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Editorial

The Role and Impact of Geofluids in Geohazards

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1. Motivation and Background

Geohazard events over recent decades are demanding state-of-the-art, real-time, scientific, and practical strategies to mitigate their social and environmental impacts. Principally, geofluids play a significant role in geohazards in many aspects, such as water infiltration, precipitation, seepage, unsaturated behavior, freezing/thawing, weathering, strength softening, liquefaction, landslide, erosion, and sediment discharge.

Geohazard activities have become more frequent and disruptive in recent decades with changing climates becoming the new normal. To properly disclose the role of geofluids in geohazards and for the purpose of forecasting, emergency response, disaster mitigation, and protecting inhabitants affected by geohazards, a thorough understanding of the scientific background and driving force is essential. At present, combined approaches, integrating state-of-the-art methods numerically, experimentally, or technologically, should be applied to stress on the scientific issues associated with geohazard activities concerning the mechanisms, interplay of geofluid scientific strategies, driving force, dynamics processes, and progress in geohazards.

2. Contents of the Special Issue

In the paper "Impact of an Extreme Typhoon Event on Subsequent Sediment Discharges and Rainfall-Driven Landslides in Affected Mountainous Regions of Taiwan" by C. Hung et al., the research focused on the role of extreme rainfall event on subsequent rainfall-driven landslides and sediment discharges. The extreme rainfall event caused by the 2009 Typhoon Morakot in Taiwan was selected as a case study, and three catchments were chosen as the study areas. Through the rating curve method and landslide mapping, the results indicate that the sediment supply in these catchments was greatly affected by the extreme rainfall. It is further revealed that a significant increase in the number of landslide was attributed to the impact of extreme typhoon event, and the critical rainfall condition triggering landslides declined for 4-5 years.

In the paper "Geohazard Caused by Groundwater in Urban Underground Excavation" by B.-C. B. Hsiung et al., the research addresses how water plays its role in urban underground excavation disaster. Underground water-related hazards, i.e., leakage of the tunnel eye due to launching and docking of the shield, failure of the cross-seepage excavation, and failure of the retaining wall caused by water ingress during deep excavation, would lead to georelated catastrophe. By using finite element simulation to analyze leakage of the tunnel eye during shield launching resulting in failure, the authors find out that flush-in water on the other side of the tunnel and gravity are the main factors causing failure. Failure prevention can be achieved through reduction of soil permeability and increase of cohesion force.

In the paper "Numerical Investigation of Rainfall-Induced Landslide in Mudstone Using Coupled Finite and Discrete Element Analysis" by C. Hung et al., the authors studied the role of water infiltration on a rainfall-induced landslide in mudstone. The prefailure and postfailure characteristics of the landslide were simulated by finite element analysis (FEA) and discrete element analysis (DEA), respectively. Based on FEA results, the onset of landslide initiation was captured through assessing the rapid change of source displacement (RCSD) within the slope. In addition, according to the DEA result, the study indicated that water infiltration and transition in steepness played significant roles in the behavior of runout process. The results of this study demonstrated that a combination of FEA and DEA can be a useful approach to better understand the process of rainfall-induced landslides.

In the paper "Consolidated and Undrained Ring Shear Tests on the Sliding Surface of the Hsien-du-shan Landslide in Taiwan" by H.-M. Lin et al., the authors developed a new consolidated undrained ring shear test capable of measuring the pore pressures to investigate the initiation mechanism of the Hsien-du-shan rock avalanche. The research discusses the postpeak behavior to address the unstable geomorphological precursors observed before the landslide occurred. Experimental results show that the shear contractions of the sliding surface generated excess pore pressure. In addition, when the sliding surface is sheared under large normal stress, the low hydraulic conductivity of a landslide gouge would result in continuous pore pressure increase during long shear displacement. The excess pore pressure feedback at the sliding surface may have accelerated the landslide.

In the paper "Preferential Water Infiltration Path in a Slow-Moving Clayey Earthslide Evidenced by Cross-Correlation of Hydrometeorological Time Series (Charlaix Landslide, French Western Alps)" by G. Bièvre et al., the authors studied the role of water infiltration on a slow-moving clayey landslide. The landslide characteristics, such as seasonal rainfall, deformation displacement, and variation of the groundwater table, were documented through a multidisciplinary monitoring from 2010 to 2017, and a conceptual hydrogeological model of the site was built. The study demonstrated that the behaviors of the phreatic water table and the water table near the shear surface agreed with the landslide kinematics in different seasons. In addition, the fissures connected to the shear surface are the preferential infiltration paths within the clayey landslide.

