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Editorial: Advancement in quantitative risk analysis of geological disaster in reservoir areas

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Editorial on the Research Topic
Advancement in quantitative risk analysis of geological disaster in reservoir areas

Reservoir areas are usually prone to geological disasters due to the significant changes taking place on the hydrogeological environment (Zhou et al., 2022a). For instance, more than 5,000 geological disasters have been reported in the Three Gorges Reservoir area, China. Extreme climate and human engineering activities have aggravated the occurrence of geological disasters in this reservoir area, posing a threat to local residents and vessels. Quantitative risk analysis of geological disasters can effectively support managers in developing strategies for disaster prevention and mitigation. Due to the complexity of deformation and failure mechanisms, there are still many unsolved issues in the quantitative analysis and prediction of reservoir geological disasters at the various spatiotemporal scales of interest. Recently, with the development and application of novel techniques, such as geotechnical testing, remote sensing, machine learning and numerical simulation, quantitative risk analysis methods of reservoir geological disaster have made great progress (Tang et al., 2019; Zhou et al., 2022b; Wang et al., 2022).

The Research Topic on "Advancement in Quantitative Risk Analysis of Geological Disaster in Reservoir Areas" has received seven contributions in the field of landslide risk analysis, including monitoring with advanced techniques, risk prediction tools, and laboratory test for terrain in landslide prone areas.

Landslide monitoring with advanced techniques

Among advanced techniques for landslide monitoring, Interferometric Synthetic Aperture Radar (InSAR) is one of the most important. InSAR enables to accurately monitor slow deformation of the ground over large areas and its operation is not limited by weather conditions. It is becoming popular for early identification and monitoring of landslides. In their contribution, Shen et al. illustrate the use the ALOS-2 PALSAR data to conduct continuous monitoring and identification of geological hazards in karst areas. Landslide deformation characteristics are quantitatively analyzed by displacement data measured by InSAR. Several hidden landslides were identified in the study area as well, and field investigations were carried out for verification of the results.

The study of Li et al. focuses on a large landslide in the reservoir area. They use InSAR techniques to investigate the variation of deformation characteristics over a period of 9 years. The variations of local deformation rate and annual maximum deformation area were analyzed by InSAR technology based on Sentinel-1 descending SAR data. According to the regional deformation characteristics, the landslide was divided into three zones, and the relationship between the deformation of each zone and their influencing factors (reservoir water level fluctuation) was analyzed. The results show that during the nine-years period the deformation mechanism of the study area changed from a retrogressive type to a progressive one after the first impoundment, and then turned back to a retrogressive.

Landslide risk prediction

Landslide risk can be predicted temporally and spatially. Accurate prediction is among the most effective ways to reduce landslide risk. Chen et al. discusses the deformation characteristics and influencing factors of a typical reservoir rock landslide by monitoring surface displacement. The discrete element numerical simulation system, MatDEM, is used by the authors to simulate the failure movement process of the landslide, analyze its kinematic characteristics, calculate the size of the surge caused by the sliding mass entering the water, and to predict the area affected by such events. This can aid disaster prevention and mitigation at the Three Gorges Reservoir area.

Landslide susceptibility mapping consists in predicting the spatial distribution of landslides. In the study of Xue et al. susceptibility is mapped using neural networks. These models take into account two correlation models of frequency ratio (FR), information quantity (IV) and the original mapping factors. The methodology is applied to map landslide susceptibility in the Baihetan reservoir area in China. The performance of the model is evaluated by Receiver operating characteristics (ROC) analysis. The coupled model employing IV as correlation method provides the most accurate results, as the susceptibility maps are more consistent with the actual distribution of landslides in the study area.

Laboratory testing

Laboratory testing is an important means to study the characteristics of slope material in areas prone to geohazards (e.g., physical, hydraulic and mechanical properties, and their occurrence environment). It is an important way to determine geological parameters under complex settings.

The dry-wet cycle test can be used to simulate the change of hydrological conditions. Taking the limestone in the Wuxia section in the Three Gorges Reservoir area as the research object, Gao et al. used the macro and micro tests to study the deterioration of rock samples under water-rock action. Based on the test results, the constitutive models of rock mass were obtained to quantify the deterioration trend. The method proposed in this paper may provide some guidance to determine the mechanical parameters for the stability evaluation of rocky reservoir banks under changing mechanical states.

The direct shear test is commonly used to determine the shear strength of rock joints. In order to provide a method to determine the representative specimens for laboratory testing on the shear strength of rock joints, and to acquire trustworthy shear strength parameters, Wang et al. propose a representative sampling method based on the maximum likelihood estimation of the overall properties of rock joints. The Mohr-Coulomb and a non-linear criterion were used to validate the derived representative specimens, demonstrating that the proposed method can produce reliable shear strength parameters and shear strength envelopes (relative errors $<10\%$ and coefficient of variation <0.1).

Gap-graded soil in dams and levees can cause suffusion failure and affect safety. To study how gap-graded soil reinforced with fibers of different types restrains suffusion in embankment dams, Teng et al. carried out one-dimensional seepage tests on soil reinforced by PPF, CF, and BTF with differing content and reinforcement-layer thickness. The reinforcement modes were explored *via* microscopy observations of particle–fiber interactions, and the process of suffusion occurrence and development was analyzed, as were the variation rules for the hydraulic gradient and fine-particle loss.

Author contributions

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

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