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Editorial

Urban Runoff Control and Sponge City Construction: Important Topics †

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1. Introduction

Rapid urbanization, which leads to a lack of adequate planning and design, has led to worsening city syndrome situations [1], such as urban flooding, water pollution, heat-island effects, and ecological deterioration. To mitigate these impacts, various technology systems have been proposed in different countries [2,3]. Additionally, a new concept in urban stormwater management strategies was announced by the Chinese government in 2013 called a "sponge city" [4,5]. The Chinese central government selected 30 pilot cities, considering their different natural and social conditions, for sponge city construction exploration in 2015 and 2016. Furthermore, in 2021, based on the experiences of these pilot cities, China began to systematically promote the sponge city concept on a national scale [6,7]. Now, many studies have been conducted and practices have been implemented related to sponge city construction in China [8,9]. More importantly, this new paradigm for a sustainable urban runoff control strategy has become a widespread focus in urban water management research and practices globally.

Along with the demonstration of sponge city construction, many related research achievements were obtained. In this context, in order to present the latest developments, technologies, and case studies related to urban runoff control and sponge city construction, following the success of "Urban Runoff Control and Sponge City Construction I" [10], this Special Issue, "Urban Runoff Control and Sponge City Construction II", is a follow-up. We aimed to discuss and address studies focused on the theories and technologies of sponge city construction; urban hydrology; methods of quantifying the benefits of a sponge city; rainwater utilization; practices that mitigate urban flooding and pollution; the performance of GI; the impact of media; vegetation; climate; the design of hydrological, hydrodynamic, and pollutant removal processes; and case studies on sustainable urban design and management using LID-GI principles and practices. We would like to express our gratitude to all the contributors who made this Special Issue so successful.

2. Summary of This Special Issue

In total, 11 papers were published in this Special Issue. The article types, authors, titles, keywords, and study areas are summarized in Table 1.

Table 1. Summary of the papers published in the Special Issue "Urban Runoff Control and Sponge City Construction II" in *Water* (https://www.mdpi.com/journal/water/special_issues/UrbanRunoff_Control2 (assessed on 16 December 2023)).

Article Type	Authors	Title	Keywords	Study Area
methods and tools	Aldrees, A.; Dan'azumi, S.	Application of Analytical Probabilistic Models in Urban Runoff Control Systems' Planning and Design: A Review.	best management practices; low-impact development; water-sensitive urban design; blue-green infrastructure; sponge cities	/
methods and tools	Zhao, Y.; Price, M.; Trowsdale, S.	Comparison of the Transition to More Sustainable Stormwater Management in China and the USA	stormwater management; transition; multi-level perspective	United States and China
methods and tools	Le, J. T.; Gonzalez, J. P.; Carson, R. T.; Ambrose, R. F.; Levin; L. A.	Integrating Non-Targeted Ecosystem Services into Assessment of Natural Stormwater Treatment Systems.	urban runoff; urban ecology; nature-based solutions; natural treatment systems; biofilters; ecosystem services; monitoring and evaluation; planning and management	Los Angeles County, United States
methods and tools	Yang, Y.; Shao, Z.; Xu, X.; Liu, D.	Impact of Storm Characteristics on Infiltration Dynamics in Sponge Cities Using SWMM.	Chicago storm; Horton; porous pavement; return period; time-to-peak coefficient	Fengxi, China
methods and tools	Xie, M.; Cheng, Y.; Dong, Z.	Study on Multi-Objective Optimization of Sponge Facilities Combination at Urban Block Level: A Residential Complex Case Study in Nanjing, China.	Multi-objective optimization; sponge city planning and design; urban block; sponge facility combination	Nanjing, China
methods and tools	Cao, Q.; Cao, J.; Xu, R.	Optimizing Low Impact Development for Stormwater Runoff Treatment: A Case Study in Yixing, China.	first flush effect; InfoWorks ICM; LID optimization; generalized likelihood uncertainty estimation	Yixing, China
methods and tools	Wang, J.; Zhou, X.; Wang, S.; Chen, L.; Shen, Z.	Simulation and Comprehensive Evaluation of the Multidimensional Environmental Benefits of Sponge Cities.	sponge city; grey and green infrastructure; stormwater management model; integrated environmental benefits; monetary value; stormwater use	Beijing, China
typical source control facility	Lee, Y. T.; Ho, M. C.; Chiou, Y. S.; Huang, L. L.	Assessing the Performance of Permeable Pavement in Mitigating Flooding in Urban Areas.	permeable pavement; monitoring instruments and management systems; flow law formula; low-impact development	Taoyuan City, Taiwan, China
typical source control facility	Chen, X.; Liu, R.; Liu, D.; Xin, X.	Analysis of Preferential Flow in Artificial Substrates with Sedum Roots for Green Roofs: Experiments and Modeling	green roofs; preferential flow; artificial substrate; Sedum roots; solute breakthrough experiments; HYDRUS-1D	/
typical source control facility	Chen, C.; Li, Y.; Le, W.; You, C.; Liu, C.; Liu, W.; Zhang, R.	Field Performance of Rain Garden in Red Soil Area in Southern China.	rainfall runoff; low impact development; runoff control; pollutant removal; Sponge City	Nanchang, China
combination of source control facility	Zhang, C.; Lv, Y.; Chen, J.; Chen, T., Liu, J.; Ding, L.; Zhang, N.; Gao, Q.	Comparisons of Retention and Lag Characteristics of Rainfall–Runoff under Different Rainfall Scenarios in Low-Impact Development Combination: A Case Study in Lingang New City, Shanghai.	Sponge City; low-impact development; stormwater management; retention time; lag time; Lingang New City	Lingang New City, Shanghai, China

