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## Article

# Shifts in Spatial Plans for Flood Resilience and Climate Adaptation: Examining Planning Procedure and Planning Mandates

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**Abstract:** The paper examines the development of different spatial plans to address flood resilience in the Chinese city of Guangzhou, one of the most vulnerable cities to flooding and climate change. The analysis focuses on the differences in planning procedures and planning mandates (determined by different plans in authority) before and after the launch of the Sponge City Plan which calls for numerous spatial resilience measures to address the increasing flood risk. The analysis reveals that the introduction of the Sponge City Plan has changed the role of planning from onlooker to active participant in the arena of flood governance. In addition, new plans combine long-term strategic visions, soft principles, and strict regulations with an aim to promote concrete planning practice between multiple layers with a clear mandate. Despite these shifts, institutional and territorial challenges remain.

**Keywords:** spatial planning; flood risk management; procedures; mandates; planning tools; horizontal interactions; vertical cross-level coordination

## 1. Introduction

Exacerbated by climate change, flood hazards have long been recognized as a considerable threat to coastal and deltaic cities [1]. The requirement to achieve a resilient and adaptive society and avoid negative economic, social, and environmental costs is becoming more urgent [2,3]. In this context, spatial planning is recognized as a useful tool to facilitate these activities, since it can be used to reduce the vulnerability of cities by, for example, restricting development in flood-prone areas, steering migration, re-zoning activities, and promoting natural-based water detention [4–7]. However, the success of planning measures relies on how they are delivered, both in terms of design and implementation.

A review of the literature on water governance and climate adaptation showed that there is only a limited number of case studies that explore in depth the procedural interactions between spatial planning and flood risk management, and the mandates of each of those sectors. They point to several ways in which existing ways of working can hinder the design and implementation of planning policies. These barriers tend to relate to the mismatches between sectors in procedures, skill-sets, and work processes [8]. Experience in Scotland, for instance, indicates that time horizons and sequences of action used by planning authorities and flood authorities are not always consistent or coordinated, thereby limiting planning opportunities to engage in co-operative work and resource sharing [8]. Another challenge comes when the ways of working are altered or regulated by some forms of legal changes. This concern emerges in recent planning literature and stresses how statutory regulations can affect the

progress of implementation and the enforcement of legal obligations when they are imposed upon planners, developers, and individuals. For example, in the United Kingdom, authorities increasingly require planners to restrict constructions in flood-prone areas to reduce flood exposure [9]; or, in Ghana, the poor enforcement of planning permission makes it impossible to restrict illegal urban construction which increases vulnerability to flood [10]. A similar concern arises more often in climate mitigation and adaptation studies: strong legal mandates of the authorities or the mandatory character of agreements may, in some cases, facilitate the effectiveness of agents' actions by providing resources or knowledge and shaping the perceptions of the issue [11,12].

We respond to the abovementioned literature and argue that the top-level development of policy procedures and policy mandates are significant in transferring commitment (ambitions) to action in urban resilience. Specifically, the former may entail 'silencing' or 'amplifying' the planners' voice in political arenas where planners have to compete with counterparts in other policy sectors, and the latter may entail weak or strong interventions to allow planners to promote adaptation across vertical governmental levels. By this, the study contributes to two highlighted topics in addressing flood affairs, positioning agents among multiple actors and spanning professions horizontally [13–15], and shifting relations between territorial authorities in hierarchical systems [16,17]. Both topics are related to a wide agreement that there is a need to integrate spatial planning and flood risk management (or water management) to address flood risk [18,19]. In spite of the acknowledgement, to realizing this integration is challenging.

It also enriches the policy science generally by showing how flood resilience and adaptation-related policies are systematically developed to create circumstances for substantive implementation. While this issue has already been studied [4,20–22], the focus, in most cases, is on how specific projects are implemented empirically in different nations, regions, and communities [23–25], whereas, in this study, we explore how the planning system determines the conditions for project design to make cities more resilient along with water sectors.

To do this, the study focuses on a Chinese case, Guangzhou, a delta city that is one of the world's most vulnerable cities to the flood risk, and is transforming its spatial planning system to cope with growing flood risk. In Guangzhou's traditional planning system (one of the earliest municipal planning systems, built in China during the 1920s), land use for economic development has always been the main focus. By contrast, the attention to flood affairs was not, and gradually decreased until this agenda was finally set for professionalized flood risk management around 2008. Planning, thus, became weak in flood governance.

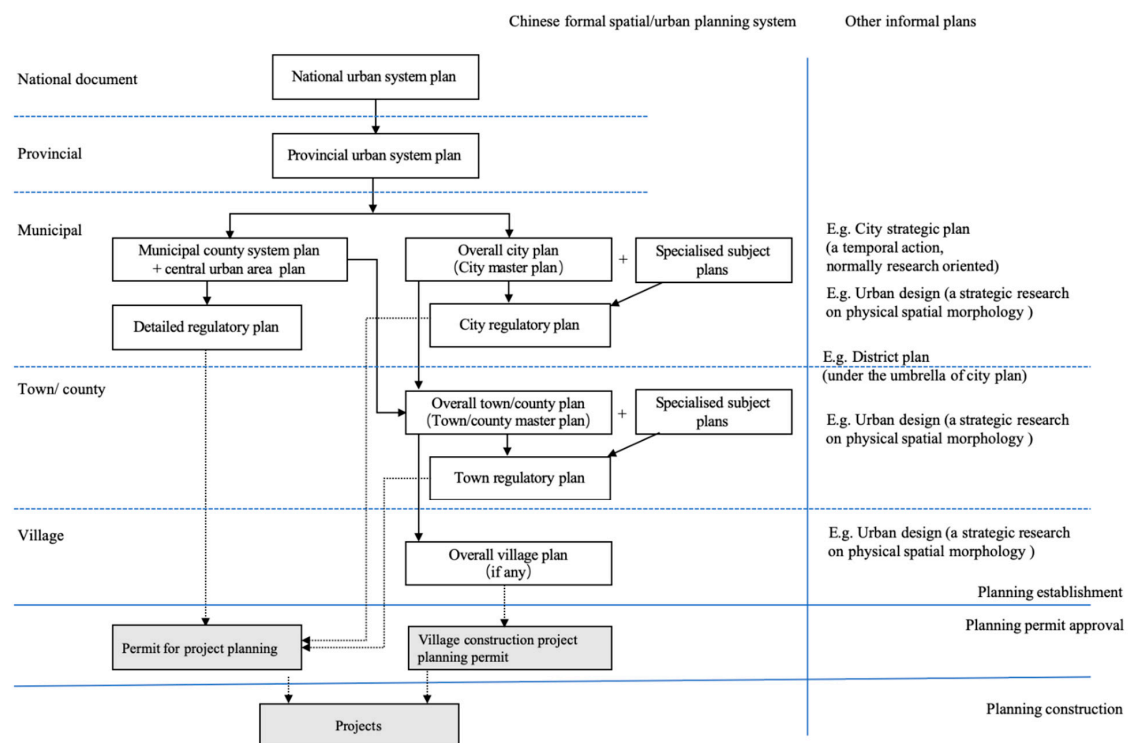
However, this situation did not last for a long time. As a milestone, the newly enacted 2017 Guangzhou Sponge City Plan officially pushed spatial/urban planning to the frontier for flood resilience [26]. It is a municipal response to a national Sponge City Programme. At the national level, this program was initiated in 2015 by the Ministry of Housing and Urban–Rural Development (MoHURD), the Ministry of Water Resources (MoWR), and the Ministry of Finance (MoF) [27], two of which represent the highest authorities in terms of urban–rural planning and flood risk management. In this context, a series of plans with innovative notions, goals, and forms are proposed in the Guangzhou Sponge City Plan to meet the national call locally [28]. Two research questions are explored in this study: (1) how these new changes, if any, alter any decision-making procedures and further affect the macro policy environment horizontally, by positioning and repositioning planners, and offering the channels for planners to enter the flood affairs domain in collaboration with external actors, hydrological engineers; and (2) how these new changes, if any, create different compelling forces and promote vertical implementation.

The paper is divided into five main parts. First, it introduces the Chinese systems of spatial planning and water conservancy (and affairs) planning as background information. Next, it outlines a conceptual framework and research methods. Empirical investigations are then presented, comparing the distinctive plans used in traditional and recent planning settings. The paper concludes with a summary of the main findings and implications for practice and future research.

## 2. Background: Chinese Spatial/Urban Planning System and Water Conservancy (and Affairs) Planning System

### 2.1. Chinese Multi-Layer Planning System

In the arena of formal or statutory spatial planning, a comprehensive planning process consists of three key stages in sequence (Figure 1): planning establishment, planning permit approval, and planning construction.



**Figure 1.** Chinese multi-layer spatial planning system, based on Countryside Planning Act (2008) [29] and Principles of Urban Planning (4th Edition) [30].

In this study, we concentrate on the complexity of planning establishment, in which plans are made at different scales: national urban system plan, provincial urban system plan, overall city plan (in parallel to municipal county system plan and central urban area plan), overall town plan, and village plan (if any). Generally, these plans express the comprehensive proposals at different administrative levels, including development goals, scales, land use structures, zoning, dominant industries, major infrastructure, and expected populations [31]. Along with these master plans, are specialized subject plans, which detail specific proposals of master plans (not always all topics) and span land use and other relevant topics, for instance, transportation, flood and sanitation calling for joint work between agents within and beyond the spatial planning system [32].

The proposals in master plans and subordinated specialized subject plans are further quantified and qualified by the corresponding regulatory plans, which regulate potential land uses and land development through a series of indexes, such as the function of land, height of houses, ratio of green coverage, and density of buildings [31]. Those indexes are latterly written into project planning permits, and are supposed to work as a kind of local ‘planning law’ to control urban–rural development by posing compelling forces on developers, designers, and engineers with strict preconditions on any real construction projects.

