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CHAPTER

19

Spatial Planning for Climate Adaptation and Flood Risk: Development of the Sponge City Program in Guangzhou

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19.1 INTRODUCTION

In China, like elsewhere in Asia, pluvial flooding events are occurring increasingly often, wreaking havoc across many cities (Yu et al., 2015). According to an investigation by the Ministry of Housing and Urban-Rural Development (MoHURD) in 2010, in the period from 2008 to 2010, 231 out of 351 Chinese cities studied (62%) were affected by pluvial flooding. Among those, 74.6% experienced waterlogging of 0.5 m or more in depth and 90% experienced waterlogging of at least 0.15 m in depth. In 79% of the affected cities studied, the stagnant water lingered for at least 30 min before it could be discharged by the drainage system (Hou et al., 2012). As such, urban pluvial flooding (or surface water flooding) has become the "new normal" in most Chinese cities.

Since 2014, the MoHURD, an important government ministry at the national level, has been promoting a policy to improve the cities' resilience to pluvial flooding in a context of rapid urbanization and climate change—the Sponge City Program. Alongside this notion, the program supports the separation of the sewer and rainwater systems and the application of low-impact development measures as a means to raise the capacity of cities to cope with storm water (Construction Department of MoHURD, 2014). The sponge city metaphor was formalized in the national document *Technical Guideline for the Construction of Sponge Cities: Rainwater System Based on Low Impact Development* launched in November 2014, combining the ambitions in terms of resilience to flood risk with a pursuit of a more sustainable way to build an attractive and livable urban environment (Ministry of Housing & Urban-rural Development, 2014).

Achieving the ambition and implementing the program locally, through spatial interventions, remains a challenge. This chapter sheds more light on how the local spatial planning system responds to a national policy in resolving the flood risk through a new policy-framing process. By doing so, it adds to the literature on effectiveness and implementation in urban climate adaptation policies and on the integration of flood resilience concerns in spatial planning.

Guangzhou, a delta city in China, is the fourth main industrial and commercial hub in China (alongside Beijing, Shanghai, and Shenzhen) and is expanding rapidly. The city is highly exposed to flooding and has been ranked as one of the most vulnerable cities that will be exposed to flooding by the 2070s considering the projected global sea-level rise, the intensity and frequency of storms, and expansion of the city's assets and populations (Hallegatte et al., 2013). Guangzhou's plight illustrates a widespread problem affecting many Chinese and Asian cities generally—the rapid expansion of the urban fabric, which worsens the vulnerability to the negative consequences of the changing climate.

In this chapter, information is mainly drawn from the analysis of a set of policy documents related to spatial planning and sponge city development. This is complemented by insights from a series of interviews with regional and

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local policy makers, researchers, private and public planning institutions, and civil engineers. Transcript materials from six interviews are presented in this chapter to help illustrate the evolution of the nexus between spatial planning and flood risk management and the implementation of the Sponge City Program in Guangzhou.

The chapter starts with a description of the socioeconomic and institutional features of Guangzhou and its exposure to flood in the context of climate change. Then, the chapter reviews the *Guangzhou Sponge City Plan (SCP)* and analyzes how this new tool has added to the transition in (1) problem framing of flood risk in spatial planning, in (2) shifting toward new climate adaptation measures (3), enforcement tools, and (4) governance practices. It is followed by a critical analysis of the cognitive, technical, institutional, and financial barriers and obstacles to the implementation of the *SCP*.

19.2 THE PROFILE OF GUANGZHOU: RAPID URBANIZATION AND EXPOSURE TO CLIMATE CHANGE

19.2.1 Demographic, Social, Economic, and Political Features in the Trend of Rapid Urbanization

Guangzhou (also known as Canton), a metropolis located in China's Pearl River Delta (PRD), is 120 km northwest of Hong Kong and 145 km northwest of Macau. Its total area of 7434 km^2 has a diversity of topography, ranging from a dense urban center area beside the Pearl River to a mainly agricultural and rural area in the north and east. The elevation generally increases from southwest to northeast, with mountains forming to the north of the city (Fig. 19.1). The southern part of the city is situated in a floodplain, with large swathes of land that have been reclaimed from the sea and onto which the city is currently expanding.

As one of China's first-tier cities, Guangzhou occupies a central position in the PRD both in administrative and socioeconomic terms, being the capital city of Guangdong province and the PRD region's major economic and commerce hub. After the launch of Deng Xiaoping's economic reform and open-door policy in 1978, this city was one of the pioneers in the shift toward open market economy. It underwent huge growth in gross domestic product from approximately 4 billion RMB in 1978 to 1960 billion RMB in 2016 (Guangzhou Statistics Bureau, 2016). Correspondingly, the population increased from 3 million to 13 million in this period, making it the third most populous city in mainland China, behind Shanghai (24.19 million) and Beijing (21.72 million) (Shanghai Government, 2017; Beijing Statistical Bureau, 2017).

