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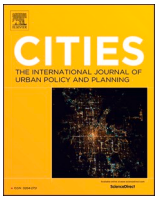

Spatial planning in the face of flood risk: Between inertia and transition

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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 in conventional planning practices remains a major challenge due to institutional barriers. Based on the theories of historical institutionalism in relation to path divergence, this paper aims to understand the factors which determine the fate of innovations and departures from established practice. Using Guangzhou as a case study, the paper 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 to enhance flood resilience in spatial planning.

1. Introduction

Flood risk is one of the most prominent consequences of climate change and poses a key challenge for many cities. Flood events around the world between 1980 and 2009 led to more than 500,000 deaths, 300,000 injuries and affected 2.8 million people (Doocy et al., 2013). The IPCC's Sixth Assessment Report suggests that extreme weather events are likely to become more frequent and intensive, which will contribute to an increase in the occurrence of compound flooding (i.e. pluvial flooding in combination with extreme river flow) (IPCC, 2021), result in considerable threats to health, safety and economic development (IPCC, 2001, 2007, 2021).

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 toward integrated flood risk management, involving a broader range of adaptation measures (Kaufmann & Wiering, 2021; Nguyen, 2019; Potter et al., 2020). 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 to enhance flood resilience across areas and sectors by, for instance, regulating building codes, setting buffer zones, and designing green-blue infrastructure (e.g. Kang et al., 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 & 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 a lock-in conventional routines, namely, institutional inertia (e.g. Gersonius et al., 2016; Harries & Penning-Rowsell, 2011; Parsons et al., 2019; Van Buren et al., 2016; Wiering et al., 2018). The scholarship on historical institutionalism explains this phenomenon with the notion of 'path dependence' (e.g. Pierson, 2000; Sorensen, 2015), highlighting that institutional choices, once decided, become increasingly difficult to

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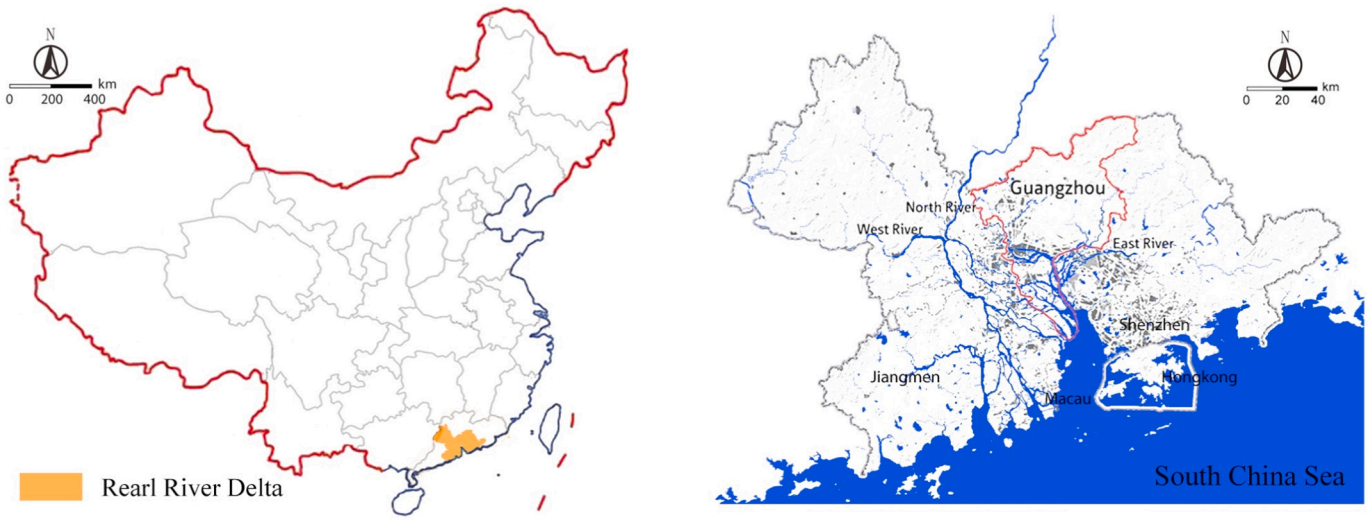

Fig. 1. Map of the Pearl River Delta and Guangzhou.

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 et al., 2005; Penning-Rowsell et al., 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. Garrelts & Lange, 2011; Harries & Penning-Rowsell, 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 paper contributes to the small but growing 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 (Hölscher et al., 2019; Hughes et al., 2013). 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 2014 when the Chinese government promoted a transition from engineering-oriented interventions toward an extended range of adaptation measures to deal with flood risk in the National Sponge City Programme. This included innovations such as nature-based solutions and non-structural basin run-off controls which have been reported elsewhere (Jiang et al., 2018).

This paper presents a historical study of Guangzhou's attempts to deal with floods starting in the 1920s. The city of Guangzhou is regarded globally as one of the most vulnerable cities to flooding by 2070, given potential flood damages in intensive populations and urban assets. 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 (Francesch-Huidobro et al., 2017; Meng et al., 2018). In this paper, we examine how the socio-economic context (e.g. societal requirement, political ambitions), institutional environment (e.g. re-organisation, responsibilities), and natural hazards (e.g. flood events) led to the emergence and implementation of new policy discourse. Two questions are addressed. The first question examines whether there are specific moments in history when policy changes in spatial planning and flood governance have led to a deviation from established ways of dealing with flood risk. The second question concerns the nature of factors which help to shape deviations or divergences from historically rooted policy paths.

The remainder of the paper is divided into five sections. First, it elaborates on the methodology employed in this study. The next two sections address the two research questions in turn. In the fourth part of the paper, 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). The paper concludes with a summary of the main findings, relevance to practice and theory, limitations, and prospects for future research.

2. Methodology

The study traces the policy measures of Guangzhou's planning system to protect its population and assets in vulnerable areas. Influenced by the national vision from central government, the municipal planning system develops comprehensive proposals of spatial development and urban policy including goals, scales, land use structures, zoning, dominant industries, major infrastructure, and expected population growth. The general rules and regulations for water or flood affairs are often included in these proposals in the form of a specialized chapter of the plan, while the technical details are developed by the regional and municipal water sector in sectoral plans (Meng, Dąbrowski, & Stead, 2019).

