Decoding Sponge City in Shenzhen: Resilience Program or Growth Policy?

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ABSTRACT

Unprecedented urbanization in China, combined with the increase of extreme weather events globally, has led to greater vulnerability of Chinese cities to urban water management issues including non-point source pollution, shortage of fresh water and urban floodings. In response to these problems, a national policy named “Sponge City” was first introduced in early 2014 to form a comprehensive alternative. Since then, two major views of its conceptualization have defined “Sponge City” as (1) a distributed resilience program modeled after Low Impact Development (LID) and Green Infrastructure (GI), and (2) a growth policy justifying the new investment in urban construction sector and the experimental field of financial innovation to involve private investment such as Public-Private Partnerships (PPP). However, a central contradiction has been widely observed in practice as the environmental and economic agendas of “Sponge City” are not always compatible with each other.

This thesis examines the phenomenon where local governments, in the face of such dilemmas, have tended to skew “Sponge City” towards pro-growth policies by branding “Sponge New Districts” in urban outskirts, and asks why and how local governments use “Sponge New District” as a potential resolution. This thesis studies the case of Guangming New District in Shenzhen, Guangdong Province and argues two rationales exist behind this strategy. First, the development of such “Sponge New Districts” provides local government with more opportunities for private investors to profit from basic urban infrastructure projects such as roads and amenities. Second, such development justifies the direct intervention of the government in financing and construction by aligning Sponge New Districts with the local expansion agenda. Nonetheless, these “Sponge New Districts” divert the original environmental ideology of Sponge City and suggest that a fundamental gap exists between an idealized resilience program and the execution of pro-growth agendas at the local governmental level in contemporary China.

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CHAPTER 1. INTRODUCTION

1.1 Background and Significance of “Sponge City” Research

China’s rapid urbanization in the past decades has led to growing demands on natural resources and relative deficiency in infrastructures. Consequently, the concentration of population and economic activities in urban areas causes the deterioration of the urban water eco-system, non-point source pollution and shortage of fresh water across the country. At the same time, the increase of extreme weather events globally contributes to the higher potential economic losses, especially in Southern China. The more developed, coastal cities of this region are suffering from more heavy rains, typhoons, storm surges and urban floodings.

In response to these urban water emergencies, a national policy named “Sponge City” was officially introduced in 2014 in seek of an alternative solution in urban water management. The ambitious policy plans to improve the situation by retrofitting 20% of all built-up areas in Chinese cities by 2020, 80% by 2030 (State Council, 2015), which requires about 3 trillion RMB ($435.6 billion) investment in the following 5 years (Sinolink Securities, 2015). The strong determination from the state level triggers heated debate on the best practice of “Sponge City”. To date, two major discourses in its conceptualization can be generalized: on one hand, “Sponge
City” is primarily designed to be a distributed resilience program modeled after Low Impact Development (LID) and Green Infrastructure (GI), which aims at maintaining post-development hydrology of a site close to the natural condition before development occurs; on the other hand, “Sponge City” serves as a growth policy justifying the new investment in urban construction sector and the experimental field of financial innovation such as Public-Private Partnerships (PPP) to involve private investment. The goal is to stimulate the next round of urban growth without piling up local government debt, since the land value-centered real estate development has slowed down in the recent years.

However, the environmental and economic objectives of “Sponge City” policy are often seen to contradict each other, since retrofitting dense urban areas with alternative water management infrastructures requires gradual investment over a long period before maturity; this induces higher costs in operation and maintenance, as well as generates little economic return in most cases. Therefore, “Sponge City” projects remain largely unattractive to private investors, and face great difficulty to meet their environmental and economic objectives simultaneously. To better understand the conflict of the duality embedded in the program design of “Sponge City”, and especially the resolution thereof for this newly introduced policy and a contested arena in both academia and industry, a closer examination at certain cases at local level is necessary.
1.2 Research Question

Based on the duality in “Sponge City” policy and its inherent contradictions revealed by literature reviews, the thesis examines the phenomenon of “Sponge New District”, where large scale new cities geographically separated from existing urban centers are developed according to Sponge City guidelines. The thesis asks why and how local governments use “Sponge New District” in urban outskirts as a resolution to the conflicts between the environmental and economic purposes of “Sponge City” policy.

Drawing from interviews and the case of Guangming, in Shenzhen, Guangdong Province, the thesis studies two rationales behind the “Sponge New District” strategy, which are (a) spatial flexibility, i.e. more development opportunities to convince private investors to contribute in exchange for prospective growth of land value, while also ensuring the environmental outcome by making “Sponge New District Plan” under the Technical Guideline for Sponge City Construction\(^1\) without being constrained by existing urban areas; (b) political leeway, i.e. the justification to take the initiative in incorporating Sponge City into the local urban expansion agenda via land leasing processes, and to directly use governmental funding in financing the construction of Sponge City in shortage of private capital.

The thesis also develops a critique by arguing that “Sponge New Districts” divert the original environmental ideology of Sponge City toward a growth policy at local level, and suggests that

\(^1\) “海绵城市建设技术指南”, Oct 2014.
a fundamental gap exists between an idealized resilience program and the execution of pro-
growth agendas at local government level in contemporary China.

1.3 Outline of Thesis

Following the introductory Chapter 1 on research background and framing, the next chapter elaborates the literature about the context from which “Sponge City” as a public policy was developed. The literature review focuses on the central contradictions imbedded in the program design of “Sponge City”. Chapter 3 explains the hypothesis to the research question, as well as methods adopted to collect evidences in the field. Chapter 4 synthesizes the consents and disagreements of multiple interviewees on implementation of Sponge City in China. It also details the case study of Guangming New District in Shenzhen, Guangdong Province, analyzes the rationale of local government in Shenzhen to construct and brand “Sponge New District”, and critiques the potential compromise in the environmental purpose of such strategies. Chapter 5 revisits the research questions and concludes with further implications of the study.
CHAPTER 2. LITERATURE REVIEW

2.1 Increasing Environmental Risks in Chinese Cities

The rapid urbanization of China for decades has led to phenomenal concentration of population and economic activities, with growing demands in natural resources and relative deficiency in sewage infrastructures. As a result, Chinese cities are suffering from increasing risks associated with water related issues including non-point source pollution, the shortage of fresh water resources and the deterioration of urban water eco-system.

In addition, climate change has increased the vulnerabilities of Chinese cities to extreme weather events such as droughts, typhoons, storm surges, heavy rains and urban floodings. The fourth assessment report of Intergovernmental Panel on Climate Change (IPCC) stated extreme weather such as heavy precipitation, damaging cyclones and sea level rise are increasing in Eastern Asia in the recent years despite a fall of the average level (IPCC, 2014). In November 2015, Ministry of Science and Technology of China issued The Third National Assessment Report of Climate Change which acknowledged that temperature will continue to increase in the region, causing projected precipitation increases of 2%-5% till the end of this century, with
increasing extreme climate events such as intense rainfall, thunderstorms, droughts, flooding and sea level rise (Ministry of Science and Technology of China, 2015).

Among these natural disasters, urban flooding has become a serious and prevalent issue in recent years as it often leads to the paralysis of the entire city. According to the statistics by China’s Ministry of Housing and Urban-Rural Development (MOHURD), 360 Chinese cities have suffered from flooding in the past 8 years, and 1/6 of flooding events are over 12 hours in duration and 500 millimeters in depth (Wu et al. 2016). On the other hand, geographical distribution of intensive precipitation (Figure 1) is largely overlapped with the more developed areas in southeastern coastal areas and in regions south of Yangtze River (Figure 2 and 3).

![Precipitation distribution in China in 2010 (mm)](image)

**Figure 1. Precipitation Distribution in China in 2010 (mm)**

Source: 2010 Annual Report of Minister of Environmental Protection
Figure 2. Population Distribution in China. It shows the concentration around the Pearl River Delta.

Source: Fifth National Population Census of China 2000 and SEDA GPW database. Created by Benjamin D. Henning, University of Sheffield
Figure 3. Centrality of GDP in the Provinces of China in 2008. Map shows the inequality among coastal and inland provinces in economic development.