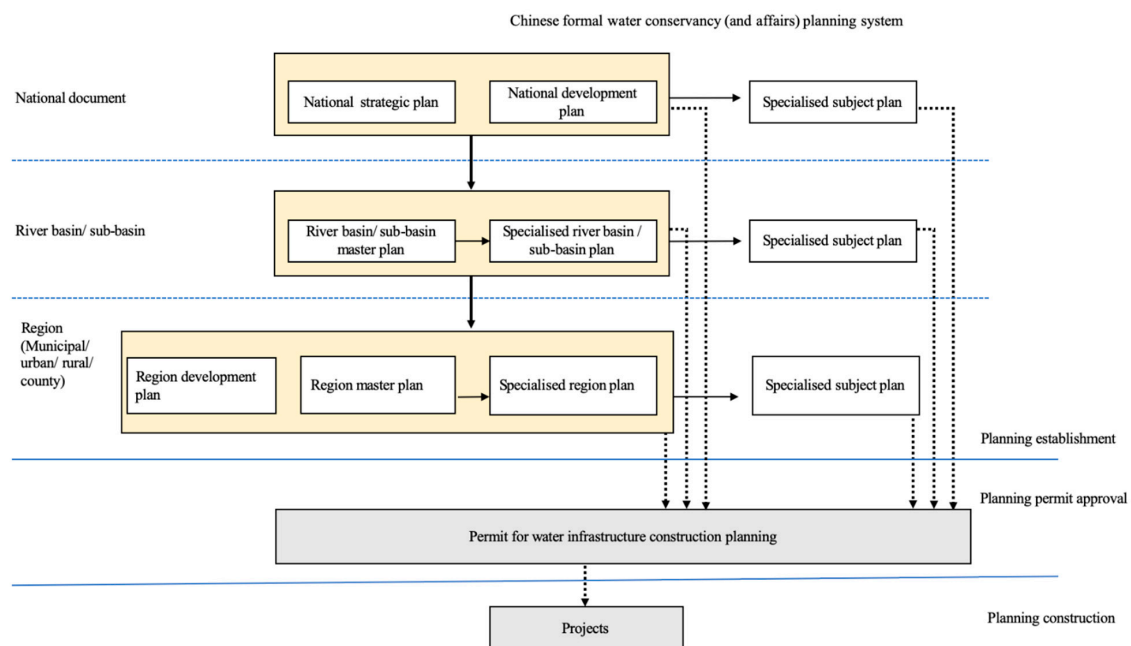
Beyond formal planning, informal planning, or non-statutory planning, there are also other types of plans, such as strategic plans, district plans, urban designs, etc. (Figure 1). In addition, they display

different features. Strategic plans originally emerged in the late 1990s when Chinese coastal cities tried to manage the opportunities and challenges for fast urbanization influenced by a market-oriented economy rather than a planning economy [31]. Unlike the time-consuming process of traditional planning, compiling and modifying a strategic plan was faster and easier, and could be decided by local governments away from the higher hierarchical approvals. Strategic plans were, thus, used to explore a temporal validation for rapid expansions breaking the strict limitations from blueprint plans, like in the cases of Guangzhou (2000), Xiamen (2001), and Ningbo (2001) strategic plans, even though they are now turning into an tool used to face the uncertainties in terms of rising capital markets, policy cohesion, and global challenges [33]. In addition, district plans are regarded as another representative of non-statutory plans after 2008, when they were cancelled from the statutory planning system but are still in use in many cities [34]. They are normally adopted by authorities to regulate the development at the district level, if any, underneath the municipal level, which often appears in megacities, like Guangzhou, Beijing, or Shanghai, where there are difficulties to manage complicated municipal agendas by one-layer authorities. Furthermore, urban designs are also included in the informal planning system. They are a research-based tool to analyze the potentiality of developments via spatial morphology, which can be operated at most levels (e.g., regional, municipal, town, district.) before, in, or even after the compiling of formal spatial plan documents (used for plan reassessment).

## 2.2. Chinese Multi-Layer Water Conservancy (and Affairs) Planning System

The water conservancy (and affairs) planning system focusses on water management and water affairs in contrast to, for instance, zoning or land use arrangement in spatial planning. Figure 2 illustrates the overarching framework of this system, consisting of three major processes: planning establishment, planning permit approval, and planning construction. The planning establishment is basically arranged in three layers at the national level, river basin (and sub-basin) level, and regional level (regional level in a water conservancy (and affairs) planning system is an overall concept used to describe a collective geographic territory at municipal/urban/rural/county levels, in contrast to a detached level higher than the municipal level from the perspective of spatial planning administration). National strategic plans and development plans concentrate on implementing the nationwide efforts of flood reduction, water resources utilization, ecological and environmental protection in terms of the national economy, and social development goals. At the river basin (and sub-basins) level and regional level, masterplans and development plans are compatible with the national calls and are combined with comprehensive physical and natural conditions locally, which are further detailed in specialized plans on concrete water issues including flood control, waterlogging, drought, irrigation, water supply, hydroelectric generation, water resource protection, forestation, and soil conservation.

The mentioned strategic plan, development plans, master plans and specialized plans are generally regarded as the core components of the water conservancy (and affairs) planning system taking place at the national level, in river basins and regions. Apart from those, there is a supplementary document, namely, the specialized subject plan. This can work as an action plan considering specific major practical projects or significant topics in the near future; in the meanwhile, it has to be compatible with the rules formulated in the core components.



**Figure 2.** Chinese multi-layer water conservancy (and affairs) planning system, based on Management Measures of Water Conservancy Infrastructure Construction and Planning Permit (Temporal) [35], Flood Risk Management in the People’s Republic of China: Learning to Live with Flood Risk [36], Water Conservancy Planning System of Zhejiang Province [37], and Management Measures of Water Conservancy Planning (Temporal) [38].

### 3. Building Blocks for an Analysis of Planning Procedures and Mandates Vertically and Horizontally

The following study explores an analysis of procedures and mandates more related to the field of spatial planning, in terms of horizontal interactions across sectors and vertical enforcement of policy. To answer the first concern, this paper explores the workflows of the spatial planning system and water conservancy (and affairs) planning system given flood affairs, and reveals how different policy procedures discuss flooding respectively and how they interact with each other at particular points, if at all. The exploration is built based on Section 2 (Background: Chinese spatial/urban planning system and water conservancy (and affairs) planning system).

To answer the second concern, this paper draws on the ideas from Hurlimann and March (2012) [20], who proposed five types of planning tools to deal with climate adaptation in general: (1) vision/mission statement, (2) strategy planning, (3) agenda/project-based, (4) policy/regulation/code and (5) design (see the columns tools and descriptions in Table 1). Different tools have their own specification and, importantly, enforcement in practice. For instance, the vision statement is inclined to present the desired future and overall directions, yet it poses limited compelling force on a following policy or plan. Similarly, the strategic guideline or principle aims to reach a wide agreement between agents with soft force by general rules (guiding rather than compulsory advice and/or items). In contrast, regulation offers strict rules that facilitate the smooth operation of a system generally, and neglect the particularity of single projects. While project-based or infrastructure development is more concrete and related to an economic purpose, which is usually used to pilot new initiatives. Thus, it can pose a strict constraint to a specific project, yet a limited compelling force to other projects or a system overall. Notably, the typology proposed by Hurlimann and March seems to pay more attention to authority, yet it considers less regarding financial and publicity issues, which can be studied in future research.



**Table 1.** Types of plans and planning tools, based on the planning tool model in climate adaptation [20].

Types of Plans	Tools	Descriptions: Specification and Enforcement
Master plan (statutory)	Visions/missions statement	A general portrait of desired future or overall directions for finding common grounds between large sets of stakeholders with limited mandate
Regulatory plan (statutory)	Strategic guidelines/principles	A broad directional statement with collective concerns and soft force (guiding advice/items rather than compulsory rules)
Strategic plan (non-statutory)	Regulation/code	Strict rules that facilitate the fairness and consistency of a system and offer hard constraints on individual actions
District plan (non-statutory), etc.	Project-based/infrastructure development	Specific single activities and projects for a special economic development goal, pilots of new notions or new solutions testing with limited mandate to other projects or a system overall

There is a challenge to use Hurlimann and March's framework directly since the proposed typology does not fully correspond to the Chinese planning system. As mentioned in Section 2.1, there are two types of statutory plans in China, the master plan and regulatory plan, along with some informal types, for instance, the non-statutory strategic plan. Thus, we abstract the features of planning tools in Hurlimann and March's model and adapt them to the Chinese planning system for easier understanding (Table 1). The tool of design is beyond our framework, given its vague working scope in the Chinese planning system. In fact, design can be operated at most levels and at any stage.

Subsequently, Sections 5 and 6 reveal the variation of types of plans in Guangzhou since the 2000s, particularly, before and after the launch of the Sponge City Plan. Both sections follow the same rules: (1) conducting a horizontal analysis spanning administrative boundaries and portraying the macro policy environment; and (2) conducting a vertical analysis across the multi-layer planning system. In this way, the study helps to explain how types of plans position the role of spatial (or urban) planners within flood governance and take actions within the planning system.

## 4. Case Selection and Data Collection

### 4.1. Case Selection

The current Guangzhou administration functions within a two-layer hierarchical structure, the municipal and district authorities. This structure has undergone many geographic changes since it was established. Figure 3 reveals the latest boundaries of the 11 districts under the umbrella of a municipal government, which was established in 2016.

This two-layer administrative hierarchy affects the components of local spatial planning system and water conservancy (and affairs) planning system. The governmental organisations in these two fields also follow the municipal-district two level structures (Table 2), in spite of a detached vital river basin flood control sector, the Pearl River Conservancy Commission, which was established to be responsible for coastal and surge floods at the river basin level in 1979 by the Ministry of Water Resources.