The research considers a time period of almost a century starting from the 1920s to the early 2010s. The period of the 1920s is a significant point in Guangzhou's history since the city's planning system was

Table 1
Five types of measures to deal with the flood risk when planning is taken into consideration.
Source: Authors, based on (Thampapillai & Musgrave, 1985; Olshansky, Johnson, Horne, & Nee, 2008; Kang et al., 2009; Sayers et al., 2013; Elsergany, Griffin, Tranter, & Alam, 2015; Van Veelen, Voorendt, & Van Der Zwet, 2015; Coutinho-Rodrigues, Sousa, & Natividade-Jesus, 2016; World Health Organization. Regional Office for Europe, 2017; Voorendt, 2017; Jamrussri & Toda, 2018; Wingfield et al., 2019).

Measures	Functions	Statements in planning policies/ regulations	Affected (non-) structural interventions in practice
a. 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 et al., 2009; Sayers et al., 2013) - Population move and building (re)locations (Thampapillai & Musgrave, 1985; Kang et al., 2009)
b. Defence	Preventing flood water entering	Multi-purpose/multifunctional engineering measures for leisure, landscape and commerce	Construction of - Dykes, flood walls 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)
c. Mitigation	Decreasing the loss	Nature-based infrastructure for water basin detention, retention and flood passages	- Creation of green buffers and flood detention areas (Kang et al., 2009; Sayers et al., 2013; Wingfield et al., 2019) - Creation and preservation of wetlands, lakes, and green-blue corridors (Kang et al., 2009; Sayers et al., 2013; Wingfield et al., 2019) - Waterways and channels de-culverting, greening and improvement (Kang et al., 2009; Wingfield et al., 2019) - SuDS/Low impact development measures (rain gardens, permeable paving, green roofs) (Wingfield et al., 2019)
d. Preparation	Organising effective reactions in flood events	Evacuation plans; safe havens arrangement; building controls	- Road networks optimization (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)
e. 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)

founded during this decade.[1] The early 2010s is the period before the launch of the *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).[2] The findings offer references for the ongoing policy transformation in *Sponge City Plan*. Fig. 1 shows the location of Guangzhou in the Pearl River Delta.

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 A *Interviews' logbook* and Table B *List of questions* in the Appendix). 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 1 presents an overarching categorisation of policy measures for spatial planning to handle flood risk based on the 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 to altering structural infrastructures physically by designing multi-purpose engineering solutions (defence), nature-based solutions (mitigation), and reconstruction in a post-recovery plan (recovery).

Coded data is used to explore the divergences in policy discourse. A shared understanding of policy measures for planning to deal with flooding over time represents the 'continuity' of planning norms and routines. It indicates a path dependence trajectory which creates inertia to change (i.e., stickiness of the established planning system). By contrast, contradictions between planning documents in the face of the flood risk provide windows of opportunity for changes and discontinuities in planning traditions or, in other words, divergences at 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 database in relation to the urban development processes and infrastructure construction.

[1] 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, Guangzhou Urban Construction Archive, and Guangzhou Institute of Architects, 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 latter shouldered broad duties including land-use planning, urban infrastructure construction and maintenance, illegal houses demolition, and land and buildings surveying (Guangzhou Urban Planning Bureau, Guangzhou Urban Construction Archive, and Guangzhou Institute of Architects, 2012, p. 22), which made a start toward a more professionalised planning system.

[2] 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.

Table 2
Diversity of measures in relation to flood risk in Guangzhou major planning documents.
Source: Authors, based on (Guangzhou Public Works Bureau, 1930; Guangzhou Urban Planning and Development Review Committee, 2005; Guangzhou Government, 2000; Guangzhou Government, 2005; Guangzhou Government, 2016).

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

[a] 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.
[b] The contents are comparable to the court-part in the Sponge City Programme, which calls for an emphasis on nature-based solutions to deal with the flood risk in addition to traditional engineering measures.

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.

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 disrupting of path dependence (Simmie, 2012). Underlying factors can include new ideologies, innovative technologies and crises (Collier & 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 paper 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) (Garrelts & Lange, 2011; Harries & Penning-Rowsell, 2011; Parsons et al., 2019), institutional environment (e.g. new organisations, legislative supports, the inclusion of new knowledge) (Garrelts & Lange, 2011; Parsons et al., 2019), and natural hazards (flood events, as a reflection of hazards or crises) (Johnson et al., 2005; Penning-Rowsell et al., 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 A *Interviews' logbook* and Table B *List of questions* in the Appendix). Historical maps were used as a supplementary form of evidence.

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.

3.1. Identifying policy changes of the types of measures to deal with floods in spatial planning discourse

Table 2 summarises the measures stated in the major spatial planning documents from 1930 to 2016 to 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. The 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 is limited attachment to 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