19.2.2 Climate Change and Flood Vulnerability in Guangzhou

Guangzhou is one of the most striking examples of how urban expansion can exacerbate vulnerability to flooding in the context of the changing climate, which brings increased intensive rainstorms, frequent typhoons, and sea-level rise. The city is frequently affected by waterlogging. According to Guangzhou's *SCP*, there are more than 100 points in the city's central districts where waterlogging occurs (Dong et al., 2015, p. 257; see also Fig. 19.2 (left)). These are related to the extent of impervious paving in the densely built-up areas. An average of 87% impervious surface in the

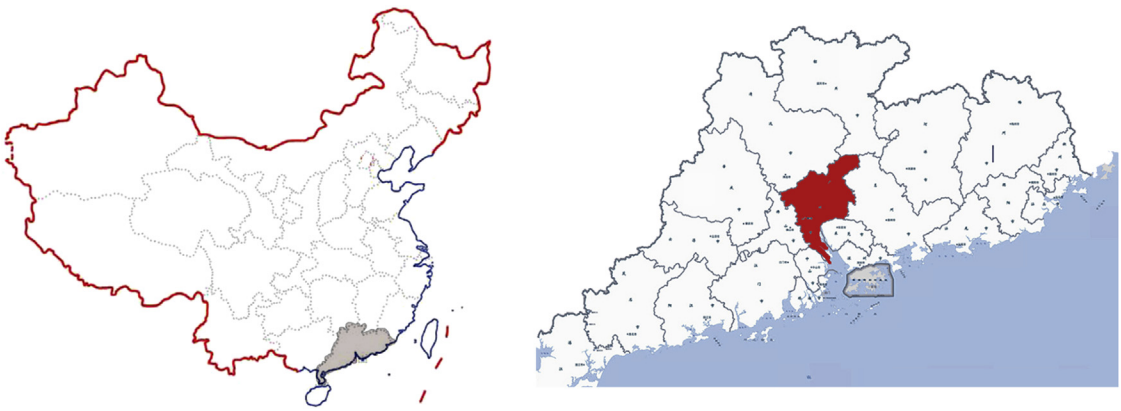

FIGURE 19.1 Map of the Guangdong Province in China (*left*) and the location of Guangzhou in Guangdong Province (*right*). *Authors' elaboration.*

