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Can "Sponge Cities" Mitigate China's Increased Occurrences of Urban Flooding?

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ABSTRACT

China is a country with severe water problems. In recent years, urban flooding has become even more frequent, pervasive and severe, threatening China's development. To tackle the issue, China launched a national initiative termed sponge cities with enormous investment commitment. Marking a fundamental shift in water management, this initiative can be an effective approach if China commits to appropriate technical, governance and financial measures to overcome implementation challenges.

Keywords: urban flooding, China, water management, water resilience urban planning

INTRODUCTION

In 2014, China formally announced a national initiative to build "sponge cities" designed to tackle urban water problems, flooding in particular (MHURD 2014a, 2014b). This program promotes water resilient, low impact development integrated with urban planning and construction, allowing cities to function much like a sponge by absorbing rainwater that mitigates flooding while also storing and purifying water to meet future use (SC 2013, 2015).

Currently, the central government has been undertaking preparatory actions, including publication of a preliminary technical guideline, target setting and establishing the regulatory framework. Two batches of pilot cities were selected, including Beijing and Shanghai, 16 in 2015 and 14 in 2016, with a committed investment of 400-600 million RMB (or 60-90 million USD) per year per city for 3 years. The State Council is committed to invest 86.5 billion RMB (or 13 billion USD) in total within 3 years for implementation. With the huge investment and its foreseeable impact on China's urbanization process as well as the interaction between humans and the environment, some questions arise naturally: can the sponge city initiative work as envisioned to alleviate the increasingly severe urban flooding faced by China? What are the practical challenges to overcome and the necessary steps to be taken by the Chinese government?

This paper review the sponge city initiative, with a particular focus on its implementation challenges. It is motivated by the direct policy relevance on a global water issue in the biggest developing country under climate change and the potential socio-economic and environmental impact. A clear understanding of the policy initiative has strong potential to feed into and influence China's current urban movement toward water resilience and security. The China experience in urban flooding management as part of climate change adaption also offers important insights and implications useful for other developing countries which will likely experience urbanization and the urban flooding challenge in the future.

CHINA'S FLOODING PROBLEM AND CAUSES

China is a country with severe water problems, including water scarcity (Jiang 2009), flooding (Duan et al, 2016), and water pollution (Jiang 2009, 2015). In recent years, urban flooding has become even more frequent, pervasive and severe (Liu and Xia 2016), attracting wide media attention (The Economist 2015, Chen 2016, Shepard 2016). It was found that 641out of 654 Chinese cities are exposed to frequent floods (TFUFPSI 2014). A survey conducted by the Ministry of Housing and Urban Rural Development (MHURD) showed that over the period 2008-2010, 62% of 351 cities surveyed suffered urban flooding due to poor drainage, and 39% experienced flooding for more than three times (Lv and Zhao 2013). Since 2008, the number of Chinese cities affected by floods has more than doubled (The Economist 2015), and at least 130 cities have experienced flooding nearly every year (Lv and Zhao 2013). With cities responsible for more than 80% of China's GDP and hosting more than 50% of the total population (NDRC 2016), the damage to property and societal impacts due to urban flooding are significant (Duan et al. 2016, Shepard 2016), becoming a serious concern for China's development (NDRC 2016).

Many factors contribute to the rising floods across cities in China, including more frequent extreme weather events induced by climate change (Liu and Xia 2016) and under developed urban drainage systems and capacity (Cheng 2013, NDRC 2016). A key contributing factor is rapid urbanization with poor urban planning and design, alongside unsustainable development, which transforms natural landscapes into imperious concrete surfaces with buildings and pavements, effectively reducing the capacity of landscapes to absorb rainwater, so increasing urban runoff, leading to floods (NDRC 2016, Zheng et al 2016). Indeed, the impervious surface area across Chinese cities has been steadily increasing at an annual rate of 6.5% (Ma et al 2014), accompanied by continuous loss of aquatic ecosystems such as lakes and wetlands, along with fragmentation of natural water pathways across cities (Du et al. 2010, Xu et al. 2011, Jiang et al. 2012). As retrofitting the existing urban drainage system is a costly and long-term endeavor to mitigate urban floods, effectively introducing green infrastructure and low impact technologies, as promoted by the sponge city initiative, offers a more realistic, cost-effective and sustainable solution.

THE SPONGE CITY APPROACH AND IMPLEMENTATION CHALLENGES

The Sponge City Approach

The sponge city approach conceptually is analogous to a number of innovative approaches to urban water management such as low-impact development in the U.S., sustainable urban drainage systems in the U.K., and water sensitive cities in Australia (Fletcher et al. 2015). The approach essentially seeks to preserve or maintain during urbanization the pre-development hydrological flow regime of local landscapes through natural ecosystem conversation, degraded ecosystem restoration and remediation, and low impact development practices integrated with urban planning (MHURD 2014b). It reflects a modern understanding of tackling water issues in an urban setting, providing a planning and design framework which promotes integrated urban water management. This holistic and systematic approach is designed to achieve multiple objectives simultaneously (principally harvesting rainwater while mitigating floods) across scale and scope. It marks a fundamental shift in the water management paradigm from the traditional isolated "grey structure" approach to one which is integrated with urban planning while building in tandem with nature, holding out promise for the alleviation of the diverse, interrelated urban water problems faced by China. As an innovative water management concept, the sponge city approach of course is subject to many implementation challenges, which requires due attention and coping strategies.