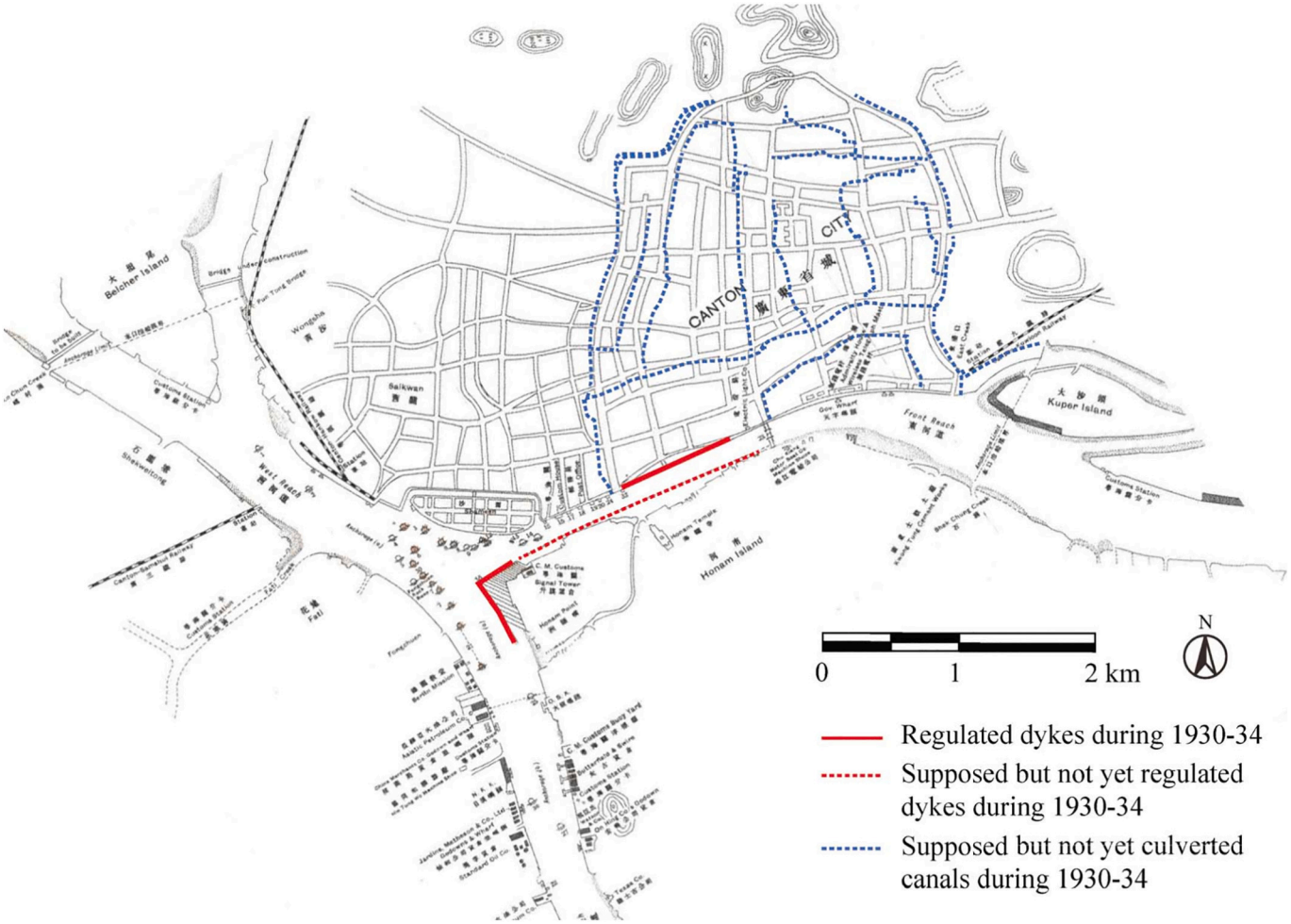

Fig. 2. The adopted measures to deal with flood risk at a municipal level during 1930–34.

on the planning system ever since.[3] 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.

3.2. Mapping the implementation of the divergences 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 of 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.[4] In fact, Guangzhou did not return to a stable political situation and a path toward 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 (Fig. 3 in Section 4.2) in the scope of the old city centre (in agreement with the coverage of the 1984 map), while the dykes beyond the centre were not shown in the investigation due to limited information available to the public.

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 to 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

[3] Even so, this document was originally designed as a guideline for short-term development (1930 to 1933) (Guangzhou Urban Planning Bureau, Guangzhou Urban Construction Archive, and Guangzhou Institute of Architects, 2012, p. 37).

[4] 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).