Covering the methods and tools aspects, Aldrees et al. (contribution 1) wrote a comprehensive review on the application of Analytical Probabilistic Models (APMs) in urban runoff control systems' planning and design. APMs are closed-form mathematical expressions representing a long-term system's output performance derived from the probability distribution of the system's input variables. Once derived, APMs are easy to handle, allow for sensitive analysis, and can be co-opted into optimization frameworks. The implementation of APMs in the planning and design of runoff control systems will not only help address the runoff quantity and quality problems of urban stormwater but will also go a long way in optimizing the benefits derived from these systems. Zhao et al. (contribution 2) presented a comparative cross-nation study of the transition to more sustainable stormwater management (SSWM) in the United States and China. Multi-level perspective and multiphase models were used to examine the transition dynamics and reflect on how transition theory explains the changes within federal and socialist contexts. The main difference between the transition processes in the United States and China is the extent to which niche level innovations are developed, especially in the type of actors and activities investigated. Le et al. (contribution 3) proposed integrating Non-Targeted Ecosystem Services into Assessment of Natural Stormwater Treatment Systems. Usually, the design of Natural Stormwater Treatment Systems (NTSs) targets water services; however, the biological communities associated with NTSs (i.e., plants, animals, and microbes) can provide non-targeted functions that result in ecosystem services, such as biodiversity, pollination, and climate regulation, or, in some cases, disservices. Additional co-benefits of NTSs include recreation, education and outreach opportunities, and aesthetic value. As NTSs become globally widespread, best practices must include the ability to holistically assess NTS performance in ways that extend beyond water treatment services.

In order to identify the Impact of Storm Characteristics on Infiltration Dynamics in Sponge Cities, Yang et al. (contribution 4) used the Horton method within the stormwater management model to investigate how uniform and Chicago storm parameters affect infiltration rates. Their findings provide the following valuable insights: (1) Increasing the porous pavement area proportionally reduces subarea sizes within subcatchments, and the infiltration rates of porous pavements are supply-controlled. (2) Uniform storms result in consistent initial infiltration rates across pervious areas, subcatchments, and the entire catchment. The duration of this stable state decreases with higher return periods. Catchment infiltration volumes exhibit linear growth with greater storm intensities. (3) Peak infiltration rates and moments for pervious areas, subcatchments, and the overall catchment exhibit correlations with both the return period and the time-to-peak coefficient. This study quantifies the influence of design storm parameters for infiltration, providing valuable insights for stormwater infrastructure design and urban stormwater control.

In sponge city construction, the optimization of sponge facility combinations at the urban block-level is a very important aspect. Xie et al. (contribution 5) utilized a residential complex in Nanjing as a practical example, selected six types of typical sponge facilities to construct a multi-objective optimization combination model for sponge facilities, and employed the Strength Pareto Evolutionary Algorithm (SPEA-2) to determine the optimal combination of sponge facility types and quantities. Cao et al. (contribution 6) used InfoWorks ICM to simulate the properties of runoff and determine the optimal LID design of a residential site in Yixing, China, based on four practical rainfall events. In this study, the software was redeveloped using Ruby object-oriented programming to improve its efficiency in uncertainty analysis using the Generalized Likelihood Uncertainty Estimation method. The simulated runoff was in good agreement with the observed discharge.

The coupling of gray and green infrastructure is another focus in sponge city construction; however, due to the complexity of the process and the diversity of the benefits, there are no measurements of the comprehensive benefits. Adopting a typical university campus in Beijing as an example, Wang et al. (contribution 7) simulated the multidimensional benefits to the water quantity, water quality, and ecology of a gray and green facility renovation by coupling the stormwater management model (SWMM) and InfoWorks Integrated Catchment Management (ICM). Monetization methods and economical means were employed to characterize the comprehensive benefits.

Within the studies of typical source control facilities, Lee et al. (contribution 8) assessed the performance of permeable pavement in mitigating flooding in urban areas. In this study, demonstration roads using a general pavement and a permeable pavement were built on Dahua North Street, Taoyuan City; rainwater was stored in a central irrigation ditch and a permeable pavement through an innovative construction method for reuse in agricultural irrigation. Monitoring instruments and management systems were built to analyze the actual discharge and peak discharge of the permeable pavement and general pavement. The results show that the permeable pavement can effectively reduce the peak discharge by 60~75%, which can not only achieve the benefit of low-impact development but can also reuse rainwater. To understand the occurrence of preferential flow in the vegetated artificial substrates of green roofs, Chen et al. (contribution 9) established an experiment with various plant substrate combinations that involved two Sedum species and two artificial substrates for three depths of 6, 10, and 14 cm. Thereafter, solute breakthrough experiments were conducted, followed by inverse and forward modeling in Hydrus-1D. To assess the performance of a rain garden in a red soil area in southern China, Chen et al. (contribution 10) built a rain garden in Nanchang city, where the local soil is red soil and has low organic carbon, strong acidity, and low permeability rainfall characteristics. Rainfall runoff control and pollutant removal efficiencies were studied based on the on-site conditions. The analysis of almost 2 years of field data showed that the volume capture ratio of annual rainfall and the mean load removal of TSS, NH_3-N, TP, TN, COD, and NO_3-N met the technical guidelines for sponge city construction in Nanchang.

In order to evaluate the actual runoff control effects of LID combination, Zhang et al. (contribution 11) used the real hydrological monitoring data collected from Lingang New City in Shanghai to analyze the retention and lag characteristics of rainfall–runoff in LID combinations under three rainfall-intensity scenarios (light–moderate, heavy, and torrential rainfall). The LID facilities were constructed over three years in the target study area, including rain gardens, retention ponds, green parking, porous pavement, and grass swales. The results confirmed the vital role of the LID combination in stormwater management and the hydrological impact of the LID combination on rainfall-induced runoff retention and lag effects.

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