Source: Mao et al., 2015

These two factors combined have increased the potential losses due to urban flooding and storm rain in southern China, and cities in Guangdong Province are especially vulnerable to the increasing exposure to environmental risk. In a 2013 report by Hallegatte (2013), the authors argue that the flooding risk of coastal cities has increased greatly because of growing
population and economic assets. Two cities in Guangdong Province, Guangzhou and Shenzhen rank the 1st and 9th place of all the coastal cities in terms of Annual Average Loss. In face of these risks, it has become a real concern of government policy makers, real estate developers, urban planners, researchers and the general public to enhance the cities’ ability to minimize economic and social disruptions during these extreme flooding events.

2.2 History of Conceptualizing “Sponge City”

Despite the huge amount of investment in traditional grey infrastructure such as pipeline and river reclamation, the number of Chinese cities affected by floods has more than doubled since 2008 (The Economist, 2015), which leads policymakers and urban planning professionals to think about other alternatives. Since early 2000s, a series of researches have been focused on the concept of aquatic ecosystem as an approach to better understand the role of natural water body in urban water management, and reflected on the negative ecological effects of conventional water infrastructures (Pu, 2001; Wang, 2003; Feng, 2002). These researches have been echoed by emerging landscape architecture practices in China at the same period, which emphasizes the ecological services provided by natural ecosystem to urban habitats. As a generalization of such practices, Yu and Li (2003) first made the connection, in the figurative sense, between “sponge” and the capacities of natural water systems to prevent flooding. From then on, the idea of “sponge-like city” as an alternative way to conventional urban water management has primarily been a concept discussed by planning and design professionals. With the increasing
frequency of urban flooding and other urban water hazards, “sponge-like city” was also incorporated into the urban planning practices in cities including Beijing, Xiamen and Chongqing (Liu, 2012; Liao 2012; Tan & Yi, 2013).

“Sponge-like city” was put under the spotlight of national politics after an exceptional storm rain hit Beijing in July 2012, claiming 79 lives and causing economic loss of $1.69 billion. In December 2013, “Sponge City” was officially institutionalized by the central government and first came into the public realm as a national policy, when President Xi Jinping appealed for cities functioning “like sponges” during a high-ranking conference on Chinese urban development (Table 1). It was quickly followed by a series of policies from mainly Ministry of Housing and Urban-Rural Development (MOHURD), Ministry of Finance (MOF) and Ministry of Water Resources (MOWR) branches (Table 1), and a boost of relevant discussions in urban planning and design industry since then.

Table 1. Political Reaction after Sponge City’s Debut in Dec 2013.

<table>
<thead>
<tr>
<th>TIME</th>
<th>SOURCE</th>
<th>CONTEXT</th>
<th>QUOTES OR SUMMARY</th>
</tr>
</thead>
<tbody>
<tr>
<td>DECEMBER 2013</td>
<td>President Xi Jinping</td>
<td>Central Work Conference on Urbanization</td>
<td>“Prompt the Sponge City that can naturally restore, infiltrate, purify water…save water resources, protect and improve urban ecological environment.”</td>
</tr>
<tr>
<td>Date</td>
<td>Event</td>
<td>Details</td>
<td></td>
</tr>
<tr>
<td>------------</td>
<td>----------------------------------------------------------------------</td>
<td>----------------------------------------------------------------------------------------------------------------------------------------</td>
<td></td>
</tr>
<tr>
<td><strong>APRIL 2014</strong></td>
<td><strong>Bureau of MOHURD, 2014</strong></td>
<td>&quot;To solve the shortage of water in cities...follow the natural way and construct Sponge City that can naturally restore, infiltrate, purify water&quot;</td>
<td></td>
</tr>
</tbody>
</table>
| President  | Speech on water safety                                               | "Sponge City is a technic of urban development than can work like a sponge to adapt to environment change and natural hazard with great resilience. When it rains, Sponge City can absorb, restore, infiltrate and purify water, and when necessary, release the water for other usage."
| Xi Jinping  |                                                                        |                                                                                                                                        |
| **OCTOBER 2014** | **MOHURD**                                                           | "Sponge City is a technic of urban development than can work like a sponge to adapt to environment change and natural hazard with great resilience. When it rains, Sponge City can absorb, restore, infiltrate and purify water, and when necessary, release the water for other usage."
| Technical Guideline for Sponge City | Construction: Low Impact Development of Rainfall System |                                                                                                                                       |
| **DECEMBER 2014** | **MOF, MOHURD, MOWR**                                               | Announcement on Central Finance to Support Sponge City Pilot Project Construction
Sponge City pilot projects will be partially supported by central government’s specific fund. |
| **JANUARY 2015** | **MOF, MOHURD, MOWR**                                               | Announcement on Application of Sponge City Pilot 2015                                                                                   |
| **APRIL 2015**  | **MOHURD**                                                          | Finalists of 2015 Sponge City Pilot
16 cities of the highest rank will be listed as Sponge City pilot.                                                                 |
“Develop a scientific, comprehensive way to evaluate the construction of Sponge City.”

“Propel construction of Sponge City…the total investment of first cohort of Sponge City pilot exceed 30 Billion RMB.”

Require local governments to push forward the construction of Sponge City.

As an idea evolved mainly in Chinese context, few English academic works can be found that directly address “Sponge City” (Yu, 2016). Therefore, this chapter will rely mostly on the first-hand material of policy documents, technical guidelines, speeches of officials, and news stories along with Chinese journal articles to define the key concepts in conceptualization of Sponge City as a national policy. Two major streams observed in the policy design of Sponge City, as will be discussed in the following sections, are a) a resilient program to support sustainable urban development and b) a growth policy to stimulate investment in construction using innovative financial vehicles.
2.3 “Sponge City” as a Resilience Program

From a theoretical point of view, “Sponge City” as a national policy has directly borrowed idea from the existing concepts of Low Impact Development. In the article of Qiu (2015), the former Vice Minister of MOHURD considers Sponge City as “the Chinese version of Low Impact Development”, and it is crucial to localize LID in order to deal with the reality that China is urbanizing 10 million people every year, which brings huge pressure on the current water management systems. As a matter of fact, as early as 2000s, LID techniques were used in the development of some residential neighborhoods in Beijing. This reference was officially confirmed by the Technical Guideline for Sponge City Construction by Ministry of Housing and Urban-Rural Development (MOHURD), with a subtitle of “Low Impact Development of Rainfall System”.

Being a significant component of the Sponge City ideology, Low Impact Development (LID) contributes to the national program the basic principle of maintaining post-development hydrology of a site close to the natural condition before development (Ahiablame et al., 2012). Like LID, Sponge City is proposed as an alternative approach for controlling storm water through the use of decentralized designs (Damodaram et al., 2010), where rainfall is collected, stored and purified at the source as opposed to conventional gray infrastructure. Most of the specific techniques indicated in the national guideline of Sponge City are also features of LID approaches, including permeable pavements, rainwater harvesting, roof gardens, infiltration swales, bio-retention areas, etc. However, LID is considered to be more focused on detailed design at the scale of individual lot, where improvements are expected as a cumulative impact
throughout the entire development period (Davis, 2005). In comparison, the current practices of Sponge City in China emphasize more on the planning of ecological infrastructure and clearly intervenes the urban planning process at a larger scale. In an interview of 2016, Kongjian Yu, one of the earliest advocates of “sponge-like city” and the head of a landscape architecture company named Turenscape, indicated that most of the “Sponge City” related projects his agency worked on are more than 30 hectares, i.e. 75 acres (Yu, 2016).

The large scale of Sponge City also suggests its relationship with the notion of Green Infrastructure (GI). Even though the concept of GI is interpreted differently in different contexts, it is widely accepted that GI serves as an interconnected network of green space that conserves natural ecosystem values and functions (Benedict & McMahon, 2006). With its emphasis on infrastructure, the concept of GI possesses a conscious analogy with hard infrastructures like transport networks (Thomas & Littlewood, 2010), and implies its attributes as a capital asset that requires investment and maintenance in order to deliver services (Naumann et al., 2011). Like Sponge City, GI is proposed as a product of soft governance that takes into account the economic development goal in to its agenda (Thomas & Littlewood, 2010). Nevertheless, GI is more often than not supposed to be more of a natural character, such as Tree Planning Initiative of local governments in the US (Young and McPherson, 2013); whereas Sponge City articulates its ambition in coordinating between green and gray infrastructures (MOHURD, 2014).