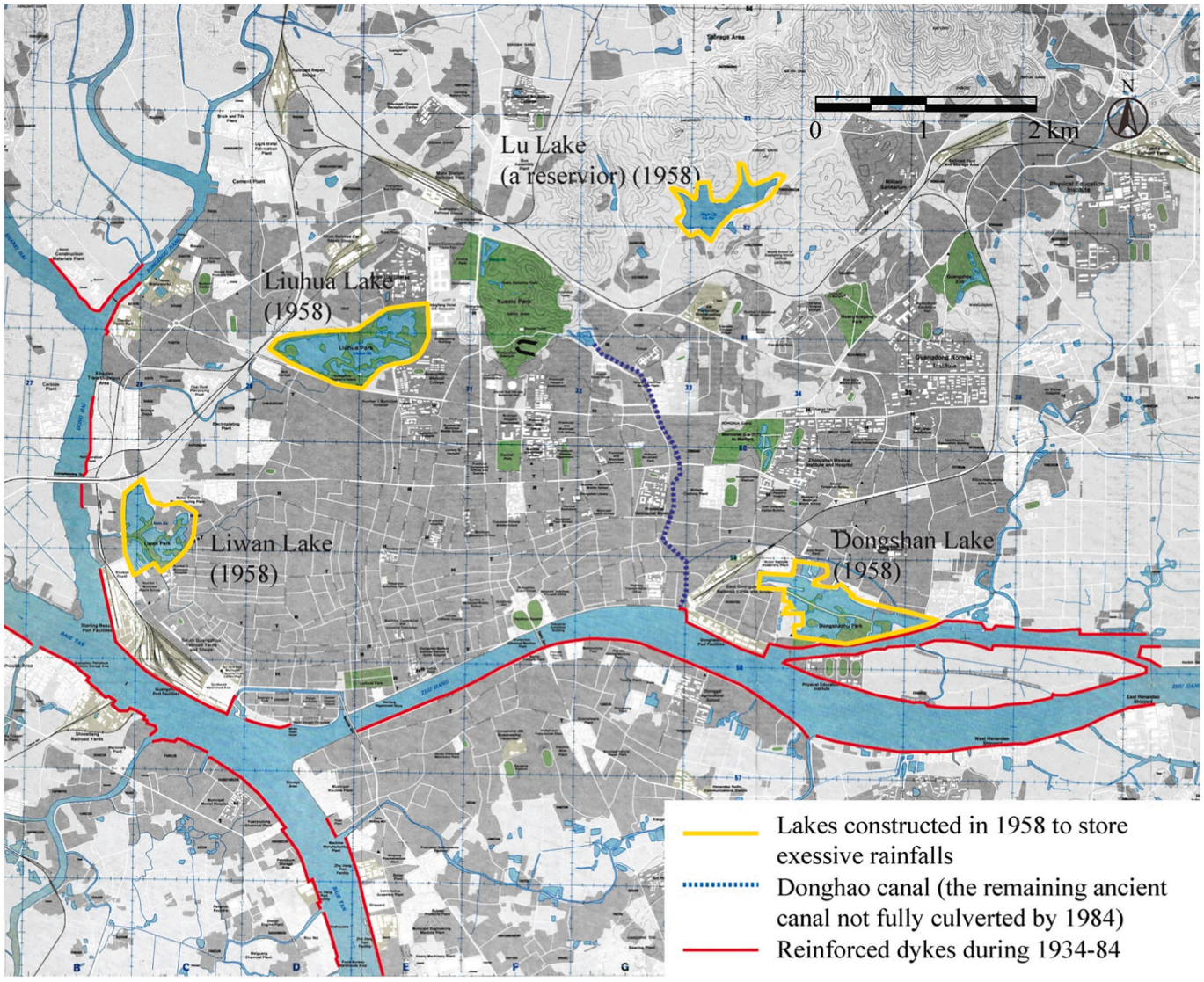

Fig. 3. The adopted measures to deal with flood risk at the municipal level during 1934–84.

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 (Fig. 2).

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 km of all inner-city canals had been culverted by 1949 (Guangzhou Urban Planning Bureau, Guangzhou Urban Construction Archive, and Guangzhou Institute of Architects, 2012).

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 related to shipping lines 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. Fig. 3 indicated the locations of the 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. Fig. 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 Digital Library, 2008; Guangzhou Urban Planning and Development Review

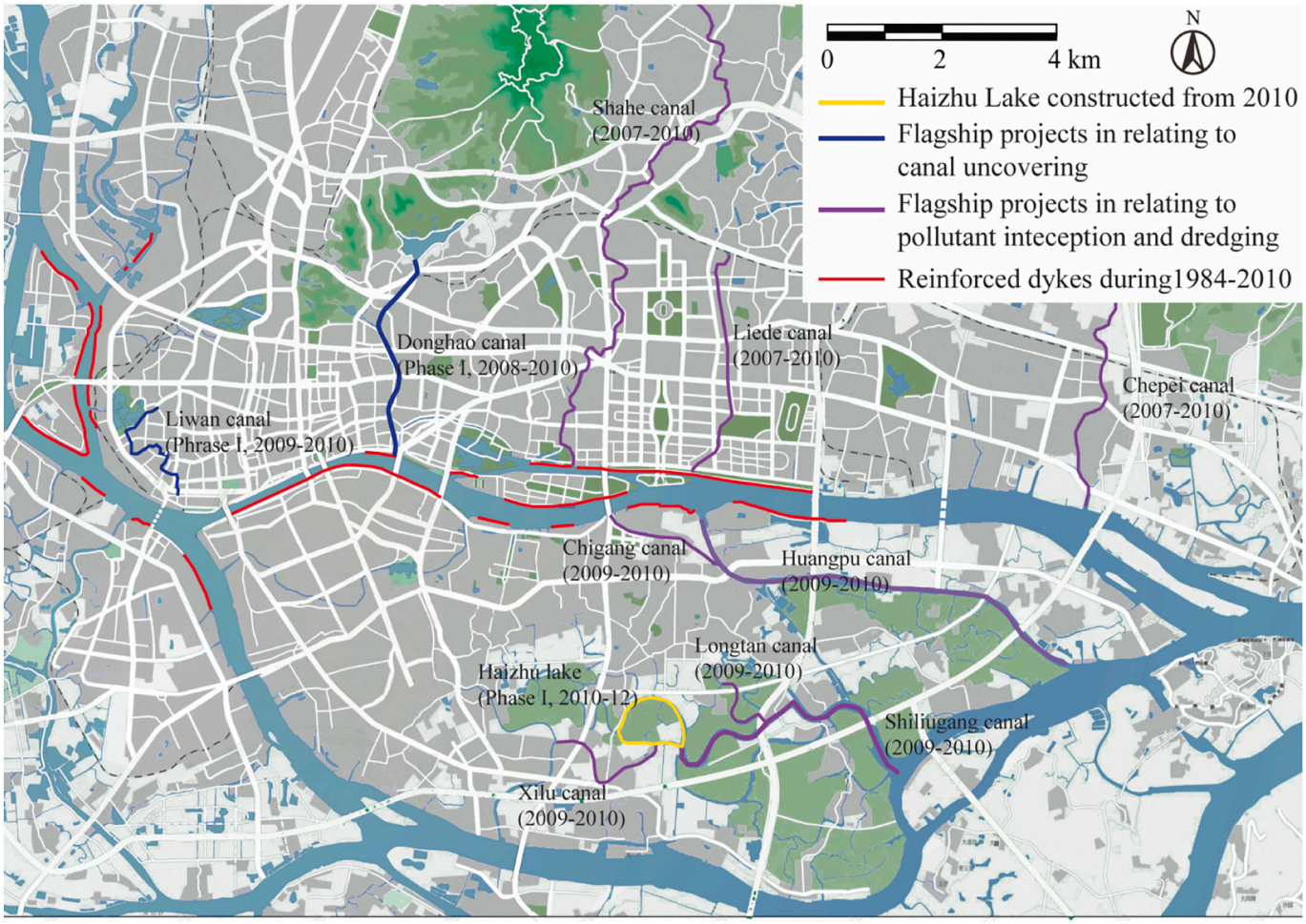

Fig. 4. The adopted measures to deal with flood risk in the Guangzhou city centre during 1984–2010.

Fig. 5. Donghao Canal renovation.

Fig. 6. New town construction based on Haizhu Lake.

Committee, 2005).[5] 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.

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

[5] The artificial lakes are Liuhua (1958), Liwan (1958), Dongshan (1958) and Lu (1958), all of which were located in or near the built areas (Fig. 3).