Implementation Challenges

Unclear pathway combined with lack of experience

While the sponge city approach provides some guiding principles, there is currently a lack of clearly outlined pathway with systematic plans and supporting governance capacity. Effective implementation requires specific steps and procedures that accounts for not only local context and heterogeneity but also institutional setting and governance structure. China's water management is traditionally prioritizes engineering or technology oriented (Jiang 2015). The transition towards more holistic and integrated urban water management fundamentally requires not only new technical skills but also new thinking and competences in management and governance, an area where China has little experience. This lack of capacity poses a big challenge for successful policy implementation across the country.

Lack of knowledge and information management mechanism

In recognition of its knowledge gap and lack of experience, China has adopted a strategy of the "learning-by-doing" type, piloting implementation in selected cities to allow learning to inform future up-scaling and wider

application across the country. To date much effort has been expended on specific technological and engineering solutions, with little attention given to scientific research, capacity building and knowledge sharing which all are necessary elements enabling implementation. As yet, there are no systems in place to facilitate city-city learning or monitoring and evaluation, resulting in the prospect that learning is not captured and assessments of success are not made. Additionally, pilot city implementation has so far been limited to a similar range of technologies, insufficient to allow experimentation-led deep learning while also missing an opportunity to adapt the initiative to local water contexts. Effective knowledge and information management plus capacity building to create an enabling environment is critical to the effectiveness and reliability of the sponge city approach to China's urban flooding problem.

Complex governance structure in conflict with required planning process

The greatest challenge for China's sponge city construction probably comes from the conflict between required planning process and the prevailing governance structure and institutional system. To shape water resilient urban environments, the sponge city approach requires an integrative and dynamic design which necessitates holistic, cross-sector planning. Key to achieving the design process is the engagement in knowledge co-creation of stakeholders committed to common objectives and proceeding with a shared understanding. Ideally, this process will be complemented with supporting information management tools that enable the production of a range of interactive, co-created designs.

Currently, administration of sponge city construction at the city level involves different government departments, such as urban construction and water resources. While the responsibility may be shared, interests and focuses however sometimes diverge across departments. Moreover, this governance structure often misses the opportunity for joint, coordinated implementation efforts (Jiang 2015). There is also a lack of tools supporting participatory assessment, interactive design and communication (van de Ven et al. 2016). Additionally, there is a dearth within local government administration of long term planning and a shared view and consideration of uncertainties.

Uncertain investment and reliable financing scheme

Constructing sponge cities of course comes with a price tag. The total cost for sponge city construction across China beyond the 16 + 14 pilot cities is expected to be substantial. To what extent the required investment will be made available in the coming decades is a question which currently has no clear answer. Even for the pilot cities, the financial assistance committed by the central government is presently for 3 years, with a future plan for scaling up unclear. While the government encourages financing from the private sector through innovative arrangements such as public private partnership (PPP) (NDRC 2016), the size of this contribution is unclear. There is also a need for a business model attractive to the investment from the private sector.

Insufficient consideration with due plan of implementation time

Given China's institutional setting, governance structure and relative lack of experience with integrated urban water management, sponge cities may take up to a generation to build. The State Council has set up a progressing goal for the initiative, requiring the absorption of 70% of rainwater to be used onsite for 80% of the developed urban area by 2030 (SC 2015). This goal seems to be over ambitious, given the technical, governance and financial challenges described above. While many smaller interventions can be implemented simultaneously initiating the process faster than the traditional retrofitting approach, the scale of investment needed plus the lack of reliable financing schemes dictates an adaptive implementation strategy, which integrates sponge city development with the regeneration process of urban development, a process that typically has a life cycle of at least one generation.

Lack of reliable cost and benefit information

Given the huge costs involved, alongside the need for substantive change to the wider enabling environment, the sponge city approach *financially* may not compare favorably with the traditional sector-based, engineering-oriented approach. Capitalizing on its rapid development over the past decades, China has probably accumulated rich experience in applying modern engineering technologies in its urban construction projects. As a result, the traditional engineering approach, from the sector-based perspective, may be financially less costly in the short run due to the accumulated know-how when compared to the learning curve associated with the sponge city approach new to China plus high transaction costs, particularly for integration across sectors, scope, and time. In Shanghai, for example, retrofitting urban sewer systems was estimated at 3,786 million RMB (or 569 million USD) using the conventional method of solely upgrading the existing drainage and sewage systems (with bigger pipes and more efficient deployment), in contrast to 5,501 million RMB (or 827 million USD) for a low impact trench technology (Wang and Li 2008). However, it is important to note that much of the advantage of sponge cities comes from economic efficiency gain, i.e., the accrual of multiple social, environmental and economic (rather than financial) co-benefits, as opposed to single sector-based outcome. Pilot projects may help document the cost and benefit

information associated with sponge city implementation, particularly the co-benefits across sectors, which will allow comparison and more efficient project design.

CONCLUSION

China is currently in the process of implementing a so-called sponge city initiative to tackle urban flooding within a systematic and holistic framework encompassing a set of urban water and environmental issues in a context characterized by rapid urbanization and increasing development pressure on the environment. Yet China's ambitious policy agenda is increasingly constrained by governance capacity and current knowledge and experience that are insufficient to tackle the fundamental complexity of the interrelated water and environment issues encountered by Chinese cities. The sponge city initiative can be effective if China commits to appropriate technical, governance and financial measures to overcome the implementation challenges. An important strategy is to enhance engagement in global city learning networks, tapping into existing experience, good practices and innovation, to improve capacity for building water resilient smart cities.

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