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Institutional Actions, Opportunities and Challenges

Meng, M.

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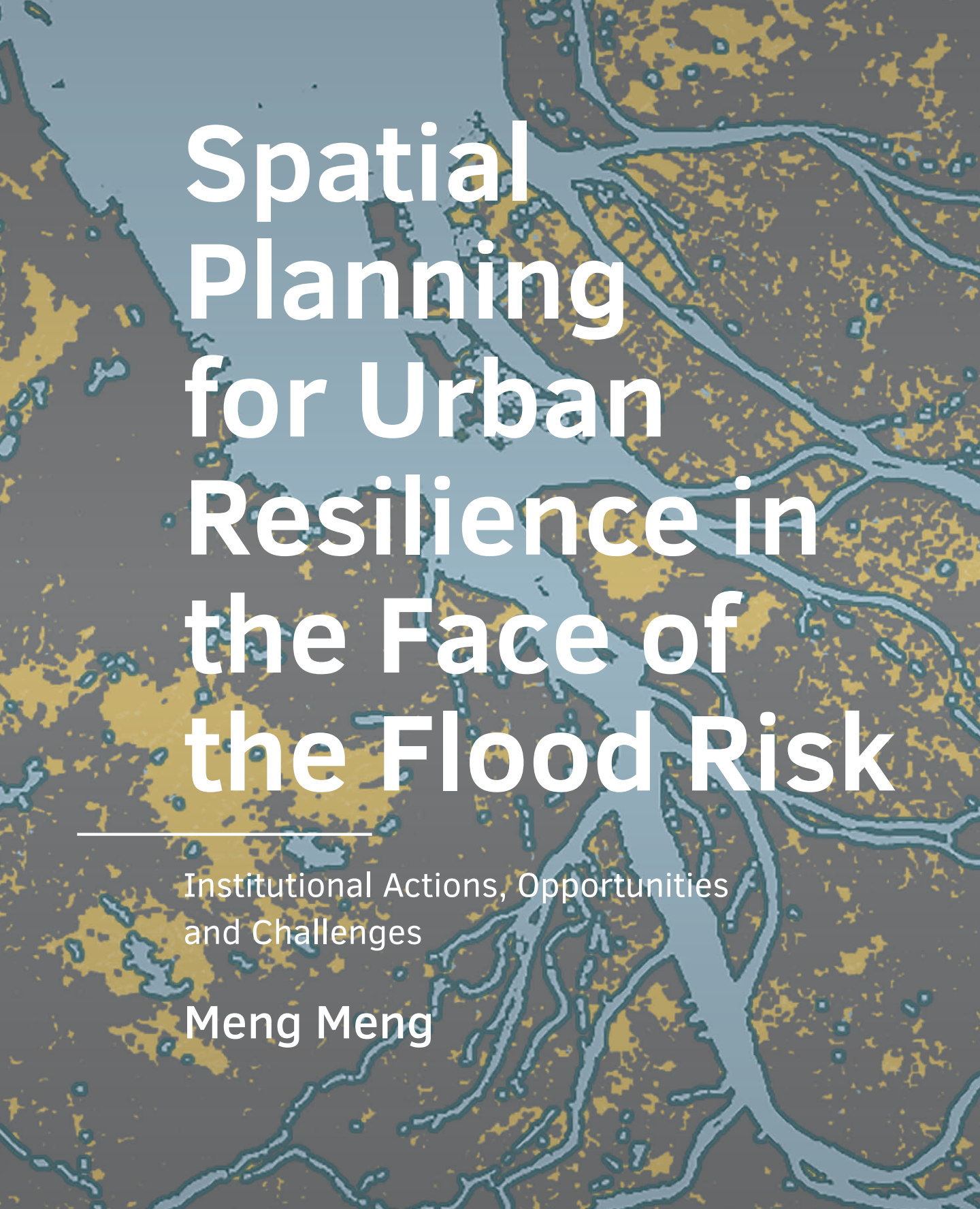
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Spatial Planning for Urban Resilience in the Face of the Flood Risk

Institutional Actions, Opportunities and Challenges

Dissertation

for the purpose of obtaining the degree of doctor
at Delft University of Technology
by the authority of the Rector Magnificus, prof.dr.ir. T.H.J.J. van der Hagen
chair of the Board for Doctorates
to be defended publicly on
Monday, 8 March 2021 at 10:00 o'clock

by

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Master of Engineering in Landscape Architecture
Southeast University, China
born in Anhui, China

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This dissertation has been approved by the promotors.

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Dr. L. Yu,	Cardiff University
Prof. dr. W.M. de Jong	Erasmus University

This study was financed by the China Scholarship Council and my family.

To my family

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Preface

In my undergraduate studies, I was trained as an innovative landscape designer with an interdisciplinary education in landscape design, urban planning and architecture. My continuous study in postgraduate education followed this route until I came across a water-sensitive planning project in which the innovative design process retreated from the scientific hydrologic analysis and the synergy between safety, land use and economic prosperity. It drew my interest to flood resilience and the underlying mechanisms and factors affecting design processes in relation to this topic. Since 2015, I have developed a series of studies in China through the lens of policy science and institutional science. My findings support practices of planning and water management systems (groups of people) in working on the flood agenda and the improvement of these two systems. I have found that they come under the influence of standardised and traditional processes on account of institutional inertia, knowledge borrowing, policy framing, co-governance procedure, the organisational setting, financial allocation and collective understanding.

The exploration of policy science and institutional science aspects of planning systems is a welcome topic in the field of spatial/urban planning studies, but it is subject to resistance from others. In the planning education systems in the UK, US and Netherlands, the attention to policy research and institutional research is well established. However, not all places pay sufficient attention to this field. For many practitioners, planning is still dominantly regarded as a physical design process or tool. This divergence is interesting and inspires the starting point of my PhD story.

My PhD is an endeavour to show that the planning process can benefit from social science-based studies. It is the journey of a 24/7 five-year struggle to show that planning is a governance approach, and that urban planners and designers cannot escape the influences of policies, regulations, legal rules, resource allocation, and institutional inertia. A better understanding of these under-estimated influences can help spatial planners, designers, strategists and also policymakers understand the dynamics and transformations of cities and regions better. They will be well prepared to touch the topics and fields in planning practice that are beyond their expertise.

Debates can be expected. The research in this thesis relies on a series of qualitative methods which is necessary to understand the motivations of many actors. In addition, the promotion of flood resilience in the domain of spatial planning

necessitates the integration of land use planning, environmental analytics, socio-economic calculation and institutional science, rather than a narrow concentration on one aspect. This contention of the need for multiple approaches applies also in other environment-related topics in planning research and practice such as health, pollution and drought. In my view, the lack of one or more of these aspects is often a serious gap in planning education. It is for all young researchers to make their contribution in the future.

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Although I am a researcher focusing on urban resilience (reacting to external shocks), I never expected my last stages of PhD would be hit by coronavirus, lock-down and quarantine. They have caused a lot of troubles for me, for instance, delays in preparing for my final defence and searching for jobs in the market. Fortunately, I have completed with the support of my family, teachers, colleagues and friends. I know in my heart that I could not achieve my standing without you all.

This work is dedicated to my beloved father for his emphasis on learning, writing and pursuing high educational achievements in the past 32 years. He is a strong but shy man who doesn't say too much to me. We did not talk too much; neither do we now. But I can feel his deep love and care with his texted messages and telephone calls, especially during my PhD study abroad, when he cannot get in touch with me easily.

This work is dedicated to my beloved mother, for her unconditional love, for all her sacrifices, for all courage that she gave to me, for all her acknowledgements of my achievements from the very first day of my life, for her unconditional faith in me whenever I failed, for 32 years of support allowing me to do what I love.

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Doing fieldwork in Guangzhou was heavy work. I am grateful to all of the interviewees, colleagues and friends who helped me with data collection. My sincere gratitude goes to Lequn Cheng (House and Urban-rural Construction Commission), Xi Teng (Guangzhou Urban Planning Design & Survey Research Institute), Binbin Wang (Urban Planning Research Centre, Nansha), Guangsi Lin (South China University of Technology), Juanyu Wu (South China University of Technology), Xiaomei Pang (South China University of Technology), and other interviewees that are not mentioned here because of secrecy.

Hearty thanks are given to my lovely friends with whom I go through the tough experience in PhD study. To Cinco Yu, you are the person who discusses with me about Taiwan's history and shares with me your open-minded attitude to career and life. Many thanks to Juan Yan, Mei Liu, Riming Wang, Hao Yu, Yunlong Guo, Langzi Chang, Biyue Wang, Haiyan Lu, Sitong Luo, Li Lv, Taozhi Zhuang, Wenting Ma, Wei Dai, Ding Yang, Wang Pan, Xiao Guo, Dan Cheng, Weixiao Gao, Hai Gong, Jinjin, Xin Du, Xun Sun, Shuai Guo, Shile Zhou, Yingying Gan, together with me doing their PhDs in the Netherlands.

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Summary

This thesis is about how the difficulties of planning for flood resilience and climate adaptation can be overcome by creating favourable institutional conditions for the preparation and implementation of spatial strategies and plans. The research was inspired by the increasing impacts of extreme weather events and changing climate patterns on flood-prone regions and cities. Human settlements in these areas are becoming more vulnerable and more frequently affected by flood damage. Global efforts by a wide range of climate analysts, economists, social scientists, politicians, hydrological engineers, spatial planners, and others have made cities more aware of the importance of developing more resilient strategies and plans for urban development. However, it is only partially clear how to deliver their ambitions effectively. The complexity of institutions is a key factor that is often under-estimated by planners, and which needs further investigation. The main question for the research is: what institutional arrangements determine spatial planning's role in managing flood risk, and how?

I have designed the research based on the Chinese context. In the early 2010s, Chinese planning officials started to recognise the urgency of flood problems in an urban context. To address the issue, the National Sponge City Programme was initiated. The programme promotes the incorporation of flood risk management into spatial planning and alters the way that planning manages urban development towards more nature-based solutions and land use regulations. Either intentionally or unintentionally, this programme caused a series of changes and controversies in the policymaking process at different governmental levels.

Against this background, the thesis investigates how spatial planning plays a role in dealing with flood risk, both before and during the implementation of the Sponge City programme. It considers the changes and controversies in the transition from the old to the new context. I chose Guangzhou as a case for a detailed exploration. It is one of the most vulnerable cities to flooding in the world and has one of the earliest modernised planning systems in China. The investigations are carried out drawing on four starting points concerning institutions that affect planning and flood governance. They include:

1. the long-established traditional ways of working in planning, shifting from engineering-based solutions to nature-based solutions and land use regulations;
2. the way of managing vertical and horizontal coordination in decision-making;
3. the way of framing policy in terms of problem setting, action scripts and governance arrangements; and
4. the contextual factors shaping the starting conditions for planning in flood governance, such as organisational structures, rules of the game, resource allocation, and agents' embedded perspectives (worldviews).

A review of the literature based on European and American experience is conducted in Chapter 2. It clarifies the state of the art of flood resilience, disaster mitigation and climate adaptation in academia and practice. Four categories are identified: environmental concerns, disaster management, socio-economic and institutional (or governance) concerns. However, not all these matters have received much attention in the field of spatial planning. More attention in planning is needed to institutional concerns, including topics such as public policies, regulations, multi-level governance, multi-actor cooperation, actors with divergent interests, public and private participation, powers, leadership, and political will.

Chapter 3 takes forward questions about institutional conditions in the case of Guangzhou. It presents a conceptual framework, the collected data and the analytical methods for detailed investigation. Multiple sources from policy science, social science and institutional studies have been used to build the conceptual framework in terms of historical institutionalism, planning performance (procedures and tools), policy framing, and collaborative governance. Official policy documents, grey literature, open access geo-information and interview scripts are used for further exploration. Documentary text analysis, geo-informed spatial analysis, semi-structured stakeholder analysis and threats, opportunities, weaknesses and strengths (TOWS) analysis are used to apply these theories to the case.

Chapter 4 employs the theory of historical institutionalism to explore the planning traditions (routines) that have been established in Guangzhou, and how these traditions hinder or facilitate planning's contribution to flood resilience. The exploration dates from the 1920s to the early 2010s. Building on documentary analysis, (GIS and non-GIS) mapping and interviews, the findings indicate that Guangzhou's spatial planning system was deeply attached to engineering-based solutions to tackle flood risk. A departure from established traditions towards nature-based and non-structural solutions was difficult. Deviations from established traditions generally only take place when the agenda of resolving flood risk meets socio-economic needs and is institutionally supported in the planning sector. These crucial findings lead chapters 5 to 7 to consider the institutional support that has

been given by the National Sponge City Programme, enacted in Guangzhou in 2017 in the form of *Guangzhou Sponge City Plan*.

The empirical evidence in Chapter 5 indicates that the Sponge City Plan gives critical institutional support by changing the conventional policymaking procedures workflows and planning tools. It was established as a 'specialised subject plan' (专项规划) prepared for the theme of flooding in particular. Specialised subject plans with different themes are often developed to support master plans in the Chinese context, which help to promote the cross-disciplinary planning process.. The Sponge City Plan promotes horizontal cooperation between the planning and water management sectors, which results into an agreed framework to mainstream flood safety into local planning agendas, such as land use development, environmental improvement, and ecological quality. This process was previously dominated by the local water management sector from the early 2000s, with spatial planning as a relative bystander. The plan brings a series of regulatory codes into the planning system for runoff control and catchment basin management (derived from the field of water management). Consequently, it allows the planning sector to regulate land use development patterns by zoning with legal enforcement across vertical administrative levels. It also gives planners the opportunity to design physical interventions for flood resilience in dry territories (not lakes or rivers, which remain the responsibility of the water management sector), both of which were formerly weakly defined in the planning system.

Policy framing theory is employed in Chapter 6 to analyse the differences in policy discourse between the *Sponge City Plan* and master plans (relevant plans in spatial planning), and detached water sectoral plans (in water management) in Guangzhou from the 2000s. It helps to explain the changes in the definition of problems and intentions to act, and also the means to realise them. The comparative research indicates that the *Sponge City Plan*, to a certain extent, compensates for the defects of master plans which are characterised by partial problem setting for floods, deficient action to cope with floods, and vague governance arrangements of planning institutions. The rules of the game of planning have changed, giving planning a legitimate role in flood governance in terms of its impact on urban development and flood risk, usable options to reduce flood loss, and its responsibilities in flood affairs. These resulting changes can be regarded as another institutional support. Importantly and positively, progress has been affected by the percolation of similar knowledge from water management to spatial planning in horizontal cooperation.

Despite progress in responding to the National Sponge City Programme in Guangzhou, many institutional barriers remain for planning officials when trying to implement the ambitions proposed in the local *Sponge City Plan*. Chapter 7 seeks

to investigate current and future barriers. The theory of collaborative governance is used to identify the governance conditions under which spatial planning operates. Three factors are investigated: organisational structure, the rules of the game and resource allocation. The evidence from the literature, empirical practice, and extensive interviews indicate that Guangzhou's spatial planning sector is disadvantaged in flood governance in terms of weak power, unskilled staff, and limited incentives. Government reorganisation also resulted in a weak voice for spatial planning in policymaking, a scarcity of skilled personnel, and insufficient financial support for flood risk management. In addition, the collective cognition embedded in culture and history is another challenge for the local planning system to work towards flood resilience. This finding is supported by many interviewees in planning and planning-related institutions who hold a neutral or negative position, not believing that planning can make a significant contribution to flood affairs.

The concluding Chapter 8 summarises the findings and offers strategies for Guangzhou to build favourable institutional conditions for resilience planning and adaptation ambitions in the future. The empirical investigations in this thesis indicate that the development and implementation of resilience or climate adaptation pathways are difficult, and institutional arrangements can create barriers or facilitate progress. Long-established planning traditions, formal planning procedures and tools, policy framing patterns and contextual organisational factors determine spatial planning's role in managing flood risk in different angles. They can affect (1) the adjustment of the planning system to flood risk, (2) the performance of vertical communication between levels and boundary-spanning work, (3) the legal framework that planners follow, and (4) the capacities of planning institutions to work on flood issues. With the Guangzhou case specifically, the settings of these institutional arrangements caused by the newly launched *Sponge City Plan* have led to (i) the emergence of procedures and planning tools in the policymaking process to enhance horizontal cooperation between sectors and vertical cooperation across bureaucratic levels, and (ii) the strengthened competence of the planning sector in official policy discourse concerning a formal position in flood governance and practical spatial measures. In the meanwhile, the local planning system has to face the barriers including (i) the engineering-based path dependence tradition; (ii) weak powers of planning sector over water issues; (iii) limited funding; and (iv) doubts about the contribution that planning can make about reducing flood risk among planning institutions and practitioners.

To improve Guangzhou's planning system, a series of strategies can be adopted either using its strengths and opportunities or minimising weakness and external threats. They include measures such as (i) optimising administrative procedures, regulations, and technical guidelines for evaluation and monitoring, (ii) creating

a supporting financial system using tax or subsidies, and (iii) combining the assessment of risk and climate with cost-benefit analysis or cost-effective analysis in planning projects. Chapter 8 also explains how theories of historical institutionalism, studies on planning procedures and tools, policy framing, and collaborative governance can contribute to explaining planning practice and the decision-making process. Nevertheless, research methods in this thesis still have limitations, which can inform further research, particularly in terms of the limited data on budget and spending and the deficiency of data on how spatial planning has managed flood risk historically.

Concluding the research, this thesis identifies five questions concerning the future direction of research and practice in integrating spatial planning and flood risk management. These questions are primarily concerned with policy framing, physical design, knowledge dissemination, financial incentives and policy transfer.

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Samenvatting

In deze scriptie wordt besproken hoe de problemen rondom het plannen van overstromingsbestendigheid en klimaatverandering kunnen worden overwonnen door gunstige institutionele omstandigheden te creëren voor het voorbereiden en uitvoeren van ruimtelijke strategieën en plannen. Het onderzoek is geïnspireerd door de toenemende impact van extreme weersomstandigheden en veranderende klimaatpatronen op regio's en steden die gevoelig voor overstromingen zijn. Nederzettingen in deze gebieden worden kwetsbaarder en krijgen steeds vaker met overstromingsschade te maken. Als gevolg van wereldwijde inspanningen door een breed scala een klimaatanalisten, economen, sociale wetenschappers, politici, waterbouwkundig ingenieurs, ruimtelijke planners en anderen zijn steden zich bewuster geworden van het belang van de ontwikkeling van robuustere strategieën en plannen op het gebied van stedelijke ontwikkeling. Het is echter niet geheel duidelijk hoe deze ambities effectief kunnen worden ingevuld. De complexiteit van instituten is een cruciale factor die door planners vaak wordt onderschat en meer onderzoek behoeft. De hoofdvraag voor dit onderzoek was: welke institutionele regelingen zijn bepalend voor de rol van ruimtelijke planning bij het beheren van overstromingsrisico's en waarom?

Ik heb dit onderzoek opgezet op basis van de Chinese context. Begin jaren 2010 begonnen Chinese planningsfunctionarissen oog te krijgen voor de urgentie van overstromingsproblematiek in een stedelijke context. Om die problematiek het hoofd te bieden is het nationale sponsstedenprogramma geïnitieerd. Dit programma stimuleert het inbedden van overstromingsrisicobeheer in ruimtelijke planning en verandert de manier waarop planning stedelijke ontwikkeling aanstuurt in de richting van op de natuur gebaseerde oplossingen en reglementen voor landgebruik. Al dan niet met opzet heeft dit programma op verschillende overheidsniveaus tot een reeks veranderingen in en controverses over het beleidsvormingsproces geleid.

Tegen deze achtergrond wordt in deze scriptie onderzocht welke rol ruimtelijke planning speelt bij het omgaan met overstromingsrisico's, zowel voor als tijdens de implementatie van het sponsstadprogramma. Er wordt gekeken naar de veranderingen en controverses tijdens de overgang van de oude naar de nieuwe context. Ik heb ervoor gekozen om Guangzhou als casus voor een gedetailleerde verkenning te gebruiken. Dit is een van de steden die het meest kwetsbaar zijn voor overstroming ter wereld en het heeft een van de eerste gemoderniseerde

planningssystemen van China. Het onderzoek is uitgevoerd op basis van vier uitgangspunten die betrekking hebben op instituten die relevant zijn voor planning en overstromingsbeheer. Dit zijn:

1. de vaste, traditionele manier om planning te benaderen, waarbij een overstap wordt gemaakt van technische oplossingen naar oplossingen die gebruikmaken van de natuur en reglementen voor landgebruik;
2. de manier waarop verticale en horizontale afstemming binnen de besluitvorming worden beheerd;
3. de manier waarop beleid wordt ingebed met betrekking tot de probleemstelling, actie-'scripts' en toezichtsregelingen; en
4. de contextuele factoren die bepalend zijn voor de startvoorwaarden voor planning van overstromingsbeheer, zoals organisatiestructuren, spelregels, toekenning van middelen en de ingebedde perspectieven (het wereldbeeld) van actoren.

Uit een literatuuronderzoek dat in hoofdstuk 2 wordt gepresenteerd blijkt dat deze voornamelijk op ervaringen in Europa en Amerika is gebaseerd. Hierbij is gekeken naar overstromingsrisicobeheer, het voorkomen van rampen en klimaataanpassing en is aandacht besteed aan milieufactoren, rampenbeheersing, sociaaleconomische factoren en institutionele factoren (of toezichtsfactoren). Binnen de ruimtelijke planning wordt aan al deze kwesties echter niet evenveel aandacht besteed. De institutionele factoren moeten meer aandacht krijgen, waaronder openbaar beleid, regelgeving, toezicht op verschillende niveaus, samenwerking tussen actoren, actoren met uiteenlopende belangen, publiek-private samenwerking, machtsfactoren, leiderschap en politieke bereidheid.

In hoofdstuk 3 wordt specifiek ingegaan op de institutionele omstandigheden van Guangzhou. Er wordt een conceptueel kader gepresenteerd, de verzamelde gegevens en analysemethodes voor gedetailleerd onderzoek. Op basis van meerder bronnen uit de beleidskunde, sociale wetenschappen en institutioneel onderzoek is een conceptueel kader opgezet met betrekking tot historisch institutionalisme, de prestaties (procedures en hulpmiddelen) met betrekking tot planning, beleidskaders en gezamenlijk toezicht. Verder onderzoek is verricht op basis van officiële beleidsdocumenten, grijze literatuur, 'open access' geo-informatie en interviewtranscripties. Op basis van analyse van documentatie, ruimtelijke analyse op basis van geografische data, semi-gestructureerde analyse van belanghebbenden en een analyse van de gevaren, zwakke punten en sterke punten (TOWS) zijn deze theorieën toegepast op de casus.

In hoofdstuk 4 wordt de theorie van het historisch institutionalisme gebruikt om de planningstradities (routines) van Guangzhou te verkennen en hoe deze tradities de bijdrage die planning aan overstromingsbestendigheid kan leveren in de weg

staan dan wel faciliteren. Deze verkenning heeft betrekking op de jaren 1920 tot en met de vroege jaren 2010. Op basis van documentanalyse, kaarten (GIS en niet-GIS) en interviews wordt geconcludeerd dat het systeem voor ruimtelijke planning voor het beperken van het overstromingsrisico in Guangzhou nauw samenhing met technologische oplossingen. Het bleek lastig te zijn om van bestaande tradities af te wijken in de richting van op de natuur gebaseerde en niet-structurele oplossingen. Algemeen gesteld wordt pas van bestaande tradities afgeweken als de agenda voor het aanpakken van overstromingsrisico's aan sociaaleconomische belangen voldoet en door instituten binnen de planningssector wordt ondersteund. Naar aanleiding van deze cruciale bevindingen wordt er in hoofdstuk 5 tot en met 7 aandacht besteed aan de institutionele ondersteuning van het nationale sponsstedenprogramma, dat in Guangzhou in 2017 in de praktijk is gebracht als het Guangzhou Sponge City Plan.

Het empirische bewijs uit hoofdstuk 5 wijst erop dat het Sponge City Plan kritieke institutionele ondersteuning heeft opgeleverd doordat de conventionele werkstromen en planningshulpmiddelen voor beleidsvorming zijn veranderd. Het betreft een 'gespecialiseerd onderwerpplan' dat is opgesteld voor het thema overstroming en horizontale samenwerking tussen de planning- en waterbeheersectoren mogelijk maakt om een afgestemd kader op te zetten dat overstromingsbescherming op de lokale planningsagenda's zet, zoals de ontwikkeling van landgebruik, milieuverbetering en ecologische kwaliteit. Voorheen, vanaf de jaren 2000, werd dit proces door de lokale waterbeheersector gedomineerd, waarbij ruimtelijke planning een relatief marginale rol speelde. Het plan voorziet in een reeks voorschriften voor de beheersing van afwatering en stroomgebieden (afgeleid van het vakgebied waterbeheer). Dit stelt de planningssector in staat om de ontwikkelingspatronen van landgebruik te reguleren door middel van juridische zonering door verticale overheidsniveaus heen. Tegelijk krijgen planners de mogelijkheid om fysieke overstromingsbarrières in droge gebieden te ontwerpen (niet in meren of rivieren; deze blijven de verantwoordelijkheid van de waterbeheersector). Allebei deze aspecten waren in het eerdere planningssysteem zwak gedefinieerd.

In hoofdstuk 6 wordt theorie voor beleidskadrering toegepast om de verschillen te analyseren tussen de beleidsopzet in het Sponge City Plan en overkoepelende plannen (relevante plannen voor ruimtelijke planning) enerzijds en die in afzonderlijke plannen uit de watersector (met betrekking tot waterbeheer) in Guangzhou vanaf de jaren 2000 anderzijds. Dit verklaart voor een deel veranderingen in hoe problemen worden gedefinieerd en de handelingsintenties en de middelen waarmee ze tot uitvoer worden gebracht. Het vergelijkend onderzoek wijst erop dat het Sponge City Plan tot op zekere hoogte compensatie biedt voor de tekortkomingen van overkoepelende plannen die worden gekenmerkt door een slechts gedeeltelijke probleemstelling met betrekking tot overstromingen, gebrekkig handelingsvermogen

om bij overstromingen op te treden en onduidelijke toezichtsregelingen van planningsinstanties. De spelregels voor planning zijn veranderd, waardoor planning een legitieme rol heeft gekregen in het overstromingsbeheer wat betreft de impact daarvan op stedelijke ontwikkeling en overstromingsrisico's, bruikbare opties voor het beperken van overstromingsschade en de verantwoordelijkheden in geval van overstromingen. De resulterende veranderingen kunnen eveneens worden beschouwd als institutionele ondersteuning. Het is hierbij belangrijk én positief om te vermelden dat de vooruitgang in de horizontale samenwerking op het gebied van ruimtelijke planning is beïnvloed door vergelijkbare kennis afkomstig uit het waterbeheer.

Hoewel er naar aanleiding van het nationale sponsstedenprogramma vooruitgang is geboekt in Guangzhou, blijven er veel institutionele belemmeringen bestaan voor planningsfunctionarissen wanneer deze de ambities in het lokale Sponge City Plan in de praktijk proberen te brengen. In hoofdstuk 7 is gepoogd om huidige en toekomstige belemmeringen nader te onderzoeken. Op basis van de theorie van gezamenlijk toezicht zijn de toezichtsomstandigheden geïdentificeerd waaronder ruimtelijke planning functioneert. Er zijn drie factoren onderzocht: organisatiestructuur, spelregels en toekenning van middelen. De literatuur, de empirische praktijk en uitgebreide interviews wijzen erop dat de ruimtelijke-planningsector in Guangzhou met betrekking tot overstromingsbeheer wordt gehinderd door een gebrek aan macht, door laaggekwalificeerde medewerkers en beperkte prikkels. Daarnaast heeft reorganisatie door de overheid tot een gebrek aan invloed van ruimtelijke planning op de beleidsvorming geleid, een tekort aan gekwalificeerde medewerkers en onvoldoende financiële steun voor het beheer van overstromingsrisico's. Ook de in de cultuur en geschiedenis ingebedde collectieve manier van denken vormt een uitdaging voor het functioneren van het lokale planningssysteem met betrekking tot overstromingsbestendigheid. Deze bevinding wordt door een groot aantal geïnterviewden in planningsinstanties en planningsgerelateerde instituten bevestigd die een neutrale of negatieve positie innemen en er niet van overtuigd zijn dat planning een significante bijdrage kan leveren aan het indammen van overstromingsproblemen.

In het afsluitende hoofdstuk 8 worden de bevindingen samengevat en worden er strategieën aangeboden op basis waarvan Guangzhou gunstige institutionele voorwaarden kan scheppen voor planning gericht op bestendigheid en toekomstige ambities op het gebied van klimaataanpassing. Het empirisch onderzoek in deze scriptie wijst erop dat de ontwikkeling en implementatie van trajecten gericht op overstromingsbestendigheid of klimaataanpassing niet eenvoudig zijn en dat institutionele factoren dit kunnen belemmeren of juist vergemakkelijken. Deze factoren kunnen gevolgen hebben voor de afstemming van het planningssysteem

op overstromingsrisico's, het functioneren van verticale communicatie tussen verschillende niveaus en grensoverschrijdende werkzaamheden, het juridisch kader waarbinnen planners te werk gaan en het vermogen van planningsinstituten om overstromingsgerelateerde problematiek aan te pakken. Om het planningssysteem van Guangzhou te verbeteren kunnen er verschillende strategieën worden toegepast, die hetzij gebruik maken van de sterke punten en kansen ervan, hetzij zwakheden en externe gevaren minimaliseren. Daaronder vallen maatregelen zoals (i) het optimaliseren van overheidsprocedures, reglementen en technische richtlijnen voor evaluatie en controle, (ii) het opzetten van een ondersteunend financieel systeem op basis van belastingen of subsidies, en (iii) het combineren van risico- en klimaatbeoordelingen met een kosten-batenanalyse of een analyse van de kosteneffectiviteit bij planningsprojecten. In hoofdstuk 8 wordt verder uitgelegd hoe theorieën met betrekking tot historisch institutionalisme, onderzoek naar procedures en hulpmiddelen voor planning, beleidskadrering en gezamenlijk toezicht een bijdrage kunnen leveren aan het verklaren van de planningspraktijk en het besluitvormingsproces. De in deze scriptie gehanteerde onderzoeksmethodes hebben echter beperkingen, die aanleiding kunnen zijn voor verder onderzoek, met name wat betreft de beperkte gegevens omtrent budgetten en uitgaven en een gebrek aan gegevens over hoe ruimtelijke planning in het verleden overstromingsrisico's beheerde.

Als afsluiting van het onderzoek worden in deze scriptie vijf vragen geïdentificeerd over de toekomstige richting van onderzoek en de praktijk met betrekking tot de integratie van ruimtelijke planning en overstromingsrisicobeheer. Deze vragen hebben hoofdzakelijk betrekking op beleidskadrering, fysiek ontwerp, kennisverspreiding, financiële prikkels en beleidsoverdracht.

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1 Introduction

Increased flooding due to climate change poses a considerable threat to the economic viability, security, safety and territorial management of cities (IPCC, 2007a; Nicholls et al., 2007; Aerts et al. 2011; Hallegatte et al. 2013). Efforts are made around the world to address flood risk that emphasises threats to people, species and human assets, which seek to strengthen urban resilience, adapt our environments to climate change and mitigate disasters. The UN Intergovernmental Panel on Climate Change (IPCC, 2012) argues that climate change exacerbates flood risk as a consequence of increased precipitation, especially when combined with human interventions such as land cover change. Because of increased risks, cities and regions are implementing adaptation measures that help them to cope with sudden flooding and other shocks. These measures are part of a wider city resilience strategy. The Resilient Cities Network (Rockerfeller Foundation and Arup, 2014) explains that effective spatial planning plays a critical role to improve resilience. These are the three central concerns of this study, the impacts of climate change on flood risk, the need for more resilience to flooding, and the contribution that can be made by spatial planning.

Spatial planning is a crucial tool to tackle flood risk because of its role in adapting the development and use of land and guiding urban infrastructure, providing opportunities to reduce losses from flooding, and mitigating climate change (Gersonius et al. 2008; Roggema 2009; Galliot & Nyer 2011; Mullan et al. 2015). Even so, the establishment of planning policies and the implementation of planning measures in practice is often challenging.

This thesis examines how planning addresses flood risk, and the facilitators and obstacles influencing its contribution. The meaning of planning in this study is not only about the regulations for managing land use and physical development but also the process of reaching agreements in policymaking in complex organisational structures, and collaboration between sectors and professions that have different norms. The research is based in China but the questions and findings are relevant generally. The main investigation is a case study based in Guangzhou, a Chinese coastal city, which has a long-term history of flooding. It provides rich materials to explore the development of planning solutions to cope with the disturbance of floods (Meng and Dabrwoski, 2016).

Problems of flooding in China are not new, but they are becoming more frequent and more severe. China, like many other Asian countries, has been affected by frequent flooding over the very long term. From 206 BC to 1949 (when the People's Republic of China was founded), there were 1,029 major floods events in China, almost one event every two years. The sources of flooding are diverse in terms of coastal floods, fluvial floods, pluvial floods, mountain floods (China Meteorological Newspaper, 2012). It is believed that more than 282,737 people were killed by flooding between 1950 and 2018, which left 6 billion hectares of land destroyed (Guo *et al.*, 2020). Significantly, the direct economic loss was up to approximately $6,000 billion between 1990 and 2018 alone (Guo *et al.*, 2020). Catastrophic floods took place in 1954 and 1998. Both of them were pluvial flooding but caused by excessive rainfall, and affecting 97 million hectares and 133 million hectares respectively.

In recent decades, attention to flooding in urban areas has increased along with the rise of planning in dealing with floods. This was triggered by frequent pluvial flood events dotted around China in the 2000s and the later-on Sponge City Programme, which sets the macro context of this thesis. According to an investigation by the Ministry of Housing & Urban-rural Development (MoHURD) in 2010, which involved 351 Chinese cities in the period from 2008-2010, 231 cities were affected by pluvial flooding (Wei *et al.*, 2012). Among those flooded cities, 74.6% experienced waterlogging of 0.5m or more in depth and 90% experienced waterlogging of at least 0.15m in depth. In 79% of the affected cities studied, the stagnant water lingered for at least 30 minutes before it could be discharged by the drainage system (Hou *et al.*, 2012). This shows that urban pluvial flooding (or surface water flooding) has become the 'new normal' in most Chinese cities.

To address the widespread flooding problems, since 2014 the MoHURD has promoted a national policy to improve cities' resilience to pluvial flooding in the context of rapid urbanisation and climate change: The *Sponge City Programme*. This programme supports the separation of the sewer and rainwater systems and the application of low-impact development (LID) measures in spatial planning (e.g. increasing the permeability of ground by implanting nature in open space and using green roofs to collect rainwater) to raise the capacity of cities to cope with stormwater (Construction Department of MoHURD 2014). The sponge city metaphor was formalised in the national document *Technical Guideline for the Construction of Sponge Cities: Rainwater System Based on Low Impact Development* launched in November 2014. This document combines ambitions in terms of resilience to flood risk with the pursuit of a more sustainable way to build an attractive and liveable urban environment. It provides opportunities for Chinese spatial planning to raise its consideration of pluvial flood problems in daily policy agendas (Meng *et al.*, 2018).

The *Sponge City Programme* caused a series of policy controversies and disputes. For instance, when this national programme is promoted at the municipal level in the Guangzhou case, the focus is broader than pluvial flooding. Coastal floods are also taken into consideration, which reveals a local interpretation different from the national call, and shows new possibilities for the role of spatial planning policy in managing flood affairs in the Chinese context (Meng *et al.*, 2019). These controversies and disputes prompted this thesis to explore how they are managed, with a particular focus on the field of spatial planning.

In this introduction, I present the foundation of the study. First, I explain the causes of floods in terms of disadvantaged topographic conditions, unsuitable urban development and climate change, which highlight the urgency and complexity of the flood-risk challenge (section 1.1). Following that, I reveal the rising notion of resilience in urban and community studies and its application to flood problems. Two narratives (hazard mitigation and climate adaptation) are present where flood resilience is discussed (section 1.2). I then narrow the focus and discuss the rising awareness of the contribution of planning to flood resilience. Four aspects of the role of planning are highlighted: territorial management, vulnerability identification, cost-saving and governing institutional activities (section 1.3). On that basis, the problem statement for the thesis is formulated, with a focus on governing institutions (section 1.4). I end this chapter by summarising the aim of this thesis and its research questions (section 1.5), and conclude with the structure of the thesis (section 1.6).

1.1 Increasing flood risk and its causes

Flooding is one of the most prominent natural hazards and presents a dramatic challenge for cities across the globe. An estimated 2.8 million people were reported to be severely affected by flood events between 1980 and 2009, with 4.6 million being made homeless by flooding (Doocy *et al.*, 2013). Floods also led to more than 500,000 deaths and 300,000 injuries around the world, excluding an estimated 38,000 to 2.7 million injuries that are unrecorded (Doocy *et al.*, 2013).

Many factors can lead to flooding. In coastal and deltaic areas, three leading factors are identified to explain the complexity and urgency that these areas have to face: disadvantages in topography, extensive urban development, and climate change. Initially, due to the low-lying locations and the lack of protection against flooding,

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coastal cities and delta areas are stunningly vulnerable to the threats from flooding (Aerts et al. 2011, Hallegatte et al. 2013). According to the survey *Ranking of The World's Cities Most Exposed to Coastal Flooding Today* (Nicholls *et al*., 2007), across all world cities, about 40 million people are exposed to a 1-in-100 year coastal flood event. This exposure is concentrated in 30 cities with 80 per cent of global exposure. Of these 30 cities, 19 are located in deltas, that is in coastal areas where major rivers flow into the sea at low altitudes.[1]

Moreover, extensive urban development increases flood risk. Before urbanisation, floods were a natural process of land-making that did not create a hazard for people or settlements. Today, high levels of human interventions such as the accelerated processes of land cultivation and the channelling of rivers have disrupted the natural process of land-making and weakened the capacity of cities to face excessive water (Meyer, Bobbink and Nijhuis, 2010). In coastal and deltaic areas, the advantages for human settlement are particularly strong because of the favourable conditions for shipping and transport, the diverse resources for manufacturing, fishing, tourism, or oil industries, and the beauty of the natural environment for a living (Gurran, 2008). These advantages attract economic development and migration and, in turn, exposes valuable assets and massive populations to potential flood events. Meanwhile, large-scale transformations from the natural environment to impervious surfaces (e.g., asphalt roads and concrete paving) interrupt the infiltration process of rainwater and lead to massive runoff (United Nations, 2009). Consequently, the risk of flood increases not only in wetlands like coastal or riverine areas but also in the territories that were previously dry.

Climate change is regarded as another leading factor that increasingly plays a role in flooding in the long-term (Adger *et al*., 2013). As early as the 1990s, the *Intergovernmental Panel on Climate Change (IPCC) First Assessment Report* warned of a doubling of CO_2 in the atmosphere between the 1990s and the period from 2025 to 2050, which could lead to a consequent 1.5 °C to 5°C increase in global mean temperature, and a 0.3 to 0.5m increase in sea-level by 2050, and 1m by 2100 (Tegart, Sheldon and Griffiths, 1990). This projection was optimised due to the improvement in observations and related modelling techniques. In 2013, the *IPCC Fifth Assessment Report* published its new result, which projects a rise in temperature from 2 °C to 4 °C in the worst scenario over the twenty-first century (IPCC, 2013). This seemingly small increase is expected to bring numerous negative impacts in the long-term, such as a dramatic increase in the frequency of

1 Six Chinese cities are in the top 20 globally on this list, with Guangzhou ranking fourth and second respectively in terms of its exposed population and assets to coastal flooding in the 2070s.

storms, precipitation and the extent of melting of the ice caps (IPCC 2001; IPCC 2007a). These impacts contribute to the occurrence of pluvial, fluvial and coastal flooding, and result in a considerable threat to the safety of lives and social-economic development.

1.2 The notion of resilience in urban studies and its application to flood problems

In consideration of flood risk, it is difficult to escape the notion of resilience. 'Resilience' first appeared in the studies of ecological equilibrium in the 1970s. It is about the ability of species to resume functionality when they are faced with external disturbance (Holling, 1973). Later, social scientists introduced the idea into the analysis of the capacity of a self-organising social system to cope with crisis (Vayda and McCay, 1975). It was also used in psychology to refer to the ability of a person to remain psychologically healthy in the face of adverse stressors and the ability to recover quickly from negative psychological effects (Terte and Stephens, 2014).

Since the late 1990s, resilience has been used in urban and community studies to define the abilities of local societies to minimise the impacts of disasters and recover from them. For instance, Tobin (1999) uses this notion to describe the ability of communities in the State of Florida to recover after Hurricane Andrew by restoring their socio-economic vitality. When resilience was used in urban areas, it gave rise to the notions of 'resilient cities' or 'urban resilience', referring to the capabilities of cities to withstand a severe shock without either immediate chaos or permanent harm (Godschalk, 2003; Fleischhauer, 2008).

The sources of 'shocks' are diverse. They can be from natural hazards (e.g. storm surges, river floods, tsunami, earthquakes, landslides, forest fires, volcanic eruptions and droughts), technical hazards (e.g. nuclear power, chemical production, oil production, process, storage and transport), and terrorism (Godschalk, 2003; Schmidt-Thomé, 2006). Many of the shocks have cascading effects, for example, flooding can lead to loss of electricity or health services. In 2013, the Rockefeller Foundation launched an initiative called 100 Resilient Cities (100RC) (now the Resilient Cities Network) which defines urban resilience as "the capacity of individuals, communities, institutions, businesses, and systems within a city to survive, adapt, and

grow no matter what kinds of chronic stresses and acute shocks they experience" (40 Cities, 2016). This definition expands the meaning of resilience by recognising that the challenges people have to deal with come from both short-term events such as hurricanes, and slow-moving risks such as climate change. And it recognises that the interlinked cascading effects require integrated policy responses.

The widespread adoption of the concept of resilience among disciplines has led to its application in dealing with flood problems. Mcclymont *et al.* (2020) reviewed the latest research and conference papers from 2004 to 2018 in relation to resilience and flood risk management. The findings indicate that the use of 'resilience' was always related to the ability to prepare for disturbances before they happened and resist their impacts (engineering resilience); cope with effects and maintain functionality throughout disturbance (systems resilience); and adapt to and learn post-disturbance (complex adaptive systems). Although different papers or scholars reflect these features selectively, such a diverse application highlights the spectrum of ideas about flood resilience. Importantly, the abilities mentioned here can be strengthened through territorial management by spatial planning (see below, the description of territorial management).

Two narratives in practice and academia shape the context in which the notion of resilience is often used in flood affairs: natural hazard mitigation and climate change. The former narrative is derived from the long-established work on natural hazard/ disaster reduction, flood risk management and emergency management policy (Mileti, 1999; Godschalk, 2003; Afedzie and McEntire, 2010; Frerks, Warner and Weijs, 2011). According to the Federal Emergency Management Agency (US) (FEMA), (2000, p.13), hazard mitigation entails "actions to reduce or eliminate long-term risk to people and property from hazards and their effects' to enable an environment more resistant to disasters".

The narrative of climate change has become more prominent since the impacts of changing climate climbed onto urban agendas in the 2000s. The monitoring, assessment and projection of climate and extreme weather events have gradually matured as academic fields. Climate change broadens attention from acute weather events to long-term impacts of climate on the possibility and extent of flooding (e.g. rising sea levels and increasing precipitation in rain seasons). Resilience, in this perspective, is regarded as a guiding principle for climate adaptation (e.g. in response to droughts, floods and extreme weather) and climate mitigation (e.g. the reduction of energy consumption and carbon intensity) (Lu and Stead, 2013; Taşan-Kok, Stead and Lu, 2013; Stead, 2014). Climate adaption, here, refers to 'the adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities'

(IPCC, 2007a, p. 6); while climate mitigation refers to activities to slow down the pace of climate change and make efforts to reduce or prevent the emission of greenhouse gases, dealing with climate agenda at its source (IPCC, 2007c).

In practice, these two scenarios are sometimes intertwined. A typical case comes from the 2015 UN report *Transforming Our World: The 2030 Agenda for Sustainable Development*. Under Goal 11, it claims that in to make cities and human settlements inclusive, safe, resilient and sustainable by 2020, we must:

"substantially increase the number of cities and human settlements adopting and implementing integrated policies and plans towards inclusion, resource efficiency, **mitigation and adaptation to climate change, resilience to disasters,** and develop and implement, in line with the **Sendai Framework for Disaster Risk Reduction 2015-2030**[2], holistic disaster risk management at all levels (United Nations, 2015, p. 24)."

In summary, the ways to use resilience are rather complicated, especially in relation to addressing flood affairs. It can be used for disaster mitigation, for climate adaptation, and for mitigation or in a mixed way.

1.3 The role of spatial planning in contributing to flood resilience

The two narratives of using resilience have encouraged an increasing acknowledgement of spatial planning's role in dealing with flood problems. In the context of hazard mitigation, spatial planning is recognised as a crucial tool to make physical systems such as buildings, infrastructures, energy facilities and waterways, together with the communities they serve in schools, neighbourhoods, agencies and organisations, more resilient. That is, they should be prepared for resisting disasters, mitigating hazards risks[3] and responding to shocks effectively in terms

2 Flood risk is one focus of Sendai Framework for Disaster Risk Reduction 2015-2030.

3 mitigating here, refers to a reduction of the severity, seriousness and painfulness of disaster in a literal sense, rather than the notion climate mitigation.

of earthquakes, floods, thunderstorms, terrorist and disease attacks (Godschalk, 2003; Laditka *et al*., 2009; Richardson, 2016). The literature on climate change acknowledges that spatial planning is well placed to promote urban resilience, adapting to climate change and reducing flood risk through the spatial configuration of cities (by way of land-use management) in the face of rising sea levels, increased precipitation, heavier peak showers and hurricanes (Biesbroek, Swart and Knaap, 2009; Lu and Stead, 2013). Here, dealing with flood risk though planning is regarded as part of the task of climate adaptation (Steele and Gleeson, 2009).

It is notable that the notion of 'spatial planning' has many variations. In different contexts, it is often described as land use planning, urban planning, or physical planning, etc. (Fleischhauer, 2008). This creates ambiguity. Some early scholars have argued that urban planning or land use planning is more technical and concerned with infrastructure, zoning and setting parameters for land development, while the contents of spatial planning are broader, not only technical but also involves the integration mechanism between agents. Healey (2006, p.321) defined planning as a collaborative process organising socio-spatial dynamics and governance processes, managing "the collective challenges arising from the co-existence and conjunctions of diverse stakeholders and their webs of relations in shared spaces". The term expressed the coordination of spatial activities and all the sectoral policies that have an influence on the development of territories (Fleischhauer, 2008; Stead, 2008). In this thesis, I choose to regard spatial planning in its broader sense. Spatial planning is understood as a process to manage land use and link physical development, economic, social and governing activities, through laws, policies, organisations, and professional norms. In this process, planning institutions interact with other sectors of public action and policy in the 'web of relations'. There will be competition and/or cooperation with the established knowledge, institutional values, culture and political preferences among the sectors.

This kind of understanding relates to the interpretation of 'institutions' in social science, in which issue-specific agents are characterised by elements or arrangements like "the formal or informal procedures, routines, norms and conventions embedded in the organisational structure of the polity or political economy" (Hall & Taylor, 1996, p. 938). These institutional elements or arrangements allow organisations to legislate, regulate and manage their activities efficiently and to coordinate with others effectively (Wignaraja, 2009).

In regard to practice, it is commonplace to find notions like 'adaptation planning' (e.g. Mimura *et al*., 2014) or 'resilience planning' (e.g. Gajjar and Jain, 2017) used according to different academic backgrounds. Sometimes these notions are confused as a sort of spatial planning and the meaning is taken for granted. According to

my experience, the contents of planning here can relate to any general planning processes or policy documents striving for climate adaptation and resilience, such as hydrological planning, budget planning, etc. with spatial planning as one reflection, coping with climate change and managing disasters.

Four ways in which spatial planning can contribute to managing flood risk are identified in the literature: (i) territorial management, (ii) vulnerability identification, (iii) cost-saving and (iv) governing institutional activities. The following four paragraphs will summarise the literature which proposes these aspects. After that, I explore empirical examples to explain how these four aspects are reflected in practices.

The primary idea is that both flood risk and planning take effect in the territory at a location. Flood events caused by rainfall, sea-level rise and river surges, take place somewhere and have a spatial dimension or footprint on the affected areas. Spatial planning is inherently concerned with the territorial management or spatial distribution of physical development, social and economic activities, and the relationship with qualities of the natural environment, which contributes to dealing with the affected areas. It works by adopting measures such as floodplain management and land activity allocations (e.g. development restriction, setbacks from coastal erosion areas, zoning plan for forests, wetlands and lakes), multi-functional development (e.g. super dykes), flood-prone land and properties acquisitions, public buildings relocation away from storm surge zones (e.g. schools, fire stations) as well as building standards for wind-bracing and flood-proofing (FEMA, 2000; Cheong, 2011; Porse, 2014; Urban Floods Community of Practice (UFCOP), 2017; Wingfield *et al*., 2019). These measures help to enhance the capacity of places to avoid flood events, resist and mitigate immediate flood impacts, maintain functionality, and provide experience for future lesson-learning, which are features defined by the notion of 'flood resilience'. A representative case is the Netherlands, where planning grew out of the coordination of activities to deal with water management and create more habitable land. Planning, in this way, offers opportunities to influence the physical environment spatially for disaster-mitigation or flood resilience at all territorial levels from international, national, regional and municipal levels, to the community level (Gersonius et al. 2008, Roggema 2009, Galliot & Nyer 2011, Mullan et al. 2015).

Second, the involvement of planning in dealing with floods is because it can identify the vulnerability of communities and societies in the face of potentially hazardous events. The identification takes place in urban plan preparation when the data on land use functions, development density, and population, etc. is overlayered by flood risk maps from flood risk management. Consequently, vulnerable assets and human

settlements in flood-prone areas affected by different climatic scenarios can be distinguished (Gemeente Rotterdam, 2008; Nickson *et al*., 2011; City of New York, 2013), even though they seem safe in the normal situation.

Third, planning is expected to reduce the costs of managing flood problems. Initially, the cost of the construction of traditional engineering-based infrastructure (e.g. dykes) to prevent or mitigate flood risk is often high. However, instant returns are not common, which leads to a heavy financial burden for cities or the relevant water authorities. In addition, modifying the built infrastructure is rather difficult. For instance, renovating pipe systems in the built environment is laborious, expensive and disruptive. Arisz and Burrell say that engineering infrastructure once built can hardly be changed, which weakens the ability and flexibility of flood-exposed areas to cope with the increasing flood risk caused by the climate change (2006). In comparison, spatial/urban planning interventions may offer ways to deal with floods in a more flexible, low impact and possibly less costly way (Kundzewicz, 2002; Shah, Rahman and Chowdhury, 2018). For instance, in urbanised areas where upgrading pipe systems is difficult, embedding micro green patches to increase permeability creates retention areas to store excessive rainfall, together with benefits in the upgrading of the green environment, urban quality and wellbeing. Or in another case, planners can be involved in evacuation route designs for a retreat in case flood events happen, which offers new opportunities to optimise an emergency plan. However, it should be pointed out that some research papers argue the measures used by spatial planning (e.g. nature-based infrastructure or retreating from water) are not always cost-saving. Although these measures do not cost too much in construction in the short term, they may cost a lot in long-term maintenance, which makes these measures expensive (Economics of Climate Adaptation Working Group (ECA), 2009; Sanghi *et al*., 2010; Chiabai *et al*., 2015). More details are included in Chapter 2.

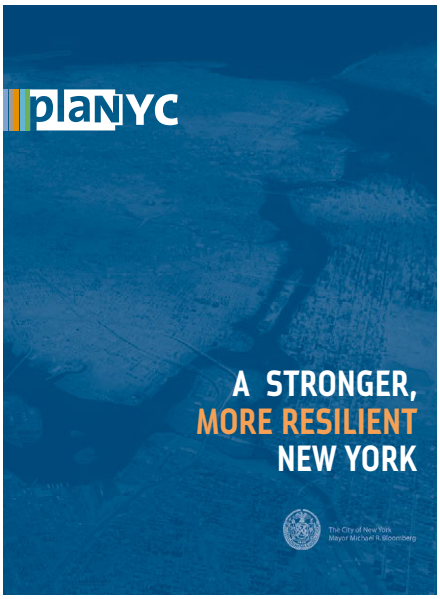
Last but not least, the increasing importance of planning for dealing with flood risk is accompanied by the decentralisation process of flood coping practices from national and regional levels to municipal and local levels (Bergsma, 2018). In other words, it is a governance issue, compromising the mechanisms and processes of interactions among collective actors in decision-making. Traditionally, flood risk was handled mainly by national and regional authorities, for instance, in the Netherlands, US and China. These national governments constructed engineering infrastructure such as levees and dyke systems to protect populations from coastal and fluvial floods, and they met the cost of the constructions. The lower level municipalities spared restricted rates of the spending and shared a limited contribution to the decisions of engineering infrastructure (Woltjer and Al, 2007). For example, in the Netherlands, national government and regional authorities, namely water boards, share most

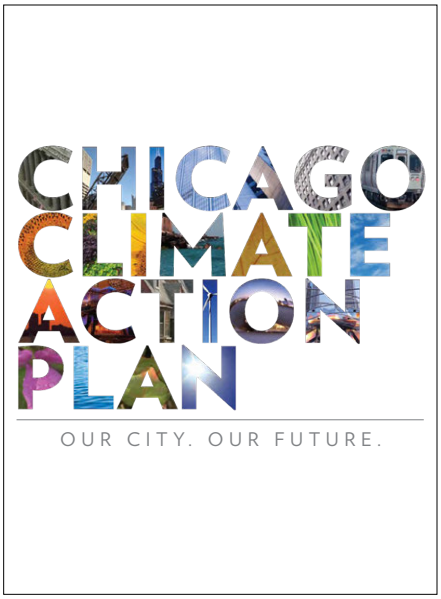
of the expense. In China, the national government take the main portion of the spending on engineering infrastructure. This situation changed when coastal and delta areas boomed in urban development and municipalities were appointed with more discretion to decide the way of development. Spatial planning agents, in this context, were regarded as actors allowing a combination of land-use management regulations (e.g. retreating from high-risk areas) and price incentives (e.g. reflecting the costs of floods in insurance premiums) to encourage damage mitigation and climate adaptation at the municipal and local levels (Woltjer and Al, 2007). Although these planning measures are regarded as alternatives to traditional engineering infrastructure, their implementation is shifting some of the responsibilities in flood governance and investment from national and regional institutions to municipal and local institutions (Butler and Pidgeon, 2011; Bergsma, Gupta and Jong, 2012). As a result, planning contributes to the shape of a new co-determined process with enlarged social relations and policy networks.

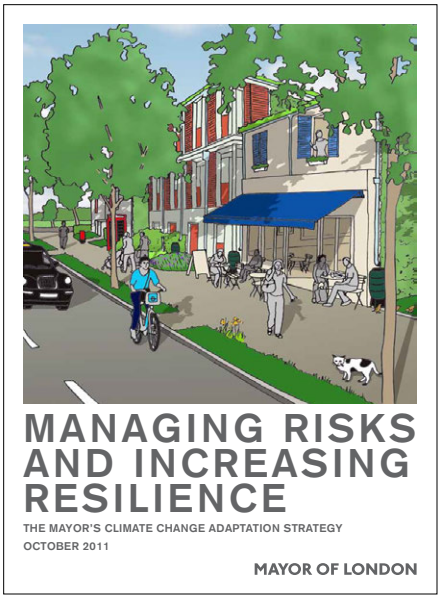
In summary, there are four principal roles that planning can contribute to managing flood risk emerging from the literature. To identify the extent to which these roles are mentioned in practical strategies, plans and policies, I briefly examined exemplary cases from six cities, each of which has been striving for urban resilience in relation to flood issues and spatial planning measures (see Figure 1.1). Table 1.1 presents their priority challenges, measures striving for urban resilience, and the defined roles of spatial planning (either named as city planning, land use planning, planning or a reflection of adaptation planning in a different context) to address flood hazards and climate change. Despite different interpretations between these policy documents, planning is mainly committed to:

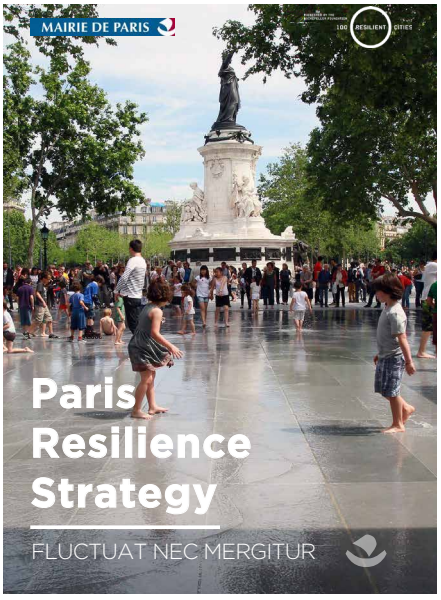
1. developing measures to influence physical development (e.g. avoiding locating land use, rebuilding destroyed buildings, supporting access to groceries and foods in vulnerable and low-income areas);
2. increasing the awareness of flood hazards (e.g. assisting the identification of vulnerabilities in coastal areas);
3. considering costs (e.g. pursuing cost-effective measures); or
4. coordinating partnerships between different stakeholders in government, the private sector and civil society.

These defined roles are comparable with the abovementioned four aspects of planning's contribution in dealing with flood problems. In other words, the categorisation seems to be strongly reflected in actual planning practice.