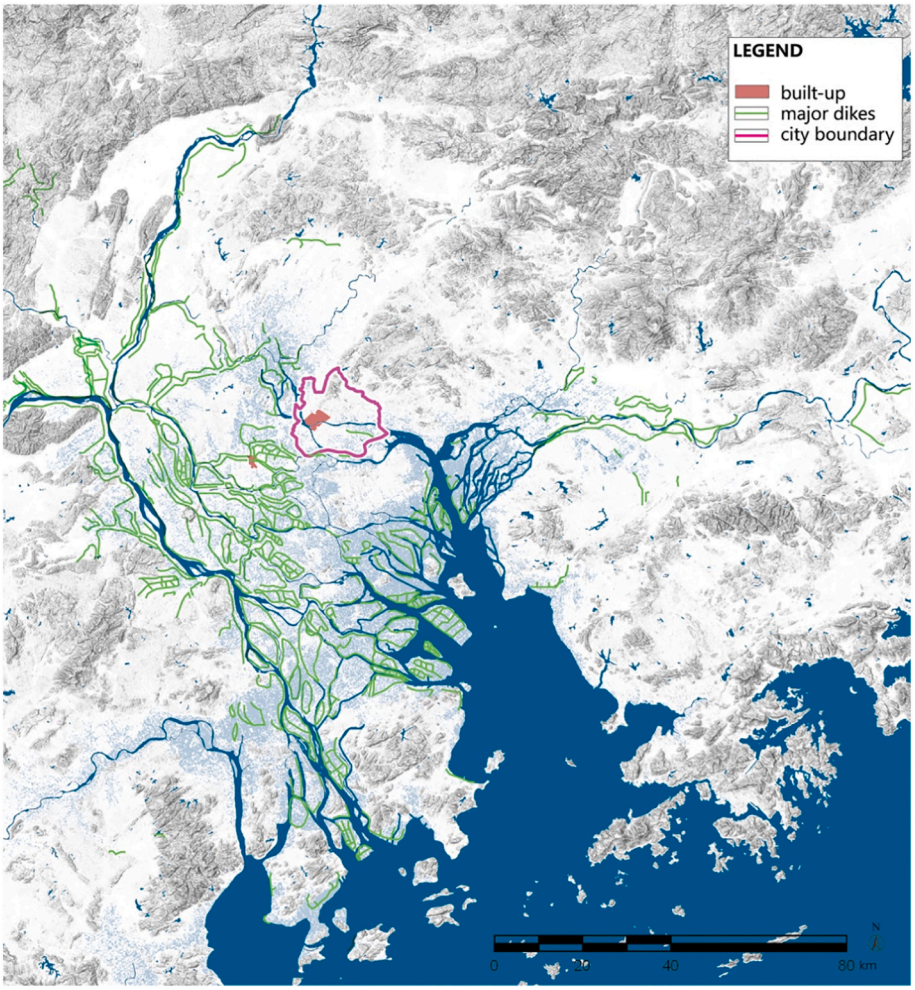

Fig. 7. Guangzhou city and Pearl River Delta by the late 1930s.

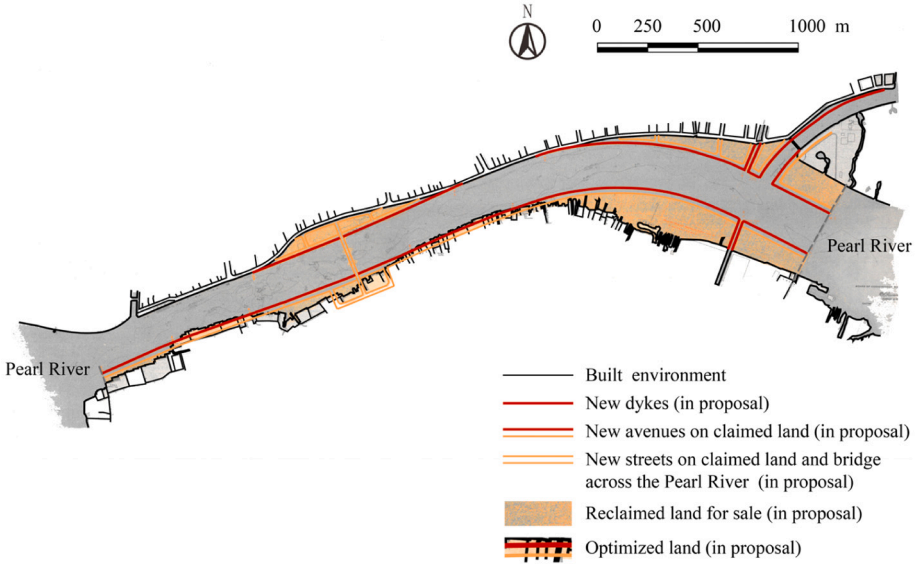

Fig. 8. Project for Improvement of the Front Reach (Partly), Guangzhou (Canton).

