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

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

Introduction

Natural and engineered slopes are geological bodies with lateral free surfaces formed naturally or artificially on the surface of the earth, which are widely distributed around the world (Zhou et al., 2022; Qiu et al., 2024). Due to climate change and intensified human activities, mountains, highways, mining areas, and reservoir slopes have become increasingly unstable, and even gradually evolved into landslide disasters, posing a serious threat to people's lives, property safety and infrastructure construction (Qiu et al., 2022; Yang et al., 2023). Recently, with the progress of slope control technology and the development of interdisciplinary theory, new development space has been provided for the dynamic monitoring and early warning of unstable slopes (Zhu et al., 2021; Wei et al., 2024; Ye et al., 2024). However, large-scale and long-term monitoring, precise risk assessment, and low-cost disaster recovery are still worth considering (Wang et al., 2022; Liu et al., 2024). Volume II of this Research Topic received 16 manuscripts (Qiu et al., 2023). Now, Volume III also gathered 16 papers aimed at further introducing the latest research progress and methods on monitoring, early warning, and mitigation of natural and engineered slopes.

Slope hazards reduction technology and mechanism

Seven of the 16 articles in the Research Topic explored research on slope displacement profile evaluation, landslide deformation monitoring, and the use of multiple models to quantitatively evaluate disaster risks, aiming at providing scientific support for slope treatment and disaster prevention. Li et al. proposed a three-dimensional nested Newmark method (3D-NNM) within the framework of kinematic theorems in limit analysis. Compared with the original nested Newmark method, the results showed that the proposed 3D-NNM can effectively evaluate the permanent displacement profile of slopes under seismic action. Bai et al. proposed a rapid evaluation method for the spatial distribution of road traffic sections under earthquake and landslide damage based on the MDT model. Liu et al. applied the time series InSAR method to determine the time series deformation of the main landslide source area of Baihetan Reservoir after water storage and conducted a refined analysis of the deformation monitoring results of typical source areas. Jiang et al. inverted the depth of the active zone of the expansive soil slope in the middle route of the South to North Water Diversion Project using the InSAR method, and analyzed its distribution pattern and dynamic characteristics, providing a basis for designing slope protection measures and ensuring the safety of water channels. Zheng et al. used $FLAC^{3D}$ numerical simulation experimental method to study the effect of coupling between the surface shape of loess slopes and the structure of coal seam cover on slope movement and deformation. Shen et al. took Meilonggou in Danba County, Sichuan Province as an example to study the factors and triggering mechanisms of the formation of debris flow disaster chains in the area, which can provide guidance for strengthening the construction of monitoring and early warning systems in the local area. Furthermore, Zhang et al. applied the RAMMS model to numerically simulate the movement process of debris flows in the Xigou area of the Three Gorges Reservoir Area, and conducted a risk assessment on debris flows with different recurrence intervals when multiple debris flows erupt simultaneously.

Natural disasters in different regions

Due to different geographical and tectonic environments, different regions face different types of disaster risks. Four different studies have revealed this issue. To evaluate the research focus and development direction of glacier lake disaster identification in plateau areas, Liu et al. collected literature related to glacier lake disaster identification from the Web of Science core Research Topic database from 1991 to 2023 and conducted a comprehensive bibliometric analysis. Huang et al. used SBAS-InSAR technology to monitor subsidence disasters in complex karst areas of mining areas. The author believed that deformation is influenced by various factors such as elevation, slope, precipitation, and vegetation. Li et al. discussed the spatiotemporal drought characteristics of winter wheat and summer maize growing seasons in the North China Plain based on the standardized precipitation evapotranspiration index (SPEI). Results indicated the spatial pattern of winter wheat and summer maize growth seasons is consistent with the distribution of drought and humid conditions. Wang et al. (2022) carried out a hydrological simulation of mountain torrents in small basins caused by rainstorms. The results indicated that the flood process in small watersheds has strong spatial heterogeneity, and there exists intensity changes between flood flow and rainfall.

Ecological and environmental security

The impact of environmental factors on ecologically sustainable development has received widespread attention from scholars. In this issue, five studies focused on the distribution of biological communities affected by environmental factors, the evolution of vegetation spatiotemporal patterns, and the estimation of biomass. Xu et al. analyzed the trend and periodicity of the evolution characteristics of secondary suspended rivers in the lower Yellow River from 1960 to 2021 and quantitatively explored the factors affecting their development. Mai et al. studied the abundance of eukaryotic plankton in the Danjiangkou Reservoir and its relationship with environmental factors. The results showed significant differences in the vertical distribution of eukaryotic plankton community diversity, which were influenced by factors such as pH, water temperature and other factors. Chen et al. used a comprehensive KNDVI dataset and trend analysis to evaluate vegetation restoration activities and changes in vegetation spatiotemporal patterns in mining areas. The results indicated the overall KNDVI of vegetation shows a clear positive trend, with further improvement compared to the years 2000–2010, which is of great significance for the ecological restoration of vegetation in the mining area. He et al. explored the practicality of various remote sensing inversion models for estimating grassland biomass, analyzed the changes in national grassland biomass of the Three Rivers Source on the Tibetan Plateau from 2015 to 2020, predicted future biomass trends, and explored the potential impact of climate change on grassland biomass. Hao et al. analyzed the efficiency of ecotourism in the Yellow River Basin from 2015 to 2019 using a method based on super-slacks-based measurement. The results showed that the four regional development factors of innovation, green, openness, and sharing have a positive impact on the efficiency of ecotourism in the Yellow River Basin. This study is of great significance in managing ecological constraints and improving the quality of sustainable development of regional ecotourism.

Perspectives

The Research Topic is dedicated to applying modern remote sensing techniques, machine learning and numerical simulation models, integrated multidisciplinary theories to monitor natural and engineered slopes and to warn and mitigate associated disaster risks. However, in the context of global climate change and intensified human activities, the in-depth study of slope failure needs further consideration. On this basis, it provides a reference for disaster mitigation from the following aspects. 1) Multi-scale and multidisciplinary integration to analyze the physical mechanism and dynamic process inside the slope; 2) Monitoring and analysis of slope instability based on remote sensing and numerical physical model; 3) Innovative green, efficient and sustainable ecological restoration projects.

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