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FIG. 1.1 The covers of strategies and policies from six exemplary cities striving for urban resilience / Source: Author, based on (Chicago Climate Task Force, 2008; Gemeente Rotterdam, 2008; Greater London Authority, 2011; City of New York, 2013; Ministry of the Environment and Water Resources and Ministry of National Development, 2016; Mairie De Paris, 2018)

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TABLE 1.1 The contents of strategies and policies from six exemplary cities striving for urban resilience

City	Strategy and Policy	Priority challenges	Measures striving for urban resilience	Given flood risk, urban planning/ spatial planning/city planning/ plan and adaptation planning is committed to the roles
New York, US	A Stronger, More Resilient New York (2013)	**Flooding, thunderstorm, extreme weather and climate change**	**Recovery from Sandy Hurricane and the improvement of coastal protection, buildings, insurance, utilities, healthcare, parks, transportation, telecommunications, communities to deal with floods and climate change,** etc.	(i) assisting the identification of vulnerabilities in coastal areas (ii) strengthening new, rebuilding destroyed and retrofitting buildings threatened by floods via zoning codes and regulations (iii) developing cost-effective measures to safeguard exposed substances; (iv) supporting access to grocers and flood in vulnerable and low-income areas (v) coordinating with diverse agents
Chicago, US	Chicago Climate Action Plan: Our city, Our Future (2008)	Smoke, overheating in summer, **floods, thunderstorms, and climate change**	The retrofit of existing buildings to save energy, the usage green roofs and green streets to moderate temperature, the upgrade of power plants to reduce GHGs, the reduction of air pollution emissions, **stormwater management (watershed plan), Green Urban Design (rainwater capturing by pavements, rooftop gardens and green alleys), the preservation of plants and trees.**	(i) including a watershed plan in the regional infrastructure plan to manage stormwater; (ii) using permeable pavement, rooftop gardens and green alleys to capture rain led by the Green Urban Design plan; (iii) fostering partnerships between government, businesses, engaging communities and environmental organisations.
London, UK	Managing Risks and Increasing Resilience: The London Climate Change Adaptation Strategy (2011)	**Flooding,** droughts, overheating and health problems	The retrofitting of existing buildings to save energy, **increase in parks and greens to** mitigate noise, raise living quality, reduce temperature, and **address floods and extreme weathers,** and the usage of green energy transport to reduce air pollution, etc.	(i) avoiding locating flood-vulnerable land uses in high flood-risk areas and identifying where current developments should be removed or exchanged for less flood-sensitive land uses in the future, (ii) reducing flood risk when the development in flood-risk areas cannot be avoided, and (iii) being the first step in flood risk management
Paris, France	Paris Resilience Strategy (June 2018)	Social, economic and spatial inequalities and exclusion, terror threat, risks related to **Seine River & water,** air pollution, **climate change,** territorial governance,	The development of citizen-involved risk management programs, the mobilisation of residents' co-creation of the city, the solidarity of communities, **the resilient planning of built city and infrastructure for multiply benefits, risk mitigation, and climate sensitivity**, the mobilisation of collective intelligence, sharing resources and cooperation with surrounding territories	(i) dispensable choices to deal with the re-occurrence of flooding (caused by hurricanes) as well as community preparedness and emergency assistance via planning and zoning (ii) providing opportunities to transform public spaces for social wellbeing and better incorporation of nature (for rain storage). (iii) incorporating resilience solutions in planning agendas through regulatory documents and specifications

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TABLE 1.1 The contents of strategies and policies from six exemplary cities striving for urban resilience

City	Strategy and Policy	Priority challenges	Measures striving for urban resilience	Given flood risk, urban planning/ spatial planning/city planning/ plan and adaptation planning is committed to the roles
Rotterdam, Netherlands	Rotterdam Resilience Strategy (2008)	Social cohesion and education, energy transition, **flood and climate adaptation**, cyber use and security, critical infrastructure, changing urban governance	The development of programs and activities to teach young people skills, disseminate health lifestyles, and connect networks, the reduce of GHGs and transition of port industries, the establishment of cyber blocks, **the management of rainwater and flood defence for climate adaption, the improvement of subsurface infrastructure (e.g. sewer system),** the creation of networks between government, citizens and institutions for self-governing	(i) considering above and below ground development in an integrated manner, (ii) supporting the understanding of self-reliance of the government and communities (mapping and scanning), (iii) considering costs and benefits in risk management in infrastructure development, and (iv) involving citizens and government allowing for decentralised governance
Singapore	Singapore's Climate Action Plan: A Climate-resilient Singapore, For a Sustainable Future (2016)	**Rising sea levels,** water supply and drought spell, heat-induced decrease in biodiversity, public health and food supply, **rainwaters,** slope instability, strong winds, **climate change**	**Coastal protection,** water resources diversification and conservation, **stormwater management,** marine conservation, bush fire restoration, **flood barriers installation,** the upgrade of telecommunication, transport, power stations against flooding and temperature change, the inspection of buildings, the development of heat index, food supply diversification	formulating options to tackle risks in a dynamic and flexible manner for adaptation

Note: (i) The bold words in the column priority challenges and measures striving for urban resilience, reveal the contents of strategies and policies that are related to flood problems. It indicates that flood hazards and climate change are either framed as detached challenges calling for adaptive measures (New York), or mainstreamed with other urban agendas calling for multi-objective solutions in parallel to overheating (Chicago), energy transition (Chicago and Rotterdam), social cohesion (Rotterdam, Paris), the terror threat (Paris), health problems (London, Singapore), droughts (London), or overheating (Chicago, London, Singapore).

Source: author, based on (Chicago Climate Task Force, 2008; Gemeente Rotterdam, 2008; Greater London Authority, 2011; City of New York, 2013; Ministry of the Environment and Water Resources and Ministry of National Development, 2016; Mairie De Paris, 2018)

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Figure 1.2 presents what has been discussed in terms of (1) flooding problems caused by climate change, geographic disadvantages and unsuitable human interventions; (2) the rising notion of urban resilience to deal with floods; and (3) the acknowledgement of spatial planning in dealing with floods. Spatial planning's contribution is through territorial management, vulnerability identification, cost-saving and governing institutions.

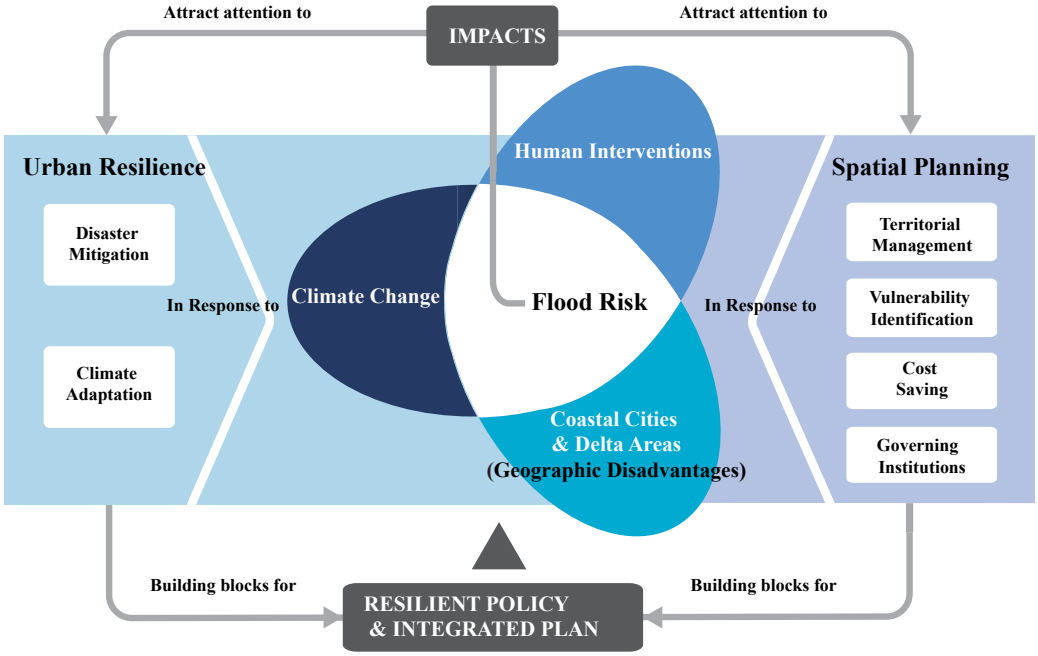


FIG. 1.2 Illustration of the interaction between flood risk, urban resilience and spatial planning, based on the illustration of the core concepts of the Working Group II AR5 IPCC document (IPCC, 2014)

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1.4 Problem statement: the challenges for the spatial planning system in the perspective of governing institutional activities

The IPCC (2014) explains that the current difficulties of adaptation to climate change reside in the transition from a phase of awareness to the construction of actual strategies and plans in societies (robust evidence, high agreement) (Mimura *et al.*, 2014, p.871). Many obstacles are related to the governance of institutions, including the barriers for the development of strategies and the tools for decision-making and implementation (Mimura *et al.*, 2014).

Planning scholars, influenced by social science, policy science, and institutional science, have shared a similar concern and argued that some institutional arrangements could be barriers which challenge the capacity of planning to contribute to managing flood problems (Mileti, 1999; Storbjörk, 2007; White and Richards, 2007; Deyle, Chapin and Baker, 2008; Francesch-Huidobro et al., 2017). This thesis follows this perspective which is increasingly recognised by many scholars but which is still under-developed in the planning literature (more details in a review in Chapter 2). In the context of China, relevant research is even more scarce.

Institutional arrangements can have a profound influence on how planning addresses flood problems. The influence of institutional arrangements on planning can be understood in terms of four theoretical starting points: (i) institutional inertia, (ii) the ways of managing the policy process, (iii) problem-framing in policy discourse, and (iv) contextual factors rooted in institutions.

The first theoretical starting point concerns the literature on the dynamics and stabilities of policies and institutions, which argues that planning systems cannot be reformed easily because of traditional conventions or institutional inertia derived from culture and rooted habits (e.g. Parsons *et al.*, 2019). Thus, to introduce notions such as resilience, adaptation or disaster mitigation so that spatial planning is better equipped to address flood risk is often difficult. Some preliminary studies have shown certain triggers or conditions can contribute to the changes of institutional inertia, such as (i) flood contingencies; (ii) the shifting values of society towards floods, rivers and green-blue infrastructure; (iii) the emergence of new governance

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arrangements; (vi) the rise of political ambitions; and (v) the inclusion of new knowledge (e.g. Harries and Penning-Rowsell, 2011; Garrelts and Lange, 2011; Parsons *et al*., 2019). However, the mechanisms directly leading to deviations are still underdeveloped, with no agreed answers.

The second theoretical starting point sees flood risk as an issue co-determined by multiple actors, multiple levels, and multiple domains. They argue that creating ways to enhance the interactions (e.g. information sharing and communication, cooperation and integration) between planning institutions and other actors in the face of floods is challenging (Deyle, Chapin and Baker, 2008, Ran and Nedovic-Budic, 2016). A considerable number of research papers have shed light on this challenge and attributed the difficulties to the divergent interests, political positions, sequences, and procedures from many stakeholders (Walker et al. 2015, Dąbrowski 2018). To reach a trade-off across stakeholders in the planning process is, thus, stressful (Ran and Nedovic-Budic, 2016). However, the exploration of how to build procedures or workflows that will deal with the necessary trade-offs to facilitate the co-determined process is insufficient.

The third theoretical starting point considers that planning for adaptation can be impaired by 'fragmented and convoluted' frameworks and legislation (Wamsler and Pauleit, 2016). Policymakers and researchers believe that the ways of framing or interpreting climate adaptation and flooding in planning discourse are significant (Brouwer, Rayner and Huitema, 2013). It is relevant not only to the definitions of problems and intentions of acts, but also to the means to do so (Foxell and Cooper, 2015). Various research papers or reports have used this perspective to testify the validity of policy documents or policy innovations (e.g.Wamsler and Pauleit, 2016; Driessen et al., 2018; Runhaar *et al*., 2018). However, in practice, it is still not easy to avoid insufficient framing (for example, no detailed guidelines for local practice and the lack of corresponding explanations at the regional and national levels), incomplete framing (for example, thinking merely flood defence in flood risks management) and disconnected framing (for example, initiating detached policies failing to mainstream adaptation) (Storbjörk, 2007; Ward *et al*., 2013; Wamsler and Pauleit, 2016; Driessen et al., 2018; Runhaar *et al*., 2018). More empirical knowledge is needed of how framing works in practice.

The fourth theoretical starting point is associated with the contextual factors rooted in institutions. The preliminary findings have indicated that these factors potentially influence the enabling conditions for adaptation goals. For instance, the setting of organisational structure, responsibilities, financial allocation, resource sharing and history embedded values can lead to fragmented administration, asymmetries of power, poor motivation, low interest, and weak perceptions of considering flood

issues in planning (Mileti, 1999; Ward *et al.*, 2013; Van Buren, Ellen and Warner, 2016). This perspective is used as a way to partly respond to early papers which highlighted the significance of capacity building of agents in dealing with flood risk and climate change (see, e.g. Smit and Wandel, 2006; Adger *et al.*, 2007; Mehrotra *et al.*, 2009). Unfortunately, they gave limited clues about how to build the capacities.

1.5 Aim and research question

This thesis aims to test these abovementioned challenges of governing institutions in the Chinese context and examine how planning institutions' capacities can be strengthened to support flood resilience and climate adaptation. The studies reported here:

1. identify the institutional arrangements in planning systems and broad flood governance that underlie and shape planning's roles in addressing flood risk;
2. explain the consequent favourable and unfavourable results; and
3. propose suggestions and possibilities to improve planning systems' capacity to cope with the challenges.

The main research question of this study is: **what institutional arrangements determine spatial planning's role in managing flood risk, and how?**

This question is explored in four ways:

1. What are the (long-established) traditions of planning institutions in dealing with flood risk and what effect do they have? What, if any, innovations have taken place and why?
2. To what extent does planning adopt a co-determined policymaking process to address flood risk across the hierarchical levels of spatial planning vertically and across the boundaries between different disciplines horizontally?
3. How are flood problems framed in the discourse of spatial planning, and with what effect?
4. What contextual factors, if any, can influence the enabling conditions of planning in flood governance?

This thesis draws on an empirical case study in Guangzhou. It is one of the most vulnerable cities concerning coastal floods and rising sea level, located in the Pearl River Delta (Hallegatte et al., 2013). It has a long history of fluvial flooding and is still affected by frequent pluvial flooding. Since the promotion of the Sponge City Programme at the municipal level in 2017, dealing with flood risk has drawn the attention of the planning authority and created a series of institutional changes (e.g. policy changes) (Meng *et al.*, 2018). Thus, the Guangzhou case provides an ideal example of the exploration of how a planning system builds its ability to deal with flood risk based on past experience.

1.6 The structure of the whole thesis

This thesis is divided into four parts, with eight chapters (Table 1.2). Part I defines the problem discussed in the thesis. Part II provides a critical review of the literature, defines the theoretical background for the thesis and elaborates its methodology. Part III focuses on the case study of Guangzhou. Finally, Part IV presents the key findings, suggestions for practice, contribution to knowledge and ventures for future research.

Chapter 1 in Part I presents an introduction of this thesis, by describing the understanding of growing flood risk, resilience and adaptation notions in flood affairs, the role of planning in handling floods, and the challenges to be resolved in this research.

Part II consists of two chapters: 2 and 3. Chapter 2 presents state of the art, which outlines the current four research strands on flood resilience, climate adaptation and natural hazards, and positions the domain of planning research in the extensive literature. Chapter 3 presents the conceptual framework and the methodology that this thesis follows in the remaining exploration. Chapter 2 is based on the paper *Enhancing Flood Resilience and Climate Adaptation: The State of the Art and New Directions for Spatial Planning* by Meng, Dąbrowski and Stead, published in the journal *Sustainability* in 2020.

The four chapters in Part III form the empirical study. Four challenges of governing institutions are discussed in Chapters 4, 5, 6 and 7, respectively. They intend to reveal, if at all, the role of planning routines, planning procedures and mandates, framing patterns in policy discourse, institutional design, and governance conditions

in facilitating or hindering planning's contributions to address urban floods. Chapter 4 is based on the paper *Between Inertia and Transition in Spatial Planning in the Face of Flood Risk: A Path Creation Perspective* by Meng, Dąbrowski, Xiong and Stead, peer-reviewed by the journal *Cities*. Chapter 5 is based on the paper *Shifts in Spatial Plans for Flood Resilience and Climate Adaptation: Examining Planning Procedure and Mandates* by Meng, Dąbrowski and Stead, published in the journal *Sustainability* in 2020. Chapter 6 is based on the paper *Collaborative Spatial Planning in the Face of Flood Risk in Delta Cities: A Policy Framing Perspective* by Meng, Dąbrowski, Tai, Stead, Chan, published in the journal *Environmental Science & Policy* in 2019. Chapter 7 is based on a paper *Supporting Governing Flood Resilience: Institutional Design and Governance Conditions*, by Meng, Dąbrowski and Stead, which has been submitted to the journal *Environmental Science & Policy*. To keep the papers forming the chapters complete as published, the backgrounds of Guangzhou case, the flood risks threatening Guangzhou and the descriptions of Sponge City Programme and Sponge City Plan are explained in different places in the thesis. This inevitably leads to some repetition.

Chapter 8 in Part IV summarises empirical findings of this thesis, offers a reflection on theory application, presents the limitations of the methodology used and provides suggestions for future research exploration.

TABLE 1.2 The structure of the whole thesis

Part I: Definition of the problem	**Chapter 1:** Introduction (Toward a brief understanding of the connection between urban resilience, climate adaptation, flood risk, and spatial planning for adaptation)	
Part II: Literature review, theory and methodology	**Chapter 2:** State of the art and new directions for spatial planning in handling flood agendas	
	Chapter 3: Conceptual framework and methodology	
Part III: Empirical study	**Chapter 4:** Spatial Planning in the Face of Flood Risk: Between Inertia and Transition	**Sub-Q 1**
	Chapter 5: Shifts in Spatial Plans for Flood Resilience and Climate Adaptation: Examining Planning Procedure and Planning Mandates	**Sub-Q 2**
	Chapter 6: Collaborative Spatial Planning in the Face of Flood Risk in Delta Cities: A Policy Framing Perspective	**Sub-Q 3**
	Chapter 7: Governing Flood Resilience: Institutional Design and Governance Conditions in Guangzhou	**Sub-Q 4**
Part IV: Key findings, suggestions, contribution and future work	**Chapter 8:** Summary and conclusions	

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2 Enhancing Flood Resilience and Climate Adaptation

The State of the Art and New Directions for Spatial Planning

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ABSTRACT The need to respond to increasing flood risk, climate change, and rapid urban development has shaped innovative policies and practices of spatial planning in many countries over recent decades. As an instrumental–technical intervention, planning is mainly used to improve the physical environment (through concepts such as regulating waterproof facades of architecture, setting buffering zones, and designing green-blue corridors). However, the implementation of the proposed physical interventions is often challenging and necessitates assistance from practices such as climate assessment, policy disciplines, civil societies, and economic resources. These extensive perspectives have spawned many new research domains in the realm of spatial planning. This chapter provides a review of the recent developments in flood resilience, risk management, and climate adaptation; based on this, it positions planning research and practice within these works of literature. Four clusters of thought are identified, mainly in the European and American scholarship of the last two decades. They are environmental concerns, disaster management concerns, socio-economic concerns, and institutional concerns. Current planning research concentrates on disaster management in the underlying belief that planning is functionally efficient. The attention to environmental concerns, socio-economic concerns, and institutional concerns of planning research remains insufficient but has been growing. This, in turn, enlarges the scope of planning research and

indicates future directions for study. These new concerns relate to spatial planning's ability to operate effectively in a multi-sectoral setting, despite limited resources and in the face of uncertain risk.

KEYWORDS flood resilience; spatial planning; flood risk; literature review

2.1 Introduction

There are lively scholarly and policy discussions on how to solve the growing flood threat and climate change, on what approaches are usable, and on how different actors can contribute to addressing these concerns (Vis et al., 2003; Economics of Climate Adaptation Working Group (ECA), 2009; Hegger et al., 2013; Löschner and Nordbeck, 2020). Although spatial planning has been recognised as a source of useful tools to handle flooding hazards, most studies appraise its physical function, as an instrumental–technical intervention to arrange the spatial layout and land use, such as regulating waterproof facades of architecture, setting buffering zones, and designing rainfall gardens and green-blue corridors (Davoudi, Crawford and Mehmood, 2009; Roggema, 2009, 2012). This chapter argues that the role of planning goes beyond this. To support it, the paper reviews a wide range of literature to (1) outline the state of the literature dealing with floods in policy, research, and practice based on multiple disciplines, and (2) position the domain of spatial planning in the different parts of the literature. This chapter concentrates on three types of flooding events: (1) fluvial floods (or river floods), (2) pluvial floods (or surface water floods occurring when rainfalls exceed the capacity of drainage systems), and (3) coastal floods (including extreme storm surges and gradually rising sea levels).

The remainder of this chapter consists of four sections. Firstly, it introduces a four-pillar conceptual framework for the literature review developed in this chapter. Secondly, it applies this framework to review the literature of relevance in the recent 20 years (the 1990s–late 2010s). We provide a brief account of the genesis of each pillar and characterize what is distinctive about their approaches to environmental, disaster management, social-economic, and institutional problems. The objective here is to outline a broad landscape of scholarship from across various disciplines over which the position of the planning field can be understood and clarified. Thirdly, the paper explores the status quo in the spatial planning research in relation to each of the four clusters of thought to identify the well-developed and neglected

perspectives, the latter creating scope for planning to contribute to the advancement of scholarship on flood resilience. The paper closes with an outline of future research directions and concluding remarks.

2.2 The four pillars of resilience agendas through the lens of sustainability

The starting point for organising the review is the literature on resilience and sustainability in urban development. The 17 Sustainable Development Goals (SDGs) associate resilience with sustainability in Goal 11 and propose to "make cities and human settlements inclusive, safe, resilient, and sustainable" (United Nations, 2015, p.24) . Diverse actions are envisaged to reach this goal which can be summarised in five perspectives: environmental concerns (the reduction of the adverse environmental impact of cities); social concerns (the protection of poor or vulnerable people, including women, children, and elderly people); economic concerns (the decrease in financial loss); disaster management concerns (access to safety through, for instance, transport infrastructure and resilient buildings); and institutional concerns (participatory and integrated planning and management). Similar categories have been proposed, for example, a fourfold categorisation of benefits: environmental benefits (e.g., land, water, climate change), social benefits (e.g., safety, risk reduction, welfare), economic benefits (e.g., recourses, payments), and institutional and governance benefits (e.g., stakeholders, institutions, networks) (Grafakos, Gianoli and Tsatsou, 2016).

Inspired by these grouping, I have adopted a four-pillar framework to organise the review of research and practice on the connection between flood resilience and spatial planning. These pillars are (i) environmental, (ii) disaster management, (iii) socio-economic, and (iv) institutional (and governance) concerns. Social and economic perspectives are merged on account of the intertwined negative impacts caused by floods, for instance, the poor (a financial problem) having limited access to safe shelter (an inequity problem). A disaster management perspective is highlighted here referring to physical interventions (e.g., infrastructure layout designs, land use allocation) and related regulations that manage physical changes (e.g., building codes).

2.3 The genesis of policies, studies and practices to address flooding

Based on the four pillars outlined above, this section provides a brief account of the genesis of policies, academic studies, and practices to address flooding. It is based on extensive (academic and grey) literature across the fields of climate science, disaster mitigation, water management, flood risk management, hydrological engineering, economics, adaptation planning, public participation, administration, and governance.

2.3.1 Environmental concerns

The literature focusing on environmental concerns aims to unpack how social-ecological systems—encompassing all ecological goods, (built) assets, services, and even populations—are threatened by flood hazards that can be exacerbated by climate change and human activities. These concerns arose from the uncertainty of climate change, extreme weather, and the risks they entail. At the global level, this strand was promoted by the ecosystem-based risk projection, proposed by the Intergovernmental Panel on Climate Change (IPCC). As early as in the 1990s, the IPCC started to assess the impacts from climate change and extreme weather based on several presumed scenarios in terms of the increase in CO_2 emissions, global mean temperature, precipitation, and sea-level rise (Tegart, Sheldon and Griffiths, 1990). In 2001, scientific progress accelerated in the Third Assessment Report (TAR), when new observations and the related modelling (for instance, greenhouse gases, solar activity, and land surface properties) were integrated. This inspired many studies to use a similar approach in climate impacts assessment, "beginning with projections of future emission trends, moving on to the development of climate scenarios, and thence to biophysical impacts studies." (Kelly and Adger, 2000, p.327)

The climatic assessment also inspired the efforts to identify gains and losses of flood-exposed entities in different regions, nations, and areas (Lehner *et al*., 2006; IPCC, 2007; Katsman *et al*., 2009; United Nations Development Programme (UNDP), 2010; Forzieri *et al*., 2016; Jana and Hegde, 2016; Barnard *et al*., 2019). In this trend, the IPCC Third Assessment Report (2001) (IPCC, 2001) initiated human-security-based assessment and brought about the notion of vulnerability. As a

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result, contextual conditions were gradually used to analyse “the degree to which a system is susceptible to, or unable to cope with, adverse effects of climate change, including climate variability and extremes" (IPCC, 2001, p.6), considering wealth, technology, information, skills, infrastructure, access to resources, and management capacities (Adger, 1996; Kelly and Adger, 2000; Eriksen and Silva, 2003; Eriksen and Kelly, 2007).

Climate impacts on ecosystems, (built) assets and human security are then visualised in climate-sensitive maps, flood-exposure maps (fluvial, pluvial, and coastal floods), and vulnerability maps. These maps contribute to an exchange of the prediction of the scale, time, location, and likely damages of impending floods (Eriksen and Kelly, 2007; IPCC, 2007; United Nations Development Programme (UNDP), 2010). They further help to provide information for setting priorities in climate-resilience activities in disaster management, for instance, risk-based education, emergency forecasting, early warning, mitigation, prevention, preparation, and post-recovery (Grasso and Singh, 2011; Hooijer *et al.*, 2015; United Nations International Strategy for Disaster Reduction (UNISDR), 2015) (see Section 2.3.2).

2.3.2 Disaster management concerns

The literature focusing on disaster management concerns aims at identifying effective solutions to reduce the negative impacts of flood hazards. Since the early 2000s, this cluster witnessed a transition from hydrological engineering defences toward integrated flood risk management, considering the increasing damage potentiality in a basin where confidence in safety is miscreated by traditional flood control infrastructure (Takeuchi, 2001; Vis *et al.*, 2003).

The notions of ‘disaster cycle’ or ‘flood risk cycle’ inspired this transition, which called for attention to the consecutive phases of flood events (before, during, and after) (Khan, Vasilescu and Khan, 2008; Klijn *et al.*, 2009). Numerous resilient measures were developed in this context, such as prevention, protection, response, and recovery, even though they were interpreted differently in diverse models (Kienholz *et al.*, 2004; European Commission, 2007; Thieken *et al.*, 2007; Hegger *et al.*, 2013)(See more details in Table 2.4 in Supplementary data).

The implementation of the proposed measures, however, often faced challenges, given the enormous investment entailed, as well as data and predictive uncertainty in modelling (Vis *et al.*, 2003). Additionally, current successful solutions may no longer be useful when hazards exceed a threshold (the maximum capacity of a system to

keep safety, e.g., drainage systems) in the future. Thus, static or on-off resilient measures are not advisable in the face of the unpredictability of climate change, and the flexibility to shift from one to another alternative is significant (Reeder and Ranger, 2010; Barnett *et al.*, 2014; Siebentritt, Halsey and Smith, 2014; Buurman and Babovic, 2016). Last but not least, there might be cases where not all adaptation options need to be implemented immediately in the short term, and the awareness, risk evaluation, and even technical support also need time to be prepared (Ranger *et al.*, 2010; Haasnoot *et al.*, 2012).

Consequently, since the 2010s the literature has gradually turned its attention to the assessment of pathways to greater resilience, and methods for the identification of optional actions, the selection of policies and actions and their implementation (Wise *et al.*, 2014). A series of studies propose to help decision-makers to (1) arrange investments in a sequential way; (2) identify scenarios for a system's (nation, region, city, area) reliance on alternatives; (3) determine the decision points for the choice and preparation of alternatives; and (4) portray the future implementation of a mix of alternatives (Denton *et al.*, 2014). The consideration of the economic efficiency of resilient measures and wise allocation of funding has been raised in this part of the literature, consolidating the strand of research focusing on socio-economic concerns (see Section 2.3.3).

2.3.3 Socio-economic concerns

Despite the growing knowledge on the effects of climate change and flood hazards and available measures to deal with the effects, substantial economic uncertainties still hinder the design and implementation of adaptation measures in practice. These uncertainties include: (1) the potential loss of threatened systems under pressures (IPCC, 2001), (2) the extent to which the resilient (or adaptation) measures could ameliorate the negative effects and enhance positive effects, and the extent of the cost of actions (De Bruin *et al.*, 2009; Debels *et al.*, 2009; Mechler *et al.*, 2014), and (3) the distributional effects of the proposed resilience measures (Anguelovski *et al.*, 2016). Correspondingly, the literature focusing on socio-economic concerns, supported by economic scientists and economic analysis institutions, provides some insights into these issues by (1) estimating financial losses of climate change and flood hazards (Stern, 2007), (2) calculating investment and payoff of flood resilience measures (Hallegatte, Henriet and Corfee-Morlot, 2011), and (3) allocating the responsibilities of a flood (or pre-flood) loss compensation (Doorn-Hoekveld *et al.*, 2016).

Initial studies from the IPCC's 2001 report (IPCC, 2001) and *The Stern Review on the Economics of Climate Change* (Stern, 2007) have made attempts to use formal economic models to estimate the global costs and risks of climate change on markets (e.g., agriculture), no-market conditions (e.g., human health), and social contingencies (e.g., migration). Their findings indicated a more sensitive economic structure of developing countries (IPCC, 2001) and a 5–20% decrease of GDP each year globally in the case that no action is taken, and the temperature continues to increase (Stern, 2007). Following a similar route, increasing economic studies formulated models to assess the effects of climate change and the damages of floods to agriculture, residential areas, properties, etc., according to different land use functions either at regional, local, or sectoral levels (Genovese, 2006; Baky *et al.*, 2019; Gould *et al.*, 2020).

The literature calculates investment and payoff aims to assess the economic effectiveness of flood resilience options and compare alternatives. Generally, measures and projects dealing with climate change and floods can be expensive; governments and institutions have to carefully consider how to deploy limited funding (Wagemaker, Leenders and Huizinga, 2007). Cost-benefit analysis (CBA), cost-effectiveness analysis (CEA), and multi-criteria analysis (MCA) have been three primary evaluation tools widely used to measure flood damages, project costs, and net benefits (Moench *et al.*, 2008; Merz *et al.*, 2010; Mechler, 2016). These tools create opportunities to explore the costs for non-resilience or non-adaptation initiatives, the benefits brought by a potential resilience choice, and the factors that should get priority considering a limited budget (e.g., the macro-economic effects, the losses in production, or the human suffering accompanying a flood) (Wagemaker, Leenders and Huizinga, 2007).

The flood (and pre-flood) loss compensation focuses on the fair distribution of adverse effects of flood risk management. This is based on the notion that actions to prevent floods, like flood defence, water retention, and planning for adaptation, can also bring about loss. It could occur when flood risk management measures are taken to protect a part of a region or an area (normally densely populated), while another group of people is left out under the threat of floods (for instance those living in deprived areas). In a flood control project, people and lands with a higher income/value can attract more resources for damage reduction and security protection compared to the poor with degraded land values (Anguelovski *et al.*, 2016).

Adverse effects of flood risk management could also occur when the construction of flood resilience infrastructures has to expropriate private properties. It leads to a debate on who should pay for private landowners' losses when individual interest is challenged by public interests. The burden-sharing and benefit-giving,

in the European context at least, follow four major principles (Doorn-Hoekveld *et al.*, 2016): (1) the solidarity principle (for instance, all Dutch citizens pay for the cost caused by flood risk management via tax and leave responsibilities to regional water boards and the Dutch state), (2) the protection of private property rights principle unless for public interests with authorised law, the appropriate ministry's approval, and compensation (e.g., in England), (3) the equity before public burdens principle (compensations to a restricted loss in the public interest in Flanders), and (4) the practice of citizens bearing minor adverse effects themselves while getting compensation in the case of strong adverse effects (e.g., in France).

2.3.4 Institutional and governance concerns

The strand of the flood resilience scholarship concerned with institutional and governance issues is a mixed body of literature spanning across the disciplines of social science (Aylett, 2015), political science (Fraser and Kirbyshire, 2017), and policy studies (Keskitalo, 2010; Bulkeley, 2013). It concentrates on exploring how an institutional system, at the national, regional urban, or community level responds to flood risk and natural hazards.

The literature observes that resilience policies and adaptation activities are a result of collective behaviours in multi-level, multi-domain, and multi-actor settings (Bulkeley, 2010, 2013; Keskitalo, 2010). Public agencies and non-state actors, within a system, adjust their structures and practices, interact with each other and carry out procedures, routine, norms, and conventions in a specific political context. Possible weaknesses are identified that could hinder the systems' adaptive capacity to deal with climate change and the flood risk. They include aspects such as human resources, social and economic capital, access to information and resources, and flexibility in decision-making processes (Yohe and Tol, 2002; Smit and Wandel, 2006; Adger *et al.*, 2007; Brooks and Adger, 2007; Vincent, 2007; Moser and Luers, 2008; Mehrotra *et al.*, 2009; Jones, Ludi and Levine, 2010). The United Nations' Inter-Agency Secretariat of the International Strategy for Disaster Reduction (UN/ISDR) emphasised the need for capacity: "a combination of all the strengths and resources available within a community, society or organisation that can reduce the level of risk or the effects of a disaster." (United Nations, 2004, p.16)

Numerous studies have examined—often interrelated—institutional and governance barriers for resilience (Bulkeley and Betsill, 2003; Kern, 2008; Bulkeley, 2010, 2013; Keskitalo, 2010; Simanjuntak *et al.*, 2012; Lienert, Schnetzer and Ingold, 2013; Aylett, 2015; Dewulf, Meijerink and Runhaar, 2015; Wamsler, 2016; Parsons

et al., 2019) (See Table 4.3 in Supplementary data). The barriers, initially, reside in policies, strategies, and project plans. Studies regarded them as the outputs of governance process through a co-determined interaction on the one hand; and on the other hand as the rules and directions to influence policymakers, practitioners, and civil society's working styles in following governance process (Bergsma, 2016; Linnerooth-Bayer *et al*., 2016; Moon, Flannery and Revez, 2017). New ways of framing resilience in these documents raise the discussions on whether to choose to incorporate it in a detached sectoral paper or mainstream it with other local agendas; how to deal with the mismatches between different governance levels caused by new framing; and how to realise the ambitions of new framing by balancing the conflicts between short-term economic benefits and long-term climatic benefits (Keskitalo, 2010; Simanjuntak *et al*., 2012; Bulkeley, 2013; Aylett, 2015; Dewulf, Meijerink and Runhaar, 2015).

Quite a few papers attribute institutional barriers to the complexity of the collaborative process in flood governance. Individual institutions or agents with different roles, interests, and leadership form a related social network in flood agendas. Such divergence can result in difficulties in building consensus between the public and private actors (Keskitalo, 2010; Bulkeley, 2013; Dewulf, Meijerink and Runhaar, 2015). The difficulty can be further complicated by the distinctive policy-making procedure features between horizontal and vertical governmental sectors such as frequencies, cycles, and workflows (Kern, 2008; Keskitalo, 2010; Simanjuntak *et al*., 2012; Bulkeley, 2013; Lienert, Schnetzer and Ingold, 2013).

The studies on authority, resources, and organisational conditions partly respond to the debate on how to facilitate policy-making and sectoral collaboration in flood governance. In a nutshell, this requires legal support, influencing powers, clear responsibilities of the different organisations involved, discretions, sufficient financial resources, accessible information and knowledge on climate change impacts and hydrological issues, proactive political wills, inclusive participation of stakeholders, skilled personnel, and innovative techniques (Bulkeley and Betsill, 2003; Bulkeley, 2010, 2013; Keskitalo, 2010; Aylett, 2015; Wamsler, 2016).

Last but not least, a few institutional research papers regard deeply rooted contextual factors as a source of institutional barriers, given how those factors shape governance conditions. As Harries and Penning-Rowsell (Harries and Penning-rowsell, 2011) identified, institutional cultures, and established public perceptions could impair the agents' capacities to embrace extensive resilient measures, given that the stickiness to institutional routine and widely accepted notions are often unchangeable. Similar ideas are also advanced in studies from Simanjuntak et al. (Simanjuntak *et al*., 2012), Bulkeley (Bulkeley, 2013), and Parsons et al. (Parsons

et al., 2019), which extend the barriers to the history- and culture-embedded institutional notions, values, and traditions (e.g., social expectations, legislation, and juridical decisions values) and institutional features such as administrational procedures, laws, and organisational structures which are relatively enduring and hard to change.

2.3.5 Summary and discussion

As outlined above, studies of flood resilience tend to fall into four groups (Figure 2.1). Even so, it is notable that these four pillars of the literature closely interact with and complement each other. Environmental concerns literature focuses on the adverse impacts of climate change on social-ecological systems and identifies the vulnerability of ecological assets, built assets, services, and populations based on observation, modelling, projection, and assessment. The findings from this strand of literature have attracted the attention of international, national, and sub-national institutions to the need for making agreements to develop climate coping strategies. Then, the literature concerned with disaster management put forward the need for integrated resilient measures to deal with flood events. Among the proposed measures, specific options were chosen and implemented in flexible pathways according to the local context. The literature on socio-economic concerns consolidated the options' selection and pathway implementation on account of investment, payoff, and compensation, as well as the understanding of the losses generated by climate change and the flood risk in case of lack of adaptation action. The abovementioned activities were all influenced by institutional and governance features, for instance, existing policies, agencies, political conditions, and history- and culture-embedded perceptions, as highlighted in the strand of the literature on institutional and governance concerns.

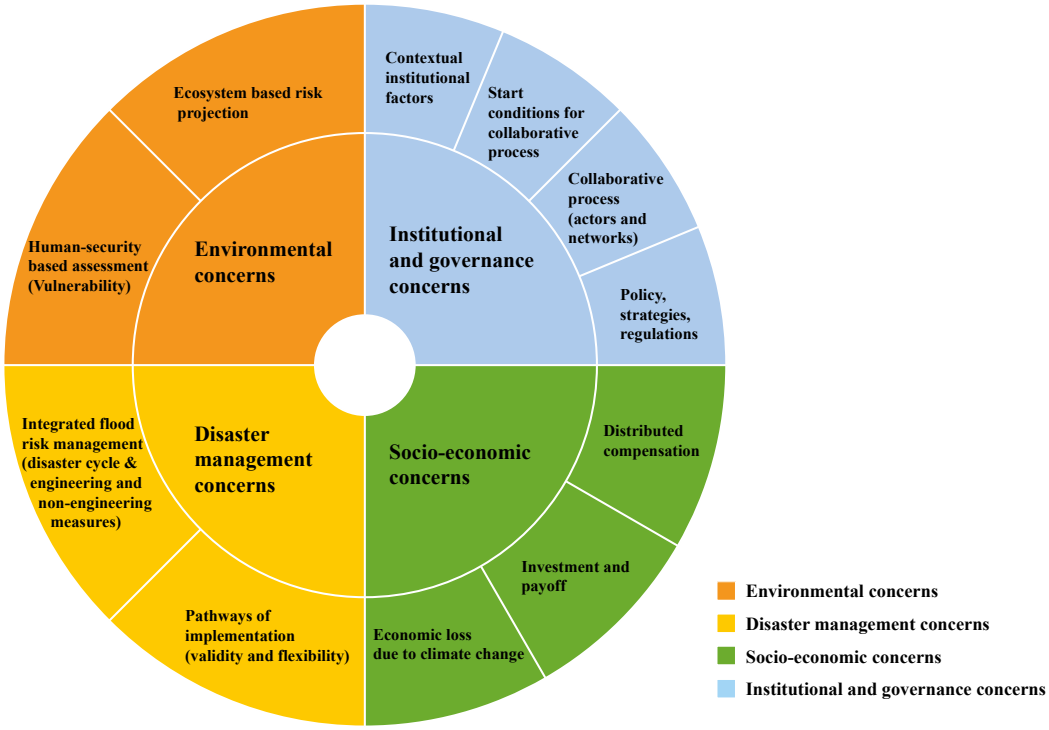


FIG. 2.1 The four pillars in the literature on flood resilience

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2.4 The development of spatial planning research, policy and practice across the four pillars of the flood resilience literature

This section explores the development and challenges of spatial planning in relation to the proposed four pillars of the flood resilience and the abovementioned disciplines, based on the literature from spatial policy, land use planning, urban studies, flood risk management reports, and water management studies. It will be argued that spatial planning research concentrated on disaster management concerns, despite the emergence of planning research, policy, and practice on environmental, socio-economic, and institutional and governance concerns. Here, the subtle difference between spatial planning and similar terms like land-use planning or urban planning is neglected for simplification. Some early research has indicated that these similar terms are more technical and concerned with zoning and setting parameters for land development, while spatial planning is broader, not only technical but also relating to the coordination of spatial activities (Fleischhauer, 2008; Stead, 2008).

2.4.1 Limited attention paid to environmental concerns

Environmental concerns have not been a main focus of the planning scholars and practitioners. In practice, agencies dealing with climate science, meteorology, environmental science, and hydrology are forerunners in flood resilience, having more experience in monitoring, weather forecasting, and climatic assessment. As a result, these agents are mainly responsible for the observation, modelling, and projection of climate change impacts and their leading flood events. For instance, in the UK, the Environment Agency in England, the Natural Resources Wales, the Scottish Environment Protection Agency, and the Department of Infrastructure in Northern Ireland launched their flood maps within their jurisdictions (Department of Infrastructure in Northern Ireland, no date; Environment Agency in England, no date; Natural Resources Wales, no date; Scottish Environment Protection Agency, no date). Similarly, in the Netherlands, the Foundation Climate Adaptation Services launched the Climate Impact Atlas, which indicates the potential flooding areas (Foundation Climate Adaptation Services, no date).

Planning institutions, due to a lack of professionalised knowledge, often step behind the abovementioned institutions. Even so, they can still make a contribution to this stream by building strategic cooperation with those forerunners and overlaying hydrological maps (e.g., flooding maps) with socio-spatial data (e.g., age, incomes, land uses) to identify gains and losses of flood-exposed entities in different regions, nations, and areas. The findings then provide opportunities for the planning sector to offer solutions to reduce flood loss (more details in Section 2.4.2). Typical cases are the Urban Waterfront Adaptive Strategies in New York (New York-Connecticut Sustainable Communities Consortium, 2013) and Climate Change Adaptation Strategies in Rotterdam (Rotterdam Climate Initiative, 2013), in which flooding maps and socio-spatial data were used to identify the vulnerabilities of communities and neighbourhoods caused by coastal floods and rainfalls and further develop strategies for flood resilience.

2.4.2 A focus on disaster management concerns

According to our observations, extensive planning literature has developed rich experience in disaster management concerns. The main aim of this literature is to identify and implement measures that planning can use to deal with floods. As with the former goal, the proposed measures in the more recent literature since the 1990s can be categorised into five aspects, based on the early study from Hegger et al. (Hegger *et al*., 2014), including avoidance, defence, mitigation, preparation, and recovery in terms of structural and non-structural interventions (see details in Table 2.1). However, these measures can be debatable and are not universally used. For instance, floodplain zoning plans in the avoidance category, which suggest retreating from waters (often coastal and fluvial floods), have faced criticism of losing valuable lands for urban development in countries and areas with high population density, like those that are members of the Organisation for Economic Cooperation and Development (OECD) (Sayers *et al*., 2013; Chiabai *et al*., 2015). Another case is the synergy of dyke systems and transportation or residential development in the defence category. This synergy has been a context-specific experience, for instance, in the Netherlands, where the integration between planning and flood risk management and un-embanked area development (urban development beyond dykes) is well-established and rooted in deeply embedded traditions in water management and planning (Van Veelen, Voorendt and Van Der Zwet, 2015; Voorendt, 2017). Thus, these experiences cannot be used in other contexts without modification.

Nature-based infrastructure for flood mitigation has been a major solution widely promoted in the planning literature to decrease flood loss. Ecological buffer zones at the macro-scale; mangroves, dunes, mashes wetlands, lakes, and green-blue river/waterway/canal branches at the mezzo-scale; and rain gardens, permeable paving, green roofs at the micro-scale are proposed to protect shorelines, retain rainwater and ensure drainage of excessive river waters as fast as possible (Kang, Lee and Lee, 2009; Sayers *et al.*, 2013; Wingfield *et al.*, 2019).

Preparation and recovery measures in the planning literature have not been much explored, such as evacuations and safe haven creations (emergency response). A few papers based on Geographic Information System (GIS) methods, transportation, and urban simulation, opened windows for the domain of spatial planning to optimise evacuation plans and shelter locations arrangements in the face of coastal and fluvial floods (Tagg, Chen and Powell, 2013; Elsergany *et al.*, 2015; Coutinho-Rodrigues, Sousa and Natividade-Jesus, 2016; Jamrussri and Toda, 2018). Similarly, critical infrastructure protection is an under-researched issue in planning literature, which calls for paying more attention to protecting critically important buildings in the flood events, such as power generation plants, healthcare centres, and police stations (Sayers *et al.*, 2013; World Health Organization (Regional Office for Europe), 2017).

The literature stressing the implementation and pathway of flood resilience leads to the rise of the notion 'adaptive planning' in the spatial planning literature. This strand of literature calls for (1) planning to keep options open to changing circumstances, avoiding locking in rigid decisions; and for (2) local societies and policymakers to remain flexible and adjust their strategies and measures in the face of the uncertainty of floods and climate change (Haasnoot *et al.*, 2013; Walker, Haasnoot and Kwakkel, 2013). While 'adaptive planning' is a well-established notion in climate change discourse or flood risk management, it remains a conceptual metaphor in the planning field mostly, used to explore how to implement a sequence of proposed measures dynamically over time. A crucial part of this literature is to define the overall adaption measures and the future conditions (threshold) determining alternative options to replace the unsuccessful measures (Gersonius, 2012; Haasnoot *et al.*, 2013; Van Veelen, 2013; Walker, Haasnoot and Kwakkel, 2013). This literature has been criticised due to its difficulty in defining successful and unsuccessful measures and the idealised assumptions that decision-makers would like to make decisions based on long-term visions and seek opportunities to adjust plans and strategies in the face of the failure of some measures or their unintended negative effects ('maladaptation') (van Veelen, 2016).

TABLE 2.1 Five types of measures to deal with the flood risk when planning is taken into consideration

Measures	Statements in Planning Policies/ Regulations	Affected (Non-) Structural Interventions in Practice	References
Avoidance/ prevention	Floodplain zoning plans; land acquisition and relocation plans	Watershed management and retreating from waters (avoiding urban development in flood-prone areas) Function arrangement (economic enterprises, residential areas and recreations) Population move and building (re) locations	(Thampapillai and Musgrave, 1985; Kang, Lee and Lee, 2009; Sayers et al., 2013)
Defence	Multi-purpose/multifunctional engineering measures to deal with coastal and fluvial floods with the consideration of leisure, landscape, and commerce	Dykes, floodwalls or quay walls (setting back, combined with residential buildings, commercial development, greening, and transportation) Reservoirs (water storage, supply, natural landscape, and recreation)	(Van Veelen, Voorendt and Van Der Zwet, 2015; Voorendt, 2017; Wingfield et al., 2019)
Mitigation	Nature-based infrastructure for coastal flooding reduction, rainfalls detention, retention, and a river discharge passage	Creation of green buffers and flood detention areas Creation and preservation of mangroves, dunes, mashes wetlands, lakes, and green-blue corridors Waterways and channels de-culverting, greening, and improvement Sustainable Drainage Systems (SuDS)/Low impact development measures (rain gardens, permeable paving, green roofs)	(Kang, Lee and Lee, 2009; Sayers et al., 2013; Wingfield et al., 2019)
Preparation	Building codes and building controls; evacuation plans; safe havens arrangement	Buildings waterproofing (removable stop logs, water-retaining walls, mobile barriers, the lowest flood elevation for footings, structural requirement to withstand water pressure, prohibiting basements, flood-proof facades, standards for buildings anchored to foundations) Road networks optimization Safe havens creation	(Water Resources Council, 1971; Elsergany et al., 2015; Coutinho-Rodrigues, Sousa and Natividade-Jesus, 2016; Voorendt, 2017; Jamrussri and Toda, 2018)
Recovery	Post-recovery plan; critical infrastructure protection	Building reconstruction Re(location) and reinforcement of supporting buildings such as power plants, healthcare centres, and police stations	(Olshansky et al., 2008; Sayers et al., 2013; World Health Organization (Regional Office for Europe), 2017)

2.4.3 A weak but emerging focus on socio-economic concerns

The discussion of socio-economic features of resilience measures has been largely neglected in the planning literature. It has been partly covered in a few planning papers which concentrate on the economic issues of flood resilience measures in urban development projects, that is the calculation of investment and payoff (Raaijmakers, Krywkow and Veen, 2008). An early study from Bruin and Goosen (Bruin and Goosen, 2014) used cost-benefit analysis (CBA) to verify the economic efficiency of flood resilience measures to deal with precipitation. They found that rainfall gardens, raised roads, and building codes were not economically efficient in contrast to ecological networks in a Dutch case. The institute Urban Floods Community of Practice confirmed the significance of regulatory instruments in Florida relying on cost-effectiveness analysis (CEA), where risk-based building codes reduced severe flood loss from Hurricane Charley by 42% (Urban Floods Community of Practice (UFCOP), 2017). Similar applications of cost-effectiveness analysis also appear in papers which confirm the effects of zoning plans and development controls in England, Colombia, Japan, New Orleans, Seoul, etc. (Urban Floods Community of Practice (UFCOP), 2017). Raaijmakers et al. explored ways of using multi-criteria analysis (MCA) to decide either a continuation of housing development in flood-prone areas for profits or a change of cultivated lands to natural lands to face the flood risk (coastal floods caused by storms) given the public and private stakeholders' worries and their individual risk perception (Raaijmakers, Krywkow and Veen, 2008).

Economic reports have given a more critical assessment of different flood resilience options available for planning and pointed out that the benefit-to-cost ratio is variable. For instance, mangroves as a natural option to create buffer zones to reduce coastal floods, supposed to have a high benefit-to-cost ratio by the Economics of Climate Adaptation Working Group (ECA) report (Economics of Climate Adaptation Working Group (ECA), 2009), was criticised by Sanghi et al. (Sanghi *et al.*, 2010) on account of an exponential increase in costs in high-income countries, like the United States. Similar discrepancies also appeared in options like retreating from low-lying areas, and building codes (see Table 2.2). The inconclusive cost-benefit results are partly due to the uncertainties related to flooding extremes and the high site-specificity (Chiabai *et al.*, 2015). The same measures adopted in different areas can have different ratios of cost and benefit due to the specific features of an area, from land prices, policy enforcement costs, to maintenance expenses, differences in risk levels, the costs of resilience measures, existing costs, and asset lifetimes, etc. (Hochrainer-Stigler *et al.*, 2010; Sanghi *et al.*, 2010). Also, the calculation can be affected by the definition of 'cost' and 'benefit' which can greatly alter the mathematical results (Sanghi *et al.*, 2010; Chiabai *et al.*, 2015).

TABLE 2.2 Economics of flood resilience measures available for spatial planning

Resilience Interventions		Calculation Methods	Findings	References
Watershed management and function arrangement	Retreating from low-lying areas *	CBA	A high benefit-to-cost ratio for hurricane protection and storm-surge; yet involving high opportunities in costs of lands, like OECD countries	(Economics of Climate Adaptation Working Group (ECA), 2009; Chiabai *et al.*, 2015)
	Zoning plan with a functional arrangement	CEA	High benefits	(Urban Floods Community of Practice (UFCOP), 2017)
	A change of cultivated lands to natural lands to mitigate loss	MCA	High acceptance of public and private stakeholders in individual risk perception	(Raaijmakers, Krywkow and Veen, 2008)
Building codes/ controls	Mobile barriers *	CBA	A high benefit-to-cost ratio	(Economics of Climate Adaptation Working Group (ECA), 2009)
	Houses with waterproof glass or windows *	CBA	A low benefit-to-cost ratio	(Bruin and Goosen, 2014)
	Retrofitting building materials against floods *	CBA	High/low benefit-to-cost ratio depending on differences in risk levels, the costs of resilience, existing costs and asset lifetimes, and assumed discount rates locally	(Hochrainer-Stigler *et al.*, 2010)
	Residential building controls reducing severe flood loss from Hurricane Charley by 42%	CEA	High benefits	(Urban Floods Community of Practice (UFCOP), 2017)
Multi-purpose engineering measures	Construction of dykes combined with transportation	CBA	A low benefit-to-cost ratio	(Bruin and Goosen, 2014)
Natural coastal and waterfront buffer zones	A change of cultivated lands to ecological networks	CBA	A high benefit-to-cost ratio	(Bruin and Goosen, 2014)
	Mangroves *	CBA	A high benefit-to-cost ratio; yet an exponentially increase in costs due to land transformation and policy enforcement costs in high-income countries, like the US	(Economics of Climate Adaptation Working Group (ECA), 2009; Sanghi *et al.*, 2010)
Water detention base on green space	Rainfall gardens for water storage	CBA	A low benefit-to-cost ratio	(Bruin and Goosen, 2014)

CBA: cost-benefit analysis; CFA: Cost-effectiveness; MCA: multi-criteria analysis

** The findings come from economic reports*

Light blue coloured blanks are the findings indicating variable benefit to cost ratios

Such a site-based uncertainty is, thus, a reason which makes scholars unable to agree on the economic efficiency of resilience measures. Even so, the analysis in the economic literature still provides insights for the planning literature on how to calculate the economic payoffs and profits of resilient measures that support option selection according to local conditions.

2.4.4 An increasing focus on institutional and governance concerns in the planning literature

A small but increasing number of planning researchers focus on institutional and governance concerns (Mileti, 1999; Storbjörk, 2007; White and Richards, 2007; Deyle, Chapin and Baker, 2008; Francesch-Huidobro *et al.*, 2017), inspired by the knowledge provided by social scientists, political scientists, policy scientists, and policymakers. One strand of the literature suggests exploring the involvement of planning in flood affairs as a by-product of water management governance under the notions such as 'integrated water resources management' (Mostert, 2006), 'synergy between flood risk management and spatial planning' (Sayers *et al.*, 2013; Ward *et al.*, 2013; Buuren, Ellen and Warner, 2016; Ran and Nedovic-Budic, 2016; Driessen *et al.*, 2018), 'multi-level governance and boundary spanning planning for adaptation' (Dąbrowski, 2018a), and 'diversification of flood risk management with spatial planning's involvement' (Driessen *et al.*, 2018). Another strand of research, although represented only in a few papers, positions planning at the centre of flood resilience and calls for the incorporation of flood risk management and climate adaption in land use planning or spatial planning (Mileti, 1999; Storbjörk, 2007; White and Richards, 2007; Deyle, Chapin and Baker, 2008; Francesch-Huidobro *et al.*, 2017).

These emerging studies share a focus on identifying the facilitators and barriers for planning to play a meaningful role in the flood governance and exploring how and why they emerge. The main points in relation to preparation for adaptation (knowledge), vulnerability assessments, adaptation strategies identification, adaptation options selection, and implementation include (Table 2.3):

1 Governance products: Some studies reported that policies, strategies, codes, standards, and planning rules provided legal supports and incentives for planning to be involved in flood agendas (Wilby and Keenan, 2012). Empirically, the literature concentrated on systematic integration of resilience or adaptation agendas into planning programmes, policies, and projects (Ward *et al.*, 2013), a necessity of functioning tools with more stringent and detailed requirements in the national and regional policies to guide policymakers and planners at lower tiers of government

(Driessen *et al*., 2018; Runhaar *et al*., 2018), and the inclusion of climate information and vulnerability assessment in long-term policy decision-making (Storbjörk, 2007). The solution to those challenges, as Wilby and Keenan (Wilby and Keenan, 2012) argued, often rests in the collaboration process between multiple stakeholders across policy sectors and levels of government.

2 Collaborative process: Increasing numbers of planning studies stress the joint work between planning and extensive actors in the formulation and implementation of resilience and adaptation policies, albeit pointing out that trade-off between governments, planning agencies, hydrological engineers, scientists, civil society, and markets are difficult (Storbjörk, 2007; Francesch-Huidobro *et al*., 2017; Dąbrowski, 2018b; Driessen *et al*., 2018). A few papers added to this line of argument and reported that mismatches in time-spans and procedures between professions could impair the transboundary cooperation between the planning sector and other sectors (Mostert, 2006; Davidse, Othengrafen and Deppisch, 2015; Ran and Nedovic-Budic, 2016). More research is needed to explore the reasons and solutions to overcome this mismatch.

3 Start-conditions for planning to participate flood governance: A small number of studies have cast light on the complexity of the collaborative process in terms of authority, resource and organisation conditions and indicated these pre-sets could affect planning's performance in the collaborative governance (Mileti, 1999; Deyle, Chapin and Baker, 2008; Driessen *et al*., 2018). For instance, the legal certainty and flexibility of planning tools could influence legal restrictions in land use and policy changes for climatic uncertainty (Mileti, 1999; Deyle, Chapin and Baker, 2008; Driessen *et al*., 2018). Also, suitable allocation of finance and access to information in relation to planning is required to deal with distributional effects of floods (fairness), information sharing between sectors, and the public's right to be informed (IPCC, 2014; Driessen *et al*., 2018). Last but not least, the establishment of technical co-working platforms, clarification of planning's accountability (or responsibilities), and the planners' knowledge determine the planning agencies' capacities in flood governance (Mileti, 1999; Storbjörk, 2007; Ward *et al*., 2013; Ran and Nedovic-Budic, 2016; Driessen *et al*., 2018).