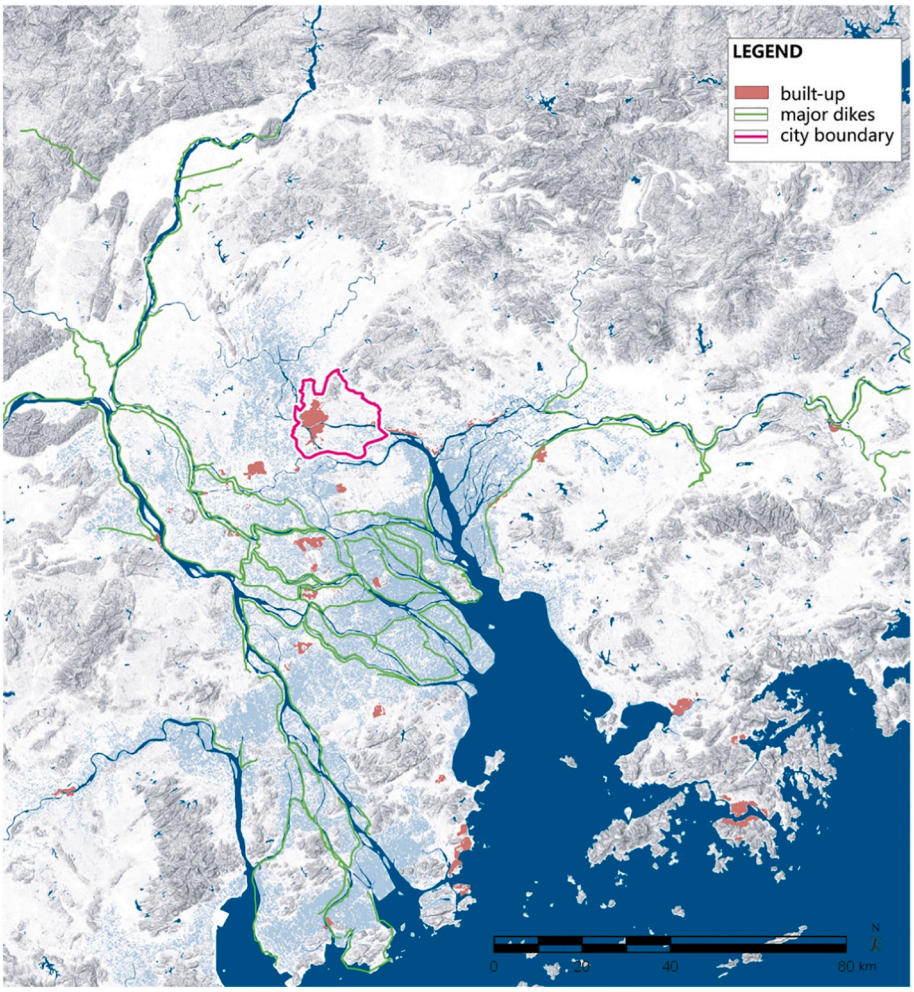

Fig. 9. Guangzhou city and Pearl River Delta by the early 1980s.

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 Fig. 4). Canal uncovering projects were also launched, including the Liwan Canal Renovation (Phrase I, 2009–2010) and Donghao Canal Renovation (Phase I, 2008–2010)[6] (see Figs. 4 and 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) (Fig. 6) and Baiyun Lake (reservoir) (2006–2011), which were later transformed into public parks. These two cases contributed to an increasing recognition to use the natural landscape to address urban pluvial floods.

[6] Some interviewees argued that the Donghao Canal project primarily focuses on engineering solutions rather than nature-based solutions, since the renovation of the sewage and stormwater infrastructure and the greening of the canal were led by the Municipal Water Affair Bureau (interview 3 and 4). Developing the project, the Bureau placed more emphasis on the benefits of engineering measures while the greening measures (i.e. nature-based solutions) were presented as an added benefit. Planning agencies during this project played a role in land acquisition and land use adjustment, not directly to the abovementioned flood resilience measures.

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.

4.1. 1930: development benefits relating to flood affairs, strong planning, and fluvial floods

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 (Fig. 7). 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 local government's ambitions from the 1920s to 1930s and drew attention to developments along riverside areas and shipping routes.

At the regional level, Guangdong River Control Affairs Department (regional sector) formulated the *Pearl River Shipping Line 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 Fig. 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 lines contained in the *Guangzhou Public Works and Implementation Plan.*

At the municipal level, 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.

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 preferred 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).

4.1.2. Institutional environment

A (modernised) regional flood risk management agency was established as early as 1914 and stayed in place (albeit with several institutional changes) (Wang & Sunny, 2011). Between 1914 and 1929, the institution in charge was Guangdong River Control Affairs Department, which was later renamed as 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) (Guangdong Local Chronicle Compilation Committee, 1995; Guangzhou Water Archives Committee, 1991). 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 the 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 constructing 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.

4.1.3. 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 D *Major flood records* in the Appendix). This event was caused by long-lasting storms and collapses in dyke systems along the West, North, and East rivers. More than 1200 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.

4.2. 1954–1977: a turmoil context, weak planning vs rising water management, and multiple flood threats

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 (Fig. 9), which involved construction during the periods 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.

The improvement of hydrological infrastructure at the regional level did not bring tangible impacts for urban areas (Fig. 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), Vietnam War (1955–1975), Great Leap Forward (1958–1960) and Cultural Revolution (1966–1976). This tumultuous period led to an unstable socio-economic environment at the municipal level and a passive national aspiration for urban development in Guangzhou (Guangzhou Urban Planning and Development Review Committee, 2005, p. 124). Consequently, most large-scale construction projects at the municipal level ceased.

In such a context, only minor projects were implemented as a trade-off to resolve urban problems in an incremental way. Culverting existing

