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Editorial: Prevention, mitigation, and relief of compound and chained natural hazards

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Editorial on the Research Topic
Prevention, mitigation, and relief of compound and chained natural hazards

Introduction

In the context of global climate warming and frequent earthquakes, extreme natural disasters have become increasingly common, posing significant threats to human life and property. Various types of natural disasters often overlap, interact, or trigger chain reactions. As a result, these natural disasters have a wide impact, long duration, and cause severe damage, exhibiting highly complex and interconnected characteristics. Therefore, the prevention, mitigation, and relief of compound and chained natural hazards have become critical issues we face today. Technological advancements are enhancing our ability to manage natural hazards, with artificial intelligence, big data, cloud computing, and space-based earth observation technologies providing valuable support in addressing compound and chained natural hazards. Against this backdrop, numerous scientists are dedicated to researching the mechanisms of natural disasters and developing technologies for disaster prevention, mitigation, and relief, yielding many outstanding results.

To advance the field of natural disaster prevention and control and promote communication among peers, we initiated a Research Topic titled "*Prevention, Mitigation, and Relief of Compound and Chained Natural Hazards*" on 4 March 2023. The goal was to collect both original research and review articles addressing state-of-the-art theories and methodologies in all types of natural hazards, with a particular emphasis on studies highlighting the compound and chained relationships between different natural hazards. Since its launch, this Research Topic has attracted widespread attention and received numerous submissions. Now that the Research Topic has closed, a total of nine papers have been accepted and published, successfully fulfilling the goals of this Research Topic. This preface provides an overview of the nine published papers, which primarily focus on earthquakes, geological hazards, and earthquake-triggered landslides. This Research Topic

has provided support for the advancement in the field of Prevention, Mitigation, and Relief of Compound and Chained Natural Hazards.

The monitoring of earthquakes and disaster assessment

Earthquakes are considered the foremost among natural disasters, with a single event potentially causing tens of thousands of fatalities (Xu et al., 2014; Yu et al., 2024). Research on earthquakes and their associated hazards has always been a prominent issue. This Research Topic publishes three papers in this field. Ahn et al. from the Korea Meteorological Administration designed a performance evaluation method for earthquake early warning systems in low seismic activity areas. This method considers the unique conditions of evaluating early warning systems in such regions and is significant for eliminating potential discrepancies from reviewers or nations. Efforts in earthquake early warning systems aid in disaster response and avoidance, while emergency shelters provide scientific reference for earthquake rescue and post-disaster emergency evacuation. Wang et al. from the National Institute of Natural Hazards, Ministry of Emergency Management of China using Xichang City in Sichuan Province, China as an example, conducted a spatial accessibility analysis of emergency shelters. They utilized data on emergency shelters and road networks, considering predicted strong ground motion and potential fault rupture characteristics in an earthquake scenario. This analysis improved the objectivity of the accessibility results for emergency shelters.

Earthquake-induced landslides are a significant type of earthquake disaster, especially in mountainous areas (Xu et al., 2014; Zhao et al., 2023). The evaluation of seismic landslide hazards is a popular research direction (Shao and Xu, 2022). Yang et al. from the Institute of Geomechanics, Chinese Academy of Geological Sciences, used the Newmark model to evaluate seismic landslide hazards based on peak ground acceleration, traditional Arias intensity, and an improved Arias intensity. They found that the results based on the improved Arias intensity were consistent with the spatial distribution of co-seismic landslides, indicating that this method is suitable for rapid assessment of earthquake-induced landslides, providing scientific support for emergency assessment of such events.

Slope geological hazards such as landslides and debris flows

The automatic identification of regional landslides has become a widely studied research direction in the context of advancements in machine learning technology (Qi et al., 2020; Yang et al., 2022; Yu et al., 2022). Ma et al. from the Institute of Geology and Geophysics, Chinese Academy of Sciences, proposed a landslide identification method based on a dual graph convolutional network. Using GeoEye-1 satellite imagery with a spatial resolution of 0.5 m, they conducted automatic landslide identification in a mountainous area of Xinyuan County, Xinjiang, achieving an accuracy of over 80%. Compared to traditional methods, this approach offers the ability to identify data over a larger area with higher efficiency, providing a reliable solution for the large-scale identification of landslides.