4 Contextual factors shaping the start conditions for planning in flood governance: This strand of research on the contextual factors that could affect the pre-conditions for planning in flood governance—from the fixed administrative structures and shared perceptions, to notions, values, and traditions embedded in history—is limited in the planning literature. Early studies reported that fragmented structures in political administration, asymmetries of powers, and persistence in the old paradigms in flood governance could hinder planning agencies in implementing a broader set of adaptation measures in flood agendas (Mileti, 1999; Ward *et al*., 2013; Buuren, Ellen and Warner, 2016). However, the means to address these challenges relating to contextual conditions remain an under-researched issue.

TABLE 2.3 Key challenges for planning to play a role in flood governance

Key Topics	Sub-Topics	Challenges for Spatial Planning	References
Outputs of flood governance	**Policies, strategies, codes, standards, planning rules**	Mainstreaming flood risk issues in local agenda Diversifying adaptation measures in discourse such as nonstructural measures Aligning the mismatches between local, regional, and national policy discourse Short-term vs. long-term benefits	(Storbjörk, 2007; Ward et al., 2013; Driessen et al., 2018; Runhaar et al., 2018)
Collaborative process	**Actors/ stakeholders**	Enhancing the roles of planning in the decision-making process (proactive participation) Resolving misaligned interests of parties, Converging conflicting understanding of parties in flood resilience and climate adaptation (awareness of risk, cognitions of adaptation measures, priorities on short- and long-term benefits), Strengthening the weak abilities in using climatic knowledge to predict future scenarios	(Storbjörk, 2007; Francesch-Huidobro et al., 2017; Dąbrowski, 2018b; Driessen et al., 2018)
	Networks	Aligning the conflicting time-spans and planning procedures in contrast to water management and environmental planning Strengthening communications and cooperation between governmental and private actors in planning and flood-risk management	(Mostert, 2006; Davidse, Othengrafen and Deppisch, 2015; Ran and Nedovic-Budic, 2016)
Start conditions for planning to participate in flood governance	**Authority condition**	Balancing legal certainty and flexibility to regulate restrictions or change land-use functions for flood resilience	(Mileti, 1999; Deyle, Chapin and Baker, 2008; Driessen et al., 2018)
	Resource condition	Adopting appropriate principles in dealing with distributional effects of planning layouts (fairness in the distribution of cost and benefit), Enabling information sharing and knowledge communications between governmental sectors Facilitating public access to spatial planning information.	(IPCC, 2014; Driessen et al., 2018)
	Organisation condition	Establishing a technical information platform for interactions between territorial, institutional, and policy cooperation Clarifying blurred accountability (responsibilities) and powers between national authorities, local planning actors, and other stakeholders for flood events Personnel skills	(Mileti, 1999; Storbjörk, 2007; Ward et al., 2013; Ran and Nedovic-Budic, 2016; Driessen et al., 2018)

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TABLE 2.3 Key challenges for planning to play a role in flood governance

Key Topics	Sub-Topics	Challenges for Spatial Planning	References
Contextual factors shaping the start conditions for planning in flood governance	**Institutional design**	Facing fragmented administrative and political structures	(Mileti, 1999; Ward et al., 2013)
	Notions, values, and traditions embedded in history and traditions	Facing the persistence in the old paradigms (institutional inertia and path divergence) Facing the asymmetries of powers	(Buuren, Ellen and Warner, 2016)

2.4.5 Summary and discussion

As an indispensable approach for flood resilience, planning makes a contribution through a broad range of inter-disciplinary experience. Figure 2.2 shows the recent developments of planning research, policy, and practice influenced by environmental concerns, disaster management concerns, socio-economic concerns, and institutional and governance concerns. The darker the colours are, the deeper the relative exploration by the publications in relation to spatial planning. The four-pillar model indicates that the planning literature pays more attention to disaster management concerns. This reflects the perspective on planning as a design approach, functionally efficient in dealing with floods, which corresponds to one origin of planning as a physical intervention approach organising city development and property.

Meanwhile, the impact of climate analysis, economic analysis, social science, and policy science on planning is emerging, even though there are still limited planning studies exploring those concerns. They inspired planning research, policy, and practice to broaden their scopes to include new topics such as vulnerability identification, investment and payoff, and governance. Planning, thus, is adapting its role as an integrated approach to contribute to flood resilience.

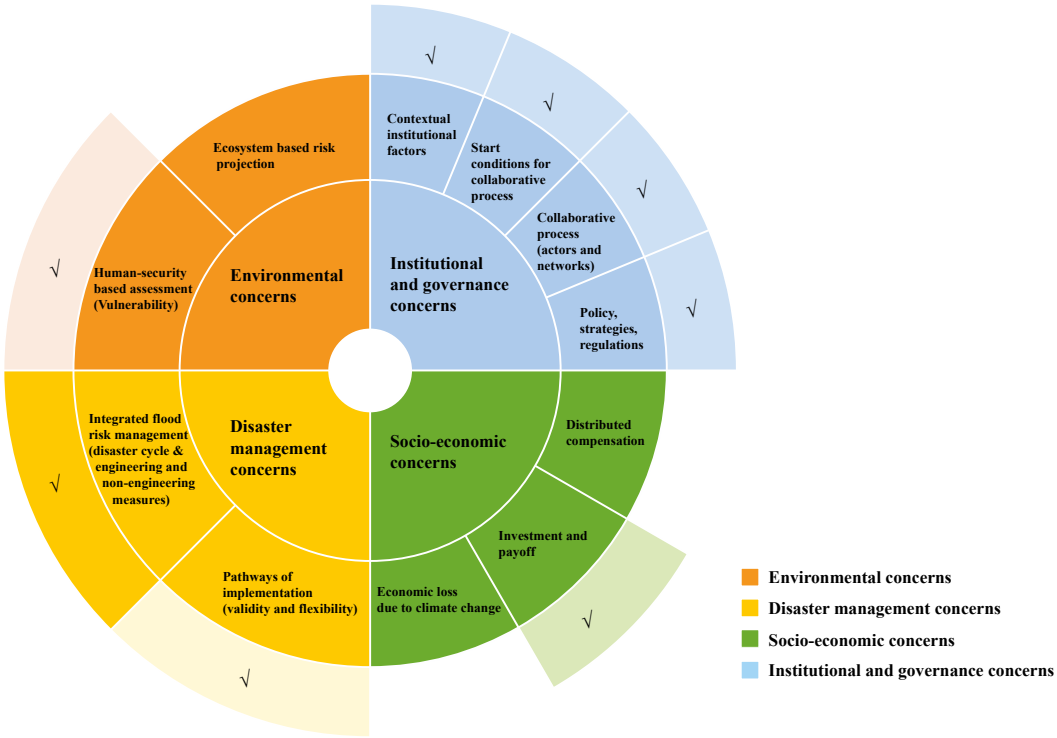


FIG. 2.2 The developments of planning literature in the four pillars (the third ring) / Note: The dark colours mean that there are many studies, pale colours mean that there is a limited but increasing amount of studies, and white means that there is a gap here and the topic is under-researched in planning literature.

2.5 Discussion and concluding remarks

The growing threats of floods and climate change necessitate long-term safe, fair, economically efficient, and institutionally coordinated circumstances for human settlements. For this goal, this chapter proposes a four-pillar framework to understand environmental, disaster management, socio-economic, and institutional challenges that need to be considered in flood resilience and climate adaptation. It was applied here to conduct an extensive literature review spanning across the fields of climate science, disaster mitigation, water management, flood risk management, hydrological engineering, economics, climate policy, adaptation planning, public participation, administration, and governance.

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Following that, the proposed framework was used to identify and assess the developments of spatial planning in relation to flood resilience and climate adaptation against the disciplines mentioned above. Our analysis of the literature indicates that the domain of planning concentrates on the improvement of the physical environment mainly in relation to disaster management concerns, in the belief that planning is an instrumental–technical intervention shaping human settlement patterns. However, planning is a broad discipline increasingly including the environmental, socio-economic, and institutional topics in the wider policy context. This trend is spurred by insights from climate change analysis, economic analysis, social science, governance and policy studies, and promoted by pioneering planning scholars.

Our analysis also indicates that emerging topics could bring valuable insights informing the implementation of physical planning in practice, which remains challenging due to uncertainty about the future risks, limited resources, and complex social and institutional relations. Relevant research can add to spatial planning's ability to (1) enhance the evidence-based evaluations and strategies for resilience; (2) act on uncertainty in the face of a shortage of financial resources; (3) address the unfair distributional effects of flood damages with adequate and equitable compensation; (4) manage societal concerns and divergent interests; (5) improve the coordination of resilience measures across sectors and spatial scales; and, finally, (6) propose spatial resilience strategies that respect and take advantage of knowledge and values embedded in local history and traditions.

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Supplementary data

Table 2.4 lists three typical models revealing the measures to reduce the negative impacts of flood hazards in terms of the risk cycle. Table 2.5 reviews the research on institutional mechanisms allowing for effective and efficient (governance) actions in multi-level, multi-domain, and multi-actor settings

TABLE 2.4 Diverse solutions/ strategies for flood resilience based on literature in disaster management

Stages of Floods			
Before Floods	**During Floods**	**After Floods**	**References**
Disaster risk reduction: • Preventive measures: natural retention, flood defence, land-use plan, building codes • Precautionary measures: insurance, training exercise, early warning	(Emergency) response: emergency measures	Recovery: relief, rehabilitation, reconstructions, event documentation and analysis	(Thieken *et al.*, 2007)
Prevention: avoiding construction of houses and industries; promoting appropriate land-use, agricultural and forestry practices Protection: structural and nonstructural, to reduce the likelihood of floods or the impacts of a location	Preparedness: informing the population about flood risks and what to do Emergency response: developing emergency response plans	Recovery and lessons learned: activities helping to return to normal conditions	(European Commission, 2007)
Prevention: spatial planning or land-use policies, insurance Defence: dykes, dams, embankments, weirs, upstream retention	Mitigation: flood compartments, flood-proof constructions Preparedness: warning system, preparing disaster management, evacuation plans, and managing floods when they occur	Recovery: reconstruction or rebuilding plans, compensation, insurance	(Hegger *et al.*, 2014)

TABLE 2.5 Research on institutional mechanisms allowing for effective and efficient (governance) actions in multi-level, multi-domain and multi-actor settings

Key Topics	Sub-Topics	Challenges for Resilience and Climate Adaptation	References
Outputs of flood governance	**Official policies/ strategies/ discourse**	Detached or mainstreamed policies/strategies with other local agendas (commitment or no commitment) Fit or mismatch of policy framing between different governance levels Short-term vs. long-term benefits	(Keskitalo, 2010; Simanjuntak et al., 2012; Bulkeley, 2013; Aylett, 2015; Dewulf, Meijerink and Runhaar, 2015)
Collaborative process	**Actors/ stakeholders**	Roles of governmental and private actors (diversity, participation, experimentation, learning and self-organisation) Misaligned interests of parties The leadership of the foremost actors/or political entrepreneurs	(Keskitalo, 2010; Bulkeley, 2013; Dewulf, Meijerink and Runhaar, 2015)
	Networks	Policy-making frequencies, cycles and procedures (horizontal and vertical; government, private, and civil society)	(Kern, 2008; Keskitalo, 2010; Simanjuntak et al., 2012; Bulkeley, 2013; Lienert, Schnetzer and Ingold, 2013)
Pre-, Start conditions for governance	**Authority conditions**	Legislative support from regional and national levels to promote local actions (regulatory and procedural support) Powers, responsibilities and discretions of governmental sectors (devolution and decentralisation)	(Bulkeley and Betsill, 2003; Bulkeley, 2010, 2013; Keskitalo, 2010)
	Resource conditions	Finance support or financial resource exchange Information sharing and knowledge communication between governmental sectors and publicity	(Bulkeley and Betsill, 2003; Keskitalo, 2010; Bulkeley, 2013; Aylett, 2015)
	Organisation conditions	Political wills to take actions, Opportunities for the inclusion of citizen and private sectors in decision-making Skills, knowledge, and capacities to organise climate adaptation Emerging of alternative technics	(Bulkeley and Betsill, 2003; Bulkeley, 2013; Aylett, 2015; Dewulf, Meijerink and Runhaar, 2015)

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TABLE 2.5 Research on institutional mechanisms allowing for effective and efficient (governance) actions in multi-level, multi-domain and multi-actor settings

Key Topics	Sub-Topics	Challenges for Resilience and Climate Adaptation	References
Contextual roots shaping governance conditions	**Institutional features by design**	Administrations procedures Laws and regulations Budget schemes (allocations) or financial instruments Organisational structures or institutional setting Stakeholder selections Transparency and openness	(Simanjuntak et al., 2012; Bulkeley, 2013)
	History and culture embedded notions, values and traditions	Fixed costs Learning effects Institutional arrangement Social expectations Legislation and juridical decisions values Continuation of mal-adaptations	(Harries and Penning-rowsell, 2011; Simanjuntak et al., 2012; Bulkeley, 2013; Parsons et al., 2019)

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3 Conceptual Framework and Methodology

ABSTRACT To explore the institutional factors that affect the opportunities for planning to deal with flooding, this chapter introduces four focal streams of theories or literature to establish a conceptual framework. They are historical institutionalism (path dependence and path divergence), planning procedures and tools, policy framing and collaborative governance. On these bases, an empirical analysis is organised from four aspects in the remaining part of this thesis along with mixed research methods, for instance, case study, content analysis, mapping, stakeholder analysis and TOWS analysis.

KEYWORDS conceptual framework, research methods

This chapter consists of two sections – the conceptual framework and methodology – which together constitute the foundation for the empirical research in Guangzhou.

3.1 Building blocks of the conceptual framework

3.1.1 The understanding of spatial planning in the perspective of institutions or governance

This section builds links between planning and institutional and governance concerns by clarifying how the profession of planning understands the notions of institutions and governance. The early studies from Healey are borrowed for the goal and used as a foundation of this research. It helps to determine a common language between social scientists, political scientist, policy scholars, policymakers, and spatial planners.

As a pioneer focusing on collaborative planning theory, Patsy Healey has long before published a series of works to emphasise the institutional and governance concerns as a means to understand the urban problems that planners are faced with (Healey, 2006). In 2003, a conceptual framework interpreting planning through the lens of institutions and governance was proposed in her paper, entitled *'My Voice: My Place': Tracking Transformations in Urban Governance*. This framework followed the sociological strands of institutionalist theory and was concerned with both how 'institutional inheritance' (like policies and plans) shapes future possibilities and how new 'institutional capacities' get built (Coaffee and Healey, 2003).

According to Healey (Coaffee and Healey, 2003), planning is understood as the dynamics of authoritative powers of political actors in a period (episode) with different interests. Actors operate in institutional practices through advantaged or bias governance mobilisation (networks and coalition, stakeholder selection, discourse, and practice) in the context of underlying culture-rooted structures, assumptions, values and habits. This framework was used in Healey's paper to assess the potentiality of introducing 'area committees' to local planning system by Newcastle City Council in the UK and explored its impact to set off institutional innovations in that local context (Coaffee and Healey, 2003).

The reference to Healey's work is significant because it brings attention to institutional mechanisms, features or settings which impact planning processes and planning outputs (such as project plans or master plans). The term 'episode' is useful in understanding the temporality of planning. It may start from an initiative

caused by a big event in the natural environment, for example, a serious flood, or a transition in the spatial planning system, such as a revocation of a department, and lasts until a new configuration of actors and arenas arises. In this episode, specific 'stakeholders' form an associated 'network' or 'coalition' and participate in decision-making their own interests, which, in turn, are shaped by their long-established institutional 'structures', 'values', and formal and informal policy 'discourse'.

Healey's way of understanding planning offers an entry point for this thesis, setting the scene for further research. The following shows how the proposed four research questions in this study stemmed from my initial interpretation of Healey's theory.

1. What are the (long-established) traditions of planning institutions in dealing with flood risk and what effect do they have? What, if any, innovations have taken place and why? - This exploration partly relates also to the notion of 'episodes of spatial planning' in Healey's work, which emphasises the temporal dynamics of authoritative powers and the rise and decline of political actors.
2. To what extent does planning adopt a co-determined policymaking process to address flood risk across the hierarchical levels of spatial planning vertically and across the boundaries between different disciplines horizontally? - This exploration is related to the 'advantaged or bias mobilization governance process' in Healey's theory, which emphasises networks, coalitions and discourse in organised institutional practices.
3. How are flood problems framed in the discourse of spatial planning, and with what effect? - This exploration is related to the literature on 'discourses' (such as framing issues, problems and solutions) in Healey's theory.
4. What contextual factors, if any, can influence the enabling conditions of planning in flood governance? - This exploration is related to the literature on 'the context of underlying culture-rooted structures, assumptions, values and habits' in Healey's theory.

3.1.2 Supporting theories

Four supporting theories are used in this thesis as building blocks of the conceptual framework (Figure 3.1). These are the theories of path dependence and path divergence, policy framing, planning tools and planning procedures, and collaborative governance. The discussion in this section explains the reasons why these theories and concepts were chosen, outlines the potentialities that they offer, and presents how they are used in a combined way for the thesis. Detailed explorations about how these theories and concepts are interpreted and employed to address the research questions are given in chapters 4, 5, 6 and 7.

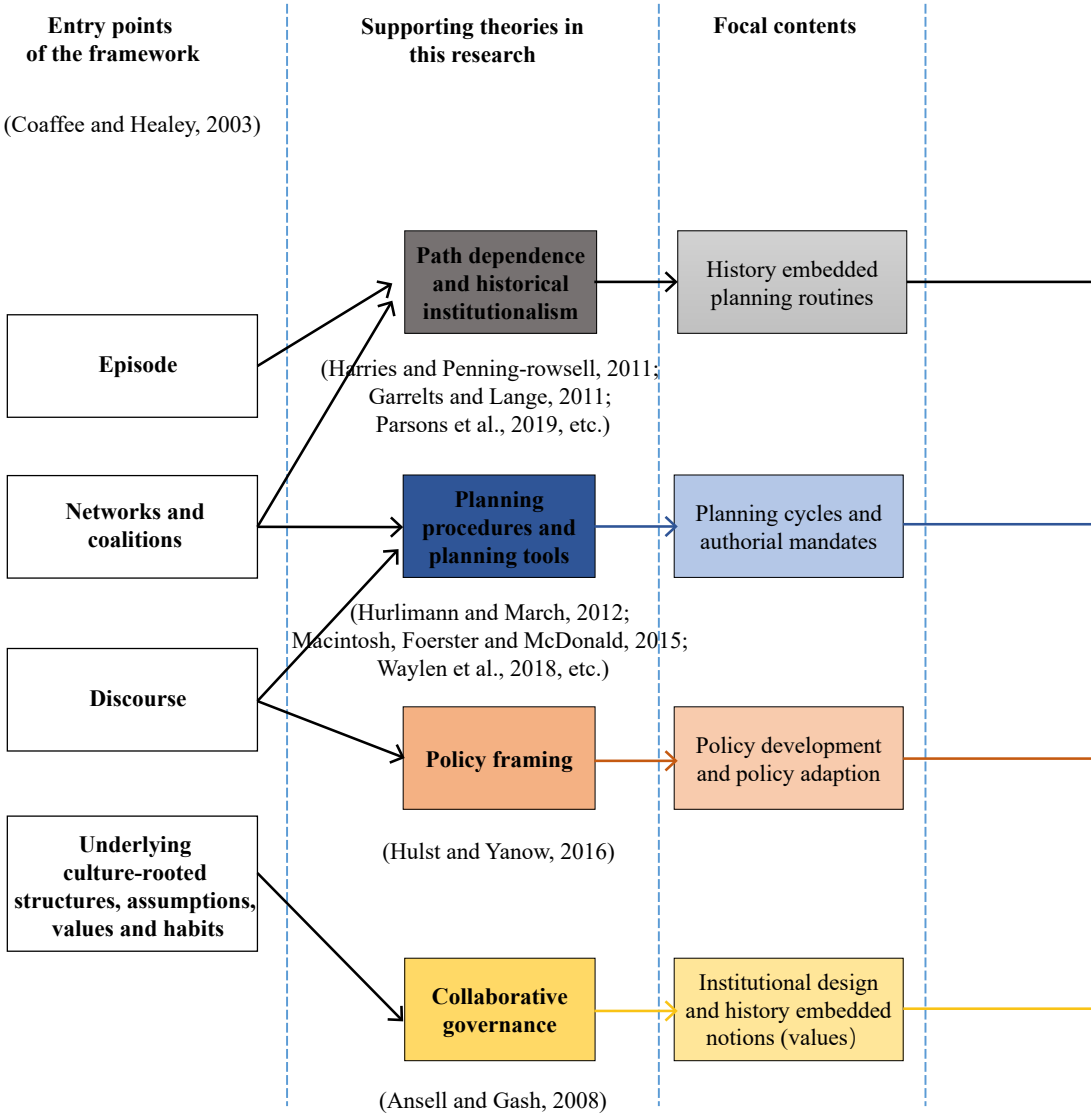
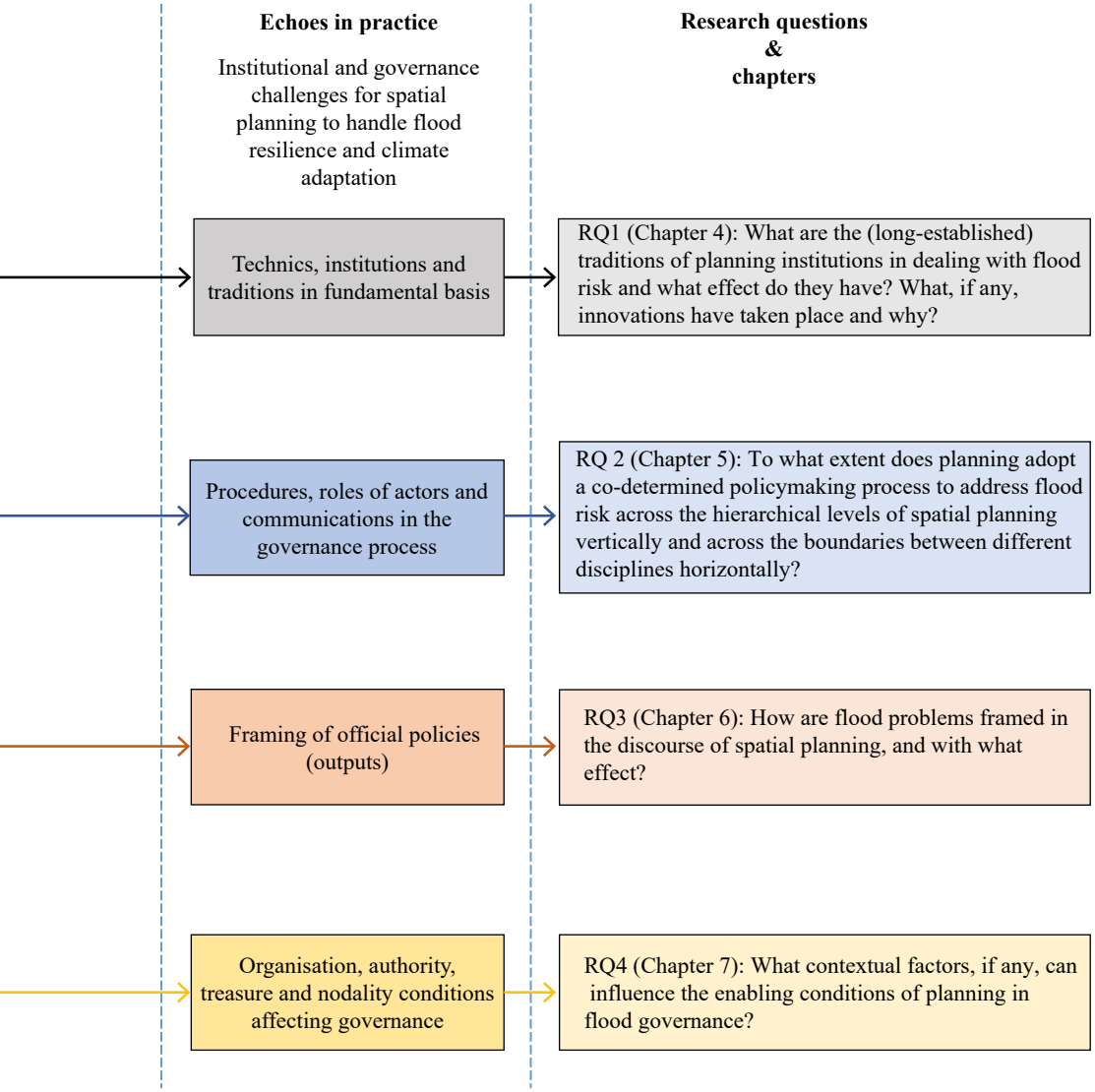


FIG. 3.1 Conceptual framework for the thesis (relating RQs to bodies of theories and chapters) / Source: Author


Echoes in practice
Institutional and governance challenges for spatial planning to handle flood resilience and climate adaptation
Research questions & chapters
Technics, institutions and traditions in fundamental basis
RQ1 (Chapter 4): What are the (long-established) traditions of planning institutions in dealing with flood risk and what effect do they have? What, if any, innovations have taken place and why?
Procedures, roles of actors and communications in the governance process
RQ 2 (Chapter 5): To what extent does planning adopt a co-determined policymaking process to address flood risk across the hierarchical levels of spatial planning vertically and across the boundaries between different disciplines horizontally?
Framing of official policies (outputs)
RQ3 (Chapter 6): How are flood problems framed in the discourse of spatial planning, and with what effect?
Organisation, authority, treasure and nodality conditions affecting governance
RQ4 (Chapter 7): What contextual factors, if any, can influence the enabling conditions of planning in flood governance?

3.1.2.1 Historical Institutionalism: Path divergence and path dependence

The thesis uses the concept of path dependence and path divergence, two important aspects of historical institutionalism, to explain continuity and change in the process of climate adaptation and flood resilience in spatial planning and water management (chapter 4). Originating in economics, these two notions were later used by social scientists and political analysts to explain, firstly, how the historical institutional experience becomes a self-reinforcing mechanism and constrains institutional innovations, and, secondly, under what conditions deviations from these established paths take place at so-called 'critical junctures' (e.g., James, 2000; Pierson, 2000; Martin and Sunley, 2006).

Preliminary studies have used these two notions in the planning field to shed light on the empirical challenges in the transition from hydrological engineering defence toward integrated flood risk management with a broader range of adaptation measures when planning actors strive to promote resilience, but face the resistance of traditions and routines embedded in institutional history (e.g. Harries and Penning-rowsell, 2011; Garrelts and Lange, 2011; Parsons *et al*., 2019).

This thesis builds on these two notions in chapter 4 to explore the barriers hindering the adoption of flood resilience and flood governance in spatial planning derived in institutional inertia, and to shed light on the opportunities to break this inertia, on the basis of an exploration of successes and failures in such deviations[4] (Figure 3.1). The historical planning discourse of Guangzhou from 1930 to 2016 is examined in terms of flood mitigation or flood prevention measures. The continuity of policy discourse indicates the path dependence feature, while discontinuity indicates policy deviation. Both continuity and discontinuity create critical junctures which are further explored in terms of the conditions that gave rise to them. The early research papers focusing on the policy deviations of flood measures. for example, Harries and Penning-rowsell (2011); Garrelts and Lange (2011); Parsons et al. (2019), etc. provide pointers about the potential conditions that matter. Three elements are particularly significant: socio-economic demands, institutional environment and natural hazards.

4 Chapter 4 introduces how path divergence concept is used in details.

3.1.2.2 Planning procedures and planning tools

The literature on planning procedures and planning tools is used to explore the interactions between planning and water management sectors in the policy-making process and project constructions (Chapter 5). These studies focused on how different institutions communicate with each other in legal procedures across horizontal professional barriers and vertical bureaucratic boundaries (e.g., Hurlimann and March, 2012; Macintosh, Foerster and McDonald, 2015; Waylen *et al*., 2018). Many papers have shown their concerns about the conflicts and coordination challenges in flood governance process, even though the solutions are under-developed (Storbjörk, 2007; Francesch-Huidobro *et al*., 2017; Dąbrowski, 2018; Driessen et al., 2018).

In this thesis, the focus on planning procedures inspires an exploration of the distinctive workflows between the planning and water management sectors in the Chinese context, and specifically the Guangzhou case from 2000 to 2019. These workflows are expected to impact on horizontal cooperation between the professions.

In addition, the notion of planning tools is used to reveal how authoritative mandates are managed in the planning sector. Mandatory (commanding) or non-mandatory (encouraging) planning tools are identified, which influence the vertical implementation through legal rule and policies set out in masterplans and regulations[5] (Chapter 5).

3.1.2.3 Policy framing

The notion of policy framing is used to explore the content of legislation and formal institutional rules for spatial planning and water management (Chapter 6). The notion is widely used by analysts in fields, including public policy analysis (Rein and Schn, 1996), linguistics (Cienki, 2007), social movements studies (Gamson, 1992) and dispute resolution (Dewulf *et al*., 2009), as a useful tool to understand the mismatch between two or more actors in governance networks based on different legislated policies and intents. It is also used for investigating the scope for possible resolutions during controversies or policy debates between administrations (Hulst and Yanow, 2016). Increasing papers are applying this notion to analyse the contents and processing of policy documents and strategies (Restemeyer, Brink and Woltjer, 2018).

5 Chapter 5 introduces how the planning procedures and planning tools studies are used in the thesis in details.

This concept is used to reveal the distinct ways that problem-setting, feasible options, values and governance models are scoped and described in formal rules[6] (Chapter 6). Hulst and Yanow's research on t framing analysis is used. Their early research (2016) highlighted three major aspects of policy framing: problem-setting, action scripts and reconceptualising of governance arrangements. These three aspects are examined in the formal discourse of Guangzhou planning and water management systems between 2000 to 2019, and help to explain the policy interactions and controversies between professions in the governance network. The exploration contributes to revealing mismatches between sectors and how flood resilience can be incorperated into planning policy alongside other urban agendas (Figure 3.1).

3.1.2.4 Collaborative governance

Collaborative governance theory, as proposed by Ansell and Gash (2008), is used in chapter 7 as a theoretical basis to explore the underlying reasons that shape the behaviour of policy officials responsible for spatial planning and flood risk management, as observed in Chapters 5 and 6. This theory has been used in a few papers as a foundation- soil literature- to explain the governance challenges in flood risk management and spatial planning (e.g. Francesch-Huidobro, 2015; Francesch-Huidobro *et al*., 2017)). According to Ansell and Gash (2008), three significant factors have an impact on the governance process (or collaborative process): (i) starting conditions (e.g., resources, powers, incentives and history embedded conflicts or cooperation); (ii) institutional design (e.g., stakeholders selection, ground rules, forum exclusiveness); and (iii) facilitative leaderships (e.g., brokers assisting consensus-building; empowerment of weaker actors).

Drawing on this theory, chapter 7 explains how the factors of institutional design and starting conditions impact on the involvement of spatial planning representatives in flood governance[7]. The results contribute to resolving the empirical challenges arising in, for example, fragmented administrative and political structures, limited source of finance and unavoidable collective institutional cognition (Figure 3.1).

6 Chapter 6 introduces how the policy framing studies are used in details.

7 Chapter 7 introduce how the collaborative governance theory is used in details.

3.1.2.5 A mixed use of the four schools of supporting theories and literature

This research selectively applies the four fields of theory from institutional and governance in the thesis. Different theories and concepts are applied depending on the specific question asked, which leads to a novel approach in explaining the role of spatial planning in dealing with flood risk. It is summarised in Figure 3.1. The framework for investigation thus combines approaches from policy science, political science, institutional science and administration, together with the creative design process. These conceptual approaches have not been widely adopted in the Chinese context, and certainly not in the challenging field of planning for flood resilience and climate adaptation.

3.2 Methodology

3.2.1 Case study research

The research in this thesis is a mainly qualitative study based on case study analysis, a method widely used in social sciences to investigate complex and dynamic issues in the original contexts of the study areas (Yin 1981, Yin 2014). In some parts of the literature, the case study is defined as a tool to illuminate the essence of a decision or set of decisions, for instance why they were taken, how they were implemented, and with what result (Schramm, 1971). It also applies to similar topics like individuals, organisations, processes, institutions and events. Bromley describes the role of case study as a "systematic inquiry into an event or a set of related events which aims to describe and explain the phenomenon of interest" (Bromley, 1990, p.302).

One advantage of the case study is in-depth research allows collecting a lot of details of cases to organise experimenters, produce novel hypotheses and testify them (Yin 1981, Yin 2014). However, there are also criticises that the collected data is too special and cannot necessarily be generalised to the wider population, especially when it is applied a limited number of cases (Yin 1981, Yin 2014). This study is single-case research, which examines one site with rich details on a particular theme: the way of planning to deal with floods. It can be a limitation of this research. Thus, cross-case analysis is needed in the future according to the theme of the study.

This method has been successfully used in many cases to explore the past and on-progressing experience, challenges, innovations and future opportunities in the field of flood resilience, adaptation and hazards management. The range covers from international (Juncos, 2017), national (Wilby, Beven and Reynard, 2008), regional (Rijke *et al.*, 2012; Nguyen and James, 2013; Glavovic and Smith, 2014) to municipal (Shaw and Sharma, 2011; Spaans and Waterhout, 2017; Duy *et al.*, 2018) and even neighbourhood levels (McEwen and Jones, 2012). Therefore, it is adopted as the main method for this research project.

3.2.2 Case selection: Guangzhou case[8]

The case study examined in this dissertation is the city of Guangzhou. The city has three distinct features. First, it is a megacity with a high level of urbanisation and high density of population. If flooded, the damage and losses would be immense. Second, Guangzhou is a city located on a river delta and is frequently affected by fluvial, pluvial and coastal flooding. These natural threats create a practical necessity and urgency for cities to focus on flood resilience and urban climate adaptation. Third, Guangzhou is a city that is considered to be a pioneer in addressing flood resilience in its spatial planning interventions (Meng *et al.*, 2018; Meng *et al.*, 2019) The city's practices and experiences offer valuable lessons for planners, engineers, policymakers, and politicians in other cities on how to deal with multi-source floods.

With an area of 7434 km^2, Guangzhou is located at the confluence of the East and North branches of the Pearl River (Figure 3.2). As a metropolis in the Pearl River Delta (PRD), it is one of China's first-tier cities. The city has significant international trade links and is a logistics hub for Guangdong province and the PRD region (Wong et al. 2006). In 2016, it had a GDP of 1960 billion RMB and a population of 14 million (Guangzhou Statistics Bureau, 2016)[9].

8 This paragraph (3.2.2) relies on the published papers *Collaborative Spatial Planning in the Face of Flood Risk in Delta Cities: A Policy Framing Perspective* (Meng *et al.*, 2019) and *Spatial Planning for Climate Adaptation and Flood Risk: Development of the Sponge City Program in Guangzhou* (Meng *et al.*, 2018), which offer a detailed introduction of Guangzhou in terms of socio-economic features, geographic features, and latest policy interventions.

9 Guangzhou ranked third in mainland China on the GDP list (2016). Shanghai (first) had 2818 million and Beijing (second) had 2567 million.

TABLE 3.1 Guangzhou: Socio-economic, geographic, and policy parameters

Location	Downstream of the Pearl River Delta (PRD)
Delta typology & Elevation	River/tidal dominated; 40.3% of urban area <3 m
Tidal influence & Annual precipitation	<2 m; 1600–1900 mm/year
Urban development Area, Population	7434 km^2 (Urban 3843 km2); 14 million (in 2016)
Flood risk sources	Coastal, fluvial and pluvial flooding; Annual precipitation 1,6–1,9k mm; 40.3% of urban area <3 m
Observations	Ranking **second** globally in the exposure to coastal floods by 2070
Latest policy interventions (examples)	Pearl River Basin Flood Control Plan 2025, Guangzhou Water White Paper 2013, Sponge City Plan (2016-2030)

Source: Author, based on (Guangzhou Water Affairs Bureau 2013, Wang et al. 2004, Yang et al. 2015, Francesch-huidobro 2015, Francesch-Huidobro et al. 2016, Nicholls et al. 2007)

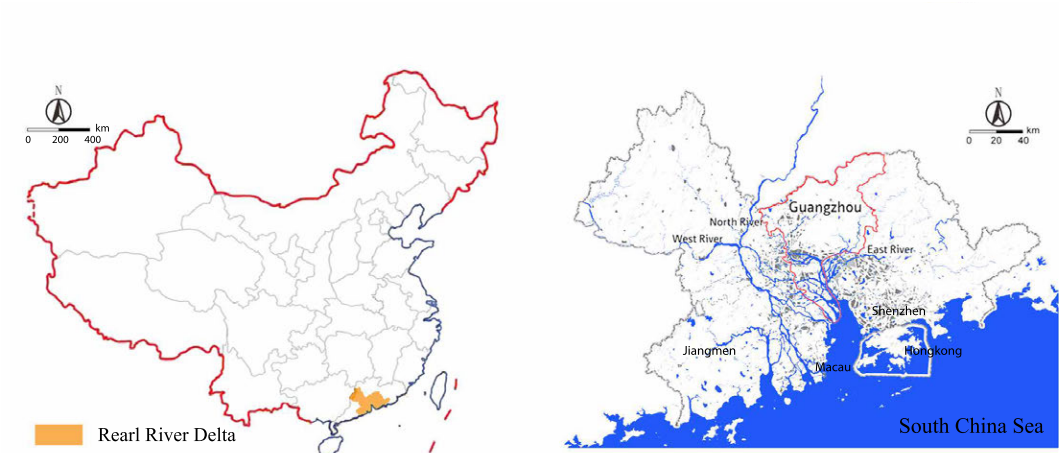


FIG. 3.2 The location of the Pearl River Delta (left) and Guangzhou (right) / Source: Authors, based on Urban-Rural Integration Plan of the Pearl River Delta 2009-2020, Issued by the People`s Government of Guangdong Province

Despite its population size and economic importance, Guangzhou is extremely vulnerable to flooding. A key problem is pluvial flooding in the city centre. Figure 3.3 illustrates that the main locations of waterlogging (Guangzhou Government 2017) are concentrated in the old city centre. High-density development in this area means that much of the paved surface (more than 87%) is impervious (Li et al. 2015, Guangzhou Water Affairs Bureau 2015). The paved surface hinders the infiltration of rainwater and contributes to the increase of the surface runoff at the source. This situation is worsened by the low discharge ability of the outdated sewage system (Wu, 2010). As a result, it is difficult for Guangzhou' dense built environment to cope with rainfall in extreme weather conditions, which have been happening more frequently in recent years, most likely due to climate change (Wu, 2010).

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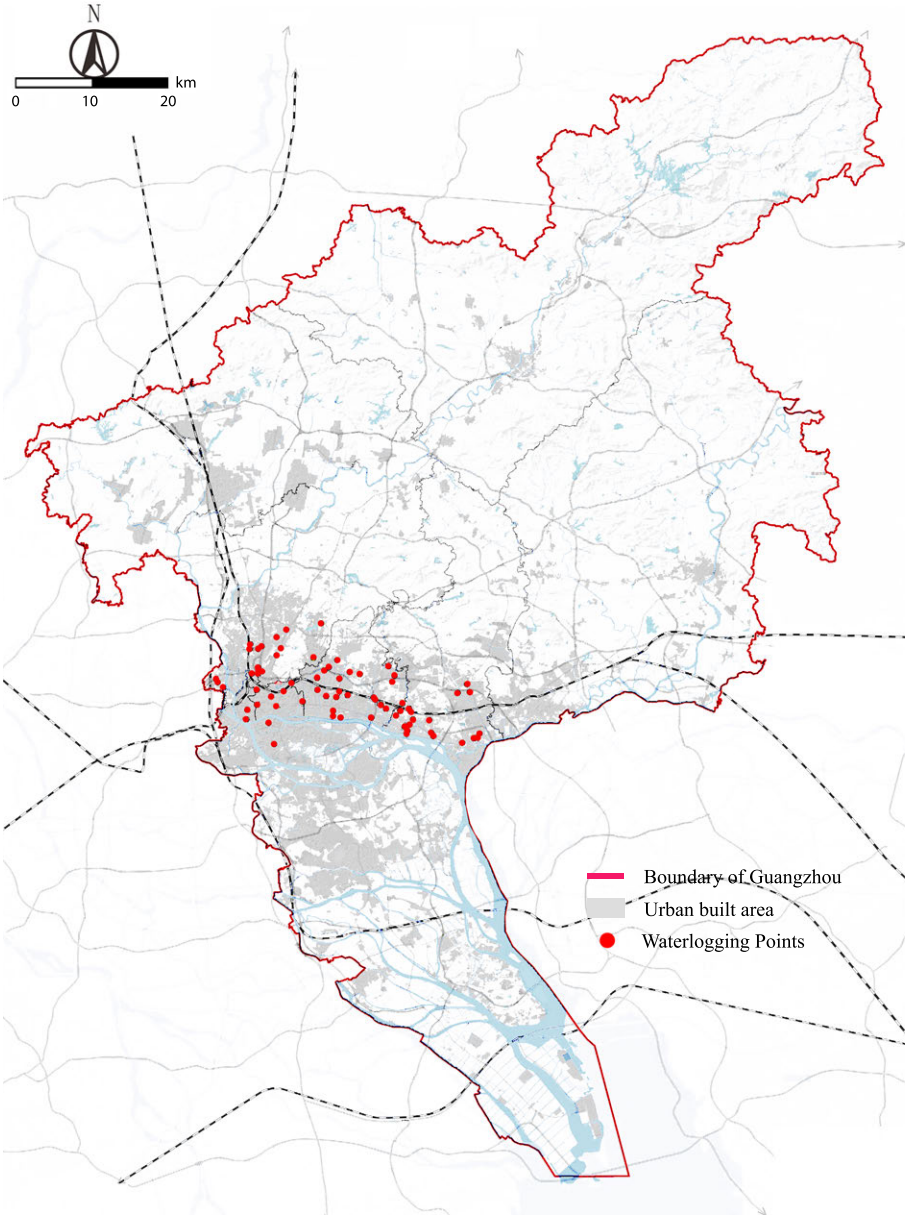


FIG. 3.3 The waterlogging points in Guangzhou / Source: Authors, based on Guangzhou Sponge City Plan 2016-2030 (Guangzhou Government, 2017)

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In addition, coastal and fluvial flooding may become another major threat if climate change impacts are not taken into account when planning future urban development. Although many local authorities place their trust in the defence capacities of structural infrastructure (e.g. the North and East River dykes), research indicates potential threats of flooding in the city of Guangzhou despite the structural infrastructure. This is due to the city's location at the estuaries of several rivers meeting in the South China Sea (e.g. Carmona et al. 2014). As early as 2002, the *China National Marine Basic Information Network Service System* elaborated four scenarios predicting the inundated areas due to the rising sea level. It indicated that the Southern part of Guangzhou may face severe flood risk in the future (Chinese Academy of Science, 2002). A later study corroborated this by estimating a 30cm sea-level rise between 2000 and 2030, threatening the Southern part of Guangzhou (Huang et al., 2004), a location where major urban extensions are planned. In fact, Guangzhou occupies the second position in terms of exposure to climate change related to the flood risk around the world in 2050, considering its population and assets which are at risk (Hallegate et al., 2013). The Sponge City Plan for Guangzhou also recognises these issues of flood risk and suggests that an area of 970 km^2 is vulnerable, mainly located in the Southern districts (e.g. Nansha) (Guangzhou Government 2017, see Figure 3.4).

Under Guangzhou's traditional planning system (Guangzhou was one of the earliest Chinese cities to develop a municipal planning system), land use for economic development has always been the main focus. By contrast, attention to flooding and water management was not a key focus. Around 2008, a separate government entity, the Water Affair Bureau, was given the full responsibility for dealing with water management issues. From then on, the local spatial planning system was only weakly connected to flood governance (Francesch-Huidobro *et al.*, 2017).

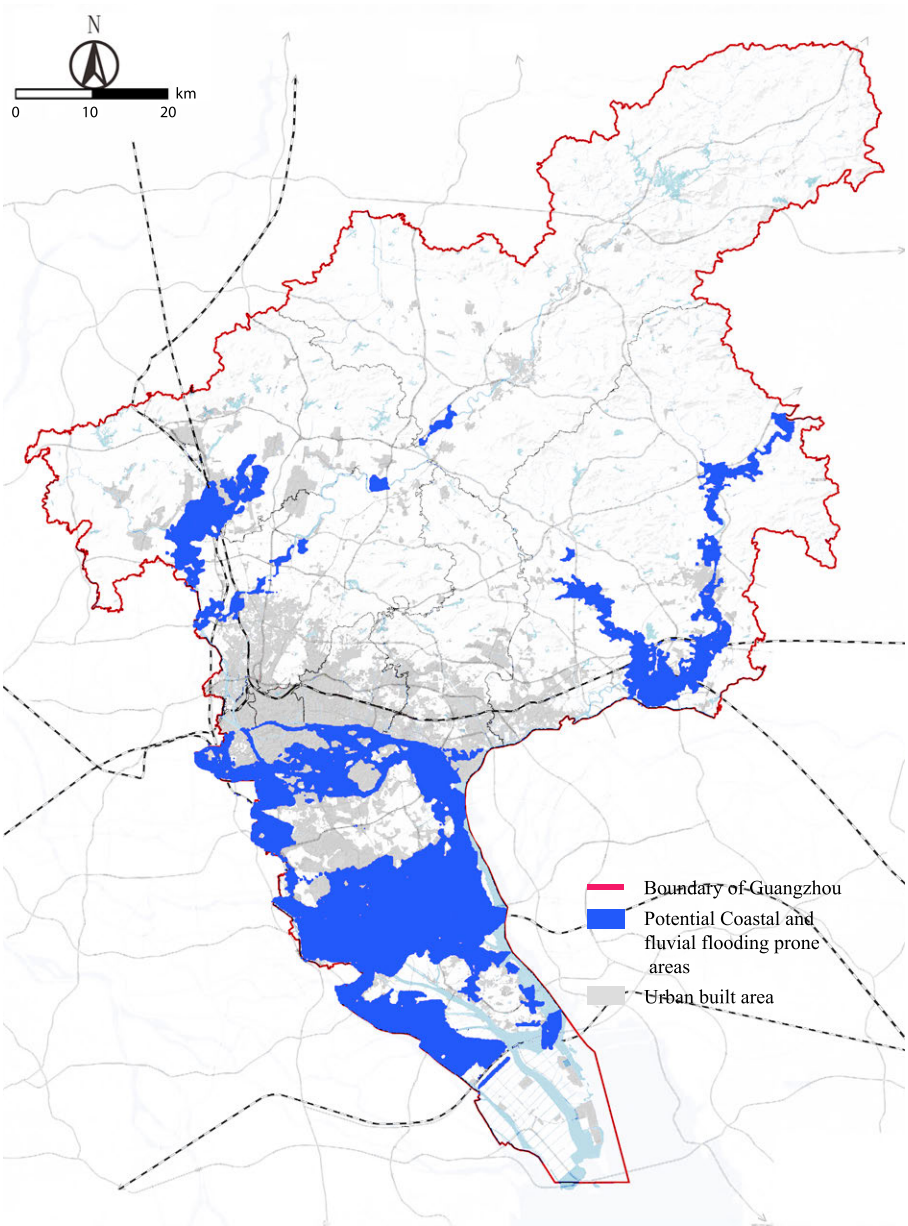


FIG. 3.4 The areas prone to potential coastal and fluvial flooding (right) / Source: Authors, based on Guangzhou Sponge City Plan 2016-2030 (Guangzhou Government, 2017)

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However, this situation changed when the newly enacted 2017 Guangzhou Sponge City Plan officially introduced the issue of flood resilience into spatial/urban planning (Meng *et al*., 2019). This plan was a municipal response to the national Sponge City Programme[10] which 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) (Ministry of Housing & Urban-rural Development, 2015), two of which represent the highest authorities in terms of urban–rural planning and flood risk management.

The national Sponge City Programme called for the improvement of the resilience to pluvial flooding in a context of rapid urbanisation and climate change. The 2017 Guangzhou Sponge City Plan was seen as an opportunity to build a comprehensive flood risk management dealing with pluvial, fluvial and coastal floods with spatial planning system actively involved (Meng *et al*., 2018). Consequently, a series of plans with innovative notions, goals, and forms are proposed in the Guangzhou Sponge City Plan through a challenging and struggling process to meet the national call (Meng, Dąbrowski and Stead, 2019).

3.2.3 Overview of research design for the case study with mixed methods

This section provides an overview of the research design, including an overview of data collected in the thesis and the methods applied to analyse the data (Figure 3.5).

10 The sponge city metaphor was formalised 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 liveable urban environment (Ministry of Housing & Urban-rural Development, 2014). This programme 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 stormwater (Construction Department of MoHURD 2014).

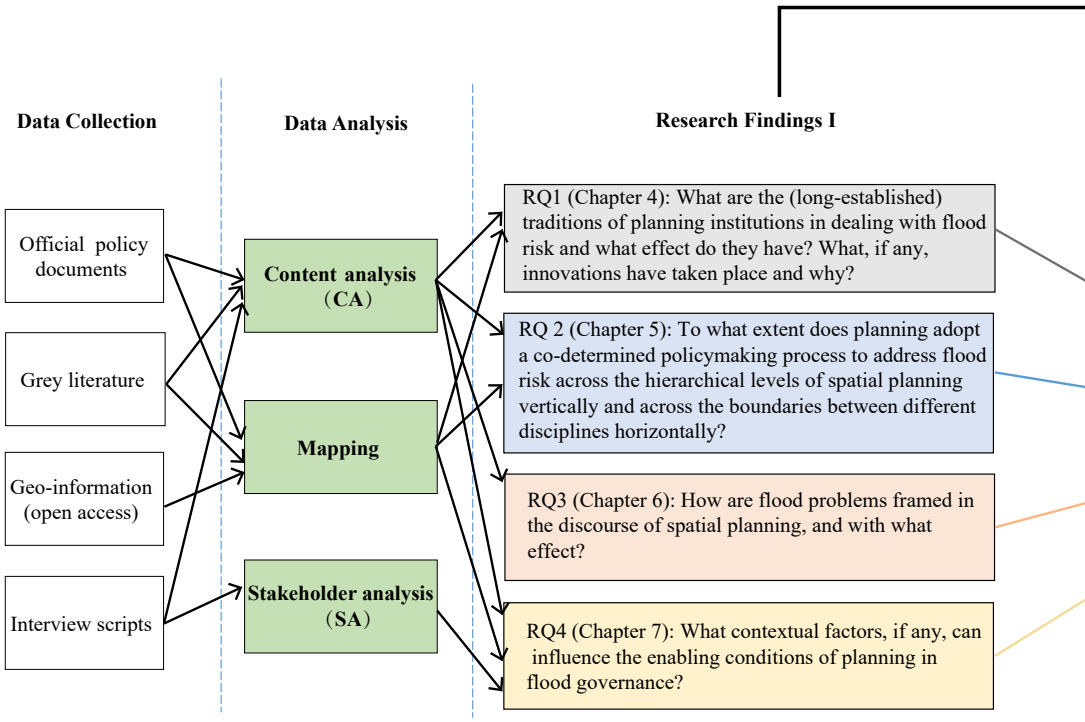
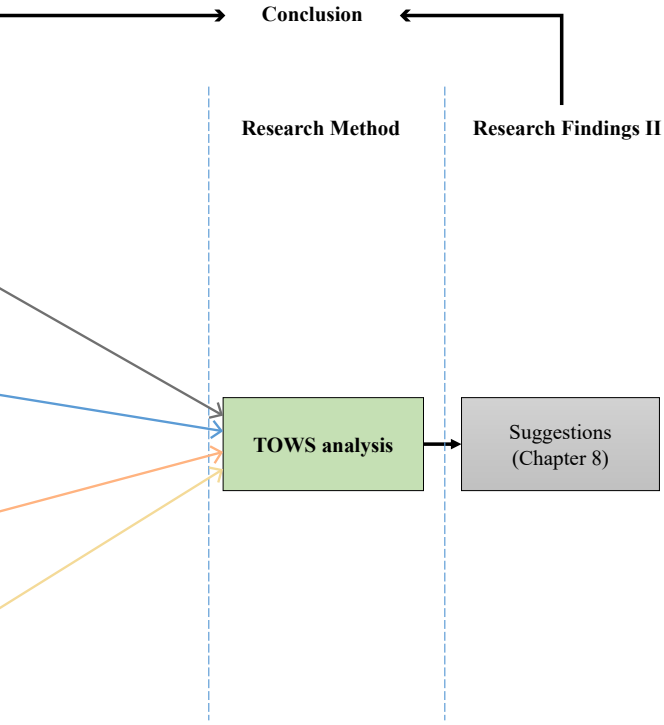


FIG. 3.5 Research design for the thesis (relating RQs to mixed research methods and data sources)

3.2.3.1 Data collection

The case study underlying this thesis spans a time of roughly 100 years, from the early 1920s until the late 2010s. At the start of this period, Guangzhou experienced a 'golden age' for urban construction (the early 1920s to the late 1930s). Thereafter was a period of stagnation due to wars and political change (the late 1930s to the late 1970s), followed by a long period of rapid urban development (late 1970s to the present) in which cities expanded into flood-prone areas. The spatial planning and water management sectors endured structural changes during these periods, which, in turn, shaped policy rules and practices at the local level.

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Evidence from official spatial planning policy documents and water/flood risk management policy documents was analysed as a primary source of data to show the strives of the planning system to deal with floods. These documents include masterplans, strategic plans, regulations, guidelines, project reports, technical handbooks.

However, there are cases when first-hand official documents are not available. To compensate that gap, grey literature (planning and water/flood risk management white papers, reports, scholarly research studies, government publications, archives, old maps, and news) and open access geo-information data (satellite photos, GIS data) were used in this thesis as an additional source of information.

In addition, 33 interviews were conducted[11] with a range of stakeholders from across the regional, provincial, municipal and district levels. These interviews recreate the contextual information in relation to historical planning documents and make the past experience come alive. Moreover, the interviews provide a first-hand pool of concepts, ideas and beliefs of actors in relation to on-going planning practice, which indicate the latest collective social attitudes of stakeholders in flood governance.

To minimise the subjectivity of interviewees, the pool of interviewees was made as wide as possible, including officials, academic researchers, practitioners, project managers and real estate agents, who had a wide range on regional and urban development, spatial planning, landscape design, engineering practice, hydrological resource management, administration, business and science (see Table 3.2 *Interviews' logbook* in Supplementary data). Respondents were initially identified from the abovementioned policy documents and then the sample was extended by using snowball sampling method (through which invited respondents are asked what other potential stakeholders are relevant and could be interviewed).

Some interviewees were involved separately in person, while others were interviewed together in group interviews. The approach was that every interview was operated either with a person to represent his organisation or several people (maximum 3-4) to represent their common organisation. Often, the group of people shared similar ideas and knowledge due to similar working experiences. Semi-structured interviews were kept small to make sure that every personal interviewee or a small group were not affected by the views of others.

Semi-structured interviews were conducted, which left spaces for interviewees to express their ideas. Interviewing questions covered issues such as the awareness of climate change, flood risk and historical struggles to deal with floods in Guangzhou, the regional and local planning and water management organisations' interests and positions in flood governance, the policy formulation process and policy implementation with flood resilience concerns, and the progress of projects helping to reduce flood loss (see Table 3.3 *List of questions* in Supplementary data). The respondents' key contentions were noted and transcribed.

11 In fact, 38 interviews were conducted for this thesis, but the findings mainly rely on 33 respondents. The other 5 were either contact persons who were not involved into flood resilience but assisting in building connections with other respondents or the interviewees whose interviews were not completed according to plan due to many practical reasons.

3.2.3.2 Methods for data analysis

Content analysis, mapping, stakeholder analysis and TOWS analysis are four major methods used in this thesis for data analysis (Figure 3.5). The method of content analysis was used in the thesis. In academia, it is widely adopted as a technique for analysing policy, which "compresses many words of text into fewer content categories based on explicit rules of coding" (Stemler 2001, p.144), applied both in quantitative or qualitative research (Hsieh & Shannon 2005). Various questions can be answered with content analysis (CA). For instance, it can be used to identify the themes in a body of text, or calculate the frequency of some key terms to present the main focus, or inferring the value preposition underlying the documents (Miller, 1998). The body of text concerns words, sentences, paragraphs and articles.

Qualitative content analysis was employed in Chapters 4, 5, 6, and 7 which helps to figure out data from official sources, grey literature and scripts from interviewees to investigate the ways that flood affairs are dealt with across planning and water management sectors. Selected themes of words in literature were coded, extracted from the textual data documents, and further analysed in *Atlas.ti* software[12]. The benefit of such a computer-assisted coding is it makes the process more systematic and robust, hence improving the validity of findings.

Mapping is a good approach to show the interventions physically which have been initiated by spatial planning to deal with the flood risk. It cross-validates the ambitions of planning documents in the text. This method was mainly used for the research presented in Chapter 4 in order to reveal the historical dimension of Guangzhou's efforts to deal with floods in physical space. The development of flood defence and flood mitigation infrastructures and the expansion of urbanisation into flood-prone areas in different periods were mapped based on information from satellites photographs, GIS open-access data, hydrological archives, planning policy documents and old maps.

Mapping is also used in Chapters 5, 6 and 7 by making use of information from hydrological archives, planning policy documents and old maps to formulate supporting materials to indicate how planning sector considers flood issues in traditional planning policies and uses innovative tools when hydrological knowledge is introduced.

12 Chapters 4, 5, 6, and 7 introduce how content analysis (CA) is organised under different topics in more detail.

A stakeholder analysis was used for the research outlined in Chapter 7. This method helps to identify and examine the key players and understand their roles, needs and concerns. This analysis was used to assess the impact, involvement and interest of different stakeholders when they were faced with a policy or an action (Lienert, Schnetzer and Ingold, 2013). In Chapter 7, this method is used to analyse the collective (or shared) visions among different groups in flood governance, in terms of their impact levels and interests in flood affairs[13].