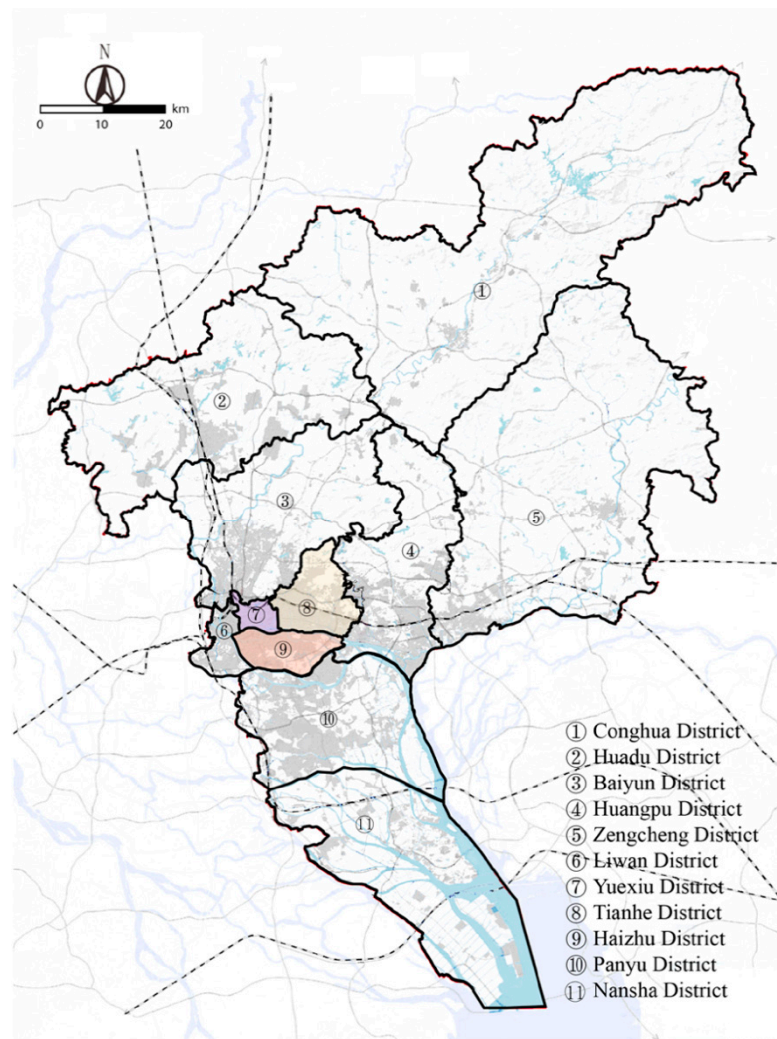


Figure 3. Eleven districts of Guangzhou.

Table 2. Structures of administration, planning, water management, and flood control.

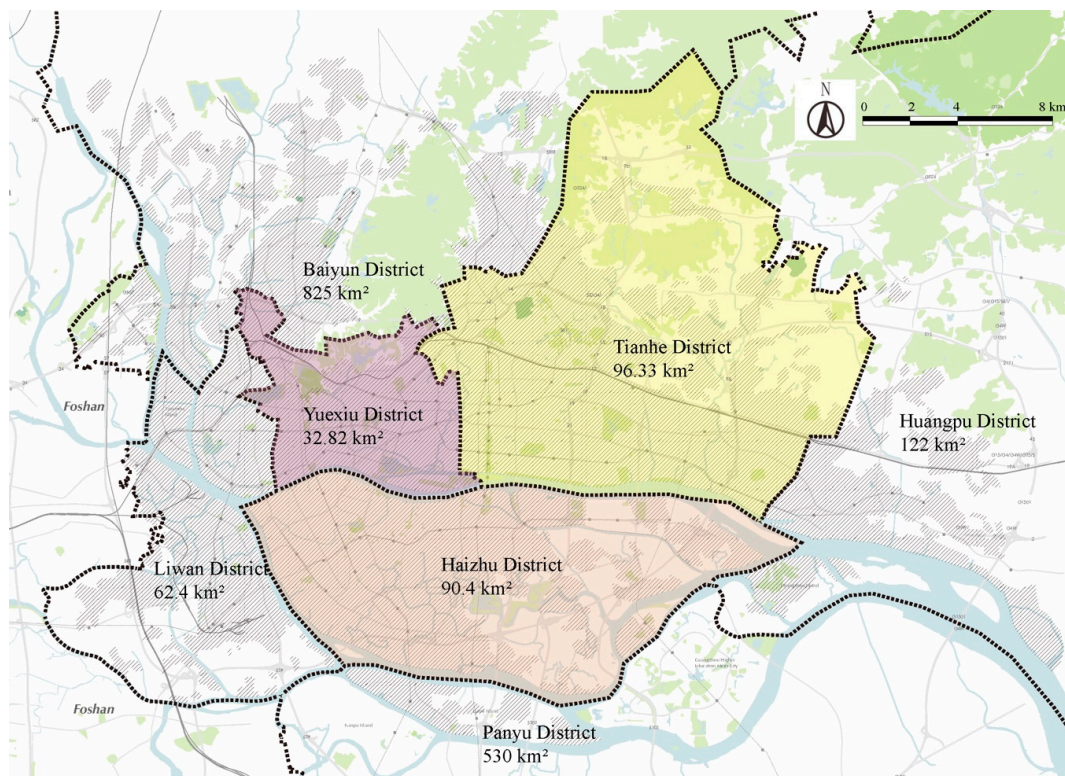
	Guangzhou Administration	Guangzhou Spatial Planning	Guangzhou Water Management <sup>1</sup>	Flood Control <sup>1</sup>
River basin level (sub-national level)				Pearl River Conservancy Commission
Municipal level	Government	Planning Bureau/Land Resources and Urban Planning Committee	Water Affairs Bureau	
District level	Government	Planning (and Construction) Bureau	Water Affairs Bureau	

<sup>1</sup> The fields relating to water conservancy (and affairs) planning system.

One subsidiary, the hierarchies of the administration, spatial planning, water management and flood control systems, may differ from one place to another according to their local context. Shenzhen, for example, is also located in the Pearl River Delta, and functions on a one-layer administration structure at the municipal level. By contrast, another adjacent city, Shaoguan, functions as a municipal-town-village three-layer administration and planning structure.

Three district cases in Haizhu, Yuexiu and Tianhe (Figure 4), are included in the study to show how planning addresses flood affairs. All of these are regarded as typical representative cases affected by different types of plans before or after 2017.





**Figure 4.** Locations of flood addressing pioneers, Haizhu and Tianhe Districts.

#### 4.2. Data Collection

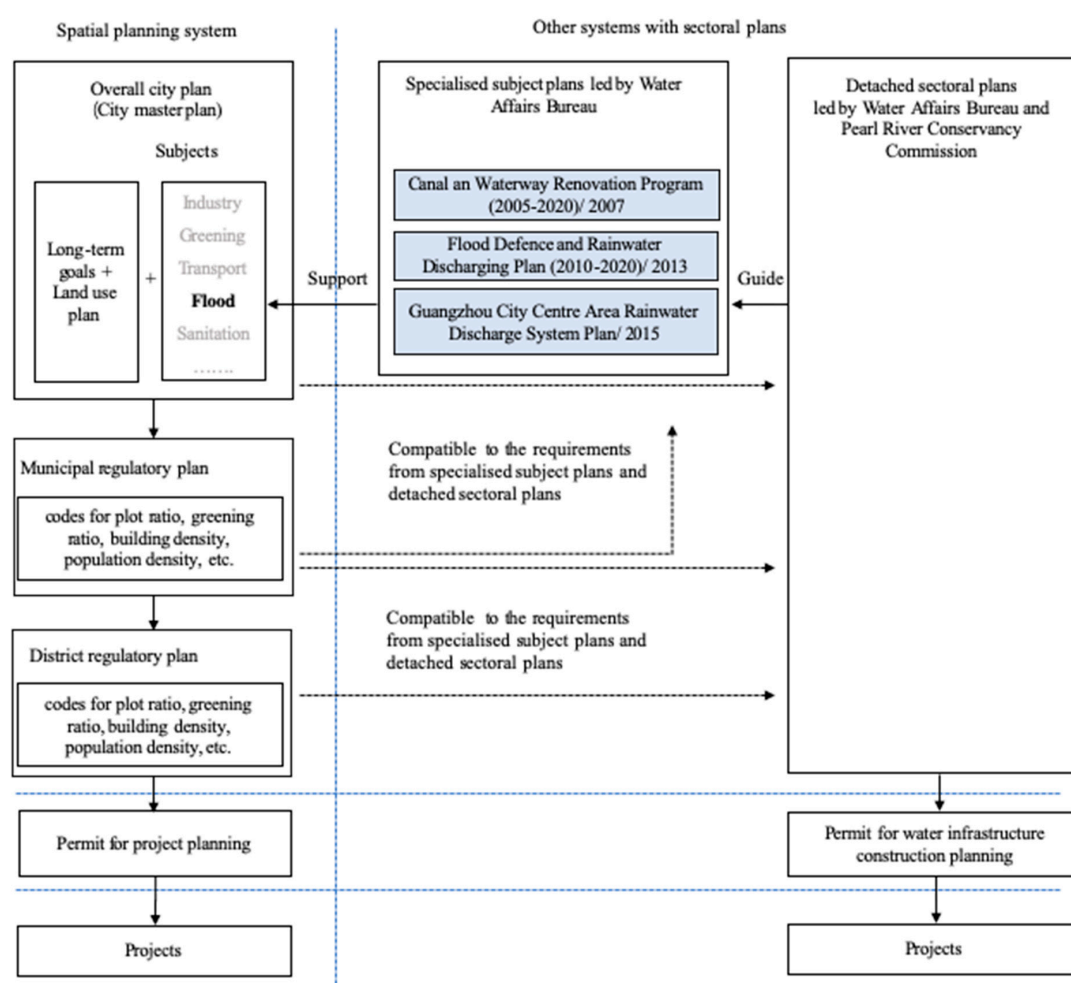
This research is conducted by examining the most representative planning practice in which flood issues are concerned in combination with land use development. A range of policy documents given comprehensive city arrangements and concrete practical projects are analyzed to reflect how plans take effect, including formal documents (for instance, city master plans), and supplementary informal documents (for instance, district plans, strategic plans, and special program documents like the Sponge City Plan).