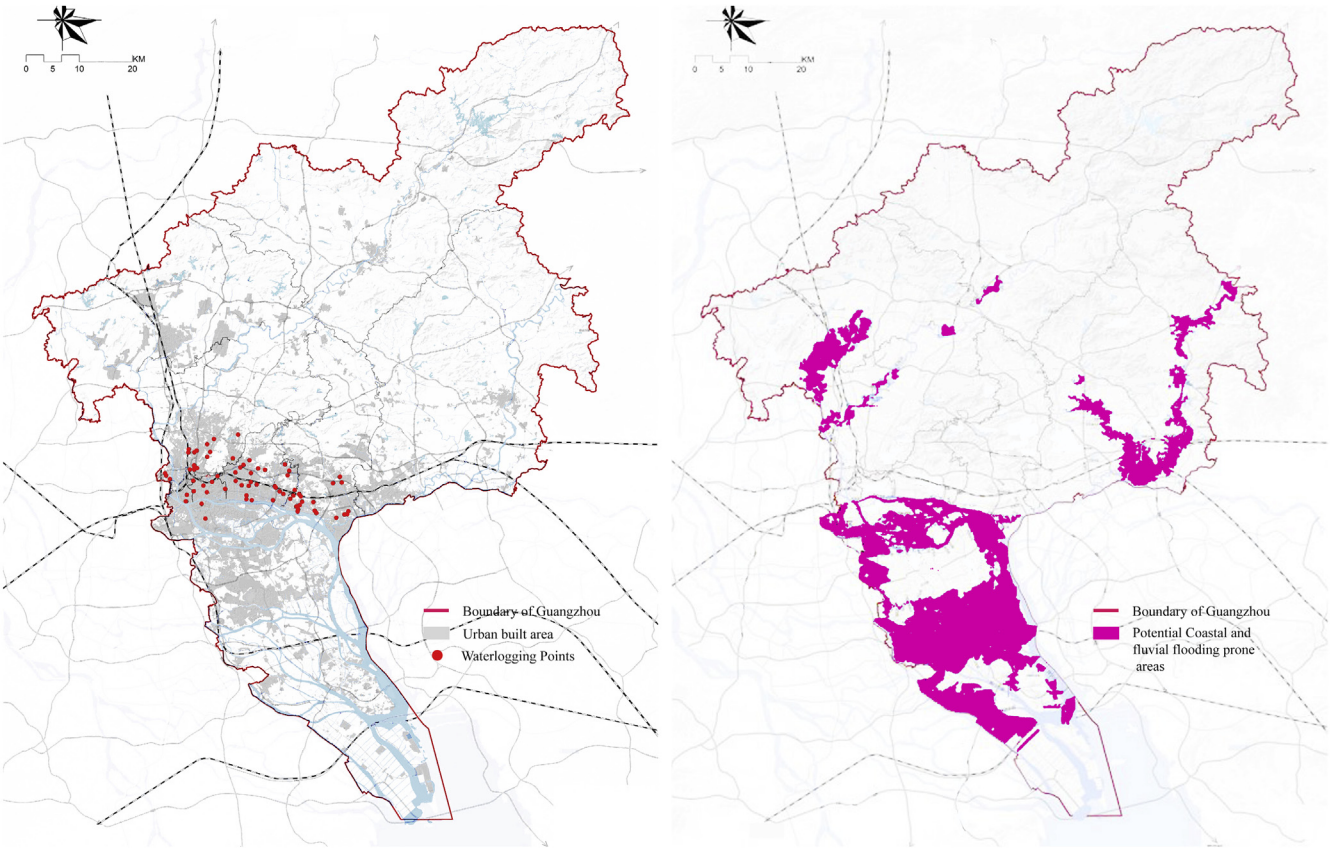

FIGURE 19.2 The waterlogging points in Guangzhou (*left*) and the areas prone to potential coastal flooding and fluvial flooding (*right*). *Authors' elaboration (based on Guangzhou Sponge City Plan, 2016–30).*

city center significantly hinders the infiltration of rainwater and contributes to the increase of the surface runoff at the source (Li et al., 2015; Guangzhou Water Affairs Bureau, 2015). Moreover, the urban drainage system is increasingly unable to deal with extreme rainstorms, which are occurring more frequently than before (Chan et al., 2014; Wu, 2010).

At present, sea-level rise is not of high concern for policy makers in Guangzhou, but it is poised to become a much more important issue if the current pattern of urban sprawl in southern areas continues and no dramatic improvement in the drainage and water storage system takes place. While being downplayed by the Guangzhou Water Affairs Bureau until recently (see Guangzhou Water White Paper from 2013), the *SCP* for Guangzhou does recognize the flood issues and indicates that an area of 970 km^2, mainly located in the southern districts (e.g., Nansha), is particularly vulnerable (Guangzhou Government, 2017, see also Fig. 19.2 (right)). Southern districts are also threatened by unexpected extreme weather. For example, the recent Typhoon Hato caused coastal flooding in southern Guangzhou (Nansha District) as well as Macau and Hong Kong (USA Today, 2017) when more than 8000 people were moved to emergency shelters (China National Radio, 2017).

19.3 SPONGE CITY: SHIFTING THE SPATIAL PLANNING FRAME

The formulation of national technical guidelines for the construction of sponge cities was led by MoHURD in 2014. This document identifies that a nationwide urban flood mitigation program should complement the traditional drainage system and excessive discharge system while relying on three nature-based approaches: (1) ecosystem preservation; (2) ecosystem restoration; and (3) low-impact development.

In response to the national program, a special section of the *Guangdong Provincial 5-Year Plan* (2016–20) was launched in 2016. In this document, four key strategies are identified: (1) restoration of the green-blue infrastructure; (2) reinforcement of the fluvial flooding defense and upgrade of the storm water discharge infrastructures; (3)

purification of polluted water environments; and (4) enhancement of the capacity in water supply and reuse (Guangdong Provincial Housing and Construction Department, 2016).

The *Guangzhou SCP (2016–30)* was published in 2017 and was jointly prepared by the Urban Planning Bureau, as lead agency, in collaboration with the Urban Water Affairs Bureau and a series of public and private planning institutions. This document relates flood risk and climate change to spatial issues, frames flood resilience solutions as multifunctional interventions, visualizes the runoff coefficient regulatory map, and emphasizes the leading role of the spatial planning system.

19.3.1 Previous Flood Concerns: A Section in the Latest Spatial Planning Documents With Limited Attention

In the Chinese context, flood affairs were previously regarded as the realm of flood risk management rather than spatial planning in most cases. Master plans,[1] which are the most important spatial policy document concerning urban development (Yu, 2014), thus, expend limited efforts on this topic. In recent masterplans for Guangzhou (2000–10 and 2010–20), flood issues were only discussed under the heading "flooding prevention and rainfall discharge," a small section in the master plan, weak relation to climate change and urban development in the planning discourse. Here, the previous elaboration in the latest two master plans are briefly discussed.

