



CSC APPROACH WATER SENSITIVE PUBLIC SPACE

Technical-socio-cultural integrative approach for
water management exemplified in Guangzhou

P5 REPORT
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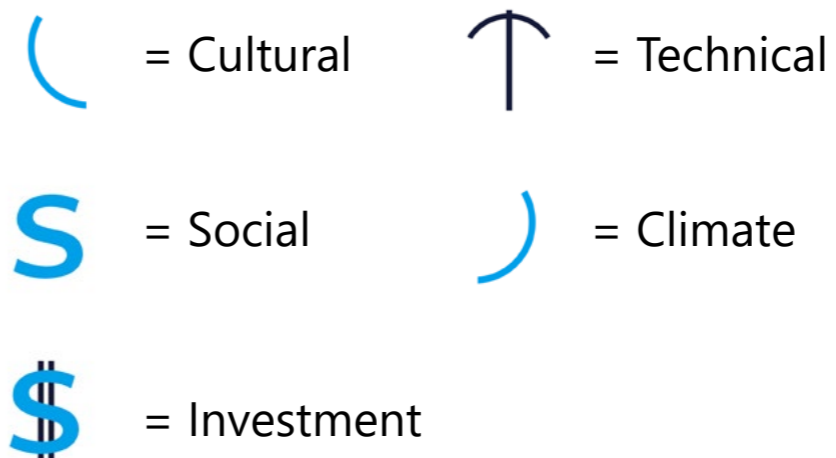
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ABOUT

CSC APPROACH



The essence of this project is actually the explanation and application of CSC approach. CSC approach is an integrative approach taking technical, social, cultural perspectives into account when developing sustainable water management, and because of the consideration of stakeholders, money is also one factor in this approach. The approach is raised under the climate change background and the emergency and trend of developing sustainable water management worldwide. The objective of using this approach is to make cities more resilient by technical solutions, simultaneously take advantage of social and cultural value of the city. Therefore, the diversity of cities can be maintained and sustainable water management will be more feasible and acceptable when regenerating a region.



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1
INTRODUCTION

1.1 MOTIVATION

Water as a source of human life (Schelwald-van der Kley and Reijerkerk 2009), is viewed as cradle of human civilization. Four great ancient civilizations all originated from rivers: the Mesopotamian Civilization developed along the Tigris and Euphrates rivers, the Egyptian Civilization along the Nile River, the Indus Valley Civilization along the Indus River, and the Yellow River Civilization along the Yellow River. (Yasuda 2013) (Fig.1-1-1) For ancient cities, water deeply influenced city construction (Fig. 1-1-2) and people life (Fig. 1-1-3), so water is the social and cultural value carrier having positive impact on people and cities and its positive value is also inherited in modern landscape (Fig. 1-1-4).



Fig. 1-1-1 Map of four river valley civilizations
Source: <https://www.slide-share.net/shiamentors/river-valley-civilization-in-indus-nile-river>



Fig. 1-1-3 Famous Painting by Chinese artist Zhang Zeduan "Along the River During the Qingming Festival": It captured the daily life of people and the landscape of the old-time capital along the river.
Source: <http://jgospel.net/>

However, under the climate change background, water risk is one of the main challenges of this century. Water-related disasters account for almost 90% of the 1,000 most catastrophic natural disasters since 1990 (UN 2015). Water-related disasters not only occupy the majority of the natural disasters, but also show a growing trend. (UNESCO 2009) (Fig. 1-1-5) Therefore, if we cannot properly deal with the relationship with water, the threats that water posed on city and human will get stronger and stronger in the future. *The United Nations World Water Development Report 2015* (WWAP 2015) ascertained that:

"The negative impacts of climate change on freshwater systems will most likely outweigh its benefits. Current projections show that crucial changes in the temporal and spatial distributing of water resources and the frequency and intensity of water-related disasters rise significantly with increasing greenhouse gas emissions. Exploitation of new data sources, better models and more powerful data analysis methods, as well as the design of adaptive management strategies can help respond effectively to changing and uncertain conditions. "



Fig. 1-1-4(left) Modern water landscape in Potsdamer Platz, Berlin
Source: <http://www.urban-greenbluegrids.com/>

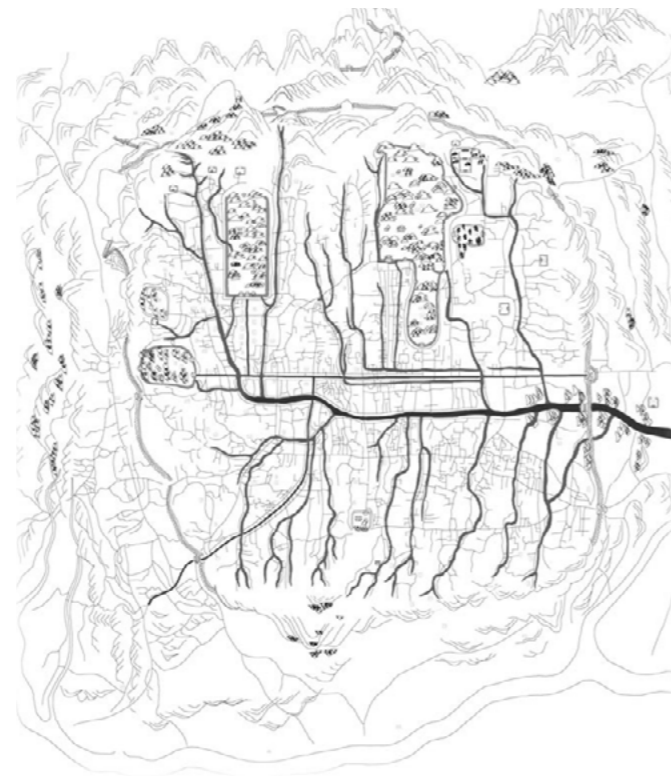
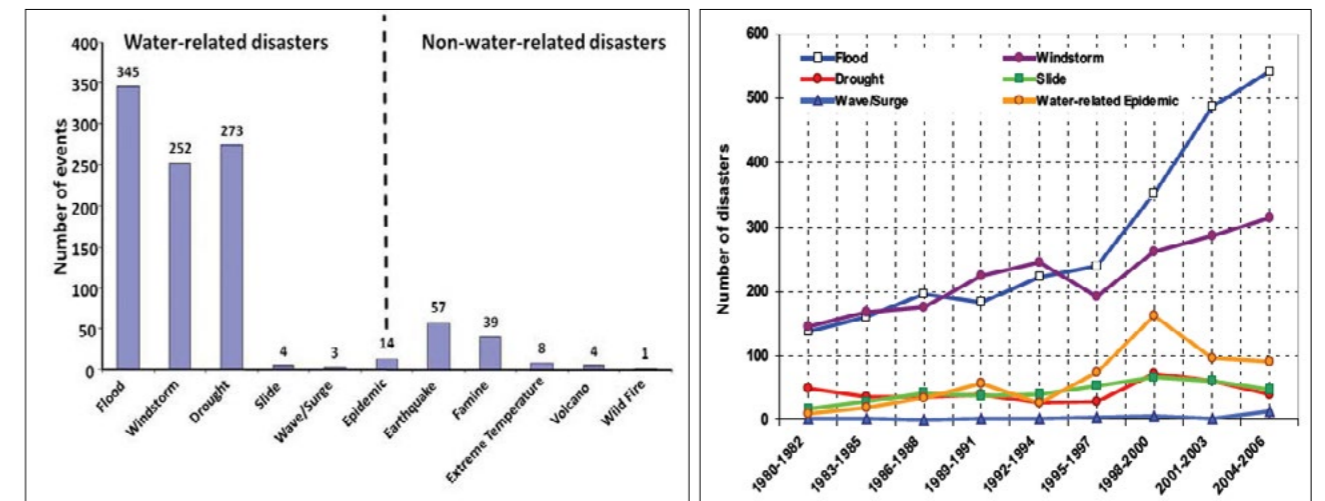


Fig. 1-1-2(right) City pattern of ancient Seoul, South Korea: Seoul was structured by a series of waterways and mountains.
Source: Shannon (2013)



Due to the urgency to tackle water problem, many countries have already put forward strategies to encourage sustainable water management, such as Low Impact Development (LID) in USA, Sustainable Urban Drainage Systems (SUDS) in UK, and Water Sensitive Urban Design (WSUD) in Australia (Liu 2016). Although the situation has been improved, many attempts were not successful. And one of

Fig. 1-1-5 The annual total and cumulative number of natural disaster events recorded globally between 1980 and 2006
Source: UNESCO (2009)



Fig. 1-1-6 People as victims of climate hazards
Source: <https://blogs.world-bank.org/http://energydesk.green-peace.org/>

the crucial reasons is the lack of consideration for local cultural context. (Schelwald-van der Kley and Reijerkerk 2009) As Hossein and Ameneh mentioned in the book *Toward an Integrative Theory of Urban Design*, the application of design principles in a specific environment requires the great effort to modify them for that particular environment. General principles might be meaningless in certain environments unless they are modified and tested for that specific culture or context. (Bahrainy and Bakhtiar 2016) To increase the success possibility of water management project, cultural context is vital aspect calling for integration.

In addition, UNESCO indicated the important relationship between water and culture in 2003: "Relations between peoples and their environments are embedded in culture. The intimate relationship between water and peoples should be explicitly taken into account in all decision-making processes." (Schelwald-van der Kley and Reijerkerk 2009) However, frequently, in the problem-solving process, people are often ignored. (WWAP 2015) In reality, climate hazards not only damage physical environment, disrupt daily life, but also affect public health (Rosenthal et al. 2007) and bring water-related diseases (WWAP 2015). People are the biggest victims of climate hazards (Fig. 1-1-6) so social influences should be involved in the process of tackling water issues of the city.

In order to mitigate economic losses and human casualties, measures were applied in many cities not only in developed countries but also in developing countries including China. One iconic water management project is Donghaochong canal management project in Guangzhou. Because of the consideration of local culture, the project revealed more additional values which on one hand physically solved water problem on the other hand attracted nearby residents well-regenerated from a lost space into a vivid public space. (Fig. 1-1-7) The achievement of these kinds of projects shows the potentials and the great advantages of socio-cultural water management. Therefore, emphasizing on increasing water resilience on the socio-cultural perspective is not only a global potential but also of great benefit in Guangzhou.



Fig. 1-1-7 Picture captured daily use of Donghaochong by local residents
Source: <https://tonyw20.tuchong.com/1002072/>

1.2

PROBLEM FIELD

1.2.1 WATER RESILIENCE

So far, to alleviate climate change effect and water risk, resilience is proven to be "more than successful climate adaptation", it not only addresses climate impacts but also reduce climate disaster risks. (Otto-Zimmermann 2012)

The meaning of resilience discussed in this report was developed from the explanation of "ecological resilience" first introduced by the Canadian ecologist C.S. Holling, who derived it from the exploration of ecological theories and the behavior of natural systems. (Holling 1973) Resilience, currently defined by IPCC, refers to "The ability of a social or ecological system to absorb disturbances while retaining the same basic structure and ways of functioning, the capacity for self-organization, and the capacity to adapt to stress and change." (Baede, Linden, and Verbruggen 2007) And resilience related to flood risk denotes "the capacity of a system to tolerate flooding and to reorganize when physical damage and socio-economic disruption occur, so as to prevent deaths and injuries and maintain current socio-economic identity". (Salinas Rodriguez et al. 2014) The modern discourse on resilience usually focuses on the system's ability to self-organize, adaptation to changes and relation to social or social-ecological systems. (Wu and Wu 2013)

Since the concept of resilience is derived from natural system and ecological theories (Holling 1973), natural environment sustains the quality that cities are recently calling for, regarding the improvement of resilience. Correspondingly, one major reason that leads to the chaos of systems and the decrease of resilience is urban development. (Wu and Wu 2013) According to NASA, the main consentaneous cause of the current climate change is human expansion. (NASA 2017) And In Guangzhou, the fundamental reason causing waterlogging is rapid urbanization. (Wan, Huang et al. 2016) Therefore, the essence of increasing water resilience is understanding the process of natural environment and design towards it.

To solve water-related issues, understanding natural water cycle is necessary. Natural water system usually recurs four phases: evaporation, precipitation, infiltration and surface runoff. However, in urbanized areas, this process is disrupted presenting the consequences of lower evaporation and increased surface runoff due to impermeable paved surface, reduced infiltration because of the alteration of natural land covers. (Hoyer 2011) (Fig. 1-2-1) Deriving from it, many countries around the world are currently striving to use sustainable water management techniques to increase evaporation, slow down surface

runoff, and facilitate infiltration in order to repair urban water cycle towards natural water cycle. (Fig. 1-2-2)

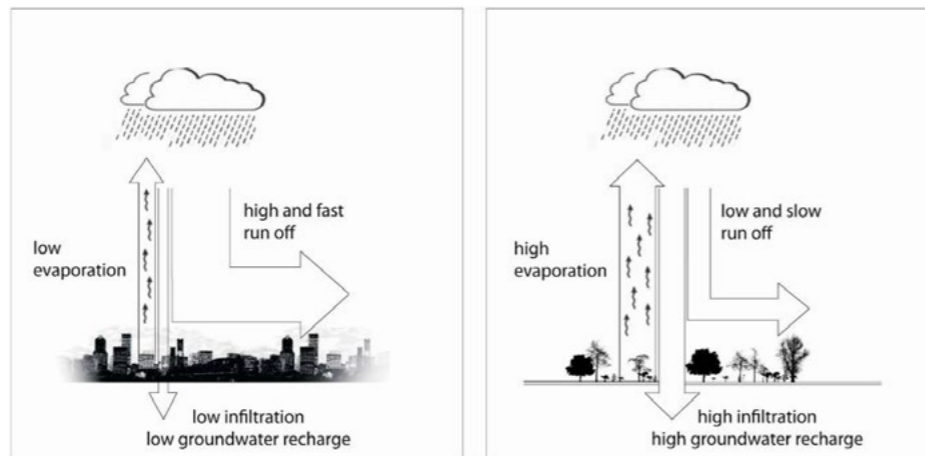


Fig. 1-2-1 Urban water cycle in comparison with natural water cycle
Source: Hoyer (2011)

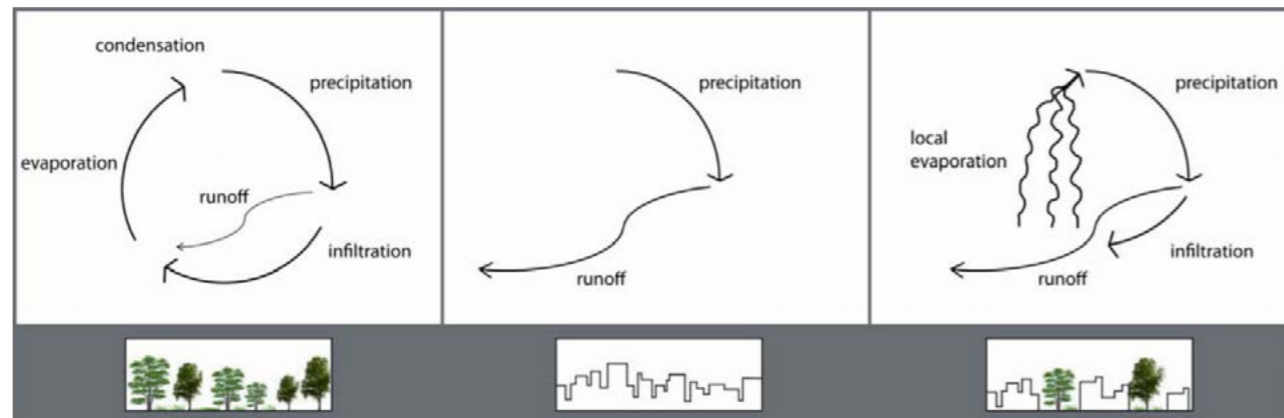


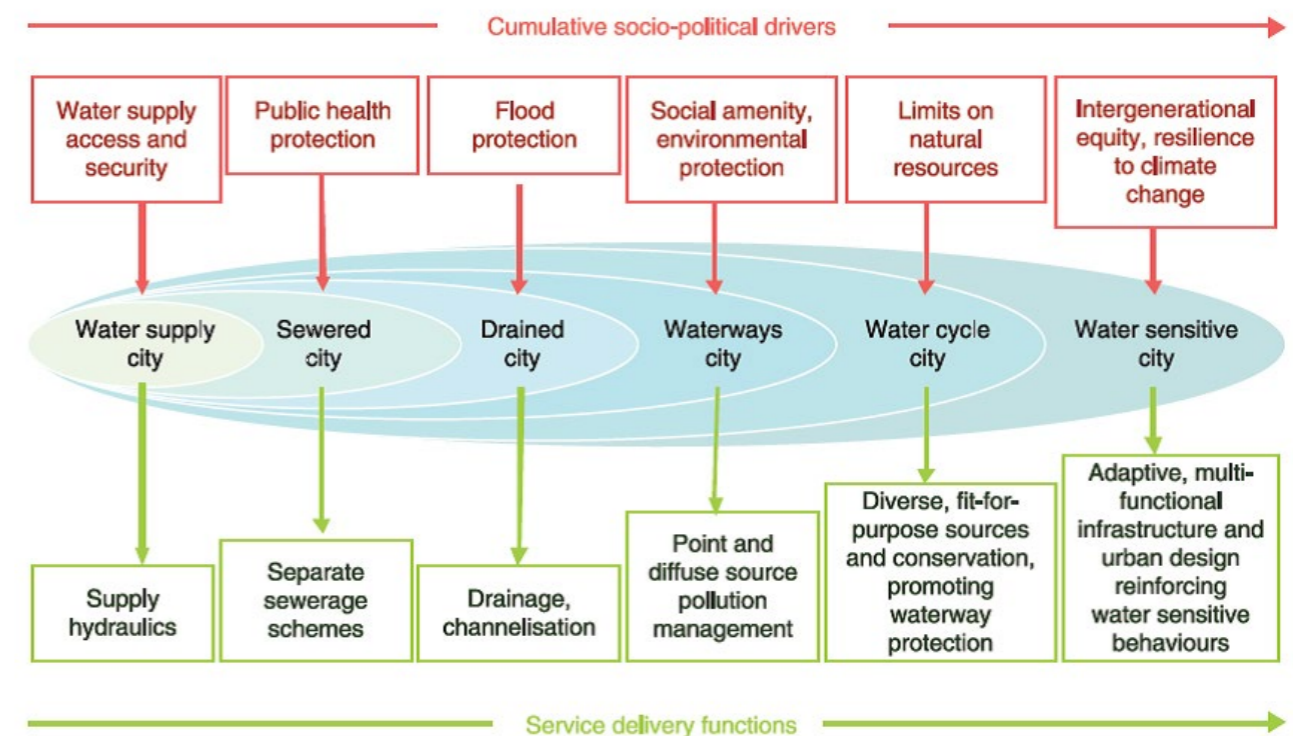
Fig. 1-2-2 Water cycle in natural systems (left); in an urban area without sustainable stormwater management (middle); and in an urban area with sustainable stormwater management (right)
Source: (Hoyer 2011)

1.2.2 URBAN WATER MANAGEMENT TRANSITION

Based on the study of Brown, Keath, and Wong (2009), urban water management would go through several phases before reaching a relatively sustainable and resilient circumstance. (Fig. 1-2-3) These phases are defined as: Water supply city, Sewered city, Drained city, Waterways city, Water cycle city and Water Sensitive City. According to the research, urban water management transition mainly depends on socio-political drivers and service expansions. During the first three phases i.e. water supply city, sewered city, drained city, socio-political drivers are basically unaffected. Government leads services expansion including sewage, drainage and flood control services fulfilling the demand of city development. The transformation process of these three phases is conquered by technical development. As the advent of waterways city towards water sensitive city, institutions representing environmental protection needs to play an important role. Social perspective becomes the motivate force of the transition process. Consequently, water sensitive city is with adaptive institutional regime and diverse infrastructure. (Wong and Brown 2009)

Hence, social factors occupy key position if cities are willing to be promoted towards a more advanced and sustainable phase.

Fig. 1-2-3 Urban water management transitions framework
Source: (Brown, Keath et al. 2009)



1.2.3 WATER CHALLENGE & SPONGE CITY IN CHINA

Recent years, many cities in China suffered from storm water calamities including big Chinese cities such as Tianjin, Beijing, Shenzhen and Shanghai, etc. (Fig. 1-2-4). Ministry of Housing and Urban-Rural Development (MOHURD) in China investigated 351 cities concerning the waterlogging problem. The statistic showed that waterlogging had occurred in 62% of all investigated cities. (Fig. 1-2-5)(Tencent News 2016)

Due to the prominent water problem, in 2014, a policy was released called *Sponge City Construction Technique Guide* (海绵城市建设技术指南) to encourage ecological approach and integrated solution for sustainable water management in urban and rural areas of China. (Yu, Li et al. 2015) Nevertheless, because China is at the experimental level of sustainable water management, various problems and potentials coexist. Based on the urban water management transitions framework (Fig. 1-2-3) put forward by Brown, Keath and Wong (Brown, Keath et al. 2009), China is at the "Drained city" phase, concentrations are on the technical field (Liu and Li 2016) while social impacts are not focused. To promote future development, social study should be incorporate into water management in China.

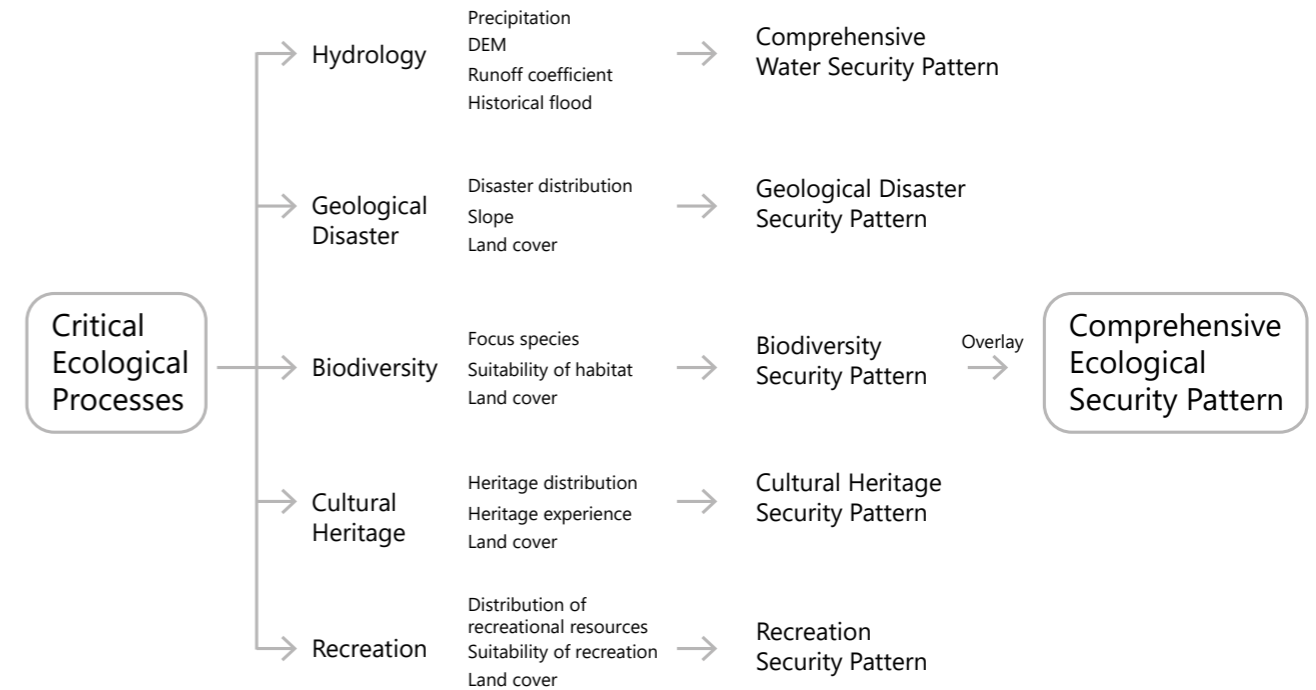
Fig. 1-2-4 Locations of Big Chinese cities and water logging phenomena
Source: Adapted from <http://www.chinahighlights.com/guangzhou/map.htm>



Fig. 1-2-5 Diagram of Water logging Happened Times of 351 Chinese cities
Source: Tencent News (2016)

Based on current Sponge City approach and completed projects study, (Yu 2016) Chinese approach is to use spatial and technical methods to achieve ecological goal. The concentration is on large scale plan, so the feasibility and effect of these projects are not carefully evaluated. From the process framework (Fig. 1-2-6) we can see that social influence is totally left out; Cultural factors are stuffless and superficial. The social and cultural value is not fully considered and taken advantage of. Therefore, to promote future development, social and cultural study should be strengthened and incorporated into water management in China.

Fig. 1-2-6 Sponge city analytical framework: the general process of establishing ecological infrastructure
Source: Adapted from Yu (2016)



1.2.4 WATER CHALLENGE IN GUANGZHOU

Guangzhou is also a typical Chinese city under water-risk threats. Guangzhou is located at the southeast part of China, on the verge of South China Sea. Its special location makes it often attacked by typhoon in summer which always appears along with heavy rainfalls and strong winds. Moreover, Guangzhou has a humid subtropical climate influenced by the East Asian monsoon. That means it has high temperature and humidity all year round accompanied by frequent and high volume rainfalls in summer. (Fig.1-2-7) The amount of annual precipitation is astonishingly large with more than 2000mm, comparing the annual rainfall in Rotterdam (816mm) (Hoyer 2011).

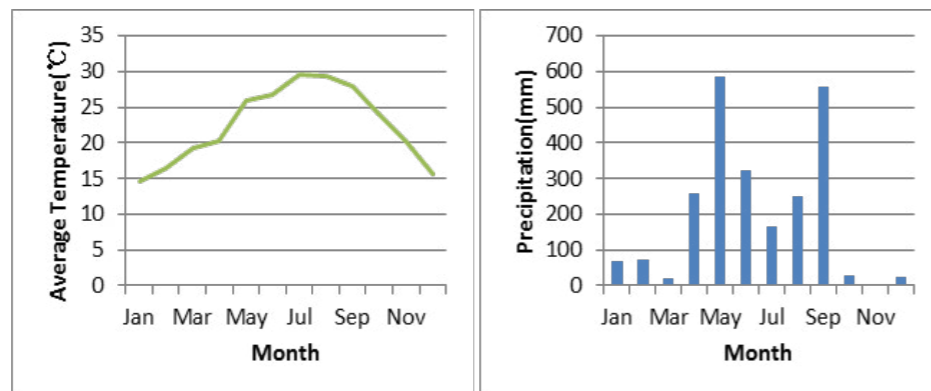


Fig.1-2-7 2010 Guangzhou climate diagram
Data resources: climate statistic data in Guangzhou Meteorological Bureau (<http://www.gz121.gov.cn/>)

Because of its original climate, water issue is one of the main climate challenges in Guangzhou. Every year, storm water hazards cause numerous economic losses and damages large number of physical environments. According to Guangzhou annual climate report released by Guangzhou Meteorological Bureau (Hu 2011), in the recent 5 years, waterlogging hazards appeared every year and grew into a really thorny problem for this city. On May 23rd 2014, the storm rainfall influenced four districts and over 700 million Yuan (about 100 million euros) flowed away along with water (Wan, Huang et al. 2016). Waterlogging not only disrupts daily life of local residents but also increase the possibility of waterborne pollution and disease (malaria, dengue fever) affecting public health. (WWAP 2015) Moreover, climate change leads to sea-level rise, which intensify the pressure on flood risks in Guangzhou. (Fig. 1-2-8) According to the assessment done by Hallegatte, Green et al. of all the 136 coastal cities analyzed, Guangzhou were estimated to have the highest average annual flood losses (AAL) (Hallegatte, Green et al. 2013) (Table 1-1) Therefore, to increase water resilience is not only a global requirement, but also a local urgency in Guangzhou.