In addition, we use semi-structured interviews (see the Appendix A Table A2. List of questions covered in the semi-structured interviews relating to the study) with a sample of individuals in this research. Seven interviews (see the Appendix A Table A1. Interviews' logbook (2016–2019)) from a variety of agencies shared their first-hand experience, representing policy sectors, research institutions, and a private company. Their professions cover land use management, spatial planning, urban design, and hydrology/civil engineering. The coverage of a wide range of professions helps to mitigate the bias related to subjective accounts given by a single interviewee.

### 5. Traditional Planning System: Attached Subject Plan in Relation to Flood Concerns

#### 5.1. The Horizontal Position of Spatial Planning in a Macro Policy Environment

Figure 5 reveals the recent macro policy environment before the launch of the Sponge City Plan in 2017. Three strands of policy interventions focus on flood affairs: flood-related discussions in spatial planning documents, specialized subject plans in water management, and detached sectoral plans in the water conservancy (and affairs) system. Led by the Water Affairs Bureau, specialized subject plans, on the one hand, supported spatial planning documents on the issues related to canals, waterways, flood defense, and rainwater discharge. On the other hand, they were compatible with the professional provisions created by detached sectoral plans.



**Figure 5.** Macro policy environment of Guangzhou during 2000–2017. Note: vertical blue dashed line indicates the boundary between spatial planning system and water conservancy (and affairs) system.

In spatial planning, the reflections on flood issues are not particularly rich. Taking master plans as an example, addressing flooding was not the main concern, especially compared to the other numerous development proposals, such as industry development, energy, greening, transportation, and energy. The discourse of flood affairs tends to be covered only in the paragraph entitled ‘flood prevention and rainfall discharge’, a sub-topic under the heading of ‘public safety and disaster prevention’ (see Table 3, which will be further discussed in Section 5.2). In addition, the content was limited to an illustration of flood defense and coping measures attached to hydrologic visions (goals) and soft principles calling for adaptation mainstreaming. More like an engineering white paper, the desired standards are formulated in terms of major dykes, pipe systems, reservoirs, and canals. The standards were followed with principles (soft requirements) in some documents (not always), which partly explained the concerns about mainstreaming flood concerns with urban agendas, improving financial and technical support, and building response and preparation systems for the long term.

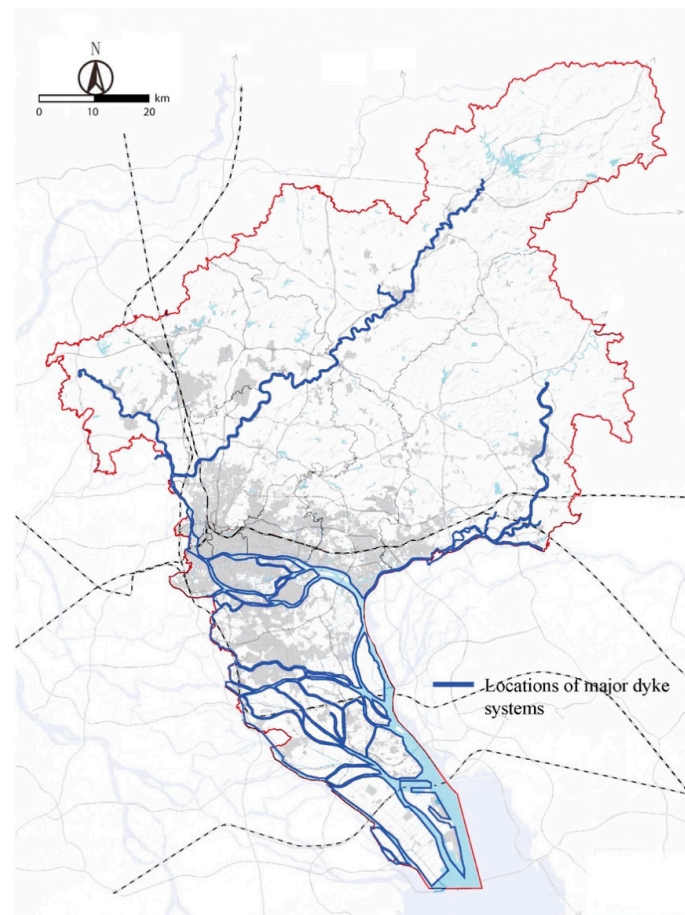
**Table 3.** Flood prevention and rainfall discharge discussion under the subject of public safety and disaster prevention in master plans, based on Guangzhou Strategic Plan 2000–2010, Guangzhou Master Plan 2000–2010, Guangzhou Master Plan 2010–2020 [39–41].

Year	Documents	Flood Defense and Coping Measures (Desired Hydrological Standard)	Principles
2000	Guangzhou Strategic Plan 2000–2010	Middle reservoirs: 100 years Small reservoirs: 20 or 50 years City center dykes: 200 years West-north River dykes (Nansha branch): 100 to 200 years East River dykes: 50 years City center pipe systems: 20 years Pipe system in other areas: rainfalls last 24 h with a density in every 20 years reoccurrence periods should be drained within one day	Building hazard response and preparation systems in the face of natural hazards, sudden sanitation contingencies and society accidents for a long-term Coordinating land use between disaster management and urban development Advancing financial and technical support, as well as education and inspector
2005	Guangzhou Master Plan 2000–2010	City center dykes: 100 years in the short term and 300 years in the long term West-north river dykes (Nansha branch): 100 to 200 years The altitude of lowlands in the city center should be higher than 107.79 m with Baiyun district as an exemption City center pipe systems: 20 years Pipe system in other areas: rainfalls last 24 h with a density in every 20 years reoccurrence periods should be drained within one day Preservation of canals and artificial lakes in the built center	None
2016	Guangzhou Master Plan 2010–2020	Same as the discourse in Guangzhou Strategic Plan 2000–2010	Seeking opportunities to combine water affairs with urban development Enhancing the efficiency of flood risk management Constructing infrastructure according to local geographic and meteorological conditions

Even so, guidance for planners to take concrete actions were vague. After all, the responsibilities for the reinforcement or improvement of flood defense elements such as dykes, canals, waterways, and rainwater discharge pipes belong to the local water conservancy (and affairs) system rather than spatial planning. In regulatory plans, the proposed hydrological visions were visualized as vital lines marking hydrological infrastructures with locations and flood control standards (see Figure 6, which will be further discussed in Section 5.2). The requirement of traditional land use indexes, such as building density and greening ratio, was scarce.

Flood related specialized subject plans, as an extension of master plans, made up the mentioned weakness and gave more systematic interpretations on how to design flood responsive measures. Crucial representatives of specialized subject plans (beyond spatial planning system) were richer in discussing flood affairs including (but not limited to) flood exposure or risk assessment, adaptative measures or options, actors' positions in decision making, project design ordinances, and monitoring [42–45].

Notably, these specialized subject plans were a merely the 'tip of the iceberg' of professional water management. Behind them were rich, detached sectoral hydrologic ordinances, rules, plans, and projects, and experienced engineers, experts and agents. Thus, it is safe to say, the flood conservancy (and affairs) planning system took charge of the decision-making process in flood governance, while spatial planning was more likely an onlooker, marginalized in flood governance.



**Figure 6.** Locations of dyke systems of Guangzhou, based on the Map of Major Infrastructures in Guangzhou, exhibited in the Exhibition Museum of Guangzhou Urban Planning.