In the Guangzhou Master Plan 2000–10, flooding-related issues were not systematically described (see Table 19.1). There was no discussion of the causes of and factors affecting flooding. Available options identified were primarily engineering based: reinforcing the dikes and sluices; raising the ground level in low-lying areas when necessary; retrofitting the underground discharge system; dredging open canals; or suppressing the occupation of existing waterways and constructing artificial lakes. Moreover, these options were merely mentioned in passing and scattered across the document. This lack of detail makes the operationalization of these options difficult in practice.

The subsequent *Guangzhou Master Plan* (for 2010–20) resulted in change regarding problem-setting and policy options (see Table 19.1). Here, severe flood risk is associated with, for instance, the outdated underground discharge system, the erosion of open waterways and canal systems, and the substandard dykes, levees, and riverbanks in the case of coastal and fluvial flooding (Guangzhou Government, 2016, pp. 442–445). The document also claims that reducing floods can be integrated into the development of new urban areas by, for example, improving water quality and enhancing the ecological environment. Nonetheless, the power of this document is weakened by limited scientific knowledge on the impacts of climate change (especially for flood risk) in urban areas and an emphasis on engineering-based (structural) solutions. Most of all, the document provides no guidance on the role of planners in tackling flood risk.

19.3.2 New Understanding of Flood Risk as a Spatial Issue Related to Climate Change

The attention on the severe loss brought by flood events contributes to a separate and special spatial policy—*Guangzhou SCP*. The participation of spatial planners in the formulation process represents a major shift in the conceptualization of flooding as a significant spatial issue according to various interviewees, including one from Guangzhou's Land Resources and Urban Planning Committee:[2]

> Guangzhou SCP is a sort of master plan for water rather than economic development. It aims to alleviate the flooding problems exacerbated by urbanization and, simultaneously, construct an attractive and livable urban environment.

Moreover, the *Guangzhou SCP* brought a new recognition of the causes of flooding. On the one hand, it attributes flood risk to the negative consequences of urbanization such as excessive paving, limited open space for water retention and runoff, and the lagging construction of drainage system. On the other hand, the role of the climate change in

[1] A master plan is normally produced by the local spatial planning authorities on behalf of municipal governments for periods of 10 years. In the case of Guangzhou, the master plan is regarded as a reference for the local spatial planning system to plan further spatial interventions.

[2] In 2014, one branch of Guangzhou Land Resources and Housing Management Bureau was combined with Guangzhou Urban Planning Bureau to create the current Guangzhou Land Resources and Urban Planning Committee.

TABLE 19.1 Planning Policy Documents and Their Attention to Flood Prevention and Rainfall Discharge

Year	Key Official Institutions Involved	Policy Activities	Areas of Attention	Key Reflection of Flooding
2005	Urban Planning Bureau	Guangzhou Master Plan 2000–2010	A new comprehensive plan for land use and economic development; The discussion of flood affairs is under the subtitle "flooding prevention and rainfall discharge"	• No discussions of causes • No clear solutions • No definition of the responsibility of spatial planning system
2016	Urban Planning Bureau	Guangzhou Master Plan 2010–2020		• Failures of rapid urbanization • A proposed interaction between adaptive measures land use and environmental improvement • No definition of the responsibility of spatial planning system
2017	Guangzhou Land Resources and Urban Planning Committee (leader), Urban Water Affairs Bureau	Guangzhou Sponge City Plan 2016–2030	To make the idea precise, clear, and short, change the content in this column to *A new thematic plan for reducing flood risk in terms of climate change and rapid urbanization* A new comprehensive plan for resolving flooding regarding the climate change; Seek the way to mitigate the flood risk attributed to the negative implication of climate change and rapid urbanization	• Links between rapid urbanization and climate change • Mainstreaming framing regarding ecosystem preservation and restoration, low-impact development, hydrological infrastructure construction, water purification, water supply, and waterfront recreation • Structural and nonstructural adaptive measures proposed • Regulatory tools • Spatial planning system given a leading position in developing collaborative relationships

Based on Guangzhou Government (Ed.), 2005. Guangzhou Master Plan (2001–2010) (Draft for Approval). Guangzhou Government (in Chinese), Guangzhou Government (Ed.), 2016. Guangzhou Master Plan (2010–2020) (Draft for Approval). Guangzhou Government (in Chinese), and Guangzhou Government (Ed.), 2017. Guangzhou Sponge City Plan (2016–2030), Guangzhou Government (in Chinese).