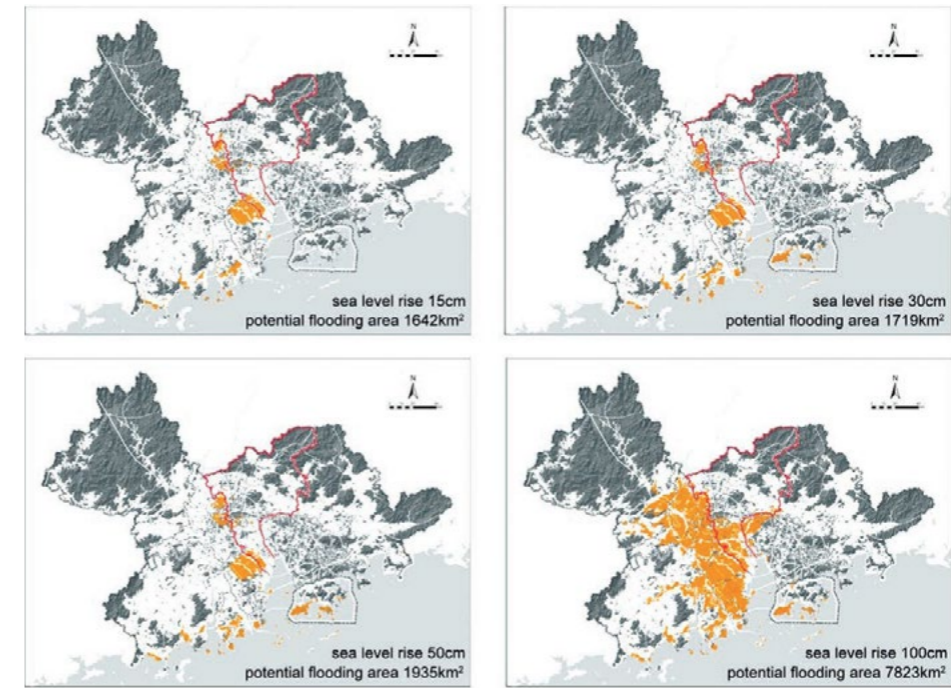


Fig. 1-2-8 Potential Flooding Areas of the Pearl River Delta with Current Flood Defense
Source: (Carmona, Qu et al. 2014)

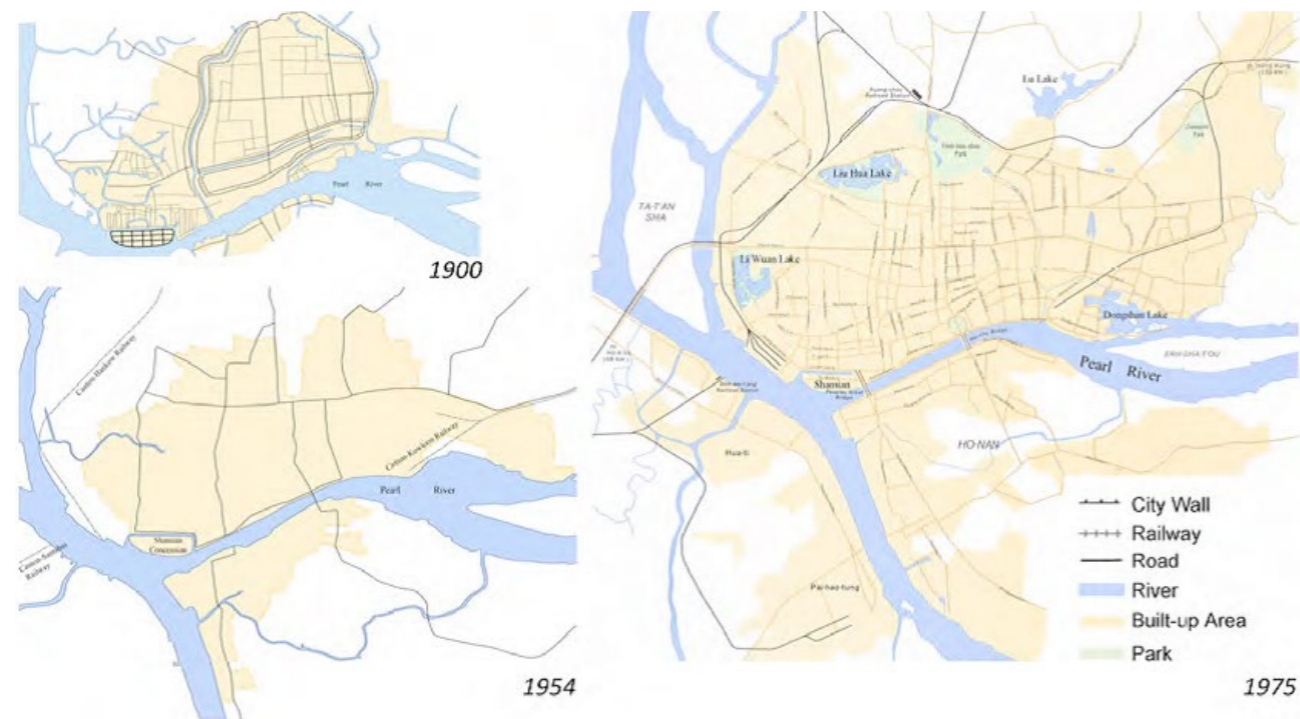
Table 1-1 City ranking by risk (AAL) and relative risk (AAL in percentage of GDP) for 2005
Resource: <http://www.nature.com/>

Ranking by AAL (US\$million)					Ranking by relative AAL (percentage of city GDP)				
	Urban agglomeration	100year exposure	AAL, with protection (US\$million)	AAL, with protection (percentage of GDP)		Urban agglomeration	100year exposure	AAL, with protection (US\$million)	AAL, with protection (percentage of GDP)
1	Guangzhou	38,508	687	1.32%	1	Guangzhou	38,508	687	1.32%
2	Miami	366,421	672	0.30%	2	New Orleans	143,963	507	1.21%
3	New York—Newark	236,530	628	0.08%	3	Guayaquil	3,687	98	0.95%
4	New Orleans	143,963	507	1.21%	4	Ho Chi Minh City	18,708	104	0.74%
5	Mumbai	23,188	284	0.47%	5	Abidjan	1,786	38	0.72%
6	Nagoya	77,988	260	0.26%	6	Zhanjiang	2,780	46	0.50%
7	Tampa—St. Petersburg	49,593	244	0.26%	7	Mumbai	23,188	284	0.47%
8	Boston	55,445	237	0.13%	8	Khulna	2,073	13	0.43%
9	Shenzen	11,338	169	0.38%	9	Palembang	1,161	27	0.39%
10	Osaka—Kobe	149,935	120	0.03%	10	Shenzen	11,338	169	0.38%
11	Vancouver	33,456	107	0.14%	11	Hai Phòng	6,348	19	0.37%

1.2.5 WATER AND GUANGZHOU CITY

Although water poses threats on Guangzhou, this city has close relationship with water since ancient time. Ancient Guangzhou was a “Lingnan” water village with dense water network. Urban pattern and development mode were all affected by water system. (Tai 2011) (Fig. 1-2-9) And many unique traditions and local customs were grew relate to water such as sea and sea gods worship rituals, waterfront festivals and etc. Even lifestyle and cognition of Canton residents are influenced by water. (Lin 2014)

Fig. 1-2-9 Guangzhou city transformation and water sytem
Source: Tai (2011)



Back in 2003, at the third World Water Forum in Kyoto, UNESCO clearly indicated the relationship between water and culture and the importance of integrating people and cultural dimension in water management : (Schelwald-van der Kley and Reijerkerk 2009)

- Water is a vital resource, having economic, ecological, societal and spiritual functions. Consequently, its management greatly determines sustainability.
- Due to its fundamental role in the life of societies, water has a strong cultural dimension. Without understanding and considering the cultural aspects of our water problems no sustainable solution can be found.
- Relations between peoples and their environments are embedded in culture. The intimate relationship between water and peoples should be explicitly taken into account in all decision-making processes.
- The ways in which water is conceived and valued, understood and managed, used or abused, worshipped or desecrated, are influenced by the cultures of which we are a part.
- As the frequent failure of “imported” solutions has proven, water resources management will fail if it lacks the full consideration of these cultural implications.”

Due to the prominent water problem in Guangzhou and under the Sponge City guide, sustainable water management is the future trend in Guangzhou. And at this phase, Guangzhou is exploring its own approach. Some projects incorporated socio-cultural dimension into water management (Fig. 1-2-10) while others were not. (Fig. 1-2-11) Hence, following the current Sponge City approach, Guangzhou is facing the threat that local culture and social impact will be neglected during the process of urban design and planning and finally squeezed out by technical projects.



Fig. 1-2-10 (left) Donghao-chong Water management Project: consideration of social and cultural importance
Source: <https://tonyw20.tuchong.com/1002072/>

Fig. 1-2-11 (right) The first Sponge City Experimental Project in Guangzhou—Daguan Wetland Park: solely ecological and technical project
Source: <http://www.archcy.com/>

1.2.6 PUBLIC SPACE POTENTIALS



Fig. 1-2-12 Public spaces in Guangzhou cannot function normally because of water issue
Data resources: 2010 Guangzhou climate report

Since social impacts should not be neglected during Sponge City construction, public space as “a meeting place and social forum for city dweller” (Gehl 2010), requires much attention on people. It is a good spot to conduct socio-cultural investigation and reflect civic life when tackling water-related issues.

Public space is of great importance for cities’ economy, social cohesion, public health and transportation, environment and safety(Bishop 2016). The regeneration for a higher quality public space can create economic, social and environmental value(Woolley, Rose et al. 2014) , which leads to a more sustainable city. When public space is not resilient enough to water nuisance, a devastating water-related disaster will disrupt public life and eliminate all values that public space owned originally. But adding water resilience to public space can not only maintain the original value that public space brings to the city, but also mitigate the consequence of climate change: attractive public space increase investment while water disaster cost economic losses; attractive public space help to improve physical and mental health while climate change might cause bad effects on public health(Goodman 2014); climate change brings “heat island effect” while good-quality public space can help to redress it. (Woolley, Rose et al. 2014)

Because of the high-value of public space and the disruptions brought by water disturbances, (Fig. 1-2-12) public space is a main focus to testify sustainable water management, during the current Sponge City development in Guangzhou. Guangzhou's first Sponge City experimental project—Daguan Wetland Park is a regional public space.

However, based on local urban designers’ reflection¹, these projects are mostly focus on spatial and technical aspects, while lacking consideration of local residents. Neither the design process nor the afterwards usage situation emphasize on local people. This may result in a dramatically drop of the vitality and attractiveness of public space in Guangzhou. Moreover, because Sponge City planning is led by Beijing Turenscape City Planning and Design Corporation, ecological function is highly focused while local culture is somehow neglected or superficially reflected. The ignorance of local culture will cause the gradual disappearance of traditions and city identity. (Guo 2007)

Therefore, public space in Guangzhou is facing huge water threats, and some public spaces in Guangzhou are under the possibility to lose vitality due to the lack of urban design, which includes local culture, people’s need and water management.

¹ Interview with urban designers in Guangzhou Urban Planning & Design Survey Research Institute on 28 Nov. 2016

1.3

PROBLEM STATEMENT

Under the climate change background and the threats brought by water risks, public spaces in Guangzhou lacks water resilience to maintain its basic function and value when facing water disturbances. And in the future, public spaces are under the threat of losing vitality and identity for technical focused projects, lacking consideration of social and cultural dimensions.

1.4

HYPOTHESIS

Currently, according to many countries' experiences, sustainable water management is mostly used to solve water risks and increase water resilience in practices, which largely depend on technical measures. At this phase, solely technical approach may result in some positive effects. However, deriving from the urban water management transition scheme put forward by Brown, Keath et al. (2009), if cities want to transform towards a more sustainable condition, solely technological dependence is not enough. Therefore, an integrated approach is the demand for cities to move forward.

Social study especially on human dimension has been overlooked for decades; however, it is peopling that use city space in large numbers. In the future, urban population is expected to keep growing, the focus on human needs is necessary. (Gehl 2010)

Cultural dimension is important in sustainable water management. Back in 2003, at the third World Water Forum in Kyoto, UNESCO clearly affirmed that the intimate relationship between water and peoples should be explicitly taken into account in all decision-making processes. Therefore, managing water is as much cultural as it is technical. For these and other reasons, the cultural dimension of water and its management deserves further exploration. (Schelwald-van der Kley and Reijerkerk 2009)

So here, it is expected that public space with abundant water resilience which created under the integration of technical, social and cultural dimensions contribute to building a more sustainable city.

1.5

RESEARCH QUESTIONS

According to the urgency of constructing water resilient public space and some related research possibilities attached to it, the following research questions are put forward:

What kind of spatial interventions integrating technical, social and cultural dimensions to solve water risks in public space?

To answer the main questions, the following sub questions are put forward to formulate the whole research:

- a. What are the future water challenges in public space as the consequence of global climate change?
- b. What kind of spatial solutions can increase water resilience?
- c. What kind of spatial solutions can evoke public space for people?
- d. How can climate adaptive measures adapt to local Chinese nature value?
- e. How can resilient public space design measures fit in local life and planning culture?

1.6

METHODOLOGY

Wang and Groat in the book *Architectural Research Methods* categorize research strategies into seven types: historical research, qualitative research, correlational research, experimental and quasi-experimental research, simulation research, logical argumentation and case study. (Wang and Groat 2013) Thus, methods chosen to conduct the whole research are based on the upper mentioned research category.

Logical argumentation: Question a, b, c, d, e

Methods: literature study, category, graphic image

Literature study helps the researcher to figure out water challenges studies by other academic researches and information about water resilience, green-blue measures, general disciplines of people's behaviors in public space and Chinese culture study.

Categories are used to extract main ideas and organize the logic and interrelation between different theories.

Graphic Image is a very visual and direct way to reveal the relation between climate change VS water challenge, the green-blue measures VS water resilience, the green-blue measures VS public space, and exotic approaches VS Chinese culture and value.

Qualitative research: Question a, c

Methods: observation with counting, location and behavioral mapping and photographing, interview of urban designers in Guangzhou.

Observation helps to "better understand the need of uses and how city spaces are used" (Gehl and Svarre 2013). By observation, more detailed and local disciplines of people's behaviors can be revealed. This can make later design more communicative to local culture and environment. Counting during observation provides quantitative data which can be used to qualify design. Mapping is mainly used to study local activities in public space and quality of physical environment. Photographing is for documenting public life and conditions for life in public space with lively data. (Gehl and Svarre 2013)

In-depth Interview is used to get information about current Sponge City development in Guangzhou.

Case study: Question e

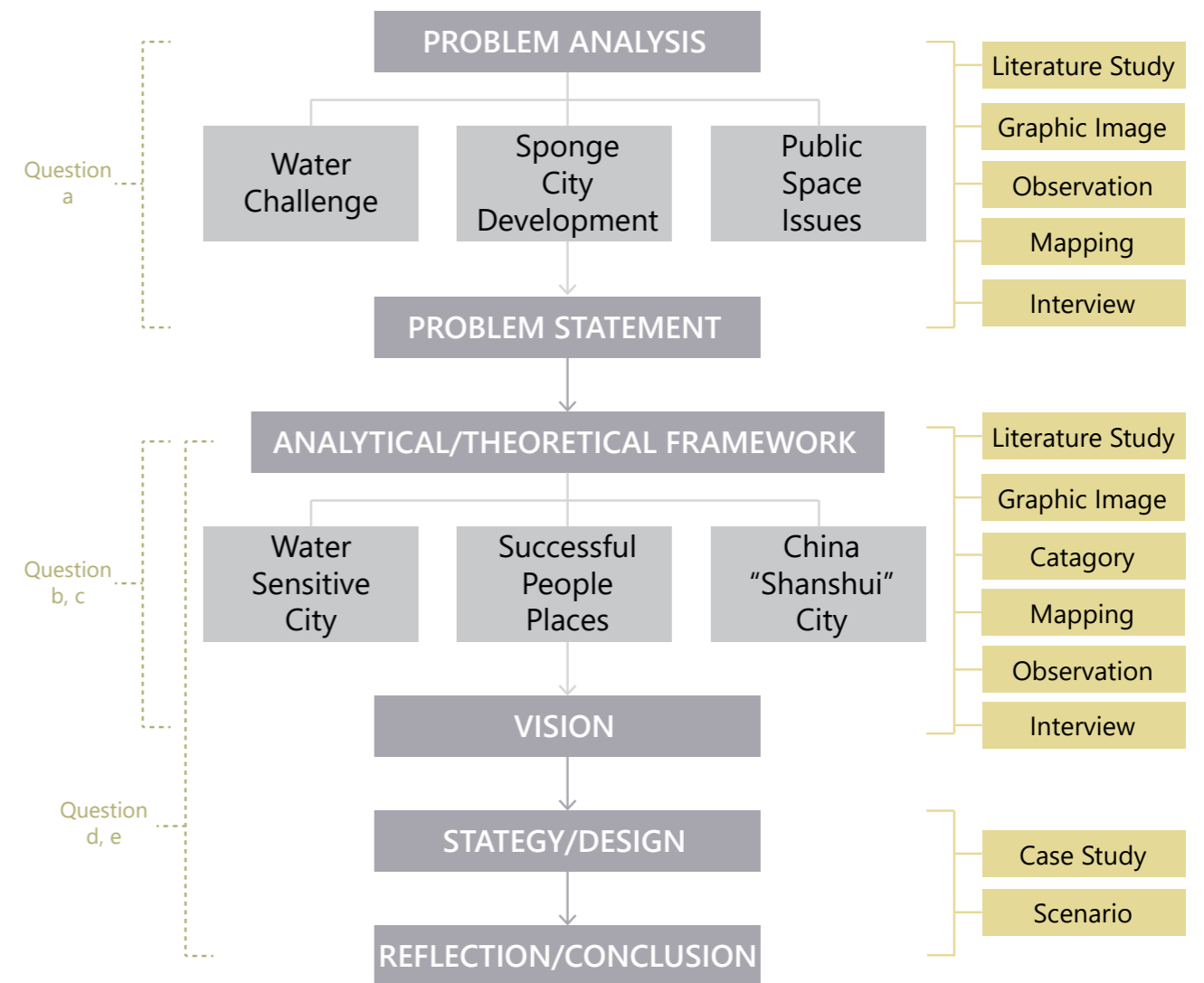
Cases aim for: Successful water sensitive urban design integrating technical, social and cultural influences.

Case study allows investigators to retain the holistic and meaningful characteristics of real-life event (Yin 2009) and give some pragmatic examples when apply design approaches to actual space. So case study here can illustrate in actual use, how green-blue measure benefit public space quality and the integration of local culture and green-blue measures.

Scenario Building: Question d, e

A scenario illustrates visions of possible future. It is an emblematic method for foresight or future studies. (JRC 2016) This project contains concepts of water resilience and climate change which rely on future expectation and consist of many uncertainties. When it comes to application of climate adaptive measures on public space, scenario building can be used as an exploratory method or tool to help specify the uncertainty and spatial possibility.

Fig. 1-6-1 Methodology Scheme
Source: Drawn by author



1.7 RELEVANCE

1.7.1 SOCIAL RELEVANCE

Nowadays, media in European and American countries already try to raise the awareness of the public about social and environmental impacts of climate change. (Fig. 1-7-1) It is expected that climate change will get worse and worse leading to damages on both physical environment and public health. Therefore, not only dealing with climate change is a societal urgency but also incorporating social reflection on climate adaptation measures is the requirement of the society.

In China, many cities suffered from waterlogging and flood for many years, it remains as an un-solved problem in the whole country. And because of climate change, this problem will pose more challenge on urban planning and design in the future. So the society is asking urban planner and designer to look for more sustainable approaches to face water issues. (Fig. 1-7-2) And this project is related to both global and local societal problems in China.



Fig. 1-7-1 Newspaper Article about climate change impacts
Source: DAILY NEWS
<http://www.dailynews.co.tz/>

Fig. 1-7-2 Newspaper Article about waterlogging in Guangzhou and Shenzhen
Source: <http://mt.sohu.com/>

1.7.2 SCIENTIFIC RELEVANCE

Because of the large-range impacts of climate change in particular water risks, there are already a lot of researches showing the fact that cities need more resilience to adapt to future changing circumstances. Some research was on the theoretical level, creating theories about resilience thinking as the foundation of urban planning and design.(Wu and Wu 2013) And some researchers tried to find design solutions to increase water resilience including water sensitive urban design (Salinas Rodriguez et al. 2014) and green-blue grid (Pötz 2016) etc. Others focused on the localization of current climate adaptive measures to support practical local planning. For example, Stephen Tyler built up assessment indicators of urban climate resilience in Asian cities, (Tyler et al.) Najet Aroua established criteria and indicators for local vulnerability and resilience assessment. (Aroua 2016)

For public space study, since 1960s, Jane Jacobs (Jacobs 1961) raised researchers' attention on public life, more and more studies focused on public space and public life. People's needs and behaviors were studied for high quality public space design. Recent decades, studies on people were more and more sophisticated and adapted to actual urban spaces design. For instance, the book People Places (Marcus and Francis 1998) has given design guidelines for urban square, street park, city park, campus, outdoor spaces for the elderly, children and the hospital according to people's needs. In 2010, Jan Gehl, who is specialized on people studies for many years, summarized design requirements on public space based on human scale. (Gehl 2010)

Since cities are under climate change challenge while social focus has been overlooked simultaneously public space can be a bridge to study people, this research tries to build up the link between the results of research in the field of water resilience, urban design, and public life and how to apply theories to spatial design solutions in order to contribute to the body of knowledge.

1.8

TIMETABLE

The planning of the whole graduation time arrangement helps to reasonably schedule assignments of different time periods and reach the final goal at the limited time. In general, the time till P2, problem analysis and statement should be formulated, so as the majority part of theoretical framework. A fieldtrip to Guangzhou was organized during this time, which is the starting point of site study and trigger the analytical framework study. In addition, a vision is aim to put forward and guide the whole research till the end. After P2 till P3, it is aim to finish the analytical framework, come up with strategies and form the first idea of design. And then, scenarios are used to test strategies and design concept combined with the results of site study. Finally, the last one month will be spent to improve the research, draw conclusions and prepare the final presentation.

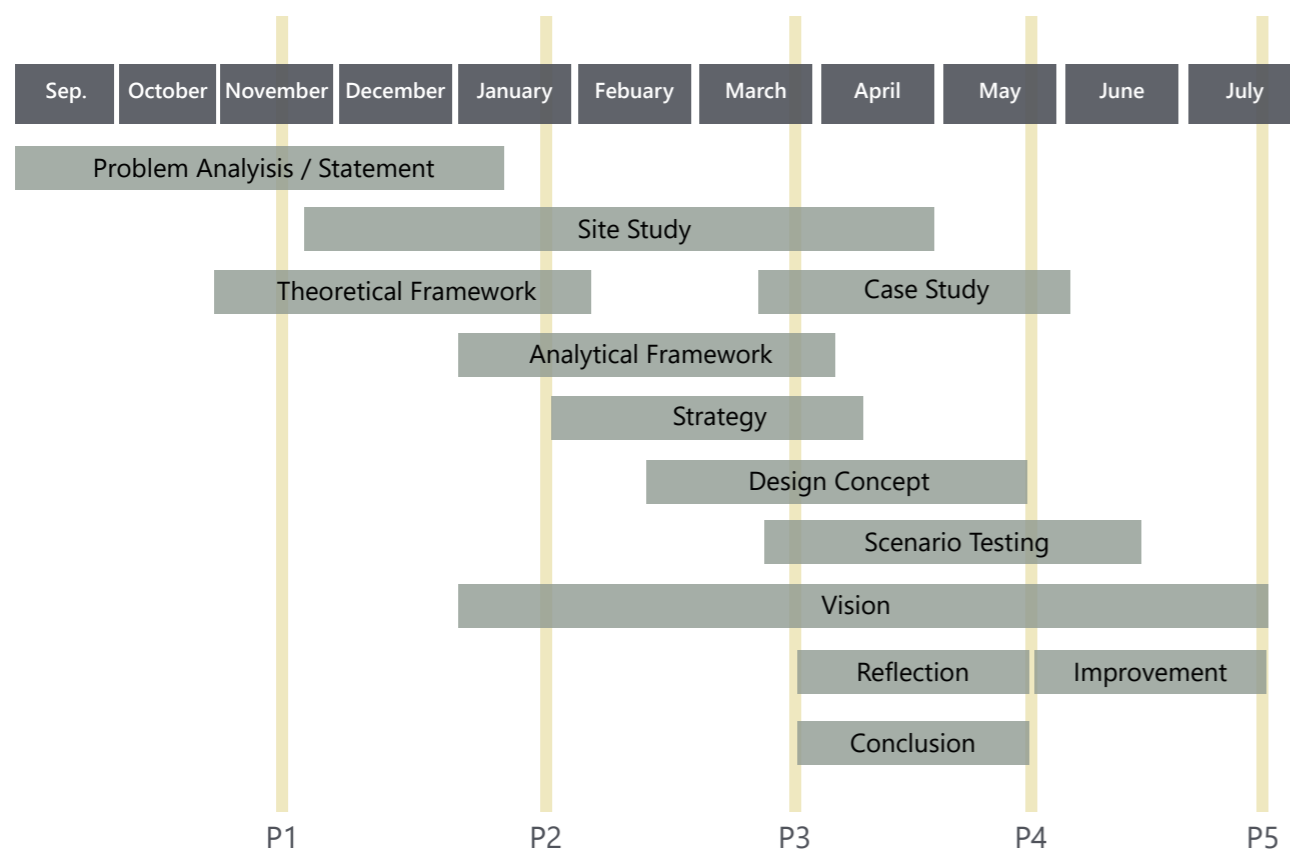


Fig. 1-8-1 Time-schedule Scheme
Source: Drawn by author



2 THEORETICAL FRAMEWORK

2.1

INTRODUCTION

Since the goal of this project is to create an integrated approach deriving from technical, social and cultural consideration of public spaces to solve water risks. Different theories relate to these aspects are reorganized to formulate integrated design principles. (Fig. 2-1-1)

The first part is focused on Water Sensitive City. This notion is put forward based on Australian water management and it is now well-developed from theory to practice incorporating with urban planning and landscape design. The study of Water Sensitive City aims at providing technical support to increase water resilience and get advance experiences of how to combine water management with spatial design as well as stakeholders.

The second part is structured according to public space design theory: how to make successful people places. This part is aimed to provide social study support about how to reflect human needs spatially.

The third part is about Chinese nature value and the reflection on traditional urban design and garden design. These theories give a glimpse about Chinese culture regarding nature.

Finally, new interpretation about the first two theories based on Chinese culture is revealed as the foundation of putting forward cultural contextualized water sensitive public space design principles as well as corresponding indicators which guide the afterwards analytical study.

