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Editorial

Urban Runoff Control and Sponge City Construction

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1. Introduction

Rapid population growth, urbanization and high-intensity human activities cause a multitude of extremely serious environmental problems all over the world [1]. In the construction of many urban areas, pervious vegetated ground surfaces have been progressively replaced with impervious pavements. Over the years, urbanization has induced floods and, consequently, the deterioration of the urban water environment. To alleviate these problems, the concept of a sponge city was first proposed and constructed in China [2,3].

Along with the onset of sponge city construction, many related studies were conducted, which yielded many positive results, such as the development of the China Sponge City database [4], environmental and economic cost–benefit comparison of sponge city construction [5,6], temporally and spatially adaptive optimal placement of green and grey runoff control infrastructures [7,8], etc. In order to reflect the state-of-the-art advances in urban runoff control and sponge city construction, we organized this Special Issue. We aimed to discuss and present research focused on the theories and technologies of sponge city construction; urban hydrology; methods of quantifying the benefits of a sponge cities; rainwater utilization; practices that mitigate urban flooding and soil erosion; the performance of GI; the impact of media; preferential flow paths; 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 wish to express our gratitude to all the contributors who made this Special Issue so successful.

2. Summary of This Special Issue

In total, 13 papers were published in this Special Issue. The article types, authors, titles, keywords and study areas of these articles are summarized in Table 1. We have categorized these papers by article type in the table below.

Yin et al. presents a review on sponge city practices in China from their inception through to a systematic demonstration [9]. The main contents of the paper include: (1) Source control or a drainage system design for China's sponge city construction. The key element of sponge city construction is to combine various specific technologies to alleviate urban water problems, such as flooding, water environment pollution, shortage of water resources and deterioration of water ecology. (2) The sponge city pilot projects in China are introduced, the achievements obtained and lessons learned are summarized; (3) the objectives, corresponding indicators, key contents and needs of sponge city construction at various scales are identified. Moreover, the paper also describes the obligations of sponge city construction for various stakeholders.

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Table 1. Summary of the papers published in the Special Issue "Urban Runoff Control and Sponge City Construction" for the journal *Water* (https://www.mdpi.com/journal/water/special_issues/UrbanRunoff_Control accessed on 13 June 2022).