the increasingly frequent flooding events is emphasized clearly, perhaps for the first time in the local spatial policy. As the document states,

> Due to climate change, there will be an increase in the frequency of storm events. Because of this, the occurrence of waterlogging will be much higher than ever… Climate change might lead to the increasing occurrence of typhoons and extreme tides, which pose a threat to the coastal areas. ***Guangzhou Government, 2017, pp. 42, 43***

19.3.3 Toward Mainstreaming and Multifunctional Interventions

With the introduction of the *SCP*, flooding concerns have become a key issue, not merely relevant to flood risk management authorities but also for those dealing with urban development. This is also reflected in the new repertoire of key solutions put forward to implement the plan with the consideration of the ecology, safety, environment, and social identity (see Table 19.2). Initially, the preservation of green-blue network provides the basis for Guangzhou, acting as a sponge, to absorb the excessive rainfall (see Fig. 19.3 (left)). In addition, a comprehensive flood-resilience system based on structural (engineered) and nonstructural measures ("soft" solutions in the urban space) is suggested through a combination of efforts to reinforce flood defense infrastructure, construction of pumps, and upgrade of discharge system (structural), consolidation of the banks of canals (structural and nonstructural) and enhancing water retention and detention areas through wetlands, parks, and green-blue corridors (nonstructural). In parallel, another three solutions are proposed that aim to pursue a high quality of water, an increase in water reuse efficiency, sufficient water supply, and friendly waterfront space. By doing so, flooding mitigation measures are mainstreamed into the local agendas of urban development. An interviewee from Guangzhou Municipal Engineering Design and Research Institute explained:

> In practice, a project might have two or more options. For instance, the "softened" banks and widening of the canals (a pattern of nonstructural measures) along with a dredging project might act as a part of green-blue corridors which help drain the excess water… while providing an attractive place for recreation.

TABLE 19.2 Mainstreaming Flood Mitigation Into Local Agendas in Guangzhou

Consideration	Solutions
Ecological Concerns	Preserving the green-blue network, including mountains, forests, farmlands, wetlands, lakes, open waterways.
Safety Concerns	Enforcing and upgrading the structural infrastructure such as dykes, pumps, river banks, and drainage systems; optimizing the nonstructural infrastructure such as the increase of water retention areas (based on low-impact development)
Ecological and Environmental Concerns	Purifying the polluted water, including building of water treatment industries and ecopurification systems
Environmental Concerns	Improving water supplement and water recycling system
Social identity Concerns	Reconstructing the connection between water and citizens by facilitating the access to waterfront areas and arranging waterfront recreation

Based on Guangzhou Government (Ed.), 2017. Guangzhou Sponge City Plan (2016–2030), Guangzhou Government (in Chinese).