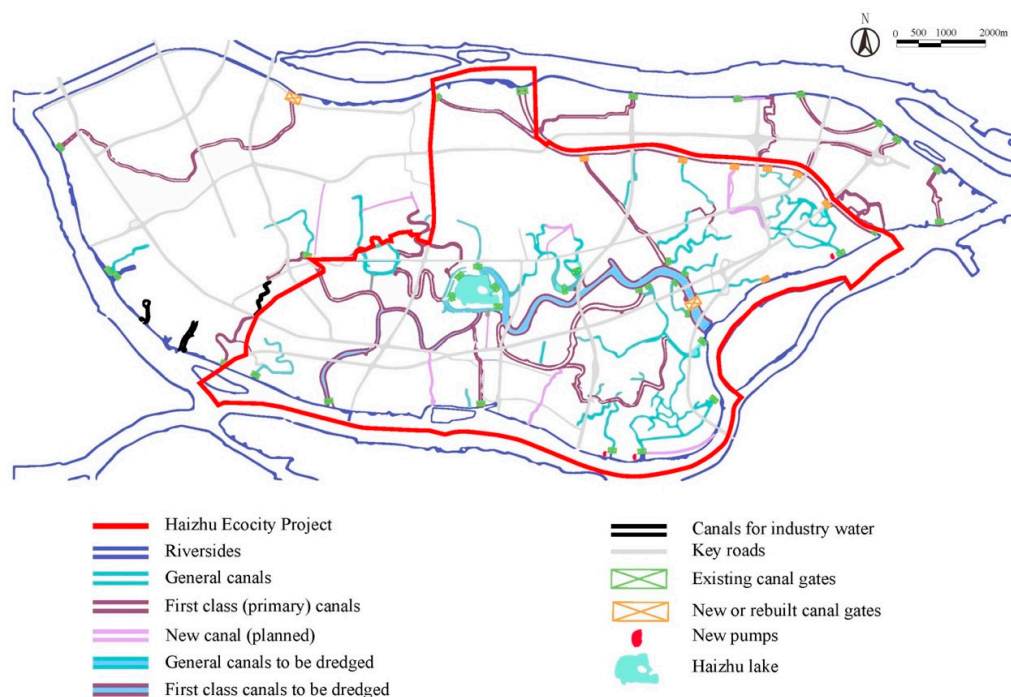
## 5.2. Vertical Administrative Shift

As described by Table 3 in Section 5.1, the paragraphs, *flood prevention and rainfall*, in master plans *discharge*, concentrate on proposing hydrological visions in the face of the reoccurrence of floods, which were later portrayed as vital lines marked as hydrological infrastructure with locations and flood control standards (Figure 6). Such a literal elaboration was also followed in the district regulatory plan. One typical example is the *Regulatory Plan for Haizhu Ecocity*. It is a follow-up of a hydraulic project *Haizhu Lake Construction*, which began in the late 2000s when Guangzhou city invested large amounts of money to improve public facilities and the environment to upgrade the city for the 2010 Asian Games. The hydraulic project was branded with reputable nature-based solutions to address pluvial and fluvial floods in flood risk management. Led by the municipal Water Affairs Bureau in the hydrological design and construction process, this project turned the originally reserved natural areas, filled with wetlands, fish ponds, and farmlands, into an artificial lake; since then, it has worked as a buffer zone to collect excessive rainfall from the whole district (Haizhu), and, by this, postponing the peaks of runoffs into rainwater drainage systems [46].

The success of this project won itself the reputation as the green lung of Guangzhou and later brought the opportunity for this district to brand itself as a pioneer in ecological development. Consequently, a bigger ecocity program, the *Regulatory Plan for Haizhu Ecocity*, was formulated in the field of spatial planning. It covered 52 km<sup>2</sup>, 57.5% of the Haizhu district [47]. Under this new framing, a new ecocity was advertised for its friendly environment, as well as convenient facilitators for outdoor leisure, favorable waterfront living, business, and exhibitions. Moreover, Haizhu lake was branded



as a significant section of green–blue infrastructure dealing with flood affairs in the *Regulatory Plan* together with adjacent orchards, wetlands, waterways, and open canals (Figure 7).



**Figure 7.** Measures to reduce the flood risk and increase the safety in Regulatory Plan for Haizhu Ecocity, based on Regulatory Plan for Haizhu Ecocity [47].

As with flood concerns, the *Regulatory Plan* (Figure 7) first classified crucial hydrological infrastructure on account of different levels of flood exposure, such as riverside banks, first-class canals, and general canals, and identified the locations of supporting facilities, such as water gates and pumps. Based on this, regulatory requirements in relation to improvement measures and new constructions were proposed, for instance:

- Reinforcing the first class (primary) canals, restricting the occupation of canals, and offering 10-meter-wide buffering zones along the control lines (if possible);
- Dredging canals with a flatbed to avoid sediment deposition and degrading discharge capacities;
- Uncovering covered canals or building new canals to connect end-breaking branches to avoid dead waters;
- Improving the ability of canal management, specifically, with two new canal gates to be constructed and seven outdated canal gates updated along the major branches;
- Constructing three new pumps at the most vulnerable locations to drainage flows and rainfall in the case of emergency.

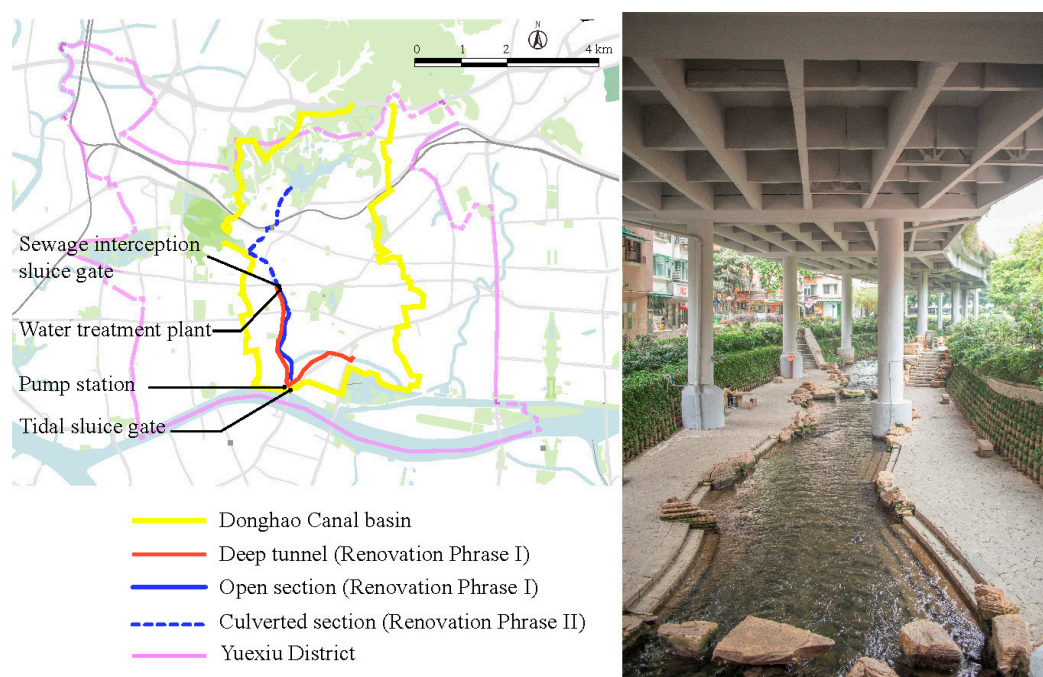
Notably, despite a rich elaboration on how to deal with flood risk in such a spatial regulatory plan, economic development and investment attraction were still the main focus. Flood concerns were merely discussed as a subordinated topic in the name of the *Water System Scheme*. Further, planning still lacked strong tools for practical operation. The various proposed measures share a common standing-point: the operational areas were mainly limited within water bodies in addition to water conservancy or affair facilities such as pumps. In the Chinese context, these areas are bordered or framed by the so-called blue lines in the statutory system; and the major responsibilities to handle flood affairs relating to blue lines belong to the water conservancy (and affairs) system in legislation (the portrait of these boards relies on the water conservancy (and affairs) system's discretion with reference

to spatial planning's arrangement (not a determinant factor)). As a result, spatial planners own limited capacities to directly affect those blue lines boarded areas once the borders have been drawn while retreating their planning activities behind blue lines. From this perspective, planners in the old context actually lacked efficient tools to work on flood resilience, yet gave more attention to making use of additional merits of water conservancy projects such as ecological or environmental enhancement. Flood concerns were left to hydrological engineers in the water conservancy (and affairs) system.

A similar subordinated position was also observed in another project-based development in Yuexiu District, *Renovation of Donghao Canal* (Figure 8). This project, significantly, represented a different stream of local efforts to deal with urban floods and was famous for utilizing engineering-based solutions 'disguised' as nature-based solutions. In the early 2000s, the tributary residential areas experienced flooded sewers in rainy seasons because of the poor capacity of Donghao canal and the conjoint sewage-drainage pipe systems (which can withstand rainfalls with recurrence periods of 3 years and less than 1 year, respectively) [48]. In addition, this project was also a regeneration practice to improve the polluted water environment in the center. Due to the polluted water released by upstream factories, the canal was then heavily spoiled. To reduce flood hazards and improve the degraded environment, the *Renovation* project was launched around 2010, including dredging and landscaping the canal, constructing a new deep tunnel to collect rainwater in rainy seasons, separating sewage and drainage pipe systems in nearby communities, and improving affiliated water facilities, such as a water treatment plant, a pumping station, and several sluice gates [49].

This project was led by the Water Affairs Bureau with support of numerous hydrological and engineering institutions, for instance, Guangzhou Municipal Engineering Design and Research Institute. An interview from this agent showed us the skeleton of this project (interviewee 1, see the interviews' logbook in the Appendix A):

'It was regarded as a hydrological project. Even though planning system was involved partly in practice, it was more like assistance, adjusting the land use in a limited way, for instance, changing the residential function to green space or setting a piece of land for a water treatment plant. Even though it was a project in the old city centre, removal of the built environment and water affairs were not the planners' job.'