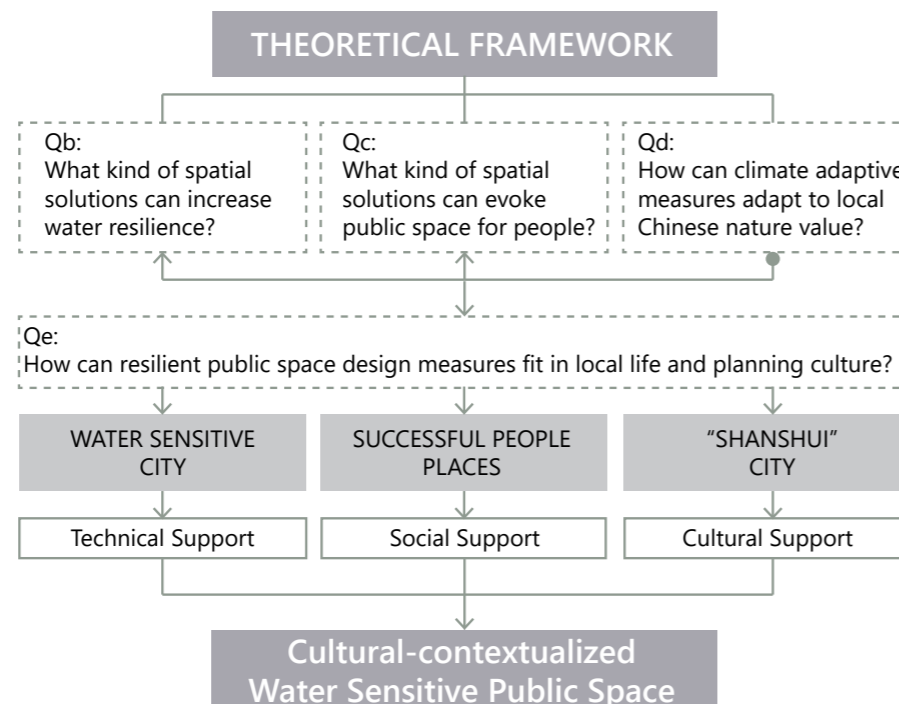


Fig. 2-1-1 Preliminary Theoretical Framework Source: Drawn by author

2.2

WATER SENSITIVE CITY

Water sensitive city is a vision seeking to "protect and enhance the health of receiving waterways, reduce flood risk, and create public spaces that harvest, lean, and recycle water." The ultimate water sensitive vision is to "facilitate better liveability outcomes more broadly, through enhancing biodiversity and providing increased public green space, healthy waterways, and connected communities" by integrating water and urban planning. (Brown, Rogers, and Werbelof 2016) In the water sensitive vision described by CRCWSC, a water sensitive city is the combination of the resilient, liveable, productive and sustainable city. (CRCWSC 2016)

2.2.1 THREE PILLARS OF WATER SENSITIVE CITY

Adopting socio-technical approach has been identified as the most promising on the reflection of the requirement for resiliency. (Meadowcroft 2005) Water sensitive city is a vision attempting to translate system resilience and socio-technical perspective into principle for practice. (Wong and Brown 2009) Based on Wong and Brown (2009), it can be categorized into three key pillars as guidance for practice, which also guides the basic structure of this chapter:

- "1) Cities as Water Supply Catchments: access to a diversity of water sources underpinned by a diversity of centralized and decentralized infrastructure;
- 2) Cities Providing Ecosystem Services: provision of ecosystem services for the built and natural environment; and
- 3) Cities Comprising Water Sensitive Communities: socio-political capital for sustainability and water sensitive decision making and behaviours."

Diversifying Water Sources and Infrastructures

According to the resilience study, urban systems are heterogeneous facilitated by diversity (Holling 2001), hence, fostering diversity in cities is vital for tackling water issues and increasing resilience. When it comes to water management, the diversity presents in two aspects: water resources and infrastructures.

Cities can have access to a wide range of water resources apart from the conventional form of potable water. Making use of alternative water resources including groundwater, stormwater, rainfall and wastewater can substitute conventional potable water and optimize urban water usage. (Wong and Brown 2009) In addition, to diversify the accessibility of various water resources breaks the reliance on current water system, which guarantees water security in a way and mitigates urban vulnerability.

Of course, the accessibility to alternative water resources should be optimized through "the availability of diverse infrastructures associated

with the harvesting, treatment, storage and delivery of the water source” Diverse infrastructures refer to both centralized and decentralized water systems. (Wong and Brown 2009) One evident application of this principle is the construction of secondary water supply pipeline. Non-potable water collected from alternative water resources can be transported and supplied through this pipeline system to replace part of current potable water use including toilet flushing, garden irrigation, and laundry. (Fig. 2-2-1) And this approach is financially feasible because the cost of building secondary water supply pipeline is much lower than retrofitting exiting pipeline system. (Wong and Brown 2009)

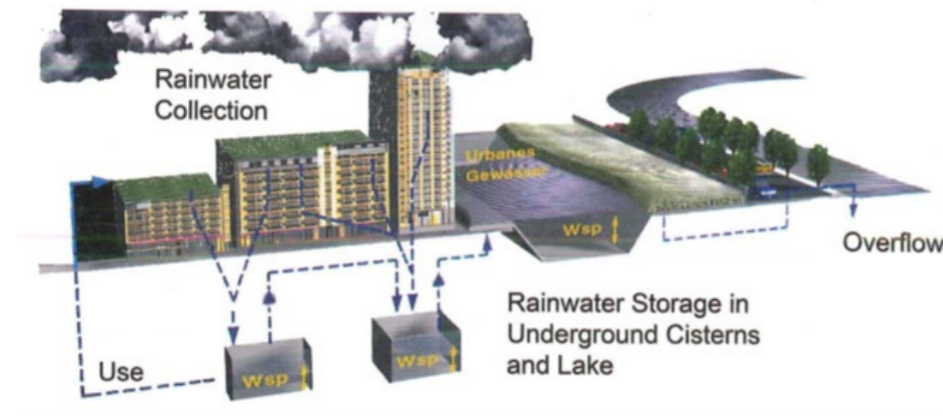


Fig. 2-2-1 The example of rainwater as alternated water resources (Potsdamer Platz in Berlin): rain is collected and stored in underground cisterns, eventually used in gardens and sanitation. Source: Hoyer (2011)

Providing Ecosystem Services

Due to climate change, cities are facing new challenges. Resilience should be incorporated in urban design to face future uncertainties in urban water supplies and climatic extremes. (Wong and Brown 2009) Making use of alternative water resources supported by diverse infrastructures is an approach in the reflection of resilience. Among alternative water resources, stormwater is well accepted as valuable alternate water resources (T.H.F. et al. 2013) , however, also closely related to the impacts of climate change. Therefore, stormwater management becomes central focus of climate adaptation issues. Nevertheless, conventional urban design has little to do with improving stormwater quality and its management as important alternated water sources, which triggers the emerging significance of green infrastructures, the philosophy behind water sensitive urban design (WSUD). (Wong and Brown 2009)

According to the 2006 Millennium Ecosystem Assessment (MA), ecosystem services are "the benefits people obtain from ecosystems". (Wikipedia 2016) Water Sensitive Urban Design is an approach for cities providing ecosystem services through urban spatial design so as to alleviate and adapt to floods and bring urban water cycle closer to natural one. (Kuzniecowa Bacchin et al. 2014)

Instead of centralized water systems, decentralized measures are the emphasis of WSUD in order to increase water systems diversity. Its main approach is to "mange water above ground rather than below" and to

"utilise green and blue rather than/ or complementary to traditional piped (grey) infrastructure" (Kuzniecowa Bacchin et al. 2014) In this case, the manipulation and the interaction among vegetation (green), water (blue) and soil, are the key concept behind WSUD.

The manipulation and the interaction among vegetation (green), water (blue) and soil have great impacts on water resilience and climate adaptation. From the perspective of natural water cycle, several phases influence the water system: evaporation, precipitation, infiltration and surface runoff. Green space helps to reduce surface runoff by provision increased storage supported by utilizing urban sustainable urban drainage (SUDS) techniques, such as creating swales (Fig. 2-2-2), infiltration, detention and retention (Fig. 2-2-3) infrastructures. Besides, green areas are mostly effective at facilitating rainwater infiltration through vegetated surface on fast infiltrating soils such as sandy soils. (Gill et al. 2007) Higher volume of green areas add urban evaporation rate simultaneously vegetated surface lower down surface runoff leaving more time for evaporation. When it comes to precipitation, green surfaces help stormwater treatment. And some green and water surfaces have sponge effect adding flexibility to urban systems so as to mitigating negative effects brought by precipitation uncertainty. (Pötz 2016) By rearranging vegetation, water and soil, urban water cycle will be more similar to natural water cycle; therefore, water resilience is increased.

Fig. 2-2-2 Swales of the police department in Brisbane, USA Source: Hoyer (2011)

Fig. 2-2-3 Biotopes for retention in Malmo, Sweden Source: Hoyer (2011)



Building Social and Institutional Capital

As cities transform towards water sensitive city, social-political capital plays more and more important part. (Brown, Keath, and Wong 2009) And technology alone will not drive cities to the final desired outcome. Brown (2008) argues that only water management technologies socially embedded into the local institutional context can it be feasibly implemented into practice. And researches in Melbourne (Wong and Brown 2009) showed that “the development of WSUD had been the result of a complex and sophisticated interplay between key champions (or change agents) and important local context variables”. The champions, representing a connected group of government, academia and the development industry, were not sufficient for successful implementations. Local context variables representing a mixture of ‘historical accidents’ and advocacy outcomes, also play a part of it. It is the associations and networks that assist in successful development of WSUD.

Moreover, both the acceptance on community level and the broad scale political support are fundamental for enhancing successful implementation rates. For example, public art can be used to highlight communities’ relationship with water and the general values of water so that public awareness and participation are raised regarding sustainable water management. (Wong and Brown 2009)

Social and institutional capital building is a reflection of the hierarchical structure of resilient systems. Because the building process mainly contains the interaction of three spheres of institutional capacity building: human resource development, intra and inter-organizational strengthening, and institutional reform. (Table 2-1) (Brown 2008) When developing WSUD, organizations on different levels including community, local hydraulic bureau, municipality or national environmental protection bureau, etc. and their inward interactions should be taken into account to increase resilience in terms of organizational hierarchical structure influences.

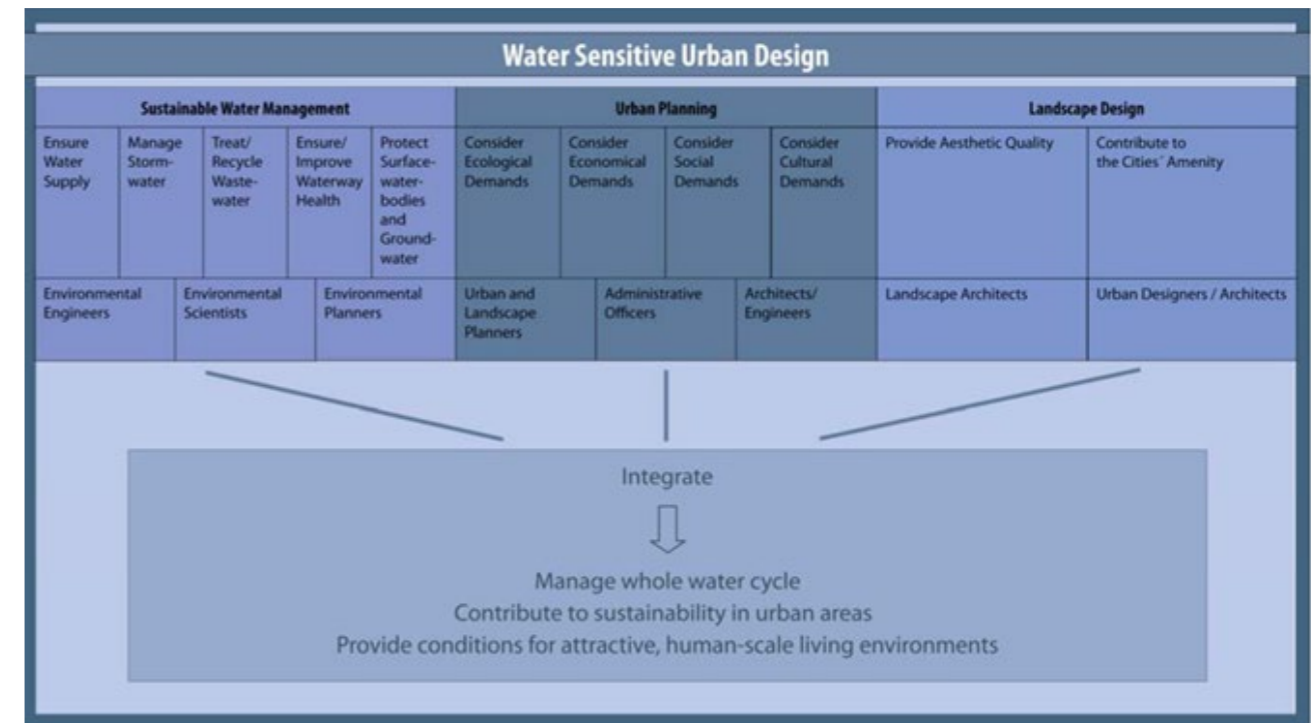
Table 2-1 Dimensions of institutional capacity building (Source: (Brown 2008))

Capacity building	Description	Interventions
Human resource development	Equipping individuals with the understanding, skills, and access to information, knowledge, and training that enables them to perform effectively	e.g., recruitment and training
Intra and Inter-organizational strengthening	Elaboration of management structures, processes, and procedures, not only within organizations, but also the management of relationships between the different organizations and sectors (public, private, and community)	e.g., incentive systems, leadership, communications
Institutional reform	Making legal and regulatory changes to enable organizations, institutions, and agencies at all levels and in all sectors to enhance their capacities	e.g., policy and legal change, constitutional reform

2.2.2 WATER SENSITIVE URBAN DESIGN PRINCIPLE

Water Sensitive Urban Design (WSUD) is an interdisciplinary approach with the corporation of water management, urban planning and landscape design, mostly concerned with stormwater management. (Hoyer 2011) (Fig. 2-2-4) It is an approach developed according to “Water Sensitive City” and well applied in Australian and some European cities on urban storm water management.

Fig. 2-2-4 Components of Water Sensitive Urban Design Source: (Hoyer 2011)



Based on water sensitive city, several design principles of water sensitive urban design are summarized to guide future practices. These principles are categorized into four attributes: water sensitivity, aesthetics, functionality, and public acceptance. (Hoyer 2011)

Water Sensitivity

Incorporation water sensitivity in urban design refers to following pillars of “Water Sensitive City” and creating solutions to bring urban water cycle closer to a natural one by increasing evaporation and infiltration as well as reducing or slowing down surface runoff. Stormwater management will be the main concern to increase diversity and flexibility of water system in case of future uncertainties by considering as much possible future changes as possible. (Hoyer 2011)

Aesthetics

Since WSUD it the integration of sustainable water management and urban design, the consideration of aesthetics benefits is a vital visual requirement of urban design. Not like other art forms such as museum,

literature and music which can appeal to a narrow audience, city form and appearance are public art forms which should “satisfy the broader public who regularly experiences it”(Nasar 1998) However, aesthetic appreciation of urban environments is based on individual perception and cognition, which alters according to personal tastes. But because individual tastes also influenced by society and culture, aesthetic appreciation is beyond simple expression of personal preferences. (Carmona 2010) Hence, aesthetics appreciation has generality under certain social and cultural background and urban designers can create public-appreciated city forms and appearance by residing beauty in them.

Sitte (1889) categorized a series of artistic principles after analyzing a range of European squares: 1) enclosure, only no more than one street can be see out of the square at a time; 2) positive space, a sense of boundary of threshold between ‘inside’ and ‘outside’(Alexander, Ishikawa, and Silverstein 1977); 3) shape, refers to reasonable scale for observers to appreciate the main building, i.e. the depth of the square should be between one and two times the main building’s height; 4) monuments, public statures and monuments as main focus. (Fig. 2-2-5)



Fig. 2-2-5 A well-enclosed square in Italy (Source: (Carmona 2010))

And according to Carmona (2010), urban aesthetic appreciation can be improved by manipulating elements including architectural façade, floorscape, street furniture and landscaping. Therefore, WSUD solutions are able to provide aesthetic benefits through manipulating these elements. For example, green and blue infrastructures can change floorscape and landscaping attached with reasonable street furniture simultaneously respond to surrounding architectural façade and nearby environment.

Functionality

Functionality relates to “how places work or how urban designers can make ‘better’ places”. From physical perspective, functional consideration on urban spaces contains daylighting, over-shadowing, traffic flow, access and circulation, etc. From social aspect, the concern on functionality refers to how the design of the environment supported people’s use. (Carmona 2010)

WSUD needs to appropriately function, which requires a thorough consideration about the physical environment in respect of topography, ground permeability, water table levels, and water quality and so on. And intended use of water and function of the site should also be central issues when making water sensitive urban design. To maximize the value of WSUD, solutions should be used to create places which complement recreational and natural environment. In addition, maintenance is essential for successful implementations. Thus, both long-term and short-term caretakers and maintenance requirements should be established during planning. (Hoyer 2011)

Public Participation

According to pillars of “Water Sensitive City”, institutions and organizations profoundly affect the implementation of water sensitive urban design. Therefore, WSUD solutions should consider the demands of all stakeholders in the process. Flexible solutions are needed to adjust according to different demands. And the cost of water sensitive urban design should be more reasonable in comparison to conventional water management to raise public acceptance. Public awareness for stormwater management and climate change can be improved by making stormwater management visible in public open spaces. (Hoyer 2011)

2.3

“SHANSHUI” CITY

2.3.1 CHINESE NATURE VALUE ON TRADITIONAL URBAN DESIGN

“Shanshui” is unique Chinese culture which developed through the evolution of urban civilization and it has profound influence on traditional Chinese urban design and planning. “Shanshui” literally means “mountain and water” generally representing nature. (Li and Cheng 2015)

The cognition of Chinese people towards nature is various and changeable. From the very beginning of urban civilization, people feared nature, which led to some corresponding behaviours like nature worship specifically, consists of water goddess temple construction, nature (sky, ground, mountain, and water) worship rituals, etc. (Li and Cheng 2015) As the appearance of Buddhism, Confucianism, and Taoism in China, some religious and philosophical influences, which encouraged the combination between personal characteristic and natural environment, and the symbiosis of nature and human, some politicians, artists, religious followers and scholars were encouraged to hide themselves in the nature and mediate. (Jiang 2007) Since then the beauty value of mountain and water and its recreational function were released.

“Shanshui” culture also has reflection on traditional Chinese urban design and planning in terms of city location, city layout, and urban landscape. Traditional Chinese cities usually situated in the space with mountain in the background and rivers nearby (Fig.2-3-1) because in “fengshui” theory¹, which followed by traditional Chinese urban and architectural construction, a space with mountain and water gathers vitality and dynamic, will bring the optimal development for the city as well as maintain safety and happiness for the owners and their descendants. (Yang 2005)

As for city layout, old Chinese cities called for balance, symmetry and interrelation with nature. (Li and Cheng 2015) Therefore, many old Chinese towns are rectangle shape with natural or artificial water running through it. Some cities has flexible layout adapted to natural geographical condition.

Conventional Chinese urban landscape often took advantage of natural

¹ Prof. Yin Hongji in New Zealand Auckland University said, “fengshui” is a unique comprehensive theory conceptualizing natural environment, its objective is to guide people how to choose auspicious environment and how to build architectures in harmony with environment in order to regulate and control human ecological environment. (p5, (Yu 2010: 5))

mountain and water in order to expand landscape scope. Affecting by “shanshui” culture, cities usually incorporated distanced mountain as urban landscape background. Then water surface was considered as front landscape of cities to provide open landscape view. We can also get some clues from Chinese “shanshui” drawings. (Fig. 2-3-2) And city layout would as well compromise to this phenomenon by adjusting streets or buildings orientations. (Li and Cheng 2015)

The general philosophy behind traditional Chinese urban design affected by “shanshui” culture is that cities should be harmony with nature. Because in traditional Chinese value, by inviting natural elements into the city, not only urban landscape would be diversified but also auspicious future would be brought to everyone in the city. (Li and Cheng 2015) Therefore, following nature including mountain and water benefits cities and people both in tangible and intangible way. It is vital for city construction and landscape building to adapt to natural environment.



Fig. 2-3-2 Chinese “shanshui” drawing: reflect the resolution of living with water nearby and mountain in the background
Source: www. 99zihua.com

Fig. 2-3-1 Guangzhou ancient city pattern and location (1947)
Source: Guangzhou City Planning Bureau and Guangzhou City Construction Archives (2010)



2.3.2 THE CONTEMPORARY CONNOTATION OF "SHANSHUI" CITY

"Shanshui" City is a vision put forward by famous Chinese scientist Xuesen Qian in 1990 according to "Shanshui" culture. It means that future urban design should base on contemporary urban development theories and practices, regard technology as technique, respect specific urban geographical environment, and express local culture, strive to create urban artistic space with local uniqueness, high liveability and harmonious relationship between people and nature. (Li and Cheng 2015) Some contemporary urban planning in Chinese cities have already followed this vision such as Hangzhou, Guiyang.

Contemporary connotation of "Shanshui" City is as following: (Li and Cheng 2015)

- 1) "Shanshui" refers to the general natural environment, and "Shanshui" City are expected to have harmonious relationship between natural environment and artificial environment.
- 2) "Shanshui" City is "Gardenized" City. It encourages integrating natural elements such as mountain, water and forest into urban landscape. It emphasizes on Chinese garden landscape and urban uniqueness.
- 3) "Shanshui" City reflects the integration between ecology and humanity. "Shanshui" City Design should fulfill human needs and increase urban liveability.

And following the vision provided by "Shanshui" City, some corresponding urban design principles are established: (Li and Cheng 2015)

- 1) The areas nears natural elements such as mountain, water and forests should have better use by turning into public spaces such as urban squares, parks. On one hand, developing areas into public spaces instead of buildings controls over-development; on the other hand, natural environment becomes the landscape foundation of public spaces. (Li and Cheng 2015)
- 2) Important architectures should take advantages of natural elements. For example, arranging architectures near water surface or in front of mountain can highlight the artistic value of the building. (Li and Cheng 2015)
- 3) Chinese classic garden design approach can be integrated into urban design to enrich urban landscape layers and building up city uniqueness deriving from features of Chinese classic garden design.

2.3.3 PRIVATE GARDEN DESIGN IN CANTON

At a relatively micro scale, private garden design in Canton also is concentrated with "shanshui" culture.

Integration with natural environment

Southeastern part of China has abundant natural resources and beautiful natural landscape, which provide the opportunities to integrate private architecture with natural environment. Besides, "shanshui" culture reveals Chinese resolution to live with nature, so traditional private garden design in Guangzhou is an epitome of "shanshui" culture.

The location and layout of private gardens in Canton mostly combined with natural environment, pursued or retained original natural landscape. Unique Chinese garden design approach by manipulating landscape views and contrasting between empty and solid space, releases the possibility to invite outdoor natural landscape into indoor space and enrich landscape levels. (Fig. 2-3-3) This is a special method to imitate wide natural landscape in a limited space and integrate artificial environment with natural environment. Besides, artificial water surface with flexible or formal water front as well as stone landscape are used to imitate natural mountain and water. (Fig. 2-3-4) (Lu 2013)

Combination with Cantonese geography and climate

Guangzhou is a place with high temperature and humidity, large amount of rainfalls and tropical storms in summer. Therefore, private garden design pays much attention on providing shade, avoiding direct sunshine. Gardens are normally enclosed by buildings because buildings can protect gardens from tropical storms and provide as much shade areas as possible. Outdoor spaces in the garden are as well mostly under shade by planting large-canopy trees and building connection corridors. The orientation of buildings all considers natural wind direction to increase the possibilities for natural ventilation. And buildings mostly combine with water, taking advantage of the microclimate formed by water surface in order to lower down temperature. (Lu 2013)

Besides, to adapt to local geography and climate, design elements such as stones and vegetation are chosen locally mass-produced or well-growth types. For example, unique fruit trees including lychee, mango, longan, pipa etc. are widely planted in private gardens. Ying Stone, which is locally mass-produced, is extensively used in Cantonese private gardens. (Fig. 2-3-5) (Lu 2013)



Fig. 2-3-3 Guangzhou Jiuyao Garden
Source: (Lu 2013)

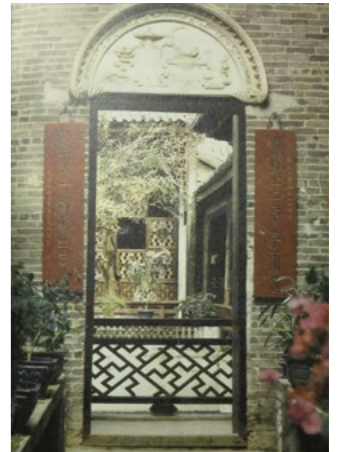


Fig. 2-3-4 Guangzhou Yuyin-shanfang Garden
Source: (Lu 2013)



Fig. 2-3-5 Ying Stone Landscape in Guangzhou Yuyin-shanfang Garden
Source: (Lu 2013)

2.4 BETTER PEOPLE PLACES

2.4.1 PEOPLE AND SPACE

Understanding the relationship between people and space is essential for urban design. Dear and Wolch (1989) pointed out that social relations can be: "Constituted through space - where site characteristics influence settlement form; Constrained by space - where the physical environment facilitates or obstructs human activity; Mediated by space - where the friction-of-distance facilitates, or inhibits, the development of various social practices." People and the environment are always interacting with each other, which provides the possibilities for urban designers to deal with spatial qualities so as to influence social life.

And how people respond to the environment is related to human needs. Maslow (1968) established a five-stage hierarchy structure of human needs: Physiological needs (for warmth and comfort); Safety and security needs (to feel safe from harm); Affiliation needs (to belong to a community, for example); Esteem needs (to feel valued by others); and Self-actualization (for artistic expression and fulfillment). (Fig. 2-4-1) And according to Maslow, if the most basic needs such as physiological needs are not fulfilled, it is difficult for the society to reach higher goals such as sustainability. Therefore, physical environment should also respond to these human needs especially the most basic needs including warmth, comfort, safety, and affiliation.

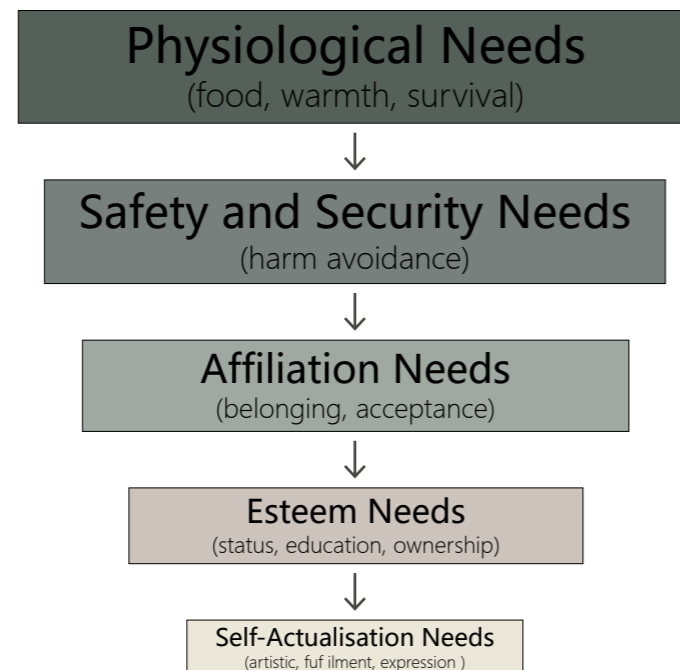


Fig. 2-4-1 Pyramid of human needs
Source: (Carmona 2010)

2.4.2 THE PUBLIC REALM

Public space is an integral part of the public realm. (Carmona 2010) So far, the concept of public space is controversial and ambiguous because its definition is influenced by four attributes: ownership, access, use and conception. The space publicly owned, publicly accessed, publicly used or publicly known is possible to be defined as public space. However, these four attributes reveal the essence of public space which can be manipulated through urban design.

Public life, mainly grouped into two types: formal and informal, is associated with public spaces. It occurs in what might be referred to as social space, which is used for social interaction regardless of whether it is publicly owned, or publicly known, provided it is publicly accessed and publicly used. (Carmona 2010)

The public realm is much associated with the concept of public life. It refers to the social space revealing formal and informal public life. Therefore, here the public realm is an extended notion of public space, encompassing all the spaces accessible and used by the public. (Carmona 2010)

2.4.3 PUBLIC SPACE DESIGN PRINCIPLE

Based on the connotation of the public realm, successful public realm can be characterized by the presence of people (Carmona 2010). Therefore, the public realm with high qualities should be an attractive and safe environment where people feel psychologically engaged enough to go and stay. The public realm fulfilling human needs owns these features. The association of Project for Public Space (PPS) has evaluated thousands of public spaces around the world and figured out that successful places have four key attributes: sociability, uses & activities, access & linkage, comfort & image (Fig. 2-4-2) ((PPS) 2000)

Sociability

A successful public space encourages people to interact with others including friends, families and even strangers and ensure the feeling of belonging and attachments to community. ((PPS) 2009) However, apart from interaction, public space also requires a certain level of privacy protection, which distinguishes "public" from "private". (Carmona 2010)

One approach is the design of "edges" in public spaces. (Fig. 2-4-3) Alexander, Ishikawa, and Silverstein (1977) point out that the public life happens in the public realm naturally forms around the edge. And the edge is the zone for life in the building to interact with the city. (Gehl 2010) It is the buffer zone between the "public" and "private". Therefore, the edge is the core area for social interaction happening in public space simultaneously suitable area to provide privacy protection. The edge of a space can be enhanced by providing formal and informal

WHAT MAKES A GREAT PLACE?