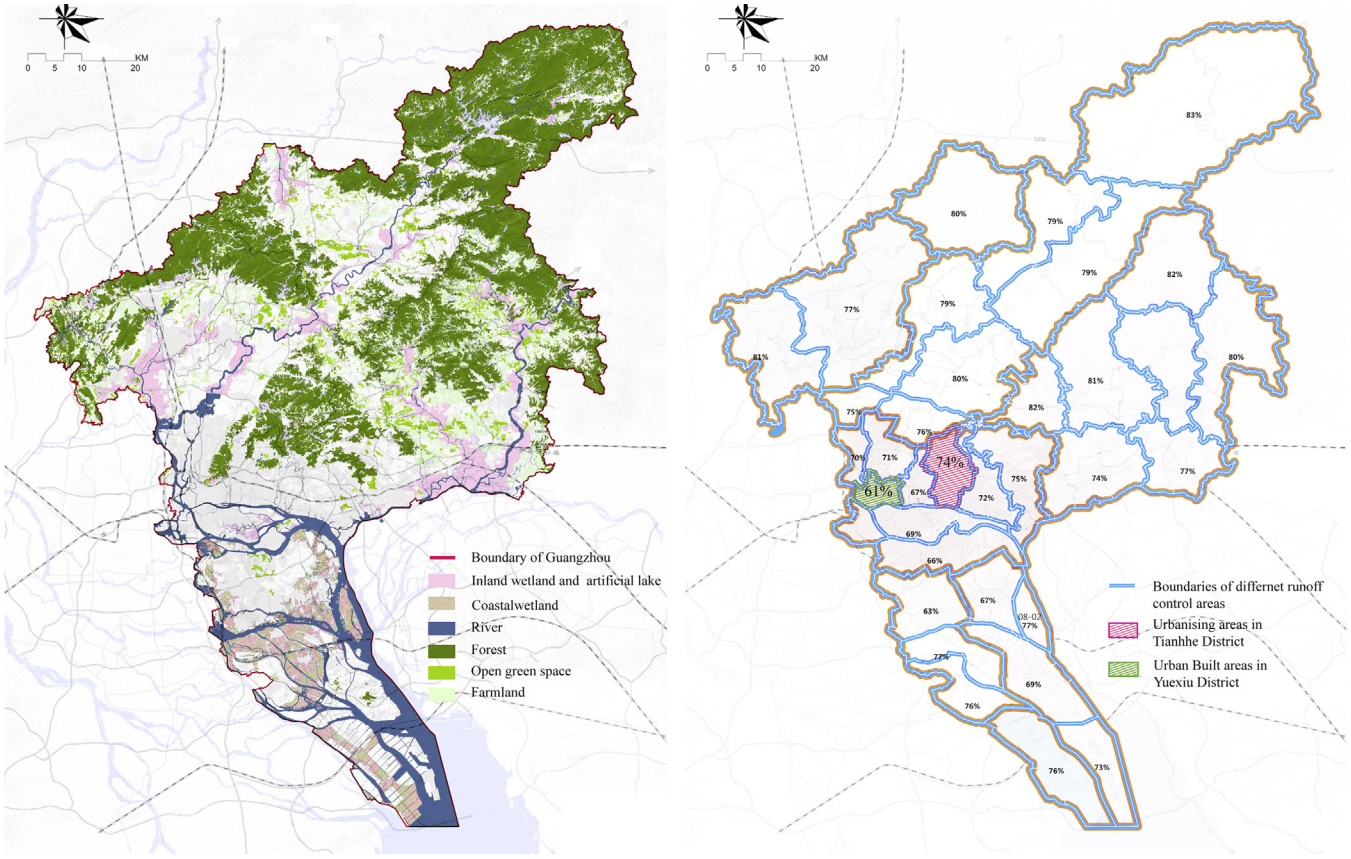

FIGURE 19.3 The preservation of green-blue network (*left*) and the runoff control map (*right*, the values presented in the map equal 1 minus the runoff coefficient). *Authors (based on Guangzhou Sponge City Plan, 2016–2030).*

19.3.4 New Regulatory Tools to Regulate the Competition for Land Between High-density Development and Water Retention and Detention

For spatial planners, the *SCP* document introduces the runoff coefficient to regulate the development of every piece of land in the city. It is an index relating the amount of runoff to the amount of precipitation received and is usually used in the low-impact development techniques (Wang et al., 2016). For example, the runoff coefficient of open green space is around 0.15, which means only 15% of precipitation flows into the water discharge system.

Green space is, therefore, a buffer that can reduce the volume of excessive water entering the discharge system. By contrast, asphalt pavement has a high runoff coefficient (around 0.8) and only a weak capacity for water infiltration. As a result, its large scale of usage would leave the pressure of excess water to the urban discharge system.

Based on this notion, the runoff coefficient is used to decide on the location and size of permeable areas such as wetlands, parks, and gardens, rather than high density of concrete forests. Fig. 19.3 (right), the runoff control coefficient map, shows how much precipitation is not allowed into the drainage system and is proposed to be stored by sponge infrastructure. The values equal 1 minus the runoff coefficient. Normally, a looser standard is set for the areas with high percentage of paving and difficult to be transformed while a tougher standard is for the opposite conditions. For instance, for a built area located in Yuexiu district at the old city center, the proposed runoff coefficient is 0.39 with 0.61 as the runoff control coefficient. It means 61% precipitation could not be discharged into the drainage system. By comparison, for an urbanizing area with abundant undeveloped land in Tianhe District, the proposed runoff coefficient is 0. 26.%; 74% should be stored by the sponge infrastructure (see Fig. 19.3 (right)).

19.3.5 A Rise of Status of Spatial Planning in a New Flood Governance

The *Guangzhou SCP* redefines the distribution of responsibilities in the spatial planning system. Guangzhou Land Resources and Urban Planning Committee (a combination of previous Guangzhou Land Resources Bureau and Guangzhou Planning Bureau) is highlighted in *SCP* as one of the key actors in flood mitigation. It is:

> responsible for policy making of comprehensive plans and detailed plans …, coordinating the interests between different administrators …, regulating the rules, building codes for construction… and inspecting the implementation of adaptation measures… ***Guangzhou Government (2017)**, **p. 120***

As such, the local spatial planning system formally and officially steps into the arena in resolving the flood risk. In parallel, it appeals for horizontal cooperation with another 13 bureaus such as Guangzhou Water Affairs Bureau, with rich experience in flood-mitigation projects; Guangzhou Finance Bureau, responsible for the funding support; and Housing and Construction Committee, working on the inspect of the project construction. Therefore, the roles of the planners are experiencing a change and new kinds of collaboration arrangements across policy silos because of the *SCP*.

