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*Editorial*

# Mitigation Techniques for Water-Induced Natural Disasters: The State of the Art

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According to the 2020 edition of the United Nations World Water Development Report (UN WWDR 2020), about 74% of all-natural disasters were water-related between 2001 and 2018. The total number of deaths due to floods and droughts exceeded 166,000 during the past 20 years. Additionally, floods and droughts caused real economic damage worth almost USD 700 billion and affected over 3 billion people worldwide. Water-induced natural disasters include floods, droughts, landslides, storm surges, storm waves, and tsunamis and are expected to worsen with climate change. Hence, there is still a growing demand for novel techniques to mitigate water-induced natural disasters.

To improve our capabilities and understandings for management, resilience, monitoring, analysis, prediction, forecast, and hindcast of the water-induced natural disasters. This Special Issue is intended to collect the latest and state-of-the-art studies on floods, droughts, landslides, storm surges, storm waves, and tsunami disasters. Eight excellent, high-quality papers are published in this Special Issue.

Chang et al. [1] developed a high-performance two-dimensional hydrodynamic model based on the finite-element method and unstructured grids. They implemented an operational high-performance forecasting system for pluvial flash floods in the southwestern Plain Areas of Taiwan. The forecasting system is composed of the Weather Research and Forecasting (WRF) model, the Storm Water Management Model (SWMM), a two-dimensional hydrodynamic model, and a map-oriented visualization tool.

Guo et al. [2] used data-driven machine learning techniques to establish a multistep-ahead prediction framework and evaluated it for river stage modeling. Four machine learning techniques, namely support vector regression (SVR), random forest regression (RFR), multilayer perceptron regression (MLPR), and LGBMR, were employed to create the data-driven machine learning models with Bayesian optimization. The data-driven models were then applied to simulate river stage hydrographs of the tidal reach of the Lan-Yang River Basin in Northeastern Taiwan.

Su et al. [3] created a 3D GIS-based flood war game assistance platform (FWGAP) for conducting rapid spatial analyses. Flooded areas are estimated in the FWGAP in three ways: (1). using a digital terrain model (DTM) with a designated flood center and depth; (2). applying historical flooding spots; and (3). potential flooding maps. The FWGAP can be adopted to estimate the impacted and vulnerable populations and has functions for locating resources such as shelters and hospitals near the flooded areas.

Chu et al. [4] proposed a strategy to optimize the performance of the Support Vector Machine (SVM) scheme for extreme Meiyu rainfall prediction over southern Taiwan. Variables derived from Climate Forecast System Reanalysis (CFSR) dataset are the candidates for predictor selection. A series of experiments with different combinations of predictors and domains are designed to obtain the optimal strategy for constructing the SVM scheme. Their results revealed that higher performance would be expected when the north of the South China Sea is characterized by more substantial southwesterly flow and abundant low-level moisture for a given year.

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Chen et al. [5] proposed using a deep learning model (DLM) to overcome these problems. We alleviated the high computational overhead of this approach by developing a novel framework for the construction of lightweight DLMs. The proposed scheme involves training a convolutional neural network (CNN) by using a radar echo map in conjunction with historical flood records at target sites and using Grad-Cam to extract critical grid cells from these maps (representing regions with the most significant impact on flooding) for use as inputs in another DLM. Finally, we used accurate radar echo maps of five locations and the flood heights record to verify the validity of the method proposed in this paper. The experimental results show that our proposed lightweight model can achieve similar or even better prediction accuracy at all locations with only about 5~15% of the operation time and about 30~35% of the memory space of the CNN.

Chiang et al. [6] applied the support vector regression (SVR) approach to the data-driven model as the core algorithm, and then to better understand the effect and constraint of different data lengths on the data-driven model training for the rainfall-runoff simulation and compared with the rainfall-runoff simulation derived from a physically based hydrologic model, the Hydrologic Modeling System (HEC-HMS). Their results indicated that the SVR model reasonably estimated the rainfall-runoff relationship, even if the simulation only used one-year observational data of one typhoon event. Overall, the SVR model was superior to the HEC-HMS model in the performance of the rainfall-runoff simulation.

Chen et al. [7] generated a flood risk map assessment under the RCP8.5 scenario using different spatial scales to integrate the projection climate data of high resolution, inundation potential maps, and indicator-based approach at the end of the 21st century in Taiwan. This flood risk map can be a communication tool to effectively inform decision-makers, citizens, and stakeholders about the variability of flood risk under climate change. They suggest that risk maps enable decision-makers and national spatial planners to compare the relative flood risk of individual townships countrywide to determine and prioritize risk adaptation areas for planning spatial development policies.

Lin et al. [8] outlined the evolution of the Taiwan Climate Change Projection Information and Adaptation Knowledge Platform (TCCIP) project. They described the significant achievements of this project, for instance, climate projection arising from participation in the WCRP Coupled Model Inter-comparison Project (CMIP), dynamically and statistically downscaled data with resolutions up to 5 km grid, impact assessments of various themes, such as flooding, as well as the support of national policies through approaches including risk maps, climate data, and knowledge brokering.

This Special Issue mainly presents state-of-the-art techniques for preventing and mitigating water-induced disasters. These outstanding papers are novel and timely for researchers worldwide to better understand the progress and improvements of disaster early warning technologies. Additionally, the on-site survey is also essential to coastal disaster mitigation, and the relevant study of the on-site survey is presented in this Special Issue.

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