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Editorial: Nature-based solutions for urban water management

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Editorial on the Research Topic
Nature-based solutions for urban water management

Water, serving as a vital resource for urban development, imparts both advantages and complications, particularly concerning urban pluvial flooding. Consequently, there is a growing recognition of the necessity to incorporate nature-based solutions (NBS) into urban water management system. These integrated solutions leverage natural processes and ecosystem services in tandem with the traditional “grey infrastructures” that predominantly depend on engineering interventions (Palmer et al, 2015). The aim is to foster resilient communities and cities adept at managing water-related hazards effectively.

To advance this mission, it is imperative to bridge the existing gap between urban hydrodynamic research and the deployment of NBS. Additionally, there is a need to expand the prevailing cost-benefit analysis methodology and develop innovative approaches that consider multiple criteria and the synergistic integration of both grey and green measures. By encouraging further exploration in this field, we propose a Research Topic focusing on *Nature-based solutions for urban water management*. The intention of this Research Topic is to provide a devoted platform for researchers to probe various Research Topic, thereby facilitating advancements in the understanding and implementation of NBS in urban water management.

Through the publication of research articles and discussions within this Research Topic, we seek to promote knowledge exchange, interdisciplinary collaboration, and the development of effective strategies and tools to address the complex challenges associated with urban water management. Integrating nature-based solutions into our urban planning and engineering practices presents a pathway towards fostering cities that are more sustainable and resilient.

We invite researchers from various disciplines to contribute their expertise and insights to this Research Topic, ultimately fostering a collective effort to enhance the management of urban water resources and mitigate the impacts of flooding events.

Liu et al. have proposed a comprehensive urban utilization model that integrates blue, green, and gray water infrastructure (Figure 1). Their study entails a quantitative analysis and simulation of the intricate relationship between rainwater infiltration, stagnation, storage, use, and drainage at the community scale. Furthermore, the authors provide in-depth discussions on the abundance and quality of rainfall water resources within blue-green-gray

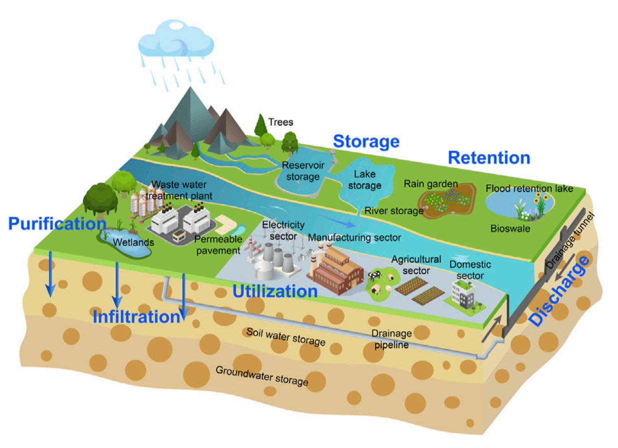

FIGURE 1
The framework of the rainwater utilization model integrated with blue, green, and gray water infrastructure (Liu et al.).

infrastructures, taking into account various urban hydrological processes, including storage, use, and drainage.

The simulation results have enabled the evaluation of rainwater management's impact on urban watersheds, as well as the assessment of utilization efficiency and the delicate balance between supply and demand. As a result, the model allows for the strategic spatial arrangement of infrastructures to maximize rainwater Research Topic and significantly enhance rainwater utilization efficiency, providing valuable support to municipal planning endeavors.

The integration of green, blue, and gray infrastructure within individual buildings and across urban network systems has demonstrated remarkable improvements in rainwater utilization capacity. When synergistically combined with other essential infrastructures such as transportation, water, energy, and telecommunications, the planning, design, and development of urban rainwater resource utilization not only effectively address challenges in water environment management but also contribute to the creation of a livable and healthful urban environment.

The articles featured in this Research Topic serve as a valuable resource, offering both technological and theoretical support for this innovative framework, while also playing a crucial role in the advancement of rainwater utilization practices.