19.4 CRITICAL ANALYSIS OF THE MUNICIPAL INTERPRETATION OF THE SPONGE CITY PROGRAM IN GUANGZHOU

In spite of the shifts in the content of Guangzhou's *SCP* and, arguably, progress in integrating efforts to ensure flood resilience in the context of climate change into spatial planning, there are at least four key obstacles for implementation of this plan: (1) recognition of the coastal flooding and socioeconomic trends; (2) attention to the changing and dynamic climate; (3) horizontal collaboration between spatial planning and flood risk management; and (4) costs of long-term development.

19.4.1 Potential Criticality in the Recognition of the Coastal Flooding and Socioeconomic Trends

The Sponge City Program mainly addresses urban surface water flood issues rather than coastal flood scenarios. This problem-framing preference could be found in the national and provincial documents, such as the *Technical Guideline for the Construction of Sponge Cities* and *Guangdong Provincial Sponge City Program*. Claimed sponge solutions are, thus, mainly used for absorbing the storm water, for instance, bioswales, rain gardens, artificial wetlands, ponds, sustainable drainage systems, etc. (Qiu, 2015; Xia et al., 2017). There are no spatial interventions taking coastal flooding into the consideration. In contrast, the *Guangzhou SCP* attempts to build a comprehensive flood resilience system with flood defense, retention, and discharge. Nevertheless, the enforcement of the flood defense, namely dykes, is still regarded as the main solution in coastal areas. Consequently, people might be under the impression that coastal flood-prone areas are totally safe behind the dykes and flood walls. However, when the extreme weather happens, it will be difficult for the communities to handle the

emergency (IPCC, 2007). Thus, the city still has to find alternative solutions to address coastal flood risk and climate issues that the Sponge City Program is unable to offer.

Moreover, flooding hazards are always associated with the density of population and value of economic assets such as property and infrastructure (Schanze, 2007). *Guangzhou SCP* mainly concentrates on the physical aspects of vulnerability to flooding while ignoring scenarios for social and economic change. Such consideration could indeed draw attention to the future severely flood-prone areas yet promising for economic development, for instance, waterfront areas with high quality of natural amenities while close to tides. By doing so, potential conflicts could be discussed and a balance between land use for economic development and for water management could be found.

19.4.2 The Mismatch Between Dynamic Changes in Flood Risk and a Static Regulatory Index

Future flood risk due to climate change has not attracted much attention in policy documents. Neither has the issue of climate change adaptation. In *Technical Guideline for the Construction of Sponge Cities* and *Guangdong Provincial Sponge City Program*, there are no parts that explicitly relate the increased risks to climatic factors. Even in *Guangzhou SCP*, climate change and climate adaptation are merely used to raise the attention of politicians, planners, and engineers. There are no further explorations of how this can affect and threaten the city over time. It could be explained by the fact that climate experts become "the missing piece" in the policy-making process of Sponge City Program at multilevels. By this, the track of changing climate information was left aside, which could have provided feedback to test and optimize the spatial plans.

In an implementation, the runoff coefficient is introduced as a static regulatory index to control the density and underlying surface of every piece of land. Its virtue is that it provides a new tool for practitioners to use. However, the current runoff coefficient index will fail if rainfall intensity increases due to changing climate (which is expected for the Guangdong province and Pearl River Delta). Areas prone to coastal flooding, like the Southern Nansha district, will also be more and more vulnerable because of more frequent extreme weather and higher tides. At this time, the city is unable to deal with these future scenarios and the *SCP* glosses over this issue.

19.4.3 Potential Challenges in the Horizontal Collaborative Implementation Around the Corner

The significance of horizontal cooperation between spatial planning with other professions is recognized in Sponge City Program. At the national level, this program is led by MoHURD and supported by the Ministry of Finance and Ministry of Water Resources. This joint venture has increased the legitimacy of professional collaboration between spatial planners and hydrological and financial experts in practice. This collaborative relationship is formalized in the *Technical Guideline for the Construction of Sponge Cities* by the contention that "In practice, spatial planning is proposed to take effect with the support from other fields such as finance, greening, transportation, drainage, architecture, and hydrology." Similar arguments could be found in the *Guangdong Provincial Sponge City Program* and *Guangzhou SCP* as well.