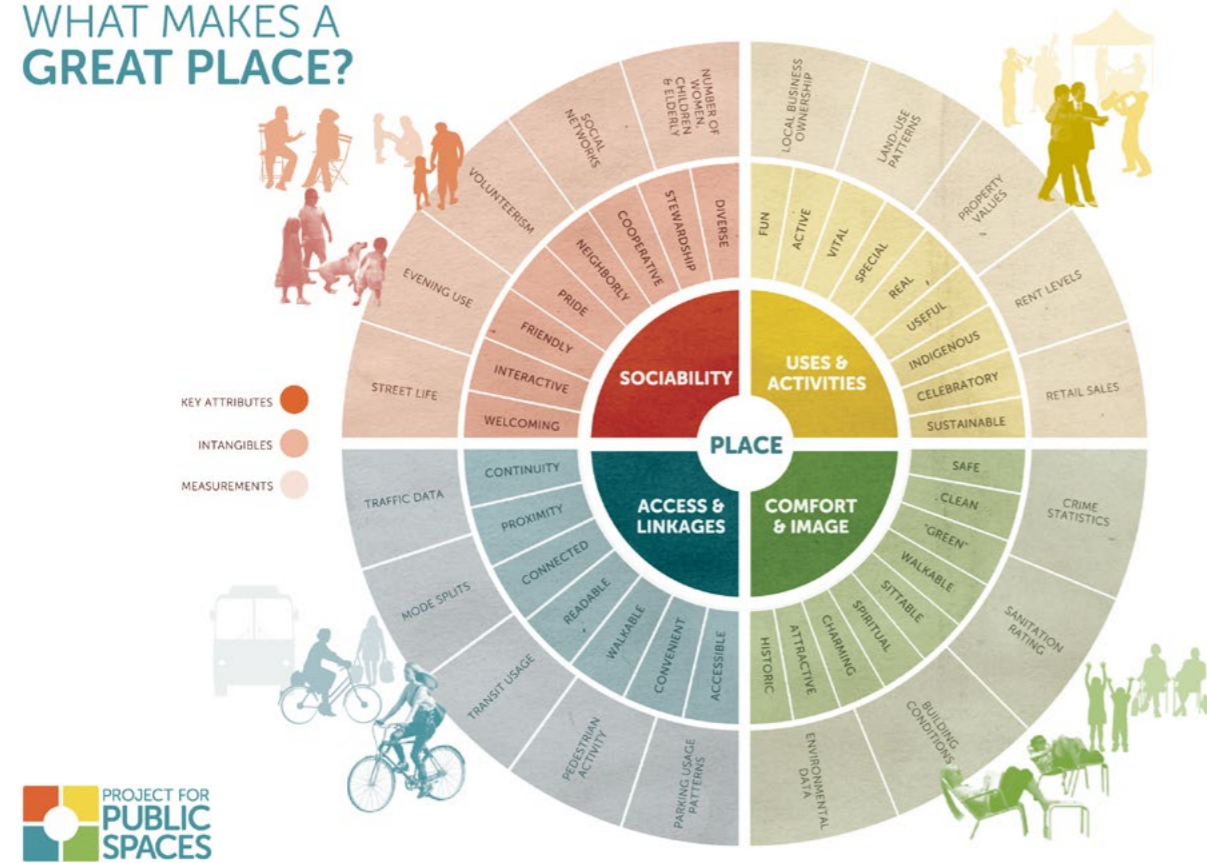


Fig. 2-4-2 A Place diagram showing qualities of a great place. Source: ((PPS) 2009)

places to sit and reasonable façade design, so that people are willing to stay, watch others. This is the natural process for the appearance of social interaction and a relatively private zone.

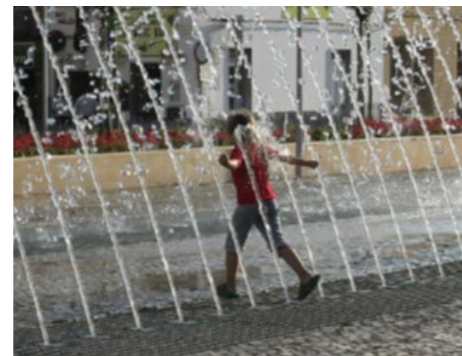
Uses & Activities

"As successful places support and facilitate the activities of people, their design should be informed by an awareness of how people use them." And these information is mainly based on "first-hand observation" (Carmona 2010) Public spaces with high quality are engaged with different user groups (men and women, retired and elderly, youth and children, single, couples and families) and providing the freedom of action to them throughout different periods of the day. ((PPS) 2009) (Fig. 2-4-4)

Fig. 2-4-3(left) Edge of the public realm: Raised vantage points (e.g. steps, balconies, upper levels, etc.) allow people to interact while providing relatively private areas. Source: (Carmona 2010)



Fig. 2-4-4(right) Children play in the public realm Source: (Carmona 2010)



Accessibility

Carmona (2010) revealed the research result that the movement network of a space's wider area had impact on the density of use. Hillier (1996b) also supported that spaces hemmed in by traffic are better use than those without traffic, exposed spaces performed better than those with over-enclosure. Hillier also argued that a measure of visual permeability of the space was the only variable that correlates with the degree of use according to Space Syntax theory. Therefore, a successful public realm is easily connected to its surroundings and local movement network, both visually and physically. It is convenient to get to and get through. And it is visible from a distance and up close. At the same time, pedestrian activities are diversified, for example, by sidewalk shops. ((PPS) 2009)

Comfort & Good Image

In accordance to Maslow (1968), comfort reflect the most basic human needs, it is the prerequisite of successful public realm. "Sense of comfort includes environmental factors (relief from sun and wind, etc.); physical comfort (comfortable and sufficient seating, etc.) and social and psychological comfort (the space's character and ambience)." In case of climate adaptation, urban designers need to design with rather than against climate. (Carmona 2010) Thus, in consideration of natural environmental elements such as sunlight, shade, temperature, humidity, rain, snow, and wind not only satisfies human sense of comfort, but also meets the demand of climate adaptation.

2.5

CONCLUSION

Design principles of Water sensitive public space are derived and integrated from the design requirements of Water Sensitive City, People Places and "Shanshui" City. Water Sensitive City gives out the vision of city and basic requirements of achieving a water-resilient city. And "Shanshui" City as well as the theory of People places both act on the formation of water sensitive public space. They provide social and cultural support for water management in Guangzhou.

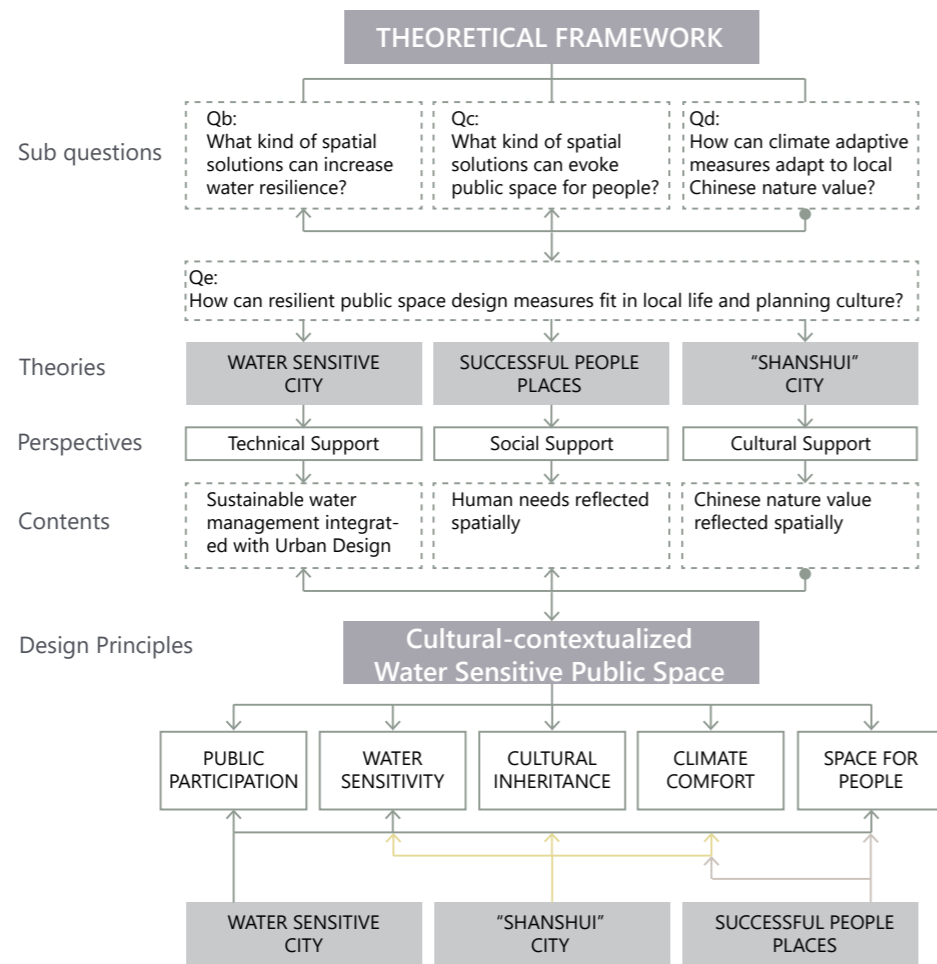


Fig. 2-5-1 Theoretical Framework
Source: Drawn by author

Water Sensitivity

Sustainable urban drainage (SUDS) techniques, such as swales, infiltration, detention and retention infrastructures are used to bring urban water cycle closer to a natural one by increasing evaporation and infiltration as well as reducing or slowing down surface runoff. Stormwater management will be the main concern to increase diversity and flexibility of water system in case of future uncertainties by considering as much possible future changes as possible. (Hoyer

2011) Green-blue infrastructures will be used to complement original centralized drainage system, diversify water resources and infrastructures. Besides, due to the demand provided by "Shanshui" City, exotic drainage techniques should be adapted according local natural environment including topography, hydrography, geology, pedology, etc.

Public Participation

Planning culture in China needs to be taken into account when implementing water sensitive public space. Institutions and organizations in Guangzhou on different planning levels including community, Guangzhou hydraulic bureau, municipality, Guangzhou urban planning survey & research institute, or national environmental protection policy and Beijing Turenscape City Planning and Design Corporation, and their inward interactions will influence the final result. Stakeholders should be involved in the process due to its influence on the feasibility of the project.

Climate Comfort

Special climate in different city affect people's behaviors and lifestyle, and urban design of different city also influenced by local climate, so public space design should adapt to local climate, considering sunshine, wind direction, temperature, etc. And the climate comfort design also contains the interpretation of local culture.

Cultural Inheritance

Because of the "Shanshui" culture in China, urban design should consider special cognition formed by this cultural background. Gardenized landscaping approach can satisfy corresponding aesthetic perception. Besides, design elements such as stone, vegetation are required to choose locally-produced types. And local culture can be interpreted through historical and cultural heritage and inherited into urban design.

Space for people

Urban design is supposed to connect people's needs with space. A successful public space encourages different user groups (men and women, retired and elderly, youth and children, single, couples and families) to interact with others and providing the freedom of action to them throughout different periods of the day. ((PPS) 2009) Usage situation and activities of different user groups should be considered at a specific spot. An the same time, the movement of people inside the public space and nearby should be studied and so as the visual permeability of the space. A successful public realm is easily connected to its surroundings and local movement network, both visually and physically and pedestrian activities are diversified, for example, by sidewalk shops. ((PPS) 2009)



3
ANALYTICAL
FRAMEWORK

3.1

INTRODUCTION

Deriving from the theoretical framework and all the summarized design principles, there are a few criteria extracted to evaluate spatial attributes and assess if current public spaces satisfies design principles put forward at the last chapter. These criteria reveal the CSC approach for spatial analysis and design.

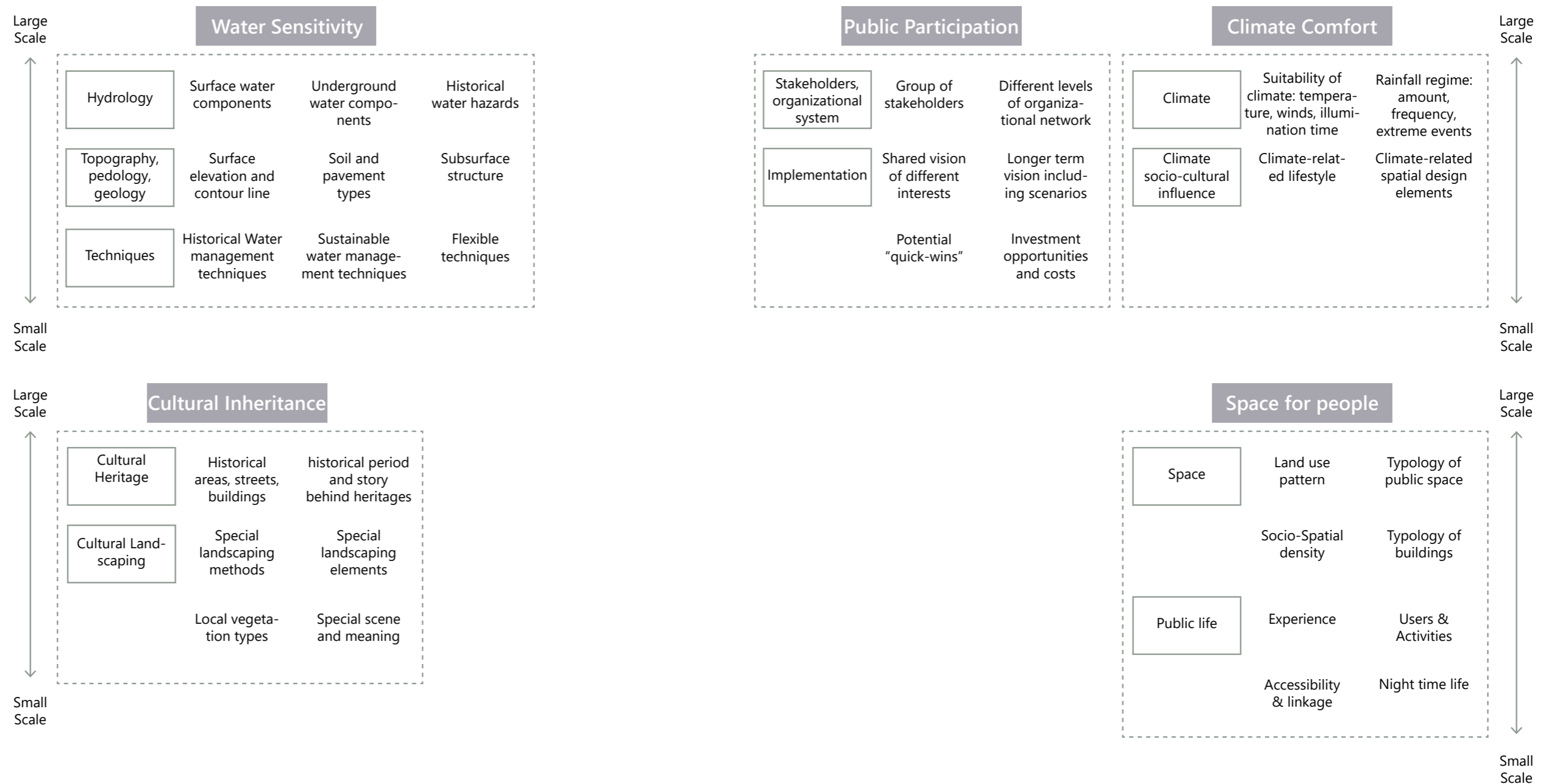


Fig. 3-1-1 Criteria and indicators of technical-socio-cultural approach
Source: Drawn by author

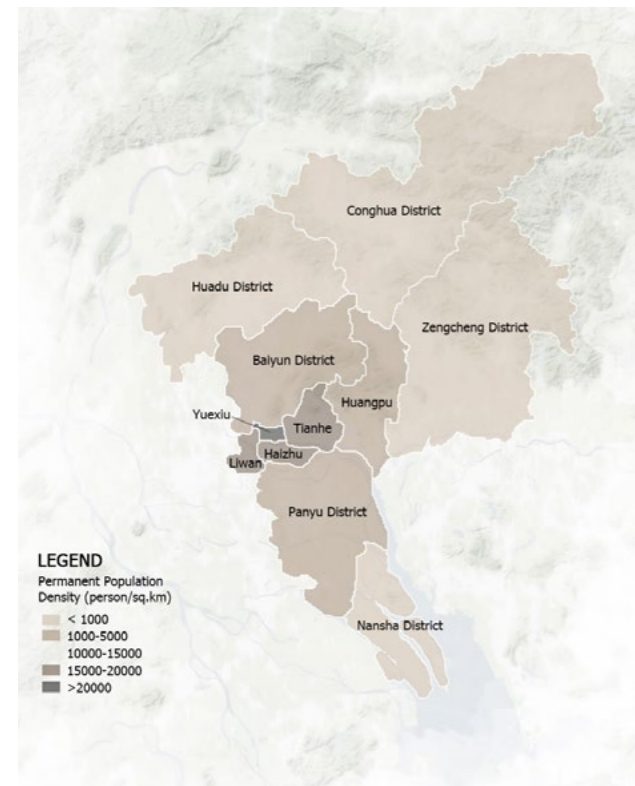
3.2 Large-scale: YUEXIU DISTRICT

Under the general water challenge of Guangzhou, urban dense area is especially under high water-vulnerability. According to Guangzhou Urban Construction and Management Development Report (2015) released by Guangzhou Development Research Institute of Guangzhou University, because of rapid urban development, in recent 30 years, the number of waterlogging spots is 16 times as much as that in 1980s. And the main focus area is Yuexiu District with the highest population density then spreads to less dense districts like Tianhe, Haizhu and Baiyun. (Fig. 3-2-1 and Fig. 3-2-2) (Liu 2016) Therefore, this district is chosen to conduct large-scale research in this project. (Fig. 3-2-3)

Fig. 3-2-2 (up) Yuexiu District and Sater Network
Source: Drawn by author

Fig. 3-2-1(left) 2013 Permanent Population Density of Urban Districts in Guangzhou
Data Source: Guangzhou Statistical Year-book (2014)

Fig. 3-2-2(right) 2010-2015 Guangzhou Severe Waterlogging Spots emphasized by annual climate reports
Source: (Hu 2011, Guangzhou Meteorological Bureau 2012, 2013, 2014, 2015, 2016)



3.3 WATER SENSITIVITY

3.3.1 HYDROLOGY

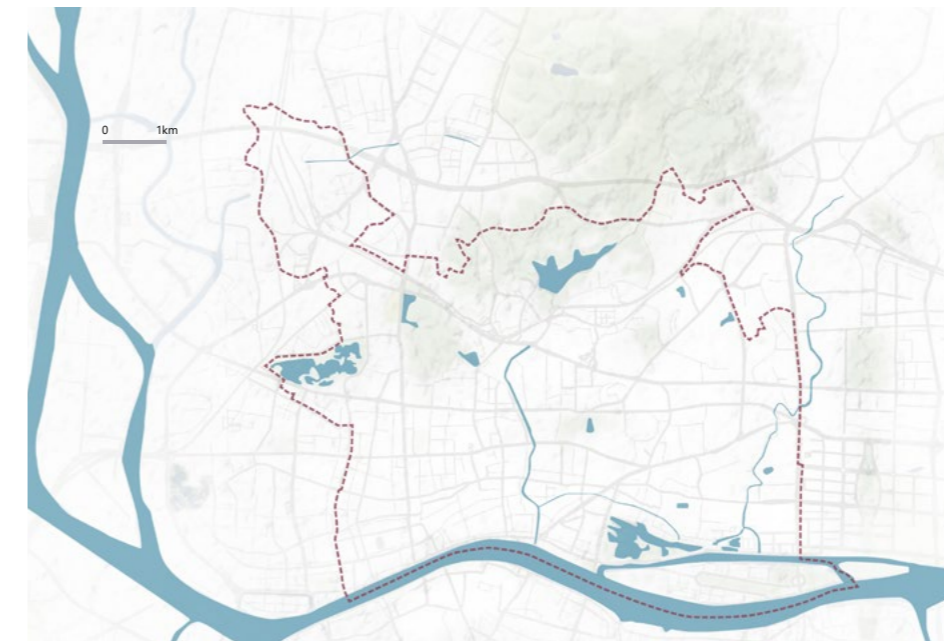


Fig. 3-3-1 Map of surface water network
Source: Drawn by author

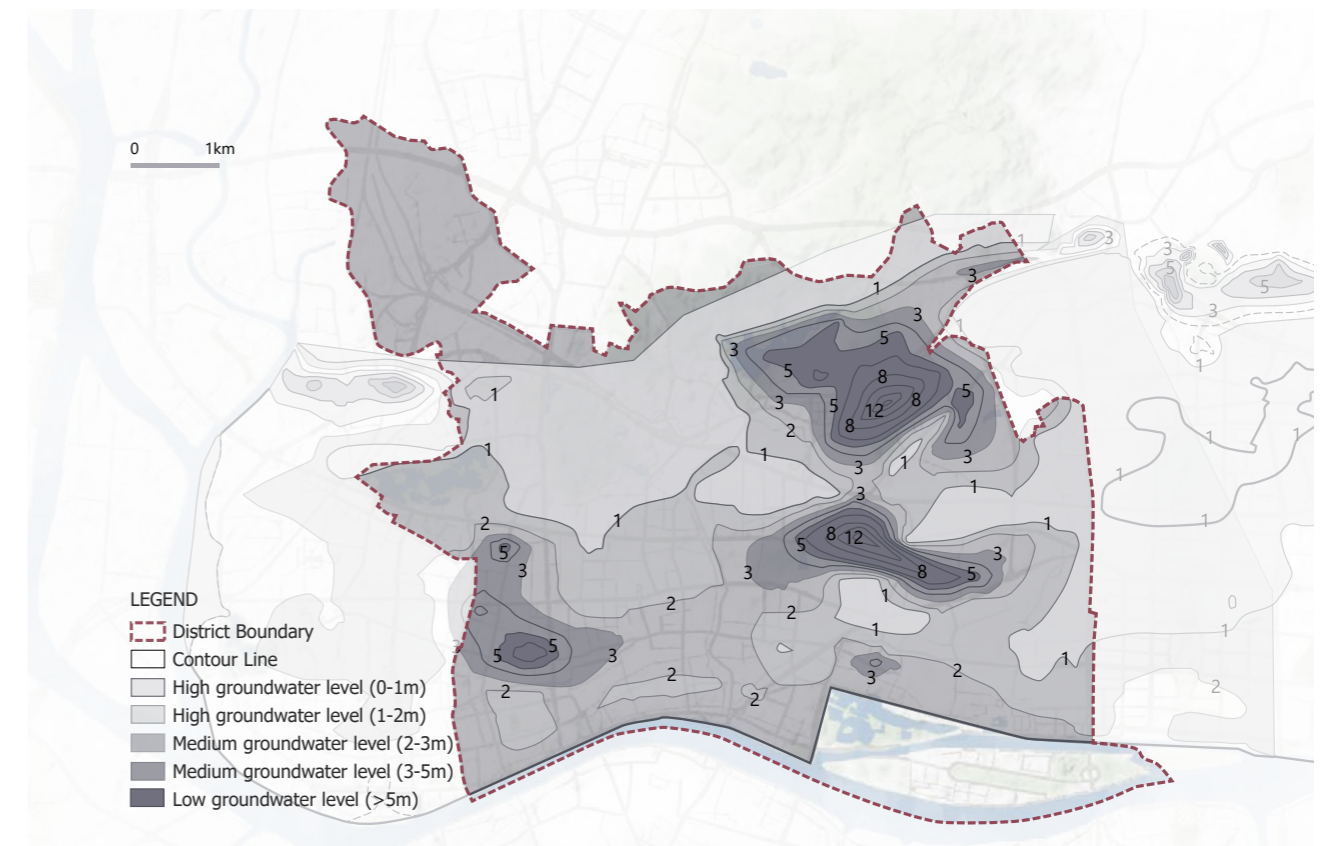


Fig. 3-3-2 Map of ground water level
Source: Adapted from Wang (2013)

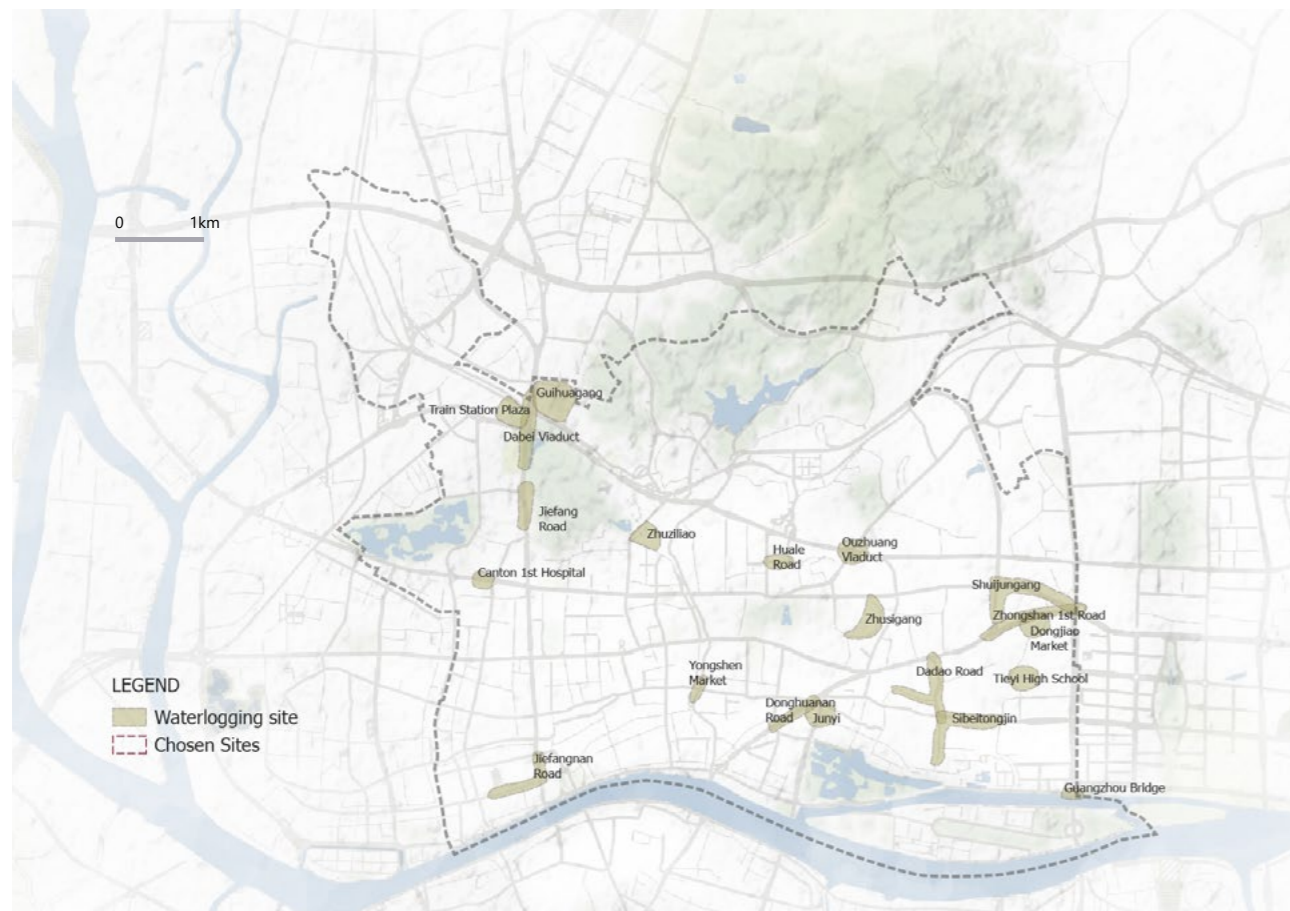


Fig. 3-3-3 Historical water hazard spots
Source: Adapted based on the study of Zhang (2015)

According to the Yuexiu district waterlogging situation study done by Zhang (2015), in recent five years, every street in Yuexiu district has ever occurred waterlogging. Three extremely devastating stormwater disasters attacked Yuexiu district on 7 May 2010, 13 October 2011 and 13 September 2013 relatively. More than 20 waterlogging spots appeared during each disaster. Every year, some areas suffered from more than 30cm depth waterlogging. And certain spots were under high water risks and stormwater at these spots went up to around 30-100cm depth. (Fig. 3-3-3)

Water hazards are affected by current hydrological environment of the city. The majority of the historical frequent water hazards spots distributes on areas with high ground water level. (Fig. 3-3-2) Once high amount of rainfalls land on the ground and cannot be charged in time to large water body, underground water overflows towards the surface.