Since the inception of the Sponge City initiative in China, substantial advancements have been made in the realm of urban rainwater resource utilization. However, the achieved outcomes have fallen short of the anticipated scale, with utilization rates remaining considerably low.

Chen et al. outlined the current Sponge City approach from the perspectives of planning content and planning process to fill the gap in the existing guidelines of the Sponge City Programme. Key missing elements that could promote the development of current Sponge City planning were identified. The study delved into and optimized the targets for pluvial flood protection, strategies for planning interventions, and instruments for interdisciplinary cooperation in the planning process. The refined approach was successfully applied in the Sponge City planning for Qinhuai District, Nanjing City.

Liu et al. conducted a review of regions and cities in China where Sponge City projects have been implemented. Their findings highlight that southern China devotes more attention to hydrological processes related to water storage, whereas northern China emphasizes processes connected to the infiltration of stormwater.

Jin et al. proposed individual criteria for mapping high-absorbance areas at the regional and local scales. Water table dynamics after large infiltration events from rainfall were simulated via numerical analysis with the consideration of different hydraulic characteristics.

Xu et al. reviewed the evolution of rainwater utilization management modes in advanced countries, classified urban rainwater utilization measures into three categories, including source control, medium transmission, and terminal treatment, and summarized the advantages, disadvantages, and scope of the application of these measures.

Jia et al. proposed a framework for blue-green-gray infrastructure classification based on machine learning algorithms and unmanned aerial vehicle (UAV) images. This framework was applied at the Southern University of Science and Technology campus, Shenzhen, China. This study demonstrated the feasibility of using UAV images in the urban blue-green-gray infrastructure classification.

Harnessing urban rainwater resources to alleviate water shortage also requires the adoption of economically efficient techniques to improve and control water quality.

Tian et al. proposed a data-driven approach to quantify the effects of rainfall on river pollution and applied it to the Shiyan River in Shenzhen, China. They found that the most important factor affecting river pollution is the dry period, followed by average rainfall intensity, maximum rainfall in 10-min interval, total rainfall, and initial runoff intensity. By employing a newly proposed artificial neural network model, they predicted that the event-mean concentration of the Chemical Oxygen Demand would be much lower during heavy rains compared to light rainfall.

Zhang et al. proposed a novel waterlogging depth prediction model that only uses rainfall data as input. A "rainfall-waterlogging amplification factor" based on the geographical features of monitoring stations is constructed to quantify the mapping relationship between rainfall and waterlogging depths at different locations. This method effectively overcomes the limited coverage of monitoring stations and historical waterlogging data.

Zhang et al. developed a three-module methodological options framework based on the combination of hydrological modeling, statistical analysis, and conceptual approaches, to guide the selection of attribution methods. The effectiveness framework was evaluated by applying it to China's Upper Yangtze River Basin. The SWAT-based method was found to be the best approach to quantify the influences of climate change and human activities on streamflow. It was also found that climate change dominates the changes in streamflow.

Dai et al. proposed a method for selecting sensitive monitoring parameters and optimizing the distribution of monitoring sites in lakes. This method was applied to the large-scale river-to-lake water diversion project, i.e., Water Diversion from the Yangtze River to Lake Taihu in China.

Seven physicochemical parameters, sensitive to seasonal water diversion, were identifies and employed to optimize the site distribution and daily water quality monitoring. It was found that the introduction of allochthonous pollutants and biological species through water diversion projects could have significant ecological effects on the urban drinking water quality.

Sun et al. unfolded the mass exchange mechanism of water and soil on the soil surface in the rainfall splash erosion process. The splash erosion was found to be proportional to the rainfall kinetic energy and has a linear relation to the infiltration amount. The single raindrop kinetic energy and the splash erosion have a quadratic parabola relation, and the splash velocity is about 1/3 of the single raindrop terminal velocity.

Author contributions

JL–conceptualization, writing, review and editing LS–conceptualization, writing, review and editing ZT–methodology, investigation, visualization, review QY–methodology, investigation, visualization, review SW–methodology, investigation, visualization, review SZ–conceptualization, writing, editing. All authors contributed to the article and approved the submitted version.

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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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