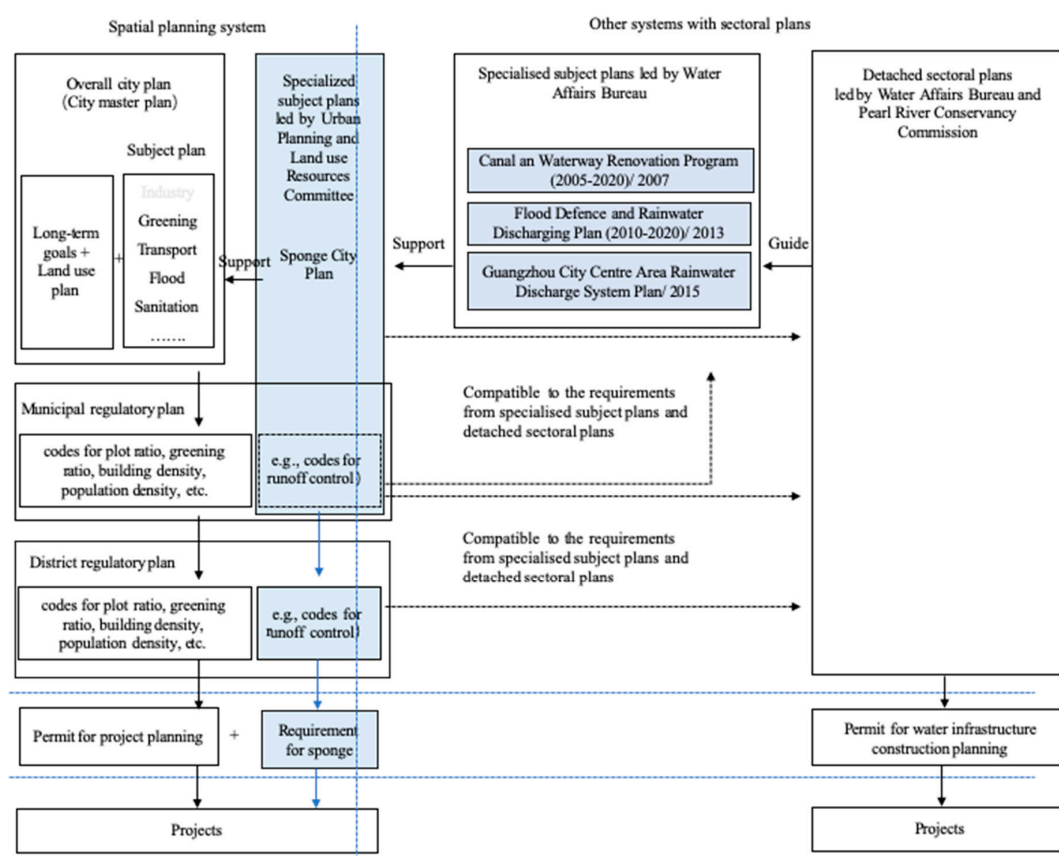
**Figure 8.** The Donghao Canal (I phase). The map is portrayed based on Basic Survey Map of the DongHaoChong Basin [49] and the photo was taken by the authors.



## 6. New Pathways Introduced by the Sponge City Plan: Detached Specialised Subject Plan Focus on Flood Affairs

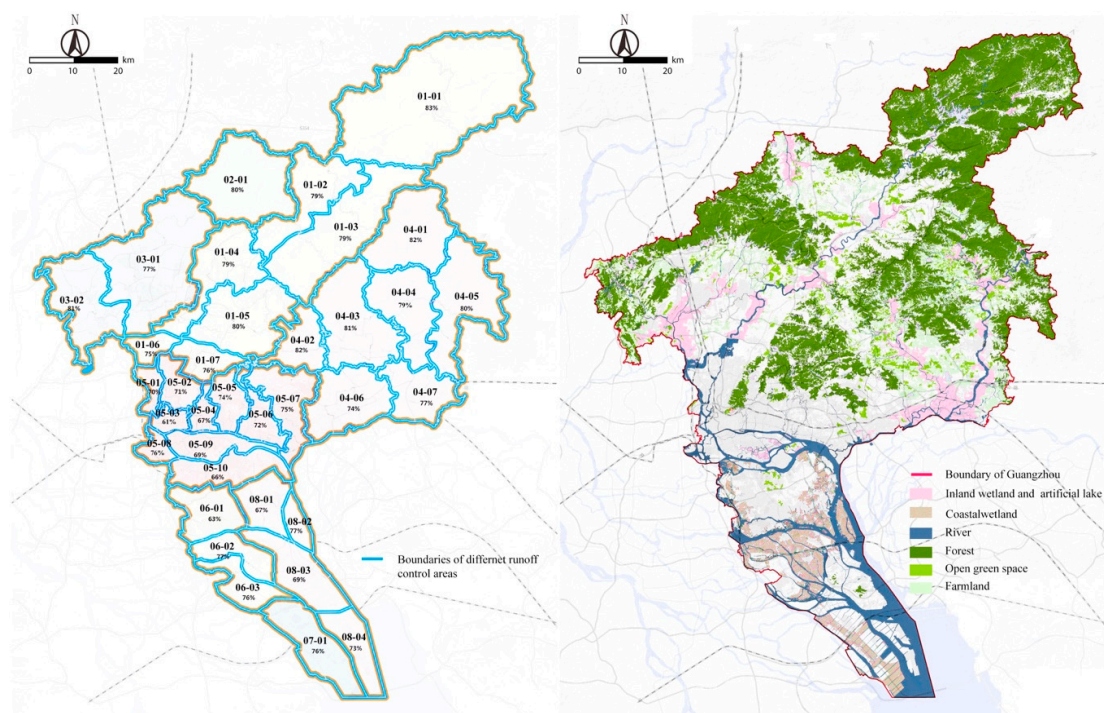
### 6.1. The Horizontal Position of Spatial Planning in a Macro Policy Environment

The preparation and enactment of the Sponge City Plan have brought with them novelties to the macro policy environment and changes in the traditional spatial planning system. As Figure 9 indicates, the boundary between planning and the water conservancy (and affairs) system has been more penetrating, although the overall macro environment still remains stable. ‘Sitting on the fence’, the *Guangzhou Sponge City Plan* triggered the spanning of this boundary. As with the degree of participation of different agents, this document is regarded as a spatial planning policy. The Land Resources and Urban Planning Committee (LRUPC, municipal planning authority) led the plan-making and announced the finalized document, and Guangzhou Urban Planning Design and Survey Research Institute (a planning institution subordinated to LRUPC) worked on the compiling process. Yet, this document was officially named as a specialized subject plan in legislation, supporting the relevant flood discourse in master plans, meaning that it could be attributed to either planning or the water conservancy (and affairs) system because both sides have such a tool (Figures 1 and 2). More convincing evidence was that this document strongly relied on the contribution from the Water Affairs Bureau (WAB, municipal water-affair authority) and Guangzhou Water Affairs Investigation, Planning and Research Institute (subordinated to WAB), acting as two leading sectors, actively involved in the formulation of the Sponge City Plan. The contents were also based on the established specialized subject plans on flood safety (interview 2 and 3) [26]. Thus, the final output, the *Sponge City Plan*, was a product of joint efforts.



**Figure 9.** Macro policy environment of Guangzhou in the preparation and launch of the Sponge City Plan in 2017. Note: vertical blue dashed line indicates the boundary between spatial planning system and water conservancy (and affairs) system.

Such a co-ordination process has led to a change of spatial planning responsibilities: managing flood issues in dry territories, lands beyond the areas scoped by *Blue lines*, in contrast to the previous orthodox approach of retreating from wet territories and leaving flood issues to hydrological engineers. Innovative measures such as codes for run-off controls have been added to the established regulatory system to control the percentages of permeable and impermeable lands in every plot in urban–rural development (see Figure 10-1, which will be further discussed in Section 6.2). These measures are supposed to be written in permits as a way to control construction projects.



**Figure 10.** Major innovative measures for flood resilience in Guangzhou Sponge City Plan, based on Guangzhou Sponge City Plan 2010–2030 [50]. 1. (left): runoff control regulatory codes (the values presented in the map equal 1 minus the runoff coefficient); 2. (right): optimizing green–blue networks.

## 6.2. Vertical Administrative Shift

In contrast to a minor discussion in the mentioned master plans, the discourse of the Sponge City Plan created a comprehensive approach to managing flood affairs in urban development. It consisted of long-term objectives, strategic visions, and the spatial layout of infrastructure at the municipal level, which are the normal features determined by a master plan, as well as a series of regulatory requirements (see below), which incorporated flood concerns in spatial planning as a mandatory element.

In this document, five strategic visions have been proposed to incorporate flood affairs into urban development agendas, namely, flood safety, ecological quality, water purification, freshwater supply, and water recreation (Table 4). In terms of flood resilience and climate adaptation, measures in safety and ecological concerns are more attached to our focus. The flood safety vision tried to build, whether intentionally or unintentionally, a comprehensive flood-resilience framework to raise the defense, drainage, and detention capacities by improving the current engineering infrastructure and implanting micro green spaces in paved areas (Table 4). In addition, the measures relating to the ecological quality vision highlighted the role of large-scale green–blue infrastructure in flood resilience, which are regarded as the city’s ‘blood vessels’ and are supposed to deal with floods with a 10-year reoccurrence

period, in comparison to microgreen spaces, such as rainfall gardens, supposed to handle floods every 1 to 2 years.

**Table 4.** Mainstreaming flood mitigation into local agendas in Guangzhou, based on Guangzhou Sponge City Plan 2010–2030 [50].

Strategic Visions	Options/Measures
Flood safety	Reinforcing and upgrading the engineering infrastructures such as dykes, pumps, river banks and the drainage system; enhancing the permeability of the over-urbanized areas by increasing micro green spaces (based on low-impact development)
Ecological quality	Optimizing crucial natural green-blue networks, including mountains, forests, farmland, wetland, lake, open waterways.
Water purification	Purifying the polluted water, including making use of water treatment industries and eco-purification systems
Freshwater supplement	Improving water supplement and water recycling system
Water recreation	Reconstructing the connection between water and citizens by facilitating the access to waterfronts and arranging waterfront recreation

Significantly, the emphasis on nature-based measures brought with it two innovative requirements for planning (which directly affect how the Sponge City Plan was interpreted at the district level in terms of flood resolving, for instance, the Tianhe case (Figure 11)). They were: the principles of optimizing municipal or branches of regional green–blue infrastructure, like forests, wetlands, ecological corridors, rivers, (Figure 10-2); and the regulatory controls of the amount of runoff discharged into pipe systems (Figure 10-1).