In the paper "Effects of the Grain Size on Dynamic Capillary Pressure and the Modified Green–Ampt Model for Infiltration" by Y.-Z. Tsai et al., the authors performed downward infiltration experiments to investigate the cumulative infiltration, wetting front depth, and wetting front velocity in sand columns with various grain sizes. They found that the sand column with a smaller grain size exhibited a lower infiltration rate and a lower wetting front velocity, resulting in increased infiltration time. The modified Green–Ampt (MGAM) model was used to estimate the equilibrium capillary head and suction head from the experiment data. The effects of grain size of sand and porosity on the model parameters were also discussed in the study.

In the paper "Modeling of Transient Flow in Unsaturated Geomaterials for Rainfall-Induced Landslides Using a Novel Spacetime Collocation Method" by C.-Y. Ku et al., the research presents a new spacetime collocation method for transient flow in unsaturated soils of rainfall-induced landslides. The numerical solution is obtained by superpositioning Trefftz basis function that satisfies linearized the Richards equation and Gardner exponential model to describe the soil-water characteristic curve in unsaturated soils. The infinite slope stability analysis with the proposed meshless method is developed to deal with the rainfall-induced landslides. Through conducting several test problems, the method is proved to be accurate to deal with the transient flow in unsaturated soils for rainfall-induced landslides. This method can also be applied to different soil textures for future studies.

In the paper "Numerical Analysis of Damaged River Embankment during the 2011 Tohoku Earthquake Using a Multiphase-Coupled FEM Analysis Method" by L. Chen and S. Kimoto, the authors use a three-phase coupled finite element program, COMVI2D-DY, a program for analyzing large deformation of partially saturated soils, to simulate not only a damaged river embankment on the Naruse River but also the embankment reconsolidation process. In order to do so, a cyclic elastoplastic constitutive model based on nonlinear kinematical hardening rule modified by considering stiffness recovery is applied. The result shows that numerical methods enable the key damage pattern, and the embankment is destroyed and collapsed towards the landside for most of the cases, and the settlement is 2.5 m above the embankment. The reconsolidation analysis can also be obtained through simulation results.

In the paper "Soil-Water Characteristic Curve of Residual Soil from a Flysch Rock Mass" by J. Peranić et al., the research presents the soil-water characteristic curves (SWCCs) of residual soil formed by the weathering process of a flysch rock mass. Six different devices were used to perform experiments on intact specimens to cover different stress conditions and from saturated to air-dried conditions. An improved understanding of the soil-water characteristic of residual soil from flysch rock mass is valuable for future studies on assessing the rainfall-induced landslide in flysch slopes.

In the paper "Seepage Behavior of an Inclined Wall Earth Dam under Fluctuating Drought and Flood Conditions" by W. Ye et al., the authors studied the seepage characteristic of an inclined wall dam under fluctuating drought-flood condition using a large-scale physical model. According to the results, the permeability coefficients were much smaller than those of the saturated permeability in the area with low crack development and were much larger than those of the saturated permeability in crack area after drought. As the water level rose, cracks could heal themselves, but the integrity of the dam slope was much less than its original state. In addition, the formation of cracks permanently weakened the antiseepage performance of the clay soil. Monitoring and protecting the weak parts of seepage dams could be benefited by the results.

In the paper "Towards Automated Real-time Detection and Location of Large-Scale Landslides through Seismic

Waveform Back Projection," E.-J. Lee et al. present a semiautomatic algorithm for detecting and locating landslide events using both broadband and short-period recordings and have successfully applied to landslides in Taiwan. The results show that the landslide detection and spatial-temporal location system could benefit the establishment of rainfall-triggered landslide forecast models and provide more reliable constraints for physics-based landslide modeling. The accumulating seismic recording of landslide events could be used as a training dataset for machine learning.

Conflicts of Interest

The editors declare that they have no conflicts of interest regarding the publication of this special issue.

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