Besides, current water network also has impact on water hazards distribution. (Fig. 3-3-1) A large amount of precipitation in short period raises up water level of the Pearl River or its branches, water of branches cannot flow quickly into the main stream, which affects water drainage of a large scope of areas. (Zhang 2015)

3.3.2 TOPOGRAPHY, PEDOLOGY AND GEOLOGY

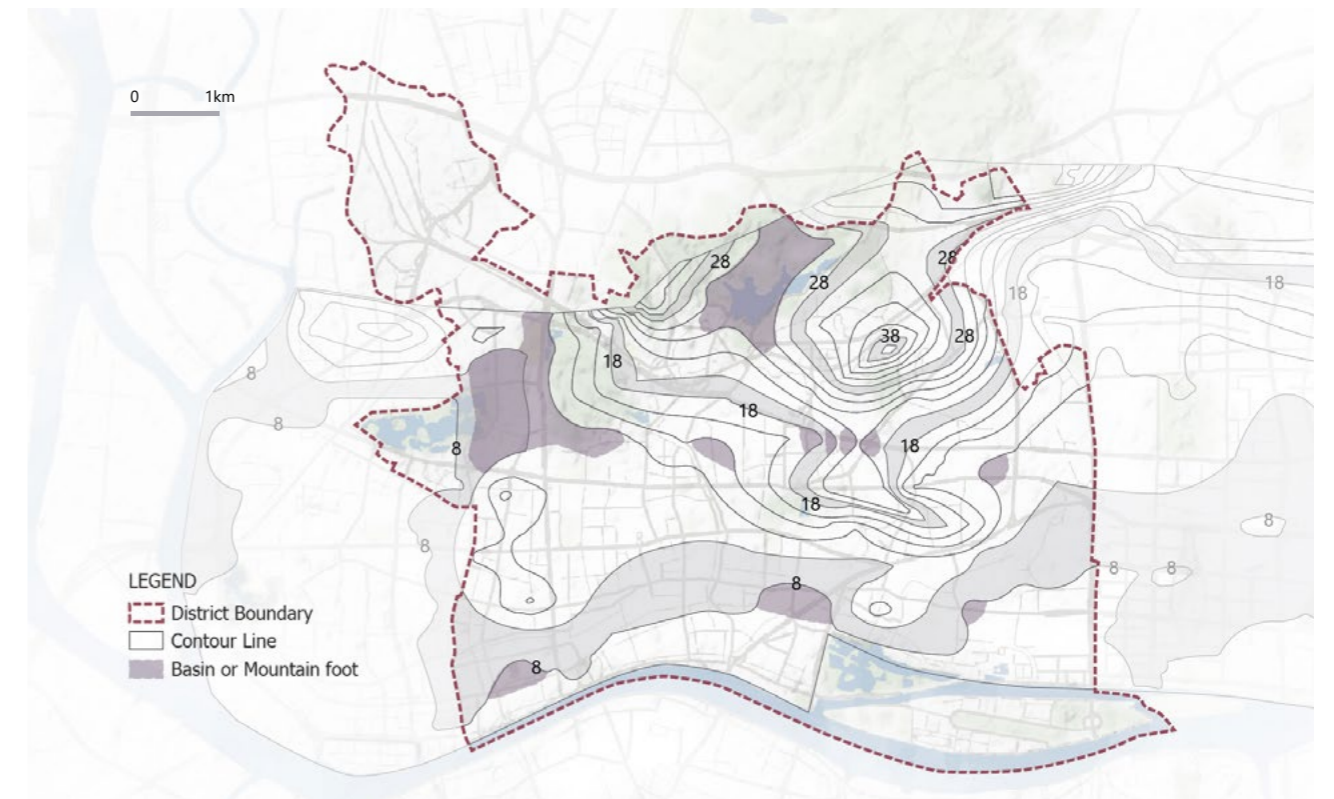


Fig. 3-3-4 Topography of Yuexiu District
Source: Adapted from Wang (2013)

Some spots soaked by storm water because of its natural topography, mostly basin or areas at the foot of a mountain. These areas originally situated on a low-altitude ground. (Fig. 3-3-4) When a storm hits, underground drainage system cannot transport water in time, in the same time, water level of river branches goes up, the basin or the mountain foot becomes "plastic bag", therefore, water hazard appears.

During the process of city transformation, due to unreasonable city planning, original old buildings had already settled down the first-storey elevation, later-built buildings or roads raise the ground elevation, Hence, old streets or blocks gradually situated much lower than newly-built areas. These areas became "man-made basin" (Fig. 3-3-5) facing much higher water risks.

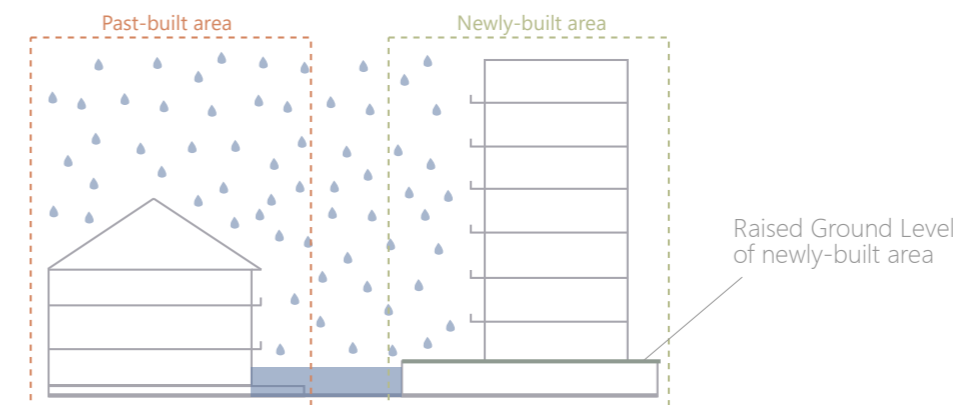


Fig. 3-3-5 Diagram of "Man-made basin"
Source: Drawn by author

Fig. 3-3-6 Map of first layer soil (1m depth)
Source: Wang (2013)

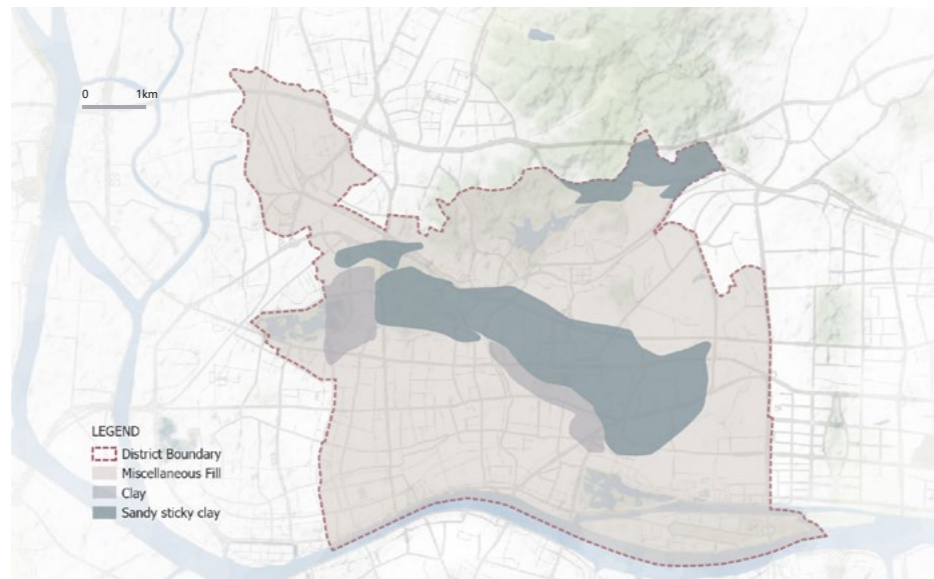


Fig. 3-3-7 Map of second layer soil (2m depth)
Source: Wang (2013)

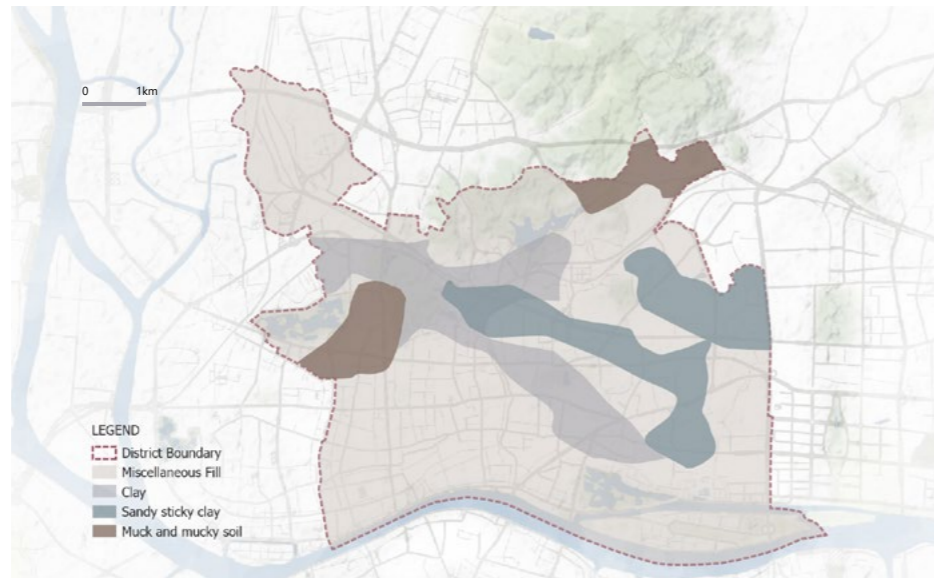


Fig. 3-3-8 Map of third layer soil (5m depth)
Source: Wang (2013)

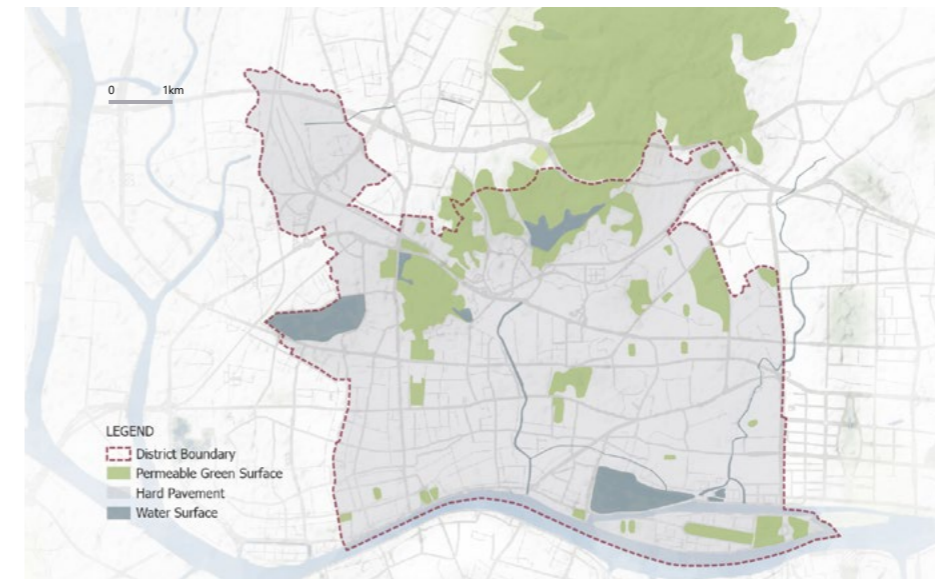
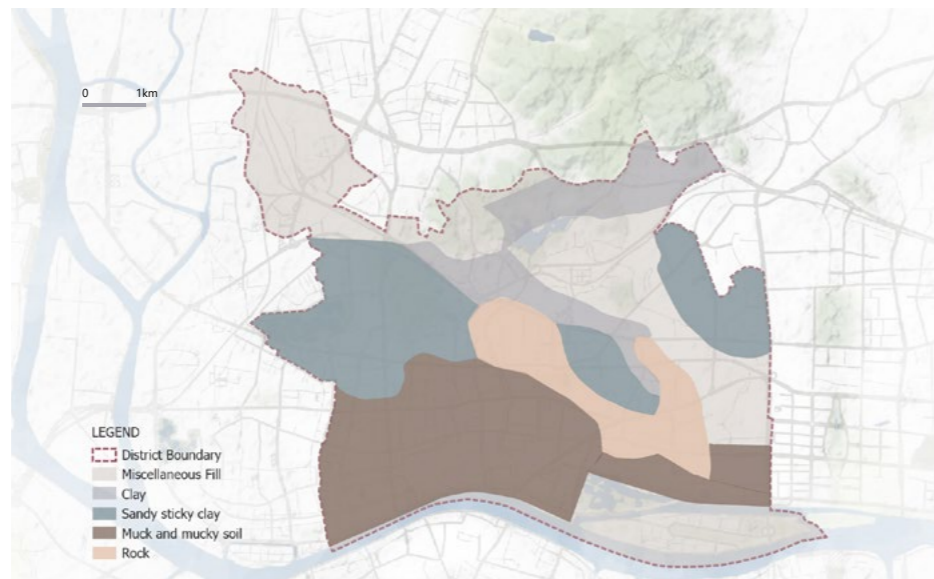


Fig. 3-3-9 Map of surface pavement
Source: Drawn by author

Soil Type	Permeability Coefficient	Pavement Type	Permeability Coefficient
Miscellaneous Fill	$1 \times 10^{-4} - 6 \times 10^{-4} \text{ cm/s} \approx \text{normal}$	Permeable Green Surface	10^{-5} cm/s
Muck and mucky soil	$10^{-7} - 10^{-6} \text{ cm/s}$	Water bottom (Sand)	$10^{-2} - 10^{-3} \text{ cm/s}$
Silty-fine Sand	$1 \times 10^{-3} - 6 \times 10^{-3} \text{ cm/s}$	Hard Pavement (Concrete & Asphalt)	$10^{-8} - 10^{-9} \text{ cm/s}$
Medium-coarse Sand	$4 \times 10^{-2} - 6 \times 10^{-2} \text{ cm/s}$		
Sandy sticky clay or Clay	$10^{-6} - 10^{-5} \text{ cm/s}$		
Rock	$1 \times 10^{-12} - 10 \times 10^{-12} \text{ cm/s}$		

Table 3-1 Permeability of soil and pavement
Source: Wang (2013)

The natural soil types with various runoff coefficient and permeability coefficient alter infiltration capacity of different areas. Soils with high permeability such as sandy soil allow fast water infiltration while soils with low permeability such as mucky soil and rock impede water infiltration. (Fig. 3-3-6, 3-3-7, 3-3-8 and Table 3-1) For this reason, soil types and their permeability need to be taken into account while implementing water management.

The superficial reason for water logging problem is that underground drainage system is not meeting the growing demand of city development. However, due to more and more city constructions, permeability of ground drops sharply. Original porous soil is substituted by concrete and asphalt. Yuexiu district, as one of the oldest towns with high socio-spatial density, lacks of green areas for drainage or water storage. (Fig. 3-3-9) Green areas on one hand can facilitate ground infiltration (Table 3-1); on the other hand can strengthen evapotranspiration. Lacking green surface not only impairs urban drainage capacity, but also causing "Heat Island Effect", especially in Guangzhou, the city with high temperature throughout the year. (Zhang 2015)

Moreover, the geological structure (Fig. 3-3-10 till 3-3-14) affects the final implementation of the project and the design process. The depth and layer of soils and subsurface components swing the result of chosen techniques especially underground development.

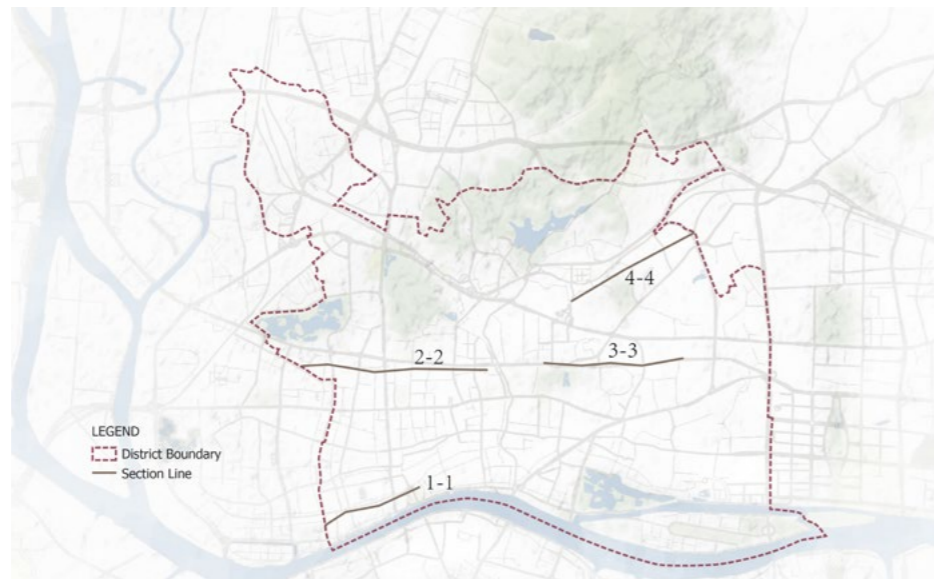


Fig. 3-3-10 Map of geological section line
 Source: Adapted from Wang (2013)

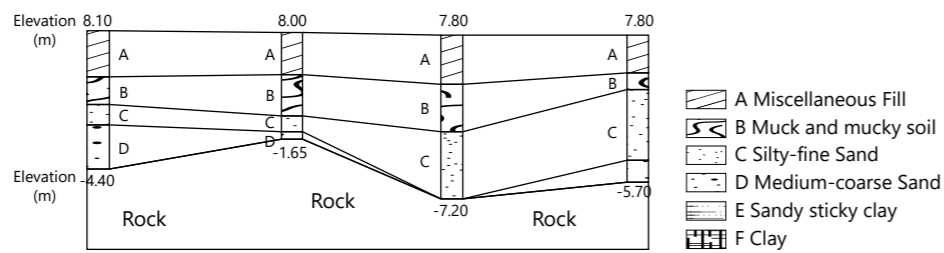


Fig. 3-3-11 1-1 Section
 Source: Adapted from Wang (2013)

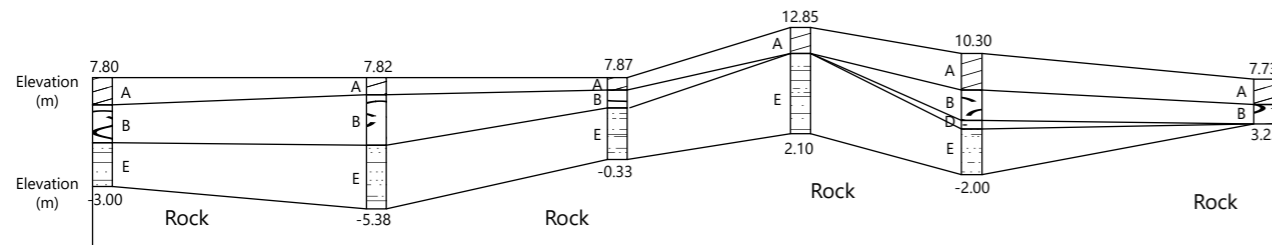


Fig. 3-3-12 2-2 Section
 Source: Adapted from Wang (2013)

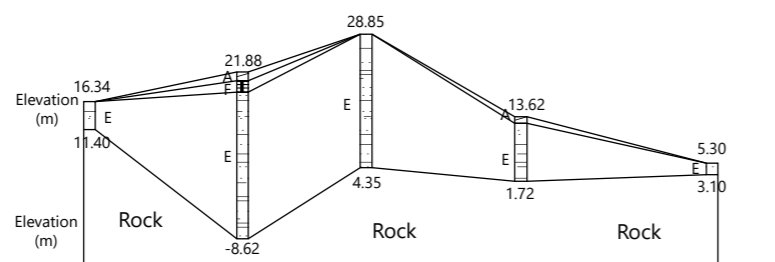


Fig. 3-3-13 3-3 Section
 Source: Adapted from Wang (2013)

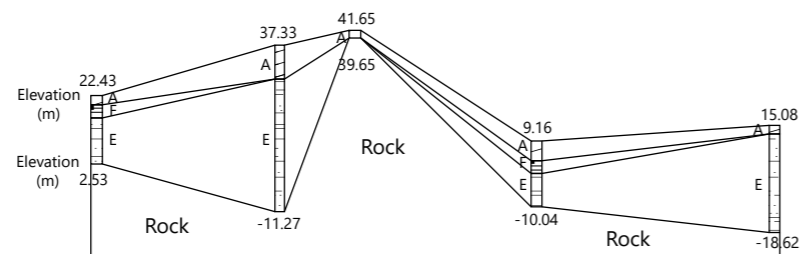


Fig. 3-3-14 4-4 Section
 Source: Adapted from Wang (2013)

3.3.3 TECHNIQUES

Based on the study of "Water Sensitive City", there are already many developed urban sustainable drainage techniques applied on reality to increase urban water resilience. (Pötz 2016)

Runoff and Drainage			
Gutters	Hollow roads and sunken channels	Ditches	Urban water channels
Buffer and Infiltration			
Permeable paving	Infiltration plane meadow	Infiltration ditches	Water roof
Detention pond	Bioswale	Urban infiltration strip	Green roof
IT sewage system	Geocellular system	Underground reservoir	
Water square (wet)	Water square (dry)	Urban Wetland	

Images Source: Pötz (2016)



Images Source: Pötz (2016) Hoyer (2011)

And to alleviate harm brought by waterlogging, there are several measures can be used to increase flexibility in the city and to tackle future uncertainty. These measures are: (Pötz 2016)



Images Source: Pötz (2016)

However, although there are various techniques, each technique has different applicability. If we need to adapt these techniques and apply in Guangzhou, we should acquire the knowledge about limits and applicability of each technique. (Table 3-2)

Techniques	Typology		Climate		Geography		Disadvantage	
	Surface space	Application	Reduce Heat	Dry & Wet	Foundation	Ground-water level	Construction difficulty	Others
Gutters	-	Streets with enough of a slope	-	√	no command	average	-	- water pollution - puddles
Hollow roads and sunken channels	-	Streets with not much traffic	-	√	no command	average	-	- traffic nuisance due to splashing water
Ditches	0	green verges or the roadside	+/-	√	no command	average	-	- need extra space and maintenance
Urban water channels	+	Newly developed zones	+/-	√	no command	average	+/-	- needed extra maintenance
permeable paving	0	pedestrian zones and not intensive use roads or car parks	+/-	×	well-drained	average	-	- risk of pollution - periodical maintenance
Infiltration plane meadow	+	public and private gardens, street planters, parks, sidewalks, median strips	+	×	average	average	-	- require a great deal of surface space
Infiltration Ditches	+/- (10% - 20%)	public and private gardens, street planters, parks, sidewalks, median strips	+	√	average	average	-	- not used too much by playing children or other intensive activity
Detention pond	+/- (10% - 20%)	pre-purify rainwater from busy roads and car parks;	+	√	average	high	+	- needed extra maintenance - should consider child safety
Bioswale	+/- (10%)	public and private gardens, street planters, parks, sidewalks, median strips	+	√	well-drained	low (highest -0.5 metres)	+/-	- rigorous requirements towards the ground and groundwater level
Urban infiltration strip	+/- (10%)	public and private gardens, street planters, parks, sidewalks, median strips	+/-	×	well-drained ground	average	+/-	- rigorous requirements towards the ground
Green roof	-	roofs with slopes ranging from 1° to 35°	+	√			+/-	- rigorous requirements towards the roof construction - extra maintenance

Table 3-2 Applicability of sustainable drainage techniques
Source: Derive from Pötz (2016)

Runoff and Drainage

Buffer and Infiltration

Legend

0: variable
-: little
+/-: medium
+: much
√ allowed
× not allowed

High applicability
Medium applicability
Low applicability

Table 3-2 Applicability of sustainable drainage techniques (continued)
Source: Derive from Pötz (2016)

Techniques	Typology		Climate		Geography		Disadvantage		
	Surface space	Application	Reduce Heat	Dry & Wet	Foundation	Ground-water level	Construction difficulty	Others	
Buffer and Infiltration	Water roof	Flat roof	-	×			+/-	- Waterproofing - the additional load	
	IT sewage system	with less available space	-	×	poorly Permeability	average	+/-	- problems such as pollution are not easily visible - cleaning and maintenance	
	Geo-cellular system	under roads, sports fields and parking garages with less available space	-	×	poorly Permeability	average	+	- problems such as pollution are not easily visible - high maintenance costs	
	Underground reservoir	residual space beneath parking garage and other building constructions	-	×	average	low	+	- high maintenance costs	
	Water square	inner-city areas with little room for water buffers	0	+/-	√	average	average or high	+	- high construction and maintenance costs - the construction need to handle the load and the upward forces
	Urban Wetland	near open water area such as river or sea	+/- (10% -15%)	+	√	average	average	-	- should combine with open water area
Treatment	Gravel or sand filter	variable	-	0	average	average	-	- limit effect of purification - maintenance is necessary	
	Bio-retention	variable	+/-	0	average	average	-	- not capable of treating all pollutants	
	Biotope (helophyte filter)	near roads or car parks	+	0	average	average	+/-	- not capable of treating all kinds of pollutants	
Evapotranspiration	Vegetation	cities with extreme temperature and heat island	+/-	0	average	average	-		
	Water system (rainwater walls, fountains, pools etc.)	inside and outside buildings	+	√	average	average	-		

Legend
 0: variable
 -: little
 +/-: medium
 +: much
 √ allowed
 × not allowed

High applicability
 Medium applicability
 Low applicability

Except for those modern exotic advanced measures, some ancient drainage measures have already been used in Guangzhou. One thousand years ago, Guangzhou used to dig artificial city moat for drainage, and moat in combination with city walls form protections against flood. (Fig. 3-3-15) Later, inner city began to have surface canal system for drainage, improved and developed as "Six Veins Canal" (Fig. 3-3-16). This system was used to discharge rainwater and wastewater into moat and then to the Pearl River. (Liu 2015) However, as city expansion and growth of population density, many canals were covered or buried by muck, water bed became higher and higher. In some basin area where were far away from drainage canals, seepage well system were used to purify wastewater and charge surface rainwater into deeper subsurface water layers. (Fig. 3-3-17 and Fig. 3-3-18) These historical techniques revealed some contextualized drainage requirement and experience which can be integrated with modern drainage techniques.

