frontiers | Frontiers in Earth Science

TYPE Editorial
PUBLISHED 13 January 2023
DOI 10.3389/feart.2022.1041180

OPEN ACCESS

EDITED AND REVIEWED BY
Candan Gokceoglu,
Hacettepe University, Turkey

*CORRESPONDENCE
Haijun Qiu,
haijunqiu@nwu.edu.cn

SPECIALTY SECTION
This article was submitted to Geohazards and Georisks, a section of the journal Frontiers in Earth Science

RECEIVED 10 September 2022
ACCEPTED 17 October 2022
PUBLISHED 13 January 2023

CITATION
Nie W, Qiu H and Asadi A (2023), Editorial: Monitoring, early warning, and mitigation of natural and engineered slopes.
Front. Earth Sci. 10:1041180.
doi: 10.3389/feart.2022.1041180

Editorial: Monitoring, early warning, and mitigation of natural and engineered slopes

Wen Nie[1], Haijun Qiu[2]* and Afshin Asadi[3]

[1]Jiangxi University of Science and Technology, Ganzhou, China, [2]Northwest University, Xi'an, China, [3]International College of Auckland (ICA), Auckland, New Zealand

KEYWORDS

natural and engineered slopes, slope failure mechanisms, slope monitoring, risk assessment, machine learning

Editorial on the Research Topic
Monitoring, early warning, and mitigation of natural and engineered slopes

Natural and engineered slopes, including mountain slopes, highway slopes, mine slopes, and reservoir dams are widely distributed around the world (Qiu et al., 2022). Such slopes may become unstable due to natural factors or human activity, causing catastrophic loss of life and damage to infrastructure. Continuous monitoring of these slopes is required to provide early warning of disasters, enabling engineers and/or emergency services to respond accordingly. In recent years, developments in science and technology and the theory of multidisciplinary interaction have brought about new opportunities for research in this field (Liu et al., 2022; Wang L et al., 2022; Zhou et al.). However, further breakthroughs are still required in the domains of efficient monitoring, accurate early warning, reliable risk assessment, and low-cost disaster recovery. This special issue brings together 14 publications designed to present the latest research advances and methods in natural and engineered slope monitoring, early warning, disaster remediation, and risk assessment.

Slope hazard reduction technology

Five of the 14 articles in this special issue investigate improvements in landslide identification accuracy, analysis of disaster risk evolution, and quantitative prediction of hazard degree using a variety of methods, with the aim of formulating new slope hazard mitigation strategies. Zheng et al. put forward an effective and reliable method of analyzing the risk evolution of tailings pond dam breaches based on a combination of DEMATEL and MISM, summarize 35 risk factors affecting the destruction of tailings ponds and the comprehensive impact degree of each factor, and establish an effective risk evolution model of tailings pond dam breaches. Dai et al. propose an improved U-Net fully convolutional neural network based on physical model experiments to automatically extract the deformation of a single landslide over time. Compared with mainstream superpixel methods, the improved U-Net exhibits higher recognition accuracy and greater robustness. To explore the surface damage caused by shallow coal seam mining, Feng et al. establish a mathematical prediction model for the relationship between trench seepage volume, trench fissure width, and trench flood volume. The model is based on field measurements of ground fracture leakage on an experimental platform and also uses aerial photography *via* UAV. The authors propose a classification standard for the leak risk of mining fissures. Xie et al. examine the development characteristics of surface damage after coal seam mining. This study found that surface crack characteristics can be used to characterize the degree of surface damage. The study graded surface damage and a surface damage prediction model was established based on the GIS platform. Yan et al. used InSAR, UAV, and ground survey technology to divide pipeline slopes into different danger zones, using real-time monitoring data to simulate pipeline slope hazards, quantitatively predict the degree of hazard, and formulate rapid prevention and control measures.

Slope failure mechanisms

The other nine articles in this special issue investigate and analyze various types of disasters related to engineering projects, such as ground cracks, surface failure, slope bedrock degradation, and tailing pond failure to understand the dynamic mechanisms involved and their relationship with the project in question.