The principles of optimizing green–blue flood resilience infrastructure included (Figure 10-2):

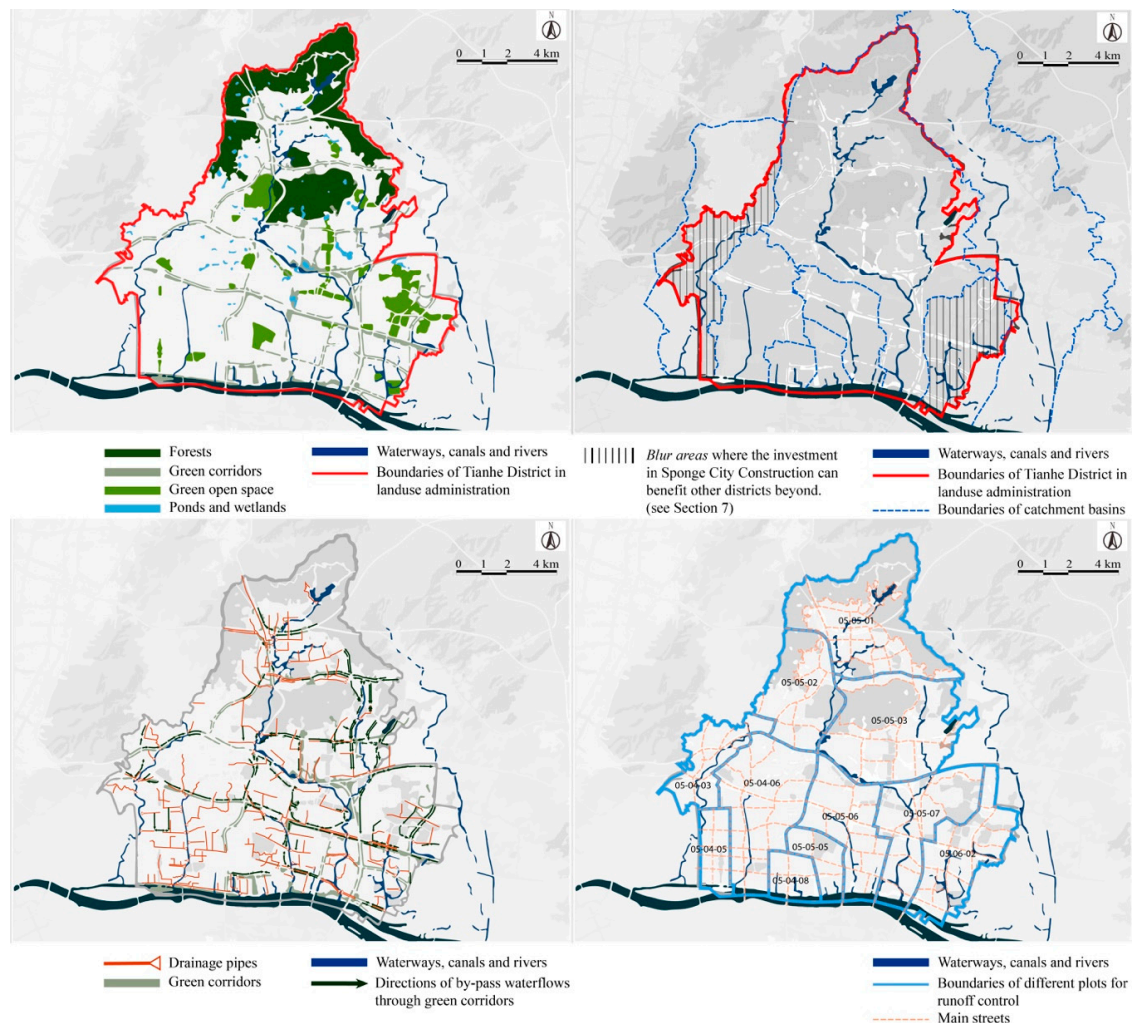
- Projects should be terminated if they occupy current wetlands or areas also with historical wetlands;
- Upstream forests should be strictly protected with a function of reducing runoff and storing rainwater;
- Built impermeable areas, difficult to be changed, should seek for future opportunities to be adjusted by embedding green–blue networks;
- Paddy fields should be strictly protected;
- Reservoirs, natural lakes, and ponds should be strictly protected;
- Blue corridors should be strictly protected.

The runoff control regulatory codes were used to regulate the permeability and impermeability of every piece of land under the dual pressures from economic development and flood hazards (Figure 10-1). It is an index based on a hydrological notion, the runoff coefficient, widely used in low-impact development techniques, relating the amount of runoff to the amount of precipitation received, and determined by roughness and permeability of ground surface [51]. For example, the runoff coefficient of parks and cemeteries, characterized by grasslands and trees, is generally around 0.1 to 0.25 [52]; this means 10% to 25% flows into the water discharge system while 75% to 90% of precipitation is supposed to be retained. By contrast, brick pavement has a high runoff coefficient (0.7 to 0.85) on account of a weak capacity for water infiltration. As a result, a large proportion of 70% to 85% of precipitation will enter into urban drainage systems. The value of a runoff control code is equal to the difference between 100% and the value of the runoff coefficient.

Figure 10-1 shows a set of runoff control regulatory codes relating to catchment basins. The term catchment basin is a hydrologic term, interchangeable with catchment area, river basin, drainage area, and drainage basin. In a closed catchment basin, all waters converge at a single point in this basin, with no visible outlets and a channel to a permanent lake, dry lake, or a stream [53]. Different basins are separated topographically from adjacent basins by a watershed or ridgeline in the form of hills,



mountains, or a ridge. In Figure 10-1, the boundary of a catchment basin identifies the plots of land in Guangzhou overall.



**Figure 11.** Major innovative measures for flood resilience in the Sponge City Plan for Tianhe District, based on the Sponge City Plan for Tianhe District [54]. 1. left-top: optimizing green-blue networks; 2. right-top: portraying catchment sub-basin boundaries; 3. left-bottom: organizing the excessive water flows; 4. right-bottom: setting floating regulatory codes.

The proposed runoff control codes were decided according to the current precipitation and infiltration, and the potentiality in improvement to avoid over-paving. A looser goal was set for the areas with intensive paving, difficult to be altered, while a tougher goal was set for new lands, easy to be altered. For instance, the goal for plot 05-03 in the old city center, part of Yuexiu District, was 0.49 (Figure 10-1), meaning 51% runoff was allowed to be discharged into the drainage system [50]. By comparison, a stricter goal was set for the plot 05-05, part of Tianhe District, an urbanizing area with abundant undeveloped areas; only 26% precipitation is allowed to be discharged into the drainage system and 74% should be stored by the sponge infrastructure (Figure 10-1) [50]. These quantitative indicators were translated into text as orders to achieve the corresponding targets in districts.

Tianhe district, as a pioneer in realising the Guangzhou Sponge City Plan, interprets how to implement the municipal calls at the district level. It is one of eleven districts in Guangzhou, which has a permanent population of 1.698 million (by 2017) and an area of 137.38 km<sup>2</sup> [55]. As a specialized subject plan and also a regulatory plan for the district, the newly published planning document *Sponge City*

*Plan for Tianhe District (2018)* followed the municipal *Guangzhou Sponge City Plan's* agenda-setting and also explained water problems, such as flood safety, ecological quality, water purification, freshwater supplement and water recreation. Under the framework of flood safety and ecological quality, four innovative regulations were proposed for flood resilience to supplement traditional engineering infrastructure, including optimizing green–blue networks, portraying catchment basin boundaries, organizing excessive water flows, and setting floating regulatory codes (Figure 11).

In the proposal of optimizing green–blue networks (Figure 11-1), six categorizing land-use covers were highlighted: forests and mountains, green patches, green corridors, hollows and ponds, canals and open waterways, and district-cross river branches. These nature-based networks were supposed to be preserved and/or improved to store rainwater in the source, reduce runoff in the passage, and increase defense capacity at the end, with an additional benefit for ecological restoration.

The map of catchment sub-basins followed a similar rule of basins at the municipal level but in a more refined way (Figure 11-2). The municipal catchment basins were divided into smaller sub-basins, within each of which the streams and rainfalls drained to a single outlet. These outlets then drained waters to a common stream, the Pearl River flowing along the Tianhe District, at a lower elevation. The catchment basin map created a basis for the following two maps: excessive water flow organization and runoff control.

In the organization of excessive water flow, great attention was paid to improve the drain capacity of canals and open water systems in every sub-basin. The major canals, seven in total, were planned to be the main channels to discharge waters in sub-basins; in addition, hierarchical green corridors and underground pipes were projected to support the channels given the directions of water flows caused by gravitational force and geographic elevation (Figure 11-3). This proposal was supposed to be accompanied by canal dredge, canal reinforcement, rainfall street construction, and drainage system improvement.

The setting of district regulatory runoff control codes (Figure 11-4) was based on the maps of catchment sub-basins boundaries (Figure 11-2) and municipal runoff control regulatory codes (Figure 10-1). Initially, the boundaries of sub-basins were redrawn to follow the axis of streets so that the water affairs' administration corresponds to land-use administration in the spatial layout. This makes it easier for planning authorities to manage and monitor the implementation in their own fields. Secondly, the fixed runoff control regulatory codes (Figure 10-1) set by the municipal *Sponge City Plan* were dissolved and replaced by a series of floating runoff requirements in the district sponge plan. For example, area 05-04-08 (Figure 11-4) was bonded with a floating code from 68% to 73%. The virtue is that the floating codes create a sort of flexibility for the practices in the face of an uncertain future. Such a flexible concern was also reflected in a series of following action items for area 05-04-08, which claimed that, to realize the runoff control goal, the permeable paving surfaces should be more than 22% of all paving surfaces and green roofs more than 19% of all roofs.

## 7. Discussion

In summary, the traditional planning system has been reshaped in the wake of the Sponge City Plan. The experience in Guangzhou city and Tianhe District presents evidence of creating new planning tools to use strategic visions, principles, and concrete regulations to address the flood risk. The transition is realized by a process named 'layering', whereby new plans are created alongside an established system for an institutional change, rather than a dramatic reform in the existing system [56,57]. Specialized subject plans play an important role in this process. They act as a carrier for discussing flood affairs, complementing and specifying the general description of these issues in spatial planning. The change is operated based on a pre-condition that, in the Chinese context, both the spatial planning system and water conservancy (and affairs) planning system regard specialized subject plans as significant operational documents (see Figures 1 and 2). Those plans are a connector that creates an opportunity for planning to step outside its original realm, concentrating on economic development, and step into the flood governance realm, cooperating with other agencies.