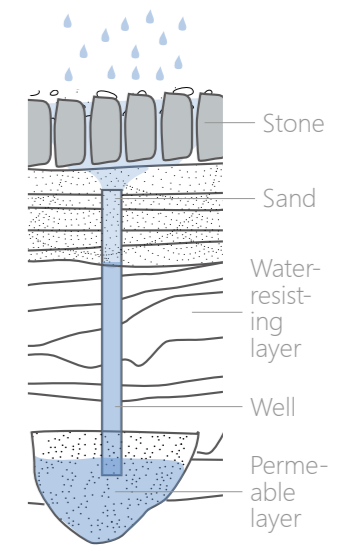


Fig. 3-3-18(up) Diagram of drainage and water treatment of seepage well
Source: Drawn by author

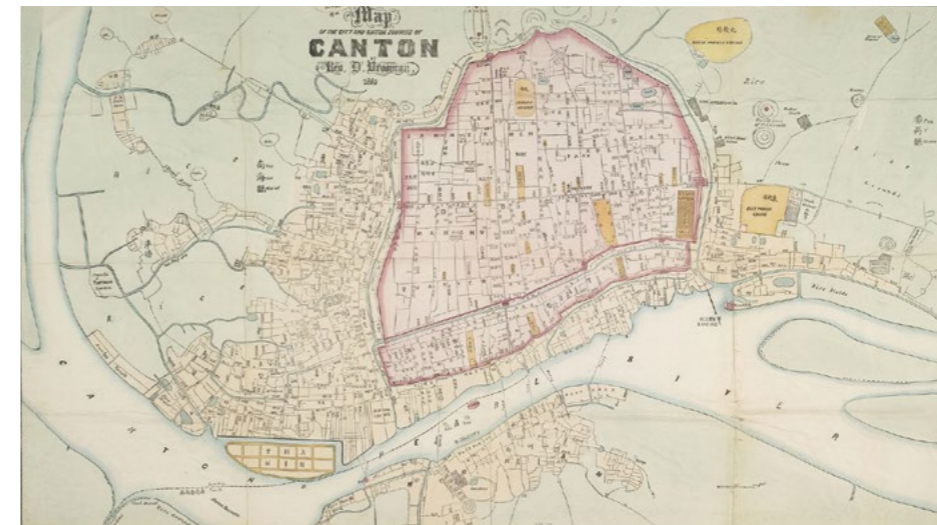


Fig. 3-3-15(left) 1860 Guangzhou Map: the city pattern with city walls and moat
Source: <https://zh.wikipedia.org/>

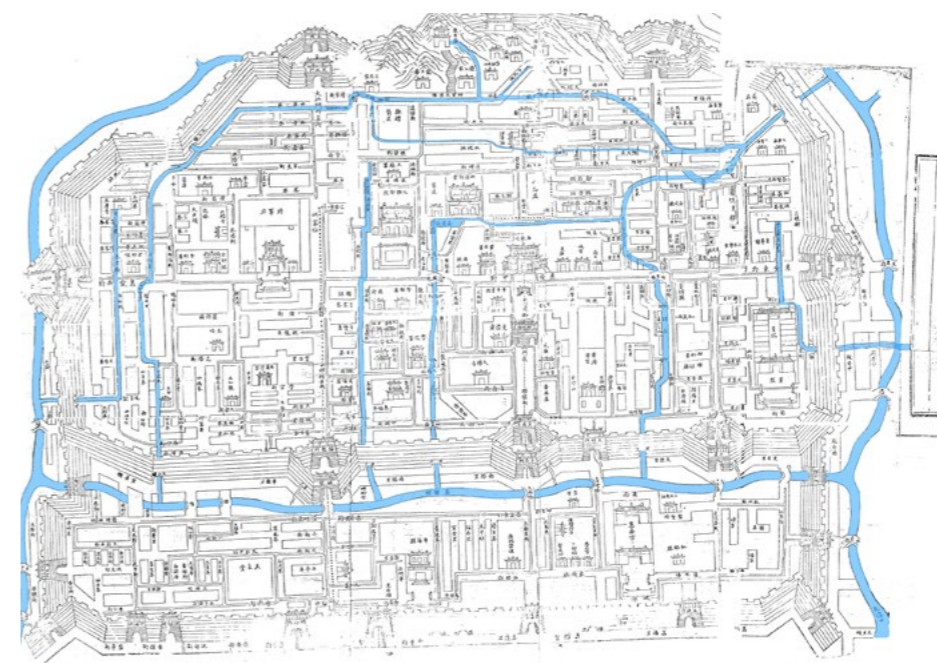
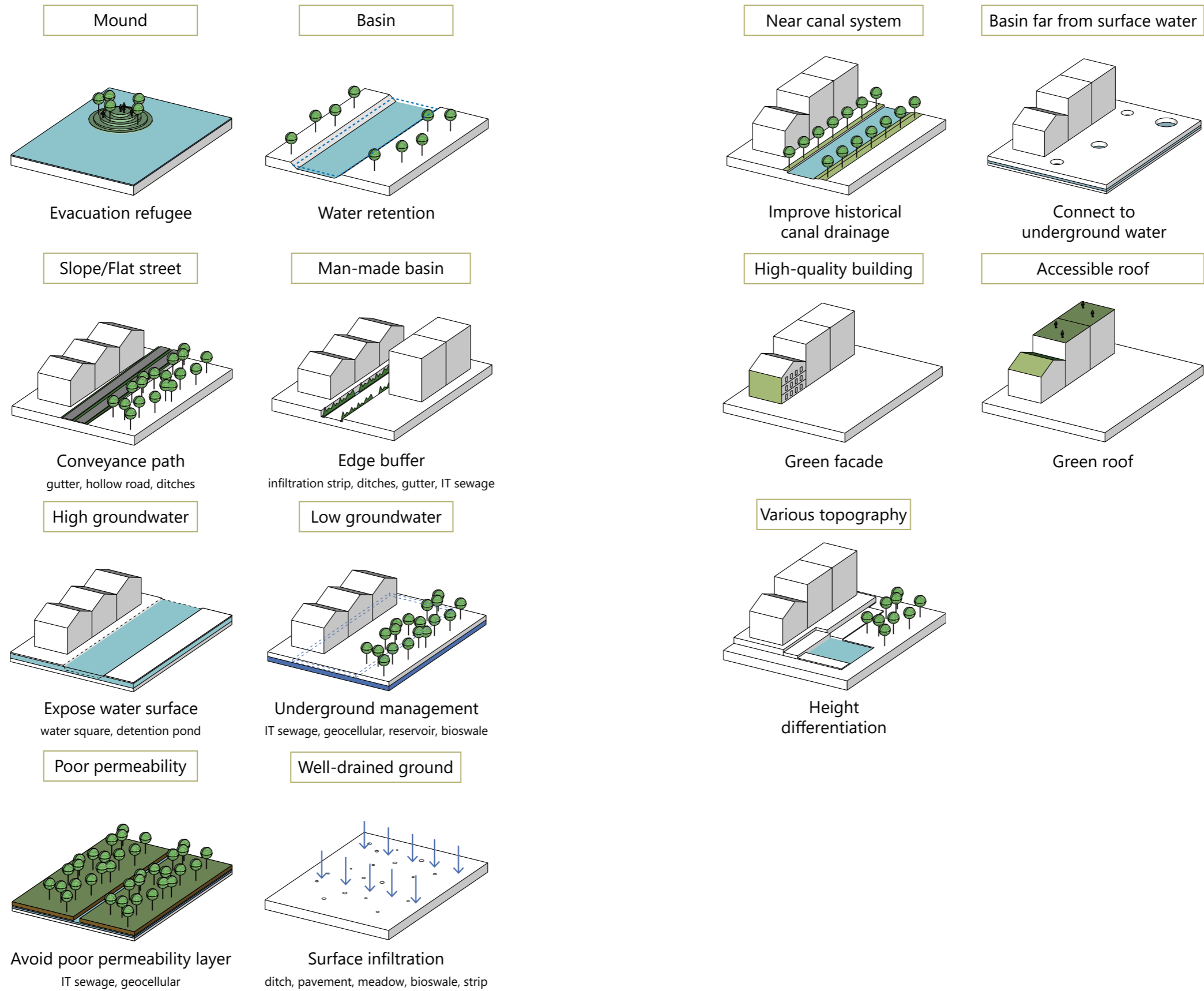


Fig. 3-3-17(up) Seepage well in ancient Canton
Source: Liu (2015)

Fig. 3-3-16 (left) Map of Six Veins Canal
Source: Zhang (2015)

Based on the analysis in terms of hydrology, topography, pedology, geology and techniques, spatial design principles regarding water sensitivity are concluded as the following:



3.4 CULTURAL INHERITANCE

3.4.1 CULTURAL HERITAGE

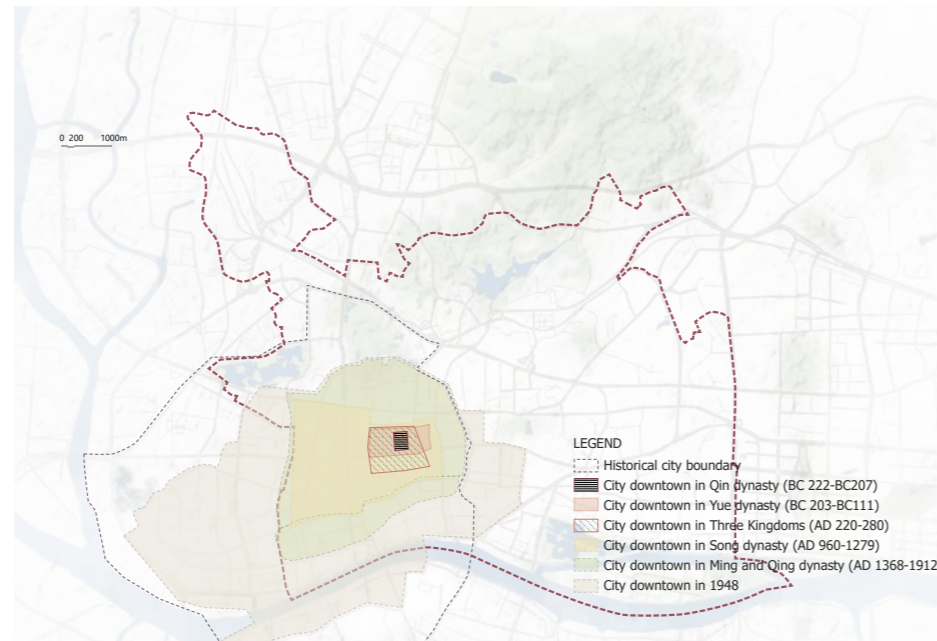


Fig. 3-4-1 Map of ancient city area
Source: DEPT. of Historical And Cultural City, <http://dhc.thupdi.com/>

Fig. 3-4-2 Map of ancient city pattern and historical heritages
Source: Source: DEPT. of Historical And Cultural City, <http://dhc.thupdi.com/>

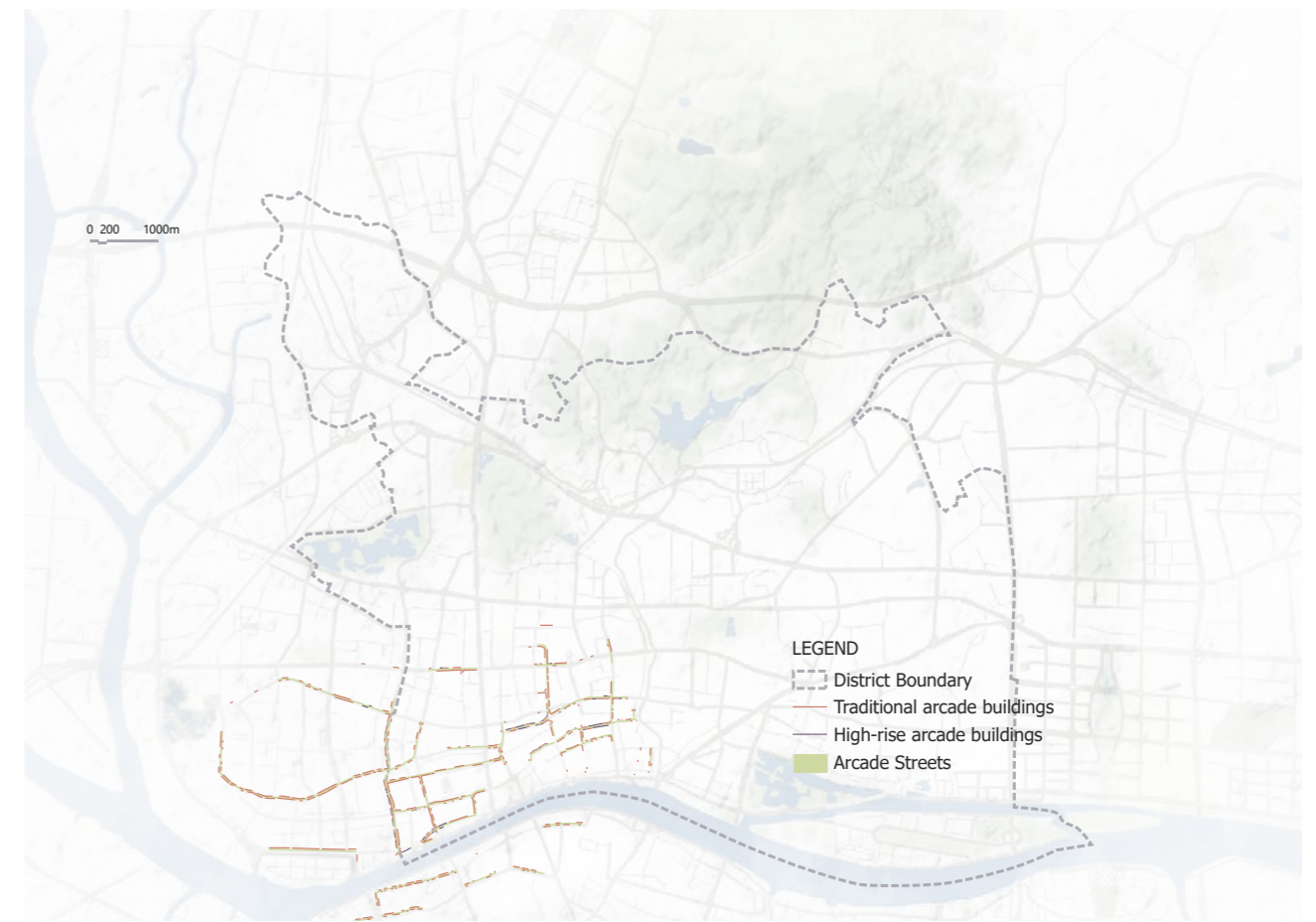
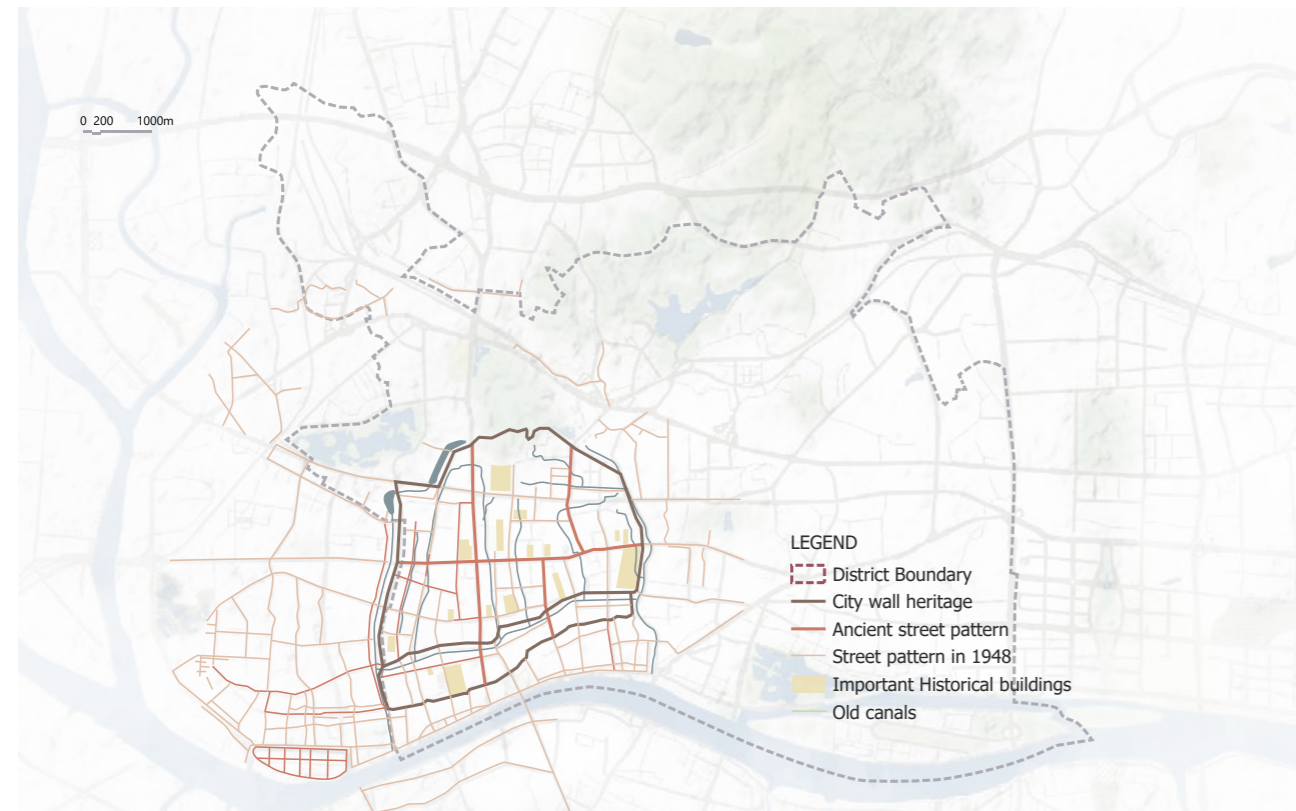


Fig. 3-4-3 Map of arcade buildings
Source: DEPT. of Historical And Cultural City, <http://dhc.thupdi.com/>

Yuexiu district used to be important ancient city area, therefore gathered many historical and cultural heritages. These heritages mostly situated in the western part of Yuexiu district. (Fig. 3-4-1, 3-4-2 and 3-4-3) Cultural heritages including ancient streets, cultural architecture and historical water management heritages hold the memory of this city and represent the intelligent of ancient people. They provide opportunity for modern study, tourist development and spatial-emotional connection. And the water management techniques applied in these areas should consider old-time city construction techniques in order to preserve cultural heritages and fit in local cultural expression.

3.4.2 CULTURAL LANDSCAPING

Because of the unique Chinese nature value in combination with Cantonese context and culture, some design methods are formed so as to express local people's aesthetic value and connect people with nature. In terms of space making in China, due to a pursuit for equilibrium between "Yin and Yang", i.e. the balance of everything in the universe, the method is comparison and penetration between empty and solid spaces. (Yang and Li 2007) And this method is also used to make small area has capacious feeling. Comparison between large and small, close and open, dense and sparse diversifies a small area. In the same time, corridor, frame, leaking window penetrate landscape in different sub spaces connecting and dividing two spaces. (Lu 2013) (Fig. 3-4-4)



Fig. 3-4-6 Musa basjoo near window: special scene for rainfall (雨打芭蕉)
Source: <http://chuansong.me/n/670869349663>

Fig. 3-4-4(left) Space division and comparison in Ke Garden
Source: http://blog.sina.com.cn/s/blog_5cf2b87f0101vvkq.html

Fig. 3-4-5(right) Natural stone bank in Lou Lim leoc Garden, Macau
Source: <http://www.bunbun-hk.com/BBS/Discuz/viewthread.php?tid=19221>

In Cantonese garden landscape, stones are often used to organize space and connect landscape.(Lu 2013) Since Chinese people prefer to use stones to metaphor natural mountains, various shapes of big stones are piled up to simulate cliff, peak, valley, etc. And some of them can become the central viewpoint of the garden because of the spectacular shape. Small stones are dispersed in Cantonese gardens as decorations. Stones under trees or several pieces of stones in the water all make the space more vivid. Stone bank along water surface can also simulate natural bank creating natural environment. (Fig. 3-4-5)And all stones, such as Ying stone, Taihu Lake stone, La stone, Stalactite, Songpi stone, Lianchuan stone, etc. used in garden landscaping are largely produced in Guangzhou or nearby city. (Lu 2013)

In Chinese landscape, vegetation is one important landscape element. As for Chinese people, vegetation has its own characteristic. For example, bamboo has integrity; lotus means purity; pine represents tenacity, etc. (Lu 2013) Therefore, certain type of vegetation is used to create a scene and connect with observers' emotion and resolution.

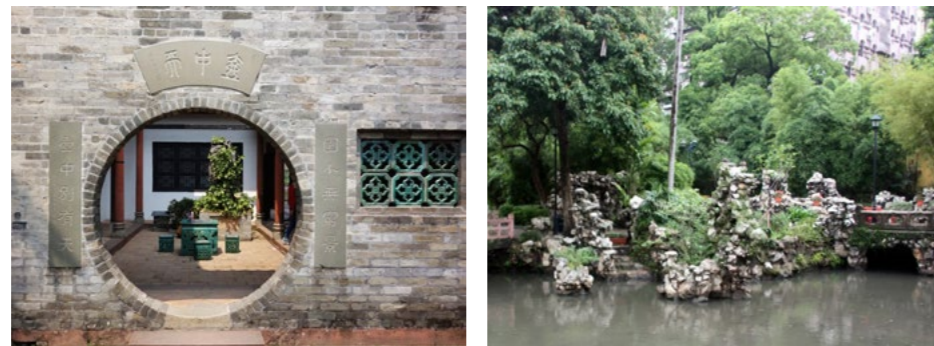
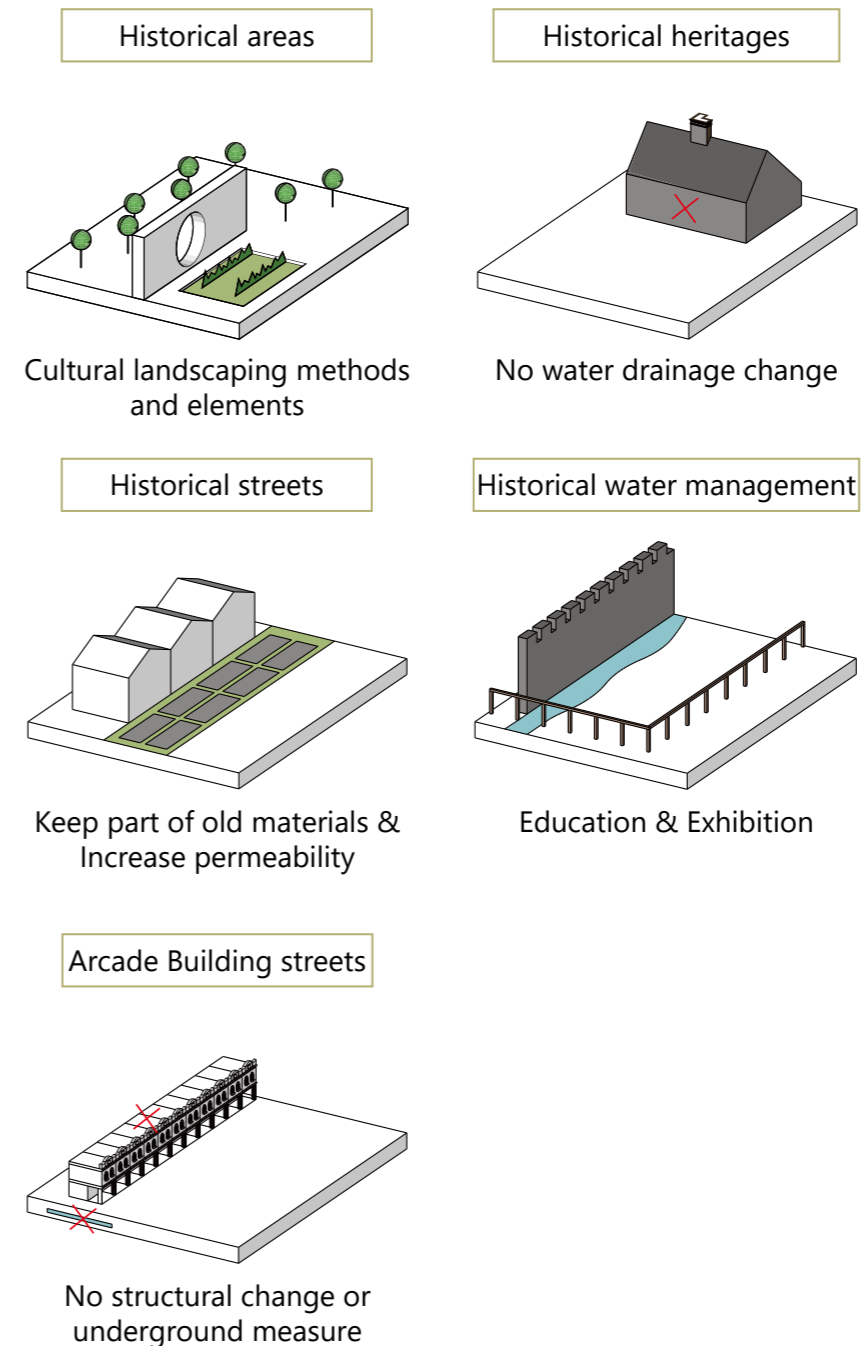


Fig. 3-4-7 Combination of White Magnolia, Fragrant Osmanthus, Lily Magnolia, and Malus Spectabilis: special scene meaning wealth full of the house (金玉满堂)
Source: <http://chuansong.me/n/670869349663>

(Fig. 3-4-6 and 3-4-7) Besides, certain type of trees has the cultural meaning. For instance, Kapok is the city tree in Guangzhou. Ficus is one extensively-used type of tree, which remind local people of their childhood. And because of the subtropical climate, special subtropical plants such as Royal Palm, Alexandra Palm, Jackfruit, Queen Crape Myrtle, Palm and different kind of fruit trees (Lu 2013) paint a subtropical style picture. (More details in Appendix 2)

So according to cultural heritage and landscaping knowledge, several design principle can be summarized as the following.



3.5 Medium-scale: SITE SELECTION

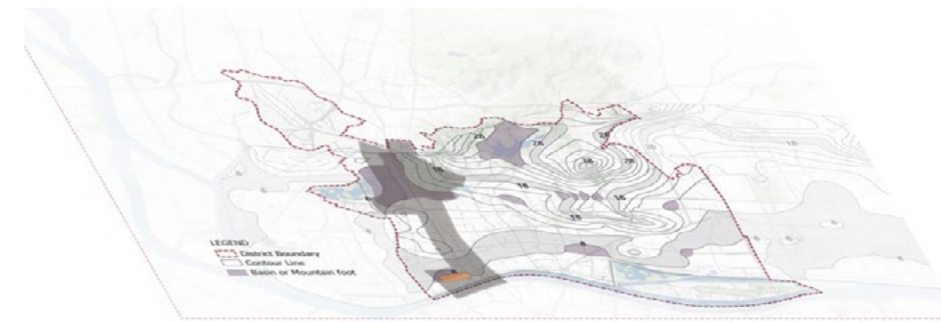


Fig. 3-5-1 Ancient city location and pattern
Source: Source: Guangzhou City Planning Bureau and Guangzhou City Construction Archives (2010)

Since this approach is a technical-socio-cultural water management approach, the chosen of study location should involve the consideration of these three perspectives. Yuexiu district as the area with the highest population density has high water vulnerability. Besides, derive from the study of "Shanshui" City, traditional Chinese city layout and location reflect Chinese nature value. Chinese cities usually situated in the space with mountain in the background and rivers nearby. Yuexiu district as the oldest district and ancient city center of Guangzhou, also follows "Shanshui" culture. The city pattern of ancient Guangzhou is described as "Connection between Six Vein Canal and the sea; Penetration between mountain and the city" ("六脉皆通海，青山半入城"). (Fig. 3-5-1) So to reflect culture study, old city axis zone is chosen as the study location, which is also under high water risk based on the analysis in terms of water sensitivity.