In spite of the above, horizontal cooperation between spatial planning and other professions is challenging in local implementation. One of the reasons is the lack of knowledge on water management among local spatial planners. According to the plan, spatial planners are expected to coordinate actions on preserving of green infrastructure and design of water retention areas. The former is relatively familiar and manageable for them but the latter is more complex and requires expert hydrological knowledge. For the spatial planners, how to calculate the runoff coefficient and interpret it at the submunicipal level could be a problem. As one spatial planner involved in the formulation of *Guangzhou SCP* mentioned,

> I don't know how to calculate the runoff coefficient index, let alone to apply the index as post-assessment criteria to inspect the proposed projects. The mission of calculation is left to Guangzhou Water Affairs Planning Design & Survey Research Institute. The engineers are the real captains. We just put their outcomes into the document.

As a result, spatial planners do not have a leading position in cooperation with engineers in the field of flood risk management.

In addition, the discussion of coastal flooding takes up a small portion of the Sponge City Program compared with the pluvial and fluvial flooding. As a result, the Pearl River Committee, a regional authority responsible for the reinforcement and maintenance of dykes along Guangzhou southern coastlines, is excluded from the policy-

making process at the provincial and local levels, let alone the definition of their position in the sponge city document. This exclusion may become an obstacle for joint working, resulting in the neglect of coastal flooding in spatial plans process.

19.4.4 Potential Conflicts Between Limited Subsidy and Long-term Investment in the Top-down Affairs

As mentioned before, the implementation of Sponge City Program is a top-down process. National authorities propose the political vision and generic principles and encourage the provincial and local authorities to operationalize these principles in their jurisdictions. Subnational authorities have the power to undertake some modifications to accommodate their specific context, as long as it corresponds to the national policy *Technical Guideline for the Construction of Sponge Cities*.

Apart from political pressure, an important driving force in promoting this program locally is the financial incentive from the central government. These sentiments are shared in interviews from Guangzhou Municipal Engineering Design and Research Institute, Guangzhou Urban Planning, Design and Survey Research Institute, and Turen Urban Planning Company, who are involved in the formulation of *Guangzhou SCP*. By 2016, 30 cities had received funding from the national government for pilot projects on sponge city development (Economy and Construction Department of the Ministry of Finance (2015); Pengpai News (Shanghai) 2016). The cities receive 3-year continuous funding of between 400 and 600 RMB million per year (Economy and Construction Department of the Ministry of Finance, 2014). Clearly, sponge-city infrastructures are expensive (Xia et al., 2017) and the construction does not bring economic benefits in the short term. Thus, new funding mechanisms may be needed. A participant in the policy-making process makes the case:

> one goal of the formulation of Guangzhou Sponge City Plan is to pursue the subsidy. It is not a problem since the financial incentives attract the attention of local authorities to take actions. The problem is if they achieved the proposed subsidy and ran out the money, what would be the next step to push forward this program and avoid becoming a temporal political movement?

19.5 CONCLUSIONS

This chapter focuses on the Chinese experience at the local level and reveals how spatial planning is involved in climate adaptation initiatives under a new metaphor—the sponge city. It does so by tracing its innovation in the local spatial planning system and its distinction and cohesion with the national and regional documents. This research contributes to the literature on the transition in the field of spatial planning in the framing of adaptation in local planning documents and the interpretation of adaptation planning in a multilevel governance context.

Through a top-down process, this national program has triggered some rethinking of flood risk in the field of spatial planning. In the case of Guangzhou, the study indicates the *Guangzhou Sponge City Plan 2016–30* makes a transformation in spatial planning. Specifically, climate change, as a new factor, has begun to attract the attention of local policy makers and affect the policy formulation in the spatial planning system. In response to its negative impacts, integrated flood adaptation measures are proposed by using the runoff coefficient to regulate the development of every piece of urban land and promoting a mixture of structural and nonstructural interventions. To ensure its implementation, flood adaptive initiatives are integrated with other urban issues such as water purification, ecological improvement, and increase in social well-being. Importantly, spatial planners are officially expected to enter the arena of climate adaptation in the face of the flood risk.

As a result, climatic factors have been introduced into problem setting, establishing mainstreaming adaptation solutions in local agendas, formulating regular tools for operation, and defining a clear position of spatial planning responsibilities in flood governance. Guangzhou provides a useful reference case for other cities that are seeking to translate national sponge city policies to the city scale. Nevertheless, various obstacles still need to be overcome for Guangzhou's *SCP* to be implemented. First, a lack of attention to coastal flooding might severely limit potential options for flood resilience. Second, a rigid and static regulatory tool, such as the runoff index introduced by the *SCP*, might not be well suited considering that the dynamic and uncertain climate change impacts may play out differently from the current expectations. Third, horizontal cooperation between spatial planning and other professions might result in a deadlock on account of the lack of hydrological knowledge among the planners and limited experience in working across sectoral boundaries. Fourth, the cost might be a concern for a long-term operation of *SCP* unless a sustainable way is found to balance the costs and benefits.

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