, 80% with Analytical Hierarchy Process, 79% with Logistic Regression, and 78% with Technique for Order of Preference by Similarity to Ideal Solution. The study offered a baseline for decision-makers for effective landslide countermeasures and long-term monitoring.

Yildiz et al. drew attention to uncertainty quantification, a computationally demanding task for designing and developing a model-based landslide risk assessment. Using a synthetic case involving simple topography and the Acheron rock avalanche near Canterbury, New Zealand, they demonstrated how uncertainty quantification workflow can be set up effectively and how this affects the model-based landslide risk assessment. GP emulation-based Monte Carlo Simulations can significantly improve computational efficiency, making GP-integrated MCS applicable for landslide run-out modelling.

A significant contemporary Research Topic of landslide hazard assessment is that socioterritorial drivers, particularly in urban areas, have intensified their impact [4,5]. Non-etheless, inter and multidisciplinary efforts [6] that combine physical, engineering, and computer sciences with geological, geographical, and social sciences required to advance the quantitative understanding of landslide processes, are still incipient.

This Research Topic focused on the *physics and modelling of landslides*. It provided a platform for the dialogue between the various disciplines on the physics of landslides, their causes and dynamics, and their socio-environmental interactions (Figure 1). This dialogue is essential to enhance landslide forecasting and management capabilities and produce novel insights by the science and technology community to contribute to implementing the Sendai Framework through future integrated disaster risk reduction policy formulation and practice [7].

Author contributions

All authors listed have made a substantial, direct, and intellectual contribution to the work and approved it for publication.

Conflict of interest

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