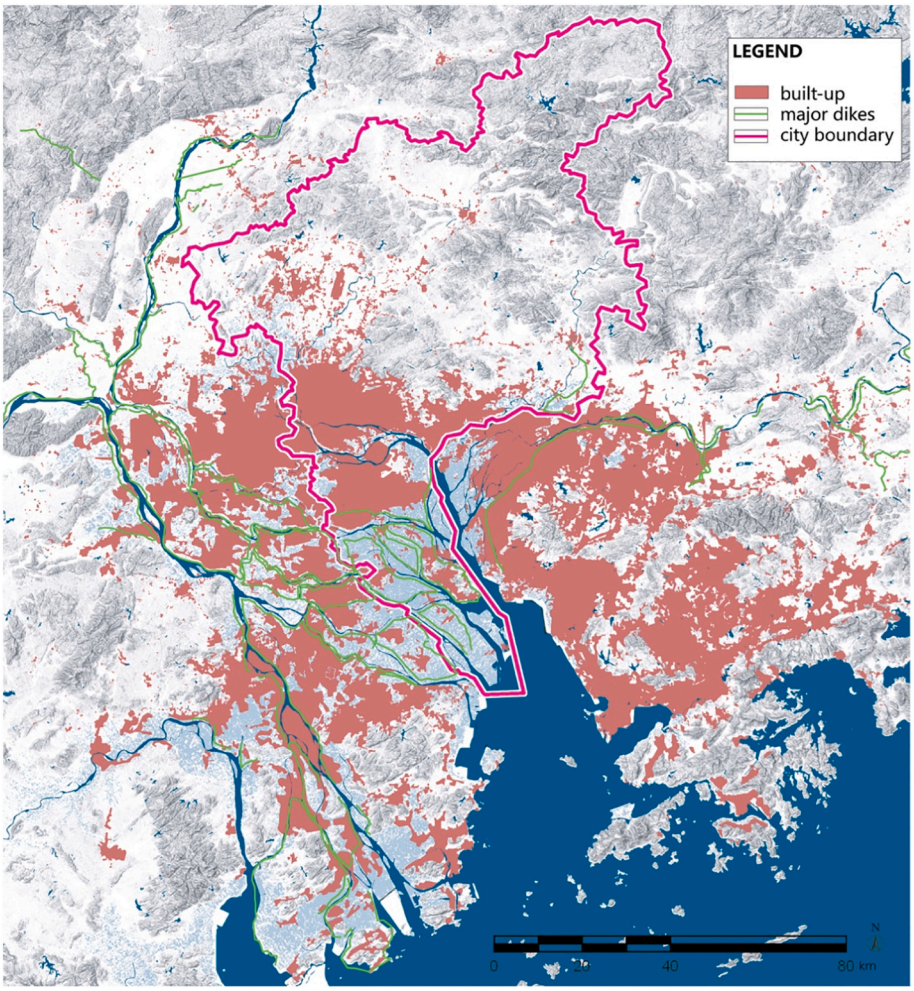

Fig. 10. Guangzhou city and Pearl River Delta by the early 2010s.

canals and transforming low-lands into artificial lakes avoided larger investments in flood mitigation by using the existing infrastructure and physical features. They also offered benefits for social well-being and the housing market by covering polluted and insanitary canals and providing land for new lakeside houses (Guangzhou Urban Planning and Development Review Committee, 2005; Southern Metropolis Daily (2002-12-9), 2009).

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 the 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 C *Shift contents of Guangzhou master plans* in the Appendix).

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.[7] 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). Yet for all that, their work was 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.

[7] 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).

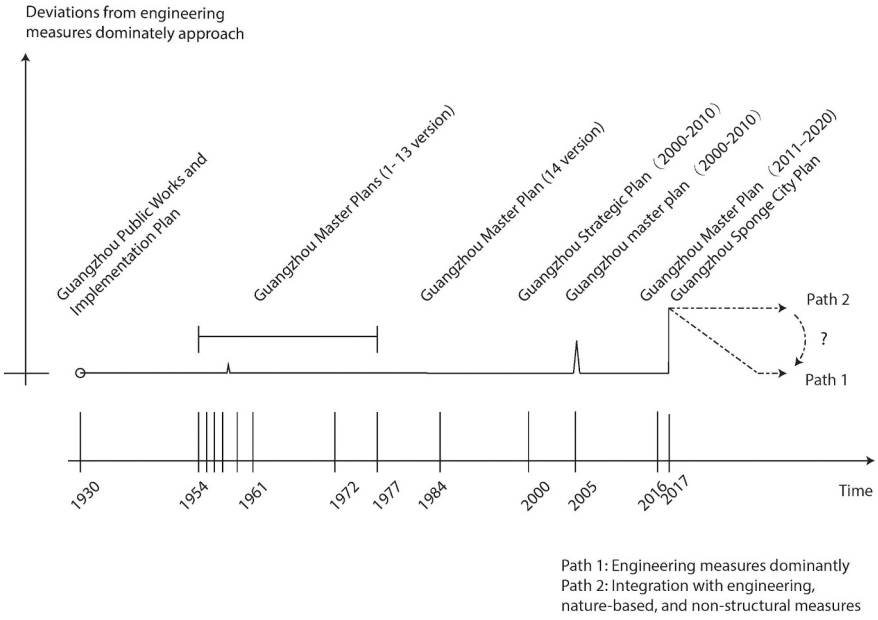

Fig. 11. The path of Guangzhou's planning system in dealing with flood issues.

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 the 1960s, and one in the 1970s (see Table D *Major flood records* in the Appendix). 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.

4.3. *2005: development benefits relating to flood affairs, subordinated planning, and multiple flood threats*

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 (Fig. 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, 2005). 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 & Yuan, 2010). These measures matched with 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 et al., 2014).

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 the 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 on 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 interviewees 5 and 7 stressed. The design and planning of Haizhu Lake were initially led by the municipal and district water affairs bureaus with much hydrological knowledge. 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 the notion of 'Water Affairs Integration Management' was accompanied by the marginalisation of spatial

Table 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 followering 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
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; Functional division led to the marginalisation of planning authorities and a rise of water affairs institutions	N/A

F: Facilitators, O: Obstacles, N/A: Not applicable or no discussed in this paper.
Source: Authors (own elaboration).

planning in flood governance. Based on an integrated and comprehensive approach to addressing all water-related issues, the notion was officially adopted in Guangzhou in 2008 (Zhang, 2013, p. 25–26), after which time the Municipal Water Affairs Bureau was reorganised and strengthened. Among other things, this reorganisation resulted in skilled workers being moved to the Municipal Water Affairs Bureau from the *Guangzhou Public Facility and Greening Bureau*, the *Guangzhou Development and Reform Commission*, the *GZ Patriotic Public Health Committee*, and the GZ *Construction Committee* in 2009 (Zhang, 2013, p. 24). As a result, the Water Affairs Bureau's geographical scope and operational responsibilities were expanded. It was no longer only responsible for rural areas but also for urban areas as well (Zhang, 2013). Moreover, the Bureau gained operational responsibilities for water supply, flood drainage, water treatment, and canal management (Meng, 2021). By contrast, spatial planning lost organisational resources, skilled personnel and powers in the arena of flood affairs.

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 D *Major flood records* in the Appendix). This correspondence indicates that the occurrence of flood events might be one of the factors to explain policy changes in 2005.

5. Discussion

5.1. The mechanism of institutional inertia

The continuity of engineering measures in Guangzhou's planning system echoes the aspects of path dependence theory in historical institutionalism: The stickiness to established practices and preferences is powerful and difficult to create deviation, even though alternatives such as nature-based measures and non-structural measures offer advantages. 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).

The historical accounts help to illustrate two potential factors which underlie the mechanism of path dependence: continuous benefits from engineering measures and the weak position of spatial planning in flood governance. Sections 3 and 4 present the stabilities and substantive changes in policy from 1930 to 2016 which have taken place at the national, regional and municipal level. Engineering approaches dominated these policies, which primarily highlighted benefits for the shipping industry, safety, housing, sanitation and urban expansion. As such, engineering approaches were well-established in policy and practice. By contrast, non-engineering measures were not believed to be involved with consistent benefits and returns. They only appeared occasionally during a crisis or a temporary situation, for instance, in the case of the Asian Games when the approaches were introduced to promote urban attractiveness. As a result, they were much less established in policy and practice.