The TOWS method was used to summarise the existing situation in the case study and propose strategic recommendations for improvement of the practices on the ground in Chapter 8 (conclusion). TOWS, which stands for *Threats*, *Opportunities*, *Weaknesses* and *Strengths*, is a variation of the widely used in business along with SWOT analysis (Weihrich 1982, Ravanavar & Charantimath 2012). While SWOT aims at taking stock of the status quo, TOWS is more oriented towards strategic actions. The analysis method helps to understand how to maximise strengths and opportunities, while at the same time minimising weak aspects and avoiding the threats in the different cases. In chapter 8, it provides a way of identifying new strategies that may be useful for practitioners.

3.2.3.3 Limitations of methods used in data collection and data analysis

There are two limitations to the methods in data collection. First, the process of data collection in the case studies depends on the skills of the investigation including the accessibility to official documents, grey literature, and open public information, and the ability to ask questions, to listen actively, to react to the situation, to understand the issues being addressed and to identify personal bias. Second, although the selection of the interviewees follows the principles presented above, it is also based on the personal network of the researcher. Like the abovementioned, the study has used multiple sources of data to minimise the insufficiency of documentary materials and occurrence of subjective evidence in relation to investigated interviewees. The variety of data sources allows for triangulation of insights which also improves validity and objectivity of findings.

13 Chapter 7 introduce how stakeholder analysis (SA) is organised with details

There are four limitations of the methods in data analysis. First, the process of coding relies on the ability to set the themes words, and filter useful textual data accord with the theme words. Second, the missing of information in GIS-open access dataset, satellites photographs, hydrological archives, planning policy documents and old maps, and the ability to figure out usable information for map drawing can result in the imprecision or bias of the outcomes. Third, the findings of stakeholder analysis rely on the ability to interpret the roles, needs and interest of different stakeholders and the ability to minimise bias from the stakeholders and the author of this thesis. Fourth, the TOWS analysis is based on the ability to interpret the evidence from the case studies and some descriptive details in the case studies have been generalised.

Supplementary data

TABLE 3.2 Interviews' logbook (2016–2019) (Semi-structured face-to-face interviews)

Code	Time	Interviewees	Field
1	Oct.25.2016	Academic, South China University of Technology	Spatial Planning
2	Oct.25.2016	Academic, South China University of Technology	Spatial Planning
3	Oct.25.2016	Academic, South China University of Technology	Landscape Architecture
4	Nov.12.2016	Academic, Guangzhou Institute of Forestry and Landscape Architecture	Greening and Ecology
5	Nov.13.2016	Senior Engineer, Guangzhou Urban Planning Design & Survey Research Institute	Urban Water Supply and Drainage
6	Nov.13.2016	Ex-Landscape Designer, Turenscape Planning and Design company (Guangzhou branch)	Landscape Architecture and Urban Design
7	Nov.14.2016	Academic, South China University of Technology	Landscape Architecture
8	Nov.20.2016	Senior Official, Liwan District Government	No data
9	Nov.21.2016	Academic, South China University of Technology	Spatial Planning
10	Nov.22.2016	Academic, South China University of Technology	Managing of Water Resources and Waterlogging
11	Nov.23.2016	Senior Engineer, Guangzhou Urban Planning Design & Survey Research Institute (Public Facility Department)	Urban Water Supply and Drainage
12 & 13 (Group meeting)	Nov.24.2016	Senior Planner, Guangzhou Urban Planning Design & Survey Research Institute	Spatial Planning
14	Nov.25.2016	Senior Planner, Guangdong Provincial Urban & Rural Planning and Design Institute	Spatial Planning
15	Nov.29.2016	Senior Planner, Guangzhou Urban Planning Design & Survey Research Institute	Spatial Planning
16	Nov.30.2016	Senior Engineer, Guangzhou Municipal Engineering Design & Research institute	Urban Water Supply and Drainage
17	Nov.30.2016	Design and Research Institute of Guangdong province	Urban Water Supply and Drainage
18&19 (Group meeting)	Nov.30.2016	Senior Official, Pearl River Committee	Water Conservancy Engineering
20	Dec.06.2016	Senior Official, Guangzhou Urban Planning Bureau (Urban Drainage Department)	No Data

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TABLE 3.2 Interviews' logbook (2016–2019) (Semi-structured face-to-face interviews)

Code	Time	Interviewees	Field
21	Dec.08.2016	Senior Planners, Urban Planning Research Centre, Nansha, Guangzhou	Spatial Planning
22	Dec.09.2016	Ex-senior Planner, Guangzhou Urban Planning Design & Survey Research Institute	Spatial Planning & Urban Water Supply and Drainage
23	Dec.14.2016	Senior Engineer, China Water resources Pearl River Planning Surveying & Designing	Water Conservancy Engineering
24	Dec.17.2016	Senior Official, Guangzhou Municipal Water Resources Bureau	Urban Water Supply and Drainage
25	Dec.20.2016	Senior Staff, Private Real Estate Company (Anonymous)	Architecture and Marketing
26	Dec.21.2016	Senior Staff, Guangdong Poly Real Estate Development Co., Ltd.	Architecture Design
27	June. 23. 2017	Senior Planners, Turenscape Planning and Design Company (Beijing Branch)	Landscape Architecture and Spatial Planning
28	Dec. 08. 2017	Senior Engineer, Guangzhou Water Affairs Investigation, Planning & Research Institute	Governmental institution
29 & 30 (Group meeting)	Apr. 02.2018	Senior Official, Sponge City Office	Urban Water Supply and Drainage, Water Conservancy Engineering
31 (same to No. 27)	Apr. 04.2018	Senior Planners, Urban planning Research Centre, Nansha, Guangzhou	Spatial Planning
32 (same to No. 27)	Apr. 04.2018	Project Manager, Times China Hold (Residential Property Managers Company, Guangzhou branch)	Landscape Design and Marketing
33	Apr. 05.2018	Senior Official, Nansha District Government	Urban Water Supply and Drainage

TABLE 3.3 List of questions covered in the semi-structured interviews relating to the thesis

No.	Questions
1	What are the main impacts of climate change in Guangzhou and wider PRD region? How do they affect flood risk? Have different resources of flood risk been considered in an integrated way?
2	How has Guangzhou historically dealt with the flood risk? Any representative examples? How are these projects going on? Do they achieve the expected effects?
3	Is there any consideration of flood risk (e.g., rising sea level, rainfalls) in the near future in the development of built and unbuilt areas, for instance, policy documents, strategies, regulations and projects?
4	What was (or is) the role of planning (or your institutions) 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?
5	How did (or do) planning authorities deal with the divergences from the engineers from water conservancy (and affairs) planning system or vice versa? Examples? Especially, in the recent Sponge City Plan?
6	How could you evaluate the promotion and implementation of Sponge City Plan?
7	Are there any challenges for planning (or your institutions) to take part in flood governance? Any examples?

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4 Spatial Planning in the Face of Flood Risk

Between Inertia and Transition

This chapter is under a peer-review by the journal Cities.

ABSTRACT Given the greater risk of flooding in cities due to climate change, spatial planning systems are increasingly expected to contribute to flood resilience. However, incorporating expanded adaption measures into conventional planning practices remains a major challenge due to institutional barriers. Based on the theories of historical institutionalism in relation to path divergence, this chapter aims to understand the factors which determine the fate of innovations and departures from established practice. Using Guangzhou as a case study, the chapter traces the history of the city's struggle against flooding from the 1920s onwards, building on documentary analysis, mapping and interviews. The findings highlight a deeply rooted attachment to engineering-based solutions to tackle flood risk. It also indicates that departing from an established path to embed nature-based and non-structural solutions in the planning system is more likely to take place in response to changing socio-economic needs and strong institutional support for changes, rather than in response to major flooding events. These findings provide lessons for policymakers and urban planners seeking to enact new policies that enhance flood resilience in spatial planning.

KEYWORDS Policy change, spatial planning, planning tradition, flood resilience, climate adaptation

4.1 Introduction

Flood risk is one of the most prominent consequences of climate change and poses a key challenge for global cities. Between 1980 and 2009, flood events around the world led to more than 500,000 deaths, 300,000 injuries and affected 2.8 million people (Doocy *et al*., 2013). In 2013, the IPCC's Fifth Assessment Report projected a rise in global temperatures of up to 4 °C during the 21st century (IPCC, 2013), which would contribute to a dramatic increase in the occurrence of pluvial, fluvial, and coastal flooding, resulting in considerable threats to health, safety and economic development (IPCC 2001; IPCC 2007a).

The need to cope with flood risk and adapt to climate change has inspired a transition in policy approaches since the early 2000s, which has witnessed a shift in emphasis from hydrological engineering towards integrated flood risk management, involving a broader range of adaptation measures. One reason for this is that conventional flood control infrastructure is considered to be insufficient and complacent about the increasing risks (e.g. Takeuchi, 2001; Vis et al., 2003). In this context, the importance of planning is increasingly recognised, expanding the range of measures that enhance flood resilience across areas and sectors by, for instance, regulating building codes, setting buffer zones, and designing green-blue infrastructure (e.g. Kang, Lee and Lee, 2009; Sayers et al., 2013; Wingfield et al., 2019)

However, this transition is often challenging in practice, as illustrated by research in the Netherlands, Poland, Germany, and England (Garrelts and Lange, 2011; Hegger *et al*., 2013; Potter, 2013). Increasing studies argue that established planning cultures and rationalities prioritising engineering-based approaches can constrain the capacity of flood-prone areas to embrace innovative adaptation measures in the face of floods and, consequently, lead to a resistance to policy changes and lock-in of conventional routines, namely, institutional inertia (e.g. Harries and Penning-Rowsell, 2011; Gersonius *et al*., 2016; Van Buren and Warner, 2016; Wiering, Liefferink and Crabbé, 2018; Parsons *et al*., 2019). The scholarship on historical institutionalism explains this phenomenon with the notion of 'path dependence' (e.g. Pierson 2000; Sorensen 2015), stressing that institutional choices, once decided, become increasingly difficult to change (Levi 1997; Pierson 2000; Sorensen 2015).

Overcoming this inertia and enabling policy innovations can be approached from two theoretical perspectives. One posits that exogenous shocks can shake the validity of established routines and paths. For instance, flooding events (of

substantial magnitude) are often regarded as shock events (Wiering, 2008), which create windows of opportunity to generate changes in policy and power relations in coalitions (Johnson, Tunstall and Penning-Rowsell, 2005; Penning-Rowsell, Johnson and Tunstall, 2006). Another perspective emphasises the importance of endogenous changes which can trigger deviations from the established policy path. Examples of endogenous changes include shifting values of society with respect to floods, rivers and green-blue infrastructure, the emergence of new governance arrangements, the rise of new political ambitions, or the emergence of new knowledge (e.g. Harries and Penning-rowsell, 2011; Garrelts and Lange, 2011; Parsons *et al.*, 2019). Both perspectives tell only part of the story, and both are needed to examine and explain the factors behind situations when institutional inertia is overcome, thereby engaging spatial planning in flood affairs.

This study contributes to the small but growing volume of literature on the integration of spatial planning and flood risk management. It draws on historical institutionalism to explore the factors enabling policy change or divergence from established institutional paths. The exploration theoretically testifies the basic conditions surrounding path divergence, which is important to know when seeking to create future policy change. It is also empirically significant to the on-going but challenging Chinese policy transformations in flood governance since in 2014, which promotes a transition from engineering-oriented interventions toward an extended range of adaptation measures to deal with flood risk with add-on innovations such as nature-based solutions and non-structural basin run-off controls (Jiang, Zevenbergen and Ma, 2018). The findings from this research can also potentially inform other flood-prone areas of policy-making.

This study presents a historical study of Guangzhou's attempts to deal with floods beginning in the 1920s. The city of Guangzhou is regarded globally as one of the most vulnerable cities to flooding by 2070, given the potential dangers to dense urban populations and damages to urban assets (Hallegate et al., 2013). Previous research indicates that the planning system did not actively address flood affairs and that initiating new measures (e.g. nature-based measures and non-structural efforts) in spatial planning to deal with floods was challenging (Meng et al., 2018; Francesch-Huidobro et al., 2017). In this study, two questions are addressed through the study of Guangzhou: (i) What are the (long-established) traditions of planning institutions in dealing with flood risk and what effect do they have? (ii) What, if any, innovations have taken place and why? The first question examines whether there are path dependence phenomena or policy deviations in spatial planning and flood governance in dealing with flood risk. The second question concentrates on the nature of the factors which help to shape deviations or divergences from historically rooted policy paths.

The remainder of the study is divided into five sections. First, it elaborates the methodology employed in this study. The following two sections address the two research questions in turn. In the fourth part of the study, the empirical findings from the two previous sections are discussed in relation to the challenges and opportunities for policy-makers and practitioners involved in the Sponge City Programme, which aims to promote integrated measures to mitigate pluvial, fluvial, and coastal floods in Guangzhou (Meng *et al.*, 2018, 2019; Meng et al., 2019). The study concludes with a summary of the main findings, relevance to practice and theory, limitations, and prospects for future research.

4.2 Methodology

The study traces the policy measures of Guangzhou's planning system to protect its population and assets in vulnerable areas beginning in the 1920s until the early 2010s. The period of the 1920s is a significant point in Guangzhou's history since the first steps were taken in constructing a system of urban planning and constuction management in the city[14]. The early 2010s is the period before the launch of Guangzhou Sponge City Plan (2017), which promotes a remarkable policy change at the municipal level for integrated flood risk management endorsed by the National Sponge City Programme (2014)[15]. As such, the study explores policy changes over the period of almost a century and the findings offer references for the ongoing policy transformation in Sponge City Plan. Figure 4.1 shows the location of Guangzhou in the Pearl River Delta.

14 In 1921, the *Guangzhou Temporary Regulations* document established Guangzhou city as part of the Guangdong province and put in place a city hall to manage urban public affairs on behalf of the government (Guangzhou Urban Planning Bureau et al. 2012, p. 20). Six sectoral departments of the municipal government were defined: Education Bureau, Sanitation Bureau, Financial Bureau, Public Security Bureau, Public Facility Bureau and Public Works Bureau. Significantly, the Public Works Bureau shouldered broad duties including land-use planning, urban infrastructure construction and maintenance, illegal houses demolition, and land and buildings surveying (Guangzhou Urban Planning Bureau et al. 2012, p. 22), which made a start towards a more professionalised planning system.

15 In 2014, the Ministry of Housing and Urban-Rural Development (MoHURD) together with the Ministry of Finance (MoF) and the Ministry of Water Resources (WMR) started the *National Sponge City Programme* to reduce flood loss by integrated solutions, with a priority to pluvial flooding events.

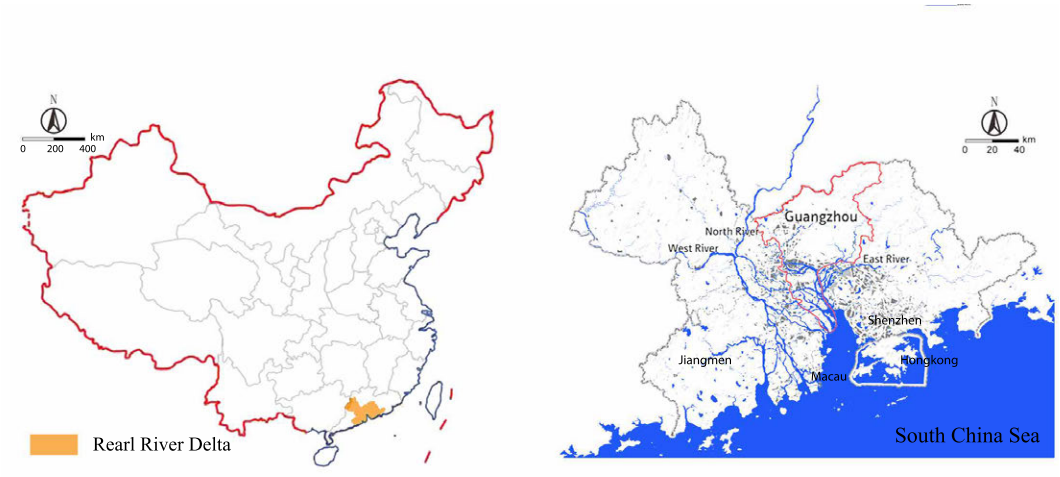


FIG. 4.1 Map of the Pearl River Delta and Guangzhou / Source: Authors, based on the Pearl River Delta Urban-rural Integration Plan (2009-2020) (Guangdong Provincial Development and Reform Commission, 2013)

4.2.1 Identifying and mapping policy changes in relation to spatial planning and flood affairs

Evidence from planning policy documents is used as the main source of empirical data. Grey literature (planning research studies and archives) and interviews (with academic experts researching regional and urban development) are used as supplementary material (see Table 4.4 *Interviews' logbook* and Table 4.5 *List of questions* in Supplementary data). The documents and transcripts were coded according to five types of measures (see below). This initial coding was done using Atlas.ti software for qualitative content analysis.

Table 4.1 presents an overarching categorisation of policy measures for spatial planning to handle flood risk based on an early study from Hegger *et al.*(2014), which distinguishes between five types of measures related to their main purpose: prevention (avoidance), defence, mitigation, preparedness, and recovery. In this categorisation, planning displays two characteristics. On the one hand, it becomes valid as a non-structural approach with no physical construction in the form of policies or regulations, yet takes effect by preventing development in flood-prone areas (prevention/ avoidance) and arranging evacuation routes (preparations) for instance. On the other hand, it is also an approach that physically alter structural infrastructures by designing multi-purpose engineering solutions (defence), nature-based solutions (mitigation), and reconstruction in a post-recovery plan (recovery).

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Coded data is used to explore the divergences in policy discourse. The continuity or consistency over time represents planning norms and routines frequently adopted, namely, path dependence features or 'sticky' features; while discontinuity or inconsistency reveals changes in the more flexible components of planning traditions or, in other words, divergences in critical junctures.

Furthermore, to find out to what extent these divergences were actually implemented, their spatial impacts are mapped based on old maps, archives, planning literature, water management reports, and GIS open-access data in relation to the urban development processes and infrastructure construction.

TABLE 4.1 Five types of measures to deal with the flood risk when spatial planning is taken into consideration

Measures	Content	Statements in planning policies/ regulations	Affected (non-) structural interventions in practice
1. Prevention (avoidance)	Control spatial development in flood-prone areas and avoid negative flood consequences	Floodplain zoning plans; land acquisition and relocation plans	- Function arrangement (economic enterprises, residentials and recreations) (Thampapillai and Musgrave, 1985; Kang, Lee and Lee, 2009; Sayers et al., 2013) - Population move and building (re) locations (Thampapillai and Musgrave, 1985; Kang, Lee and Lee, 2009)
2. Defence	Hindering floodwater entering	Multi-purpose/ multifunctional engineering measures for leisure, landscape and commerce	Construction of - Dykes, floodwalls or quay walls (setting back, combined with residential buildings and commercial development, greening) (Van Veelen, Voorendt and Van Der Zwet, 2015; Voorendt, 2017) - Reservoirs (water storage, supply, natural landscape and recreation) (Wingfield et al., 2019)
3. Mitigation	Decreasing the loss	Nature-based infrastructures: Water basin detention regulations; green space utilisation; waterbody preservation	- Creation and preservation of wetlands, lakes, and green-blue corridors (Kang, Lee and Lee, 2009; Sayers et al., 2013; Wingfield et al., 2019) - Creation of green buffers and flood detention areas (Kang, Lee and Lee, 2009; Sayers et al., 2013; Wingfield et al., 2019) - SuDS measures (rain gardens, permeable paving, green roofs) (Wingfield et al., 2019) - Waterways and channels de-culverting, greening and improvement (Kang, Lee and Lee, 2009; Wingfield et al., 2019)

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TABLE 4.1 Five types of measures to deal with the flood risk when spatial planning is taken into consideration

Measures	Content	Statements in planning policies/ regulations	Affected (non-) structural interventions in practice
4. Preparation	Organising effective reactions in flood events	Evacuation plans; safe havens arrangement; building controls	- Road networks optimisation (Elsergany et al., 2015; Coutinho-Rodrigues, Sousa and Natividade-Jesus, 2016; Jamrussri and Toda, 2018) - Safe havens creation (Coutinho-Rodrigues, Sousa and Natividade-Jesus, 2016) - Buildings waterproof (removable stop logs, water-retaining walls) (Voorendt, 2017)
5. Recovery	Facilitating a good and fast recovery after a flood event	Post-recovery plan; critical infrastructure protection	- Building reconstruction (Olshansky et al., 2008) - Re(location) and reinforcement of supporting buildings such as power generation, health-caring centres, and police stations (Sayers et al., 2013; World Health Organization (Regional Office for Europe), 2017)

Source: Authors, based on (Thampapillai and Musgrave, 1985; Olshansky et al., 2008; Kang, Lee and Lee, 2009; Sayers et al., 2013; Elsergany et al., 2015; Van Veelen, Voorendt and Van Der Zwet, 2015; Coutinho-Rodrigues, Sousa and Natividade-Jesus, 2016; World Health Organization (Regional Office for Europe), 2017; Voorendt, 2017; Jamrussri and Toda, 2018; Wingfield et al., 2019)

4.2.2 Explaining the factors affecting the emergence of new pathways and path divergence

After investigating the planning divergences in relation to flood affairs, the study explores why they took place, building on ideas from the literature about breaking or disrupting path dependence. It helps to draw lessons from planning history and indicate in what context a deviation could take root and establish a new path.

The literature on historical institutionalism sheds light on the evolution of institutions. According to Capoccia and Kelemen (2007), there are specific moments in history, called critical junctures, at which structural constraints from an established system become weaker. This weakness leads to "a new context in which divergences from the previous stable pattern can emerge" (Soifer, 2012, p. 1574). Although the sources of these critical junctures are still debated in historical institutionalism literature, (external) forces and/or (internal) failures to meet new requirements are often regarded as the sources of these divergences, which trigger the breaking or disruption of path dependence (Simmie, 2012). Underlying factors can include new ideologies, innovative technologies and crises (Collier and Collier, 2002).

In terms of flood affairs, there are two schools of thought to explain departures from path dependence, based on either exogenous or endogenous factors. This study combines these two perspectives and proposes an integrated framework with three perspectives including the socio-economic context (e.g. shifts in social values and shared opinions, the use of extended adaptation measures for political advantages in elections) (Harries and Penning-rowsell, 2011; Garrelts and Lange, 2011; Parsons *et al*., 2019), the institutional environment (e.g. new organisations, legislative supports, the inclusion of new knowledge) (Garrelts and Lange, 2011; Parsons *et al*., 2019), and natural hazards (flood events, as a reflection of hazards or crises) (Johnson, Tunstall and Penning-rowsell, 2005; Penning-Rowsell, Johnson and Tunstall, 2006). This framework is used in the analysis of path divergence and the emergence of new pathways in Guangzhou's planning system.

Evidence from a range of literature sources, including academic articles, books, official plans, and government reports, were used in the analysis, as well as information from seven interviewees (four with academics working on the history, regional and urban development, and water affairs; two with municipal officials working on planning and water affairs; and one engineer working on water engineering issues) (see Table 4.4 *Interviews' logbook* and Table 4.5 *List of questions* in Supplementary data). Historical maps were used as a supplementary form of evidence.

4.3 Policy changes in relation to spatial planning and flood affairs

This section first identifies the policy changes of the types of measures to deal with floods in spatial planning discourse and then verifies their implementation through mapping.

4.3.1 Policy changes of the types of measures to deal with floods in spatial planning discourse

Table 4.2 summarises the measures stated in the major spatial planning documents from 1930 to 2016 that deal with floods. The analysis of these documents, initially, indicated that Guangzhou's planning system did not cover all measures as mentioned above by the conceptual framework. They had a narrow concentration of flood defence and flood mitigation. Protection (avoidance), preparation, and recovery measures, by contrast, were seldom found in planning policy documents over that period.

Guangzhou's planning documents shared a consistent preference for engineering structural measures. An attachment to dyke systems and underground pipe systems was dominant with reservoir construction and canals culverting at specific points. This preference was rooted in the *Guangzhou Public Works and Implementation Plan,* which was published in 1930 and was repeatedly echoed by the later documents from 1954 to 2016. Even though there are some examples of nature-based or non-structural solutions, the extent of the changes was relatively minor, and municipal spatial planning remained attached to conventional engineering measures.

Three critical junctures appeared in 1930, the period between 1954 and 1977, and 2005. The first critical juncture initiated by the *Guangzhou Public Works and Implementation Plan* created a zero-to-one template for nascent modern planning to deal with floods. It has resulted in a dependent route on engineering options with long-term impacts on the planning system ever since[16]. The two latter critical junctures, by contrast, marked departures from path-dependent behaviours without the development of a new pathway when non-engineering solutions (like nature-based and non-structural solutions) were proposed in a limited way.

16 Even so, this document was originally designed as a guideline for short-term development (1930 to 1933) (Guangzhou Urban Planning Bureau et al. 2012, p. 37).

TABLE 4.2 Diversity of measures in relation to flood risk in Guangzhou major planning documents

Municipal policy documents	Protection	Defence	Mitigation	Preparation	Recovery
1930 Guangzhou Public Works and Implementation Plan	None	– Dyke enforcement (combined with shipping development)	– Canals culvert – Underground pipes construction	None	None
1954 -1977 * Guangzhou Master Plans (1- 13 version)	None	– Dyke enforcement (combined with shipping development)	– Artificial lakes and reservoir construction for storage# – Canals culvert	None	None
1984 Guangzhou Master Plan (14 version)	None	– Dyke enforcement (for safety)	– Canals culvert – Underground pipes construction	None	None
2000 Guangzhou Strategic Plan (2000-2010)	None	– Dyke enforcement (for safety)	– Reservoirs construction – Underground pipes construction	None	None
2005 Guangzhou Master Plan (2000-2010)	None	– Dyke and sluice enforcement (for safety)	– Preservation of existing lakes for storage# – Construction reservoir combined with natural landscape# – Preservation and improvement of blue corridors such as open waterways and canals# – Elevation of low-lying areas – Underground pipes construction	None	None
2016 Guangzhou Master Plan (2011–2020)	None	– Dyke and sluice enforcement (for safety)	– Reservoir construction – Underground pipes construction	None	None

**: Due to the limited access to sources from this sensitive and instable period (1954-1977) in Chinese history, a precise portrait is hardly possible. The contents of planning policies here are based on grey literature and interviews. #: The contents are comparable to the court-part in the Sponge City Programme, which calls for an emphasis on nature-based solutions and non-structural regulations to deal with the flood risk in addition to traditional engineering measures.*

Source: Author, based on (Guangzhou Public Works Bureau 1930; Guangzhou Urban Planning and Development Review Committee 2005; Guangzhou Government 2000, Guangzhou Government 2005 ; Guangzhou Government 2016)

4.3.2 Implementing divergencies out of planning conventions

In the following analysis, the three abovementioned critical junctures were mapped to indicate how they were implemented. Historical maps from 1932, 1934, 1984, and 2010 were used and compared to trace physical changes in the urban fabric, dyke infrastructure, canals, rivers, reservoirs, wetlands, and lakes, using newspapers, archives, and literature as supplementary materials.

One limitation is that there was only partial geographic information from 1954 to 1977 available to the public. Thus, maps from 1934 and 1984 were used to deduce the situation during this period, which was characterised by slow urban development[17]. In fact, Guangzhou did not return to a stable political situation and a path towards growth until 1984 when the central government approved its 1984 master plan.

Another limitation appeared when the physical changes were mapped: the coverage of the old maps was different over time due to rapid urban growth in recent decades. Thus, between 1984 and 2010, the development of reinforced dykes was mapped (see Figure 4.3 in section 4.3.2.2) in the scope of the old city centre (in agreement with the coverage of 1984 map), while the dykes beyond the centre were not shown in the investigation due to limited information available to the public.

4.3.2.1 1930: Handling flood affairs in an early phase of a modern planning system

Three engineering strategies were mentioned in the 1930 *Guangzhou Public Works and Implementation Plan*: building new dykes along shipping lanes adjacent the ancient Guangzhou city, constructing combined pipe systems, and culverting open canals in the inner city. New dykes were supposed to deal with fluvial floods in riverfront areas and to create a stable navigation environment for the shipping industry (pp. 70-72). However, the implementation of the plan was limited, merely one section of the dyke on the north side had been finished by 1934 (Figure 4.2).

17 This was due to a number of events such as the Japanese invasion (1937-1945), the Chinese Civil War (1945-1949), the Korean War (1950-1953), the Vietnam War (1955-1975), the Great Leap Forward (1958-1960) and the Cultural Revolution (1966-1976).

New (combined) drainage systems were proposed to improve the discharge capacity, with canals culverted as part of this proposal, transforming open canals into pipes to transport sewage and rainfalls and avoiding blocks from urban encroachments (p. 54, 55). In this plan, the old canal systems in the inner city (about 11 km) were scheduled to be changed as the backbone of the combined pipe systems, which collected water from communities and side-street canals (about 225 km) into the ancient city moat (17 km) and finally into the Pearl River (Guangzhou Public Works Bureau 1930). However, progress was limited. Fewer than 3 kilometres of all inner-city canals had been culverted by 1949 (Guangzhou Urban Planning Bureau et al. 2012).

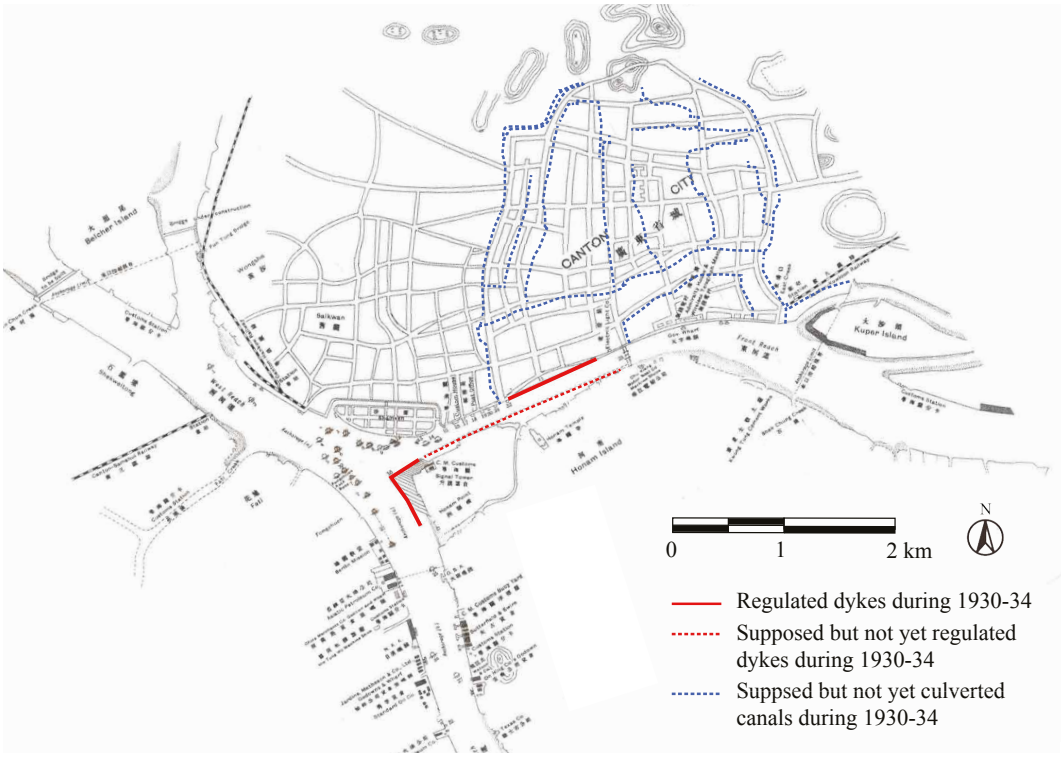


FIG. 4.2 The adopted measures to deal with flood risk at a municipal level during 1930-34 / Source: Author, based on Guangzhou Road System Map (1932) and Guangzhou Harbours Map (1934) included in the book Annals of Guangzhou: The Urban Construction from 1911 to 1949 (Guangzhou Urban Planning Bureau, Guangzhou Urban Construction Archives and Guangzhou Institute of Architects, 2012)

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4.3.2.2 1954 to 1977: The initial deviation with an attempt to use nature-based measures

Due to insufficient public information on master plans from 1954 to 1977, the analysis of this period drew upon grey literature and interviews. At the city scale, three major strands that echo flood concerns can be identified: reinforcing dykes along shipping lines, culverting the canals, and constructing artificial lakes.

Reinforcing dykes for shipping lanes was a continuation of the *Guangzhou Public Works and Implementation Plan* published in 1930. Its implementation was traced based on maps in 1934 and 1984. Figure 4.3 indicates the locations of these interventions. The developed dykes followed urban expansion in this period.

Attention to culverted canals was another way of executing the *Guangzhou Public Works and Implementation Plan*. Its implementation was identified from maps in 1934 and 1984. Figure 4.3 indicates that almost all ancient major canals had been culverted by 1984, with only one surviving (Donghao Canal).

The development of artificial lakes took place in 1958 when the local government initiated the construction of four artificial lakes in lowland areas to store 2.5 million cubic metres of rainwater (Guangzhou Urban Planning and Development Review Committee 2005a; Guangzhou Digital Library, 2008)[18] . In the 1960s, all of the lakes were transformed into public parks for recreation and tourism. According to interviewees 1 and 2, large-scale construction of flood infrastructure in Guangzhou almost stalled around the late 1950s until another new round of city-making after 2005.

18 The artificial lakes are Liuhua (1958), Liwan (1958), Dongshan (1958) and Lu (1958), all of which were located in or near the built areas (Figure 4.3).

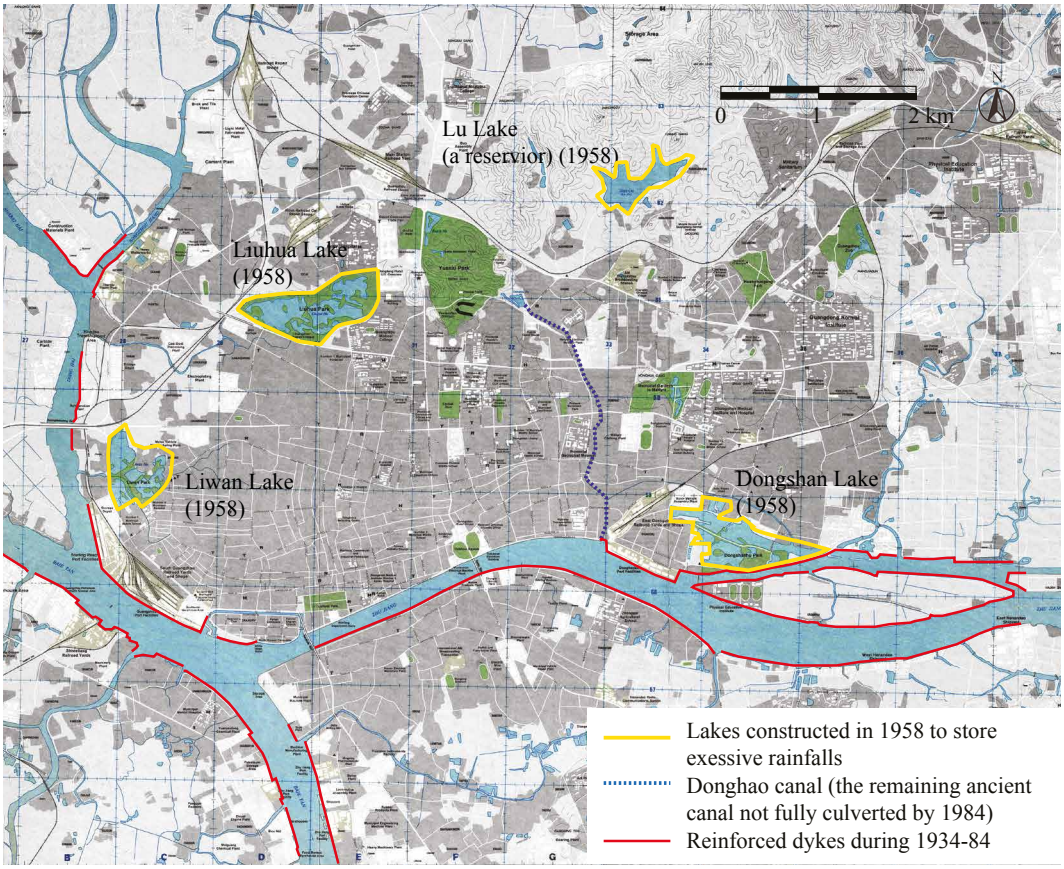


FIG. 4.3 The adopted measures to deal with flood risk at the municipal level during 1934-84 / Source: Author, based on Guangzhou Map 1984 (U.S. Central Intelligence Agency, no date)

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4.3.2.3 2005: The following deviation with an attempt using nature-based and non-structural measures

Another deviation calling on non-engineering solutions appeared in 2015 in the *Guangzhou Master Plan (2000-2010)*. Although engineering measures, such as the reinforcement of dyke systems, pipe layering, and reservoir construction, were still dominant in the new plan, new discourse about nature-based solutions and non-structural measures were mentioned. One consequence of this was that two new policy pathways emerged in the late 2000s in relation to waterway systems and artificial lakes in flood management strategies.

The first pathway concentrated on preserving and renovating the existing open water systems, and uncovering the culverted canals, which was contrary to previous strategies that proposed culverting open water systems and transforming canals into underground pipe systems. This pathway was echoed in a later flood risk management document entitled *Canals and Waterways Renovation Programme 2005-2020 (CWR)* published in 2007, which raised the status of green-blue infrastructures in the city centre. Consequently, a series of pollutant interception and dredging projects began, such as Liede Canal Renovation (2009-2010), Chepei Canal Renovation (2009-2010) and Huangpu Canal Renovation (2009-2010) (see Figure 4.4). Canal uncovering projects were also launched, including the Liwan Canal Renovation (Phrase I, 2009-2010) and Donghao Canal Renovation (Phase I, 2008-2010)[19] (see Figure 4.4 and Figure 4.5). Different approaches, such as the opening, cleaning, dredging, deepening, restoration, and greening of canals, were used in the projects according to the local situations, such as the physical spaces available for changes in highly urbanised areas.

The second pathway was the revival of strategies from the 1950s: constructing artificial lakes, in some cases in the form of reservoirs, to store excessive rainfalls. This was exemplified by the flagship cases of Haizhu Lake (Phase I, 2010-2012) (Figure 4.6) and Baiyun Lake (reservoir) (2006-2011), which were later transformed into public parks. These two cases contributed to an increasing recognition of the value that natural landscapes helped to address urban pluvial floods.

19 Some interviewees argued Donghao Canal was a representative of engineering solutions rather than one of nature-based solutions accounting for the attached sewage water and stormwater pipe systems that were also constructed in this project (interview 3 and 4).

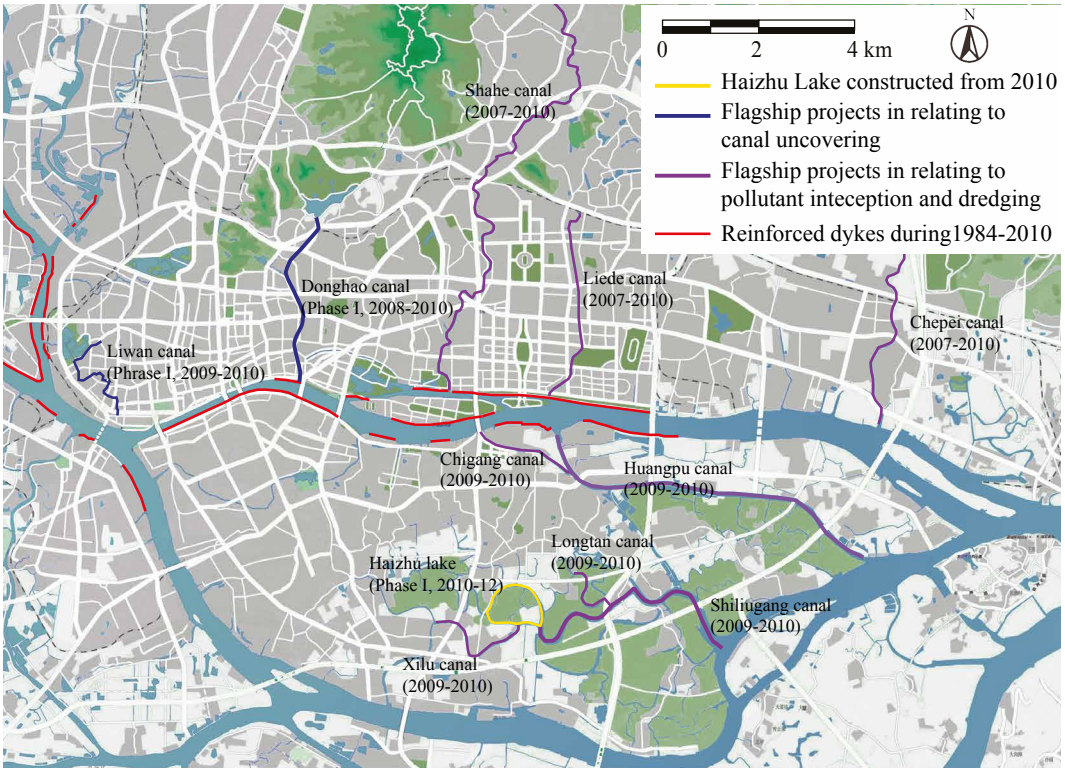


FIG. 4.4 The adopted measures to deal with flood risk in the Guangzhou city centre during 1984-2010 / Source: Author, based on Guangzhou Old Map 2010 (Guangzhou Old Maps Dating back from 1697, 2015)



FIG. 4.5 Donghao Canal renovation / Source: Author



FIG. 4.6 New town construction based on Haizhu Lake / Source: Author

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4.4 Why did divergences take place?

Among these three deviations, there was merely one moment (1930) when innovation took root and continued. The other two cases, by contrast, did not result in continuous change. To understand the different trajectories of these changes, the following section explores the contextual factors that have shaped these divergences. Three factors are examined: socio-economic context, institutional environment, and natural hazards.

4.4.1 1930: Development benefits relating to flood affairs, strong planning, and fluvial floods

4.4.1.1 Socio-economic context

The attention to dyke systems along shipping lanes in 1930 corresponded to socio-economic demands at multiple levels. As early as the 1920s, there was a national call to expand riverfront development in the old parts of Guangzhou. In 1922, Sun Yat-Sen, the founder of the Republic of China, proposed a vision of Guangzhou in the book *International Development of China*, which aimed to establish a world-level seaport in South China and a commercial metropolis in Southern Asia… with convenient land transportation and smooth shipping lines (Sun, 1922). The discourse affected the ambitions of the local government from the 1920s to 1930s and drew attention to developments along riverside areas and shipping routes. Figure 4.7 presents Guangzhou city and the Pearl River Delta by the late 1930s.

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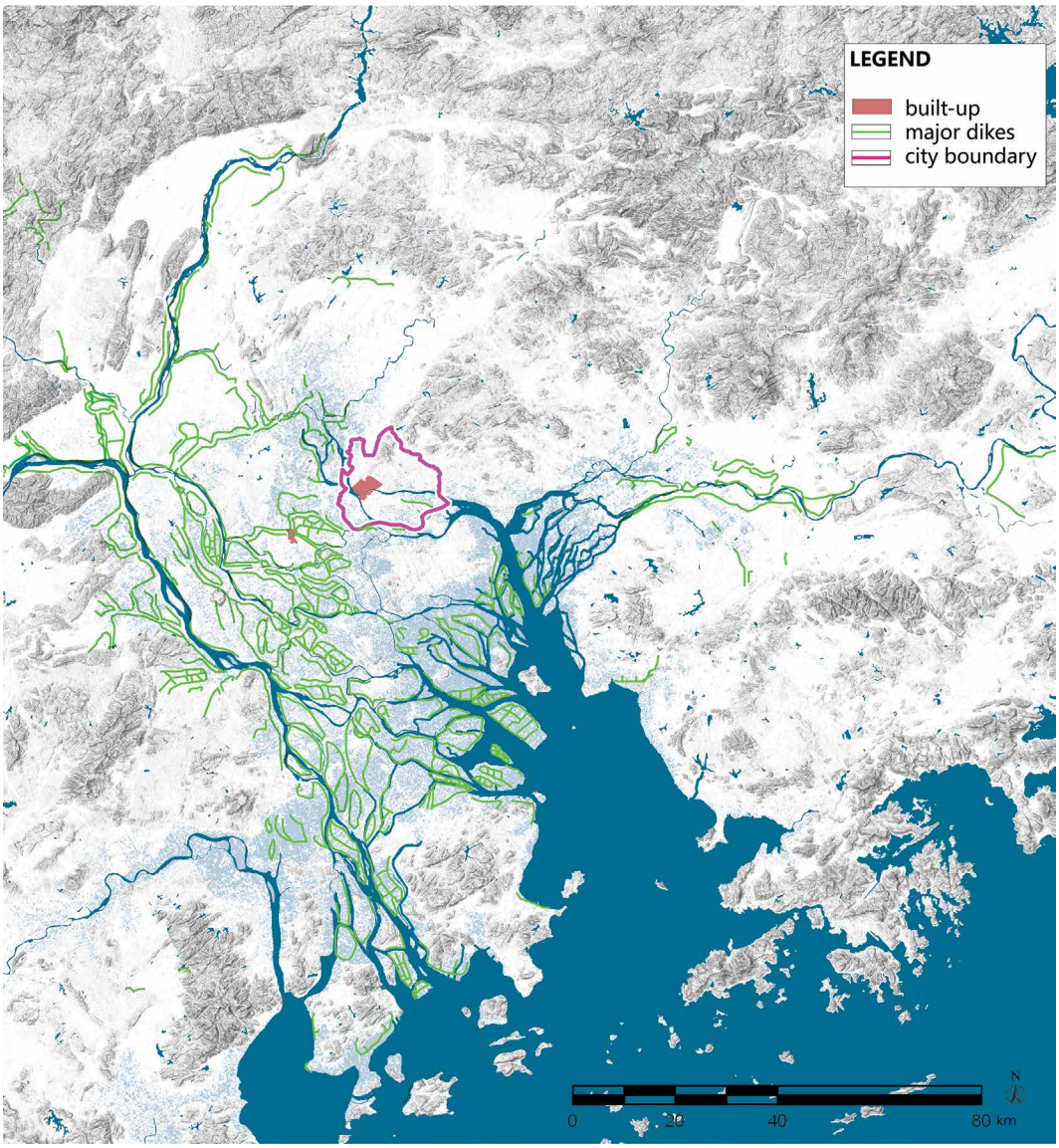


FIG. 4.7 Guangzhou city and Pearl River Delta by the late 1930s / Source: Authors, based on Agriculture Gazetteer of Pearl River Delta (2): History of Dike and Reclamation in Pearl River Delta (Board of Pearl River Delta Agriculture Gazetteer in Foshan Revolutionary Committee, 1976), The Historical Atlas of China (Tan, 1982), Guangdong historical Atlas (Guangdong Historical Atlas Board, 1995) and Guangdong Provincial Standard Map (basic elements version) (Guangdong Provincial Department of Land and Resources, 2009), Landsat image 31/12/1984. ('[Dataset] U.S. Geological Survey, 1984.', no date)

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At the regional level, Guangdong River Control Affairs Department (regional sector) formulated the *Pearl River Shipping Lane Plan* in 1922, which included a detailed spatial layout about how to improve the Pearl River along the Guangzhou section and how to reinforce riverside dyke systems (see the Figure 4.8). However, no actions were implemented before the 1930s, due to limited funding and insufficient construction experience (Guangzhou Public Works Bureau 1930). Even so, this document provided technical support for the regulation of shipping lanes contained in the *Guangzhou Public Works and Implementation Plan.*

At the municipal level, the potential benefits to navigation and real estate were the two driving forces for the regulation of dykes along the Pearl River. Regulated river shorelines were intended to provide steady water flow and a safe shipping environment. In this context, higher-level harbours, piers, and docks could be built to service the shipping industry (Guangzhou Public Works Bureau 1930). In addition, the construction of dykes also provided opportunities for land reclamation and urban development. This was needed to increase the stock of houses and ease the shortage in the face of an increasing population.

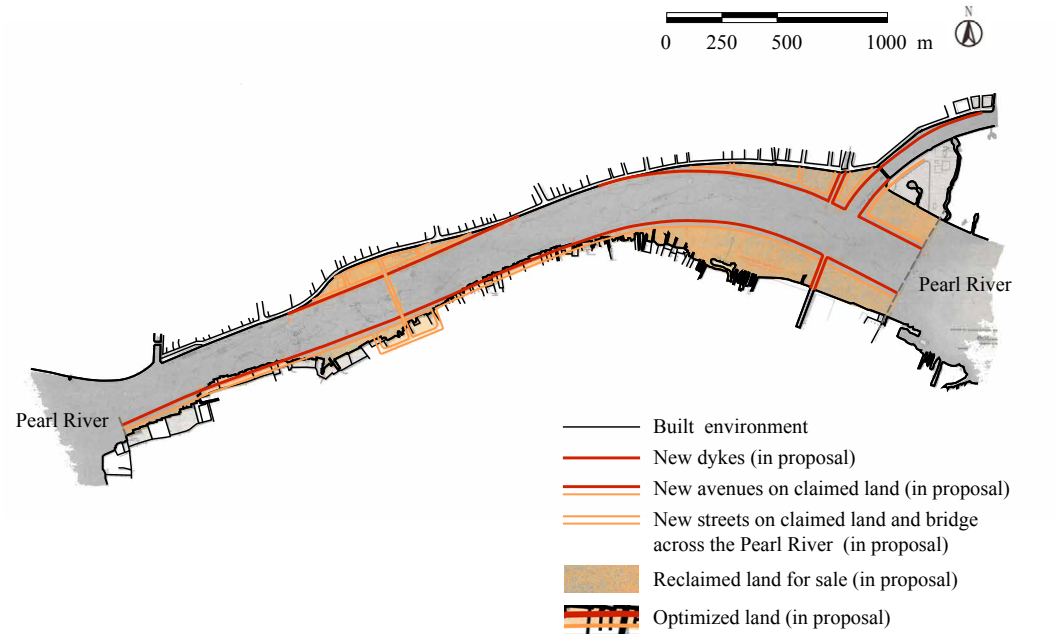


FIG. 4.8 Project for Improvement of the Front Reach (Partly), Guangzhou (Canton) / Source: Author, based on the map of Project for Improvement of the Front Reach (Partly), Guangzhou (Canton) included in the book Annals of Guangzhou: The Urban Construction from 1911 to 1949 (Guangzhou Urban Planning Bureau, Guangzhou Urban Construction Archives and Guangzhou Institute of Architects, 2012)

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The transformations of pipe systems and canal systems were also beneficial to the municipal environment. In the 1930s, the inner canal systems were physically degraded. Many canals were blocked due to waste accumulation and a lack of maintenance (Guangzhou Public Works Bureau 1930). This situation resulted in reduced drainage capacity and poor sanitation. In addition, the canal systems also experienced a decline in use for navigation. Shipping in the inner city gradually disappeared and gave way to land transportation, starting in the 1920s (Pan 2013, p. 36). In this context, culverting canals and transforming them into underground pipe systems became a prefered option, which increased urban space, improved the urban environment and reduced investment in maintenance. However, policy implementation proved difficult. New drainage and canal systems were not fully completed in the originally envisaged timescale due to limited funding for construction, the Japanese invasion (1937-1945) and the Chinese Civil War (1945-1949).

4.4.1.2 Institutional environment

A (modernised) regional flood risk management agency was established as early as 1914 and remains in place today (albeit with several institutional changes) (Wang and Sunny, 2011). Between 1914-1929, the institution in charge was Guangdong River Control Affairs Department, which was later renamed as the Guangdong River Control Committee (1929-1937), Guangdong Water Conservancy Bureau (1937), Pearl River Water Conservancy Bureau (1937-1947), Pearl River Water Conservancy Engineering Bureau (1947-1953), Guangdong Water Conservancy & Electricity Hall (1953-1978), and Pearl River Water Resources Commission (1979 to now) (Guangzhou Water Archives Committee 1991, Guangdong Local Chronicle Compilation Committee 1995). In the early 1930s, the Guangdong River Control Committee was responsible for regional water affairs and large hydro-projects such as the planning and construction of dyke systems.

By contrast, there was no dedicated municipal level institution responsible for water affairs in the early 1930s. The Public Works Bureau, which was engaged in urban development, shouldered the work of spatial planning and flood risk management at the same time. In terms of the projects relating to dyke systems, which affected regional and urban flood risk, the Public Works Bureau worked as a mediator between regional sectors and local civic organisations at the municipal level. For culverting canals and the construction of combined discharge systems in the inner city, it acted as a leader in organising the planning, financing, and construction process. Thus, the duties of urban planning and urban flood risk management were organised under the same bureau and were intended to be closely associated.

4.4.1.3 Natural hazards: flood events

Severe flood events did not always result in changes in planning discourse. Before the launch of the *Guangzhou Public Works and Implementation Plan,* Guangzhou witnessed one serious fluvial flood event in May 1915, known as Yimao Disaster (see Table 4.7 *Major flood records* in Supplementary data). This event was caused by long-lasting storms and collapses in dyke systems along the West, North, and East rivers. More than 1,200 km^2 farmlands near Guangzhou were flooded along with 1.5 million residents. Therefore, the attention to implementing engineering infrastructures, like the dyke systems in the *Guangzhou Public Works and Implementation Plan*, was understandable.

This flood event, however, caused a limited loss of property and life in the inner city: the damaged areas were outside, in the adjacent western areas, such as the low-lying, high-density Xicun and Huadi neighbourhoods (Lao, 1982). Consequently, natural hazards had few direct effects on plans for drainage systems and canal culverts in the 1930s.

4.4.2 1954-1977: A tumultuous context, weak planning vs rising water management, and multiple flood threats

4.4.2.1 Socio-economic context

At the regional level, a long-term dyke consolidation programme was implemented to increase the defence capacity of the dykes along major branches of the Pearl River. This programme linked previously disconnected dykes to form a connected system (Figure 4.9), which involved construction during the periods of 1955-1957 and 1970-1972, followed by large-scale reinforcement between 1983 and 1987. These infrastructural projects were intended to protect the population and assets in Guangdong province as well as Guangzhou city from severe coastal and pluvial floods.

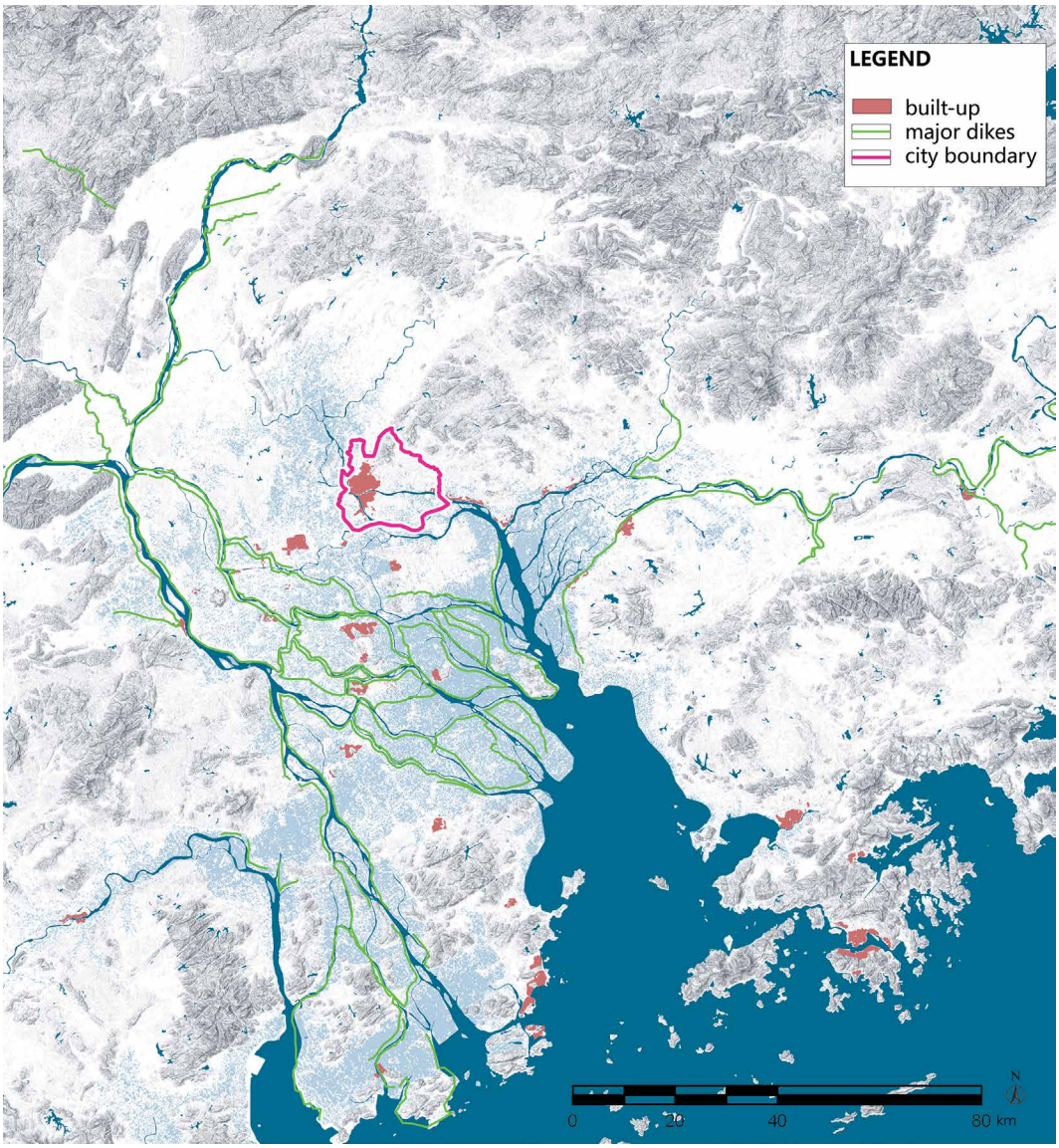


FIG. 4.9 Guangzhou city and Pearl River Delta by the early 1980s / Source: Authors, based on China AMS Topographic Maps (U.S. Army Map Service, 1954), Guangdong Provincial Standard Map (basic elements version) (Guangdong Provincial Department of Land and Resources, 2009) and Coordinator List for Guangdong 10 major dikes in 2011(Guangdong Headquarter Office of Control of Flood_Wind & Drought, 2012)

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The improvement of hydrological infrastructure at the regional level did not bring tangible impacts for urban areas (Figure 4.9). Guangzhou's development slowed down from the 1950s until the 1970s due to the turbulent international and domestic context caused by the Korean War (1950-1953), the Vietnam War (1955-1975), the Great Leap Forward (1958-1960) and the Cultural Revolution (1966-1976). This tumultuous period led to an unstable socio-economic environment at the municipal level (Guangzhou Urban Planning and Development Review Committee 2005, p. 124). Most large-scale construction projects at the municipal level ceased.