With commitment from government and the support of academia, the Technical Guideline for Sponge City Construction was published by Ministry of Housing and Urban-Rural
Development in October 2014, which defines Sponge City as a set of storm water management
techniques that could be applied across scales from buildings to regional landscape. At its core,
Sponge City or the “Sponge-ification” of the city is designed to absorb, store, permeate, purify,
and when necessary, release the storm water on site (Ministry of Housing and Urban-Rural
Development, 2014). The Technical Guideline conceives three major components of Sponge
City: low impact development rainwater management system; urban drainage system
(traditional gray infrastructure); exceeding runoff drainage system (natural or artificial
infrastructures) (Ministry of Housing and Urban-Rural Development, 2014.) The Technical
Guideline codifies the specific methods to carry out the idea of Sponge City in building and
neighborhood design, urban road design, green space and open spaces and urban water system
planning (ibid.), which could be applied to both newly developed area as well as dense urban
settings. While it borrows practices and aspects of LID and GI, Sponge City is also clearly
different in that it is more of a top-down, central planned program that aims at solving the
mismatch of traditional grey infrastructure and natural water bodies.

2.4 “Sponge City” as a Growth Policy

In numerous contexts, “Sponge City” is also considered by the government to be the next
opportunity in massive urban infrastructure investment. Much like real estate, “Sponge City”
development is hoped to boost construction materials productions and relevant green industry.

According to a 2015 interview of Zhenggao Chen, Minster of Housing and Urban-Rural
Development, “Sponge City” developments are helpful in “tackling potential economic recession” (Ningbo Economy, 2015). This was seconded by Weilin Zhang, Deputy Director of Urban Construction Bureau of Minister of Housing and Urban-Rural Development, that the direct financial intention of Sponge City projects is to ultimately “stabilize economic growth, optimize industry structure, promote reform, benefit livelihood” (Zhang, 2015). The ambitious national programs aim at retrofitting 20% of all built-up areas by 2020, (State Council, 2015), which requires about 3 trillion RMB ($435.6 billion) investment in the following 5 years (Sinolink Securities, 2015). This number is expected to be 80% of all built-up area by 2030, leading to an even larger amount of total investment. At national level, the Ministry of Finance promised in December 2014 to provide $148.6 million financial support to the pilot cities. However, it proves to be only a fraction of the $12.79 billion total investment required by the 16 pilot cities in the coming three years. In these pilot cities, Sponge City projects are financed at the average cost of $28.1 million per square kilometers (Liu, 2016).

It is reasonable for the government to expect proper economic return from Sponge City projects, essentially large-scale public infrastructure upgrading programs similar to transportation, communication and power generation, where increased government-led investment can greatly stimulate the growth (Eichengreen, 1995). Potential effects include directly raising productivity of other public and/or private investment, as well as indirect ways such as increasing labor productivity (Agénor & Moreno-Dodson, 2006). Strongly pushed forward by central

______________

2 Based on data released in Notice on Central Financial Support on Pilot Construction of Sponge City by the Ministry of Finance, Dec 2014.
government, municipalities across the country have strong motivation to propel the “Sponge City” campaign, especially those that are relatively left behind in infrastructure construction. In 2015 and 2016, two cohorts of pilot Sponge City, totaling 30 cities with a wide range of geographical distribution in China has been selected by the central government through an application and competition process. A 2015 research report on the 14 out of 16 first cohort of Sponge City pilots indicates that 7 (50%) of them has insufficient infrastructure system compared to its economic development level (Tan, 2016).

Nonetheless, the central government has a more cautious financial commitment in “Sponge City” projects, and turns to innovative financial vehicles, such as Public-Private Partnerships (PPP). Given the fact that land value-centered real estate development has slowed down in the recent decade, using PPP and involving private capital will help to alleviate the fiscal burden of the local governments from the long run (Zhang, 2015). In 2016, the Ministry of Housing and Urban-Rural Development and China Development Bank, the biggest policy bank in China and a major creditor in infrastructure investment, introduced the policy to offer crediting priorities to Sponge City projects using PPP. Another policy in 2014\(^3\) promised that the central government will give extra 10% financial support on top of the contractual subsidies to the pilot cities where certain amount Sponge City projects are being funded through a PPP deal.

Different from the traditional urban growth, where the government invests in grey

\(^3\) “关于中央财政支持海绵城市建设的通知”, Dec 2014.
infrastructures such as highways and bridges, “Sponge City” is expected to stimulated a new
type of development in which private investors play a bigger role.

2.5 The Contradictions within “Sponge City”

“Sponge City” as a public policy was initially designed as an ideal combination of a resilience
program and a growth policy. However, as scholars and planning professionals in China
actively seeking a more developed theory of “Sponge City” and the best way to materialize it,
the two parts of the program design are not always found to be compatible with each other.

Many findings suggest that “Sponge City” may not be, or should not be, a profitable investment
for private investors. In the US context, for instance, it usually takes more than 10 years to
collect the payback of most GI which is longer than most investors would accept (Valderrama et
al., 2013). Similarly, Chinese researches contend that the environmental requirements of Sponge
City ideology do not necessarily general immediate economic profit. Rather, it requires gradual
investments over a long period before maturity, inducing relative high cost in operation and
maintenance. Qiu (2015), the Director General of Chinese Society of Urban Studies and former
deputy minister of MOHURD, defines Sponge City as the new relationship of complying to and
cooperating with, rather than conquering or profiting from the aquatic environment and the
nature in general. Hu (2015) has also argued that Sponge City should avoid simply installing
permeable pavement and roof-top vegetation, but should adopt a multi-layer engineering
system including surface runoff control, retention ponds, reuse of precipitation and runoff, as
well as the gradual upgrade of traditional grey infrastructure. Yu defined Sponge City as more of “new philosophy of dealing with water” rather than “piecemeal, manmade engineering projects” (O’Meara, 2015), vocally arguing against the expectation of immediate economic gain from Sponge City projects (Yu, 2016). Professor Wu Che of Beijing University of Civil Engineering and Architecture argues that Sponge City techniques are effective as one type of Green Infrastructure, but require more rigorous study through longer period of time, and should focus more investment on continuous maintenance, thus private capital should only expect “moderate” return in a relatively long period (Che, 2016).

These features, in practice, force local governments to step in and finance the bigger half of the “Sponge City” projects. With a total plan of 435 square kilometers in a 3-year investment horizon, the overall investment for the 16 pilot cities in 2015 amount to 86.5 billion RMB, most of which come from the direct municipality investment, or credit loan from policy banks such as China Development Bank and Agricultural Development Bank of China (Liu, 2016). This centralized, intensive investment in “Sponge City” is pronounced by comparison with other countries. In the case of Philadelphia in the United States, the investment of Green Infrastructure comes from three parts: municipal funding in public spaces such as roads and parks; developers’ investment on commercial land use on private properties; other kinds of incentives to encourage spontaneous retrofitting (Valderrama et al., 2013). In other countries, such as Australia, the Netherlands, Germany and New Zealand, a general trend of rising costs of water infrastructure is stimulating water cycle localization within urban neighborhoods (van Roon, 2007).
These contradictions have triggered debates on what are the optimal financing strategies to fulfill the potential of Sponge City. Yu (2016) questions the legitimacy and effectiveness of the huge investment in the “Sponge City Campaign” and proposes that Sponge City should achieve its environmental goals with minimum cost of resources. Researches in the US context also indicate that although the installation costs of LID technologies can be more expensive than conventional infrastructures, they can be more cost-effective on a volumetric basis in terms of storing storm water (Montalto et al., 2007). Other costs could be saved due to narrower streets, the absence of curbs and gutters, and smaller storm-water management infrastructure (Davis, 2005). Furthermore, properly functioning green infrastructure is based more on natural processes and will mature during the entire life cycle, whereas capital intensive, infrequent maintenance in the traditional infrastructure industry requires increasing cost as equipment depreciate (Odefey, 2012).

