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Editorial: The urban fluvial and hydro-environment system

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Editorial on the Research Topic
The urban fluvial and hydro-environment system

Introduction

With the rapid urbanization of cities around the world, water security, flood control, and urban hydro-environmental management have become important tasks to tackle. The majority of large to megacities are located in delta regions surrounded by river networks, due to their historical development. They are not only threatened by floods from upstream river basins, but also endangered by the challenges of urban hydro-environmental governance. Fast urbanization causes interference and fragmentation of the river system and impedes its hydrodynamic potential, which is a primary driver of flooding, pollution, and sediment deposition. Consequently, water security and environmental problems are major issues for sustainable urban development.

The purpose of this Research Topic (RT) is to examine the latest advances and developments in addressing the challenges in urban fluvial and freshwater systems as well as to discuss the opportunities they create for improvement in modelling, management practices and governance. This RT consists of twenty research articles from 99 authors under three different research themes, which feature contributions on urban space management, water pollution mitigation and urban watercourse behavioural sciences to strengthen resilience. The RT includes the following themes:

- State-of-the-art numerical models,
- Urban environmental and hydrological advances, and
- Sustainable cities implementation.

State-of-the-art numerical models

Urban river networks are usually subjected to physical and environmental changes over time. Numerical studies present an effective way to investigate such networks and their alteration in structure and function. The work by Wang et al. employed numerical non-stochastic quasi-uniform iterative binary tree networks (QU-IBTNs) to simulate two natural river networks. The Yellow River in China and the Amazon River in South America have been used for the validation of the proposed model. Liu et al. further investigated the Smoothed Particle Hydrodynamics (SPH) model using two types of Particles Shifting Techniques (PSTs). Their proposed model with optimized PST was suggested for the practical applications. Tian et al. proposed a SPH-SWE (Smoothed Particle Hydrodynamics-Shallow Water Equations) diffusion model to study the diffusion process of soluble and insoluble pollutants transport in the Nanmenxia River. Their study demonstrates that the SPH-SWE method has great potential for simulating the dispersal process of pollutants. In terms of flood modelling, Ding et al. studied the Gengdi village flash flood incident with an efficient and accurate coupled water-sediment model. The proposed model was established with a Godunov-type finite volume depth-averaged flow approach. Moreover, a sediment module and OPENMP parallel computing module were added to enhance the model's capability. They found a direct relationship between the sedimentation intensity and the magnitude of Alpine flash floods, thus proving to be a powerful tool for the detection of the effects of flash floods on sedimentation processes.

In small-scale hydrodynamic modelling, Cho et al. characterized open channel flows for rough bed and rigid lid (rigid cover to flow) using Computational Fluid Dynamics (CFD). It was observed that turbulent structures produced from the rough bed flow interact with the free water surface. However, for rigid lid flow, its Reynolds stresses associated with the vertical velocity fluctuation were artificially reduced to zero near the lid due to the boundary condition assignation. That led to no vertical fluctuations, and thus reduced the turbulence structure estimation accuracy near the lid. The investigation by Wang et al. studied the generation and transport of turbulence associated with flow separation around submerged structures. Results of the study showed that the developed Incompressible Smoothed Particle Hydrodynamics (ISPH) method with the k-ε turbulence closure model is capable of reproducing the velocity fields and the turbulence characteristics accurately, and thus can be used to represent comprehensive hydrodynamics of flow-structure interactions in urban hydro-environmental systems. Liu et al. described model integration methods for the hydro-model platform under cloud computing environments, and proposed two methods of model integration, namely EXE integration and interactive integration methods. It suggested a solution to the plug-and-play problem when running more than one software model under concurrent simulations. The different scenarios were passed among the software to encapsulate different conditions. It was found that the interactive integration method can be used as a tool to solve the problem of real-time data transfer. Also, these integrated models can be accessed by end-users anywhere and can be driven by the described platform to perform real simulations.

Urban environmental and hydrological advances

Fluvial environments around the world have been increasingly stressed and altered by the urbanization process. One such stresses is the sediment transport and debris-induced flow that can cause pollutant related issues. The study by Shu et al. found that the overflow rate was dominant in controlling the debris flow formation in partial and en masse dam failure modes. While the vertical grading parameter appears to have a secondary impact, the dam height showed a negligible influence on dam failure. Peng et al. evaluated five flow resistance formulae for sand bed channels. A total of 1,636 sets of field data were recorded from the hydrological stations of two large Chinese river systems, the Yellow and Yangtze Rivers. They found that the fitting of the Yellow and Yangtze Rivers' data to those formulae are described by relatively high root-mean-square error, hence, all formulae still need improvement in their predictive ability. Wang et al. studied the relative fractions of the overall bed load yields produced during the rising and falling limbs of all symmetrical hydrographs (i.e. the bed load yield ratio), which are shown to be predominantly reliant on bed load transport hysteresis. Their finding demonstrated that the relationship between the bed load yield ratio and the ratio of reference stresses for the fractional sediment motion of each size class on both limbs follows a power law.