In such a context, only minor projects were implemented. Culverting existing canals and transforming low-lands into artificial lakes saved larger investments in flood mitigation by using the existing infrastructure and physical features. In addition, they also improved social well-being by covering over-polluted canals which had sanitation benefits (Southern Metropolis Daily (2002-12-9), 2009).

4.4.2.2 Institutional environment

Responsibility for flood risk management at the regional level did not experience a significant change. The Pearl River Water Conservancy Office (1956-1958) and its successor the Pearl River Water Conservancy Commission (1979 to present), were the main actors who made a firm contribution to the flood defence.

At the municipal level, urban flood affairs were shared by the municipal planning authorities and the Construction Committee (the successor of Public Works Bureau) in a limited way. In such an age of turmoil, their capacity to affect urban development and urban construction was severely impaired. They even had difficulties in formulating a clear vision of Guangzhou city. This lack of future vision was reflected in the changing planning discourse from 1954 to 1977 in terms of shifting development patterns, city size, and population growth (see Table 4.6 *Shift contents of Guangzhou master plans* in Supplementary data).

Meanwhile, detached flood management institutions to address flood affairs at the municipal level started to step into the political arena and initiated a trend of functional separation, despite that these institutions merely focused on rural areas. This situation emerged around 1960 when Guangzhou expanded by gradually incorporating three adjacent counties (Panyu, Conghua, and Hua) into

its jurisdiction[20]. The Municipal Agriculture, Forest and Water Conservancy Bureau was founded to take charge of the water conservancy offices that had previously belonged to these counties. This newly established bureau was separated into the Agriculture Bureau, and the Forest Bureau in 1963, with most water affairs being handled by the former. In 1970, the Xiliu River Commission was established, which launched an era of professional water management and provided a specific agency for water affairs at the municipal level (Guangzhou Water Archives Committee, 1991). These institutions were mainly engaged in managing natural lakes and rivers protection, agriculture irrigation, and flood drainage (Guangzhou Local Chronicles Committee, 1996). However, their work was mostly in rural areas. Most urban areas were beyond their remit. There were no changes in this situation until 2005 when flood management institutions took over urban and rural flood affairs together (see section 5.3.2).

4.4.2.3 Natural hazards: flood events

The changing measures to reduce flood risks still did not show a clear correspondence with frequent flood events, despite a coincidence in fluvial and coastal floods. According to the local water affairs archives, fluvial floods were one of the key hazards during the 1950s to 1970s. There were four events in the 1950s, three in 1960s, and one in 1970s (see Table 4.7 *Major flood records* in Supplementary data). Meanwhile, severe coastal floods also stood out in 1957 and 1964 when two events caused by typhoons brought about substantial damage. The large loss from two sources partly explains the great efforts to integrate the dyke systems at the regional level from the 1950s to 1980s and the construction along shipping routes in Guangzhou.

Large pluvial floods did not result in the same sort of changes. Records from 1949 to 1985 reveal severe pluvial damage on four occasions in 1959, 1964, 1966 and 1968. They took place later than the construction of artificial lakes in 1958 and cannot be regarded as the reason to construct artificial lakes and culvert canal systems at the municipal level.

20 According to the Guangzhou Water Conservancy Archives, by 1954, the jurisdiction of Guangzhou Municipality only covered the urban area, but counties in rural areas were excluded. There were no specialised institutions to manage the urban and rural water affairs in an integrated way at the municipal level. Regional hydrological projects, like dyke systems, were managed by the Pearl River Water Conservancy Engineering Bureau (a regional institution), while agriculture-related projects in rural areas were in the charge of Guangdong Provincial Agriculture Bureau (a regional institution).

4.4.3 2005: Development benefits relating to flood affairs, subordinated planning, and multiple flood threats

4.4.3.1 Socio-economic context

The dyke integration project was finished by the late 1980s. It created a defence system to protect the Pearl River Delta. Guangzhou, in this condition, greatly expanded its boundary to coastal areas (Figure 4.10). This trend was fuelled by changes in 2000 when the national government agreed to the expansion of Guangzhou's administrative boundary (Guangzhou Urban Planning and Development Review Committee, 2005b). The adjustment provided new land for urban expansion in the South and North.

In parallel, the 2010 Asian Games became another incentive for urban expansion in the city. This expansion was accompanied by the attention to nature-based flood mitigation projects. Options such as uncovering and greening previously culverted canals and constructing artificial lakes were promoted in order to enhance spatial quality, liveability, and recreation (Lai and Yuan 2010). These measures corresponded to the requirements placed on Guangzhou for improving its international image and hosting the Asian Games. In return, the improved urban environment became advantageous for attracting real estate investment and triggered a boom in urban regeneration and new urban development (interview 5). According to *Nandu Digital News*' report, all districts (at the sub-municipal level) were eager to have a lake located within their territories in the early 2010s (Li, Li and Liu, 2014).

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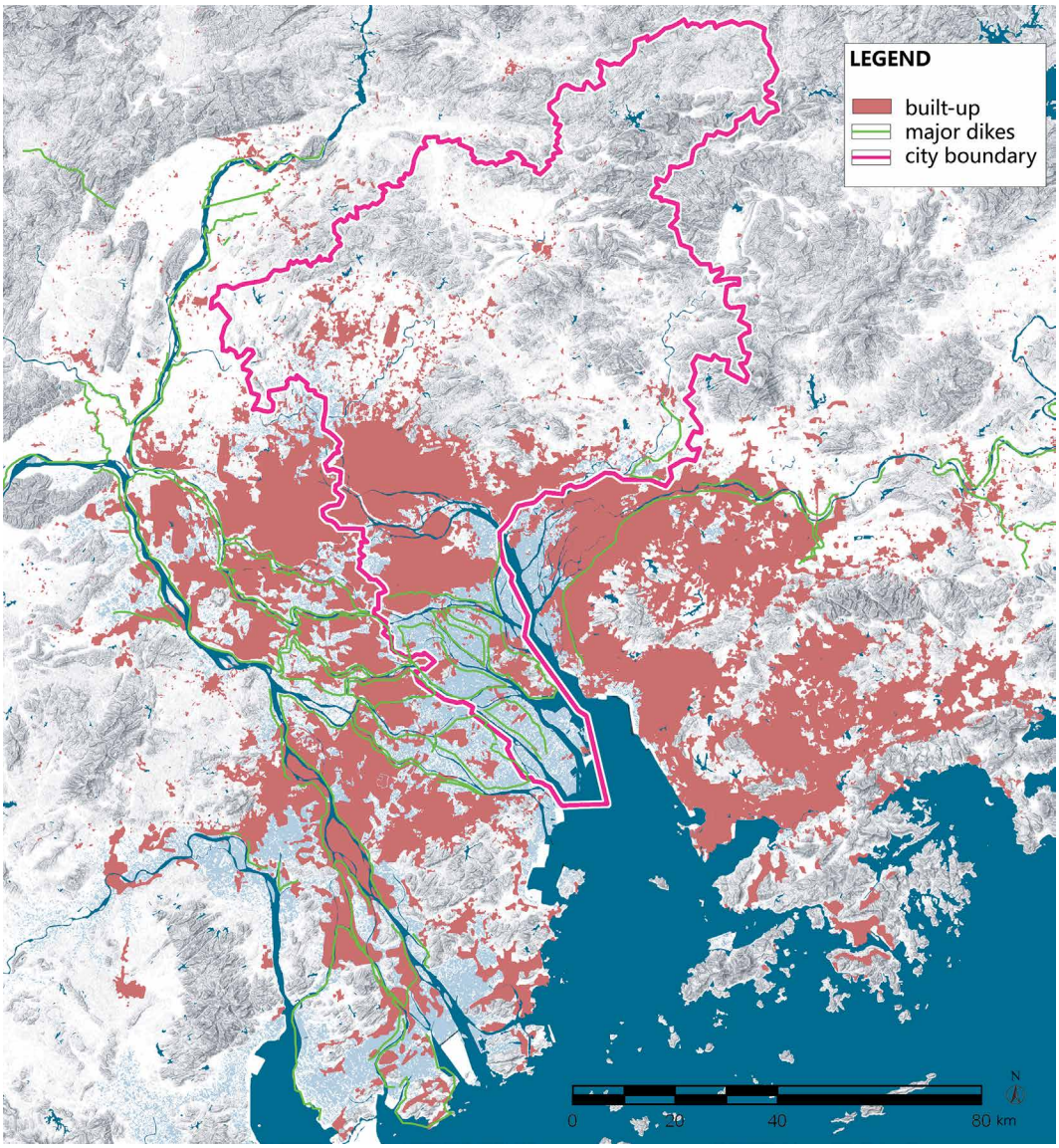


FIG. 4.10 Guangzhou city and Pearl River Delta by the early 2010s / Source: Authors, based on Guangdong Provincial Standard Map (basic elements version) (Guangdong Provincial Department of Land and Resources, 2009), Coordinator list for Guangdong 10 major dikes in 2011(Guangdong Headquarter Office of Control of Flood_Wind & Drought, 2012) and Pearl River Delta rural-urban Integrative Plan (2009-2020)(Guangdong Provincial Development and Reform Commission, 2013)

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4.4.3.2 Institutional environment

Local planning institutions lost their position in flood governance dramatically when urban sprawl confronted regional coastal regulations. As one planner (interview 6) indicated,

"Planning authorities compromise their principles in the face of the predominance of Pearl River Water Conservancy Commission in coastal flood affairs… The fast urbanisation after 2000 brought sprawl to the flood-prone coastal district of Nansha. Because of its convenient location for harbour and marine industry, this area was regarded as a promising engine for the economy… However, spatial planning had to completely retreat on decisions about land use arrangements along the coastal dykes. The regional authority, Pearl River Water Conservancy Commission, set the rules."

Additionally, spatial planning found its influence in flood affairs diminishing at the municipal level. In the context of the Asian Games, planning was regarded as a strong tool to promote city-making. However, in flood-related projects, the role of planning was limited. This was the case with the renovation of Donghao Canal, an urban regeneration project which transformed an abandoned and partially covered canal. As interviewee 4 argued,

"Planning authorities merely acted as assistants to support the decision from water conservancy institutions. The major workloads, including adapting the existing sewer system, dredging the polluted canal, greening the concrete channel, and reinforcing the new banks, were in the hands of the Municipal Water Affairs Bureau."

A similar situation was apparent in the case of Haizhu Lake (2010-2012), as interviewee 5 and 7 stressed. The design and planning of Haizhu Lake were initially led by the municipal and district water affairs bureaus with an extensive knowledge of hydrology. Planning authorities played a supporting role in this project, assisting its operationalisation and used this project to attract investment and build the city image.

The increasing prevalence of Water Affairs Integration Management partly explains how spatial planning has been marginalised in flood governance. It was initiated by Shenzhen in 1993 and was officially introduced in Guangzhou in 2008. In this context, the Municipal Water Affairs Bureau's responsibility was expanded from rural areas to urban and rural areas (Zhang, 2013). Water supply, flood drainage, water treatment, canal management, etc. were all included in its working scope.

As a result, flood risk management took over responsibility for urban and rural flood management at the municipal and regional level and became more prominent on the local political stage. Spatial planning, however, stepped back and took a supporting role.

4.4.3.3 Natural hazards: flood events

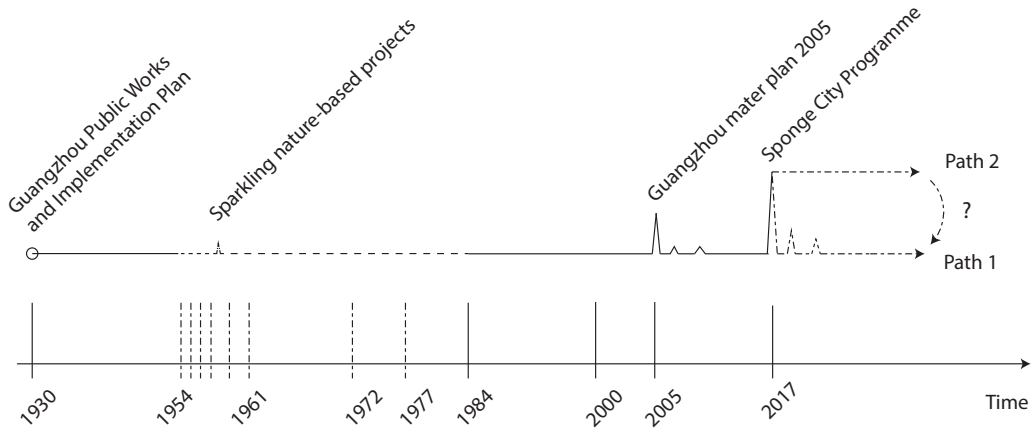
The planning discourse in the Guangzhou Master Plan (2000-2010) shows some correspondence to the flood events in the early 2000s. The official document proposed dyke systems to defend against the coastal and fluvial floods, reservoirs to reduce mountain floods, pipe systems to discharge pluvial floods and an open green-blue network to decrease the pressure for storing and conveying water from excessive rainfalls. The statement was comparable to the diverse source of flood events from 2000 to 2005, including pluvial, fluvial, coastal, and mountain floods (see Table 4.7 *Major flood records* in Supplementary data). This correspondence indicates that the occurrence of flood events might be one of the factors to explain policy changes in 2005.

4.5 Discussion

4.5.1 Institutional inertia and its potential clash with the ongoing policy divergence

The continuity of engineering measures in Guangzhou's planning system echoes the aspects of path dependence theory in historical institutionalism: The stickness to the established preference is powerful and difficult to depart, even though alternatives such as nature-based measures and non-structural measures seem to be useful as well. (Figure 4.11). The findings partly support the idea that Guangzhou's planning system has struggled to embrace newly promoted nature-based solutions and non-structural approaches (Meng *et al.*, 2018).

This study also provides clues for policymakers and practitioners from Guangzhou in the future that implementing the ongoing *Sponge City Plan* is challenging (see the path-dependent track in Figure 4.11): The orthodox in planning traditions could clash with the major departure which promotes expanded measures for flood resilience.



Path 1: Engineering measures dominantly
Path 2: Integration with engineering, nature-based, and non-structural measures

FIG. 4.11 The path of Guangzhou's planning system in dealing with flood issues / Source: Author

4.5.2 Ways to initiate policy changes and overcome inertia

Despite these challenges, the local planning system can still find opportunities to deliver nature-based and non-structural measures under the new *Sponge City Plan*. Table 4.3 summarises three moments of innovation in Guangzhou's history. It indicates that it was easier to shape new flood defence and mitigation measures in planning documents if they met socio-economic needs and if planning authorities were strongly involved. The implementation of these newly formed measures could be impaired by the weakness of any of these two factors, leading to incomplete implementation (as was the case in 1930), limited results (as in 1954-1977 period), or merely a commitment in policy discourses (as was the case in 2005).

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Socio-economic demands are important for new proposals to address flood risk. In 1930, engineering measures were given priority and became dominant because the multi-level benefits, brought to the shipping industry, water safety, housing stock, and sanitation, helped the rise of the newly established Republic of China and the Guangzhou municipal government. Similarly, nature-based and non-structural options were encouraged in 2005 because they helped improve spatial qualities and attracted real estate investment locally but also enhanced the international image of the city in the wake of the Asian Games. Likewise, from the 1950s to the 1970s, few major changes occurred because flood affairs were not important societal concerns due to domestic and international political and military tensions at the time. The findings partly fit the early literature which considered that shifting values of society with respect to floods, rivers and green-blue infrastructure and the rise of new political ambitions shape enabling conditions for policy deviations (e.g. Harries and Penning-rowsell, 2011; Garrelts and Lange, 2011; Parsons et al., 2019).

The institutional environment is closely related to the delivery of new measures. The head-on position of planning authorities with flood affairs led to the intention to consider flood defence measures in urban development and a clear and formal discourse in the master plan of 1930. However, the consolidated discourse was weak or confined to literal statements when planning became subordinate in flood governance, as it did in the period from the 1950s to 1970s, or its counterparts, like regional water sectors and municipal water affair institutions, took over the responsibility in 2005. The institutional transitions from the 1930s to 2000s revealed that the previously leading role of spatial planning in flood affairs gradually faded in the context of specialisation and functional division. Consequently, the original flood management coalition led to a new order, which impaired the participation of planning in return. These findings partly respond to primary papers which argue that the emergence of new governance arrangements could lead to policy changes (Garrelts and Lange, 2011; Parsons et al., 2019). What is more, the transformative political status in flood governance explains the tension in the contribution of spatial planning to flood affairs (Francesch-Huidobro et al., 2017), which could continue to weigh on the current efforts to promote the Sponge City Programme.

By contrast, the occurrence of natural hazards is not always associated with new measures. A typical case was in 1930 when serious fluvial floods did not limit municipal efforts to handle pluvial floods by constructing pipe systems and culverted canals. This non-correspondence also appeared in the period from the 1950s to 1970s, when constructing artificial lakes were adopted before the frequent pluvial flood events. These findings are different from early studies which regarded flooding events as shock events which create opportunities to shake established policies

and the political arena (Johnson, Tunstall and Penning-Rowsell, 2005; Penning-Rowsell, Johnson and Tunstall, 2006). One possible explanation is that planning documents relied mainly on long-term flood records rather than a few flood events which took place over a short-term. Thus, a mismatch appears when comparing planning discourse with a single or a series of flood events. This topic represents an interesting avenue for further research.

TABLE 4.3 Summary of deviations in Guangzhou's planning history (including 1930)

Critical junctures		Socio-economic environment	Institutional environment	Natural environment
1930 Engineering measures – such as dyke enforcement, canals culvert, underground pipes construction – were formalised in the planning discourse. They were continuously claimed in its following masterplans for a long-term. However, it was not fully completed in the short term.	F	Engineering measures brought with the benefits for the shipping industry, safety, housing stock and sanitation improvement in the inner city, which were closely related to national, regional and municipal visions	Public Works Bureau (responsible for spatial planning and flood risk at the same time) played a strong role in dealing with fluvial and pluvial floods municipally; No dedicated municipal water authorities working as counterparts	Fluvial floods were remarkable during 1900-1930, which merely corresponded to the attention to dyke enforcement
	O	Wars disturb its implementation and funds were insufficient to reach the proposed ambition in the short term	N/A	N/A
1954-1977 Engineering measures – dyke enforcement, canals culvert, underground pipes construction – were insisted on and implemented in practice; Natural measures – artificial lakes and reservoirs construction for water storage and landscape – gradually arose yet limited amount and inconsistent	F	Engineering projects provide opportunities for sanitation improvement and nature-based projects brought about ecological benefits in the inner city	N/A	The attention to dyke enforcement was accompanied by pluvial and coastal floods. However, the construction of artificial lakes losses the direct association with pluvial floods events.
	O	There was no national statement to provide policy support for major construction municipally in the context of unstable settings; Political turmoil and limited resources were left to municipal infrastructure	Planning authorities were weak in urban development; Water authorities started to step into the political arena	N/A

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TABLE 4.3 Summary of deviations in Guangzhou's planning history (including 1930)

Critical junctures		Socio-economic environment	Institutional environment	Natural environment
2005 Nature-based and non-structural measures arise in the formal planning policy, albeit not well elaborated in policy document; Flagship projects were constructed	F	Besides traditional engineering measures, non-structural regulations helped to relieve the pressure from rapid urbanisation in flood-prone areas and the encroachment of natural areas, which are significant for water storage and discharge; In addition, the ecological benefits from nature-based measures were good for real estate, the urban environment, and China's international image	N/A	The attention to engineering, nature-based and non-structural measures were accompanied by severe coastal, fluvial and pluvial flood events
	O	N/A	Guangzhou planning authorities merely occupied mild participation in flood affairs and acted as an assistant to water affair institutions; The functional division led to the marginalisation of planning authorities and a rise of water affairs institutions	N/A

F: Facilitators, O: Obstacles
Source: Authors (own elaboration)

4.6 Conclusion

This study has explored the historical development of Guangzhou's spatial planning system alongside changes in flood governance. Drawing on ideas from historical institutionalism, the study has shed light on the institutional inertia of the local planning system in flood affairs and major divergences based on past experiences (section 3) and the factors affecting path divergence (section 4). Clearly, this research does not give an explanation of why institutional inertia in engineering-based approaches has been continually seen in planning policy, and one cannot

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exclude that other factors, beyond the socio-economic context, institutional environment, and natural hazards, also play a role as facilitators in overcoming path dependence. These limitations offer new opportunities for future research.

Historical analysis has revealed how the local planning system traditionally relied on engineering measures to reduce flood loss. This situation became dominant in the 1930s and has had a long-lasting impact even in the early 2010s. This inclination became deeply embedded in the planning system and made it difficult to change. Innovative departures based on nature-based solutions and non-structural approaches, from 1954 to 1977 and in 2005, appear to be disturbances, which have failed to change mainstream practice. The strength of flood management measures with the needs of the socio-economic context and the relationship between planning authorities and water management actors were vital for embedding these innovations in discourse and practice.

In relation to recent practice, the study offers a new perspective to understand the barriers in implementing the Sponge City Programme: past planning conventions can shape the recent obstacles in implementing climate adaptation initiatives. The findings add to the existing literature which stress issues such as inexperienced staff, inadequate governance mechanisms, a lack of knowledge and education, inadequate project preparation, management and evaluation, and insufficient investment (e.g. Xia et al. 2017, Jiang et al. 2018).

The results suggest that policymakers, researchers, and practitioners should not be overly optimistic about the uptake of innovations in planning. A policy change necessitates specific socio-economic and institutional conditions for new policy pathway or path divergence to occur.

Theoretically, this research has offered an overview of how planning can act upon flood affairs through avoidance, defence, mitigation, preparation and evacuation (section 2.2), through both non-structural measures (zoning plans, relocation regulations, etc.) and its influence on structural interventions (e.g. multifunctional engineering projects, nature-based infrastructures, evacuation routes development). In addition, it contributes to the literature on historical institutionalism by exploring the role of the socio-economic context, institutional environment, and natural hazards (disaster events) during critical junctures.

While the above findings are context-specific, the methods and theories used in this study could also be applied to other coastal cities, which are threatened by floods. It can be used to highlight how traditions can hinder policy change and identify factors which can facilitate new ideas, concepts, and policies.

Acknowledgements

The author would like to thank China Scholarship Council, which provided funds for this research.

Supplementary data

TABLE 4.4 Interviews' logbook (2016–2017)*

Code	Date	Interviewees
1	May 25 2016	Academic, involved in planning in the PRD, South China University of Technology
2	May 25 2016	Academic, researching on the history of architecture and urban planning in Guangzhou, South China University of Technology
3	Nov. 30 2016	Senior Engineer, involved in the Donghao Canal Renovation Project, Guangzhou Municipal Engineering Design & Research Institute
4	Nov. 22 2016	Academic, involved in the Donghao Canal Renovation Project, South China University of Technology
5	Dec. 6 2016	Senior Official, Guangzhou Urban Planning Bureau - Urban Drainage Office
6	Dec. 18 2016	Senior Planner, Nansha District Spatial planning Research Centre, Guangzhou
7	Nov. 27 2017	Academic, researching on Haizhu Lake project, South China University of Technology

** Semi-structured face-to-face interviews*

TABLE 4.5 List of questions covered in the semi-structured interviews relating to the study

Number	Questions
1	How 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 practise? Any examples?
3	How did (or do) planning authorities deal with the divergences from the flood risk management? Examples?
4	How could you evaluate the non-structural practise in Guangzhou in the late 2010s, let's say the Haizhu lake? There is a criticise that the real estate became one of the major beneficiaries in such a flood mitigation project.

TABLE 4.6 Shift contents of Guangzhou master plans from 1954 to 1977 based on public information, adapted from (Guangzhou Urban Planning and Development Review Committee 2005, p.85-93)

Year (finished)	Municipal Policy events	Industries Arrangement	Development pattern	City size (km^2)	Expected Population (10, 000)	Planning term (years)
1954	Guangzhou Master Plan (1st version)	Light industry	Extension to the east	177	220	-
1954	Guangzhou Master Plan (2nd version)	Light industry	A new centre in the east aligned with the old city centre	177	220	-
1954	Guangzhou Master Plan (3rd version)	Light industry	Extension to the west	177	220	-
1954	Guangzhou Master Plan (4th version)	Light industry	Extension to the east	210	200	15-20
1955	Guangzhou Master Plan (5th version)	Light industry	A new centre in the east aligned with the old city centre	121	160	20
1955	Guangzhou Master Plan (6th version)	Light industry	Extension to the east	99	140	15
1955	Guangzhou Master Plan (7th version)	Light industry	A new centre in the east aligned with the old city centre	131	145	15
1956	Guangzhou Master Plan (8th version)	Light, service, and logistics industry	Extension to the east	99	145	40
1957	Guangzhou Master Plan (9th version)	Light, service, and logistics industry	Extension to the east	180	185	20
1959	Guangzhou Master Plan (10th version)	Light industry	Poly-centric extension to the east	201	250	15
1961	Guangzhou Master Plan (11th version)	Light industry	Poly-centric extension to the east	117	200	10
1972	Guangzhou Master Plan (12th version)	Light, heavy, shipping, and foreign trade	Poly-centric extension to the east	150	250	50
1977	Guangzhou Master Plan (13th version)	Light, heavy, shipping, and foreign trade	Poly-centric extension to the east	185	-	25

TABLE 4.7 Major flood records in the administrative domain of Guangzhou from the 1910s to 2000s

Year	Month	Damage Source	Flooded Area in Guangzhou (km2)	Affected population in Guangzhou	Type of floods
1915	May	West River, North River, East River	1 200,000 (farmland)	1 500 000	Fluvial flood
1931	Aug.	North River	333,333	200 000	Fluvial flood
1947	June	North River	933,333	860 004	Fluvial flood
1949	Summer	West River, North River	No precise data	No precise data	Fluvial flood
1951	Apr.	North River	293,333	No precise data	Fluvial flood
1953	June	East River, Zeng River	158,227	110 000	Fluvial flood
1957	Sep.	No.5719 typhoon	66,667 (farmland)	No precise data	Coastal flood
1959	June	East River, Zeng River	226,667	No precise data	Fluvial flood and pluvial flood
1964	May	No.6402 typhoon	233,333	No precise data	Coastal flood
1966	June	East River	100,000	No precise data	Fluvial flood and pluvial flood
1968	June	North River, Zeng River, Xiuliu River	336,667	No precise data	Fluvial flood and pluvial flood
1974	June	Zeng River, Xiuliu River, Xinfeng River	308,333	≥50 000	Fluvial flood
1982	May	North river, Bing River, Bijia River	251,400	No precise data	Fluvial flood and pluvial flood
1983	June	Bing River	23,333	15 816	Fluvial flood
1983	Sep.	No.8309 typhoon	369,067 (farmland)	No precise data	Coastal flood and fluvial flood
1994	June	West River, North River	No precise data	No precise data	Fluvial flood and pluvial flood
1997	May	Pa River, Xinjie River, Tianmei River, Xinma River	24 counties	109 000	Fluvial flood and pluvial flood
2000	Apr.-Oct.	Heavy storm events took place in Guangzhou city centre, Panyu District, Huadu county, Zengcheng county	No precise data	No precise data	Pluvial flood
2001	May, June	Mountain torrents caused by storm with Zengcheng county as the biggest victims	No precise data	13 villages in Zencheng county affected	Mountain flood

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TABLE 4.7 Major flood records in the administrative domain of Guangzhou from the 1910s to 2000s

Year	Month	Damage Source	Flooded Area in Guangzhou (km2)	Affected population in Guangzhou	Type of floods
2002	July	Heavy storm hazards in Guangzhou city-wide, especially in Conghua county, Zengcheng county and Huadu District	No precise data	No precise data	Pluvial flood
2003	May	Heavy storm hazards in Conghua county	No precise data	No precise data	Pluvial flood
2003	Sep.	Heavy storm in Nansha District caused Typhoon near Pear River mouth	No precise data	No precise data	Pluvial flood
2004	June	Tieshan River in Huadu district	No precise data	No precise data	Fluvial flood and pluvial flood
2004	July, August	Typhoon Yuangui and Aili in Panyu district	No precise data	No precise data	Coastal flood and pluvial flood
2005	March	Heavy storm hazards in Guangzhou city wide	No precise data	No precise data	Pluvial flood
2005	June	Zeng River, Waterloggingg in Huangpu District, Baiyun District, Fangcong District	No precise data	No precise data	Fluvial flood and pluvial flood

Source: Author, based on (Guangzhou Water Archives Committee, 1991) and (Guangzhou Local Chronicles Committee, 2010)

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5 Shifts in Spatial Plans for Flood Resilience and Climate Adaptation

Examining Planning Procedure and Planning Mandates

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ABSTRACT The chapter 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

5.1 Introduction

Exacerbated by climate change, flood hazards have long been recognized as a considerable threat to coastal and deltaic cities (IPCC, 2018). The requirement to achieve a resilient and adaptive society and avoid negative economic, social, and environmental costs is becoming more urgent (Stern, 2007; UN-HABITAT, 2011). 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 (Cheong, 2011; Porse, 2014; Urban Floods Community of Practice (UFCOP), 2017; Wingfield *et al*., 2019). 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 (Waylen *et al*., 2018). 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 (Waylen *et al*., 2018). 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 (Ran and Nedovic-Budic, 2016); or, in Ghana, the poor enforcement of planning permission makes it impossible to restrict illegal urban construction which increases vulnerability to flooding (Tasantab, 2019). 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 (Ryan, 2015; Clémençon, 2016).

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 (Fröhlich and Knieling, 2013; Hutter, 2016; Ishiwatari, 2019), and shifting relations between territorial authorities in hierarchical systems (Keskitalo, 2010; Fidelman, Leitch and Nelson, 2013). 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 (Dąbrowski, 2018; Dieperink *et al*., 2018). 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 (e.g. Cheong, 2011; Hurlimann and March, 2012; Macintosh, Foerster and McDonald, 2013, 2015), the focus, in most cases, is on how specific projects are implemented empirically in different nations, regions, and communities (e.g. Few, Brown and Tompkins, 2007; Albers *et al*., 2015; Paganini, 2019), 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 (Meng *et al*., 2019). 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) (Ministry

of Housing & Urban-rural Development, 2015), 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 (Meng *et al.*, 2018). 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 study 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 study concludes with a summary of the main findings and implications for practice and future research.

5.2 Background: Chinese spatial/urban planning system and water conservancy (and affairs) planning system

5.2.1 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 5.1): planning establishment, planning permit approval, and planning construction. 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,

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and expected populations (Yu, 2014). 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 (Chinese Planning, 2018).

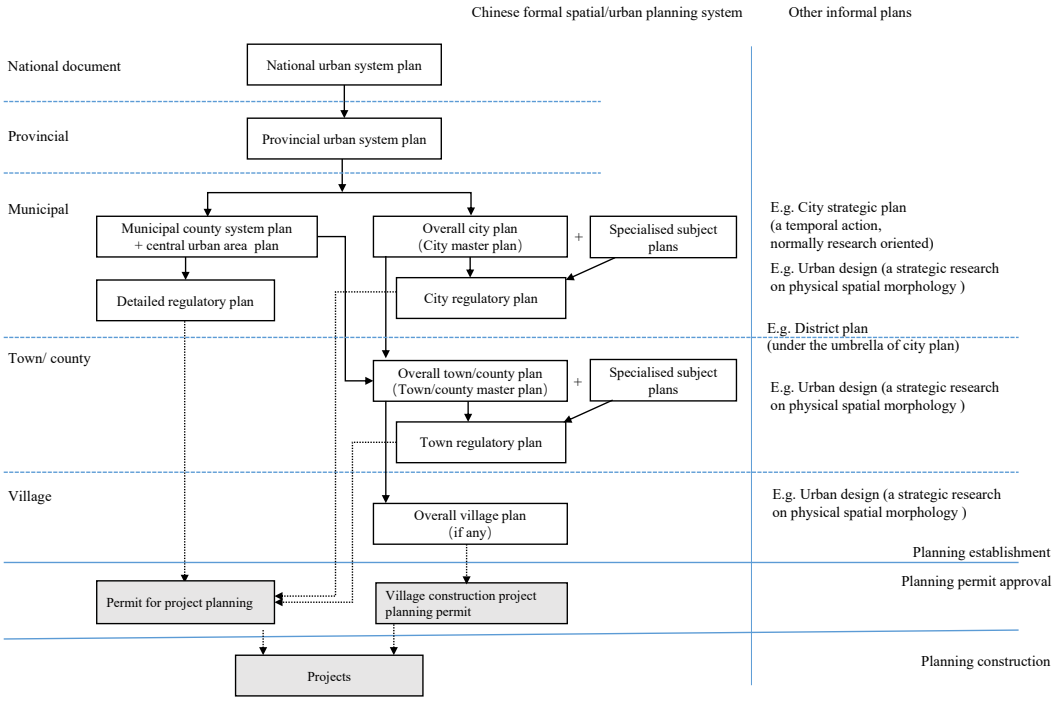


FIG. 5.1 Chinese multi-layer spatial planning system / Source: Author, based on Countryside Planning Act (2008) (Standing Committee of the National People's Congress, 2008) and Principles of Urban Planning (4th Edition) (Wu and Li, 2010)

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 (Yu, 2014). 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.

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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 5.1). 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 (Yu, 2014). 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 a tool used to face the uncertainties in terms of rising capital markets, policy cohesion, and global challenges (Wang, 2015). 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 (Pengfei, 2015). 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 analyse 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).

5.2.2 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 5.2 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

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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.

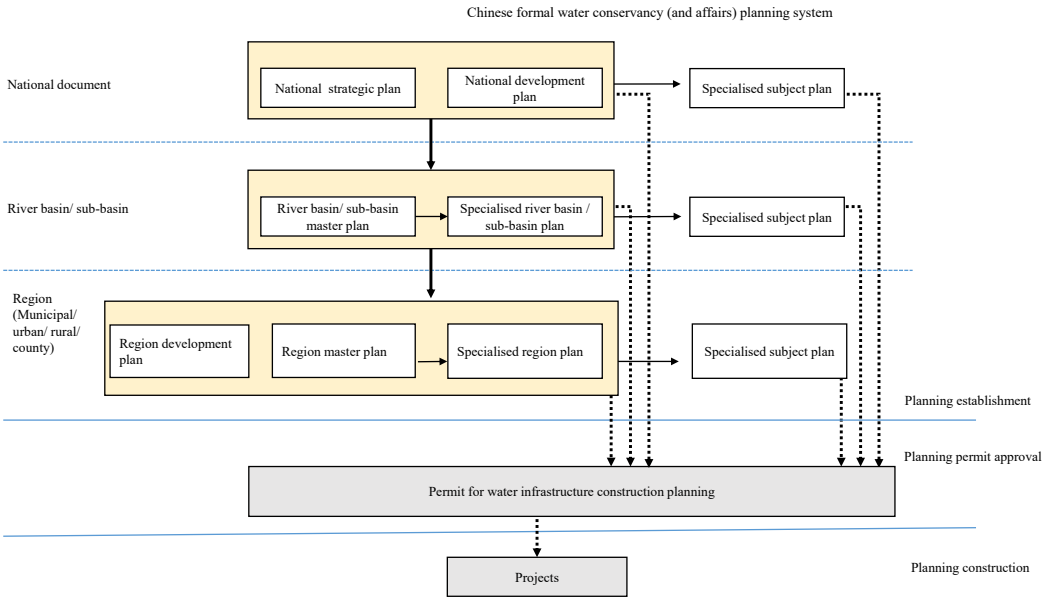


FIG. 5.2 Chinese multi-layer water conservancy (and affairs) planning system / Source: Author, based on Management Measures of Water Conservancy Infrastructure Construction and Planning Permit (Temporal) (Ministry of Water Resources, 2007a), Flood Risk Management in the People's Republic of China: Learning to Live with Flood Risk (Kobayashi and Porter, 2012), Water Conservancy Planning System of Zhejiang Province (Zhang, Shen and Chen, 2017), and Management Measures of Water Conservancy Planning (Temporal) (Ministry of Water Resources, 2018)

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.

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5.3 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 the policy. To answer the first concern, this study 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 5.2 (Background: Chinese spatial/urban planning system and water conservancy (and affairs) planning system).

To answer the second concern, this study draws on the ideas from Hurlimann and March (2012), 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 *forms* and *descriptions* in Table 5.1). 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, regulations offer 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.

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 5.2.1, 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 5.1). 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.

TABLE 5.1 Types of plans and planning tools

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

Source: Author, based on the planning tool model in climate adaptation (Hurlimann and March, 2012)

Subsequently, Sections 5.5 and 5.6 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.

5.4 Case selection and data collection

5.4.1 Case selection

Guangzhou's spatial planning functions within a two-layer hierarchical structure, at the municipal and district levels. This structure has undergone many geographic changes since it was established. Figure 5.3 reveals the latest boundaries of the 11 districts under the umbrella of a municipal government, which was established in 2016.

The municipal water management agents also follows this two level structure and works at the municipal and district levels (Table 5.2). In addition, there is a detached vital river basin flood control sector, the Pearl River Conservancy Commission. It was established to be responsible for coastal and surge floods at the river basin level in 1979 by the Ministry of Water Resources.

One subsidiary, the hierarchies of spatial planning and water management, may differ from one place to another according to their local context. For example, Shaoguan, an adjacent city also located in the Pearl River Delta, functions as a municipal-town-village three-layer planning structure.

TABLE 5.2 Structures of administration, planning, water management, and flood control

	Guangzhou Administration	Guangzhou Spatial Planning	Guangzhou Water Management[1]	Flood Control[1]
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	

1: The fields relating to water conservancy (and affairs) planning system

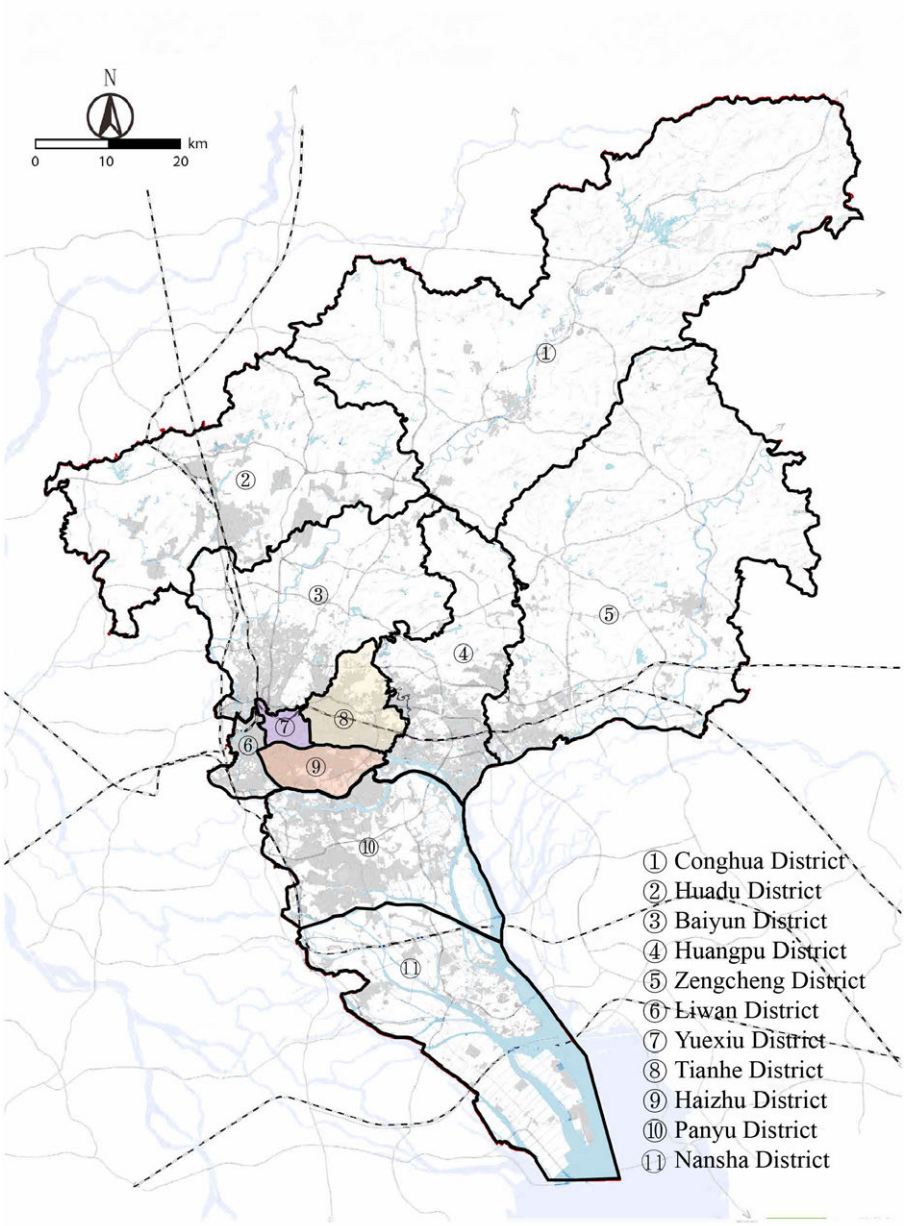


FIG. 5.3 Eleven districts of Guangzhou / Source: Author

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Three district cases in Haizhu, Yuexiu and Tianhe (Figure 5.4), 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.

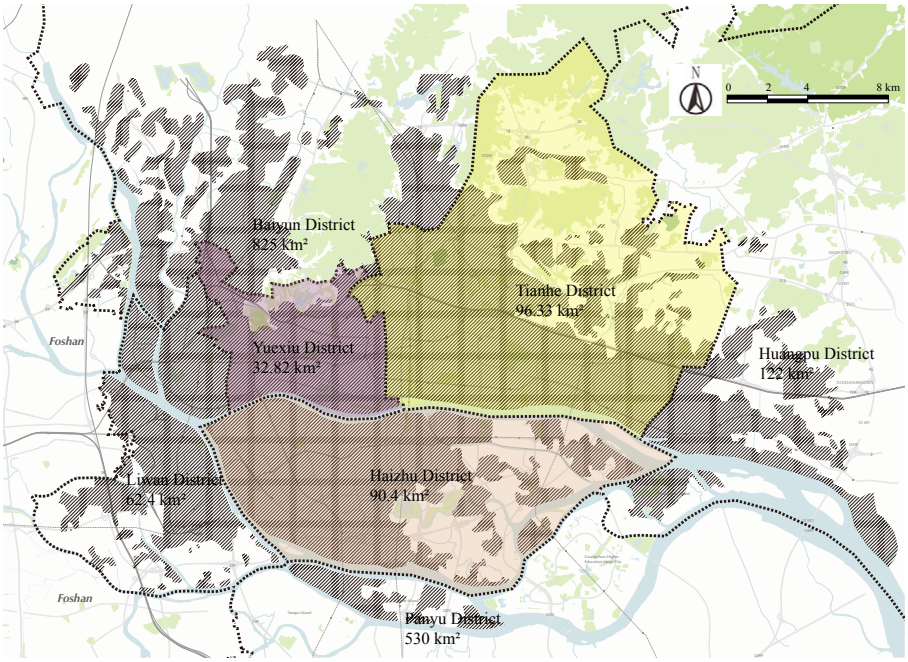


FIG. 5.4 Locations of flood addressing pioneers, Haizhu and Tianhe Districts / Source: Author

5.4.2 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 analysed 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).

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In addition, we use semi-structured interviews (see Supplementary data Table 5.6 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 Supplementary data Table 5.5 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.

5.5 Traditional planning system: attached subject plan in relation to flood concerns

5.5.1 The horizontal position of spatial planning in a macro policy environment

Figure 5.5 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 defence, and rainwater discharge. On the other hand, they were compatible with the professional provisions created by detached sectoral plans.

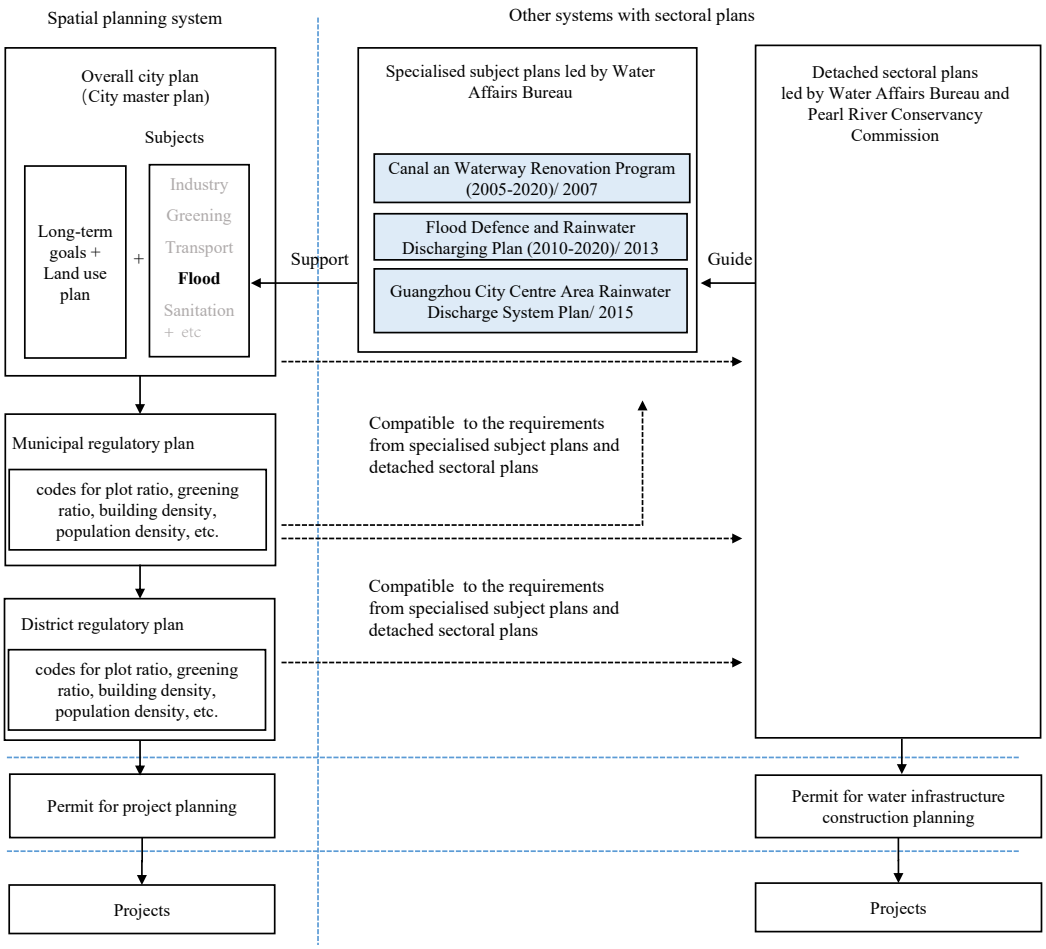


FIG. 5.5 Macro policy environment of Guangzhou during 2000–2017 to deal with flood risk between spatial planning system and water conservancy (and affairs) planning system (urban water management and regional flood control) / Source: Author. Note: vertical blue dashed line indicates the boundary between the 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

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prevention' (see Table 5.3, which will be further discussed in Section 5.5.2). In addition, the content was limited to an illustration of flood defence 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 5.3 Flood prevention and rainfall discharge discussion under the subject of public safety and disaster prevention in master plans

Year	Documents	Flood Defence and Coping Measures (Desired Hydrological Standard)	Principles
2000	Guangzhou Strategic Plan 2000–2010	Middle reservoirs: 100 years Small reservoirs: 20 or 50 years City centre dykes: 200 years West-north River dykes (Nansha branch): 100 to 200 years East River dykes: 50 years City centre pipe systems: 20 years Pipe system in other areas: rainfalls last 24 hours 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 centre 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 centre should be higher than 107.79 meters with Baiyun district as an exemption City centre pipe systems: 20 years Pipe system in other areas: rainfalls last 24 hours with a density in every 20 years reoccurrence periods should be drained within one day Preservation of canals and artificial lakes in the built centre	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

Source: Author, based on Guangzhou Strategic Plan 2000–2010, Guangzhou Master Plan 2000–2010, Guangzhou Master Plan 2010–2020 (Guangzhou Government, 2000, 2005, 2016)

Even so, guidance for planners to take concrete actions were vague. After all, the responsibilities for the reinforcement or improvement of flood defence 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 5.6, which will be further discussed in Section 5.5.2). 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 (Guangzhou Water Conservancy Bureau, 2007; Ministry of Water Resources, 2007b; Guangzhou Water Affairs Burea, 2012, 2013).

Notably, these specialized subject plans were 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.

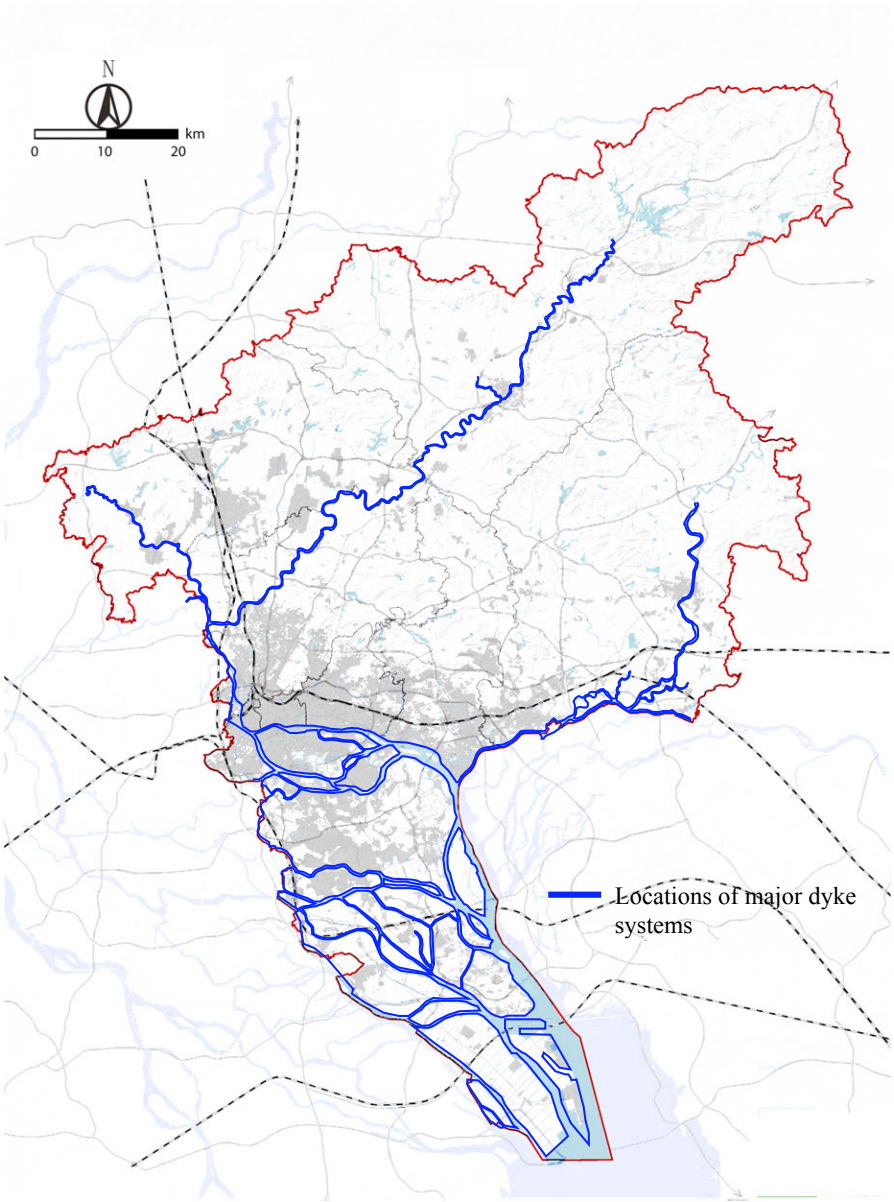


FIG. 5.6 Locations of dyke systems of Guangzhou / Source: Author, based on the Map of Major Infrastructures in Guangzhou, exhibited in the Exhibition Museum of Guangzhou Urban Planning

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5.5.2 Vertical administrative shift

As described by Table 5.3 in Section 5.5.1, 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 5.6). 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 natured-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 (Wu *et al.*, 2018).

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 52km^2, 57.5% of the Haizhu district (Haizhu District Urban Planning Bureau *et al.*, 2013). Under this new framing, a new eco-city 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 5.7).

As with flood concerns, the *Regulatory Plan* (Figure 5.7) 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 facilitates, 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.

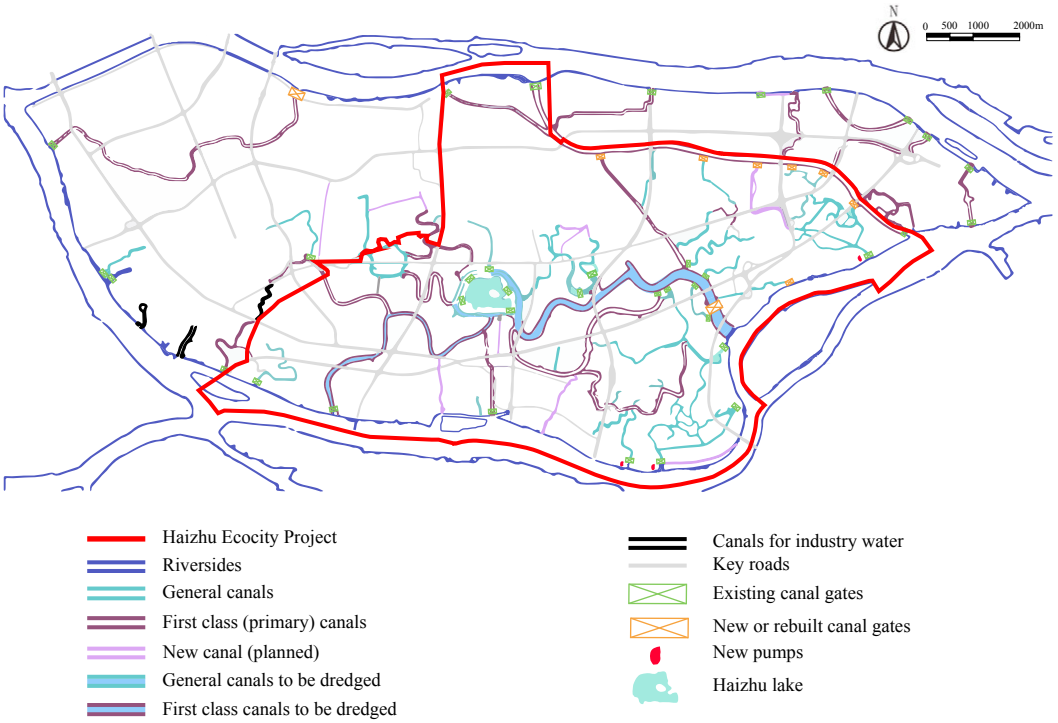


FIG. 5.7 Measures to reduce the flood risk and increase the safety in the Regulatory Plan for Haizhu Ecocity / Source: Author, based on Regulatory Plan for Haizhu Ecocity (Haizhu District Urban Planning Bureau et al., 2013)

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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 5.8). 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) (Guanghua *et al*., 2016). In addition, this project was also a regeneration practice to improve the polluted water environment in the centre. 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 facilitates, such as a water treatment plant, a pumping station, and several sluice gates (Wu *et al*., 2016).

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 Table 5.5. interviews' logbook in Supplementary data):

"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. The improvement of the built environment and water affairs were not the job of spatial planning institutions."