Also, others have raised the concern that, given the great dependence on governmental financing vehicles, the actual contribution of Sponge City is likely to depend on how long the national policy and financial institutions continue investing (Zhao, 2016). In many ways Sponge City as a national policy seems to be too broad and too ambitious, leaving a lot of ambiguity in terms of actual implementation and coordination with current environmental and infrastructural planning system in China. Bo Liu, one of the earlier practitioners of LID and later an advocate of Sponge City, admits in an interview in 2015 that Sponge City still needs to be implemented in a convincing fashion to answer these questions. (Wu, 2015).
CHAPTER 3. RESEARCH FRAMEWORK

3.1 Hypothesis of a Potential Resolution

The contradictions of “Sponge City” as both an environmental campaign to upgrade the water-related infrastructure, as well as an investment initiative to stimulate economic growth by involving private investment is central to the bigger picture. Local governments in China, especially the ones listed as pilot cities, have little patience for agreed best practices. It is hard to conclude how these seemingly contradicting aspects will resolve with each other in practice; however, the empirical evidences that a few pilot municipalities choose to skew “Sponge City” towards a pro-growth policy by branding “Sponge New District” in urban outskirts suggest a potential resolution.

The thesis hypothesizes that, by directing massive Sponge City construction to the urban fringes, local governments will be able to get: (a) spatial flexibility, i.e. more development opportunities to convince private investors to contribute in exchange for prospective growth of land value, while also ensuring the environmental outcome by making “Sponge New District Plan” under the Technical Guideline without being constrained by existing urban areas; and (b) political leeway, i.e. the justification to take the initiative in incorporating Sponge City into the
local urban expansion agenda, and to directly use governmental fund in financing the construction of Sponge City in shortage of private capital, a model which has been successfully implemented in the past decades. According to the Technical Guideline for Sponge City Construction, Sponge City is of larger scale compared to LID or GI and “emphasizes on the planning of ecological infrastructure”, clearly intervenes the urban planning process at a larger scale compared to LID, and articulates its ambition in “coordinating between green and gray infrastructures” (MOHURD, 2014), a task that could only be made possible by the public sector.

Arguably, these two rationales help to justify Sponge City as a government-led city-making initiative without evidently compromising the environmental goals. However, it is still unclear why and how local governments incorporate them into the execution of “Sponge City” policy, and to what extent “Sponge New District” strategy can fulfill the original environmental ideology of Sponge City. Therefore, a more thorough examination of actual cases in indeed necessary, in order to identify the potential gap between an idealized resilience program and the execution of pro-growth agendas at local governmental level in contemporary China.

3.2 Research Method

The thesis examines the hypothesis with the case of Guangming New District in Shenzhen, Guangdong and its successful application process to be the second cohort of pilot cities in 2016. The field work started with interview of planners, landscape architects, water conservancy expert, financing agencies in both private and public sector in Beijing to get a general idea of the
bigger picture in Sponge City’s implementation and some of the challenges. The research then focuses on Shenzhen’s Guangming New District, examining the site from both planning and financing aspects, while also interviewing the local practitioners in related projects. The author visited the site in January, 2017 to collect data and talked to the key interviewees listed below (in the sequence of interview time):

**Kongjian Yu**, professor of Landscape Architecture at Peking University, head of Turenscape;

**Jingzhou Chang**, Appraisal Manager at China Development Bank;

**Dangsheng Zhu**, Deputy Director of China Renewal Energy Engineering Institute;

**Feng Zhu**, Deputy Director of Sponge City Branch at Turenscape;

**Hui Han**, Researcher of Green Infrastructure and Sponge City at Asian Development Bank;

**Shouguo Chang**, Head of China Development Bank, Guangdong Branch;

**Enjian Lu**, Director of Developmental Financing Office, China Development Bank, Guangdong Branch;

**Weizhen Tang**, Urban Planning & Design Institute of Shenzhen;

**Zhong Tang**, Urban Planning & Design Institute of Shenzhen;

**Li Zhao**, Deputy Director of China Architecture Design & Research Group;
Xiaoyue Zhen, Chief Planner of Sponge City Planning and Design Institute at Tetra Tech & Oriental Landscaper;

Dr. Yanyun Zhai, Shenzhen Eco Vista Tech. Co., Ltd.

With each of the interviewees, an outline of the conversation is prepared based on the following structure:

1. (For informants in urban planning and landscape design profession) Since when do you first observe the rise of Sponge City as a national program? How many projects under that name, approximately speaking, have you been working on in total?

A. Where are these projects? How large are these projects in size?

B. Are you familiar with LID? Do you consciously use the technology in your design?

C. Who are your clients? Are they governmental entity or private developers?

D. Have you participated in the editing the national guideline of Sponge City Technology? If yes, what are some of the consideration that you prioritize?

E. How do you see the current debates on Sponge City and the urban resilience infrastructure in China?

2. (For informants in infrastructure financing profession, such as banks) Since when do you first observe the rise of Sponge City as a national program? How many projects under that name, approximately speaking, have you been working on in total?
A. How are these projects funded? Are they mainly through governmental funding?

B. What are some of the difficulties to attract private investors? How can you increase return on these projects?

C. Do you think the money are spent properly and address the local issue, or acting more like a vehicle for economic stimulation?

D. How long would you predict the national policy would prioritize Sponge City and other resilience related program?

3. (For informants in developing profession) Since when do you first observe the rise of Sponge City as a national program? How many projects under that name, approximately speaking, have you been working on in total?

A. Who are your clients? Are they governmental entity or private entity?

B. How do you get financed on these projects? Are banks supportive in project crediting?

C. Do you consider these projects profitable? If not are you having any other funding support?

D. Do you plan to have longer term maintenances after the construction and completion of these projects?
CHAPTER 4. CASE STUDY IN SHENZHEN

4.1 An Overview of “Sponge City” Implementation

Drawing from the interviews of planners, designers, financers and governmental officials, three major observations can be generalized regarding the reality of “Sponge City” implementation in China: (1) large scale of planned “Sponge New Districts” are prevalent; (2) local governments use package deal to bundle LID techniques with conventional urban infrastructures in order to attract private investor; and (3) governmental involvement is dominant in planning, financing and construction as “Sponge City” projects are incorporated into the local expansion agenda. These three conclusions help to support the previous hypothesis, and will be further examined in the case study of Shenzhen, Guangdong.

4.1.1 Large Scale “Sponge New Districts” are Prevalent

Most interviewees mentioned the prevalent situation of current Sponge City projects happening in expansion districts, where a new city will be built from scratch according to the national guideline of Sponge City. Many of the sponge city pilots are explicitly named as “new cities”, such as Xiangan New City in Xiamen, Fujian; Jixi Expansion Zone in Jinan, Shandong; Hebin New District in Hebi, Henan; Yuelai New City in Chongqing; Guian New District in Guiyang,
Guizhou; Xixian New District in Xi’an, Shaanxi; Guangming New District in Shenzhen Guangdong.

The motivation of local governments behind it is mostly the high cost associated with inner city “Sponge City” projects, both economically and politically. Hui Han, a researcher of Green Infrastructure and Sponge City at Asian Development Bank, admitted in the interview that “retrofitting dense urban areas with alternative water management infrastructures requires gradual investment over a long period before maturity”. Jingzhou Chang of China Development Bank, in response to a case in Wuhan, Hubei Province where residents are reluctant to adopt Sponge City retrofitting at their door steps, said that these projects seriously affect the local residents’ daily life and incur great political pressure. Besides, these projects in inner city induce higher costs in operation and maintenance, as well as generate little economic return in most cases, making themselves largely unattractive to private investors. Under this circumstance, the local government has the incentive to direct the pilot of Sponge City development to the newer parts of the city.

When constructed at urban outskirts, Sponge City projects are usually much larger in physical scale as compared to the LID projects in other countries. Table 2 shows that the area of Sponge City pilot zone for the 16 cities in the first cohort of 2016, with the average project scale of 28.43 square kilometers, or 10.97 square miles. Designers and civil engineers, on the other hand, tend to justify “Sponge New District” strategy from the environmental benefit it could bring. During the interview, Kongjian Yu of Peking University insisted on the importance of understanding the ecological pattern of natural context before making any plan. He said that the “combination
and coordination of grey and green infrastructure can only be realized at regional scale”.