Article Type	Authors	Title	Keywords	Study Area
General review	Yin, D.; Xu, C.; Jia, H.; et al.	"Sponge City Practices in China: From Pilot Exploration to Systemic Demonstration"	sponge city; low-impact development; pilot exploration; systematic demonstration; construction scale; stakeholders	China
Methods and tools	Liu, Z.; Yang, Y.; Hou, J.; et al.	"Decision-Making Framework for GI Layout Considering Site Suitability and Weighted Multi-Function Effectiveness: A Case Study in Beijing Sub-Center"	multifunctional decision-making framework; cost-effectiveness; site suitability; stakeholders' preference; green infrastructure	Beijing, China
Methods and tools	Wang, H.; Han, G.; Zhang, L.; et al.	"Integrated and Control-Oriented Simulation Tool for Optimizing Urban Drainage System Operation"	control-oriented model; urban drainage system; real-time optimization; Simuwater	/
Methods and tools	Peng, Z.; Jin, X.; Sang, W.; et al.	"Optimal Design of Combined Sewer Overflows Interception Facilities Based on the NSGA-III Algorithm"	combined sewer overflows; optimization; SWMM; NSGA-III	Wuhan, China
Methods and tools	Martínez, C.; Vojinovic, Z.; Price, R.; et al.	"Modelling Infiltration Process, Overland Flow and Sewer System Interactions for Urban Flood Mitigation"	Green-Ampt method; infiltration; overland flow; urban flood modelling; 1D/2D coupled modelling	/
Methods and tools	David, L.; Carvalho, R.	"Designing for People's Safety on Flooded Streets: Uncertainties and the Influence of the Cross-Section Shape, Roughness and Slopes on Hazard Criteria"	dual drainage modelling; extreme rainfall; flooding; safety criteria; urban drainage; uncertainty	/
Methods and tools	Wei, C.; Wang, J.; Li, P.; et al.	"A New Strategy for Sponge City Construction of Urban Roads: Combining the Traditional Functions with Landscape and Drainage"	urban water management; drainage function; permeable pavement; biological retention	Suzhou, China.
Typical source control facility	Tang, W.; Ma, H.; Wang, X.; et al.	"Study on the Influence of Sponge Road Bioretention Facility on the Stability of Subgrade Slope"	sponge city; bioretention facility; rain infiltration; slope stability	Chongqing, China
Typical source control facility	Li, Q.; Jia, H.; Guo, H.; et al.	"Field Study of the Road Stormwater Runoff Bioretention System with Combined Soil Filter Media and Soil Moisture Conservation Ropes in North China"	modified bioretention facility; road stormwater runoff; combined soil filter media; soil moisture conservation rope; field study; microbial diversity	Tianjin, China
Typical source control facility	Ho, C.; Lin, Y.	"Pollutant Removal Efficiency of a Bioretention Cell with Enhanced Dephosphorization"	low impact development; Sustainable Development Goals; non-point source pollution; enhanced dephosphorization bioretention	Hefei, China
Typical source control facility	Lim, F.; Neo, T.; Guo, H.; et al.	"Pilot and Field Studies of Modular Bioretention Tree System with Talipariti tiliaceum and Engineered Soil Filter Media in the Tropics"	urban runoff remediation; Talipariti tiliaceum; modular bioretention tree; field study; tree-pit	Singapore
Typical source control facility	Neo, T.; Xu, D.; Fowdar, H.; et al.	"Evaluation of Active, Beautiful, Clean Waters Design Features in Tropical Urban Cities: A Case Study in Singapore"	urban stormwater runoff management; field monitoring; ABC Waters design features; water quality; bioretention; swales	Singapore
Typical source control facility	Meng, B.; Li, M.; Du, X.; et al.	"Flood Control and Aquifer Recharge Effects of Sponge City: A Case Study in North China"	Sponge City; aquifer recharge; urban stormwater; green infrastructure	Zhengzhou, China

There are six papers that focus on the methods and tools of urban runoff control and sponge city construction. Liu et al. proposed a decision-making framework for GI layout considering site suitability and weighted multi-function effectiveness [10]. A case study in Beijing Sub-Center showed the feasibility of the proposed framework. Wang et al. developed an innovative modeling software that could play a role in the integrated simulation and overflow control application of urban drainage system [11]. The software was utilized in a real-time case–control study in one city of China, and it obtained significant optimized operation results, reducing combined sewer overflow (CSO) by making full use of the storage facilities and actuators. Peng et al. proposed a new simulation optimization method with new features of multithreading individual evaluation and fast data exchange by recoding SWMM with object-oriented programming [12]. These new features can rapidly accelerate optimization processes. The non-dominated sorting genetic algorithm-III (NSGA-III) was selected as the optimization framework for a better performance in dealing with multi-objective optimization. The proposed method was used in the optimal design of a terminal CSO interception facility in Wuhan, China.

Martínez et al. considered the influence of green infrastructure on urban surface runoff generation and proposed a new modelling setup, which includes a rainfall–runoff infiltration process in overland flow and its interaction with a sewer network [13]. The effect of infiltration losses on the overland flow was evaluated through an infiltration algorithm added in a so-called Surf-2D model. Then, the surface flow from a surcharge sewer was also investigated by coupling the Surf-2D model with the SWMM 5.1. An evaluation of two approaches representing urban floods was carried out based on two 1D/2D model interactions. Two test cases were implemented to validate the model. David and Carvalho highlighted how the change in street cross-section profile affected flood characteristics, which pose different levels of risk to pedestrians [14]. They also found that the uncertainty of roughness could be more influential in runoff than in street profiles. This methodology can be applied to improve street and drainage design to better manage urban runoffs. Wei et al. proposed a new strategy to combine roads, green spaces, and drainage systems [15]. The crux of this strategy is to consider the organization of the runoff and the construction of the drainage system (including sponge city source control facilities), so that both the drainage and traffic functions are achieved. This new strategy was implemented in a pilot study of road reconstruction conducted in Zhangjiagang, Suzhou, China.