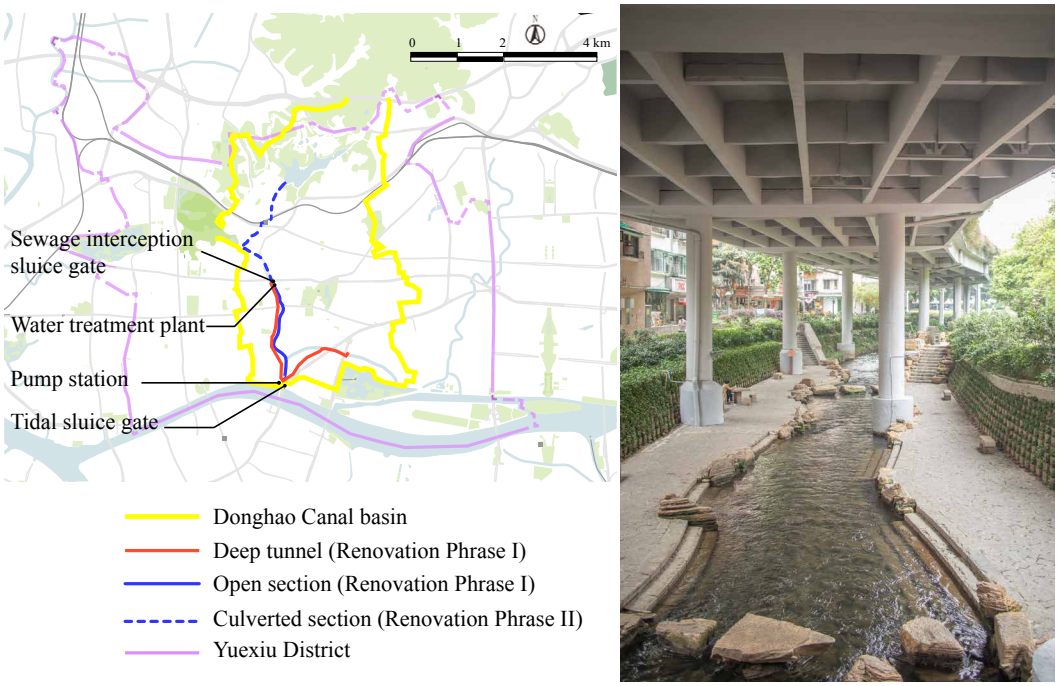


FIG. 5.8 The Donghao Canal (I phase) / Source: Author, the map is portrayed based on Basic Survey Map of the DongHaoChong Basin (Wu et al., 2016) and the photo was taken by the authors

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5.6 New pathways introduced by the Sponge City Plan: a detached specialised subject plan focusing on flood affairs

5.6.1 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 5.9 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 (Figure 5.1 and Figure 5.2). 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) (Meng *et al*., 2019). Thus, the final output, the *Sponge City Plan,* was a product of joint efforts.

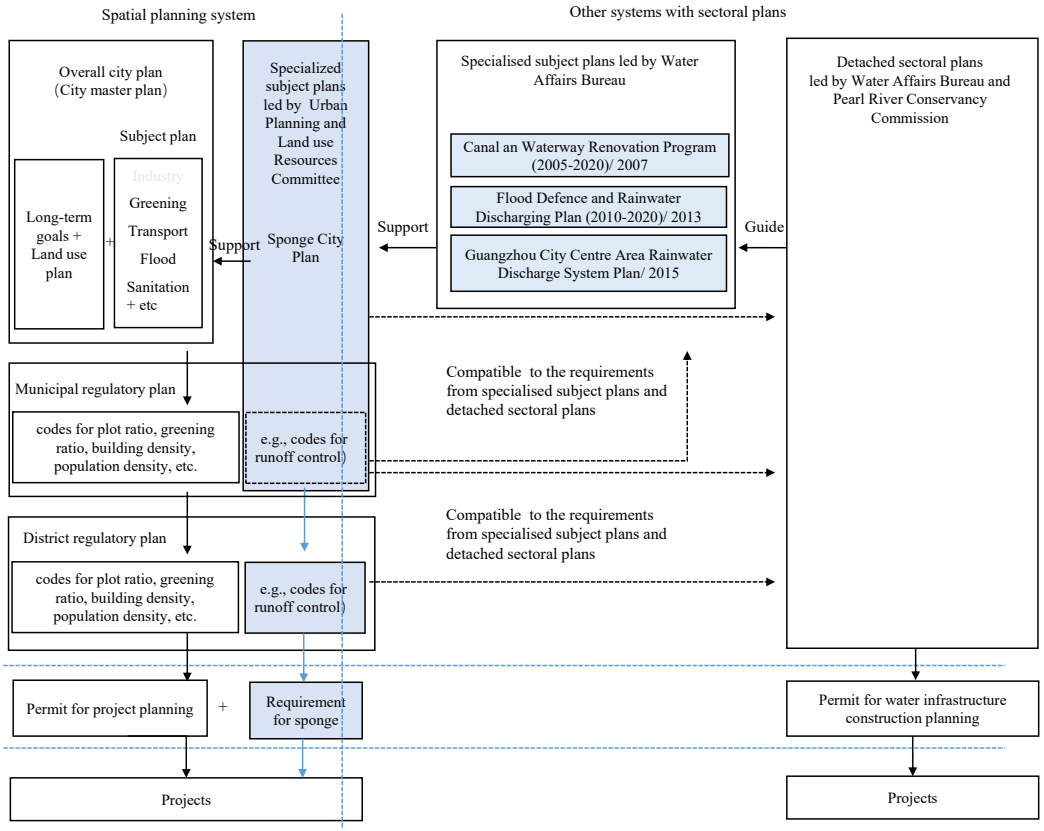


FIG. 5.9 Macro policy environment of Guangzhou in the preparation and launch of the Sponge City Plan in 2017 / Source: Author. Note: vertical blue dashed line indicates the boundary between the spatial planning system and water conservancy (and affairs) system

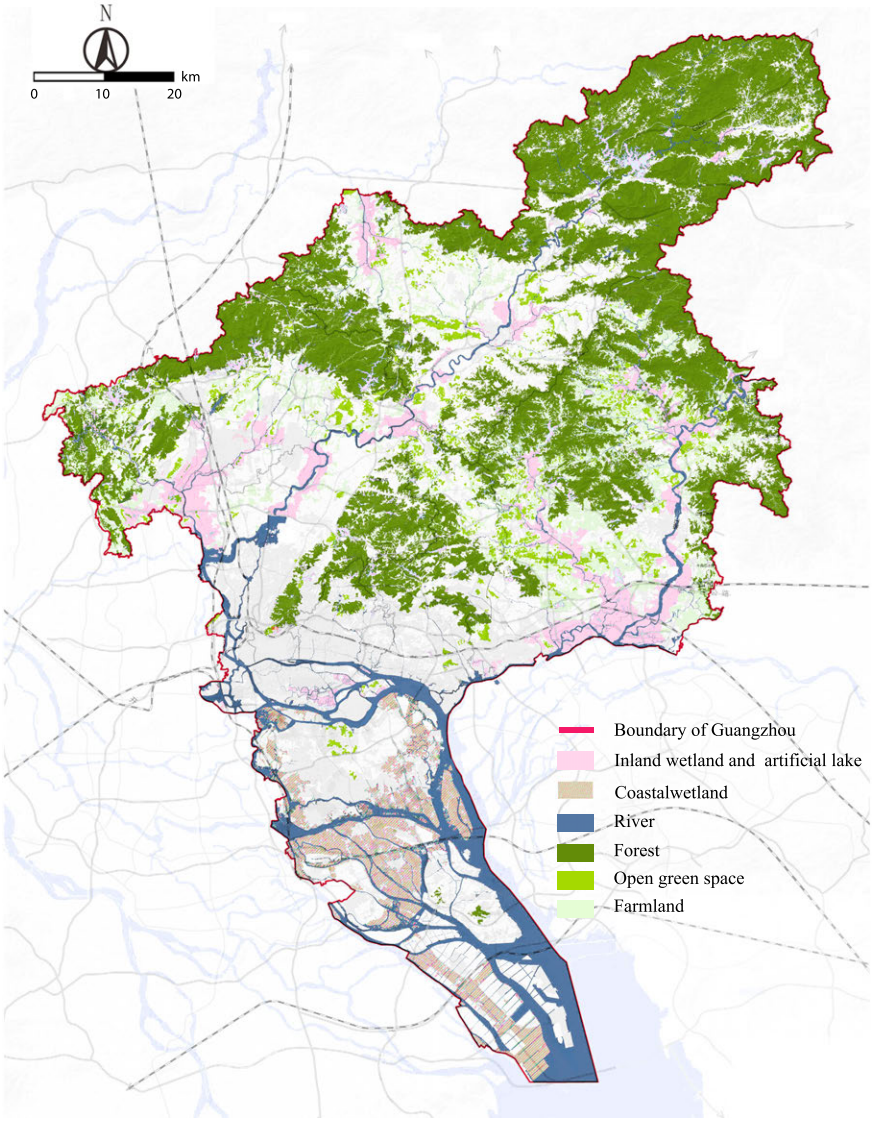
Such a co-ordination process has led to a change of spatial planning responsibilities: managing flood issues in dry territories, lands beyond the areas scoped by *Blue lines*, in contrast to the previous orthodox approach of retreating from wet territories and leaving flood issues to hydrological engineers. 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 5.10-1, which will be further discussed in Section 5.6.2). These measures are supposed to be written in permits as a way to control construction projects.

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1 Runoff control regulatory codes (the values presented in the map equal 1 minus the runoff coefficient)

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2 Optimizing green–blue networks

FIG. 5.10 Major innovative measures for flood resilience in Guangzhou Sponge City Plan / Source: Author, based on Guangzhou Sponge City Plan 2010–2030 (Guangzhou Government 2017)

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5.6.2 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 5.4). 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 defence, drainage, and detention capacities by improving the current engineering infrastructure and implanting micro green spaces in paved areas (Table 5.4). 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 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 5.4 Mainstreaming flood mitigation into local agendas in Guangzhou, based on Guangzhou Sponge City Plan 2010–2030 (Guangzhou Government 2017)

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. They were: the principles of optimizing municipal or branches of regional green-blue infrastructure, like forests, wetlands, ecological corridors, rivers, (Figure 5.10-2); and the regulatory controls of the amount of runoff discharged into pipe systems (Figure 5.10-1).

The principles of optimizing green–blue flood resilience infrastructure included (Figure 5.10-2):

- 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 5.10-1). 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 (Wang *et al*., 2016). For example, the runoff coefficient of parks and cemeteries, characterized by grasslands and trees, is generally around 0.1 to 0.25 (*Runoff Coefficient in InfoSewer and InfoSWMM*, 2017); this means 10% to 25% flows into the water discharge system while 75% to 90% of precipitation is supposed to be retained. By contrast, the 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.

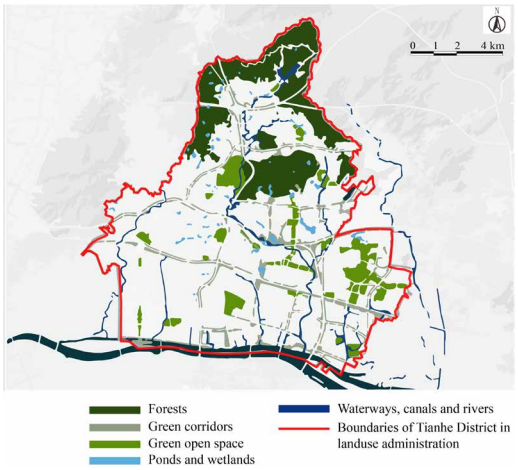
Figure 5.10-1 shows a set of runoff control regulatory codes relating to catchment basins. The term catchment basin is a hydrologic term, interchangeable with catchment area, river basin, drainage area, and drainage basin. In a closed catchment basin, all waters converge at a single point in this basin, with no visible outlets and a channel to a permanent lake, dry lake, or a stream (Lambert, 2006). Different basins are separated topographically from adjacent basins by a watershed

or ridgeline in the form of hills, mountains, or a ridge. In Figure 5.10-1, the boundary of a catchment basin identifies the plots of land in Guangzhou overall.

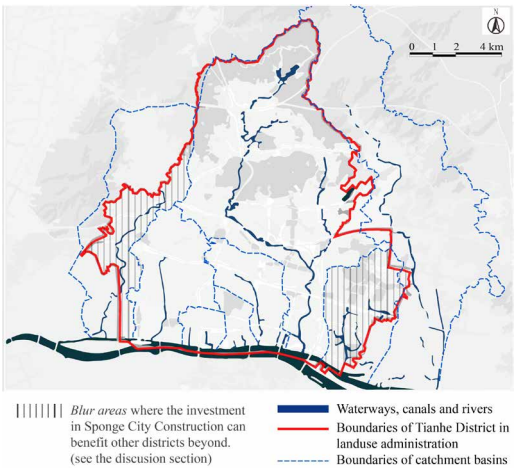
The proposed runoff control codes were decided according to the current precipitation and infiltration, and the potentiality in improvement to avoid over-paving. A looser goal was set for the areas with intensive paving, difficult to be altered, while a tougher goal was set for new lands, easy to be altered. For instance, the goal for plot 05-03 in the old city centre, part of Yuexiu District, was 0.49 (Figure 5.10-1), meaning 51% runoff was allowed to be discharged into the drainage system (Guangzhou Government, 2017). 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 5.10-1) (Guangzhou Government, 2017). These quantitative indicators were translated into the 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^2 (Tianhe District Government, 2018). As a specialised 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 5.11).

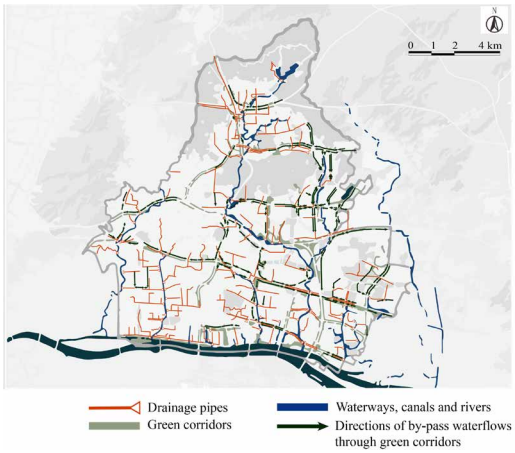
In the proposal of optimizing green–blue networks (Figure 5.11-1), six categorizing land-use covers were highlighted: forests and mountains, green patches, green corridors, hollows and ponds, canals and open waterways, and district-cross river branches. These nature-based networks were supposed to be preserved and/or improved to store rainwater in the source, reduce runoff in the passage, and increase defence capacity at the end, with an additional benefit for ecological restoration.



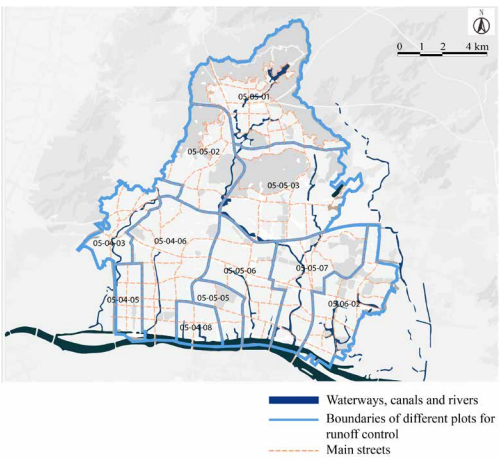
1 optimizing green–blue networks



2 portraying catchment sub-basin boundaries



3 organizing the excessive water flows



4 setting floating regulatory codes

FIG. 5.11 Major innovative measures for flood resilience in the Sponge City Plan for Tianhe District / Source: Author, based on the Sponge City Plan for Tianhe District (Turenscape Planning and Design Company, 2018)

The map of catchment sub-basins followed a similar rule of basins at the municipal level but in a more refined way (Figure 5.11-2). 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 organisation and runoff control.

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In the organisation 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 5.11-3). 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 5.11-4) was based on the maps of catchment sub-basins boundaries (Figure 5.11-2) and municipal runoff control regulatory codes (Figure 5.10-1). 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 5.10-1) 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 5.11-4) 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.

5.7 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 (Mahoney and Thelen, 2009; Van Der Heijden, 2011). 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. Specifically, specialized subject plans help to explore the approaches to the coordination between the water affairs organisations and planning organisations in the decision of land uses. As a result, the agreed principles, rules and codes from both fields can be written into planning permission to regulate the development of projects.

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 5.1 and 5.2). 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 of 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 5.11-2).

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 comprehensive agencies' conversation across vertical and horizontal boundaries. The means to achieve this agreement call for further investigation.

5.8 Conclusion

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 study 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 study 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 study is the analytical framework, based on Hurlimann and March's work (2012), used to analyse 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 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 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 study 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 (Waylen *et al.*, 2018, Ran and Nedovic-Budic, 2016, Tasantab, 2019). 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 study, 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 study 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.

Author contributions:

This article is the result of the joint work by all authors. D.S. and M.D. supervised and coordinated work on the study, and contributed to conceptualisation and theory building. M.D. reviewed and edited the original draft. M.M. conceived, designed, carried out the selection of the methods, analysed the data, prepared the data visualization and contributed to the writing of this study. All authors discussed and agreed to submit the manuscript.

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Conflicts of interest:

The authors declare no conflict of interest.

Supplementary data

TABLE 5.5 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 5.6 List of questions covered in the semi-structured 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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6 Collaborative Spatial Planning in the Face of Flood Risk in Delta Cities

A Policy Framing Perspective

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ABSTRACT Integration of flood risk in spatial planning is increasingly seen as a way to enhance cities' resilience to the growing flood hazards, albeit its operationalisation remains challenging. This study aims to explain the reasons for this difficulty through the case study of Guangzhou, a Chinese delta city that is highly vulnerable to coastal, fluvial and pluvial flooding, particularly in the context of a changing climate and rapid expansion of the urban fabric. It does so by investigating the recognition of flood risk in spatial planning and vice-versa, of spatial issues in the flood risk management field, using framing analysis. The study reveals that the integration of flood risk concerns in spatial planning in Guangzhou remains an emerging process, gradually shifting from informal to formal activities grounded in legislation. This happens through percolation of framing discourse from the flood risk management policy to spatial planning, leading to changes in problem setting, action scripts and the prescribed governance arrangements in the planning discourse. The vagueness of governance arrangements, however, undermines the integration of flood risk management in spatial planning.

KEYWORDS Climate change, flood risk, delta cities, spatial planning, framing analysis, boundary spanning

6.1 Introduction

Flood risk, substantially increased by climate change, is affecting cities across the world. The Inter-governmental Panel on Climate Change (IPCC) Fifth Assessment Report predicts the rise in temperature from 2 °C to 4 °C for the worst scenario (IPCC, 2013). The rising temperature may increase the frequency of storms, precipitations and the extent of ice cap's melting, contribute to the occurrence of pluvial, fluvial flooding and coastal flooding, and, finally, pose a considerable threat to the safety and social-economic development by causing significant losses.

Given those climate science predictions, close collaboration across disciplines is needed to address cross-cutting flood issues (see e.g. Storbjörk 2007, Sayers et al. 2013, Ward et al. 2013). Spatial planning is, in this context, drawn into the complex flood affairs governance to raise the cities' ability to face the impacts of climate change and avoid or reduce the hazards from potential floods, by, for instance, locating suitable types of land use, arranging activities across spatial scales and shaping the built environment (see e.g. White & Richards 2007, Gersonius et al. 2008, Roggema 2014). However, incorporating flood risk and climate change science insights into spatial planning is a challenging task, and, consequently, flood affairs tend to be underestimated by planners (e.g. Carter et al. 2005). Moreover, research has identified a range of institutional barriers to integrating climate adaptation into planning (Walker et al. 2015, Dąbrowski 2018). To work, it requires mainstreaming those issues into national overarching policy framework and into local policies to mobilise commitment to the climate adaptation goals (White and Richards, 2007).

As a tool to influence planning practice, policy discourse stands out. It makes a difference by constructing policy problems, setting proposals for planning practice, and shaping subjective values, beliefs, perceptions and political concerns in a followed decision-making response (e.g. Bacchi 2000). These reflections in policy discourse are named as a 'framing pattern' in brief in this research. We argue that this pattern matters for the mainstreaming. Until appropriate knowledge is clearly defined in formal documents, the problem of downplaying flood risk by planners will persist.

To elaborate on our contention, delta cities are selected as the main focus of this study. They are engaged with a high possibility to be affected by floods due to their location in low-lying floodplains and dense watercourses (Meyer et al. 2010, Meyer 2014). What is more, the potential loss could be further amplified by socio-economic

activities in terms of high-value assets and densely concentrated population (see e.g. Hanson et al. 2011, Hallegatte et al. 2013). As for the studied Guangzhou case, it is a deltaic city, ranking the second in global cities exposed to the flooding risk (Hallegatte et al. 2013, see more details in Section 6.2). However, climate change and growing flood risk have still been limited recognised in the local planning system, and flood affairs are normally left to the professionals in the flood risk management authorities[21] (Francesch-Huidobro *et al.*, 2017). The newly launched National Sponge City Programme in 2014 are supposed to change such neglect of warning on climatic hazards and reluctant participation. As a major turning point, the programme aims to render Chinese cities more resilient to major pluvial floods through spatial planning working in close collaboration with other policy fields, for instance, the flood risk management, economic planning, or transportation (Meng *et al.*, 2018). This study is produced in this context at the time when the Guangzhou Sponge City Plan 2016-2030 (SCP), a local response to this national programme, has been launched in late 2017 (see Section 6.3.2).

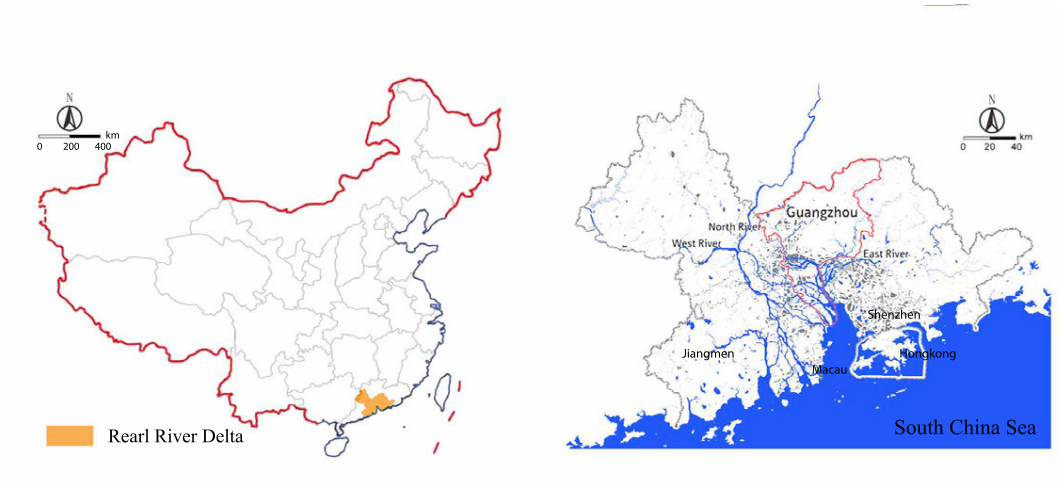


FIG. 6.1 The location of the Pearl River Delta (left) and Guangzhou (right), based on the Urban-Rural Integration Plan of the Pearl River Delta 2009-2020, Issued by the People`s Government of Guangdong Province

21 Flood risk management here refers to a process concerned with risk analysis, risk assessment and interventions for risk reduction aiming at mitigating and preventing the negative impact of flooding (see e.g. (Schanze, Zeman and Marsalek, 2007).

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To explore the changes in framing in the policy discourse between traditional planning policies, the Sponge City Plan (SCP) and flood risk management policies, three research questions are proposed. First, how are flood affairs acknowledged in the traditional spatial planning system? Second, how the SCP innovatively framed flood concerns? Third, how, if at all, do specific components of flood risk management policy discourse penetrate into spatial planning, and affect these new features in the SCP? Our findings, initially, add to the literature on the science-policy interface (e.g. G. Dunn et al. 2018, Dunn et al., 2017), by investigating how the policy formulation process in spatial planning incorporates the insights derived from climate change science. Further, it responds to the calls made in previous studies for integrating spatial planning and flood risk management in flood-prone areas (Francesch-Huidobro *et al*., 2017), by pointing to ways in which coordination and interaction across these fields could be facilitated.

The next section outlines the flood risk in Guangzhou case, which is followed by a conceptual framework and methodology used for framing analysis in section 6.3. Then section 6.4 traces the changing discourse on flood affairs in spatial planning documents and explains the underlying sources of these changes by comparing the innovations of spatial planning with external flood risk management discourse. The study concludes with a summary of the main findings and implications for practice and future research.

6.2 Guangzhou: a deltaic city at risk

Guangzhou, with an area of 7434 km^2, is located at the confluence of the East and North branches of the Pearl River. As a metropolis in the Pearl River Delta (PRD), it is one of the first-tier cities in China, having administrative priority, significant international trade links and being a logistics hub for Guangdong province and the PRD region (Wong et al. 2006). In 2016, it boasted a GDP of 1960 billion RMB and a population of 14 million (Guangzhou Statistics Bureau, 2016).

Guangzhou is, however, extremely vulnerable to flooding. The thorniest problem is the pluvial flooding in the city centre. High-density development in this area has brought too much paving surface, with 87.5% of the surface ground, on average, impervious (Li et al. 2015, Guangzhou Water Affairs Bureau 2015). The paving surface hinders the infiltration of rainwater and contributes to the increase of the surface runoff at the source; this situation is even worsened by the low discharge ability of the outdated pipe system (Wu, 2010). As a result, it is difficult for Guangzhou' dense built environment to cope with the rainfalls in extreme weather, which happens increasingly frequent due to climate change (Wu, 2010).

In addition, coastal and fluvial flooding will become another major threat if climate change impacts are not taken into account in the steering of future urban development. Even though the local authorities hold a positive view of the decent defence capacities of structural infrastructure (Interviews 7 & 8), like North and East River dykes, many research has warned the potential loss of Guangzhou due to its location at the estuaries of several rivers meeting in the South China Sea (e.g. Carmona et al. 2014). As early as 2002, the *China National Marine Basic Information Network Service System* elaborated four scenarios predicting the inundated areas due to the rising sea level. It indicated, in particular, that the Southern part of Guangzhou faces severe flooding risk in the future as a result of climate change (Chinese Academy of Science, 2002). A later study corroborated this by estimating a 30cm sea-level rise between 2000 and 2030 threatening the Southern part of Guangzhou (Huang, Zong and Zhang, 2004), where major urban extensions are planned. Guangzhou, in fact, occupies the first position in terms of exposure to climate change related to the flood risk around the world in 2050, considering the population and assets at risk (Hallegate et al., 2013). The Sponge City Plan for Guangzhou does reconfirm those flood issues and indicates that a vulnerable area of 970 km^2 , mainly located in the Southern districts (e.g. Nansha) (Guangzhou Government 2017).

6.3 Framing in Policy discourse

6.3.1 The conceptual framework

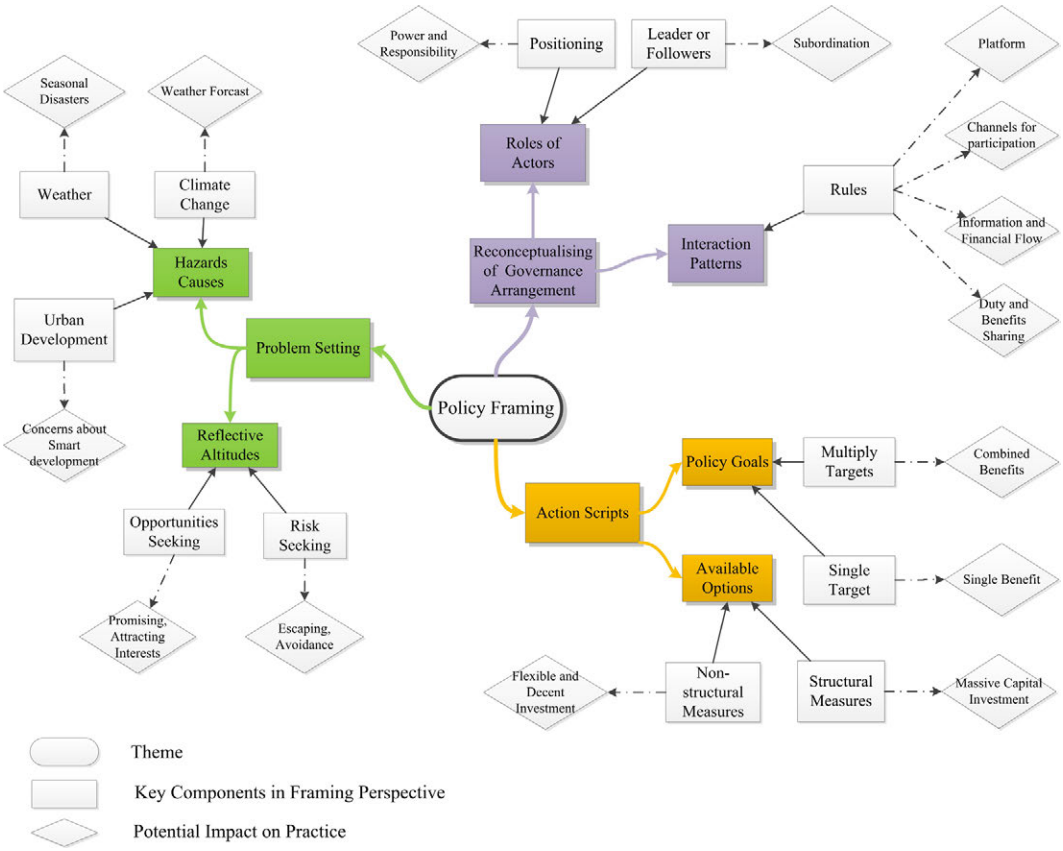


FIG. 6.2 Framework for the framing analysis of the spatial planning and flood risk management policy discourse, with key components shown in green, yellow and purple colours / Source: Author, based on (Hulst and Yanow, 2016)

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This study borrows ideas from Hulst and Yanow's research on the framing analysis, which is used to understand policy interactions and controversies between two or more actors in the governance network (2016). Accordingly, framing concentrates on three major aspects. First, it is a problem-setting process, in which specific phenomena are defined and converted into explicit challenges to address into the political arena. Second, framing is also an interactive process, in which actors form their own action scripts by reacting to the choices made by others; by this, problem-setting is linked to problem-solving, enabling a leap from the sense-making of the present situation to what needs be done about it. Third, framing is also a reconceptualising process for the governance arrangement. By claiming the actors` identity, for instance, the scope of powers and responsibilities in a governance setting, it affects patterns of benefit-sharing and modes of interactions and communications.

This study conceptualises policy framing through those three functions and explores them through the prism of six categories (Figure 6.2): (1) the causes and (2) attitudes in problem-setting; (3) the goals and (4) proposed options in action scripts; (5) the roles of actors and (6) interaction patterns in the re-conceptualisation of flood governance. Admittedly, many other components are relevant for the framing process, such as the desirable ways to resolve conflicts, power construction and reconstruction, social orders of institutions and dependence on other participants (Goffman 1981, Golec & Federico 2004, Lewicki et al. 2003, Donohue 2001, Dewulf et al. 2009). However, it is impossible to cover such a diverse range of components in one article, not to mention that many of those components cannot be traced easily in policy documents.

The discussion of problem setting tries to explore what foundations may affect the agenda setting in the policy-making process. On the one hand, the flood risk in delta cities is not merely a problem of natural or climate hazards but also related to the water system stemming from urbanisation, land-use patterns and hydraulic infrastructure construction (Meyer 2014). Comprehensive problem setting might contribute to a corresponding response, while partial sense-making might lead to a biased reaction. On the other hand, gain or positive framing can contribute to an opportunity-seeking behaviour in the face of challenges and risks, while a loss or negative framing tends to relate to risk-seeking behaviours and reluctance to invest efforts in mitigating risk (Neale and Bazerman, 1985). Based on this, framing flooding affairs as opportunities (positive) might portray flood mitigation as a promising option and attract the interest from potential stakeholders, while a loss framing (negative) might lead to avoidance of responsibilities.

The dimension of action scripts aims to explore what goals are set and what options are stated. It is built on the notion that both structural and non-structural measures are crucial, while the latter brings opportunities for spatial planning. The flood control infrastructure (a structural option) is costly and might lead to a false impression of being well-protected with no need to prepare for the impacts of climate change (IPCC, 2007). When sudden inundation happens, inhabitants would encounter a great loss with little knowledge on how to handle it. Further, the traditional underground discharge-dependent system (a structural option) may be insufficient in the face of the increasing strength of thunderstorms and it is hard to update such a system in a built-up area as well. By contrast, non-structural options in spatial planning such as natural water storage, zoning, or building regulations can enhance the capacity to respond to flood risk with a relatively low cost and be operationalised more easily (Traver, 2014).

Reconceptualising of governance arrangement relates to the concern that whether spatial planners are self-believed or believed as a game player in flood governance, and how they are supposed to work with other players. Unlike a clear declaration of power and responsibility of an actor in official documents, a vague description may result in weak enforcement and leave a grey area for the potential participators to choose to be or not to be. In that case, spatial planning might be inclined to keep themselves out of water affairs, leaving them to the environmental or water management institutions (Herk *et al.*, 2011). Likewise, a definite description of the interaction mechanism of participants in discourse clues the agreed rules about knowledge, benefit and responsibility sharing. Policy discourse is, thus, regarded a foundation in shaping the participants' values and common grounds (Rein & Schon 1996, Forester 2012).

6.3.2 Data sources and methods

Data for this study is drawn from a range of formal documents across spatial planning and flood risk management documents from 2000 to present (Table 6.1 shows the details). Two master plans, the 2000-2010 version (MP1) and 2010-2020 version (MP2), and the newly launched Sponge City Plan (SCP) are chosen for the analysis in the field of spatial planning. In the Chinese context, a master plan is produced by the municipal planning authorities under the supervision of local municipal governments. It is traditionally regarded as the most important document steering urban development in terms of population size, land use pattern, industrial programs, urban safety, flood affairs, etc. (Yu, 2014). The MP1 and MP2 are investigated as the reflection of traditional planning discourse in the face of flood risk.

TABLE 6.1 Relevant documents on spatial planning and Flood risk management in Guangzhou

Spatial plan policy documents (SP)				
Issued dates	Documents	Types of floods	Themes	Reviewed by (key actors)
2005	Guangzhou Master Plan 2000-2010 (MP1)	Fluvial, pluvial and coastal flooding	Overall rural and urban development, which concentrates on economic development, land uses, and infrastructure construction, etc	Urban Planning Bureau
2016	Guangzhou Master Plan 2010-2020 (MP2)	Fluvial, pluvial and coastal flooding		Urban Planning Bureau
2017	Guangzhou Sponge City Plan2016-2030 (SCP)	Fluvial, pluvial and coastal flooding	Integrated policy in terms of flood risk and urban development	Urban Planning Bureau (leader), Urban Water Affairs Bureau
Flood risk management policy documents (FRM)				
Issued dates	Documents	Types of floods	Themes	Reviewed by (key actors)
2007	Canals and Waterways Renovation Program 2005-2020 (CWR)	Fluvial and pluvial flooding	Canals dredging, environment Improvement and waterlogging discharge	Water Conservancy Bureau (predecessor of the Urban Water Affairs Bureau)
2012	Overall Plan of Guangzhou Rainwater Discharge System (2008-2020) (RDS)	Fluvial flooding	Rainwater discharge plan	Urban Water Affairs Bureau
2013	Flood Defence and Rainwater Discharge Plan (2010-2020) (FDRD)	Fluvial, pluvial and coastal flooding	Reinforcing flood defence infrastructure, preventing the loss of tide and rainwater discharge	Urban Water Affairs Bureau

Source: Author, based on (Guangzhou Government 2005, Guangzhou Government 2016, Guangzhou Water Conservancy Bureau 2007, Guangzhou Water Affairs Burea 2012, Guangzhou Water Affairs Burea 2013, Guangzhou Government 2017)

By contrast, the SCP is formulated in response to the National Sponge City Programme. As an 'alien' spatial plan, it is compiled by a joint work from the Urban Planning Bureau and Water Affairs Bureau, and specifically, put floods concerns to the first priority. Consequently, this document is a flood thematic spatial plan with detailed guidance on water affairs.

In parallel, three hydrological policies after the 2000s were studied as the supplementary materials (see the Table 6.1), including the Canals and Waterways Renovation Program 2005-2020 (CWR), Rainwater Discharge System Comprehensive Plan 2008-2020 (RDS) and Flood Defence and Rainwater Discharge Plan 2010-2020

(FDRD). They are the key reference policies directly related to water affairs and used by local authorities to formulate the local SCP in terms of pluvial, fluvial and coastal floods in past ages (interview 13).

The analysis firstly entailed coding the three framing components in the formal documents, including problem-setting, action scripts and reconceptualising of governance arrangement. Based on that, the traditional master plans (MP1 and MP2) and the Sponge City Plan (SCP) are compared to explore the distinctions, which reveal the innovations in the realm of spatial planning (see Section 6.4.1.1 and 6.4.1.2). This is followed by a comparison between the innovative discourse in spatial planning and counter-part in flood risk management documents to seek the common ground between them (see Section 6.4.2.1). Here, similarity indicates a process of percolation of ideas from flood risk management to spatial planning. Section 6.4.2.2 points out the mismatch framing in the SCP, which indicates the current limits and potential future work.

Admittedly, due to the limited access to data, this study is unable to cover all official documents after 2000, which have a close association with the current planning system. Thus, it merely concentrates on the major documents that related to flood risk issues, spatial planning and the latest flagship policy SCP. In addition, there are typically some gaps between the glossy and positive discourse in the documents and the reality on the ground, when it comes to implementation. The framing analysis based on documents does not show how the frames in the documents are interpreted and understood by the local stakeholders. To address these issues, we conducted interviews to enrich and triangulate the insights of framing analysis, by providing first-hand accounts from a variety of stakeholders. Twelve semi-structured interviews (Supplementary data), representing different policy sectors, researchers and societal groups, have been conducted to mitigate the typical limitation of the interview as a research method, namely the bias related to subjective accounts given by the interviewees, including officials from Urban Land Resources and Urban Planning Committee, Urban Water Affairs Bureau, experts from state-owned spatial planning and flood risk management planning and design institutions, directly related to the policy formulation, and academic experts in the fields of spatial planning, urban design, hydrology and civil engineering.

6.4 Results and discussion

Table 6.2 is the result of the investigated documents in terms of six categories in policy framing. The followed Section 6.4.1 is the major findings directly presented by this table, which reveal an underplay of the flood risk in the Master Plan 2000-2010 (MP1) and Master Plan 2010-2020 (MP2) while a leap-forward of acknowledgement in the Sponge City Plan (SCP). Section 6.4.2 is a deduction based on Table 6.2, which explores, to what extent, if at all, there is any evidence of cross-fertilisation between flood risk management policies and the planning field.

TABLE 6.2 Policy framing in spatial planning and flood risk management

	Issues in content	Spatial planning policies			Flood risk management policies		
		MP1	MP2	SCP	CWR	RDS	FDRD
Causes of flood risk	Natural hazards	○	●	●	●	●	●
	Ageing and weakness of structural hydrological infrastructure		●	●	●	●	●
	Erosion of the open water system in urban sprawl		●	●	●	●	●
	Increase in paving and decrease of infiltrating areas due to the high-density development			●			●
	Climate change			●			●
	Urban expansion into flood-prone areas						●
Attitudes towards flood issues	Loss / negative framing	●				●	
	Opportunity / positive framing		○	●	○		●
Goals setting of agendas	Raising the capacity of structural hydrological infrastructure for flood resilience	●	●	●	●	●	●
	Reducing the surface runoff by responsible development patterns concerning the permeable land intensity			●		○	
	Good spatial quality, concern for environment and ecology	○		●	○		●

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TABLE 6.2 Policy framing in spatial planning and flood risk management

	Issues in content	Spatial planning policies			Flood risk management policies		
		MP1	MP2	SCP	CWR	RDS	FDRD
Responsive options	Reinforcing the dykes and sluices	●	●	●	●		●
	Retrofitting the underground pipe system	●	●	●		●	●
	Dredging open canals and constructing artificial lakes	●		●	●		●
	Raising the ground altitude in low-lying areas when necessary	●		●			
	Limiting encroachment on the existing waterways	●		●	●		●
	Protecting the green and blue infrastructures from the erosion by urban sprawl			●	○		●
	Regulating the density of permeable land (e.g. vegetative cover in public space and building roof, swales, grassed channel, permeable paving, detention ponds) and impermeable land (e.g. asphalt)			●		○	
Positions of involved actors	Spatial planning authority			●			
	Water affairs authority			●	●	●	●
	Other supporting authorities			●			
Interaction pattern between actors	Interaction between professions		○	○			
	Interaction within a profession				○	○	○

○ *indicates that the notion or a similar one is merely proposed in passing with insufficient details, e.g. in one or two sentences;*
● *indicates that the notion or a similar notion is covered extensively, e.g. described using examples with an explanation on how to apply them; blank space indicates that this notion or a similar notion is not mentioned in the document.*

Source: Author, based on (Guangzhou Government 2005, Guangzhou Government 2016, Guangzhou Water Conservancy Bureau 2007, Guangzhou Water Affairs Burea 2012, Guangzhou Water Affairs Burea 2013, Guangzhou Government 2017)

6.4.1 Changing policy framing in spatial planning

6.4.1.1 Underestimation of flood risk in masterplans: Master Plan 2000-2010 (MP1) and Master Plan 2010-2020 (MP2)

In the traditional planning discourse in Guangzhou, flood affairs are not the main focus. They are normally given a low priority and merely discussed in general under the subtitle of 'flooding prevention and rainfall discharge', a section of the chapter 'public safety and disaster prevention.' The analysis of the Master Plan 2000-2010 (MP1) and Master Plan 2010-2020 (MP2) in this section illustrate such neglect among planning documents.

Problem setting

First of all, the agenda has not been fully set up. Causes of the flood risk have been limited discussed in initial master plans. The MP1 even lacks the acknowledgement; the policy discourse merely hints an uncontrolled natural hazards sense-making and entails the worries about pluvial, pluvial and coastal flood events. The MP2 enriches this topic by bringing the incapacity of hydrological infrastructure and overexpansion of urban size ahead of flood events (Guangzhou Government 2016, p. 442-445); it reveals the insufficient protection by substandard dykes, riverbanks and outdated underground pipe system, and mentioned the degraded self-adjustment by open canals system and natural lakes during the urban erosion. Yet, the underlying reasons behind flood events, for instance, climate change and unsuitable urban development pattern are blank, still an elephant in a room.

Soon to come is the dominant negative altitude (albeit with some nuance in the MP2). In the MP1, floods are merely regarded as a natural threat impairing the safety of residents. Correspondingly, the construction of flood mitigation infrastructures is singled out as a way to reduce the potential damages. The MP2 makes an advance here by intentionally linking reducing flood risk to urban development (Guangzhou Government, 2016a). Apart from an emphasis on safety concerns from flooding defence infrastructure and water discharge system, it suggests in brief that implementing flood resolving projects "should be bounded with developing urban areas" and simultaneously "improving water quality […] enhancing ecological environment […] and shaping cultural identity" (p. 445). Such a description hints a subtle transition to a positive framing, which reappears remarkably in the SCP (see section 6.4.1.2).

Action scripts

Further, the goals setting and responsive options in action scripts are unprepared. Single target setting is remarkable in the MP1, which strongly concentrates on engineering solutions to reduce flood loss. Even though the MP2 tends to frame flood reactions as a multi-objective issue, at best, linked to an improvement of ecological, environmental and social circumstances (Guangzhou Government 2016, P 445), it seems more like a one-sentence slogan, with no further explanation.

When it comes to the stated options, structural options are privileged, with penny concerns for non-structural measures. The MP1 does not propose any systematic options to resolve flooding. Different options are merely mentioned in passing. The scattered content across the document discloses the attention to the structural measures such as dykes and pipe systems, while mentioning in passing modest non-structural measures such as the rise of ground altitude for new building projects and the prevention of encroachment on waterways as a result of the urban sprawl (p. 51, 52, 99, 126). The options listed in the MP2 seems narrowly defined in comparison to the MP1. They focus on structural measures, while the previous non-structural options related to open waterways, lakes and water retention areas are neglected in this document (p. 442-447).

Reconceptualising of governance arrangements

The weakness in positioning and clarifying involved actors in the governance arrangement is another reflection of the underestimated flood affairs. In fact, the definition of flood-relevant actors is totally missing in the MP1. A similar situation arises in the MP2, which merely cover one vague sentence claiming that “water administration institutions could contribute to enhancing water safety, water purification and waterfront environment improvement” (Guangzhou Government 2016, p.445), without any mention of the role of spatial planners. This missing recognition of planners is underpinned by the planning convention that, in practice, flood affairs are left to water institutions (Interviews 4, 11), in terms of no instant economic returns in urban development which planning authorities give their priorities to.

The same embarrassment comes to interaction patterns. Neither the MP1 nor MP2 provides guidance on how spatial planning could cooperate with the other actors to reduce flood risk. It partly reflects the function segregation shaped after the 2000s (interview 10), when Municipal Water Affair Bureau progressively took the leading position in municipal flood governance while planning authorities gradually lost their voice and concentrated on economic development.

6.4.1.2 Towards acknowledgement of flood risk as a planning issue: Sponge City Plan (SCP)

Unlike the traditional spatial planning discourse, the Sponge City Plan (SCP) breaks new ground by showing a tendency for a more scientific and detailed explanation of flood risk, a more comprehensive way to resolve hazards, and more collaborative governance to enact initiatives. This section analyses the innovative discourse.

Problem setting

Initially, new perspectives are introduced to enrich the problem setting. It begins with a forward of climatic change ahead of flood hazards; the term 'climate change' is officially stated to rationalize flood events. To support this, a series of flood vulnerability assessments are proposed which reveal, in the current climatic condition, the waterlogging areas and high-risk inundation areas concerning pluvial, fluvial and coastal floods. It is significant because it, for the first time, shows a clue for planners to know which area is more vulnerable in the official spatial planning document. As one of the planners engaged in compiling the SCP said, this effort would be a reminder for the local authorities to focus on flood resilience in the coming future (interview 5).

In the meanwhile, unsuitable land-use patterns are blamed as another new source to shape an increasing flood frequency: limited permeable surface and too much paving brought by the high-density land use pattern are blamed for the difficulty in water infiltration, which pushes excessive waters to the overloaded discharge system. When the volume is beyond a threshold, the city has to face the inundation. Needless to say, this discussion lays seeds for options to regulate the density of impermeable surface during urban land exploitation (see 5.2 action scripts).

The progress is also reflected in the attitude to flood hazards. Opportunities framing is clearly shown in this document. Under this umbrella, the notion of 'bounded reaction' is emphasized. In comparison to the similar yet generalised idea 'linking urban development with flood risk reduction' flashing in the MP2, dealing with flood affairs, here, are mainstreamed into local concerns in terms of ecology, environment, water resource management and social welling-being. For instance,

"the protection of green spaces decreases the run-off volume and also brings ecological benefits; […] the dredging of canals enforces the capacity for water passaging and brings better sanitation; […] the retention and detention ponds act as buffers, storing excessive rainfall and create possibilities for water reuse;

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[…] the reinforcement of river banks strengthens the flood defence capacity while bringing opportunities for renewal of the waterfront (Guangzhou Government 2017, p. 70-115)."

Action scripts

Correspondingly, action scripts are upgraded. The SCP develops a multi-objective principle for goals setting. The single target safety concern in the Master Plan 2000-2010 (MP1) and inadequately expressed multi-function idea in the Master Plan 2010-2020 (MP2) are extended to three ambitions in a visionary language: to raise the capacity of structural hydrological infrastructure for flood resilience; to reducing the surface runoff by responsible development patterns with less paving and more infiltration; and to build an attractive, ecological and liveable water-related environment (Guangzhou Government 2017, p.53-54). As an interviewee explained (Interview 9):

“In practice, a project is given more priority when it takes two or more benefits into consideration. […] the ‘softened’ canal banks might act as a part of green-blue corridors which help drain the excess water […] while providing an attractive place for recreation.”

The stated options follow this multi-objective principle. On the one hand, they confirm the significance of traditional structural measures, such as improving dyke system and pipe systems, proposed in the MP1 and MP2. On the other hand, non-structural measures are, significantly, enriched. First, the ever mentioned protection of canals and waterways in the MP1 is strengthened, backing on the contribution of green-blue networks in water flow passaging and waterfront landscape shaping (p. 70-115). Second, innovative options encourage sustainable land use with more permeable surfaces rather than the predominant untamed expansion of paved and densely built-up urban fabric. This idea is based on the notion of Low-Impact Development (LID),"a land planning by hydrologic controls to replicate the pre-development hydrologic regime of watersheds through infiltrating, filtering, storing, evaporating, and detaining runoff close to its source" (Eslamian, 2014). By these, a prototype of three-layer options on defence, discharge and detention systems to deal with coastal, fluvial and pluvial floods is well-developed.

Reconceptualising of governance arrangements

More than anything else is a sea change in clarifying the position of planning authorities. As it claims, Guangzhou Land Resources and Urban Planning Committee (the local spatial planning sector) is supposed to be

"a coordinator who negotiates the interests from different administrations such as Water Affairs Bureau, Transportation Bureau, Construction Bureau and etc.; a regulator who formulate the rules in zoning plan to carry out the ambitions of sponge city programme at municipal district and block level; an inspector who strictly reviews the implementation in following project-based plans" (Guangzhou Government 2017, p.120).

Apparently, planners are pushed to a particular point of contention and nominated as one of the major actors, responsible for coordinating flood affairs.

Further, it makes a leapfrog development in interaction patterns by casting a light on collaborative planning for flood resilience and tries to build a new flood governance model through horizontal interactions between different professions, for instance, spatial planning, flood risk management, transportation planning, financial planning, etc. (Guangzhou Government 2017, P.120). This interactive relationship is formalised by the position of fourteen governmental bureaus in implementation. For instance, the Municipal Water Affairs Bureau is responsible for the hydrology knowledge support, and the Finance Bureau has a duty to provide fundings for implementation (Guangzhou Government 2017, p. 120-121).

Nevertheless, no further details about how the modalities of the cross-boundary interactions can be operated such as the channels for mutual knowledge learning, the platforms for information exchange or the sharing of costs and benefits. The proposed cooperation pattern, therefore, relies on an underlying tacit agreement in a black box (Interview 12). These concerns were highlighted by several spatial planning experts interviewed (interviews 1, 2 and 3). Past experience indicates it is not easy to reach such an ideal agreement: planners may be supposed to consider flood safety, but they tend to have different ideas on how to tackle it than water experts, which is likely to result in conflicts:

"The governance system in China is complicated [...] there is not enough integration between the various actors involved. Urban planners may suggest that dykes can be a dual system – one layer based on levies built for 1-in-50 years flood, and then the second layer can entail green space and landscape infrastructure. But the Water Affairs Bureau then want a concrete dyke, built the traditional way, safety first.

Then the financial authorities look at what is cheaper. But the final decision is made by the mayor, who has a limited budget." (Interview 1, 2, 3)

6.4.2 Discussion

6.4.2.1 The influence on Sponge City Plan (SCP)'s framing from the flood risk management

The alterations in the Sponge City Plan (SCP) raises a question about what factors facilitate such a major transition. The following section offers an explanation by exploring how the framing in the flood risk policies if any, shapes the changes. The major reference documents for the SCP in relation to the flood risk management are coded, including the Canals and Waterways Renovation Program (CWR), Rainwater Discharge System Comprehensive Plan (RDS) and Flood Defence and Rainwater Discharge Plan (FDRD). Their similarity to the innovations, not rooted or visible in the traditional master plans, indicates the potential knowledge penetrating or learning from one field to another. The point is, even so, it is still difficult to say such knowledge penetrating or learning is a spontaneous behaviour. After all, the SCP is a program led by the central government and imposed upon the cities. The municipal response, therefore, could be regarded as an answer to the national political movement (interview 6). That is to say, learning can still take place, but triggered by the national policy.

Problem setting

The problem setting in flood risk management is strongly related to the counterpart in the Sponge City Plan (SCP), especially the causes of land use pattern and climate change in the Flood Defence and Rainwater Discharge Plan (FDRD), which declares an increase in paved surface and decrease in wetland area are deemed to contribute to the excessive surface run-off and burden to the rainwater discharge system. In addition, it shares the contention with SCP that climate factor is an underlying yet influential reason for the aggravation of flood risk:

"Due to climate change, the frequency of thunderstorms increases from 5.5 days per year in 1950 to 7.3 days in 1990. This number rises to 8.7 days from 2000 to 2009" (p. 58)…in addition,"sea level has increased by 90mm in the latest 30 years, and the trend will continue due to the melting ice cap" (p. 60).

Both of these two factors have not been shown in the traditional Master Plan 2000-2010 (MP1) and Master Plan 2010-2020 (MP2). Thus, it suggests a potential knowledge learning process.

The positive framing in flood risk management, another reflection of the problem setting, is comparable to that in the SCP as well. In the Canals and Waterways Renovation Program (CWR), the reinforcement of the river banks or enlargement of the canals and waterways are supposed to open windows for improving waterfront environment and restoring the green-blue infrastructures (Guangzhou Water Conservancy Bureau 2007, p.13); similarly, the FDRD alleges that flood mitigation projects can make a contribution to the restoration of the natural ecosystems, improvement of the living environment and recreation on the waterfront (Guangzhou Water Affairs Burea 2013, p. 25). Those gain-framed attitudes, which try to link water safety issue with urban benefits, later arise in the SCP.

Action scripts

High similarity in action scripts comes after the problem setting. As for policy goals, the ambitions, in the Canals and Waterways Renovation Program (CWR), Rainwater Discharge System Comprehensive Plan (RDS), Flood Defence and Rainwater Discharge Plan (FDRD), to raise the capacity of structural hydrological infrastructures, to reduce the surface runoff by increasing permeable land intensity and to pursue good spatial quality in flood mitigation with environmental and ecological concerns reappear as a combination in the Sponge City Plan (SCP).

This coincidence takes place again in the stated non-structural options. The way to deal with flood risk in the CWR, RDS and FDRD are analogous to the non-structural options outlined in the SCP. The CWR, for instance, has developed options, such as preserving the existing open water system for a smooth run-off passage, enlarging the natural lakes for large capacity in water storage, and broadening and softening the canals and lakes to provide more space for water discharge and ecological diversity (Guangzhou Water Conservancy Bureau, 2007a). In the RDS, the application of Low-impact Development (LID) pattern is encouraged in urban development, in spite of engineering pipe systems as the major way in this document. Water retention and water detention examples are envisaged, such as swales, permeable paving, and green roofs (Guangzhou Water Affairs Burea 2008, 168- 178). The FDRD agrees with this pattern and praises its positive function in collecting excess rainwater and relieving the pressure on the discharge system (Guangzhou Water Affairs Burea 2013, p.119-120). As the interview 13 mentioned, the attention to the open water system, artificial lakes, bank softening and LID pattern in the CWR, RDS and FDRD inspired a similar discourse in the SCP.

Reconceptualising of governance arrangements

In relation to the reconceptualising of governance arrangements, more consolidated evidence is needed to support the contention that the flood risk management documents directly affect the Sponge City Plan (SCP). Initially, positioning the relevant actors in the investigated flood risk policies merely cover water institutions; they do not foresee a clear place for spatial planning institutions in this endeavour. Urban Water Conservancy Bureau, its successor Urban Water Affairs Bureau, and the subordinate actors like Canal Management Office, Pearl River Dike Office, etc., are claimed to be responsible for the inspection of changes of water level in canals, waterways, lakes, reservoirs, the legislation of water affairs regulations, maintenance and construction of the hydrological infrastructures, and emergency response in flooding events (Guangzhou Water Conservancy Bureau 2007, p. 77-80, Guangzhou Water Affairs Burea 2008, p.182-189, Guangzhou Water Affairs Burea 2013, 160-165). By contrast, planning authorities are totally neglected with no clues in the formal statement.

The discussion of interaction patterns between different professions is also limited. The Canals and Waterways Renovation Program (CWR), Rainwater Discharge System Comprehensive Plan (RDS) and Flood Defence and Rainwater Discharge Plan (FDRD) share an agreement on joint work in a narrow realm within the flood risk management. This notion is even more explicit in the FDRD, which calls for a platform to promote the cooperation within flood risk management within water affair sectors, for instance, Urban Water affairs Bureau, District Water affairs Bureaus and their subordinate departments. That is to say, no big pictures about the cross-span flood governance have been mentioned.

Nevertheless, considering the CWR, RDS and FDRD are the reference documents taken by the SCP (interview 13), it is hard to say the former has no impact on the governance framing, as outlined in the later. After all, positioning and collaboration have not been explicitly discussed in the planning arena until the SCP. Flood risk management, thus, could be regarded as a prototype for the discourse on governance arrangement in the SCP, even if the statement is originally discussed within one field.

6.4.2.2 Inconsistency in the policy framing

The difference in problem setting and action scripts: the local VS the national

The National Sponge City Programme has been launched in 2014 to deal with the increasingly frequent pluvial floods in Chinese inland cities since the early 2000s. One building block is a report released in 2010 by the Ministry of Housing & Urban-rural Development (MoHURD) (the initiator of the following National Sponge City Programme), which revealed that 231 out of 351 Chinese cities studied (62%) were affected by pluvial floods in the period from 2008-2010 (Hou *et al.*, 2012). This background determines the main focus of the national Programme is to enhance urban flood resilience, especially with respect to pluvial floods.

Guangzhou being a deltaic city, however, faces a combination of coastal, fluvial, and pluvial floods. This complex situation brings a requirement for expanding the flood concerns of the National Programme. That is what has happened in the Sponge City Plan (SCP), which calls for integrated options to enhance urban-rural defence, discharge and detention capacities (see section 6.4.1.2). Such a localisation process shows planning authorities' attempts to build comprehensive solutions based on the local settings, even if it mismatches the national call.

The mismatch between action scripts and governance arrangement in the Sponge City Plan (SCP)

The explicit description of action scripts and governance arrangement in the Sponge City Plan (SCP) indicates the attention to formalising the duties and approaches of potential stakeholders in the flood governance. For instance, Water Affair Bureau is appointed to take charge of canals and pipe systems, Urban Planning Bureau can intervene on the land use pattern. By this, integrated options are linked with a collaborative network.

Even so, there is still a mismatch: the role of Pearl River Commission (PRC) and their cooperation with the other actors are not included in the discourse. This regional institution is, in reality, responsible for the reinforcement of dyke systems that mentioned in action scripts. Our interviews (7 and 8) in this institution confirm their lack of involvement in the formulation of the local SCP. It could be partly due to the fact that national or sub-national discourse neglect to position them in the new Sponge City Programme. Consequently, when the municipality implements

this national programme, there is no legislative base for municipal authorities to order or even mobilise a regional sector to participate in the local responses. Such a mismatch between action scripts and governance arrangement might limit the scope for facilitating collaborative planning needed to tackle the multi-faceted flood risk in Guangzhou because the role of the actual actor is vague, beyond the claimed institutional network.