As a result, flood concerns are incorporated in the urban development agenda in a formal, legal, and mandatory way in dry territories, which is in contrast to traditional planning relying on soft hydrological visions and vague operational tools for planners, while practically leaving water affairs to engineers. This new way of planning is supposed to affect all practical implementation, since those regulatory requirements will be written in permits to constrain all project construction. This workflow corresponds to the Chinese planning system in which regulatory plans are used to interpret the ambitions of master plans and impose strict rules on projects.

In spite of these promising changes, the popularity of the innovations might not be as smooth as expected. There are still two challenges. The first is the direct impacts on planners working on flood resilience from the macro policy environment. While the Sponge City Plan set a good example for agents from the spatial planning and water conservancy (and affairs) planning system to work jointly, it is notable that the positions of the actors in the plan-making process are slightly different. As two interviewees (2 and 4) from the Guangzhou Urban Planning Design and Survey Research Institute indicated:

‘We offer the basic information in the plan-making process, for instance, land use, spatial layouts of infrastructure, population. However, they are not very relevant to flooding datasets. In addition, we have no idea how to calculate the runoff coefficient . . . From this point of view, we are outsiders.’

The involvement of an external mediator has resolved this problem to some extent. Turenscape Planning and Design Co., a private planning company, with knowledge of both spatial planning and hydrology, worked as a key actor for Guangzhou’s Sponge City Plan and was heavily involved in the process. An interview (interviewee 5) from Turenscape offered more details of plan-making:

‘Water Affairs Investigation, Planning and Research Institute provided us with rich hydrological information based on their past experience, which is significant for us to make the assessment of flood risk and calculate the runoff.’

This indicates two bottlenecks of the joint work in the Sponge City Plan: limited access to hydrological data collection and the weak ability to assess and simulate floods among spatial planners. These barriers partly explain ‘a lag in promoting the Sponge City Plan vertically in every district in Guangzhou’, as interviewee 6 indicated. Remarkably, Tianhe District does not show this lag because the involvement of the previously mentioned Turenscape in the district plan-making process. However, this is not always the case. Another interview in early 2019 from Nansha District government in Guangzhou gave a similar description (interviewee 6 and 7):

‘Not all districts are prepared to make their own district sponge plan. For Nansha District, the formulation is not straight forward. Due to the limited knowledge of hydrology, we could not manage it. Thus, the plan is handed over to the district Water Affairs Bureau for a solution.’

This study, thus, tends to assume that flood risk assessment is now beyond the responsibility of spatial planners in the Sponge City Plan context and is very likely to remain so in the future. This assumption can be confirmed in future research.

Another underlying problem is a governance issue, which relates to the conflict between administrative boundaries and hydrologic catchment basin boundaries in realizing sponge city ambitions. A new way of managing land use organized by catchment basin boundaries emerges at the municipal and district levels: within every catchment basin boundary, water naturally flows downwards and accumulates at one point (the lowest point) according to topographic features. However, the hydrologic boundaries are often different from the traditional land administration boundaries which are drawn by man-made street-building blocks, leading to mismatches. Consequently, areas belong to different administration jurisdictions share one catchment basin (see for example the dashed western edge of Tianhe District on Figure 11-2).

This mismatch can cause trouble for lowlands. Infrastructure in a lower area in one district administratively requires greater investment for protection from the flooding stress created by another district at a higher elevation. This unfair condition may undermine the motivation for the actors in the low-lying areas (*blur areas*) to invest in resilience projects, which may bring benefit to another



district. Thus, an agreement between districts is needed, calling for a comprehensive agencies' conversation across vertical and horizontal boundaries. The means to achieve this agreement call for further investigation.

## 8. Conclusions

As mentioned in the introduction, planning research and planning practice struggle to turn policy ambitions (within resilience and adaptation discourse) into concrete implementation. Previous studies concluded by highlighting the significance of channels for planning to step into the flood affairs domain and the need for enforcement in order to promote planning for flood resilience (e.g., Waylen et al., 2018). This study responds to these arguments by demonstrating that specific planning procedures and types of plans are vital for promoting planning's involvement with flood affairs and making a difference. The first contribution of this paper is that it shows how the spatial planning system and water conservancy (and affairs) planning system are organized separately and where specifically they interact. Previous studies merely indicated that this separation is a problem without defining clearly how and why it occurs. By showing this, the paper helps us understand the position of planning in the macro policy environment and the capacities of planning actors to engage in potential interactions with other agencies. The second novel contribution of the paper is the analytical framework, based on Hurlimann and March's work (2012), used to analyze the role of different types of plans in promoting the implementation of top-down policies to adapt to climate change. Since the study did not fully cover the roles of planning tools, there is scope for a further exploration of how planning tools affect (if at all) the distribution of financial resources for flood mitigation. Future research could also consider whether and how the existing planning tools create the scope for engaging the public in this process.

Our research findings indicate that, with the Sponge City Plan, the macro policy environment is changing towards more openness for working across sectoral boundaries to address floods, which broadens the planning role from merely echoing the wording from the hydrological documents towards operationalization of measures to mitigate flooding by combining long-term strategic visions, soft principles, and strict regulations. Sponge city-related specialized subject plans catalyze this transition, by spanning the boundary between planners and hydrologic engineers, and allowing a simultaneous coordination of land use and flood affairs.

In addition, these sponge city subject plans thus play an important role in shifting the planning practice at the municipal and district levels with a compelling force. The municipal-level long-term goals, guiding principles, and strict codes are followed and scripted at the district-level, and finally written into regulatory permits with statutory force in the established planning system. This is different from past planning practices, which were dependent on vague and soft planning discourse, making vertical cross-level coordination difficult.

However, a shift from traditional planning to these new pathways relies on the knowledge of planners. A lack of hydrological experience pushes planners to stick to their previous ways of doing things. This phenomenon is also reflected in Guangzhou where, even though an overall sponge plan has been launched, with a pilot application in the Tianhe District, the wider implementation across the city at the district level is still in progress and faces difficulties. Future research could shed more light on this process.

This paper also offers a new perspective by highlighting the importance of the multi-level structures of the planning system and water conservancy (and affairs) planning system in the Chinese context. It shows, for the first time, how these two policy systems interact with each other at the municipal and district levels for flood resilience, using Guangzhou as an example.

While the above findings may be context-specific, the results offer lessons for changing the flood governance in other coastal cities in China and elsewhere. Our findings show that the success of an approach to strengthen planning status and promote cooperation between policy sectors by changing macro-policy procedures, such as the one used in Guangzhou, depends on fostering a common language between spatial planning and water management institutions. In Guangzhou's case, this was

facilitated by the specialized subject plans that are shared by both sectors. In other contexts, however, the features of the planning system may call for using other kinds of planning tools to enable this. Therefore, identifying such cross-sectoral connectors in the planning system (or introducing new ones, similar to the specialized subject plans in the Chinese context) is both a general recommendation for urban practitioners and an area for further research focusing on case studies from other countries. The second lesson from the case of Guangzhou is that the success of coordination across levels of government relies on the presence of a set of clear and specific tools and indicators for translating national policy goals into local plans and policies. Both of these lessons are helpful in responding to the flood governance challenges observed in other cities across the world [8–10]. The potential challenges concerning the capacity of planners to tackle flood issues and governance conflicts, such as those mismatches concerning administrative and water basin boundaries portrayed in this paper, require great attention. Such challenges are likely to arise in other cities or areas undergoing rapid changes in planning procedures and planning tools in the face of climate change and growing flood risk. In addition, the methods and theories used in this paper could be applied in other coastal or delta cities to assist understanding of the macro policy environment of flood governance, and the tools used by a planning system to actively embrace flood resilience.

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## Appendix A

**Table A1.** Interviews' logbook (2016–2019) \*.

Code	Date	Interviewees
1	Nov. 30 2016	Senior Engineer, involved in the Donghao Canal Renovation Project, Guangzhou Municipal Engineering Design and Research Institute
2	Nov. 24 2016	Senior Planner, involved in the compiling of Guangzhou Sponge City Plan, Guangzhou Urban Planning Design and Survey Research Institute
3	Dec. 8 2017	Senior Engineer, involved in the compiling of Guangzhou Sponge City Plan, Guangzhou Water Affairs Investigation, Planning and Research Institute
4	Nov. 29 2016	Senior Planner, involved in the compiling of Guangzhou Sponge City Plan, Guangzhou Urban Planning Design and Survey Research Institute
5	June 23 2017	Senior Planner, involved in the compiling of Guangzhou Sponge City Plan and Sponge City Plan for Tianhe District, Turenscape Planning and Design Company
6	Apr. 4 2019	Senior Planner, Nansha District Spatial Planning Research Centre (Governmental Sector), Guangzhou
7	Apr. 4 2019	Senior Official, Nansha District Construction Bureau, Guangzhou

\* Semi-structured face-to-face interviews.

**Table A2.** List of questions covered in the semi-structure interviews relating to the study.

No.	Questions
1	How has Guangzhou historically dealt with the flood risk? Any representative examples?
2	What was (or is) the role of planning in the flood governance? Were (or are) they the leaders in dealing with flood risk in practice? Any examples? Especially, in the recent Sponge City Plan?
3	How did (or do) planning authorities deal with the divergences from the engineers from water conservancy (and affairs) planning system? Examples? Especially, in the recent Sponge City Plan?
4	How could you evaluate the promotion and implementation of Sponge City Plan?

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