Dangsheng Zhu, Deputy Director of China Renewal Energy Engineering Institute under the Ministry of Water Resource, also supported the idea of implementing “Sponge City” at larger scale, saying “water-related issues such as urban flooding can only be solved when considered from a large scale regarding the city’s relationship with natural water system”. This seems to be a shared view among experts from water conservancy background. Xiaotao Cheng, chief editor of Journal of Hydraulic Engineering, also emphasizes on planning at the scale of river basin to realize full potential of Sponge City (Tang, 2017).

Table 2. Area of Sponge City Pilot Zone for the First Cohort (in square kilometers)

<table>
<thead>
<tr>
<th>City</th>
<th>Area (sq. km)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Qian’an</td>
<td>21.5</td>
</tr>
<tr>
<td>Baicheng</td>
<td>22</td>
</tr>
<tr>
<td>Zhenjiang</td>
<td>22</td>
</tr>
<tr>
<td>Jiaxing</td>
<td>18.44</td>
</tr>
<tr>
<td>Chizhou</td>
<td>18.5</td>
</tr>
<tr>
<td>Xiamen</td>
<td>35.4</td>
</tr>
<tr>
<td>Pingxiang</td>
<td>32.98</td>
</tr>
<tr>
<td>Jinan</td>
<td>39</td>
</tr>
<tr>
<td>Hebi</td>
<td>29.8</td>
</tr>
<tr>
<td>Wuhan</td>
<td>38.5</td>
</tr>
<tr>
<td>Changde</td>
<td>36.1</td>
</tr>
<tr>
<td>Nanning</td>
<td>54.6</td>
</tr>
<tr>
<td>Chongqing</td>
<td>18.67</td>
</tr>
<tr>
<td>Suining</td>
<td>25.8</td>
</tr>
<tr>
<td>Guian</td>
<td>19.1</td>
</tr>
<tr>
<td>Xixian</td>
<td>22.5</td>
</tr>
</tbody>
</table>

4.1.2 Local Governments Propose Package Deals

As a way of attracting more private investors to the construction of “Sponge New Districts”, local governments try to create “package deal” which combines LID and conventional infrastructures in order to generate enough profit, and city-making from scratch allows this type of deal to happen. As landscape architect Feng Zhu of Turenscape mentioned, Sponge City
is more conceived as a kind of “Sponge Urbanism” at local governmental level, which can be readily combined with the constructions of roads, bridges, residential compounds and industrial park. This also ensures the environmental outcome by making “Sponge New District Plan” under the Technical Guideline without being constrained by existing urban areas. These projects, when constructed under certain techniques, will be categorized as Sponge City projects and are then eligible to the “Sponge City” funding from central government.

Hui Han, a Sponge City experts of Asian Development Bank, said this adaptability of “Sponge Urbanism” to conventional infrastructure creates a special incentive for local government to apply and compete for the funding support of central government. Since “they are going to upgrade the road infrastructure and build up new district anyway, it is of their best interest to do it with outside financial aid.” This partially explains the willingness for local government to mobilize a great amount of municipal resources to compete to be enlisted as a national pilot, and make obvious the motivation for governments to provide “package deal” to capable private partnerships.

“Package deals” of LID and conventional infrastructure are also favored by private investors. One obvious reason is the higher potential return from the highways, pipelines and sewage factories. Professor Kongjian Yu does not agree with this strategy, and argues from a technical perspective that Sponge City projects are subject to a more rigorous, smaller scale planning and design that takes into account the local situation and implemented through a longer period of time. However, his critiques help to explain why private capital dislikes these projects unless they are getting return on other more profitable projects along with the more “technical” ones.
Zhong Tang, an urban planner in Shenzhen, pointed out that the prospective growth of land value in such new districts is a driver for privately invested real estate development. More importantly, as Jingzhou Chang of China Development Bank said, the relatively small size of each “package deal” at Sponge New Districts lowers the threshold for private enterprises to form PPP with the local government. Chang argues that “Sponge City initiatives in existing urban area is often too large to find one entity from the private sector to manage the entire project”. It is especially true for big cities such as Beijing as the only way is to divide the city according to administrative boundary at district level, which is not necessarily aligned with the watershed analysis.

4.1.3 Governmental Interventions are Dominant

Despite the clear message from central government to encourage PPP in “Sponge City” program and local governments’ exertion of proposing “package deal” to attract private investors, literature reviews of public data show that governmental financing of “Sponge City” is still dominant. All interviewees have agreed that PPP is hardly feasible when applying to Sponge City projects at this moment, for the lack of a clear business model to generate profit.

On the government side, structuring a PPP contract with a private company for the construction of Sponge City is both economically expensive and administratively troublesome. Enjian Lu of China Development Bank said “when government borrows from a national back for Sponge City projects, the discounted interest rate is around 4.9%, while the private will usually ask for 8% or more.” At the same time, prevailing mistrust between the public and private sector also act as a barrier to the formation of partnership. Weizhen Tang of Urban Planning & Design
Institute of Shenzhen admits that government also lacks the resources to “select a trustworthy private partner and then structure a feasible PPP contract” which will define the rights and obligations of each party clearly. The same logic applies to the private sector.

This leads to a mixed feeling about the PPP among local governments of different fiscal capacity, and urges the governments to consider the justifications for direct governmental involvement, if they are to carry out “Sponge City” at all. The construction of “Sponge New Districts”, therefore, provides local government with the political leeway to take a justifiably initiative in the new town construction, as new town development has been one of the priorities of local government’s agenda. Shouguo Chang of China Development Bank said that it is especially true in Guangdong Province, a relatively developed area where municipalities are competing for limited educated population and investment opportunities as the urbanization pace slows down. When talking about the cost-benefit Sponge City projects in Guangzhou, he argued that “if the city is not willing to invest, enterprises will be moving to Dongguan”, a neighboring city with relatively low living cost, and that Guangzhou “has a lot to loss” in face of such possibility. Zhong Tang of Urban Planning & Design Institute of Shenzhen admits that local government in Shenzhen has the legal power to integrate “Sponge City related requires” in the zoning document when planning for the new district. Hui Han of Asian Development Bank also argues that the administration is not doing cost-benefit analysis solely on one single projects or the direct benefit from rising land value, but rather the long-term return to the entire city. “The government is willing to bear some lost on the construction of Sponge City if it could bring about a greater growth opportunity in the long run”, says Han.
The aligned interest between Sponge City construction and the economic prosperity of the entire city is also reflected by the administrative structure of Sponge City-relative affairs. In a presentation on Sponge City’s regulation, Yanyun Zhai of Shenzhen Eco Vista Tech. Co., Ltd., a Sponge City related construction advisory company, commented that when any municipality applies to the central government to be listed as a pilot city, it is required that a high rank city official, usually a member of the city’s leadership, should chair the planning and applying process, and also pitch the city to the experts’ committee from the central government. He takes Beijing as an example: “if Beijing’s Sponge City Task Force is led by the director of Water Affair Bureau, it is very likely that the city will fail in competing with another city whose group is led by the vice mayor”. As the Technical Guideline demands a better inter-departmental coordination in carrying out Sponge City plan, cities will readily form task force led by municipal leadership, as will be seen in the case of Shenzhen. This, however, provides the means of evasion to push Sponge City beyond simply a resilient program or urban water management plan, especially in the construction of Sponge New Districts. Jingzhou Chang of China Development Bank pointed out that the whole perception is very similar to the development of industrial park at urban fringes, where local governments used to offer free land or even pay companies if they come to the newly built industrial parks. The local government believes that once the industrial parks is occupied, it could capture the increase of tax revenue and land value to pay back their initial investment. Even so, he remains doubtful on whether the experience is transferrable to public policy like “Sponge City” with inherent environmental purposes.
4.2 Background on Shenzhen and its Sponge New City

Among the many cities actively pursuing this concept of “Sponge New District”, Shenzhen is uniquely positioned to implement such alternative storm water management strategies. Located at the southeast coastline of China, the Pearl River Delta region suffers from severe torrential rain during summer time, averaging 1900 mm per year. Especially in Shenzhen, 84.8% of a year is considered to be flood season which will see frequent and intense precipitation. The average annual amount of precipitation of Shenzhen is 1837 mm, and is greatly unevenly distributed across the city. Most rainfalls in Shenzhen is characterized as short but intense, with a peak of runoff appearing in the early stage of the rainfall. What’s more, the eastern side of Pearl River Delta where Shenzhen locates is abundant with mountainous river with a steep slope, increasing the probability of flooding in Shenzhen’s natural water system. Urban districts of Shenzhen are mostly in the low-lying areas which is likely to be flooded during heavy rains.