A major omission: urban expansion into flood-prone areas

While the Sponge City Plan (SCP) brings flood risk into spatial planning discourse it misses one important issue: the encroachment of urban expansion into flood-prone areas, one cause of floods mentioned in the Flood Defence and Rainwater Discharge Plan (FDRD). This issue might lead to future tensions considering the ambitious plans for the urban sprawl in the Southern part of Guangzhou, for instance, in the case of Nansha District. This area has been officially acknowledged as a state-level Special Economic Zone in 2012 (Ma, 2012). In the coming years, a fast urban expansion is expected. Ironically, the new development zones in Nansha district including the port areas are located in a flood-prone low-lying reclaimed land, directly exposed to coastal flooding (Liu, Wang and Yip, 2013). If the development follows a similarly rapid path as elsewhere in the Pearl River Delta (PRD), this expansion would definitely weaken the hydrological system and raise the flood risk, especially concerning the climate change and rising sea level in the coming decades.

6.5 Conclusions

While previous research acknowledged the difficulties in considering flood risk in spatial planning (e.g. Carter et al. 2014), this study explores one underlying reason in relation to this challenge: the framing pattern of flood risk in the policy discourse. It did so by tracing the latest spatial planning and flood risk management documents in the case of Guangzhou, a Chinese delta city that is extremely and increasingly vulnerable to flood risk. The findings reveal the changing framing pattern and underscore the percolation of knowledge from flood risk management to planning.

One experience from the Guangzhou case is that traditional spatial planning policy, like the Master Plan 2000-2010 (MP1) and Master Plan 2010-2020 (MP2), do not consider flood risk extensively. Firstly, the understanding of the causes of flood is limited, concentrating on the uncontrolled natural hazard while restricted to the negative impacts of urban sprawl. Furthermore, a negative framing of flooding is dominant, narrowed down to a safety concern. Flood resilience, in this context, relies on the major structural options, mostly ignoring non-structural measures. Under this umbrella, the specification of the role of planners in flood governance is vague. In short, traditional spatial planning did not provide a full preparation to address the growing flood risk in master plans. However, it is understandable in the Chinese planning system. After all, a detailed extension of topics such as flood defence or flood prevention, is supposed to be conducted in a specialised plan or regulatory plan.

The Sponge City Plan (SCP) fills the gap left by traditional planning playing a limited role in specialised plan or regulatory plan to deal with flood issues. It does so by incorporating flood risk in the spatial planning discourse. This shift is reflected in the spatial plans: (1) by recognising that both urban development patterns and climate change result in growing flood risk; (2) by promoting opportunity framing of the nexus between flood affairs and urban development; (3) by connecting the multiple objectives of enhancing safety, attractiveness, ecological diversity, environmental quality and social well-being, (4) by proposing integration between non-structural and structural measures; and (5) by clarifying the role of the planning sector in cross-sectoral collaboration between a wide range of municipal institutions. By this, the SCP innovatively strengthens the linkages between planning and flood risk management and pushing planners to the frontline of efforts to increase flood resilience.

While the above findings are context-specific, the methodology for framing analysis used in this study could be applied in research on other delta cities or other flood-prone urban areas. It can be used to highlight the role of discourse in the tensions within flood governance and the difficulties in considering flood risk in spatial planning while pointing towards ways to avoid them. One limitation of this research, and more generally of framing analysis, is that it traces the change in discourse, however, it cannot explain fully explain the reasons behind it. Future research could thus explore how planning discourse and frames change in relation to the wider context such as shifting economic, political and even the increasingly frequent flooding events. Moreover, there is a need to study further the implementation of the SCP and explore how this new framing of flood risk in Guangzhou is interpreted by the relevant policy actors and how it affects the ways in which they collaborate with each other.

Supplementary data

TABLE 6.3 Interviews' logbook (2014 – 2017)*

Code	Date	Interviewees
1	Nov 18 2014	Senior Official, Guangzhou Water Affairs Bureau
2	Nov 18 2014	Senior official specialised in urban redevelopment, Liwan District Bureau of Urban Construction and Landscape, Guangzhou
3	Nov 18 2014	Official specialised in water resources, Liwan District Bureau of Urban Construction and Landscape, Guangzhou
4	Oct 25 2016	Academic involved in planning in the PRD, South China University of Technology
5	Nov 29 2016	Planner, involved in the formulation of Guangzhou Sponge City Plan, Guangzhou urban planning design & survey research institute
6	Nov 30 2016	Senior Engineer, Design and Research Institute of Guangdong province
7	Nov 30 2016	Senior Official, Pearl River Committee
8	Nov 30 2016	Senior Official, Pearl River Committee
9	Dec 6 2016	Senior Official, Guangzhou urban planning Bureau- urban drainage Department
10	Dec 9 2016	Ex-senior planner, Guangzhou urban planning design & survey research institute
11	Dec 17 2016	Senior Official, Guangzhou Municipal Water Resources Bureau
12	Jun 23 2017	Landscape Planners, involved in the formulation of Guangzhou Sponge City Plan, Turenscape Planning and Design Company
13	Dec 8 2017	Senior Engineer, involved in the formulation of Guangzhou Sponge City Plan, Guangzhou Water Affairs Investigation, Planning & Research Institute

** Semi-structured face-to-face interviews*

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7 Governing Flood Resilience

Institutional Design and Governance Conditions in Guangzhou

A draft is being submitted to the journal Environmental science & policy.

ABSTRACT Researchers and policymakers have long called for a collaborative governance process to address flood affairs. However, this is often challenging when spatial planning is supposed to be integrated with water management institutions. Based on collaborative governance theory, this study aims to 1) identify the long-term disadvantaged conditions of spatial planning in flood governance; and 2) reveal the factors and mechanisms referring to institutional design and cognitions embedded in culture and history that shaped them. Using Guangzhou as a case study, our empirical research indicates that in comparison to the dominant position of water management in flood governance, spatial planning sector has been in the status with weak power, legitimate informal opportunities and limited incentives during the most of time. These conditions are shaped by the established organisational structures, game rules and financial resource allocations. The emergence of the Sponge City Plan in 2017 legalised planning in flood governance and altered the rules of games. However, it still faces significant challenges from a history-rooted distrust of planning's function in handling floods.

KEYWORDS Flood resilience, spatial planning, institutional design, governance condition, cognitions embedded in culture and history

7.1 Introduction

For a long term, academics and policy thinkers studying climate adaptation, disaster response and resilience building have highlighted the significance of governance in delivering interventions that respond to external shocks and pressures (Lebel *et al*., 2006; Bulkeley, 2010). According to Ansell and Gash (2008), governance refers to the procedures of decision-making complying with laws and rules to coordinate the actions and positions of the different stakeholders from across various public agencies and non-state actors. The rising attention to this topic derived from the uncertainty of future climate change, the widespread negative impacts on the exposed areas, and the complication of policymaking, all of which necessitate the participation of diverse stakeholders to ensure inclusive and context-specific solutions, rather than a one-size-fits-all approach (Winsvold *et al*., 2009; Fröhlich and Knieling, 2013). Even so, narrowing down divergent ideas across multiple stakeholders presents a major challenge for policymaking. The same is true for improving coordination across levels of government and balancing the interests of citizens and market actors in the decision-making process (Betsill and Bulkeley, 2006; Djalante, Holley and Thomalla, 2011; Marana, Labaka and Sarriegi, 2018; Mees *et al*., 2019).

A similar predicament arises within flood governance. It occurs when spatial planning and water management institutions are supposed to work jointly to make handy adaptation solutions for flood resilience (e.g. Ran and Nedovic-Budic, 2016). A series of governance-related findings have indicated a list of constraining factors that put planning institutions at a disadvantage in the decision-making process such as limited access to data (and weak knowledge grasp), misfit organisational settings (Dessai, Lu and Risbey, 2005), undefined roles of authorities (Amundsen, Berglund and Westskogh, 2010), budgetary constraints (Fournier *et al*., 2016), and divergent (and often conflicting) mindsets among stakeholders (Dąbrowski, 2018).

This study explores how those constraining factors are shaped, an under-developed direction in the domain of spatial planning when it is integrated with flood affairs. The findings respond to the recent calls to incorporate planning institutions into flood governance (e.g. Ran and Nedovic-Budic, 2016), while also resonating with broader governance literature stressing how different factors (e.g. powers and resources allocations, institutional arrangement, and incentives for stakeholders to participate) can hinder or facilitate the governance process in the face of climate change and natural hazards (see. e.g. Bulkeley and Betsill, 2005; Djalante, Holley and Thomalla, 2011; Miller and Douglass, 2016). The study builds on the literature to strengthen

the capacities of a system to deal with hazards and climate change, specifically related to institutional structures, availability of and access to resources, human capital (including skills and education), organisational and institutional capacity to implement adaptation responses, society's ability to act collectively to develop and implement adaptation responses, and the willingness of institutions to act (see, e.g. Smit and Wandel, 2006; Adger *et al.*, 2007; Mehrotra *et al.*, 2009).

An empirical study is developed in Guangzhou (China), with two research questions (i) what is the status of planning in flood governance? (ii) how is this status shaped? The preliminary research on this topic, conducted by Francesch-Huidobro et al. (2017), indicated that planning institutions were excluded from flood affairs at the municipal level. A recent municipal Sponge City Plan (introduced in 2017) is supposed to change this situation, as planning actors were pushed to be more proactive in flood resilience and climate adaptation (Meng *et al.*, 2018).

The remainder of this chapter is divided into four sections. Section 7.2 introduces the background of the selected case. Section 7.3 outlines the theory and methods used in the study. Sections 7.4, 7.5, 7.6 and 7.7 investigate the dynamics and stability of flood governance in Guangzhou from 2000 to 2019. The chapter closes with sections 7.8 and 7.9, summarising the findings and proposing future research on the Sponge City Programme.

7.2 Background of the selected case

The case study in this research spans a time of roughly 20 years, from the early 2000s until 2019. In this period, Guangzhou experienced a dramatic urbanisation process and rapid urban sprawl into flood-prone areas, which are highly exposed to floods. In the same period, water affairs-related institutions endured structural changes, which, in turn, have shaped the current political rules and forms at the local level.

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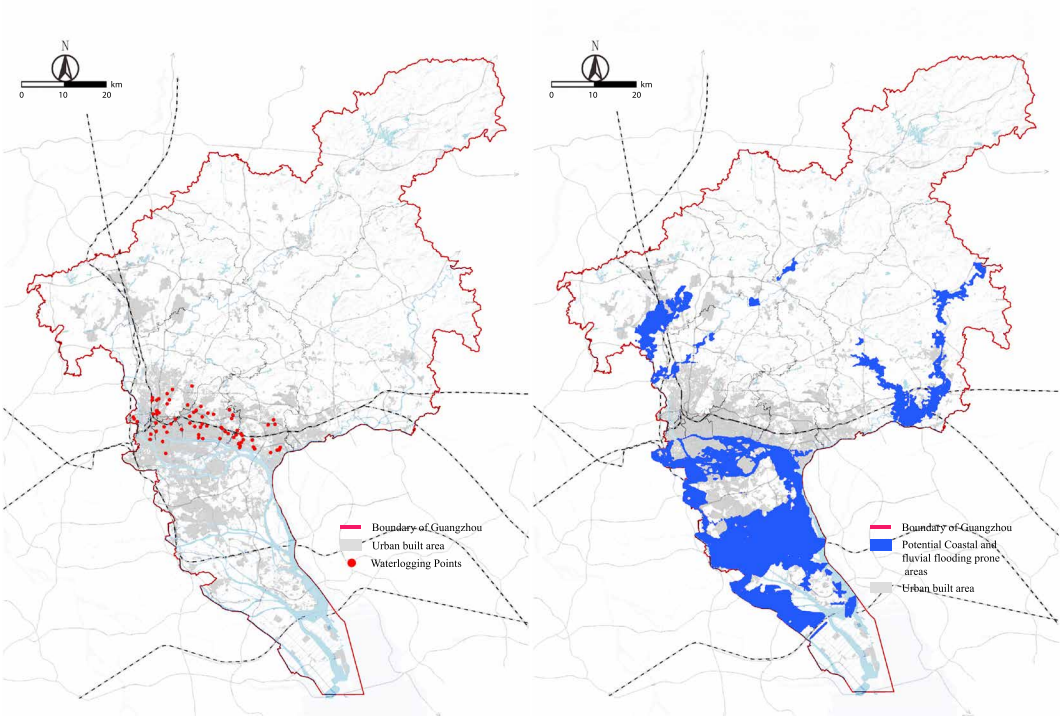


FIG. 7.1 The waterlogging points in Guangzhou (left), and the areas prone to potential coastal and fluvial flooding (right), based on Guangzhou Sponge City Plan 2016-2030 (Guangzhou Government, 2017)

In 2014, the *National Sponge City Programme (NSCP)* was launched in China to manage pluvial flood risk, calling for integration between engineering solutions, nature-based solutions and non-structural regulations. This programme was initiated by the *Ministry of House and Urban-rural Development* (MoHURD), the *Ministry of Water Resources* (MoWR) and the *Ministry of Finance* (MoF), across professions and administrations. Among them, the MoHURD and MoWR are the highest central sectors relevant to spatial planning and water management.

When it comes to municipalities, the promotion of the *National Sponge City Programme* is a kind of decentralisation process, by which local authorities combine national requirements with local needs for concrete implementation. However, this national programme did not clearly mandate which policy sectors should lead the implementation of local responses. This leaves flexibility for choosing institutional leaders in a multi-disciplinary and multi-stakeholder context. For instance, the city

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of Shenzhen (close to Guangzhou, in the same region), a forerunner in implementing the Sponge City Programme, appointed the *Shenzhen Water Affair Bureau* (a water management institution) as the operational leader. By contrast, in Guangzhou, the *Land Resources & Planning Commission* (a spatial planning institution with limited experience and knowledge in water management) was designated as a leader for the Sponge City Plan locally, even though water management institutions were naturally seen as the first candidate for leadership.

7.3 Theory and research method

7.3.1 Theoretical basis and conceptual framework

This study draws on the insights from the research by Ansell and Gash (2008), which argues that governance process (or collaborative process in their words) is influenced by three factors: (i) start conditions, (ii) institutional design and (iii) facilitative leadership. In this theory, start conditions were highlighted on account of 1) imbalanced resources and powers, 2) the incentives of stakeholders, and 3) the past history of conflict or cooperation. The institutional design took effect given its contribution to 1) promoting broad participants, 2) selecting stakeholders exclusively (intentionally neglecting some stakeholders), 3) clarifying ground rules, and 4) creating a transparent governance process.

In this study, we focus on the relationship between start conditions and institutional design, which can be used to explain the shape of capacity features yet given a small consideration in Ansell and Gash's theory. For instance, the ground rules set by institutional design can be a sources of start condition which formulates the regulations or forms that stakeholders should follow before they are involved in a decision-making process. Or stakeholders occupying strong powers could have a higher possibility to be invited to join the governance process because of an organisational monopoly, an institution with a dominant position in the political or financial arena (Olsthoorn and Tol, 2001; Soma, Dijkshoorn-dekker and Polman, 2018), on account of strong support from organisational structures, like a technological monopoly.

This study builds a conceptual framework inspired by Ansell and Gash's theory (Figure 7.2). Three factors in governance conditions (or start conditions) are highlighted: powers, legitimate opportunities and incentives. These conditions are assumed to be affected by setting organisational structures, launching the rules of game (ground rules and transparent process), and resource allocation in institutional design. In addition, the history of conflicts or cooperation is supposed to shape shared beliefs or cognitions, which act as a background against the governance conditions and institutional design.

In this framework, we use organisational structures to interpret the promotion of broad participants and selecting stakeholders exclusively (claimed by Ansell and Gash) by arguing that the status of stakeholders is already shaped before a decision-making process by the structures, which inherently create advantages or disadvantages, for instance, in terms of the powers held by the different stakeholders. Thus, weak stakeholders are left out of decision-making.

The rules of game are a collection of formal norms (called clear ground rules by Ansell and Gash) and informal norms referring to the transparent process of the collaborative decision-making, which claims stakeholders' legitimate opportunities to be involved (newly added in governance conditions), the principles they should follow or even the means available for stakeholders to have their voice heard. These rules can be formulated by either formal discourse such as laws or regulations, or informal discourse stemming from tacit knowledge[22].

Resource allocation is added as an aspect of institutional design considering that the means of distribution determines the resources available for players to use and incentives that attract stakeholders. The resources can be financial, information, or assets. This study concentrates on the financial aspect.

The abovementioned interactions between governance conditions and institutional design do not operate in a 'vacuum'. They take place in the background of cognitions

22 A typical case is a Dutch programme, *Room for The River*. It was proposed in the 1990s to reduce the flood risk. Foreseeing problems, like fragmented policy institutions, conflicting objectives between politicians, potential exceeding budgets and postponements, challenged the Ministry of Infrastructure and Environment to formulate relevant policies (Wolsink, 2006). These difficulties were addressed by an alternation of rules between players to reach a consensus and avoid deadlocks. The main target for flood protection was broadened to a multi-target agenda, including e.g. spatial quality, tourism, harbour expansion, new forms of housing (on the water), and new economic activities (Wolsink, 2006; De Bruijn, De Bruijne and Ten Heuvelhof, 2015). The adjustment created flexibility for different stakeholders to organise a process of give-and-take negotiation, involving, for instance, concessions to pay for the cost of widening and deepening rivers which benefited harbours' development (De Bruijn, De Bruijne and Ten Heuvelhof, 2015).

that actors share, which are embedded in culture and history. These long-established cognitions operate as a way to filter which institutional design and governance conditions shape the process of decision-making.[23] One can note here that the historically rooted cognitions, if one considers a long period of perspective, could also be shaped by institutional design, as organisational structures put in place can eventually provide a structure for the socialisation of actors and emergence of shared cognitions. This, however, remains a matter for investigation in future research.

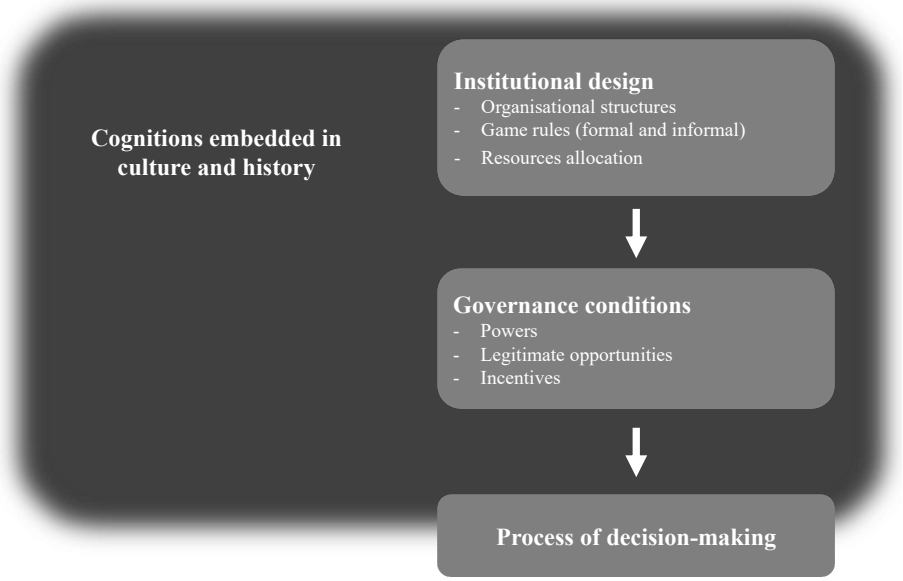


FIG. 7.2 The relations between institutional design, governance conditions and process of decision-making (against the background of cognitions embedded in culture and history) / Source: Author, adapted from Ansell and Gash, 2008

23 The phenomena rose, for instance, in Jakarta from 1999 onwards, where a multi-level framework across national, regional and local regimes has been introduced to strengthen collaborative flood risk governance with community participation but received refuse in implementation (van Voorst, 2016). However, the riverside inhabitants were reluctant to accept assistance from government institutions and relied on their own actions because of long-term distrust shaped by earlier violent slum evictions (van Voorst, 2016). Thus, a national policy got stuck at the local level when an attempt was made for decentralisation.

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The real-world governance conditions and institutional design in Guangzhou are explored based on the proposed framework in sections 4, 5, 6, and 7, with attention to organisational structures, game rules, financial resource allocation, (history rooted) cognitions, and their resulting impacts. Empirically, these features are fundamental characteristics, which rarely change rapidly, and thus any changes or reforms to enhance resilience governance need to accommodate and work with these features.

7.3.2 Research method

7.3.2.1 Literature review and content analysis

The research on institutional design and governance conditions is mainly built on literature review and content analysis. It examines research studies, historical archives, news, policy documents, regulations, governmental budget statements, together with semi-constructed interviews (used to provide supplementary information and make up the missing information in literature). Interview questions concern: (1) how flood affairs are managed? and (2) what challenges may hinder concrete flood resilience initiatives regarding the transition that the Sponge City Programme that might bring?

7.3.2.2 Stakeholder analysis

The research on cognitions explores the collective interest of different institutions and groups in flood-related agendas and their positions in resilience governance. To do so, expert interviews were conducted from 2016 to early 2019. Agents were selected from regional, provincial, municipal and district levels covering different domains (e.g. planning, landscape design, engineering practice, administration, business and science). Most interviews lasted 60-90 minutes. Thirty-seven interviews in total were conducted out of which thirty were useful for the analysis of collective behaviours (see the Supplementary data). Seven cases are deleted in the analysis in terms of incomplete interviews or no relation to research questions. Two questions are concerned: (1) Is your institution interested in flood affairs; and (2) what do you think of the role of your institution in flood affairs? The respondents' key contentions were transcribed and analysed qualitatively. This is intended to provide more information of the status of planning in flood governance.

7.4 Organisational structures and powers

The research on the organisational structure explores the institutional stability and change between three major governmental institutions relating to flood affairs: Pearl River Commission (regional flood control sector), Water Affair Bureau (municipal water engineering sector) and Planning Bureau (municipal planning sector). At the regional level, the institutional environment concerning flood affairs has been quite stable since 2000. The *Pearl River Commission* leads the coastal flood controls (also within Guangzhou' territory) under the supervision from the *Ministry of Water Resources* (MoWR)) at the national level.

By contrast, the way of addressing flood issues at the municipal level was changeful. The Guangzhou Government witnessed three changes of organisational structures in 2008, 2014 and 2017, which caused long-term impacts on how flood affairs are managed into the late 2010s (Figure 7.3, see the next page). The following section discussed them in detail on account of organisational adjustments, driving forces and the resulting impacts.

7.4.1 Rise of the Water Affair Bureau in flood resilience governance (2008)

Generally, it is recognised that the establishment of *Xiliu River Commission* in 1970 opened the era of a professionalised water management in Guangzhou (Guangzhou Water Archives Committee, 1991). It focused on natural river and lake protection, reservoir construction and management, agriculture irrigation, electricity farming, and flood drainage (Guangzhou Local Chronicles Committee, 1996). Even so, it merely served rural areas, while urban areas were outside its administrative scope.

This tradition remained until 2008 when its successor, the *Guangzhou Electricity and Water Conservancy Bureau,* was upgraded into the *Guangzhou Water Affair Bureau.* The newly established institution converged the original *Bureau* and partially the *Guangzhou Public Facility and Greening Bureau* which was concerned with responsibilities and personnel in urban water affairs, for instance, the design, construction, and management of water supply, pipe-based flood drainage, wastewater treatment, canals, etc., (Zhang 2013, p.23). Consequently, the *Water Affairs Bureau* won the powers to manage comprehensive water affairs within urban and rural areas.

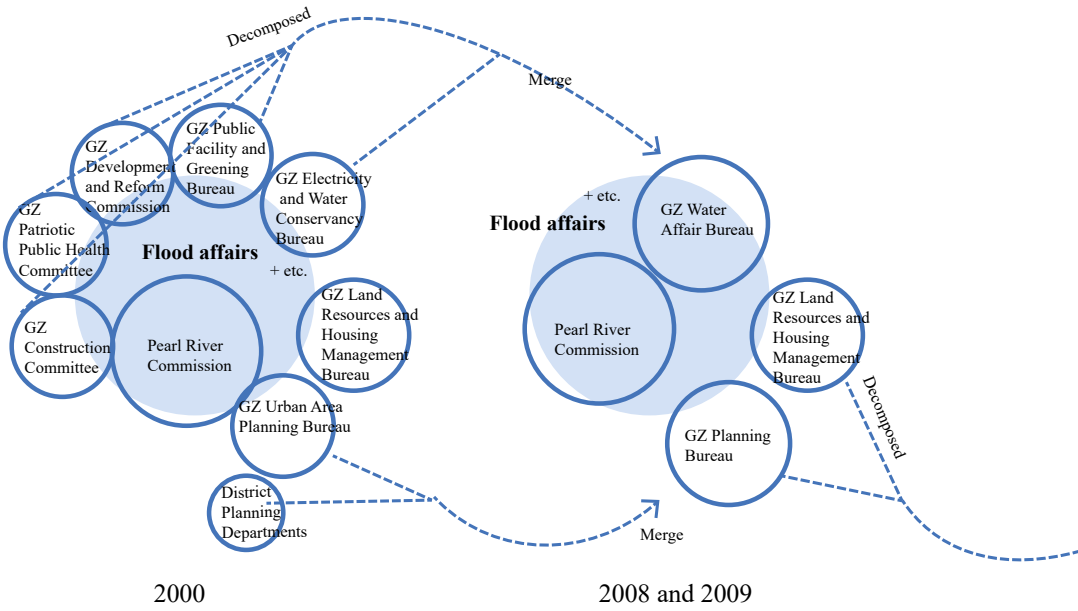
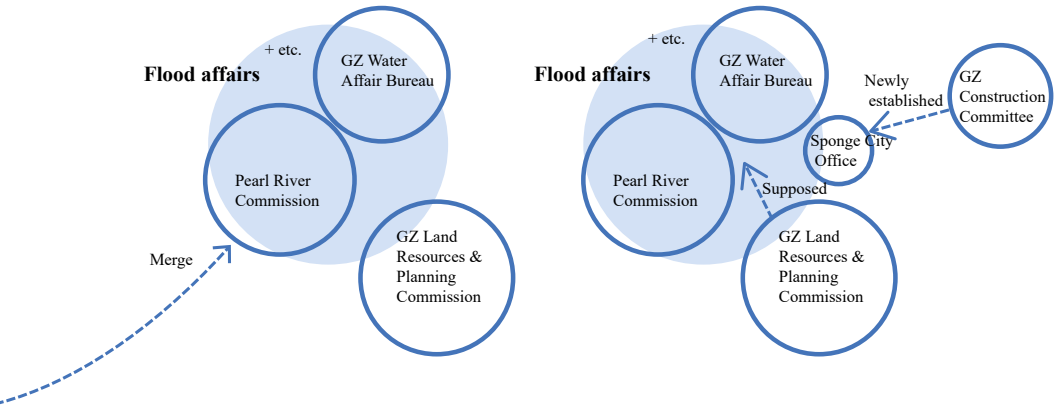


FIG. 7.3 Dynamics in institutional structures of Guangzhou (GZ) / Source: Author

In addition, the Water Affairs Bureau's capacities were further strengthened by partially absorbing the functions of the Guangzhou Development and Reform Commission, the GZ Patriotic Public Health Committee, and the GZ Construction Committee in 2009 (Zhang 2013, p.24). Responsibilities and skilled workers on schedule, monitor, and financial management in relation to water projects were separated from the abovementioned bureaus and merged into the *Water Affair Bureau,* which led to its dominant position in local flood affairs.

Two driving forces shaped these organisational reconstructions. The nationwide prevalence of the notion 'Water Affairs Integration Management' was one driving force leading to this organisational reconstruction. It praised an integrated and comprehensive system to address all water-related issues, which was initiated by Shenzhen in 1993 and officially introduced in Guangzhou in 2008 (Zhang 2013, p.25-26). The promotion of Water Affairs Integration Management was another force, which sped up by a followed national call for Super-ministry Reform in Guangzhou in 2009, which aimed to simplify governmental structures by shutting down redundant institutions and merging similar functions.

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In the same period, a series of organisational adjustments were also launched in Guangzhou's spatial planning system. However, these changes were hardly relevant for water affairs, focusing on the strengthening of vertical cooperation within the planning system[24] and the merge of urban and rural development issues to raise governance efficiency (Guangzhou Planning Bureau, 2010). As a result, the *Guangzhou Urban Area Planning Bureau* was renamed as the *Guangzhou Planning Bureau*.

24 The previous 'seesaw' leadership at the district level (subordinate to the municipal level), with one decision-maker from the municipal planning bureau and another from the district planning department, was changed to municipal authorities in charge of district authorities (Ying, 2009)

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7.4.2 The merger of bureaus for a better way of land use and land management (2014)

In 2014, another organisational change took place, which had a significant impact on the planning system. The *Guangzhou Land Resources and Housing Management Bureau* was dismantled. Part of its functions and personnel, related to land and mineral resources management, was merged with the *Guangzhou Planning Bureau* and led to a new agency called the *Guangzhou Land Resources & Planning Commission* (Yin, 2014). The remaining power related to house management such as construction, real estate market management, property management and social housing supplement, were incorporated into the *Guangzhou Construction* Commission, which led to the *House and Urban-rural Construction Commission*.

This reorganisation was operated in the context of the nationwide promotion of *Integrated Planning* from 2014. It is a concept that calls for coordination between economic, social and development planning, urban-rural development planning, land use management, and natural environment planning, which were compiled by multi-level and multi-divisional governmental sectors and usually mismatched with each other (Zhang and Zhao, 2015). Particularly, the merger in Guangzhou between the *Planning Bureau* and *Land Resources* and the *Housing Management Bureau* was to resolve a bottleneck that the requirement to develop a piece of land from one bureau could face the restrictions in land use regulations from the other bureau. Furthermore, this merger also facilitated the above-mentioned (section 4.1) efforts to simplify and professionalise governmental sectors, beginning in 2009. As a result, while these changes of organisational structures offered benefits for the planning system, this transition turned out to have little influence on flood affairs and water institutions.

7.4.3 Minor organisational adjustments to implement the Sponge City Plan (2017)

The promotion of the Sponge City Programme brought no significant changes to the municipal structures but did trigger a minor change in the *House and Urban-rural Construction Commission*[25]. Beneath this municipal institution, a new municipal department - *Sponge City Office* - was founded in 2017. It was

25 It is the superior of *Guangzhou Land Resources & Planning Commission.*

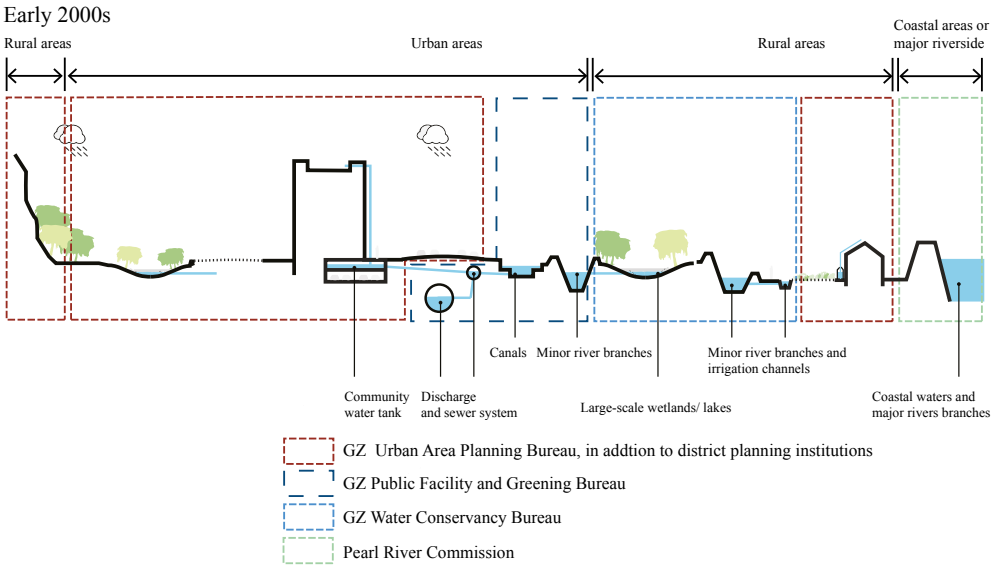
tasked with coordinating *Sponge*-related policymaking, monitoring the progress of constructions, developing post-construction evaluations and raising public awareness (interviewees 7, 8). With spatial planning and water management sectors, there were no concrete organisational adjustments.

7.4.4 Summary: Impacts on powers

Since 2000, the central theme of organisational exploration has been building a simplified but professionalised system with integrated solutions to development problems. The *Water Affairs Bureau* gradually took over the responsibility of municipal water management and became a leading institution in flood affairs. Flood-related departments and staff were merged and accumulated under its wings, which strengthened its power. By contrast, the planning system did not enjoy this benefit in terms of organisational and knowledge support.

7.5 Rules of game and allowed legitimate opportunities

An exploration of the changing game rules focuses on how flood affairs were operated between the mentioned sectors in territories or physical spaces (see Figure 7.4-1, 7.4-2, 7.4-3). The territorial responsibility of the regional water authority,, the *Pearl River Committee (PRC),* has been stable since the 2000s: it has been in charge of coastal areas and major riversides and focusing on designing, building and consolidating dyke systems. These dyke systems, which are supposed to handle a flood return period of 50-300 years (interview 2, 3), work as a safety baseline in the Pearl River Delta. They protect southern lowlands from rising sea level, sea tides, and inland flood basins from major river branches, for instance, North, West, and East Rivers. By contrast, the territorial responsibilities of the water affair sector *Guangzhou Water Conservancy Bureau* (and *Guangzhou* Water Affairs Bureau after 2008), and the planning sector Guangzhou Planning Bureau (and Land Resources & Urban Planning Committee after 2014) at the municipal level changed a lot from 2000 to 2019.


Early 2000s
Rural areas
Urban areas
Rural areas
Coastal areas or major riverside
Canals
Minor river branches
Minor river branches and irrigation channels
Community water tank
Discharge and sewer system
Large-scale wetlands/ lakes
Coastal waters and major rivers branches
GZ Urban Area Planning Bureau, in addtion to district planning institutions
GZ Public Facility and Greening Bureau
GZ Water Conservancy Bureau
Pearl River Commission

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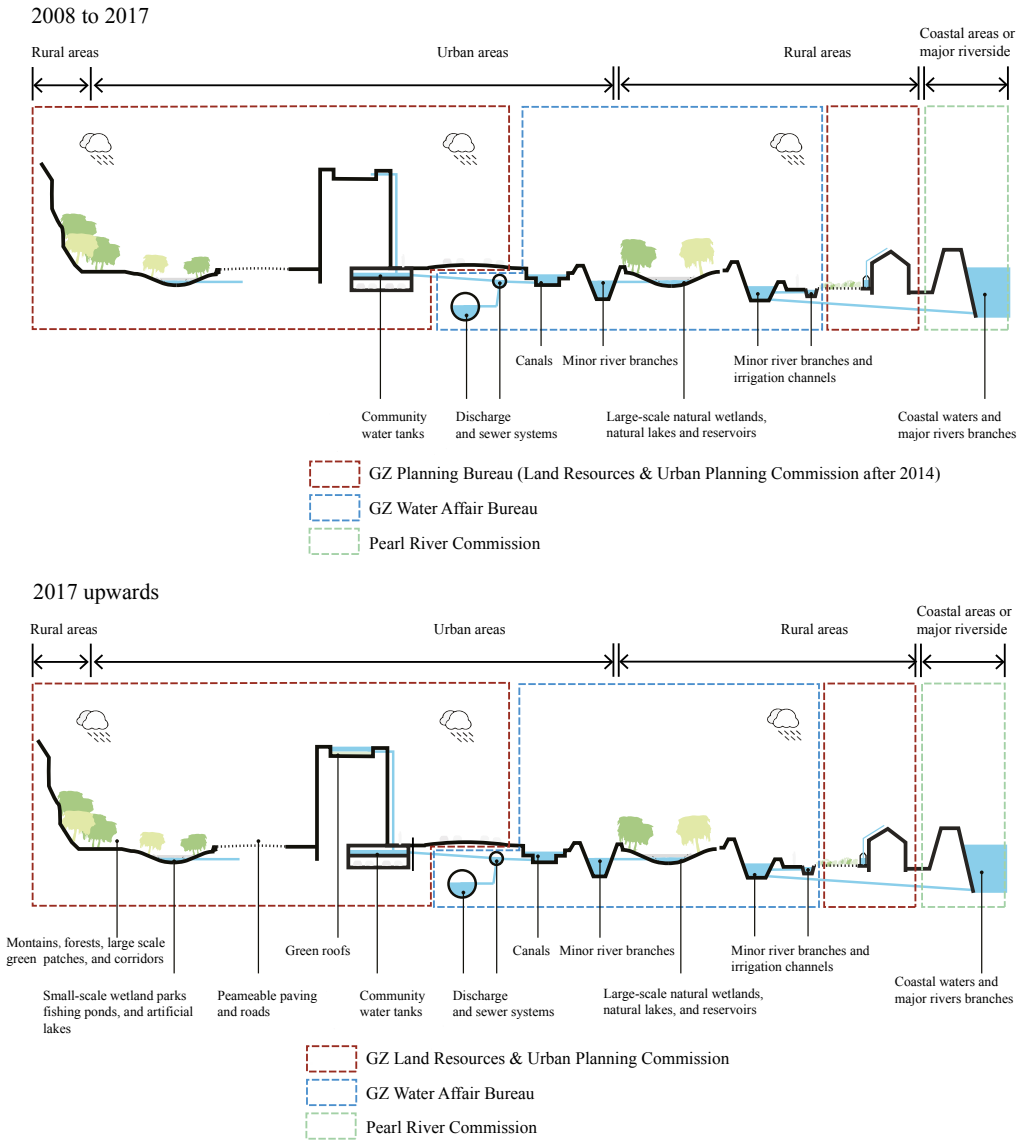


FIG. 7.4 The Responsibilities of Pearl River Commission, Guangzhou Water Conservancy Bureau (Guangzhou Water Affairs Bureau after 2008), and Guangzhou Urban Planning Bureau (Urban Planning Bureau after 2009 and Land Resources & Urban Planning Committee after 2014. 7.4-1: The early 2000s; 7.4-2: 2008-2017; 7.4-3: 2017 upwards.) / Source: Author

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7.5.1 Broader executive scope of the Water Affair Bureau (2008)

After 2008, the *Water Affairs Bureau* endured the major responsibilities of flood issues in the regime of the municipality of Guangzhou through a combination of the *Guangzhou Water Conservancy Bureau* and the *Public facilities and Greening Bureau*. Figure 7.4-1 and 7.4-2 indicate this newly established bureau and its subordinated institutions (for instance, district water affair bureaus) own the legitimacy to deal with flood issues within wet territories and major water-related public facilities[26] in both urban and rural areas. Concrete initiatives included managing defence walls along minor river branches and canals; flood storage and buffer areas, like large-scale wetlands, natural lakes, reservoirs; and water passages, for instance, urban discharge and sewer pipe systems and agricultural irrigation systems.

In contrast to the *Pearl River Committee*, the *Water Affairs Bureau* and its subordinated institutions focus on infrastructures with a lower safety standard. As the interviewees added (no. 1,2 and 3), "the defence we dealt with is generally supposed to face flood events less than a1 in 50 years return period; pipe systems have a lower standard, merely a1 in 10 years in the built area and 1 in 5 years in the high-density city centre".

The role of the *Urban Planning Bureau* (*Urban Planning Bureau* after 2009) is less visible for flood affairs. Generally, the Bureau merely narrows its jurisdiction to land development, as opposed to water development. The Figures 7.4-1 and 7.4-2 indicate that wet territories and major water-related public facilities were beyond the responsibility of the *Urban Planning Bureau* and there were limited initiatives in dry territories (thus within the planning sector's scope) to address floods. This situation led to territorial segregation of jurisdictions between the planning and water affair sectors.

26 Blue Lines scope the areas of wet territories, including canals, rivers, natural lakes and the infrastructures related to them, for instance, dykes, levees, and pumps.Yellow Lines scope the areas used for public facilities such as electricity corridors, discharge and drainage pipes, telecom pipes, and gas pipe network (Wu and Li, 2010). Although spatial planning is usually involved in the confirmation of these lines, once decided, the responsibilities of the scoped areas belong to authorities beyond the spatial planning system. Depending on local contexts, the scoped lands (areas) are under the charge of different water-related and public facilities-related bureaus. From the perspective of planning design and operations, Blue Lines and Yellow Lines in planning regulations lead to a kind of orderly territorial segregation.

7.5.2 Legitimate opportunities of the Land Resources & Urban Planning Committee to deal with flood affairs within dry territories (2017)

The Guangzhou Sponge City Plan launched in 2017 called for innovative initiatives to deal with the flood risk within dry territories. As a result, managing flood affairs were incorporated into the territorial domain of the spatial planning, giving the Land Resources & Urban Planning Committee legitimacy to enact flood resilience interventions (see Figure 7.4-3), even without a change of its organisational structure and administrative scope. The Sponge City Programme promotes new nature-based solutions to supplement drainage pipes and river systems in absorbing peak run-off. At the municipal level, these solutions included preserving forests, large scale green patches, green corridors, and farms to decrease run-off at the sources; making use of small-scale wetlands, artificial lakes and fishing ponds to store run-off, etc. At the neighbourhood level, solutions such as replacing paving and asphalt roads with permeable materials, building rainfall gardens and using green roofs to collect rainwater were encouraged. Notably, the responsibilities of the *Water Affairs Bureau* and the *Pearl River Committee* did not change in terms of wet territories and major water-related public facilities.

Figure 7.5 gives an example of how, according to the *Guangzhou Sponge City Plan*, spatial planning is supposed to use regulatory codes for runoff control to limit paving in urban development. These codes specify that the amount of rainfall that has to be stored on every plot of land, using either nature-based solutions or engineering facilities. For instance, on the plot 05-02, 71% of the rainwater has to be retained and only 29% can flow directly into the drainage system.



FIG. 7.5 Runoff control regulatory codes for flood resilience / Source: Author, based on Guangzhou Sponge City Plan 2010-2030 (Guangzhou Government 2017)

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7.5.3 Summary: Impacts on legitimate opportunities

The changes in game rules triggered by the Sponge City Plan offer planners new opportunities to implement flood resilience activities in dry territories relying on nature-based solutions. Still, the spatial planning sector is a relative chaser in flood affairs, compared with the water management sector which acts as a forerunner owning a long-established legal authority in flood agendas.

7.6 Resource allocation and incentives

In this section, public financial statements from spatial planning are traced to explore how funding is projected and spent on flood issues, in addition to those in water management[27] (Table 7.1). Due to limited access to data, only statements between 2008 and 2017 are available. The analysis focuses on two indicators: water conservancy and flood affairs (W) and urban and rural community development (U).

The indicator water conservancy and flood affairs (W) reflects the budget and spending on major flood resilience infrastructures. It has a similar meaning in both water management and spatial planning fields: it is concerned with the cost of (1) the construction and maintenance of farming-related water infrastructures, for instance, dams, dykes, reservoirs, lakes, irrigation channels, pump stations; of (2) management of water resource, for example, hydrological monitor, flood prediction and alarm, and water quality inspection; of (3) flood migration; and of (4) administration and wages.

The indicator urban and rural community development (U) differs between the water management and planning sectors. For the Water Affair Bureau, this indicator concerns the budget and spending on (1) the construction and maintenance of water supply, flood discharge and water treatment infrastructures; (2) land adjustment and land acquisition due to water infrastructures; (3) the administration and labour wages. For the planning sectors, urban and rural community development focuses on land use plan and regulation; therefore, it cannot precisely reflect the budget and

27 The statistics of the local flood control system led by Pearl River Committee (PRC) is not public available, thus it cannot be used as a reference in this section.

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spending on flood resilience. In reality, the spending on flood resilience within the spatial planning sector is only a small portion of the overall spending on land use adjustment and land acquisition in relation to flood mitigation projects. After all, economic development is their main focus rather than flood safety. Still, the analysis takes it into considerations on account of the potential that part of the funding is related with floods, including the construction of green-blue infrastructures for water storage in the planning process, and land use adjustment from buildable land (e.g. for residential use) to unbuildable land (water buffer zones). What is more, this imprecision does not impair the result that the budget and spending related to flood resilience from spatial planning sectors is far less than those from the water management (Table 7.1).

TABLE 7.1 Budget and spending relating to flooding issues of Planning Bureau, Land Resources & Planning Commission and Water Affair Bureau

	Planning Bureau and Land Resources & Planning Commission (2014 up to now)*						Water Affair Bureau*					
	U budget	U spending	W budget	W spending	U+W budget in total	U+W spending in total	U budget	U spending	W budget	W spending	U+W budget in total	U+W spending in total
2008	N/A	N/A	N/A	N/A	N/A	N/A	N/A	1,71	N/A	101,77	N/A	103,48
2009	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0,08	N/A	100,53	N/A	100,61
2010	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2011	208,48	187,93	0,00	0,00	208,48	187,93	8,28	8,28	490,68	404,02	498,96	412,30
2012	166,34	186,95	0,00	0,00	166,34	186,95	7,85	7,85	436,85	414,01	444,69	421,86
2013	223,22	218,52	0,00	0,00	223,22	218,52	96,78	96,78	682,79	432,49	779,57	529,27
2014	160,19	160,31	0,00	0,00	160,19	160,31	104,70	104,45	506,20	749,12	610,90	853,57
2015	176,05	176,81	0,00	0,00	176,05	176,81	16,47	16,56	419,03	450,88	435,50	467,44
2016	458,11	458,13	0,00	0,00	458,11	458,13	26,86	26,86	516,34	509,33	543,20	536,18
2017	434,40	433,38	0,00	0,00	434,40	433,38	25,67	25,69	711,81	722,05	737,48	747,74

1: U: Urban and rural community development; W: Water conservancy and flood affairs facilities. N/A: Not Available; 2: Orange marked blanks: the max difference between two sides; Green marked blanks: the min difference between two sides
** Chinese yuan (million)*

Source: Author, based on (Guangzhou Planning Bureau, 2012, 2013, 2014; Guangzhou Land Resources & Planning Commission (Planning Section), 2015, 2016; Guangzhou Land Resources & Planning Commission, 2017, 2018; Guangzhou Water Affair Bureau, 2009, 2012a, 2012b, 2013, 2014, 2015, 2016, 2017, 2018)

7.6.1 Limited incentives to promote spatial planning to address flood risk

Table 7.1 indicates that the total budget for water conservancy and flood affairs (W) and urban and rural community development (U) from the *Water Affairs Bureau* is higher than that from the *Land Resources & Planning Commission* ranging from 1.2 times (min) in 2016 to 3.5 times (max) in 2013. Similarly, the total spending on Water conservancy and flood affairs and Urban and rural community development of the *Water Affairs Bureau* is also higher than the *Land Resources & Planning Commission* ranging from 1.2 times (min) in 2016 to 5.3 times (max) in 2014. As a result, the financial resources allocated to the planning sector to work on flood affairs are relatively low.

In terms of projects specifically for water conservancy and flood affairs, Table 7.1 further reveals that the *Planning Bureau* and the *Land Resources & Planning Commission* had no budget and spending between 2011 and 2017, while the *Water Affairs Bureau* has a large proportion of funding during the same period[28]. This corresponds to the practice of addressing floods in wet territories with engineering infrastructures via constructing like dams, dykes, reservoirs, lakes, irrigation channels, and pump stations. This type of infrastructure is mainly shouldered by water management rather than spatial planning.

Within terms of urban and rural community development, due to a lack of details, the official statements cannot reflect the real sum of money projected and used by the *Planning Bureau* and the *Land Resources & Planning Commission* on flood-relevant work in urban development activities. However, the situation of the *Water Affairs Bureau* is clearer: it does spend a small but increasing proportion of its budget on major water-related public facilities, such as drainage systems[29].

28 The budget climbs from 490,68 to 711,81 million RMB with full swings. The spending follows a similar trend of budget rising from 404,02 to 722,05 million Chinese yuan.

29 The budget and spending for this tripled from 8,28 to 25,67 million Chinese yuan between 2011 and 2017 with an unexpected peak appeared in 2014 due to additional contingency projects

7.6.2 The retreat of subsidy opportunities: fewer incentives

Flood resilient infrastructures in sponge city trend are expensive (Xia *et al*., 2017), and the construction does not bring economic benefits in a short-term. To promote it, the national government has allocated a specialised subsidy to support pilot cities, in 2015 and 2016 (Economy and Construction Department of the Ministry of Finance 2015, Pengpai News (Shanghai) 2016). Thirty standard-compliant cities in total, thus, could receive three-year continuous funding between 400 and 600 RMB million per annum, depending on their significance and size (Economy and Construction Department of the Ministry of Finance, 2014).

Unfortunately, Guangzhou government did not win the financial support in either of the two rounds, let alone the second re-allocation to the spatial planning system. What is worse, this national support for the Sponge City Programme seems to retreat. There has not been any similar funding to support this national programme at the local level since 2017. Therefore, the opportunity to get additional financial resources for the planning sector does not exist anymore.

7.6.3 Summary: Impacts on incentives

There are two financial constraints for the planning system in resilience governance: (1) the allocation of daily municipal budget to the planning sector has been limited and vaguely defined, and (2) the additional subsidy from the national government has been in retreat. Consequently, the spatial planning sector lacks financial resources to participate in flood affairs. By contrast, there are clear and abundant budgets (and spending) for the water management sector to work on flood affairs. This distinct situation can result in a reliance on traditional engineering solutions, which inhibits the diversity of the possible (and much needed) resilience initiatives.

7.7 The filter: embedded cognitions

Figure 7.6 presents a plot of the perceived impact of agents in handling flood risk against the strength of interest they demonstrated in flood resilience (see additional information in Supplementary data). The Figure partly indicates how different agents, including spatial planning agents, now understand flood agendas in their work after flood issues have been traditionally handled on a local scale for roughly 20 years.

The agents are first classified into four quadrants: administration, business, engineering practice institutions, and planning/ planning-related institutions. Furthermore, we categorise the agents respectively, on the one hand, along the vertical axis- which concerns their impact levels, and on the other hand, concerns their interests in flood affairs, on the horizontal axis. It should be noted that this classification is not based on measurable quantitative indicators but rather on expert judgment and qualitative insights from the interviews. By impact, we mean the amount of power, resources and influence that an institution has on flood governance. The impact depends on whether an institution operates at regional, provincial, municipal or district levels. It also depends on the proximity of the institution to the decision-making centre. For example, governmental institutions at the municipal level have the power to affect regulations and public decisions on flood governance at the city scale, which has a higher impact level than that of a similar institution at the district level. At the same time, a municipal level government institution will have a similar impact as a regional level research and practice institution which may operate at a higher level yet with a role to give advice lacking decision-making powers. For the sake of simplicity, we consider 0 as no impact, 5 slight impacts, 10 medium impacts, 15 strong impacts, and 20 most important impacts. On the other hand, agents are classified by how strong of an interest they show in participating in efforts to address flood they show in face-to-face interviews from 0 to 8 with four equal intervals (0: actors show no interest, 2: weak interest, 4: neutral, 6: strong interest, 8: put the topic as the first priority).

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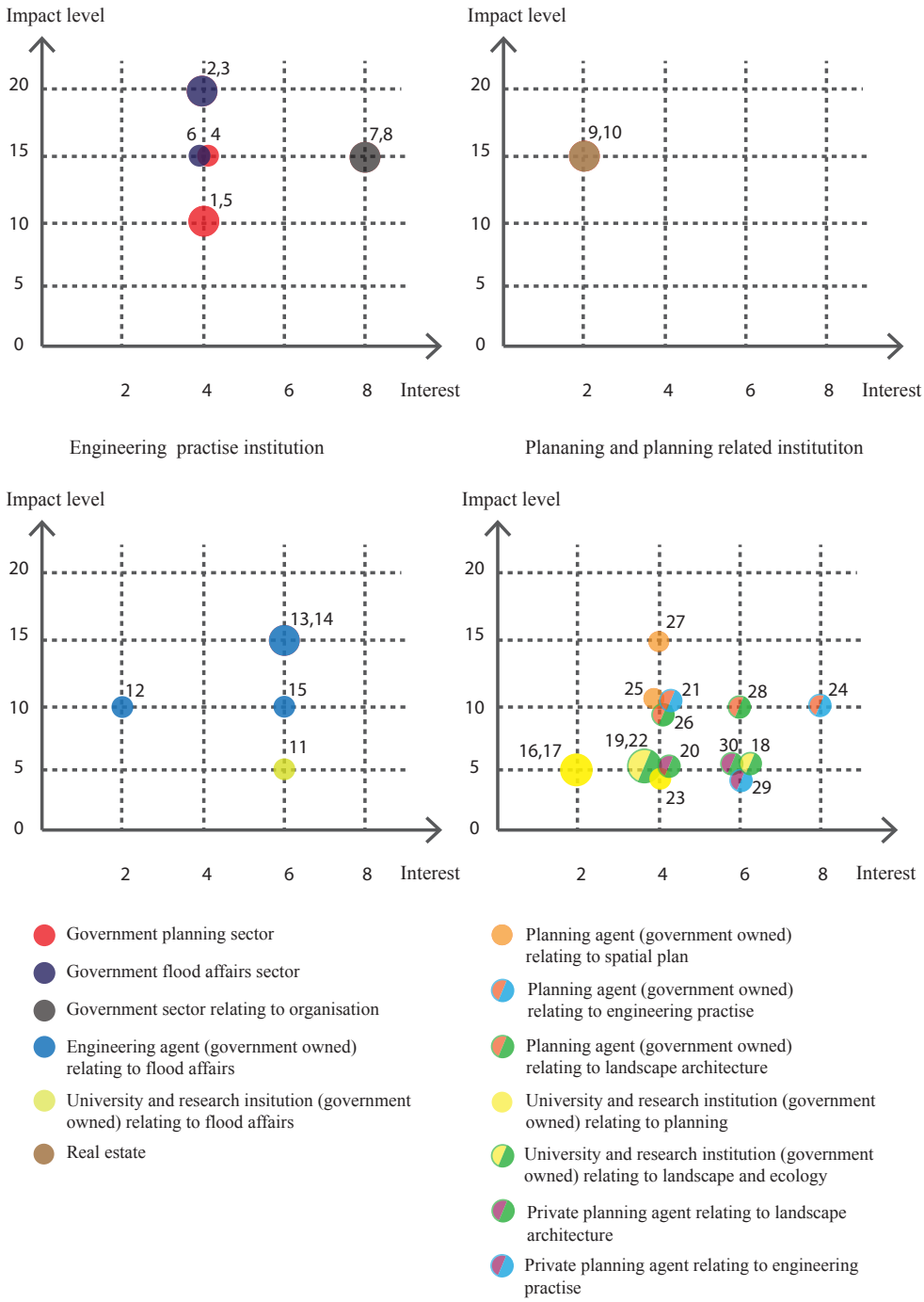


FIG. 7.6 Interests and perceived impacts indicated by agents / Source: Author

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7.7.1 Diverse cognitions within four groups

Figure 7.6 indicates divergent visions in four quadrants. For administrators, most of the interviewees (six out of eight respondents) show a neutral interest in flood affairs, particular to the latest Sponge City Programme; and this cognition is rather similar across the fields of spatial planning, water management and flood control fields, as well as their impact levels (i.e. no.1, 4, 5 planning-related interviewees vs no.2, 3, 6 in hydrological engineering-related interviewees). One potential reason for the overall neutral attitude among agents is the time of the interviews (1 to 6), from late 2016 to the start of 2018. It was a moment when the National Sponge City Programme was in its initial stage: new regional, provincial and local policies were still being built; responsibilities and rights of relevant governmental sectors were also undefined. Thus, it takes time for related governmental sectors to digest knowledge and react to new trends. Unsurprisingly, the Municipal Sponge City Office declared a high interest and placed flood mitigation as the priority of this organisation, which makes sense since it was established to promote the Sponge City Programme.

In the field of business, the interviewees engaged in real estate development indicate a weak interest in handling flood risk in their occupations. They showed a similar concern: flood-proof and flood-resilience initiatives are not attractive because of the increasing and new expenditure on, for instance, the construction of water tanks and high-standard pipe systems to collect water, as well as the long-term maintenance of green roofs and water detention ponds.

The majority of interviewees from water management, water resources, and water conservancy engineering have a positive impression of the long-established engineering-based flood risk management and the on-going Sponge City Programme. Four out of five respondents (no. 11, 13, 14, 15) showed a strong interest in the potential opportunities brought by the new trend. This high level of interest is noted at all impact levels. The exception to this is one interviewee from the Guangzhou Municipal Engineering Design & Research Institute (no. 12), an institution dealing with, for instance, sewers, drainage, water supply, and gas supply systems. The interviewee indicated a strong interest in flood affairs but weak interest in ‘Sponge City Programme’:

"for a long time, I have been working on engineering solutions to reduce flood risk […], and it makes little sense to overestimate the importance of the Sponge City Programme. […] It has a limited impact on my work, at least at the current stage."

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Unlike a clear preference from flood engineering practice, the reported interests in flood affairs among government-affiliated planning institutions and planning-related education institutions are divergent: eight respondents standing with a neutral position, four with strong interest, two with weak interest, and one placing flood affairs as the first priority. One likely factor of this divergence is the background of each respondent. The traditional planners (no. 16, 17, 25, 27) who focus on land use, land management and economic development are more conservative, showing a weak or a neutral position in dealing with flood affairs. As one interviewee (no. 25) explains that,"flood-related projects increase the workload of planners in practice." This argument might be related to the lack of necessary knowledge in water issues due to an outdated planning education, which deserves further explorations. By contrast, planning related respondents with mixed backgrounds, engaged with water drainage (no. 24, 29) and landscape architecture (no. 18, 28, 30) in planning institution, are inclined to show a positive attitude towards handling flood affairs in terms of the potential benefits of the nature-based and engineering-based infrastructures to be implemented as part of the Sponge City Programme. Still, the impact levels do not appear to matter for the declared interests among this group of interviewees.

