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Editorial: Advances and applications in modeling, assessment, and mitigation of landslide disasters

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Editorial on the Research Topic
Advances and applications in modeling, assessment, and mitigation of landslide disasters

Introduction

In recent decades, natural hazards and anthropogenic-induced disasters such as earthquakes, landslides, rockfalls, debris flows, rainstorms, floods, tunnel collapses, dam failures, and forest fires have posed major challenges. These events necessitate efforts to mitigate risks and safeguard structures, infrastructure, economic activities, and human lives, especially in mountainous areas (Cutter et al., 2015; Zou et al., 2018; Klein et al., 2019; Adler et al., 2020; Alcántara-Ayala and Geertsema, 2022).

Landslides: a persistent threat

Landslides are among the most common and destructive natural disasters worldwide, threatening human lives, properties, and infrastructure safety (Chen and Song, 2023; Chen D. et al., 2024; Liu et al., 2024; Zhang Q. et al., 2024; CRED, 2023; Kennedy et al., 2015; Froude and Petley, 2018; Fidan et al., 2024). They are characterized by intricate formation mechanisms, nonlinear deformation, and uncertainty, necessitating multidisciplinary approaches for their analysis and prediction.

Advances in monitoring and prediction

Scientific research has focused on enhancing understanding and developing technologies for effective risk mitigation against landslides (Carrión-Mero et al., 2021). Advanced monitoring tools like InSAR (Interferometric Synthetic Aperture Radar) (Scaioni et al., 2014; Xu et al., 2023), UAV (Unmanned Aerial Vehicles) (Sun et al., 2024; Zhang Z. et al., 2024), Fiber Optics (Ivanov et al., 2021; Brezzi et al., 2023), Beidou (Huang et al., 2023), and MEMS (Micro-Electro-Mechanical System) have been employed (Barzegar et al., 2023).

Yang et al. used multi-temporal InSAR techniques combined with geospatial statistical analysis to study the Muyuba landslide in China. Findings revealed continuous subsidence largely influenced by drainage networks, rock strata orientation, and reservoir water level variations, linking anthropogenic activities with increased landslide risk.

Wang et al. applied wavelet transform and ARIMA models for landslide displacement prediction. The ARIMA model demonstrated high accuracy, with a root mean square error (RMSE) of 4.52 mm, confirming its effectiveness in specific conditions. This model's applicability was further validated in practical scenarios.

Innovative modeling techniques

Numerical methods such as CDEM continuum-based discrete element method) (Li et al., 2024), 3D-DDA (three-dimensional discontinuous deformation analysis) (Wang et al., 2021; Ma and Liu, 2022), NMM (numerical manifold method) (Cao et al., 2024; Zhang and Li, 2024), SPH (smoothed particle hydrodynamics) (Dai et al., 2014; Mahallem et al., 2022; Chen W. et al., 2024), MPM (material point method) (Conte et al., 2019; Yamaguchi et al., 2023), and LBM (Lattice Boltzmann Method) (Krüger et al., 2016), provide deeper insights into landslide dynamics. Research contributions highlight the integration of machine learning and artificial intelligence to predict soil evaporation rates using models like KNORA (Kainthura and Sharma, 2022; Tehrani et al., 2022; Youssef et al., 2023; Zhang and Wang, 2024).

Priyanka et al. utilized machine learning to predict soil evaporation, employing a novel feature selection technique to enhance accuracy. Their findings underscore the superiority of certain ML models in predicting environmental phenomena.

Testing and laboratory advances

Laboratory techniques have been refined to better understand influential factors in gravitational phenomena (Hemeda, 2018; Menon and Kolathayar, 2024). Guo et al. focused on soil stability through wet and dry compaction tests, shedding light on risks associated with field compaction variations.

Zhao et al. analyzed water inrush disasters in coal seam mining through numerical simulations. Findings emphasized the role of mining stress and confined water in crack propagation along hidden faults, offering insights for preventing water inrush incidents.

Mitigation and defense structure design

Effective defense structure design significantly reduces landslide impact on infrastructure (Luo et al., 2023). Barbini et al. proposed methods to control sediment volume in debris flows through deposition areas and retention basins, confirmed through hydraulic modeling.

Future directions and studies

Research on landslide dynamics continues to evolve, with interdisciplinary efforts advancing our understanding of geological disaster science. This ongoing pursuit provides a scientific foundation for forecasting and mitigating geological hazards.

We express gratitude to all contributors to this Research Topic, advancing the modeling, assessment, and mitigation of landslide disasters. This compilation serves as a valuable resource, inspiring further studies in this critical field.

Author contributions

ZC: Writing–original draft, Writing–review and editing. DT: Writing–review and editing, Writing–original draft. OG: Writing–review and editing. DS: Writing–review and editing. MJ: Writing–review and editing. EP: Writing–review and editing. TO: Writing–review and editing.

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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.

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