Landslide relics refer to areas where landslides have occurred or are occurring. Most landslide relics have undergone deformation, instability, movement, and accumulation, reaching a stable state. Some continue to deform without large-scale instability, or experience deformation again due to external factors such as earthquakes and rainfall after initial instability and accumulation. Landslide relics provide the only direct information for understanding the background of landslide development in a region. Some researchers have conducted specialized studies on landslide relics in various areas, revealing the background of landslide development in those regions (Wang W. et al., 2024; Feng et al., 2024; Sun et al., 2024; Zhang et al., 2024). Li et al. conducted a study on landslide relic identification in the boundary area between the Qinghai-Tibet Plateau and the Loess Plateau, specifically in Jianzha County, Qinghai Province, China, using high-resolution imagery from Google Earth platfrom for visual identification. They developed a comprehensive and detailed landslide relic database, which includes 713 landslide relics. The study analyzed the spatial distribution characteristics and area distribution of these landslide relics, providing support for analyzing landslide influencing factors, hazard assessment, and disaster prevention and mitigation efforts in the region.

Cai et al. from the Research Center of Applied Geology of the China Geological Survey studied the accumulation and movement patterns of potential source materials for debris flow disasters under conditions of extreme short-term heavy rainfall using numerical simulation methods. They revealed and analyzed the maximum movement speed, accumulation height, impact range, and evolution process of a debris flow in a mountainous area in southwestern China. This research provides support for debris flow risk assessment and disaster prevention and mitigation in mountainous regions. Wang et al. from the Institute of Geology and Geophysics, Chinese Academy of Sciences, determined the occurrence date of a historical debris flow in Qingyang Mountain, Qinghai Province, China as July 1982, using historical tree-ring data. They obtained the boundaries of the historical debris flow through remote sensing imagery before and after the event. Using a depth-integrated continuum model, they reconstructed the process of this debris flow. This study provides a reference for dating historical debris flows and reconstructing their movement processes.

Liu et al. from Beijing Forestry University combined Landsat 5 and Sentinel-2 imagery to construct a time series of deformation for the Beishan landslide in Lijie Town, northeastern Qinghai-Tibet Plateau, Gansu. They analyzed the relationship between landslide deformation and rainfall, revealing a significant correlation between recent deformation and precipitation levels. This work integrates Landsat 5 and Sentinel-2 imagery to trace landslide deformation over nearly 40 years, showcasing its profound value. It establishes a reliable technical framework for integrating comprehensive optical and radar deformation remote sensing data, including pixel offset tracking and InSAR techniques, for landslide deformation monitoring. Moreover, it provides scientific support for landslide monitoring and disaster prevention and mitigation under the backdrop of climate change.

Assessing landslide susceptibility and hazard based on machine learning is an important research direction, with numerous papers published in recent years (Zhao et al., 2021; Shao et al., 2024). Xia et al. from the Key Laboratory of Degraded and Unused Land Consolidation Engineering, Ministry of Natural Resources, employed four methods including Naive Bayes, J48 decision tree, and multilayer perceptron models to assess landslide susceptibility in Xiaojin County, Sichuan Province, China. They achieved a high accuracy rate of around 90%. This study serves as a beneficial case for applying machine learning models to assess landslide susceptibility.

Conclusions and prospects

Human understanding of natural laws is boundless, and the study of natural disasters remains an eternal topic crucial to human survival and development (Xu and Xu, 2021). The research outcomes of this Research Topic have furthered our profound understanding of the mechanisms and patterns of earthquakes and geological disasters. They have also advanced the development of technologies for disaster warning, assessment, and emergency response. This technological support is crucial for reducing the risks and losses associated with seismic and geological hazards. It is important to note that the theme of our Research Topic is "*Prevention, Mitigation, and Relief of Compound and Chained Natural Hazards*". We aimed to collect more research related to comprehensive natural hazards and disaster chains. However, the nine papers included in this Research Topic specifically focus on earthquakes and geological disasters. In reality, there are many types of natural disasters, such as meteorological events, floods, droughts, wildfires, and tsunamis. Against the backdrop of global warming, the risks associated with meteorological disasters and their chained interactions with floods and geological hazards are undoubtedly increasing. Therefore, considering this aspect, we have not concluded this topic with the completion of this Research Topic. Instead, we have opened Volume II of this Research Topic, samely titled "*Prevention, Mitigation, and Relief of Compound and Chained Natural Hazards II*." For more details, please visit https://www.frontiersin.org/research-topics/64578. We welcome continued submissions from colleagues, especially in directions beyond earthquakes and geological disasters, such as meteorological events, floods, droughts, wildfires, tsunamis, and their compound and chained hazards.

Author contributions

CX: Writing–review and editing, Writing–original draft. QY: Writing–review and editing. XH: Writing–review and editing. WQ: Writing–review and editing. SM: Writing–review and editing. WY: Writing–review and editing. LT: 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.

The author(s) declared that they were an editorial board member of Frontiers, at the time of submission. This had no impact on the peer review process and the final decision.

Publisher's note

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