The lack of motivation wide-scale among planning-related agents could negatively impact their participation in flood governance in the future, reducing the diversity of the stakeholders involved. According to relevant sociological institutionalism literature, the cultural context embedded in established institutions would work as a constraint in the creation and alteration of institutions (Hall and Taylor, 1996; Nichols, 1998). Thus, the existing conservative attitude in planning could be difficult to change, which is likely to affect the attitudes of planners in the future, keeping them reserved towards flood resilience. Furthermore, planners may also place less emphasis on flood issues compared to other urban agendas, such as economic development.

7.7.2 Convergent cognitions of spatial planning-related agents

Considering the sum of all planning-related respondents, including no. 1, 4, 5 from administrations and no. 16 to 30 from affiliated governmental institutions, research institutions, and private companies, it is clear that more than half of the interviewees (13/18) do not show a strong interest or enthusiasm in addressing floods within the field of spatial planning. The planning-related respondents who declare interest in flood affairs (no. 18, 24, 28, 29, 30) are related to either the traditional civil engineering solutions (still preserved in the Sponge City Programme) or the highly

praised nature-based solutions (highly promoted in the Sponge Programme). The findings hint that the new Sponge City Programme is more likely to create (job) opportunities for the interdisciplinary talents in the planning system.

7.8 Discussion (participation and diversity)

The findings on the role of the institutional design for flood governance throughout roughly 20 years are summarised in Table 7.2 below. The new game rules, in the Sponge City Plan launched in 2017, has allowed spatial planning taking concrete actions in dry territories for flood resilience. However, Rome was not built in a day. This positive change driven by the new game rules is confronted with challenges shaped by the after-effects of the previous rules, the long-established organisational structures and the allocation of the financial resources. In reality, the participation of spatial planning in flood resilience can be hindered by a lack of organisational support and knowledge, insufficient economic support, and the disbelief that planners can make significant contributions. These factors could weaken the participation of planners in resilience governance and decrease the much-needed diversity of resilience stakeholders and of the promoted types of solutions for dealing with urban floods.

Consequently, flood governance might turn to traditional habits, relying on engineering-based solutions to handle floods. Water management institutions support these solutions by occupying a dominant position in water affairs, thanks to their organisational infrastructure and qualified personnel, long-term experience in addressing flood affairs in wet territories and major water-related public facilities, strong financial incentives and inspiring self-recognition as important actors in flood governance.

TABLE 7.2 Institutional design and resulting governance conditions in flood governance: spatial planning (SP) vs water management (WM).

Institution design 2000- 2019	Resulting governance conditions	Potential impacts on the status of spatial planning in (flood) resilience governance
Organisational structures SP: Limited changes in relation to flood affairs WM: An agglomeration of water affair-related institutions	**Power** SP: Weak power in terms of disadvantaged organisational infrastructure and qualified personnel WM: Strong power of water management with advantages in terms of organisational infrastructure and qualified personnel	(-): Spatial planning lacks organisational support and knowledge
Rules of game SP: Newly confirmed legitimate opportunities in flood affairs WM: Long-established legitimate opportunities in flood affairs	**Legitimate opportunities** SP: Incorporating flood agendas into planning's accountability formally with feasible spatial interventions in dry territories WM: Long-term experience and efforts to address flood affairs in wet territories and major water-related public facilities	(+): New game rules give the spatial planning a possibility to take concrete actions in flood governance
Financial resources allocation SP: Vague and limited budgets (and spending) for flood resilience WM: Clear and abundant budgets (and spending) for flood resilience	**Incentives to take part in flood governance** SP: Limited foreseeing financial incentives for the planning sector WM: Strong and long-term financial incentives to attract hydrological engineers	(-): Planning sector's participation can be hampered by insufficient economic incentives
The background of cognitions embedded in culture and history		
Long established cognitions SP: A combination of neutral and negative motivations among most of the planning-related agents WM: An inspiring self-recognition as an important actor in flood governance		(-): Planners may think they make a limited contribution to flood governance and prioritise other urban agendas, such as economic development

7.9 Conclusions

Building on the work of Ansell and Gash (2008), this study explored how institutional design, including organisational structures, game rules and financial resources allocation, shape flood governance in practice. To do this, it explains their resulting impacts on governance conditions such as changing powers, legitimate opportunities and financial incentives since 2000. Furthermore, culture and history embedded cognitions act as a macro background and deeply affect this cause-and-effect process.

The limitation of this study is that a longer time perspective is needed to fully evaluate the consequences of changes in the institutional design and governance conditions after 2017. Future research, thus, could explore this issue further, shedding light on the longer-term impact of these changes on the role of the spatial planning system in the implementation of the Sponge City Programme.

Our research findings indicate that local planning actors have gained new legitimate opportunities from the adjustment of game rules in flood resilience as a result of the Sponge City Plan launched in 2017. The plan gave the planning sectors a legitimacy to apply nature-based solutions to change the physical environment in dry territories via spatial planning interventions. However, the evidence suggests that the long-established game rules, organisational reconstruction and financial allocations result in limited capacities and motivation for planners to engage pro-actively in flood governance from the 2000s.

In terms of national-local government relations, the findings from Guangzhou indicate an incomplete decentralisation process. Namely, the implementation of the *National Sponge City Programme* in Guangzhou suffers from an insufficient transfer of power and financial resources to spatial planning institutions, which can prevent the local government from meeting its supposed resilience ambitions and leads to a neglect of innovative nature-based spatial alternatives (highlighted by *National Sponge City Programme*) in practice. As a result, planners have a high possibility to fall back on the traditional engineering-based solutions, which are based on water management and flood control. These governance bottlenecks can be resolved by (1) strengthening the development of new skills among planners; (2) seeking for multiple financial resources; and (3) exploring the spatial impacts of resilience projects to attract planners' attention and build their awareness. Further researchers and policymakers can work on these topics.

While the above findings may be context-specific, the methods and theories used in this study could be applied to other coastal cities or delta cities, which are threatened by floods. They can be used to evaluate a system (regions, cities, communities, or institutions) and explore whether and how they can create conditions to strengthen the capacities to embrace flood resilience and climate adaptation.

Supplementary data

TABLE 7.3 Interviews' logbook (2016–2019) *

	No. in this study	Original No.in the interview list in CH 3	Time	Interviewees	Field	Impact levels	Differences in interest
Governmental sector/ Administration	1	8	2016.11.20	Senior Official, Liwan District Government	No data	10	4
	2	18	2016.11.30	Senior Official, Pearl River Committee	Water Conservancy Engineering	20	4
	3	19	2016.11.31	Senior Official, Pearl River Committee	Water Conservancy Engineering	20	4
	4	20	2016.12.6	Senior Official, Guangzhou Urban Planning Bureau (Urban Drainage Department)	No Data	15	4
	5	21	2016.12.8	Senior Planners, Urban Planning Research Centre, Nansha, Guangzhou	Spatial Planning	10	4
	6	24	2016.12.17	Senior Official, Guangzhou Municipal Water Resources Bureau	Urban Water Supply and Drainage	15	4
	7	29	2018.4.2	Senior Official, Sponge City Office	Urban Water Supply and Drainage, Water Conservancy Engineering	15	6
	8	30	2018.4.2	Senior Official, Sponge City Office	Urban Water Supply and Drainage, Water Conservancy Engineering	15	6
Business (Private real estate company)	9	25	2016.11.12	Senior Staff, Private Real Estate Company (Anonymous)	Architecture and Marketing	15	2
	10	26	2016.11.13	Senior Staff, Guangdong Poly Real Estate Development Co., Ltd.	Architecture Design	15	2

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TABLE 7.3 Interviews' logbook (2016–2019) *

	No. in this study	Original No.in the interview list in CH 3	Time	Interviewees	Field	Impact levels	Differences in interest
Engineering practise	11	10	2016.11.22	Academic, South China University of Technology	Managing of Water Resources and Waterlogging	5	6
	12	16	2016.11.30	Senior Engineer, Guangzhou Municipal Engineering Design & Research institute	Urban Water Supply and Drainage	10	2
	13	17	2016.11.30	Design and Research Institute of Guangdong province	Urban Water Supply and Drainage	15	6
	14	23	2016.12.14	Senior Engineer, China Water resources Pearl River Planning Surveying & Designing	Water Conservancy Engineering	15	6
	15	28	2017.12.8	Senior Engineer, Guangzhou Water Affairs Investigation, Planning & Research Institute	Governmental institution	10	6
Planning and related fields	16	1	2016.10.25	Academic, South China University of Technology	Spatial Planning	5	2
	17	2	2016.10.25	Academic, South China University of Technology	Spatial Planning	5	2
	18	3	2016.10.25	Academic, South China University of Technology	Landscape Architecture	5	6
	19	4	2016.11.12	Academic, Guangzhou Institute of Forestry and Landscape Architecture	Greening and Ecology	5	4
	20	6	2016.11.13	Ex-Landscape Designer, Turenscape Planning and Design company (Guangzhou branch)	Landscape Architecture and Urban Design	5	4
	21	5	2016.11.13	Senior Engineer, Guangzhou Urban Planning Design & Survey Research Institute	Urban Water Supply and Drainage	10	4
	22	7	2016.11.14	Academic, South China University of Technology	Landscape Architecture	5	4
	23	9	2016.11.21	Academic, South China University of Technology	Spatial Planning	5	4

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TABLE 7.3 Interviews' logbook (2016–2019) *

	No. in this study	Original No.in the interview list in CH 3	Time	Interviewees	Field	Impact levels	Differences in interest
>> Planning and related fields	24	11	2016.11.23	Senior Engineer, Guangzhou Urban Planning Design & Survey Research Institute (Public Facility Department)	Urban Water Supply and Drainage	10	8
	25	12	2016.11.24	Senior Planner, Guangzhou Urban Planning Design & Survey Research Institute	Spatial Planning	10	4
	26	13	2016.11.24	Senior Planner, Guangzhou Urban Planning Design & Survey Research Institute	Spatial Planning	10	4
	27	14	2016.11.25	Senior Planner, Guangdong Provincial Urban & Rural Planning and Design Institute	Spatial Planning	15	4
	28	15	2016.11.29	Senior Planner, Guangzhou Urban Planning Design & Survey Research Institute	Spatial Planning	10	6
	29	22	2016.12.9	Ex-senior Planner, Guangzhou Urban Planning Design & Survey Research Institute	Spatial Planning & Urban Water Supply and Drainage	5	6
	30	27	2017.6.23	Senior Planners, Turenscape Planning and Design Company (Beijing Branch)	Landscape Architecture and Spatial Planning	5	6

By impact levels, 0 means no impact, 5 slight impacts, 10 medium impacts, 15 strong impacts, and 20 most important impact. By differences of interest, 0 means actors show no interest, 2 with weak interest, 4 with a neutral position, 6 with strong interest, 8 with flood issues as the first priority.

** Semi-structured face-to-face interviews*

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8 Conclusions

The final part of this thesis presents the research findings and reflects on the outcomes. As discussed in early chapters, Chinese cities have a requirement to cope with diverse flood risks (e.g. coastal floods, fluvial floods, pluvial floods and mountain floods) and to be more adaptive to climate change and resilient to flood events. Around the early 2010s, a central governmental review of pluvial floods across most Chinese cities spawned the national Sponge City Programme. This programme was initiated to mitigate the effects of urban floods. It paid great attention to proactively involving spatial planning in addressing flood problems along with other water-relevant actors. In this context, the thesis examined the institutional challenges that planning has faced in tackling flood risk based on a case study of Guangzhou, one of the most vulnerable cities in China and globally.

The research presented in this thesis contributes to knowledge in three ways.

1 It responds to the concerns in IPCC (2014) document which argues that the latest challenges of climate adaptation reside in the transition from flood hazard awareness to intervention and implementation (Mimura et al., 2014) . It does so by exploring the mechanisms and factors in planning process which facilitate or hinder this transition.
2 It strengthens the under-developed literature on institutional concerns in planning literature in relation to flood and climate problems. The mixed use of theories on historical institutionalism, planning procedures and planning tools, policy framing, and collaborative governance presents a good example about how to borrow knowledge from policy science, political science, and social science to analyse the nature of planning process.
3 It partly fills a gap in knowledge in the Chinese scholarship where there is weak attention to the institutional conditions or mechanisms that facilitate or hinder the engagement of spatial planning in flood affairs.

The thesis asks: **what institutional arrangements determine spatial planning's role in managing flood risk, and how?** This question has been investigated with particular attention to four aspects of institutional arrangements: (i) the traditional ways of working in planning to deal with flooding risk; (ii) the way that planning manages vertical and horizontal coordination; (iii) the way of policy framing; and (iv) the contextual factors shaping the starting conditions for planning in flood governance. Four sub-questions are formulated as follows:

1 What are the (long-established) traditions of planning institutions in dealing with flood risk and what effect do they have? What, if any, innovations have taken place and why?
2 To what extent does planning adopt a co-determined policymaking process to address flood risk across the hierarchical levels of spatial planning vertically and across the boundaries between different disciplines horizontally?
3 How are flood problems framed in the discourse of spatial planning, and with what effect?
4 What contextual factors, if any, can influence the enabling conditions of planning in flood governance?

The findings show that these four elements do influence (1) the extent to which it has been possible to adjust the planning system towards the objective of mitigating flood risk, (2) the performance of cross-level communication and boundary-spanning work, (3) the legal framework that planners follow, and (4) the capacities of planning institutions to work on flood issues.

For the Guangzhou case specifically, the newly launched Sponge City Plan has amended (i) the way that planning manages vertical and horizontal coordination and (ii) the way of policy framing to enable a stronger role for planning. The changes have (i) facilitated the emergence of procedures and planning tools in the policymaking process to enhance horizontal cooperation between sectors and vertical cooperation across bureaucratic levels; (ii) strengthened the competence of the planning sector in official policy discourse; and (iii) created a formal position for it in flood governance with practical spatial measures.

However, these amendments did not fix the barriers created by other institutional arrangements from the established planning system. These barriers or disadvantages include (i) the engineering-based path dependence tradition; (ii) the weak powers of the planning sector over water issues; (iii) limited funding; and (iv) doubts about the contribution that planning can make to reducing flood risk among planning institutions and practitioners.

The rest of this chapter consists of six sections. The first section (8.1) summarises the findings of the four investigations (sub-questions) one by one. Following that, the second section (8.2) develops a TOWS analysis to propose a set of policy and practice advice for Guangzhou's spatial planning authority. Section 8.3 and 8.4 gives a reflection on the theoretical aspects, existing literature and research methods, with an explanation of the contributions of the research in section 8.5. The chapter closes by outlining recommendations for future research directions.

8.1 Summary of empirical findings: what has been learnt?

This section presents the findings of the four interlinked investigations of the Guangzhou case from the early 1920s to late 2010s and indicates how the findings can offer lessons and practice that can be used by other coastal cities or delta areas. By this, it reveals the city's experience in integrating planning with flood risk management and links the latest efforts with the on-going National Sponge City Programme in China [2000 to 2019]. It also opens windows for future studies on the role of planning in flood risk governance which can test the generalisation of the Guangzhou experience .

1 **What are the (long-established) traditions of planning institutions in dealing with flood risk and what effect do they have? What, if any, innovations have taken place and why?**

Planning traditions play an important role in the path that spatial planning is able to take towards flood resilience and climate adaptation. Chapter 4 explains this argument based on the historical experience of Guangzhou from the 1920s to early 2010s (before the launch of the Sponge City Programme). The exploration indicates that engineering-based measures were the dominant approach to tackling flood risk in planning policy documents and urban development practices. Although there were some deviations from this path, focusing on nature-based measures during the 1950s to 1970s and in the early 2000s, they did not become mainstream. Established routines, in turn, hinder innovations. This phenomenon can be explained according to the notion of path dependence as used in neo-institutionalist literature, which claims that once a choice has been made, it is difficult to change the pathway. The experience implies that the subsequent proposals of the Sponge City Programme (since 2014) and their implementation in Guangzhou involving a combination of engineering and nature-based measures to reduce flood risk (particularly with respect to pluvial floods), could face enormous challenges in implementation at the municipal and local levels.

The path dependence phenomenon inspires further exploration of the conditions that may enable or frustrate innovations or deviations. Reviewing historical experience in Guangzhou uncovered two necessary but not sufficient conditions for change to happen. First, the innovation must meet a widely shared socio-economic demand. Second, the institutional environment must be able to support planning authorities

to impose and implement policy change. These findings are consistent with others in the literature which argues that the rise of new political ambitions and the emergence of new governance arrangements can trigger policy innovations in an established planning system to deal with flood problems (e.g. Parsons *et al*., 2019). It implies for the success of the Sponge City Programme and its implementation, Guangzhou should build facilitating conditions which combine innovative, resilient measures with socio-economic demands in urban development and build institutional environment to support planning agents to work on the new programme. However, there is another finding which is not consistent with the literature: the occurrence of natural hazard events (flooding) did not always lead to policy innovations. This discovery is not consistent with other early research (e.g. Wiering, 2008), which regard hazard events as a trigger for policy changes.

The findings from Guangzhou arise from a complex history and particular critical moments which have defined the general path, and extent to which innovations and deviations have taken place over time. The following sections explain why some reforms were successfully embedded in practice and why others were introduced but did not continue.

The first critical moment was in 1930 when the *Guangzhou Public Works and Implementation Plan* was launched. This plan called for engineering-based solutions to deal with flooding, and was followed by many subsequent master plans. It also initiated a path-dependent route of Guangzhou's planning system in managing flood affairs. The wide acceptance of the plan and its continuity over time were built on two factors. First, the proposed engineering-based measures corresponded to mixed socio-economic requirements when introduced and over a period of time following. For instance, there was general agreement about the need for shipping line improvement, sanitation improvement, urban economic development, and increased housing supply in the 1930s. The reinforced and regulated dike systems, culverted canals and constructed underground pipes ('engineering-led' approaches to deal with flooding) offered opportunities for smoothed river shorelines, steady water flow (good for shipping), land reclamation, improved drainage capacity, better sanitation with low cost, and housing building along rivers. Second, in the 1930s, there was no specialised water affairs bureau working on flooding. The functions of planning and dealing with flood problems were both shouldered by one governmental sector, namely, the Public Works Bureau. Thus, the integration between planning and water management in managing urban development was relatively easier than nowadays.

The second 'moment' involves the attempts to use nature-based solutions to deal with pluvial flooding by constructing artificial lakes for rainfalls storage between the 1950s and the 1970s. However, there were hardly any concrete 'heritages'

in planning discourse. The unrest caused by wars, political disturbance and weak planning authorities hindered the progress of the local planning system and urban development. As a result, these conditions did not bring remarkable changes in planning policy documents given flood affairs. In practice, only a limited number of pilot projects (several artificial lakes) were developed during this period.

The third moment is in the early 2000s. The planning sector in Guangzhou began to promote nature-based measures and land use regulations at the municipal level (shown in *2005 Guangzhou masterplan*), such as the encourage of artificial lakes to reduce flood risk and the preservation and improvement of blue corridors such as open waterways and canals. These solutions offered additional benefits in terms of spatial quality, international city image and attractiveness for real-estate investments. Consequently, a series of large-scale artificial lakes were constructed together with projects bringing green space to man-made canals. But these were not supported over the longer-term in planning and policy documents. In the latest *2016 Guangzhou Masterplan*, the measures to deal with flooding returned to only engineering solutions. This is because the planning sector had a subordinated position in flood governance and only weak capacity to provide legal support in discourse.

In summary, the (long-established) traditions of planning in dealing with flood risk in Guangzhou have been closely attached to engineering-based measures. This traditional way of tackling the problem has persisted ever since it was established. Although there were innovations and deviations from this tradition over time, they did not succeed in changing the dominance of the general engineering approach. These findings suggest a considerable challenge for the application of the Sponge City Programme in Guangzhou, although it immediately led to the production of the *Sponge City Plan* in 2017. The previous history draws attention to the question of whether the *Sponge City Plan* matches general social-economic demands, and if the institutional context would be supportive of its implementation. Perhaps it is too soon to say whether the Sponge City Plan can be successful in countering the planning traditions in the longer term. More research is needed. The following research questions 2 to 4 help to uncover the impacts of Sponge City Plan on the institutional context so far.

The findings here can be meaningful for other coastal cities or delta areas which want to make new policies or adopt new concepts to manage flood problems, as the experience shows that local traditions are likely to hinder innovations. Appropriate action will be needed to establish favourable conditions in social-economics and institutions that can support reforms.

2 **To what extent does planning adopt a co-determined policymaking process to address flood risk across the hierarchical levels of spatial planning vertically and across the boundaries between different disciplines horizontally?**

The management of vertical integration and horizontal cooperation is very significant for spatial planning sector to successfully work on flood resilience and climate adaptation in practice. The issue was explored in the thesis by addressing RQ 2, with a detailed study of changes in procedures and tools that planning institutions followed. This issue also partly responds to RQ 4 which provides a way to testify how the new planning tools are expected to work in practice under the notion of the 'rules of the game'.

The experience of Guangzhou from 2000 to late 2017 reveals a series of efforts by spatial planning to improve its performance in dealing with the flood risk. Progress concentrates on (i) the creation of clear, well-understood and formalised planning discourse with practical and concrete approaches (such as advisory principles and binding ordinances) to facilitate vertical implementation; and (ii) the construction of a common language shared by the planning system with other sectors to facilitate horizontal cross-sectoral collaboration. These efforts show how to transform local planning from a system with informal procedures and limited tools in managing flood risk to a system with formal procedures and diverse tools that can address flood concerns in spatial development. The efforts discussed here partly fill the gap in the literature that there are insufficient explorations of particular procedures or workflows to facilitate the co-determined process in flood governance between, for instance, planning and water management agents. The following two paragraphs give more contextual details.

Before 2017, flood risk was not treated as a primary topic in urban development priorities in Guangzhou. Flood risk was generally managed by the water management[30] sector through water policies, water master plans as well as specialised subject plans. Among these policies and plans, the specialised plans are often used between sectors to deal with cross-sectoral issues in terms of spatial development, agriculture, energy, transportation, industry, etc. The water management sector used the specialised subject plans to regulate spatial development within coastal and river areas directly. While, within the planning system, the procedures and planning tools to work on flood affairs were still under-developed. In the investigated municipal masterplans and district (sub-municipal) regulatory plans, planning discourse is mostly a restatement of hydrological visions

30 It is also named as water conservancy (and affairs) management in China.

and regulations from water policies, water master plans and specialised subject plans, concentrating on engineering-based infrastructure. No operable tools are available for planners to work on flood affairs.

The situation changed when the Sponge City Plan was introduced from 2017. This plan is also a specialised subject plan, but it is led by the spatial planning sector with a specific concern about flooding in spatial development. Through this plan, the planning sector built an active connection with the requirement in water policies, water master plans and specialised subject plans from water management. The development of the *Sponge City Plan* was deeply involved with the collaboration between institutions in spatial planning, water management, finance, greening, etc. at the municipal level. In this document, a series of options are widely agreed in a formal way combining the well-established engineering-based infrastructure solutions, like dykes (used by engineers), and novel measures such as nature-based solutions and permeable-impermeable land use controls (used by planners, but also urban designers and landscape architects). In addition, long-term strategic visions and soft principles (e.g. encouraging adaptation mainstreaming if possible), and strict regulations (e.g. zoning plans to protect green-blue infrastructure and regulatory codes for the percentage of green spaces used for flood retention) are expressed in this spatial planning document to guide urban development. This kind of cross-sectoral procedure was followed and mimicked at lower district levels accordingly, which produced a set of district sponge plans. They gave similar attention to the promotion of nature-based solutions, the protection of green-blue infrastructure and the regulations to avoid over-paving development.

In summary, the policymaking process in relation to vertical integration and horizontal cooperation has been reformed. On the one hand, the *Sponge City Plan* relied on broad involvement with a range of policy sectors, and especially an agreement between planning and water management. In this approach, a combination of engineering-based solutions, nature-based and land use regulations were proposed. On the other hand, new planning tools were created to guarantee vertical implementation, such as strategic visions, soft principles, and strict ordinances to deal with flood risk in particular. Such a way of managing spatial development and adaptation was clear and followed the general tools used by planning systems. Thus, they could be understood by planners easily, which facilitated the communication between hierarchical levels in the planning system.

For other coastal cities or delta areas, a concrete procedure to ensure horizontal cooperation is important, allowing planning agents to talk with and learn from other actors, like water management agents. At the same time, the ways to ensure vertical integration within the planning system is significant, facilitating the implementation of higher-level policy at lower levels.

3 How are flood problems framed in the discourse of spatial planning; and with what effects?

Framing is important. It is about how a problem is defined, responded to and delegated. The way in which flooding is framed in planning discourse affects how spatial planning understands flood problems, proposes responsive actions and makes governance arrangements to deal with them. This issue was explored in the thesis mainly by investigating RQ 3, with a detailed study of changes in the text discourse that planning institutions followed. It also partly responds to the investigation of the changing 'rules of the game' in RQ4 which provides a way to testify how policy framing works in practice.

The following three paragraphs present more contextual details about the experience of Guangzhou before and after the launch of the *Sponge City Plan*. During the period from 2000 to 2017, the spatial planning sector discussed flood problems in only a limited way, especially in master plans. Often, flood topics were positioned under the heading of 'flood prevention and rainfall discharge', as part of the master plan chapter' public safety and disaster prevention'. The causes of floods were often either not acknowledged or not fully mentioned. For example, the impacts of climate change and unsuitable urban development patterns on floods risk were neglected in problem construction. Floods problems were dominantly associated with natural disasters leading to loss and damages with engineering-based structural measures used to tackle them. Non-engineering measures which could be used by planners in practice (e.g. nature-based measures, low-lying ground elevation raising and regulations to prohibit encroachment on waterways) were scattered in policy discourse, despite significance. In addition, the role of spatial planning that can play in mitigating flood risk was seldom discussed in the planning discourse in terms of responsibilities and potential opportunities. This led to a weak recognition of planning in flood governance.

The *Sponge City Plan (2017)* changed the framing of policy discourse. By introducing ideas from water management to spatial planning in terms of the problem setting, responsive measures and governance arrangements, this *plan* made considerable progress to incorporate flooding issues into spatial planning. Initially, the negative impacts of climate change and unsuitable urban development patterns were highlighted, accompanied by a series of risk assessments to show the flood-prone areas. Also, it brought forward a new perspective that concentrated on flood risk management rather than flood resistance which helped to change official attitudes towards a recognition the benefits of flood resilience projects in terms of ecology, environment, water resources management and social well-being. A multi-objective goal-setting approach was favoured. What is more, the orientation to combine engineering-based measures and alternatives used by planners (e.g.

nature-based measures and non-structural regulations) was apparent, together with promoting a higher status for planning in flood governance, highlighting its role in coordination, regulation and inspection.

In summary, the framing of planning discourse has been changed due to the Sponge City Plan. Against this new framing, planning institutions were appointed with responsibilities and opportunities to manage flood issues in urban development.

The Guangzhou case provides an example of how to integrate flood concerns with spatial planning discourse by changing policy framing and borrowing knowledge from water management. These two aspects are useful for emerging cities that need to establish a new framing of flooding and adaptation issues.

4 What contextual factors, if any, can influence the enabling conditions of planning in flood governance?

The contextual factors matter for the spatial planning sector to work effectively on flood resilience and climate adaptation in practice. Four contextual factors are identified in Chapter 7, whose disadvantages are expected to impair the planning sector' capacities. They are organisational structures, the rules of the game, financial allocations, and the culture and historically embedded cognition (the perceptions of flood relevant actors). These factors shape the favourable or unfavourable conditions for planning in flood governance regarding powers, legitimate opportunities, incentives and popular beliefs. The findings here are helpful to understand the sources of the inability of planning agents to deal with flood problems and to find paths to strengthen their capacity.

The experience of Guangzhou from 2000 to 2019 indicates that the spatial planning sector gained some advantaged conditions in flood governance after the enactment of the *Sponge City Plan (2017)*. New rules of the game in terms of planning tools and policy framing have offered the spatial planning sector legitimate opportunities and responsibilities to implement flood resilience activities in its jurisdiction: (i) Spatial planning is appointed with measures in managing flood problems in dry territories – beyond coastal and river areas, adopting such as nature-based solutions and permeable-impermeable land use controls; (ii) the required binding ordinances to address flood problems in urban development make flood concerns a mandatory in the planning process.

However, the spatial planning sector still has to face unfavourable conditions created by past experience. On the one hand, a series of adjustments of organisational structures and limited allocations of funding have deprived planning institutions of powers, knowledge and resources. One the other hand, the long-established

weak understanding of the potentiality of planning in addressing flood risk can also constrain planning actors' interests to work on flood issues. Most respondents investigated in this research, who have a background in land use planning and land use management, expressed doubts about the effectiveness of planning measures in flood affairs. In other words, not all of the planners and planning agents are ready to accept the new rules of game. Changing individuals' perceptions is very difficult! Education background matters!

In summary, the changes in the rules of the game, as a reflection of contextual factors, has helped planning to gain opportunities and options to deal with flood problems in the dry territories. However, there are still other contextual factors which seem to constrain the capacity of planning in flood governance. Potential restraints derive from disadvantages in organisational structures, the limited allocations of funding and the long-established weak belief of planning' role in reducing the flood risk.

For other cities or areas striving for climate adaptation and flood resilience, contextual factors are crucial to strengthen the capacity of planning authorities in dealing with flood risk, like organisational structure or the allocation of funding. However, most of them are often difficult to be reformed or optimised. This is an example of institutional inertia. It is a reminder to other cities that changing the rules to promote new policy ideas is just a start; more efforts are needed to face the barriers arising from contextual factors.

8.2 Recommendations: creating strategies from TOWS analysis

This section focuses on developing future strategies that may benefit practitioners in Guangzhou as well as other flood-prone areas. The TOWS method - *threats*, *opportunities*, *weaknesses* and *strengths* – is used in this task. It is often applied in business to identify strategies to maximise the internal strengths and external opportunities (SO), minimise the internal weaknesses using external opportunities (WO), counter external threats using internal strengths (ST), and avoid the double effects from internal weakness and external threats (WT) (Weihrich, 1982; Ravanavar and Charantimath, 2012). The notion of 'strategies' here follows the definition from Hopkins (2001, p.41). He regards strategies as

"a set of decisions […] determining what actions should be taken now contingent on related future actions […which are] explicit about the relationships among interdependent actions, their consequences, intentions, uncertainty, and outcomes."

This section, firstly, abstracts the threats, opportunities, weaknesses and strengths of spatial planning for flood risk in Guangzhou based on the results discussed above. It then develops strategic recommendations to improve the status quo through the four prisms (SO, WO, ST and WT) (Table 8.1). It should be noted that proposing recommendations for improvement is challenging and the knowledge from the perspective of institutional and governance concerns is not complete[31]. To solve this problem, I borrow insights from environmental management, disaster management, and socio-economic policy to create strategies for the future.

External threats (T): Two external threats can impair the development of the Guangzhou planning system in flood governance: a lack of financial support from central government and a lack of a framework which would locate planning as part of integrated flood risk management at the national level. It deserves more elaboration about the framework. In the Guangzhou case, the *Sponge City Plan* frames planning as a means to resolve pluvial floods (the major target of this plan), but also coastal floods and fluvial floods. However, the on-going National Sponge City Programme concentrates on pluvial floods. There is a mismatch here, which could mislead regional and national authorities into thinking that planning can only contribute to resolving pluvial floods and, consequently, neglecting planning's role in handling coastal floods and fluvial floods.

External opportunities (O): External opportunities for the local planning system come from the status given by national call and the accompanying technical guideline of the Sponge City Programme. The former confirms the contribution that spatial planning can make to flood agendas, and the latter proposes basic requirements for the incorporation of flood concerns into spatial development plans in relation to residential areas, open space, roads and water systems.

Internal weaknesses (W): The internal weaknesses facing the local planning system on flood concerns are (i) the engineering-based path dependence tradition; (ii) weak powers of planning sector over water issues; (iii) limited funding; and (iv) doubts about the contribution that planning can make about reducing flood risk among planning institutions and practitioners.

31 The author believes that problems created by one system internally cannot always be solved by the system itself.

Internal strengths (S): The internal strengths for the local planning system in flood risk management lie in (i) the emergence of procedures and planning tools in the policymaking process to enhance horizontal cooperation between sectors and vertical cooperation across bureaucratic levels, and (ii) the strengthened competence of the planning sector in official policy discourse concerning a formal position in flood governance and practical spatial measures.

8.2.1 SO (Maxi-Maxi Strategy, strengths to opportunities]

A system can take firm steps by using strengths to maximise opportunities. The Guangzhou planning system, under this approach, can optimise the formal planning system in terms of building suitable administrative procedures, regulations, and technical guidelines for evaluation, implementation and monitoring. It not only enhances the promotion of the Sponge City Programme in response to the national call (O1) but also promotes the incorporation of flood concerns in planning as required by the *Technical Guidelines* (O2). The facilitators arise from the two strengths: the emerging cross-sectoral policymaking process between the local planning system and water relevant actors (S1), and the acknowledged position of planning in managing flood affairs, which enable the knowledge learning, knowledge sharing and policy transfer between planning and other fields (S2).

8.2.2 ST (Maxi-Mini Strategy, strengths to threats)

The spatial planning authorities in Guangzhou can use their strengths to counter threats. The promotion of multi-objective projects is an option, in which flood resilience projects are mainstreamed as part of urban development projects. In that way, resilience projects can be mainstreamed in many daily planning projects like coastal development and river development (in response to S1, S2). These projects, if constructed, can, in turn, bring combined benefits which attract the interests of planning agents (countering T1, T2). One good example is the 'smart combination' (named by the Dutch National Water Plan 2016-2011) of the dyke system with transport, which has been used widely in the Netherlands in low-lying areas (Ministry of Infrastructure and the Environment and Ministry of Economic Affairs, 2015). These transport routes, often in the form of railway or highways, have a dual function working as a flood defence system to protect the population from flood contingencies. Another typical example is in Guangzhou, where the construction of artificial lakes with urban development has been used in the period

between the 1950s to 1970s and in the early 2000s (more details in Chapter 4), for instance, the Haizhu Lake. This lake was paid for by the local government to provide flood retention, ecological improvement and recreation. Later on, the designed lake encouraged and enhanced the development of the real estate nearby due to the good living conditions. As a result, the returning economic benefits are far larger than the investment in the construction of the lake.

8.2.3 WO (Mini-Maxi Strategy, weaknesses to opportunities)

In order to minimise weaknesses, the spatial planning system can take advantage of external opportunities. The national call and national sponge city guidelines (O1 and O2) can be used as triggers to initiate incremental changes in the local planning, (i) by creating occasions to link non-engineering-based measures with the social and economic agendas through disaster management and planning (similar to the abovementioned multi-objective projects) (minimising W1); (ii) by creating a coalition or strategic cooperation with the water management sector for joint-work in terms of data access and information sharing (minimising W2); (iii) by creating a supporting financial system, for instance, by using tax and subsidies (Doorn-Hoekveld *et al.*, 2016)[32] (minimising W3); and (iv) by raising the awareness of the role of planning in flood resilience through education and knowledge sharing (minimising W4). These new measures are not new ideas but based on what has been done in Guangzhou with additional steps.

8.2.4 WT (Mini-Mini Strategy, weaknesses to threats).

In the case of the worst scenario, a system needs a 'survival strategy' or 'defence strategy' in the face of pressures from great internal weakness and external threats. Guangzhou does not have to fall back on this due to the strengths and opportunities identified. However, some efforts are needed to protect the initiatives for resilience

32 The burden-sharing and awards-giving ways to solve the expense on flood affairs in Europe follow four major principles (Doorn-Hoekveld *et al.*, 2016): 1) the solidarity principle (for instance, all Dutch citizens pay for the cost caused by flood risk management via tax and leave responsibilities to regional water boards and the Dutch state); 2) the principle of protecting property rights in a case for public interest with authorised law, ministry's approval and compensation (e.g. in England); 3) equity before public burdens (for instance, compensation for restricted loss in the public interest in Flanders); and 4) citizens bearing minor adverse effects while getting compensation with strong adverse effects (e.g. in France).

and adaptation from losing momentum over time. A potential direction to overcome the weaknesses and avoid threats is to frame spatial planning's contributions under the umbrella of integrated flood risk management rather than a detached Sponge City Plan (in relation to T2). It could be done at the national level, as in done in the Multi-layer Flood Risk Management in the Dutch Delta Programme (flood defence, spatial planning for adaptation and disaster control) (*Delta Programme 2018*, 2017). Such new framing would strengthen the legitimate opportunities for spatial planning in flood governance (in relation to W2) while bringing potential formal financial support, as it does for the water management system (in relation to W3).

Another direction is to diversify spatial planning measures (in relation to W1) and, more importantly, develop an appropriate approach to evaluate the benefits of alternative measures in flood resilience, such as cost-benefit analysis or cost-effectiveness analysis (in relation to W2). These methods calculate the investment and benefits of resilience projects (Mechler, 2004; Mechler, 2016; Reguero et al., 2018). The results can help politicians and planning practitioners to identify what resilience projects can save money in the long-term (in relation to T1).

The third possible direction is to improve scientific research on the assessment of risk and climate, which offers evidence for the necessity of using planning interventions, for instance, limiting urban development and sprawl into flood-prone areas (in relation to W4). This would, however, need to be coupled with measures to enhance the dialogue between academia and planning practice (in relation to W2).

TABLE 8.1 TOWS Matrix

	External Opportunities (O)	External Threats (T)
	1. National call for the spatial planning's contribution to the Sponge City Programme for flood risk 2. National Sponge City Programme Technical Guidelines proposing basic requirements for the incorporation of flood concerns into spatial development in relation to residential areas, open space, roads, water systems, etc.	1. A risk of reducing financial support from the national level for the planning sector in the Sponge City Programme 2. The main focus at the national level on pluvial floods to be addressed by spatial planning with a lack of attention to position integrated flood risk management including coastal and fluvial floods
Internal Strengths (S)	**SO (Maxi-Maxi Strategy)**	**ST (Maxi-Mini Strategy)**
1. The emergence of policymaking procedures to enhance horizontal cooperation between sectors and the emergence of soft and strict planning tools for vertical cooperation across bureaucratic levels 2. Strengthened competence of the planning sector in official policy discourse concerning a legal position in flood governance and the use of spatial planning measures	1. Optimising the formal planning system in terms of building suitable administrative procedures, regulations, and technical guidelines for evaluation, implementation and monitoring 2. Developing conditions for knowledge learning, sharing and transfer from other fields	1. Promoting a multi-objective approach and mainstreaming in practice
Internal Weaknesses (W)	**WO (Mini-Maxi Strategy)**	**WT (Mini-Mini Strategy)**
1. History rooted in engineering-based measures to deal with flood risk via land-use planning 2. Weak powers concerning organisational infrastructures and qualified personnel. 3. Limited funding at the municipal and sub-municipal level 4. Weak self-understanding of the contribution to reducing flood risk in the planning sector	1. Creating opportunities to link non-engineering-based measures with social requirements and economic benefits through disaster management 2. Creating a strong coalition with the water management sector for joint-work in terms of data access and information sharing 3. Creating a supporting financial system, for instance, by using tax or subsidies 4. Raising the awareness of the role of planning in flood resilience through education and knowledge sharing	1. Framing planning's potential contributions under the umbrella of an integrated flood risk management notion, which strengthens its legitimate opportunities and brings with it formal financial support 2. Diversifying the alternative approaches in flood resilience that planning can adopt such as nature-based measures, flood risk zoning plan, etc., and combining with cost-benefit analysis or cost-effectiveness analysis 3. Promoting more scientific research on the assessment of risks from climate change, which offers evidence for the necessity of using planning interventions

Source: Author

TOC

8.3 Reflection on theory and existing literature

This section explains the lessons learnt from this study in relation to theory and existing literature. Initially, this thesis is built based on the premise that planning is an interactive decision-making process with different stakeholders from various institutions representing their own interest. Without this premise, this thesis has no base. In other words, if planning was merely regarded as a technical process or a design product, there would be no reasons for this thesis. Healey's theory of collaborative planning (2006) conceptualised this decision-making perspective which highlighted the consideration of institutions in planning research. It is used as a starting point for this thesis. This kind of understanding offers paths to explore the factors and mechanisms affecting the final products of planning, like project plans or blueprints, "where implementation [are] unproblematic and outcomes are expected to conform to intentions" (Faludi, 1989, p.135). It is meaningful for planning research because one project plan or one blueprint can be developed at a given point in time, while the factors and mechanisms underlying, such as legacies in relation to institutions and governance, can have a long-term impact on numerous blueprints once they are established.

Four focal clusters of literature are employed in this thesis, spanning disciplinary boundaries beyond the planning literature into social science and policy science, including (i) path dependence and path divergence, (ii) planning procedures and planning tools studies, (iii) policy framing theory, and (iv) collaborative governance theory. They help to understand the existing practical and conceptual deficits and the strengths of the current governance settings and mechanisms in Guangzhou.

These four clusters of literature can also be used in other cases to explore the facilitators and barriers for implementing resilience initiatives and climate adaptation by the planning system at the municipal level. Similar to the Guangzhou case, potential topics can involve planning traditions, multi-actor and multi-level networks, departmental mismatches, legitimacy and responsibility, institutional design and capacity, territoriality and policy adaptation.

8.3.1 Historical institutionalism, path dependence and path divergence

Chapter 4 used two notions from historical institutionalism, namely, path dependence and path divergence, to explore the conditions under which it is possible to break away from established institutional paths constraining the capacity of planning to deal with growing flood risk. The findings correspond to the empirical challenges for planning to deal with flood risk caused by the stickiness of the old paradigms embedded in history and culture and the asymmetries of powers in flood governance (Buuren, Ellen and Warner, 2016).

The results from applying the notion of path dependence, in this case, are comparable to two ideas from historical institutionalism that 'the past matters' (Levi 1997) and once a choice selected, it is difficult to be changed (Levi 1997; Pierson 2000; Sorensen 2015). Moreover, the exploration relying on the notion of path divergence reflects on the ideas from Capoccia and Kelemen (2007) that deviations emerge when there are specific moments or critical junctures at which structural constraints from an established system become weaker. The identified sources of deviations in the Guangzhou case include, for instance, the socio-economic context and institutional environment (the status of planning agents in policy arena). This adds knowledge to the debate in historical institutionalism which often posits that new ideologies, technologies, and crises can shake the established routines (Collier and Collier, 2002).

Significantly, the research in Chapter 4 finds that flooding events do not always result in policy changes. This argument is in opposition to conclusions in the early empirical studies (e.g. Johnson, Tunstall and Penning-Rowsell, 2005; Penning-Rowsell, Johnson and Tunstall, 2006), which thought the occurrence of floods could lead to policy changes if the magnitude was substantial.

8.3.2 Collaborative governance theory

In Chapter 7, collaborative governance theory from Ansell and Gash (2008) provides an approach to describe the pre-conditions for planning institutions in flood governance and explore the mechanisms in institutional design that shape these conditions. The results reflect on the barriers which are often regarded as factors hindering planning's capacities to address flood affairs, such as the lack of legal certainty, blurred accountability (responsibilities), weak powers, insufficient personnel skills and insufficient incentives (Mileti, 1999; Storbjörk, 2007; Deyle,

Chapin and Baker, 2008; Ward et al., 2013; Driessen et al., 2018). These barriers are linked with changes in organisational structures, shifting rules of the game and insufficient resource allocation.

It also sheds light on the concerns that history embedded values (or perceptions) of planning agents can cause obstacles for the implementation of new adaptation measures. This point has been increasingly recognised by flood risk management literature (e.g. van Voorst, 2016), but needs more attention in the planning literature.

8.3.3 Planning procedures, planning tools and policy framing

Unlike the explanatory studies in chapters 4 and 7, both of which aim to explain why institutions collectively behave in particular patterns, studies in chapters 5 and 6 regard planning as an engineering technology with implications on how design and mapping activities operate. In particular, the concepts of planning procedures and planning tools have been used to examine how planning and flood risk management actors address flood concerns in practice. In contrast, the idea from policy framing has been used to examine what planning and flood risk management actors claim in policies and planning documents. Three innovative points are highlighted. First, legal acknowledgement is important, enabling the planning sector to develop formal interventions and to be considered as an essential actor in flood affairs. In other words, the likelihood for the planners to take part in flood governance increases. Second, policymaking procedure offers channels and opportunities for planners to step into the decision-making process. Third, the mandates from planning regulations push planners to sit at the negotiation table and equip spatial planning with tools and powers to control and guide practice.

The findings clarify the important issues often discussed in flood resilience, for example, (i) the mainstreaming of flood risk issues in planning policies; (ii) the ways to combine short-term and long-term benefits in urban development; (iii) managing conflicting understandings of flood resilience and climate adaptation from different parties; (iv) the roles of planning institutions in the decision-making process; (v) the conflicting planning procedures in contrast to water management; and (vi) the communications and cooperation between actors in planning and flood risk management (e.g. Mileti, 1999; Mostert, 2006; Storbjörk, 2007; Deyle, Chapin and Baker, 2008; Ward *et al*., 2013; Davidse, Othengrafen and Deppisch, 2015 Francesch-Huidobro *et al*., 2017; Dąbrowski, 2018; Driessen et al., 2018; Runhaar *et al*., 2018).

8.4 Reflection on research methods

In this thesis, a wide range of methods has been used to collect and analyse data. Methods for data collection include literature review, semi-structured interviews, and the usage of open-access geo-information. Methods for data analysis include content analysis, GIS-based analysis, stakeholder analysis, and TOWS analysis. These collection measures help to abstract information from a broad range of text-based and visualise-based information behind official policy documents, white papers, research papers, archives, websites, scripts from interviews, geo-dataset, and satellites photographs. In addition, these analytical methods contribute to the production of a rich body of findings.

Even so, there are two limitations that I want to point out. One limitation of this study is the imprecision of some findings due to the limited access to data. For instance, in Chapter 7, the exploration of the spending on flood resilience from spatial planning sector is not precise, albeit it does not affect the result that planning is financially inferior to the water management sector on flood affairs. The imprecision stems from a lack of sufficient public information of budget and spending of the spatial planning sector to confirm what the proportion of this spending is related to flood issues.

The difficulty in access to data also led to missing details on some aspects discussed in Chapters 4 and 6. In Chapter 4, there is an exploration on mapping the measures adopted by Guangzhou city to deal with the flood risk in the 2010s. However, open sources such as old maps and archives in this period lacked sufficient evidence to inform this inquiry fully. Thus, only the adopted measures within the limits of the city centre are portrayed rather than all of them.

A similar situation appears in Chapter 6, where the content analysis is conducted to trace the dynamics of policy framing in the planning and water management sectors. The ideal way is to code all policies from these two sectors from 2000 to 2019 to explain problem construction, responsive measures and governance arrangements in planning documents. However, due to limited data, this study had to rely on qualitative data on the milestone policies. Thus, Chapter 6 merely reveals the major changes, but cannot trace precisely the incremental changes during the last 20 years.

The second limitation is about the single case study method in this thesis. One can argue that there are difficulties to extend the experience of a specific case to general use. Whilst the Guangzhou case is special, its flood problems, planning activities and lessons are generalisable, especially to those places that share similar

characteristics, problems and opportunities. First, in terms of geographic and socio-economic context, it is a deltaic megacity, 7434 km2, with a GDP of 1960 billion RMB and a population of 14 million (in 2016), ranking second in terms of it flood risk in 2070. Similar cases are limited in China and globally, but Shanghai and New York are two examples with a comparable situation. Second, Guangzhou is not among the first group of cities to develop a Sponge City type of Plan, but it is a pioneer in China, where other cities are trying to make some institutional transformations to promote the role of planning in dealing with flooding problems. Similar transformative cases can be seen in Beijing and London. Third, Guangzhou has one of the earliest modern planning systems in China. The well-established established planning institutions in Guangzhou have become 'sticky' – they are hard to change and hinder the transformations. The exploration of how to overcome this institutional stickiness through changes in rules, regulations, norms, structures, financial allocations, etc. correspond to similar problems elsewhere in the world. Therefore, the experience and findings from Guangzhou are very relevant to those places. This is shown by studies based on cases in the Netherlands, Poland, Germany North Sea Coast, and England and Scotland (Garrelts and Lange, 2011; Hegger et al., 2013; Potter, 2013). However, the generalisation of findings from one city to another is always going to be difficult. Other cities will always have different institutional settings and arrangements from their specific history which will have to be considered.

8.5 Unanswered questions and areas for future investigation

Five unanswered topics can be further investigated in the future in Guangzhou case, also applicable to other flood-prone urban areas. Most of these topics have already been mentioned in Chapters 5, 6, and 7, and are summarised again here. The first one is the way of framing the role of spatial planning in flood affairs, which is inspired by Chapter 6. The National Sponge City Programme merely concentrates on the function of planning in dealing with pluvial floods. Such a framing could lead to a neglect of planning as a way out of other flooding problems such as coastal floods, fluvial floods, mountain floods and rising sea levels. An extensive research project can explore the full role of planning in different sources of floods based on Chinese and global cases. The result is expected to provide more evidence to consolidate integrated water or flood risk management with the engagement of spatial planning.

The second topic for further research is to investigate the full range of measures that spatial planning could adopt to mitigate flood risk and to integrate the many cascading interactions from flooding. As mentioned in Chapter 6, the current measures appraised in Guangzhou's spatial interventions are built on hydrological solutions, such as dykes or nature-based solutions to defend or mitigate floods, and the density of development in terms of impermeable paving materials. Social-economic factors, however, are not considered in flood-related spatial plans. For example, what extent the citizens will be affected concerning the disturbance of employment, poor sanitation, chaotic public order and unmanaged evacuation routes? What industries are the most vulnerable? Chemical industries could distribute poisons, and electricity plants could meet power failures once flooded. These explorations need integrated information both on hydrological knowledge to show the scope of risk and on social-economic knowledge (e.g. to indicate the employment, healthcare centres, policy stations, industries) in relation to spatial features. The research on flood response and recovery gives clues for this direction (e.g. Lansen and Jonkman, 2010; Coutinho-Rodrigues, Sousa and Natividade-Jesus, 2016). Notably, the difficulty of accessing the information can impair responses. It is one of the reasons why this thesis did not exam the making of plans including risk mapping, post-assessment and designing spatial development based on a place. I leave this exploration for further studies, which is a worth-deserved topic.

Following the second direction, there is potential from exploring the methods to facilitate data sharing, knowledge dissemination and assessment, so that spatial planning can be involved in cross-sectoral policymaking effectively. As Chapter 5 expressed, despite progress in developing spatial measures to address flood problems by the Sponge City Plan, many planners do not understand how to do the simulation or projection in relation to flood risk. A technical tool for simulation or an easy way to access risk maps from other sectors would help to solve this problem. One potential exploration is to build an open e-platform or flood toolkit, for example, based on GIS platform that linking planning with other different policy sectors, as Ran and Nedovic-Budic suggested in their study (2016).

A further promising direction is about the financial incentives, mentioned in Chapter 7. Are there any financial tools available for spatial planning to use in the pathways towards flood resilience, which help transform a political commitment to concrete practice? The findings in this thesis are more related to the allocation of governmental financial resources, which seems insufficient to support the planning sector's work on flood agendas. One promising way to raise money for the local government is the solidarity principle used in the Netherlands, where "every person in a certain area has the same level of protection" and "resources are provided by taxes from the regional water authorities combined with funding by general taxes"

(Driessen et al., 2018, p.10). Another option is to encourage private investment to deal with floods, for instance, by insurance companies.

Finally, the topic of policy transfer or policy learning merits further attention. This thesis pays more attention to the exploration of the internal self-development of the Guangzhou planning system and water management system as well as of regional and national policy development. External opportunities are seldom discussed. Future research can explore whether there are international lesson learning cases in Guangzhou. It would help to understand if the local planning is affected by foreign experience on flood resilience and what has or has not been learnt. This direction is also significant for other flood-prone areas since international cooperation and communication is increasing due to a growing awareness of climate change globally.

In conclusion, I hope this thesis has provided inspiration to those seeking to develop actions to promote resilience and climate adaptation, and to take opportunities to deal with challenges in the context of achieving proactive responses to climate change. While at the same time, I hope the findings have provided inspiration to those who aim to broaden the role of spatial planning in managing flood problems regarding institutional features and governance as well as environmental benefits, socio-economic balances, and physical disaster management. There are no simple answers for such goals. The path to these goals is rocky and twisted, as it has been shown in the past experience, and also as presented in this thesis. But it does not impair the significance of such efforts, as the future is determined by what we make and what we chase.

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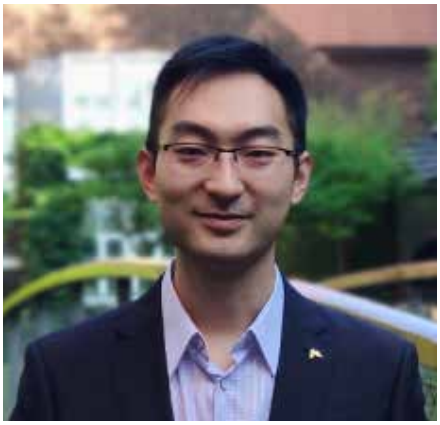
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Publications

Journal paper

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2019 The Challenges from the Path Dependence Feature of Spatial Planning in Handling the Flood Risk. Young Scholars International Forum on Design Innovation from Shanghai Jiao Tong School of Design, Shanghai Jiao Tong University, Shanghai, December 28-29.

2019 The Transition of Spatial Planning Instruments in Flood Resilience and Climate Adaptation: Guangzhou Case in the Pearl River Delta, AESOP Annual Congress: Planning for transition, Venice, July 10-13

2019 Spatial Planning for Flood Resilience: A Policy Framing Perspective, the 3rd Nanjing University Youth Forum, Nanjing University, May 8-10.

2018 Between Inertia and Transition in Spatial Planning in the Face of Flood risk: A Path Creation Perspective, the 18th International Planning History Society (IPHS) Conference: Looking at the world history of planning, Yokohama, July 15-19. *One of Panel organisers.

2017 Climate Adaptation and Flood Risk in Delta Cities: Policy Framing and the Collaborative planning, AESOP Annual Congress: Space of Dialogue for Places of Dignity (conference): Fostering the European dimension of planning, Lisbon, July.

2017 Policy Transfer in Urban Flood-proof Initiatives: Learning from the Dutch Experience in linking Spatial Planning and Flood Risk, Program of the Second International Seminar: the (historical) Interaction between Urban Development and Water management in Global Metropolitan Delta's, Ghent University, Belgium, April.

2016 Challenges of Guangzhou: Incorporating Flood Risk into Spatial Planning, Sustainable Urban Development for the PRD (Pearl River Delta) Workshop: Challenges, Opportunities and Innovations, South China University of Technology, China, November.

2016 The Governance of Flood Risk Planning in Guangzhou, China: Using the Past to Study the Present, the 17th International Planning History Society (IPHS) Conference: History, Urbanism and Resilience, Delft University of Technology, Netherlands, July.

2015 Making City More Resilient: A Spatial Planning Case to Climate Change in the face of the Uprising Water Levels in China, 52nd International Federation of Landscape Architects (IFLA) Conference: History of the Future, St. Petersburg, Russia, June.

2014 Gentrification Phenomenon in the Process of Urban Renewal--The Impact of the Cultural Environment on Space Construction", the Southeast University Anniversary Graduate Student Academic Forum, China.

Mentoring Experience

2019 Design in Process, Process in Design (Q4 Course), teaching assistant

2019 Master essay of Lakshmi Baiju, entitled The Public Participation in the Stakeholder Engagement Process of Urban Regeneration Projects, first supervisor

2019 Master essay of Sankarnath Pothannoor Mukundan, entitled The Evaluation of Policy Impacts on Social Cohesion in Gentrified Neighbourhoods of Rotterdam, first supervisor

2019 Master essay of Mae-Ling Stuyt, entitled A Review of Vitality and Success Factors of Mixed-use Development in Transformation Locations, first supervisor

2018 EMU (European Post-master in Urbanism) graduation thesis, consultant

2018 Post-master graduation thesis of Chen, Zhouyiqi, entitled Learning from Vernacular Water-management Practices In Hangzhou, consultant

TOC

21#03

Spatial Planning for Urban Resilience in the Face of the Flood Risk

Institutional Actions, Opportunities and Challenges

Meng Meng

The research was inspired by the increasing impact of extreme weather events and changing climate patterns on flood-prone regions and cities, and the consequent human and economic costs. Despite global efforts for flood resilience and climate adaptation involving climate analysts, economists, social scientists, politicians, hydrological engineers, spatial planners, and policymakers, it is only partially clear how best to construct resilience measures and implement concrete initiatives. The complexity of institutions is a key factor that is often neglected, and which needs further investigation. The thesis examines the institutional arrangements that determine the role of spatial planning in managing flood risk, through an in-depth case study of Guangzhou, one of the most vulnerable cities in China and globally.

The thesis employs theories of historical institutionalism, planning procedure and planning tools, policy framing and collaborative governance, to explore the mechanisms and factors that influence the creative planning and design process. Content analysis, GIS-based mapping, stakeholder analysis and TOWS analysis are used to investigate data from official policy documents, grey literature, geo-information data and interview scripts. The findings indicate that institutional arrangements, such as long-established planning traditions, formal planning procedures and tools, policy framing patterns and contextual organisational factors, determine spatial planning's role in managing flood risk. They do this through (1) the extent of the changeability of an established planning system towards expanded flood resilience measures; (2) the performance of cross-level communication and boundary-spanning work between planning and water management; (3) the legal framework that planners and hydrological engineers follow; and (4) the capacities of planning and water management institutions to work on flood issues. This research shows how to apply knowledge from policy science, political science, institutional science and administration, to analyse the nature of the planning process in tackling the urgent challenge of flood risk and climate change.

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