Historical hazard spots



Topography

Selected sites
Study location

Water Sensitivity



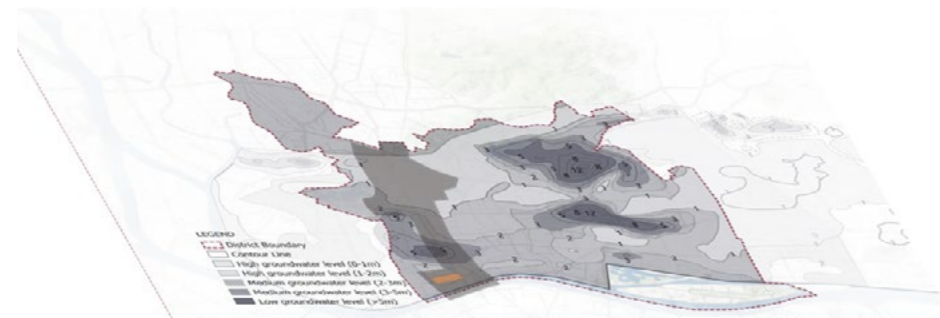
Green-blue network

Selected sites
Study location

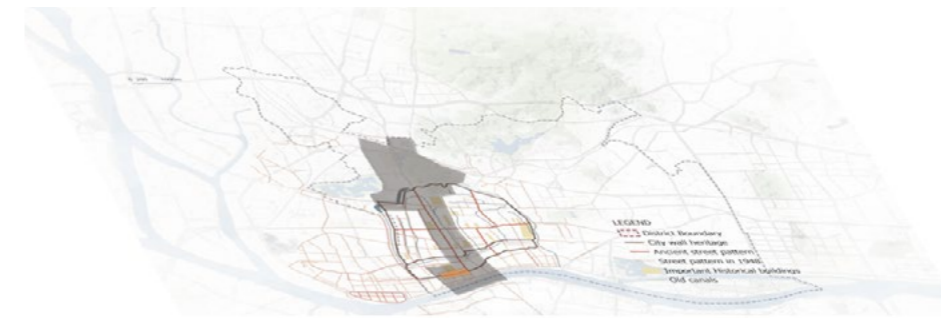
Cultural Inheritance



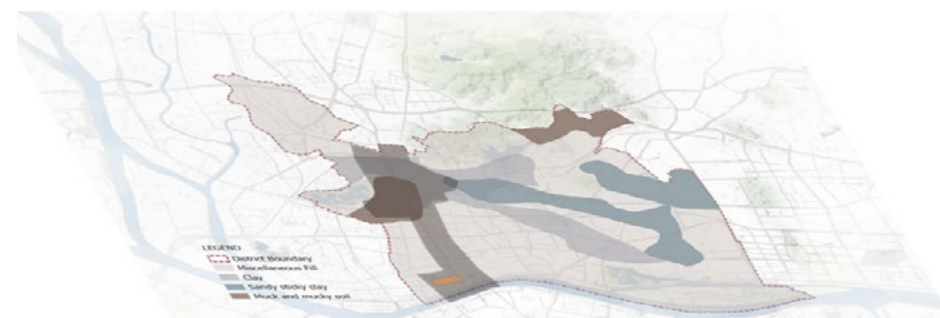
Distribution of historical areas



Underground water level



Distribution of historical heritage



Surface and subsurface permeability



Distribution of arcade buildings

Fig. 3-5-2 Site Selection Scheme
Source: Drawn by author

Fig. 3-5-2 Site Selection Scheme
Source: Drawn by author



Fig. 3-5-3 Map of building distribution of the Site
Source: Drawn by author



Fig. 3-5-4 Current situation of the Site
Source: Drawn by author

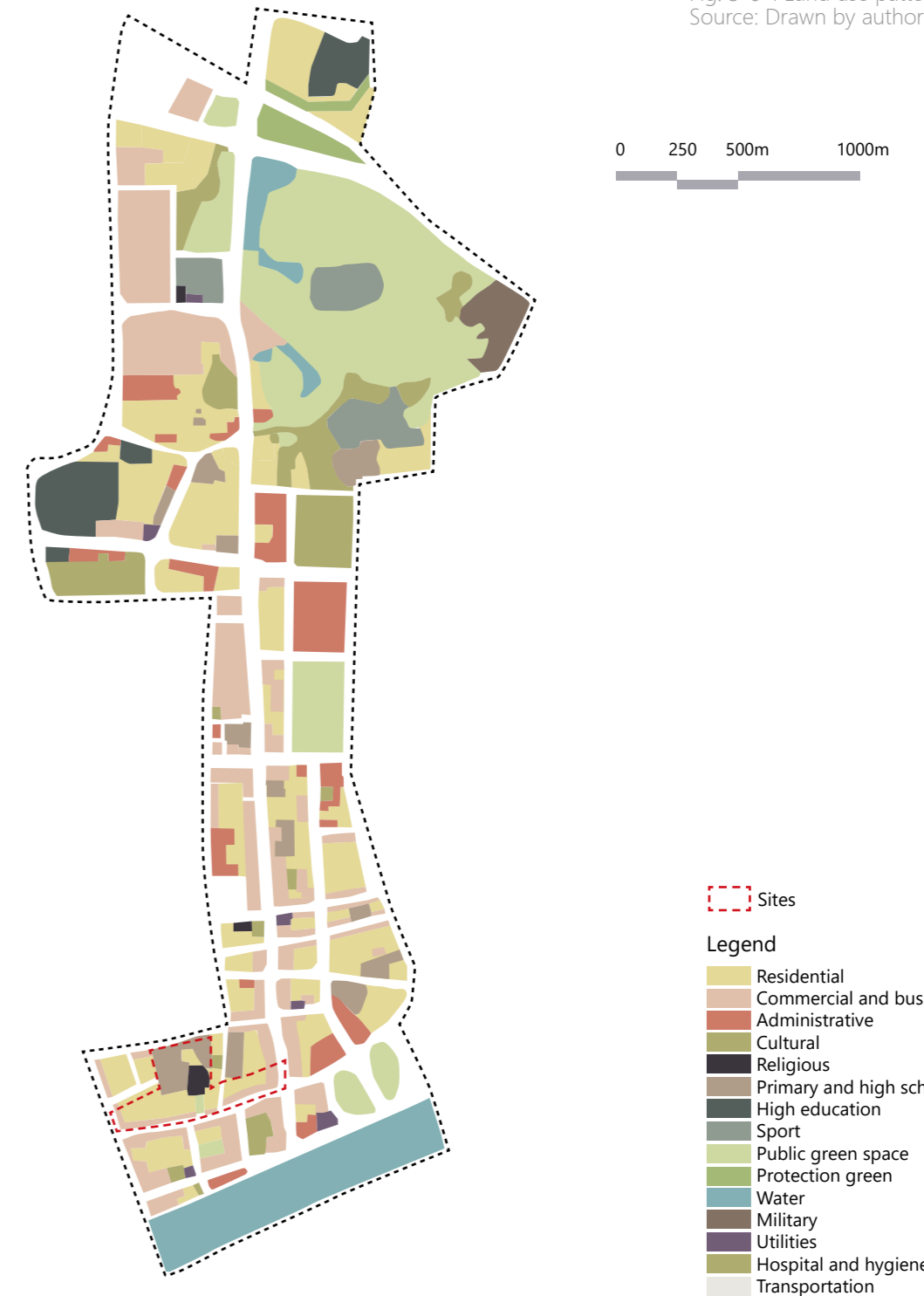
Main function:
Commercial, Religious and Residential, Educational

- Main challenge:
- Basin topography
 - Historical streets with "Man-made" basin - Conflicts between religion, residents and merchants
 - Urban dense area
 - Schoolyard water management

3.6 SPACE FOR PEOPLE

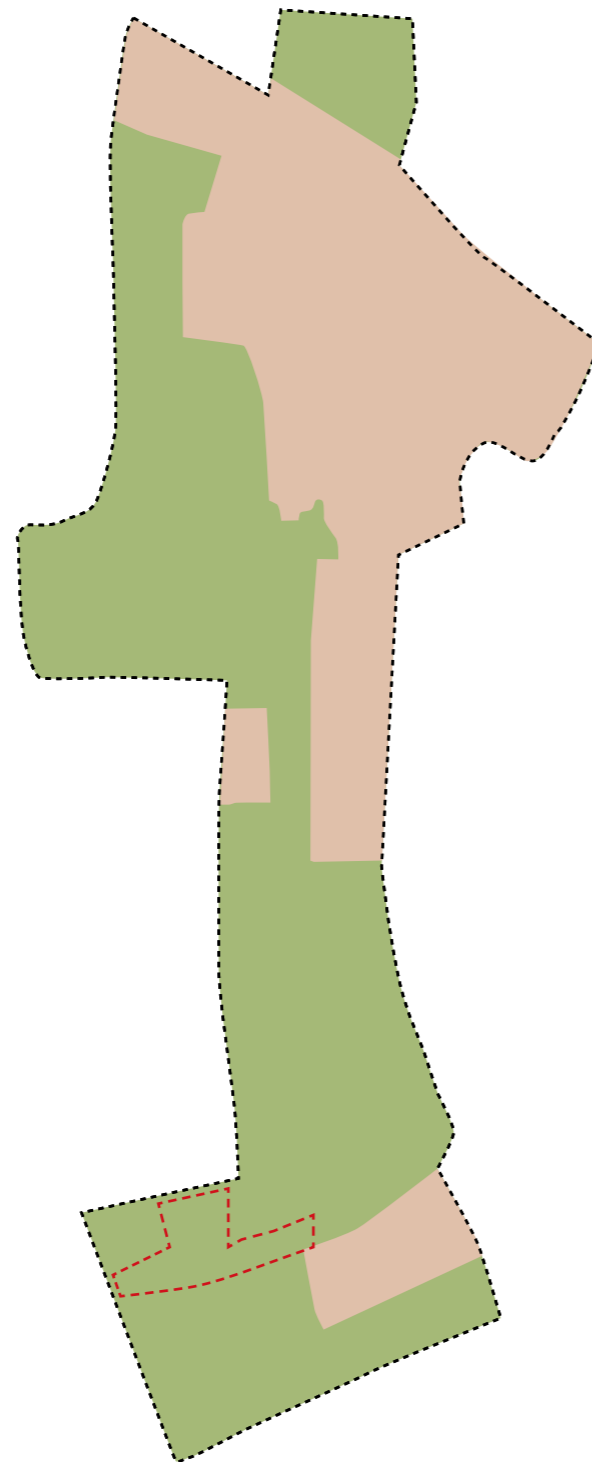
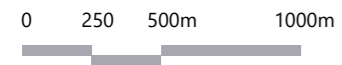
3.6.1 SPACE

Fig. 3-6-1 Land use pattern
Source: Drawn by author



- Sites
- Legend
- Residential
 - Commercial and business
 - Administrative
 - Cultural
 - Religious
 - Primary and high school
 - High education
 - Sport
 - Public green space
 - Protection green
 - Water
 - Military
 - Utilities
 - Hospital and hygiene
 - Transportation

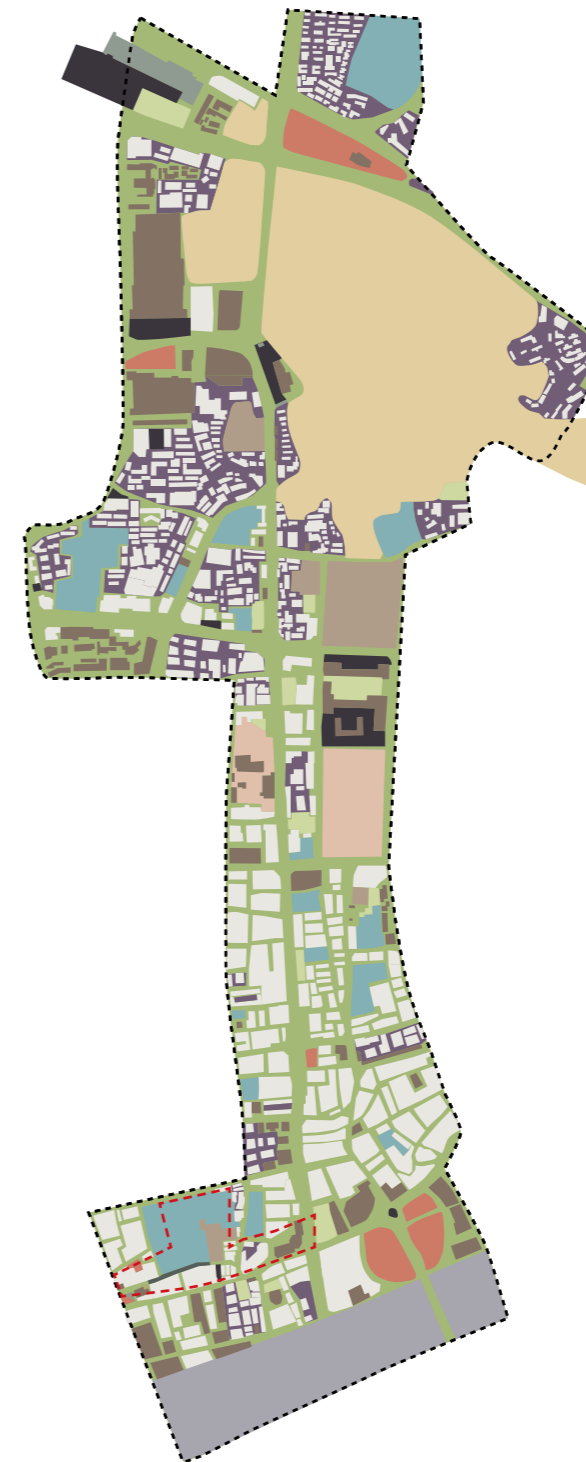
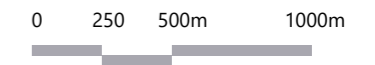
Fig. 3-6-2 Spatial Density
Source: Drawn by author



Legend
 [Red dashed box] Sites
 [Dotted line] Boundary
 [Light brown] Dense Area
 [Green] Sparse Area

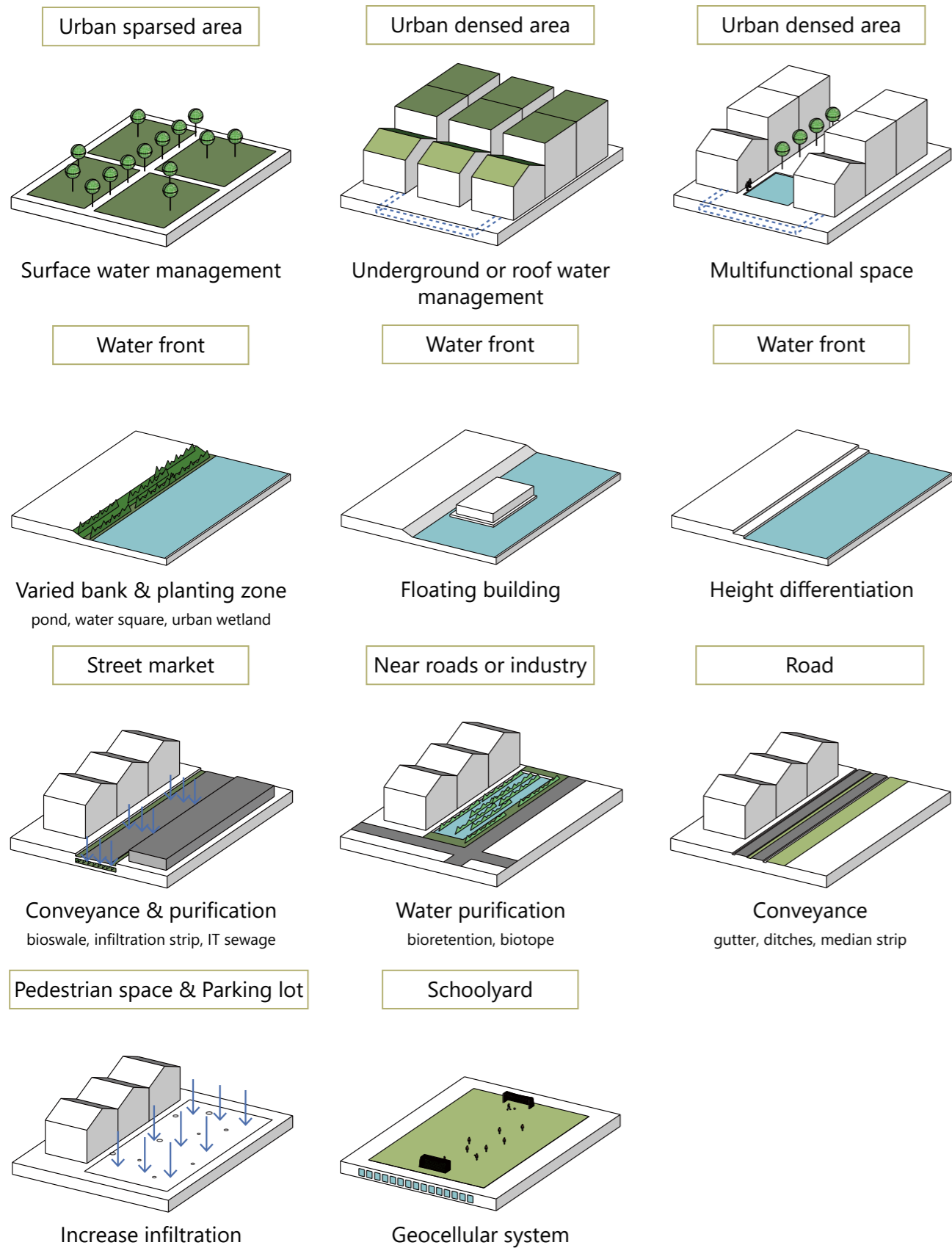
Public space as the main research object, is categorized into several spatial types (Fig. 3-6-3) according to Carr, Francis et al. (1992) which defined public spaces as "open, publicly accessible places where people go for group or individual activities".

Fig. 3-6-3 Typology of public space
Source: Drawn by author



Legend
 [Red dashed box] Sites
 [Yellow] Regional Park
 [Light brown] Downtown Park
 [Red] Neighborhood Park
 [Green] Pocket Park
 [Black] Square
 [Dark brown] Memorials
 [Dark grey] Market
 [Light grey] Traffic Transit Mall
 [Light green] Parking lot
 [Light green] Street
 [Blue] Schoolyard
 [Dark brown] Indoor Public Space
 [Purple] Neighborhood Space
 [Grey] Waterfronts
 [Light grey] Private Territory

To combine the analysis of land use pattern, typology of public spaces and the requirements of water sensitivity, some design principles are concluded.



3.6.2 EXPERIENCE

Guangzhou used to be a water village, people has close relationship with water: play, work, live with water. (Fig. 3-6-4)When local people were kids, they play in the water. (Fig. 3-6-5) There are many traditions or rituals related to water, such as dragon boat racing, dragon-lion dance, and worship for Goddess Matsu, Dragon King and Queen, etc. (Lin 2014) And ancient Cantonese people not only live in boats, but also work with water. Fishing is the basis industry in ancient Guangzhou. (Fig. 3-6-6) In Cantonese language, water means money: "return money" is "return water" ; "give money" is "give water"; "rob money" is "rob water" etc. in Cantonese. Therefore, Cantonese people are willing to have intimate contact with water. And water somehow represents the history of Guangzhou and some old-times memory. Water can build up link with local people's emotion and psychological cognition.







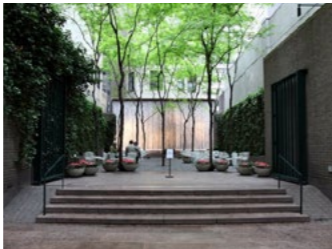





Fig. 3-6-4 Guangzhou water village life drawn by local artist
Source: www.zhen-ji.com













Fig. 3-6-5 (left) Image showing people play with water
Source: Photo taken by author in Donghao Canal Museum

Fig. 3-6-6 (right) Image of Canton water village
Source: Chen (2011)

Water not only remind people of the history, but also has the ability to create certain atmosphere or experience and establish a link between people and space. (Table 3-3)

Experience	How to achieve	Reference
Create Quiet Atmosphere/ Meditation	<ul style="list-style-type: none"> - Geometry water pond or canal with stone or brick bank - sand and stone simulate water surface - Located in front of buildings or in the center of squares 	 <p>Nanen-ji Zen Garden, Japan</p>  <p>Meditation Center in Stanford University, USA</p>
Set off Achitecture	<ul style="list-style-type: none"> - Geometry static water surface - Located in front of buildings or in the center of squares 	 <p>Taj Mahal, India</p>  <p>Suzhou Museum, China</p>
Increase Level of Space Sense	<ul style="list-style-type: none"> - Geometry static water surface - Water curtain 	 <p>Paley Park, New York, USA</p>  <p>Bridal Veil Water Curtain, France</p>
Simulate Natural Envrioment	<ul style="list-style-type: none"> - Flexible shape water pond with stone, mud or plant bank or stream with bridge, stone, beach, or aquatic plant alongside - Located in natural-style park or residential area 	 <p>Stanley Park Salmon Stream, Vancouver, Canada</p>  <p>Liang Garden in Foshan, China</p>
Connection and Continuation	<ul style="list-style-type: none"> - Long and flexible water surface or stream with natural bank 	 <p>Three-Gorges Tribe Scenic Spot, Yichang, China</p>  <p>Plitvice Lakes National Park, Croatia</p>

Experience	How to achieve	Reference
Provide Growth Environment for Flora and Fauna	<ul style="list-style-type: none"> - Water surface with enough depth for certain creature 	 <p>Stanley Park Salmon Stream, Vancouver, Canada</p>  <p>London Wetland, UK</p>
Entertaining	<ul style="list-style-type: none"> - Water surface with less than 30cm depth and slippery-proof bottom - Land fountain 	 <p>Public Space in Bordeaux, France</p>  <p>Normal Green Water Square in Illinois, USA</p>
Create Splendid Atmosphere	<ul style="list-style-type: none"> - Large or High Fountain - Musical Fountain - Waterfall - Adapt to geography 	 <p>Kunming Waterfall Park, China</p>  <p>Fountain at the Bellagio Hotel and Casino, Las Vegas, USA</p>
Create Dynamic Atmosphere	<ul style="list-style-type: none"> - water surface with sound, such as stream, cascade, fountain, water curtain, waterfall 	 <p>Jamison Square Fountain, Portland, USA</p>  <p>Square Four Beirut, Lebanon</p>
Create romantic/ illusion atmosphere	<ul style="list-style-type: none"> - overflow, thin water curtain, fog fountain 	 <p>Public Space in Bordeaux, France</p>  <p>Tanner Fountain, Harvard University, USA</p>

Experience

How to achieve

Reference

Improve Microclimate

- Large water surface, water curtain, fog fountain



Hong Village in Anhui, China



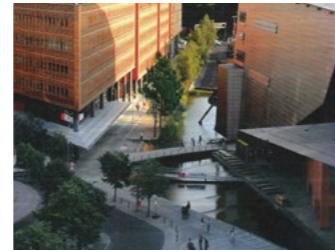
Harbor Fog Sculpture in Boston, USA

Water Buffer and Drainage, Prevent Flood

- Water surface with flexible water level

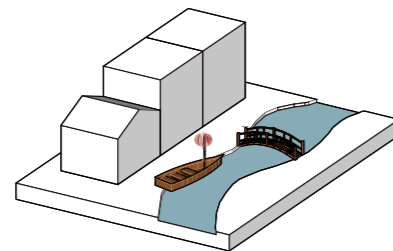


Tanner Springs Park, Portland, USA

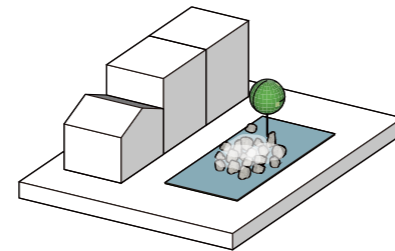


Potsdamer Platz, Berlin, Germany

Water as the key subject manipulated in water management, can be taken advantage of and optimize its value by connecting space and people. It can be integrated into landscape and helps to improve culture identity.



Introduce historical value of water



Use water to create experience

3.7

CLIMATE & PUBLIC LIFE

Guangzhou has the subtropical humid climate, which means it is with high temperature all year round and rains a lot especially in summer. (Fig. 3-7-1) The rainstorm intensity is showed in Table 3-4. The average temperature in Guangzhou is 21.8 °C and the average relative humidity is 79%. (Yu 2016)

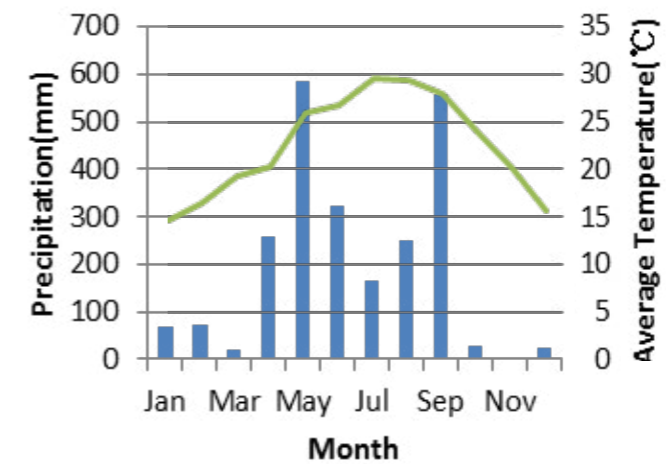


Fig.3-7-1 2010 Guangzhou monthly precipitation and temperature
Data resources: climate statistic data in Guangzhou Meteorological Bureau (<http://www.gz121.gov.cn/>)

Rainstorm Recurrence Period	Rainstorm Intensity (mm/h)
A decade	52.7
Twenty years	64.7
Fifty years	67.9
A hundred year	87.3

Table 3-4 Rainstorm intensity of Guangzhou
Source: Yu (2016)

Because of high temperature along with high humidity, suitability of outdoor activities in Guangzhou is undesirable. Therefore, local residents enjoy going out at night. Based on the observation by the author, the neighborhood park was crowded by people running and walking even at 10 o'clock in the evening. And because of the prosperity of trade and commercial industry, many younger citizens go out for shopping or join nighttime entertainment activities in the evening. In dynamic areas, small grocery shops, clothes shops in combination with lots of food shops and restaurants reflect daily needs of local people. (Fig.3-7-2) And due to the climate, commercial streets normally provide shade by large-canopy trees, shadow of buildings, arcade buildings or shelters of small shops.(Fig. 3-7-3) Considering special climate and context in Guangzhou, the chosen of vegetation which is one of the key elements of water management, should match the environment. (More details in Appendix 2) In addition, on different time periods, activities and user groups alter which should also be taken into account. (Fig.3-7-4)



Fig.3-7-2 Site 2: Map of business types
Source: Drawn by author

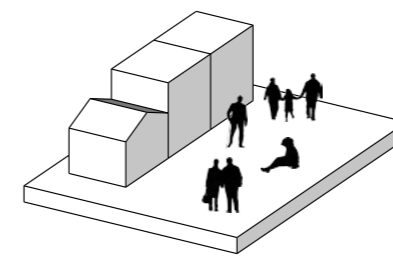


Fig. 3-7-3 Site 2: Map of climate design
Source: Drawn by author

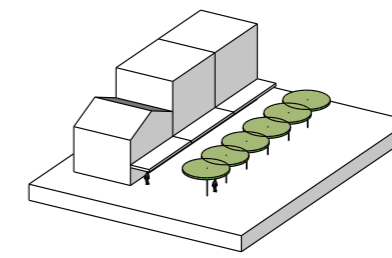


Fig.3-7-4 Site 2: Map of activities and user groups
Time: Nov. 29 17:30 2016
Source: Drawn by author

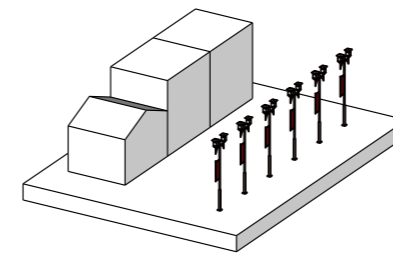
Deriving from the discipline of public life in Guangzhou and the special climate design requirements, several design principle is revealed:



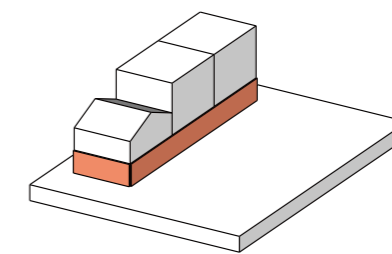
Consider different needs of user group



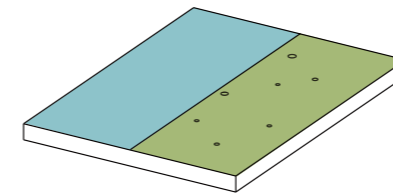
Provide enough shade



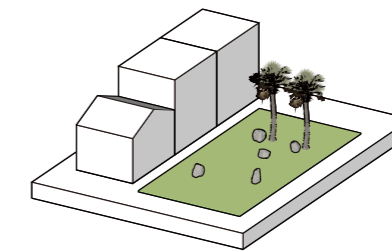
Nighttime design



Sealable ground floor



Dry & wet scenarios



Local type vegetation

3.8 PUBLIC PARTICIPATION

Public participation refers to two layers of meanings. One is the participation of certain groups and the other one is the direct engagement of groups and individuals. Traditional mono-decision by "an expert who knows best" is no longer capable of dealing with uncertainties of future water challenges (Ashley, Blecken et al.) Therefore stakeholders should be involved in the process of design or implementation.

