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Editorial: Investigation, monitoring, stability, and risk assessment of geohazards

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Editorial on the Research Topic
Investigation, monitoring, stability and risk assessment of geohazards

Introduction

The investigation, monitoring, stability, and risk assessment of geohazards—aimed at understanding, predicting, and mitigating potential risks—are fundamental research areas in the field of engineering geology (Zhang et al., 2024). The investigation and monitoring of geohazards emphasize the early identification and early warning of potential geohazard risks through field surveys, geomechanical analysis, and the deployment of an integrated monitoring system spanning from the ground to the air and subsurface for systematic data collection. This includes multi-scale indoor experimental studies on geohazards, focusing on the behavior of soil and rock under various loading or unloading conditions. The stability and risk assessment of geohazards aims to comprehensively assess their occurrence mechanisms, impact scope, and potential hazards via interdisciplinary methods. By developing experimental, analytical, and numerical techniques for characterizing and modeling the evolution mechanisms of geohazards, it is possible to predict and mitigate risks more accurately. The use of advanced data collection, experimental testing, numerical simulations, and monitoring methods offers scientific support for public safety and the reduction of economic losses. In recent years, there has been growing recognition of the importance of enhancing the basic theory of geohazards.

To showcase the latest achievements in this area, this Research Topic entitled "Investigation, monitoring, stability, and risk assessment of geohazards" was organized. This collection includes 14 papers, addressing the sensitivity and risk assessment of geohazards such as earthquakes and landslides, the mechanism and dynamics of debris flows, early warning for debris flows, landslide failure mechanisms, railway tunnel stress state assessment, geohazard identification methods, and the physical and mechanical properties of rock mass. The findings presented in this paper provide valuable references for addressing potential geohazards in engineering projects such as hydropower, highways, railways, and open-pit mining.

Investigation of geohazards

The physical and mechanical properties of geotechnical materials are critical controlling factors in the evolution of geohazards, directly influencing the occurrence, development, and severity of their impacts. These properties include, but are not limited to, strength, deformation characteristics, permeability, and the development of fractures within the geotechnical mass. Together, they determine the response behavior of geological materials under natural or anthropogenic influences. Therefore, a comprehensive study of the physical–mechanical properties of geotechnical materials is essential for accurately assessing geohazard risks and formulating effective prevention and mitigation strategies.

Zhang et al. explored the impact of freeze–thaw cycles on the pore structure and crack evolution in sandstone, revealing how freeze–thaw degradation can influence rock stability. He et al. introduced two new 2D roughness parameters for rock joints, which improve shear strength estimation models for assessing rock mass stability, particularly in relation to joint roughness. Li et al. investigated the rheological properties of blasthole stemming slurry, showing how variations in material composition affect fluidity and stability, relevant for evaluating risks in open-pit mining. Zheng et al. analyzed the dynamic performance of cemented tailings backfill under low-impact conditions, shedding light on its crack development and stability under dynamic disturbance. Li et al. studied the deformation and crack propagation in sandstone with different flaw inclinations under varying loading rates, providing valuable insights into rock mass failure mechanisms in engineering applications.

Collectively, these studies underscore the pivotal role of understanding the physical and mechanical properties of geotechnical materials in evaluating the risks associated with geohazards. By enhancing our knowledge of these properties, particularly in relation to material behavior under stress, deformation, and environmental influences, these studies contribute to the development of more accurate hazard prediction models and more effective mitigation strategies.

Monitoring, stability, and risk assessment of geohazards

In the context of earthquake activity, Ali and Abdelrahman investigated the seismicity and seismotectonics of the Aswan region, focusing on analyzing earthquake patterns, stress accumulation, and fractal dimensions, and assessed the implications of these characteristics for disaster reduction and risk management in the region. Jian et al. proposed a two-step clustering method to analyze mining-induced seismicity, addressing the challenge of differentiating seismic events caused by various mining activities.

In the context of debris flows, Wang et al. proposed a refined typhoon-induced debris flow warning model by integrating rainfall thresholds with geological factors, identifying key geological influences such as rock mass type and vegetation, and demonstrating the model's high accuracy for the early warning and prediction of debris flows in typhoon-prone areas of southeastern China. Wang et al. proposed a conjugate shear-type geomechanical model to analyze the mechanism of frequent debris flow disasters in the Yizhong River Basin, utilizing field data, drone photography, and Rapid Mass Motion Simulation (RAMMS) to provide a scientific basis for disaster prevention and highlighting the benefits of nap-of-the-object photogrammetry for geological surveys in alpine and gorge areas.

For analyzing landslides, Li et al. developed a landslide susceptibility mapping method for road slopes in Pingshan County, Hebei Province. This method integrates the analytical hierarchy process (AHP), CRITIC, and game theory to evaluate landslide risk, providing an effective tool for reducing infrastructure vulnerability in mountainous regions. Dai et al. proposed an unmanned aerial vehicle (UAV) photographic method integrating orthophotography, 3D multi-angle oblique photography, and high-precision digital elevation models to effectively identify 116 potential geohazard sites triggered by rock mass deterioration in the hydro-fluctuation belt of the Three Gorges Reservoir area. Wang et al. evaluated the risk of seismic-collapsed loess landslides on the Loess Plateau by compiling a risk zoning map based on eight factors, including peak ground acceleration and loess microstructure, using the minimum disaster-causing seismic peak ground acceleration zoning method and analytic hierarchy process, and concluded that earthquakes are the primary inducing factor, with other factors influencing the landslide risk.

In addition, Chen et al. explored the causes and mechanisms of damage to well-vegetated soil slopes under extreme rainfall, demonstrating that vegetation has a dual effect on slope stability: it enhances soil shear strength while increasing permeability, leading to shallow slope saturation and triggering landslides. Lyu et al. proposed a method for evaluating stress distribution in high-altitude railway tunnels on the Tibetan Plateau using high-precision radar satellite technology. By integrating time-series interferometric synthetic aperture radar with vertical displacement monitoring, this method was applied to assess tunnel deformation and stress states of the Dongelu Tunnel of the China–Tibet Railway.

Collectively, these studies offer valuable methodologies for monitoring, assessing, and mitigating risks posed by geohazards, with a focus on the identification of potential hazards, understanding the mechanisms and dynamics of geohazard events, and evaluating risks using advanced methodologies such as numerical simulations, UAV-based imaging, InSAR technology, and clustering techniques.

Conclusions and prospects

Driven by advancements in sensing technology, geographic information systems (GISs), computer science, and interdisciplinary collaboration, the fields of geohazard investigation, monitoring, stability assessment, and risk evaluation are poised for continued growth. These innovations promise enhanced accuracy, efficiency, and predictive capabilities, ultimately leading to more effective hazard management and risk mitigation strategies.

Author contributions

JZ: writing–original draft and writing–review and editing. TW: writing–original draft and writing–review and editing. WZ: writing–original draft and writing–review and editing.

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Reference

Zhang, J., Tang, H., Li, C., Gong, W., Zhou, B., and Zhang, Y. (2024). Deformation stage division and early warning of landslides based on the statistical characteristics of landslide kinematic features. *Landslides* 21 (4), 717–735. doi:10.1007/s10346-023-02192-7