Cracks alter the structure of soil and reduce its strength and stability. In their contribution, Jiang et al. explored the crack evolution process in clay-sand mixtures under various clay content conditions. They observed almost no cracks on the surface of soil samples with clay content below 30%. In samples with a clay content greater than 50%, the formation and development of cracks can be divided into three stages. Finally, in samples with clay content greater than or equal to 30% and less than or equal to 50%, no stage characteristics were associated with the formation and development of cracks. Kang et al. studied the stages of the influence of wet-dry cycles on the stability of sandstone slopes in subsidence areas. The characteristics of strength deterioration in intact sandstone were analyzed through the application of wet–dry cycles and uniaxial compression tests. The authors found that the most serious process for the induction of sandstone slope instability occurs in the early stage of the wet–dry cycle. Zhong et al. studied the effect of leaching on the physical and mechanical properties of slope bedrock; the results showed that the mechanical properties of bedrock samples deteriorated significantly at first, then recovered significantly, and subsequently fluctuated within a narrow range. Wang et al. studied the effect of the degree of reconsolidation on the dynamic characteristics of liquefied tailings under cyclic loading. They found that the reconsolidation process undergone by tailings following liquefaction improves their liquefaction resistance. In another study, Li et al. explore the differences between multiple types of vegetation in terms of soil erosion resistance and multifractal parameters. They found that soil erosion resistance was significantly correlated with multifractal parameters and that multifractal parameters could predict soil erosion resistance. Wu et al. explored how quantitative flood risk and emission reduction contribute to risk mitigation by constructing a loss rate curve and quantitatively characterizing the spatiotemporal variation characteristics of flood loss rate. The results show that the curve representing flood loss rates from 2020 to 2060 exhibits a trend of “rising in the early stage, stabilizing in the middle stage, and declining in the late stage” in low- and medium-emission scenarios and an upward fluctuation trend in a high-emission scenario. Zhou W et al. (2022) used a seepage field numerical simulation method to analyze the permeability and physical properties of composite materials. They found that the permeability coefficient of these materials increases with increasing backfill tension in the initial stage of composite stacking, while permeability decreases gradually in the later stage to become stable. Taking the Qinling mountain disaster as a case study, Hao et al. used a questionnaire-based method to analyze the impact of the disaster on tourists’ behavioral intentions. The results show that perception of risk exerts a negative impact on tourists’ behavioral intentions, while knowledge of the disaster exerts a positive effect. Finally, through analysis of geological hazard data, settlement data, and cultivated land data, the study by He et al. identified a coupling mechanism between geological hazards, rural settlements, and cultivated land in mountainous areas of the upper Min River.

Perspectives

This special issue is dedicated to the use of modern technologies, data-based approaches, and techniques, grounded in multiple disciplines for monitoring natural and engineered slopes and for early warning and mitigation of the associated risks. However, in the context of extreme weather and the execution of large-scale construction projects, slope failure requires further research. On this basis, this set of articles provides reference points for the following aspects of damage mitigation: 1) multiscale and multidisciplinary integration for analyses of the physical mechanisms and dynamic processes inside slopes; 2) early warning and analysis of slope instability based on big data and field-refined detection systems; and 3) innovative green, efficient, and sustainable post-disaster slope restoration projects.

Author contributions

Three authors co-organized the album, with NW on Slope Hazard Reduction Technology, QH on hazard risk assessment, and AA on Failure mechanism of slope.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's note

References

Liu, Z., Qiu, H., Zhu, Y., Liu, Y., Yang, D., Ma, S., et al. (2022). Efficient identification and monitoring of landslides by time-series InSAR combining single- and multi-look phases. *Remote Sens.* 14, 1026. doi:10.3390/rs14041026

Qiu, H., Zhu, Y., Zhou, W., Sun, H., He, J., and Liu, Z. (2022). Influence of DEM resolution on landslide simulation performance based on the Scoops3D model. *Geomatics, Nat. Hazards Risk* 13 (1), 1663–1681. doi:10.1080/19475705.2022.2097451

Wang, L., Qiu, H., Zhou, W., Zhu, Y., Liu, Z., Ma, S., et al. (2022). The post-failure spatiotemporal deformation of certain translational landslides may follow the pre-failure pattern. *Remote Sens.* 14, 2333. doi:10.3390/rs14102333

Zhou, W., Qiu, H., Wang, L., Pei, Y., Tang, B., Ma, S., et al. (2022). Combining rainfall-induced shallow landslides and subsequent debris flows for hazard chain prediction. *CATENA* 213, 106199. doi:10.1016/j.catena.2022.106199