A further six papers concentrated on research of the structures and performances of typical source control facilities; among these source control facilities, bioretention facilities are the focus. By establishing a three-dimensional finite element model for numerical analysis and combining it with geotechnical tests, Tang et al. studied the effects of bioretention facility on water pressure distribution, seepage path, and slope stability under rainwater seepage conditions [16]. In addition, this study explored the relationship between the parameters of the bioretention facility and the stability of the slope in combination with the effect of runoff pollution control. Li et al. invented a modified bioretention facility that contains soil moisture conservation ropes [17]. Additionally, a modified bioretention facility and a contrasting traditional bioretention facility were constructed in Tianjin Eco-city, China. A redundancy analysis was performed to evaluate the relationships between the variation in media physicochemical properties and microbial communities. It was found that an increase in media moisture could promote an increase in the relative abundance of several dominant microbial communities. Ho and Lin developed a new type of enhanced dephosphorization bioretention cell (EBC), which can not only efficiently remove nitrogen and COD, but also provides excellent phosphorus removal performance [18]. An EBC (length: 45 m; width: 15 m) and a traditional bioretention cell (TBC) of the same size were constructed in Anhui, China to treat rural nonpoint source pollution with high phosphorus concentration levels. After almost 2 years of on-site operation, the results indicate that TBCs and EBCs show similar performances in the removal of ammonium nitrogen and COD, but that the EBC significantly outperforms the TBC in terms of the total phosphorus removed.

In Singapore, Lim et al. developed a modular bioretention tree with a small footprint and a reduced on-site installation time for applications in a tropical environment [19]. The results show that the modular bioretention tree can effectively remove total suspended solids (TSS), total phosphorus (TP), zinc, copper, cadmium, and lead with removal efficiencies of greater than 90%. A field study in Singapore had a very clean effluent quality. Neo et al. characterized the performances of a rain garden and a vegetated swale that were implemented in a 4 ha urban residential precinct and monitored for a period of 15 months [20]. The results show that total suspended solids (TSS), total phosphorus (TP) and total nitrogen (TN) concentrations were low in the new residential precinct runoff. The findings from this study can help us to better understand the performance of source control facilities receiving low influent concentrations and the implications for further investigations that aim to improve stormwater runoff management in the tropics.

In order to evaluate the effect of aquifer recharge on flood control, Meng et al. proposed a sponge city design that highlighted aquifer recharge in a study area in Zhengzhou, China [21]. The stormwater management model of SWMM and the groundwater flow model of MOD-Flow were adopted to evaluate the flood control effect and aquifer-recharge effect, respectively. The results show that the sponge city design has a positive impact on maintaining groundwater level stabilization and even raises the groundwater level in some specific areas where stormwater seepage infrastructure is located.

3. Conclusions

This Special Issue highlights and discusses topics related to urban runoff control and sponge city construction. During the call period, 22 submissions were received. After the peer review process of the journal, a total of 13 papers were published in this Special Issue. Among the published papers, one review paper presents an in-depth review on sponge city practices in China, from its inception to national pilot construction projects and then to systematic demonstration. Six papers focus on the methods and tools of urban runoff control and sponge city construction, including planning strategies, simulation models, and optimization methods. Six papers concentrate on new findings regarding structures and performances of typical source control facilities, especially bioretention facilities. However, sponge city construction is still a new paradigm in city management; therefore, there are many theoretical, technical and practical problems that need to be addressed and solved, and it is expected that groundbreaking and innovative findings.

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