Rainfall intensity has increased in many regions through global climate change. Various studies have investigated rainfall characteristics in urban contexts. The study of Nazrien Ng et al. investigated the Sg Langat behaviour under the influence of extreme rainfall. The study focused on determining slope angles' effects on slope stability and assessing the development of pore water pressure. They also studied how extreme rainfall can influence the safety factor of the slope. The landslide research by Choi et al. developed two criteria for its efficient management, namely Surface displacement-based evacuation management and Surface angle-based evacuation management. In the Surface displacement-based criteria, they further developed short-term-based management criteria using experimental studies and long-term-based management criteria using collapse data. Bai et al. investigated the critical response characteristics of micro-droplets under the action of low-frequency acoustic waves, i.e. by studying the response of microdroplets. They found that the width of Droplet Size with Significant Response (DSSR) was affected by both microdroplet sizes and

concentration. Also, the critical Sound Pressure Level (SPL) and its equilibrium response time were presented based on average droplet size increment and variation of droplet size respectively.

Offshore structures and artificial reefs can be subjected to wave and wind loads. Their effects are complicated, but need to be understood for successful implementation of structures in urban hydro-environments. Wang et al. developed a theoretical potential flow method to calculate the motion of offshore wind turbines. The study successfully simulated the motion characteristics and aeroelastic responses of the DTU-10MW semi-floating offshore wind turbine under the coupling effect of wind and wave. Liu et al. further studied the hydrodynamic characteristics around the circular pile in the Guoyuan Project in Chongqing Port with the help of fixed pressure sensing system as well as a dynamic signal test. They found the hydrodynamic pressure signal in the Yangtze River water flows to be a low-frequency signal. Shu et al. described the influences of typical artificial reefs on flow hydrodynamics and carbon sequestration potential using offshore Juehua Island in the Bohai Sea as a targeted site. They aimed to study the effects of square and M-shaped artificial reefs on localized flow fields, biomass production, and offshore carbon sink capacity. It has been found that although the offshore ground attached to M-shaped artificial reefs was only three times larger than those with square artificial reefs, the total carbon sink potential was up to seven times greater than that of regions covered by square artificial reefs.

Sustainable cities implementation

In the search for the best sustainable practice in urban spaces and fluvial managements, many factors need to be considered. Climate, flood risk and sediment-laden fluvial systems are among those factors under constant investigation in research programs. Chen et al. studied the combined effects of climate warming and grazing in the Qinghai-Tibet Plateau. The grazing effects were separated with a climate-driven probability model and scenario comparison, using the Normalized Difference Vegetation Index (NDVI). The study revealed that grazing has positive effects on NDVI at the beginning and end of the growing season, and negative effects in the middle. Liu et al. developed a time-dependent model for the corrosion of steel components under sediment-laden flow. They presented an evaluation method for the resistance degradation of steel piles and proposed a time-dependent model for the corrosion of steel components under sediment-laden flow. The article by Tallar and Geldoffer used the Flood Potential Index (FPI) to carry out a micro-scale study of flood risk assessment in urban fluvial areas in DKI Jakarta. Flood Potential Hazard Maps (2021–2024) for each sub-district of DKI Jakarta were developed by the analysis of rainfall data. The NDVI was obtained from Landsat eight interpretation and population density. The result predicted 10 sub-districts with high flooding potential, 219 with medium potential, and 32 with low flood potential in 2024. Kim et al. researched the hydrological behaviours of a green roof system using a SEEP/W model. The actual observed data from a test bed of the green roof system was validated with the simulated results of rainfall-runoff relationships within the green roof system to verify the applicability of the SEEP/W model. The authors found that the model shows good agreement with observed data.

Overall, this RT highlights the challenges and opportunities in urban and fluvial systems through a wide-range of research papers, models and techniques currently being used and/or developed to improve the resilience of urban water infrastructure, simulate effects of increased rainfall intensity, enhance flood prediction, evaluate sedimentation processes, and propose pollution mitigation and related efforts. All of the selected contributions help to discover innovative theories, advanced technologies, and application examples in these targeted fields of study. Finally, we would like to thank all the editors, reviewers and authors for their crucial contributions to this RT.

Author contributions

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

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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