Institutional transitions from the 1930s to 2000s reveal that the previously leading role of spatial planning in flood affairs gradually faded in the context of specialisation and functional division. Events in the 1950s, 1960s and 1970s created turmoil in planning which was quite different from previous decades. The capacity and desire of the planning sector in managing urban development and built environment was severely impaired during this time. What was more, the water sectors became more professionalised almost in the same period and started to capture a large share of flood governance. By the 2000s, the water sectors were in the lead of flood governance while planning institutions were much less influential due to a lack of resources, knowledge and powers. Consequently, the original flood management coalition led to a new order, which impaired the participation of planning in return. In this context, planning institutions could not easily deviate from the path-dependent approach. They had few resources to help them to do so. The stickiness of existing approaches can be regarded as either a passive choice with a weak capacity to make a dramatic change in the new institutional order or a more reasonable proactive choice leaving long-term responsibility to water sectors.

5.2. The potential clash with the ongoing policy divergence

This paper also provides clues for policymakers and practitioners from Guangzhou in the future that implementing the ongoing *Sponge City Plan* is challenging. Fig. 11 presents a path-dependent route and indicates this difficulty. The *Guangzhou Public Works and Implementation Plan* in 1930 initiated a preference to engineering measures in planning policy. This preference was followed by many subsequent master plans and passed to the recent *Guangzhou Master Plan (2011–2020)* launched in 2016. Between the 1950s and the 1970s, there was a critical juncture that involved the deviations by using nature-based solutions to deal with pluvial flooding. However, there was little constancy in planning discourse: it was in almost constant flux. Another critical juncture was 2005 when a divergence was shown in the *Guangzhou masterplan (2000–2010)* calling for nature-based and non-structural measures for flood resilience. Nevertheless, these measures were not supported over the long term in planning and policy documents. In the latest 2016 Guangzhou *Masterplan*, the measures to deal with flooding returned to only engineering solutions. Against this route, although the Sponge City *Plan* was designed to promote divergence from the dominant engineering-based approach and to encourage the new measures (e.g. nature-based measures and non-structural regulations) for flood resilience, planning traditions posed a significant barrier to change. The future is unconfirmed, which needs further observations.

5.3. Ways to initiate policy changes and overcome inertia

The history and particular critical junctures of Guangzhou define the extent to which innovations and deviations have taken place over time. Table 3 helps to illustrate why some reforms were successfully embedded in practice and why others were introduced but did not continue. It indicates that it was easier to shape new proposals to address flood risk in planning documents if the proposals 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 the 1954–1977 period), or merely a commitment in policy discourses (as was the case in 2005). These findings are consistent with other studies which argue 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).

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 (national, regional and municipal levels) benefits they 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 quality and attract real estate investment locally (municipal benefits) and also enhanced the international image of the city in the wake of the Asian Games (national benefits). Likewise, minor changes occurred at the municipal level from the 1950s to the 1970s with a few nature-based projects. They are trade-offs between a conservative vision at the national level and a desire for the urban development at the municipal level in the context of domestic and international political and military tensions at the time. The new era created by the *Sponge City Plan* can draw on past lessons and find a way to address multiple socio-economic demands.

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. This transformative political status in flood governance partly explains the tension in the contribution of spatial planning to flood affairs, which continues to weigh on the current efforts to promote the *Sponge City Plan* at the municipal level.

Importantly, the occurrence of natural hazards was not a necessary factor for policy change to happen. The occurrence of natural hazards is not always associated with new measures. This observation is not consistent with other research (e.g. Wiering, 2008), which regards hazard events as a trigger for policy changes. 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. The case in 2005 was different as planning discourse was closely related to recent flood events in terms of pluvial, fluvial, and coastal floods. 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. Clearly, this research cannot exclude the fact that other factors, beyond the socio-economic context, institutional environment, and natural hazards, also play a role as facilitators in overcoming path dependence. Here come with more research opportunities.

6. Conclusion

This study has scrutinised the long-term development of a policy domain, namely, the role of spatial planning in flood governance in Guangzhou. Based on historical analysis, we reveal the continuous and discontinuous measures adopted by planning for flood resilience, shed light on the institutional inertia of the local planning system in flood affairs, and figure out the critical junctures with changes and the factors affecting path divergence.

The analysis has shown that the measures for flood resilience in Guangzhou's planning documents are not unchangeable. In most cases, it relied on engineering measures for flood defence and flood mitigation. However, there have been some critical junctures when innovative measures like nature-based solutions and non-structural regulations for flood mitigation appeared. This dominance of the engineering approach began in the 1930s, and was reflected in planning documents almost continuously up to the present. This created institutional inertia, where the engineering approach was so strongly and deeply embedded in the planning system that change was increasingly difficult. The innovative attempts, from 1954 to 1977 and in 2005, appear to be disturbances, which failed to mainstream new notions or practices. The strength of flood management measures with the needs of the socio-economic context and the relationship between planning authorities and water management actors partly explained the difficulties in embedding these deviations in planning discourse and practice.

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

Theoretically, this research contributes to the literature by, firstly, offering an overview of how planning can act upon flood affairs through avoidance, defence, mitigation, preparation and evacuation (Section 2.1), 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 furthers the research on historical institutionalism by exploring the role of the socio-economic context, institutional environment, and natural hazards (disaster events) in path divergence at critical junctures.

While the above findings are context-specific, the methods and theories used in this paper 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 that can facilitate new ideas, concepts, and policies.

CRediT authorship contribution statement

Meng Meng: Conceptualization, Methodology, Resources, Data curation, Investigation, Visualization, Formal analysis, Writing – original draft, Validation, Funding acquisition. **Marcin Dąbrowski:** Supervision, Writing – review & editing. **Liang Xiong:** Visualization. **Dominic Stead:** Supervision, Writing – review & editing.

Declaration of competing interest

None.

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Appendix A. Supplementary data

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