Meanwhile, Research shows that explosive urbanization of the past three decades has led to a dramatic change in local climate and underlying surface in Shenzhen and the trend is especially obvious since 1980s (Zhang et al., 2007). Table 3 show the categorization of Shenzhen’s underlying surface, where paved area constitutes 19.3% within the entire administrative boundary, and is 47% of the built area excluding green space and water surface. This type of development has greatly affect the natural catchment system, making it hard for the rainfall to run through the drainage system and eventually going into urban rivers.
Table 3. Underlying Surface of Shenzhen as of 2014

Source: Construction Implementation Plan of Shenzhen as Sponge City Pilot

<table>
<thead>
<tr>
<th>Percentage</th>
<th>Green Space</th>
<th>Water Surface</th>
<th>Roof Top</th>
<th>Road Surface</th>
<th>Exposed Soil</th>
<th>Paved area</th>
</tr>
</thead>
<tbody>
<tr>
<td>54.0%</td>
<td>5.7%</td>
<td>11.2%</td>
<td>7.1%</td>
<td>2.7%</td>
<td>19.3%</td>
<td></td>
</tr>
</tbody>
</table>

These two factors combined cause serious trouble of urban flooding in Shenzhen. In the past 60 years, the region has suffered from 111 times of flooding, water lodging and storm surge. These hazards have claimed 167 lives in total (Municipality of Shenzhen, 2015). Shenzhen Climate Bulletin (2014) found that the risk of intensive precipitation is much higher than the average of recent 5 years (Figure 4). Most recently, during March to May in 2014, 5 intense storms hit Shenzhen, especially the one happened on May 11, which caused water lodging at over 300 locations across the city, damaging around 2,500 vehicles with economic loss of 95 million RMB. In 2014, totally 446 urban flooding incidents were recorded throughout the entire city (as in Figure 5). Even though the local drainage system is planned to cope with the surface runoff from a storm with a 2-year return period, in case of a heavier storm runoff often exceed the capacity, causing flooding in low-lying areas (Qin, 2013). The high risk of urban flooding is exacerbated by the successful economic development of Shenzhen, which is the first economic

4 “深圳市海绵城市建设试点城市实施方案”.
zone in China right next to Hong Kong. Losses from suspended economic activities is estimated to be $32.5 million in 2014 (Meteorological Bureau of Shenzhen Municipality, 2014).

Figure 4. Comparison of Frequency of Intense Precipitation in 2014 and Recent 5 Years.
(Colors stand for different frequency in times/year)

a/b: Distribution of Short-time Intense Precipitation in 2014 and 2009-2013.


Source: Shenzhen Climate Bulletin 2014, Meteorological Bureau of Shenzhen Municipality
Figure 5. Urban Flooding Records in Shenzhen.

Source: Shenzhen Drainage and Flood Prevention Plan 2014, Urban Planning and Design Institute of Shenzhen
Flooding is not the only water-related issue the city is facing though. Shenzhen is also facing a shortage of freshwater resources due to the high demand from urbanization. It is estimated that by 2020, the city will face a shortage of 0.97 billion cubic meters in freshwater, should current situation remains (Municipality of Shenzhen, 2015). An integrated solution is expected for a long time to not only solve the urban flooding issue, but also the shortage of water resources in the region, and the municipality of Shenzhen is actively reacting to the issues as early as 2009, five years before Sponge City became a national resilience campaign. To address these severe issues from an urban planning approach, Shenzhen has revised its urban planning codes complying with LID standard in 2014. Coordinated by the mayor’s office, the city has also designated 13 areas (Figure 6) to test out the planning and construction techniques of Sponge City since the concept was brought up by the national leadership, including Guangming District (and its core area Fenghuang Cheng), International Low Carbon City, Pingshan Central District, etc., amounting to a total area of 200 square kilometers.
Figure 6. 13 LID Areas within Shenzhen

Source: Source: Planning and Design Institute of Shenzhen
The quick response could only be possible with the relative strong fiscal capacity of Shenzhen. By the end of 2013, the local GDP of the municipality is 1,450 billion RMB, a 10.5% increase compared to the previous year. The local fiscal income of the city is 209.2 billion RMB, and expense was 201.5 billion RMB in 2013. With a developed financial industry and private sector, a lot of private capital was reported to be involved into the development of infrastructure and urban construction. In November 2015, Shenzhen government passed Water Management and Quality Improvement Plan: 2015-2020\(^5\), promising $12.07 billion investment in the following 5 years, and trying hard to make itself listed as a national pilot city. Guangming District, as the experimental planning zone within Shenzhen and a case study in the national Technical Guideline, is therefore an important site of Sponge City’s actual implementation on the ground. Instead of fully funded by local government, 24 individual infrastructure projects (roads, pipelines, water system) in Guangming District are supposed to be funded through Public-Private Partnership and Engineering Procurement Construction (PPP+EPC), with a total amount of $309.3 million (Fang, 2016).

### 4.3 Guangming New District and Fenghuang Cheng

As early as 2004, Shenzhen has started its exploration of Low Impact Development, and Guangming became one of the leading areas for the new techniques. In Master Plan of Guangming District of 2007, Guangming was planned as the first “green” district in Shenzhen,

which will serve the as “the platform of innovative services and industries in Pearl River Delta, with various administrative, commercial and cultural amenities.” As an experiment field of the “New Urbanization”, Fenghuang Cheng, the core area of Guangming New District, will take advantage of the existing ecology base of the site, including 418 ha of water body, mountains, farmland and greenland. Featuring the park and wetland system of “Emerald Necklace”.  

(Figure 7).

Figure 7. Ecological Context of Guangming

Source: Construction Implementation Plan of Shenzhen as Sponge City Pilot
With such high expectation, Guangming is therefore considered as one of the priorities of the city. However, based on interviews and analysis of the previous chapter, local governments have complicated and entangled incentives to pursue a new branding under the concept of Sponge City. It may be environmental, but can also be of economic and political. Also, local officials could try various ways to converge it with other development goals so as to incorporate it into the bigger growth agenda. Based on the materials from Shenzhen’s application to become the second cohort of pilot cities, the following part of the section uses Guangming to check the three general conclusions drawn from the previous interviews.

4.3.1 Location and Scale of Guangming District

In many sense, Guangming is like the typical new town geographically separated from the existing urban areas (Figure 8). It is located in the city’s northwestern suburbs, 40 kilometers away from the downtown area. Its currently land use is mainly agricultural with small fraction of industrial. In terms of transportation, it is connected by the high-speed railway to the downtown area. Trains from Shenzhen will run for about 12 minutes, stop for 2 minutes at the brand new Guangming Station (Figure 9), and then set off to other northern destinations. The area around the transportation node will also provide commercial and residential uses, so as to improve the overall development of the entire area.
Figure 8. Location of Guangming New District in Shenzhen

Source: Construction Implementation Plan of Shenzhen as Sponge City Pilot

Figure 9. The Newly Built Guangming City High Speed Railway Station. It connects the new districts to downtown Shenzhen, which were separated by hilly country in between.
Apart from the six administrative districts, Shenzhen has four “Functional District”, Guangming, Pingshan, Longhua and Dapeng, to serve as a special area for certain development methods. What distinguishes Guangming from other new districts was the role as an experiment field for exploring sustainability urbanization. The area was chosen as one of the many new towns to help Shenzhen further develops despite the strict “Ecological Protection Area”, which restricts development in almost half of the city’s land. In 2009, under the instruction of MOHURD, Shenzhen officially started the construction of LID in Guangming, with a planned area of 150 square kilometers (57.9 square miles). After the development and investment since 2010, Shenzhen picked Guangming and its core district Fenghuang Cheng (“Phoenix City” in English) as the candidate for applying to the second cohort of National Sponge City Pilot. The Fenghuang Cheng area locate within the catchment of Maozhou River, with a planned working population of 350,000 and residential population of 220,000. The current land use is mainly industrial, but is planned to transform into an integrated work-life hub in the future.

4.3.2 Package Deal in Developing Guangming District

As of the time of application, Guangming District has installed 18 Sponge City demonstration projects (Figure 10), all government funded, including 1 public building, 5 urban roads, 3 green spaces and parks, 2 wetlands, 5 residential compound and 2 industrial parks. These projects are categorized in such way that “cover the usually project types of general urban construction (Municipality of Shenzhen, 2015)”. 
Figure 10. 18 Demonstrative projects of Guangming District at the Time of Application for National Pilot. From top to bottom: 1 Public Building, 5 Urban Roads, 3 Parks and Green Spaces, 2 Water System and Wetland, 5 Residential Areas, 2 Industrial Parks

The experience of implementing LID techniques in these projects has been edited into the case study appendix in the national guideline of Sponge City. For example, the Technical Guideline elaborates on the construction of 17 km public roads, which will direct the rainfall into bioswale on both side of the road in order to supplement underground water and control run-off pollutions (Figure 11). After the retrofitting, the roads will be able to cope with rain fall at a 4-year recurrence period. The techniques are proved to be quite compatible with existing road construction methods, thus has been widely introduced across the new district.
Figure 11. The water entryway of runoff along Gongyuan Road in Fenghuang Cheng.

Source: Construction Implementation Plan of Shenzhen as Sponge City Pilot

The techniques are also tested out to be built into the construction of public facilities, residential real estate developments and industrial parks. People’s Athletic Center of Guangming New District, a city level public facilities funded by local government has adopted the green roofs on top of the structure (Figure 12). The Merchants Technological Enterprises Incubator adopted the infiltrating landscape techniques into the campus planning. The industrial park also designs its parking lots and open spaces according to the Technical Guideline.
Figure 12. The vegetation roof top of People’s Athletic Center of Guangming New District.

The vegetation roof top of People’s Athletic Center of Guangming New District

Source: Construction Implementation Plan of Shenzhen as Sponge City Pilot

These feasible experiments of combining LID techniques and general urban construction projects make possible a richer type of programming in “Sponge City” projects of Guangming, which will be able to attract more private investors. In the actual application process for national funding support, Guangming has further listed 43 new projects to be carried out in the future to equip the city with all kinds of facilities necessary for development. These projects can be roughly classified into six categories: Roads Constructions, Open Spaces and Green Spaces,
Industries Services Projects, Public Amenities and Housing, Sewage Facilities, and Management System Development Projects. Despite the specific emphasis on sewage factory and pipeline system, these newly proposed projects have shown a bigger ambition in an all-rounded urban development beyond a simple resilient program that aims to solve the water related issues. Of all the projects proposed, Sewage Facilities takes up about ¾ of the total funding available, and most of them are invested into the pipeline system (Figure 13). This reflects the lack of basic infrastructure in Guangming area due to its short development history for less than a decade. Besides pipeline, construction of roads network is ranked at the second place, followed by Open Spaces and Green Spaces. Admittedly, all these projects are designed under the new techniques of Sponge City, but it is hard to argue that they do not intend to serve for the city-making agenda of the area.

![Funding Allocation of Different Categories](image)

**Figure 13.** Funding Allocation of Different Categories.
As planned, the cost of these future project will be shared through public and private investors, and the government is offering quite favorable conditions to lure in private capital. The public area will be fully funded by the government, with the rest non-public, profit generating project shared between shareholders, although the government has offered a subsidy covering around 70% of the total investment. The second part of the full projects list details the financing of the 43 projects. The spreadsheet only breaks up the investment between government investment and private sector investment. A preliminary analysis shows that most of the infrastructure program are government invested, except that a few Industries Services Projects and Public Amentias will be constructed by the entities fall into the categories of “private enterprises”, which makes a fraction of the total investment (Figure 14).

Figure 14. Funding Sources of Proposed Projects in Shenzhen’s Application.
Besides offering direct assistance in financing the “Sponge City” projects in the new district construction, the local government also introduces a series of encouragement such as economic compensation and FAR awards. Overall, among the project that has already started construction, government investment is 385.16 million, whereas social investment expected to eventually reach 386.22 million through Public-Private Partnerships.

Local government at Guangming is also expecting the Sponge City to bring about the increase in land value, as another condition to bring private investors into the region, according to the Construction Implementation Plan. The entire land value to capture is estimated to be about 3 billion RMB in the cost-benefit analysis. Based on a 10-year development period, the annual fiscal income from the Sponge City program will be more than 300 million RMB, which is taken seriously into account of the cost-benefit analysis for Sponge City in Shenzhen.

However, as Zhong Tang mentioned, the local government also use its administrative power to “make sure that private capital is part of the financing of Sponge City in Guangming”. The calculation of private investment is actually a doubtable measure of the willingness of private sector to implement Sponge City related techniques to their own projects. In fact, the government use the planning permit as a vehicle to incorporate Sponge City code into the development procedures, thus when the social capital want to get into the land lease it is forced to implement under the code, and then these investments are considered to be “social investment in Sponge City”. The different government branches will put the relative requirement into the permits, such as agencies in charge of land resources and planning, economic planning, and urban construction.
4.3.3 Governmental Intervention

“City planning of Guangming” states that the development of new district is “strategic” at municipal level. As is show in the Figure 15, Guangming New District (indicated by red arrow in northwestern suburb) is mapped as the norther nodes of urban expansion of Shenzhen, serving as a gateway connecting neighboring Dongguang and Guangzhou.

![Figure 15. Urban Agglomeration and Functioning Belt in Shenzhen.](image)

Source: Construction Implementation Plan of Shenzhen as Sponge City Pilot

Therefore, it is hardly surprising that the government is mobilizing all kinds of resources in the construction and operations period, given the yet inadequate presence of private capital. The full list of the projects shows that most of the constructors and operators fall into the category of
“Public Institutions”, which is a kind of quasi-government agencies that is active in urban construction area. For example, most of the roads are constructed and operated by Guangming Urban Construction Bureau and Construction and Land Development Center of Guangming New District (Figure 16), which is the major arm of governmental land development and infrastructural construction. As a result of strong government intervention, most project operators profit on these infrastructure programs from “Government Procurement of Public Services” or “Government Subsidy”. Only the sewage projects are able to directly collect user fee, though at a relatively low rate and face great constraints when trying to pursue for-profit goals.

Figure 16. The Pavement of a “Sponge Road” Using Governmental Financing.
This is also reflected in the administrative entity to lead the development of Guangming (Figure 17), and especially its application to be listed as national pilot was also of high level in the government. In February 2015, the municipal government formed the special task force for the application process of a national pilot status, under the direction from Mayor XU Qin and Deputy Vice Mayor LV Ruifeng. The task force will be able to coordinate government branches in Water Affair, Economic Planning, Urban Habitants, Science, Industry, Commerce, Information, Planning, Land Resources, Market Regulation, Statistics, Legislation, Education and Propaganda, etc. Chaired by the Vice Mayor, the task force is responsible for making plans that guides the future development of Guangming as an independent new town besides the city center. The mentoring body of the application is fully equipped with representative from all branches of government apparatus, clearly suggesting that Sponge City is more than a resilient program, but rather an all-rounded urban development strategies.
Figure 17. The Administrative Structure of Shenzhen Municipality Sponge City Task Force.

The bottom left is 10 institutional members of the task force which are all sub-city level departments, which the vice mayor as the chair of the entire group.

Source: Construction Implementation Plan of Shenzhen as Sponge City Pilot

Local government is also using the administrative power to push forward the projects against barriers. The application promise that most of the projects will be completed by the end of 2016, two years after the development at Guangming took off. However, the city does look quiet and empty in early 2017. In the application file provided to the Ministry of Housing and Urban-Rural Development, the city admits that some of the projects has been approved at a very early stage, but due to the slack of demolition and relocation, some has actually been suspended.
Once selected as a national pilot, “the relocation process will be greatly accelerated”, and the displaced people are very likely to move into sponge residential buildings in Fenghuang Cheng.

4.4 Discussion

Facing the inherent dilemma due to the policy of Sponge City, local government at Shenzhen turned to plan, design, construct and brand Guangming as a “Sponge New District” to boost the development in its northwestern suburbs with large scale Sponge City Plan. Based on the analysis of Guangming New District as a typical “Sponge New District”, it is safe to land on the conclusion of the two rationales behind this strategy at the local governmental level. First, rather than considering Sponge City as a specific and separate case, the local government tends to package the “Sponge Urbanism” with other infrastructural and economic developmental projects through the land leasing and permitting process. This creates more potentiality for private investors to capture the future land value growth. Second, the emphasis of Sponge New District as a municipal priority has lend justification of strong government (and state-owned companies) presence in planning, financing and construction. With a governing entity comprised of all the apparatus necessary to kick-off the city-making process, the Guangming New District has apparently transcended a resilient program aiming to solve water related urban issues.

By emphasizing the LID techniques and ecological planning ideas, the Sponge New District dose put resilient purpose in its planning priority, but it is fair to question that from a technical
point of view, the solution diverts the original environmental ideology of Sponge City.

Borrowing from LID and Green Infrastructure, Sponge City proposes equal importance between large scale ecological infrastructure and small scale distributed installations. This environmental concern is not necessarily promised by the “Sponge New District” solution. For the purpose of generating more profitable bundles and providing basic urban infrastructures, deal packaging practices is not helpful in bringing in private investors interested in technical Sponge City installations. On the other hand, dominated by the pro-growth government as a priority of local developmental agenda, the environmental purposes are likely to be in a political limbo. At its best, LID or Green, which are considered to be a more narrow and technical definition of Sponge City, are incorporated in this development “package” where roads, houses and industrial parks are developed complying to the new national standard. Sponge City is not considered as a separate physical project that is visible, but rather an ideology or a “greener” alternative to the traditional city making processes. Thus, it is not surprise to see the terminology like “sponge roads”, “sponge parks”, “sponge communities” or “sponge industrial parks” in the official documents.

Even though at current stage, the implementation of Sponge City takes a form that is more like a growth-orientated city-making process, the thesis does not intend to argue that it will eventually deteriorate into tokenism urban resilient program, or that there is an obvious solution better than the government-led investment to push forward the sustainable urbanization. As a matter of fact, the Sponge City program may face two fates in the following decades: (1) when the new district gradually mature, people will recognize the value of such
techniques and the future construction will trickle down to urban center with higher density, and Sponge City can truly transform itself into a distributed green infrastructure to increase urban resilience; (2) as the two aspect of the duality conflicts each other, people may start to consider Sponge City as an excuse of urban growth, a bad one because of the constrain as the environmental purpose limits its long-term profitability. Admittedly, “Sponge City” has only been institutionalized for around three years, and its final outcome still remains to be seen.
CHAPTER 5. CONCLUSION

“Sponge City” has been institutionalized as a national policy of China in the alternative urban water management since 2014, in response to the increasing risk and pressure in existing urban water system which fails to cope with the water related issues including urban floodings, non-point source pollutions, the shortage of fresh water resources and the deterioration of urban water eco-system. Since its introduction, “Sponge City” has stimulated heated discussion on the best practice both technically and financially.

Up till now, two major streams of conceptualization can be generalized in the Sponge City discourse. On the one hand, “Sponge City” as a national policy has directly borrowed idea from the existing concepts of Low Impact Development, thus is primarily designed to be a distributed resilience program. The policy aims at maintaining post-development hydrology of a site close to the natural condition before development occurs. On the other hand, “Sponge City” and the incurred investments are considered by officials to be crucial in future urban growth, given the fact that land value-centered real estate development has slowed down in the recent decade. It is also considered to be the experimental field of financial innovation such as Public-Private Partnerships (PPP).
With its imbedded environmental and economic purposes, Sponge City has been idealized as an effective resilient program that will bring about positive social externality, and will help to stimulate next round of urban growth through public and private investments. However, the two parts of the program design in Sponge City has been observed to be not always compactible with each other. As scholars and planning professionals actively seeking a more developed theory and the best way to materialize Sponge City, these projects are found to be unattractive to private investors for the long payback period and generally low economic return. This, in turn, has forced local government to rely heavily on government funding, as they tend to be not in favor of the high cost associated with negotiating a PPP contract, which again triggers debates on what is the optimal financing strategies to fulfill the potential of Sponge City.

In seeking for resolutions to such dilemma, local governments tend to skew “Sponge City” towards a pro-growth policy by branding “Sponge New District” in urban outskirts. Using the case of Guangming New District, in Shenzhen Guangdong Province, the thesis proves the twofold benefits that local governments will be able to get from the “Sponge New District” resolution: (a) spatial flexibility, i.e. more development opportunities to convince private investors to contribute in exchange for prospective growth of land value, while also ensuring the environmental outcome by making “Sponge New District Plan” under the Technical Guideline without being constrained by existing urban areas; (b) political leeway, i.e. the justification to take the initiative in incorporating Sponge City into the local urban expansion agenda, and to directly use governmental fund in financing the construction of Sponge City in
shortage of private capital, a model which has been successfully implemented in the past decades.

In practice, this strategy proves to be working well in Guangming New District. Rather than considering Sponge City as a specific and separate case, local government tends to package the “Sponge Urbanism” with other infrastructural and economic developmental projects, making it possible to bring in private investors for the relatively profitable infrastructural or industrial projects. The emphasis of Sponge New District as a municipal priority has lend justification of strong government (and state-owned companies) presence in planning, financing and construction. With a governing entity comprised of all the apparatus necessary to kick-off the city-making process, the Guangming New District has apparently transcended a resilient program aiming to solve water related urban issues, but rather has been incorporated into the local development agenda as a growth policy.

Nonetheless, it is fair to question that from a technical point of view, the solution diverts the original environmental ideology of Sponge City. Borrowing from LID and Green Infrastructure, Sponge City proposes equal importance between large scale ecological infrastructure and small scale distributed installations, which are not necessarily promised by the “Sponge New District” solution. For the purpose of generating more profitable bundles and providing basic urban infrastructures, package deals are not helping to bring in private investors interested in technical Sponge City installations. On the other hand, dominated by the pro-growth government as a priority of local developmental agenda, the environmental purposes are likely to be in a political limbo. In the case of Guangming, Sponge City is essentially conceived as a
retrofitting and upgrading policy for the purpose of continued growth in the more developed
urban area of China, where the ideas of “resiliency” or “green” have been used as a justification
for a neoliberal growth strategies against the slacking economic.

These conclusions imply the existence of a fundamental gap between an idealized resilience
program and the much more complicated situation in the execution of pro-growth agendas at
local government level in contemporary China. Whether this gap will do any harm to the final
efficacy of Sponge City as a resiliency storm water management program remains debatable.
But with the potential conflict of interest of the two goals, even though Sponge City may
eventually prove to be an effective solution to the water related issue, it is likely that Sponge
City in many pilot areas might still be blamed, or even suspended, for not meeting the growth
expectation. Should “Sponge City” policy eventually fail, it could still contribute to shedding
more light on what is referred to as “New Urbanization” in the official terminology. Sponge
City, along with the many other discourses in alternative urbanization strategies, may possibly
serve as what David Harvey calls “spatial fix”, which is series spatial vehicle and governance
agenda to creatively reconfigure the built environment to cope with the crisis in the slowing
down of capital accumulation.

Even so, it is still too early to call that Sponge City is merely a neoliberal justification for further
urban development. After all, it is only 3 years since the idea come into the public realm, and 2
years since the first cohort of Sponge City pilot is assigned. Most of the projects in the first and
second cohort will be completed in this year or the next, and a long-term close observation on
the future performance is certainly necessary for a better understanding of the phenomenon.
REFERENCES


Che, Wu. 海绵城市建设的难点与关键, March 30, 2016.


Sinolink Securites. “Prospect of Sponge City Capital (‘海绵城市资本远景’),” 2015.


Wang, Pei-fang, Chao Wang, Qian Feng, Jin Qian, and Jian-ren Zhou. “Advances in Research of Urban Water Ecosystem Construction Mode.” *Journal of Hohai University (Natural Science)* 31, no. 5 (September 2003).