The essence of stakeholder issue is to balance different interests and create shared vision accepted by various groups. During the whole process, stakeholders who can possibly bring funding into the project play key role.

Learning and Action Alliances (LAA) approach which is defined as "a group of individuals or organizations with a shared interest in innovation and the scaling-up of innovation, in a topic of mutual interest" (Ashley, Blecken et al.) is gaining popularities in establishing stakeholder studies. The phases of LAA approach is shown in Fig. 3-8-1.

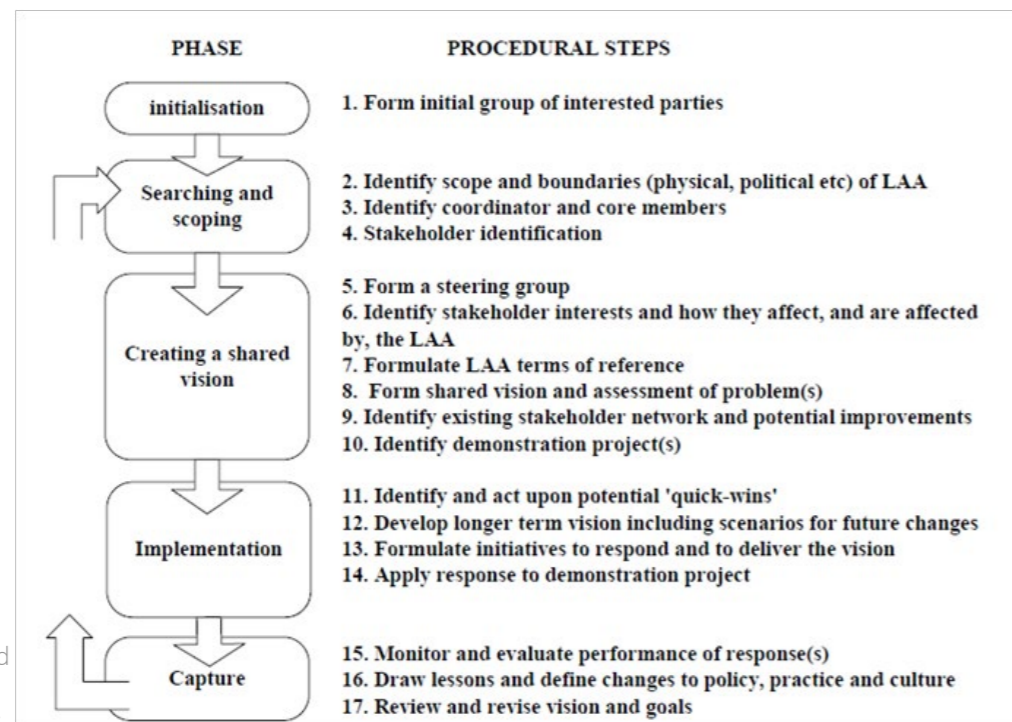


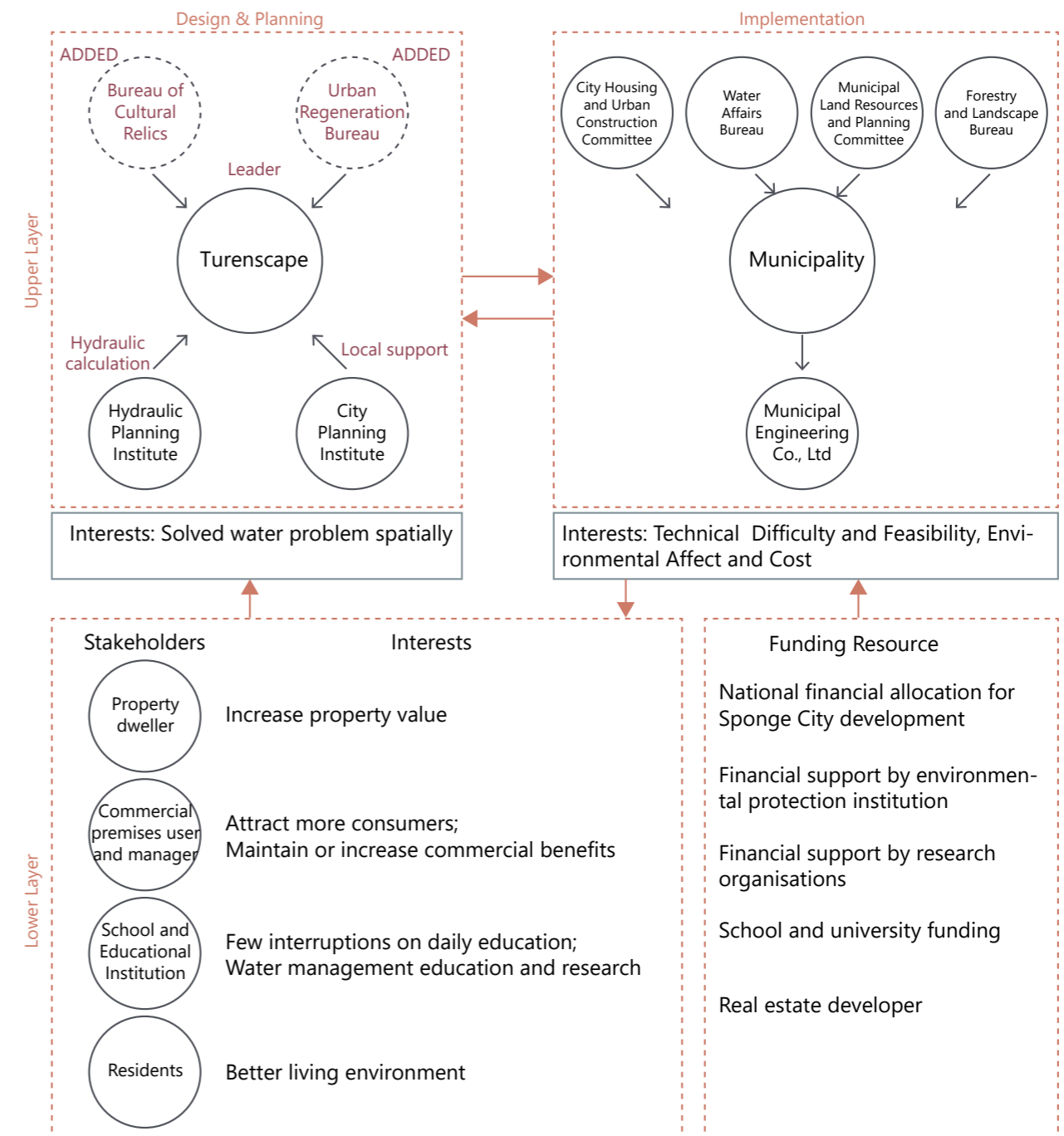
Fig. 3-8-1 Establishing and running LAA approach
Source: Ashley, Blecken et al.

In Guangzhou, the planning and design of Sponge City projects are led by Beijing Turenscape Urban Planning and Design Co., Ltd, Guangzhou Hydraulic Planning Survey and Design Institute, and Guangzhou City Planning Survey and Design Institute. Among them, Beijing Turenscape Urban Planning and Design Co., Ltd lead projects which complemented

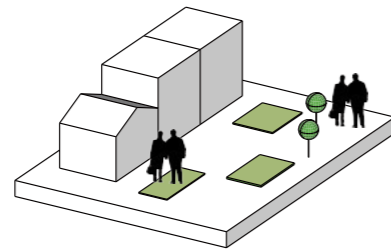
by local support of Guangzhou City Planning Survey and Design Institute while Water Planning Survey and Design Institute is only in charge of hydraulic calculations. On the other hand, the monitor of project implementation is involved by Guangzhou City Housing and Urban Construction Committee, Guangzhou Water Affairs Bureau, Guangzhou Municipal Land Resources and Planning Committee and Guangzhou Forestry and Landscape Bureau. The municipality finally decides whether projects can be implemented.

To match this technical-socio-cultural approach of water management, current organizational structure needs to be revised and take more lower-layer-stakeholder's opinion into account. (Fig. 3-8-2)

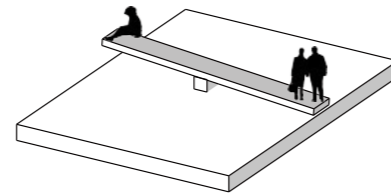
Fig. 3-8-2 Diagram of involved stakeholders and their interests
Source: Drawn by author



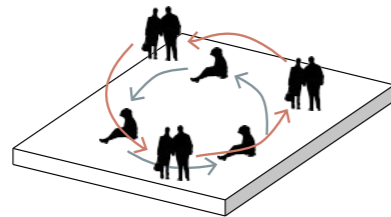
Following the LAA approach, some principles are summarized to involve stakeholders into water management and improve public participation.



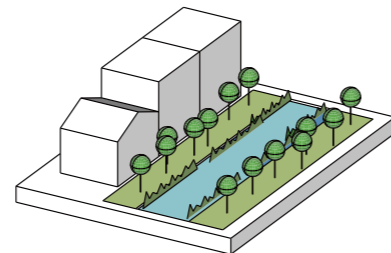
Half guide initiatives



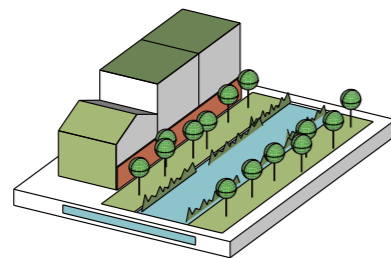
Balance various interests



Cross-layer organizational network



Effective "quick-wins"



Long-term shared vision

3.9

DESIGN PRINCIPLE

Water sensitivity

Different natural contexts require different design principles. Mound can be used for evacuation refugee when flood comes. Basin, on the other hand, is better to function as water retention. And space with slope or is flat can be used as water conveyance. If a space with fluctuated topography, it is better to take advantage of it and strengthen the height differentiation in order to create more spatial flexibility. Groundwater level is vital for water management. Space with high groundwater level cannot be applied for underground measures, but can be exposed water surface and combine it with water retention pond. And space with low groundwater level can accept underground technical measures such as IT sewage system, geocellular system, etc. Regarding original ground permeability, well-drained ground is supposed to directly improve surface infiltration by porous paving, urban infiltration strips etc. However, poor permeable ground has low infiltration capacity so poor permeable layer should be avoided by technical measures in order to connect surface to permeable subsurface smoothly. Green roof and green façade also have effects on water management. Therefore, high quality building walls can be transformed into green façade; simultaneously accessible roofs' structures can be reinforced into green roofs. As for historical techniques applied in Guangzhou, original canal drainage system can be improved if applicable into recreational water drainage canals. And areas especially basins which are far from nearby water body can connect to natural water cycle by linking to underground water. Areas with "Man-made" basin left over by history can create edge buffer using infiltration strips, ditches, etc. to solve water problem locally.

Cultural inheritance

Urban design should inherited cultural feature of the city and cultural study also affects the chosen of technical measures. In historical areas, cultural landscaping methods such as garden landscaping for Guangzhou should be applied using water, stone, and vegetation as design elements to complement water management project design. Besides, most historical streets were paved with stones filled by cements later, so the original drainage function was weakened. If we want to maintain historical memory, it is likely to keep part of old materials such as stones and substitute permeable paving for other materials. In addition, arcade buildings are one important symbol representing certain periods of history in Guangzhou, and most of arcade building streets are currently used for commerce and business. In order to protect arcade buildings, technical measures involved structural change

both above ground or underground are not applicable. Small changes such as temporary protection devices are acceptable. For historical heritages, those with water drainage functions can be developed as education and exhibition zones, and others require carefully protection so no water drainage changes are allowed.

Space for people

Urban design should consider public life and different types of public space are calling for corresponding water management measures. In public spaces of urban sparse areas, technical measures requiring much surface area such as infiltration plane meadow, urban channels are feasible while in urban dense areas, water management should occupied as least surface space as possible so underground or roof water management and multifunctional surface space are better options. Water front is important public space in terms of water management. And water banks can be diversified by planting or height differentiation so as to increase flexibility facing water disturbances. Besides, floating buildings can be placed along water front as evacuation refugees under emergency. Street markets are important spots reflecting local public life in Guangzhou. However, street markets contain large amount of contaminants which require conveyance and purification. And so are roads or industrial areas. Moreover, not intensively used roads, car parks and pedestrian space should increase surface infiltration. For instance, substitute porous paving for original concrete or cement paving. Schoolyard can also be used for water management with underground geocellular system. And to protect commercial benefits, ground floors of commercial buildings are better to equipped with sealable devices or architectural skins. Concerning people's activities and emotions, needs of different user groups should be taken into consideration. And water as the key element, can be used to create different atmosphere or experience and connect people's emotion with the space.

Climate comfort

A good public space for water management should also provide climate comfort. Design principles regarding climate comfort alters depending on local climate. For Guangzhou, because of the subtropical humid climate, public space should provide enough shade by large-canopy trees, buildings, shelters or arcade buildings to prevent people from strong direct sunshine and sudden extreme rainfalls. And due to the local preference of nighttime activities either on neighborhood parks or in commercial areas, nighttime design such as the arrangement of lights, nighttime business types, etc. is very important to support local public life. Since high humid and high temperature climate is suitable for mosquitoes' reproductions, every summer, water bodies in public spaces in Guangzhou will be dried out. Hence, public space for water management with exposed water surface need to be designed with dry & wet scenarios. Local types of vegetations owns local cultural feature and in the same time adapt to local climate, so vegetations such as Kapok, Ficus, Palm etc. are the optimal design elements.

Public participation

Stakeholders should be involved in the design and action process, so cross-layer organizational and institutional network need to be considered. Design proposals should balance different interests of stakeholders. Therefore, a long-term shared vision can play the role of "bridge" for all stakeholders reaching one final ubiquitous objective. And regarding smaller scale spaces, there are initiatives of stakeholders, so guidance is necessary while room for initiatives is also important. In order to raise public awareness and attract investment, some municipality-leading projects with obvious effects on water management should be concentrated and finished at a short period.

All these design principles should be followed as the CSC approach for better water management in Guangzhou. The box of design principle is shown on the next page.



WATER SENSITIVITY

Mound Evacuation refugee	Basin Water retention
Slope/Flat street Conveyance path	Various topography Height differentiation
High groundwater Expose water surface	Low groundwater Underground management
Poor permeability Avoid poor permeability layer	Well-drained ground Surface infiltration
High-quality building Green facade	Accessible roof Green roof
Near canal system Improve historical canal drainage	Basin far from surface water Connect to underground water

CULTURAL INHERITANCE

Historical areas Cultural landscaping methods and elements	Urban sparse area Surface water management
Historical streets Keep part of old materials & Increase permeability	Water front Varied bank & planting zone
Arcade Building streets No structural change or underground measure	Street market Conveyance & purification
Historical heritages No water drainage change	Pedestrian space & Parking lot Increase infiltration
Historical water management Education & Exhibition	Use water to create experience Use water to create experience
Man-made basin Edge buffer	Introduce historical value of water Introduce historical value of water

SPACE FOR PEOPLE

Urban dense area Underground or roof water management	Urban dense area Multifunctional space
Water front Floating building	Water front Height differentiation
Near roads or industry Water purification	Road Conveyance
Schoolyard Geocellular system	Commercial area Sealable ground floor
Consider different needs of user group 	

CLIMATE COMFORT

Provide enough shade
Nighttime design
Dry & wet scenarios
Local type vegetation

PUBLIC PARTICIPATION

Half guide initiatives
Cross-layer organizational network
Balance various interests
Effective "quick-wins"
Long-term shared vision





4 STRATEGY AND DESIGN

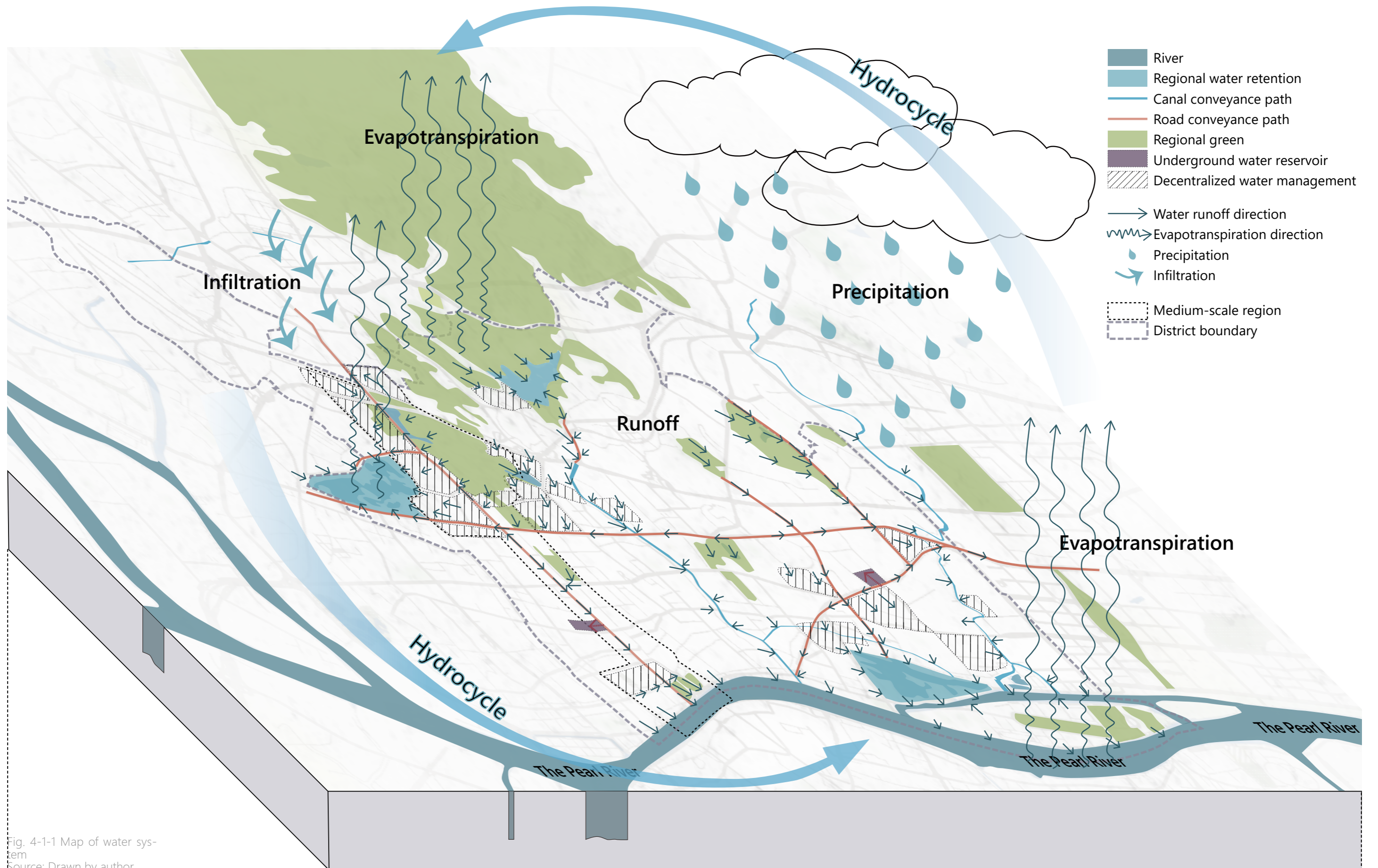
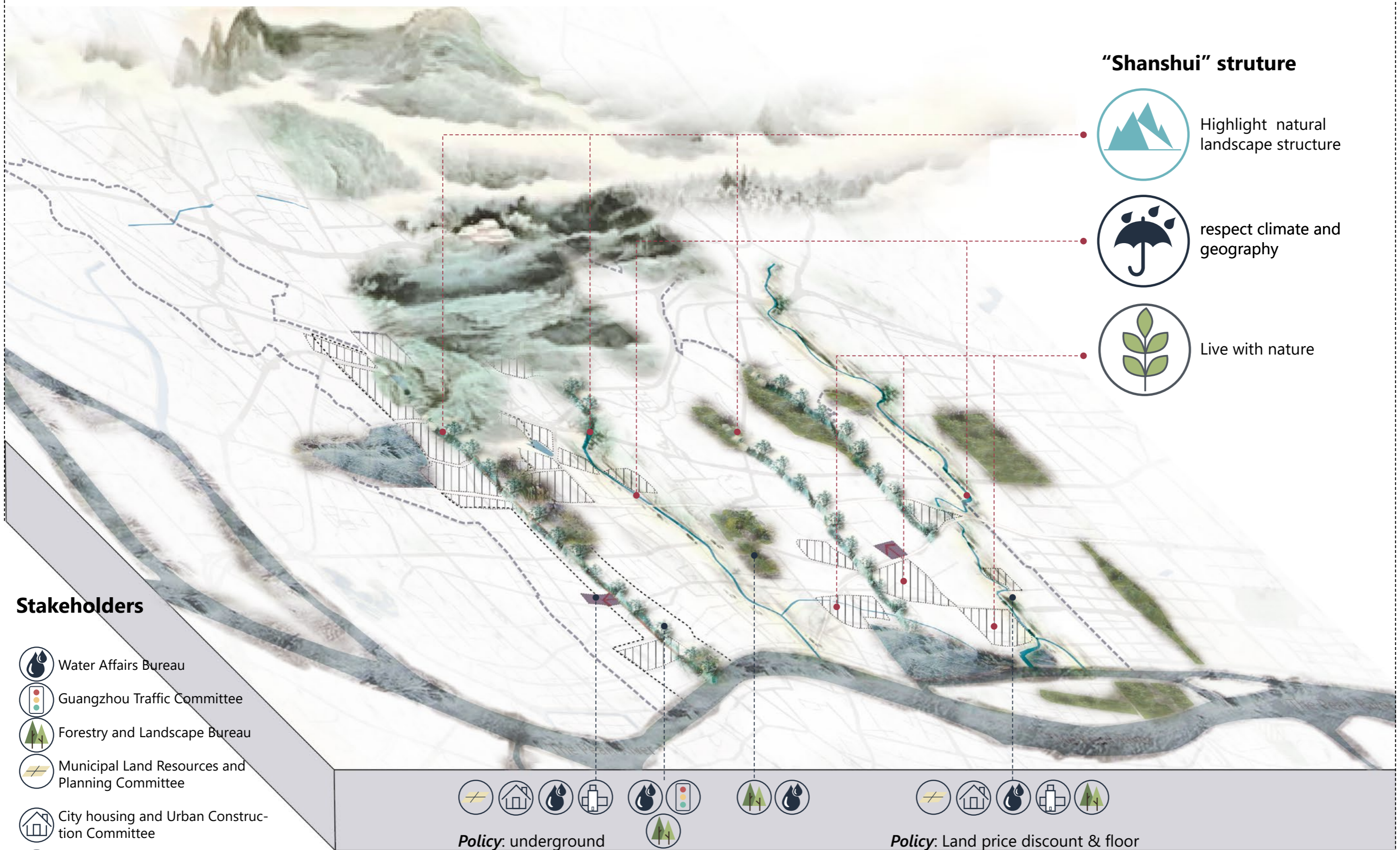


Fig. 4-1-1 Map of water system
Source: Drawn by author



“Shanshui” structure

-  Highlight natural landscape structure
-  respect climate and geography
-  Live with nature

Stakeholders

-  Water Affairs Bureau
-  Guangzhou Traffic Committee
-  Forestry and Landscape Bureau
-  Municipal Land Resources and Planning Committee
-  City housing and Urban Construction Committee
-  Real Estate Developers

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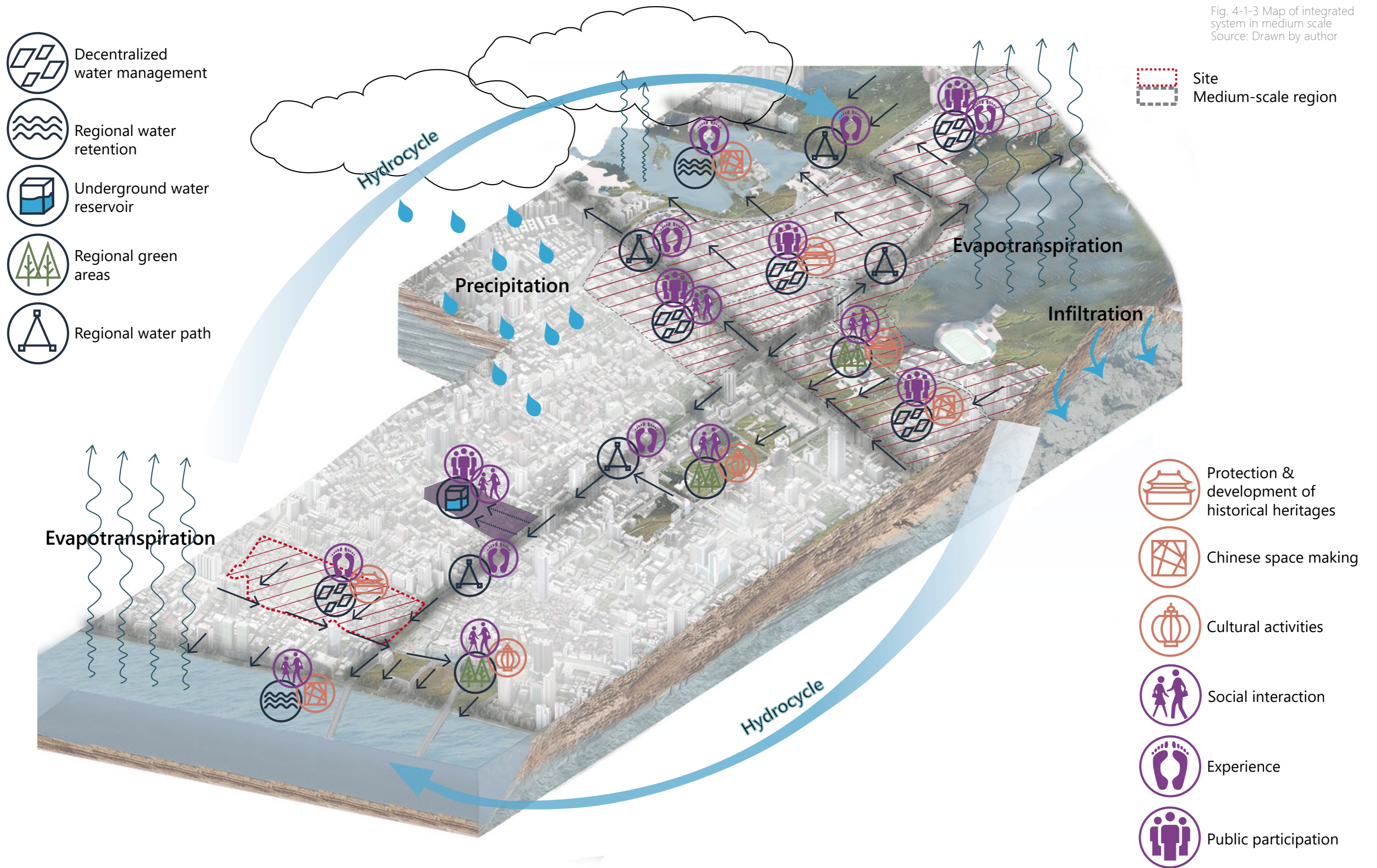
Policy: underground commercial area reward

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- 
- 
- 
- 

Policy: Land price discount & floor area ratio reward if develop canal recreation and water management

Fig. 4-1-2 Map of socio-cultural refection on the system
Source: Drawn by author

Fig. 4-1-3 Map of integrated system in medium scale
Source: Drawn by author



4.1 SYSTEM MECHANISM

After applying the approach, every region works as circular system varied from a small block to the whole city. Decentralized water management developed through dispersed neighborhoods forms micro water cycle. Then regional water paths (road or canal) transport dispersed water to regional green areas or underground water reservoir and finally river or lakes if the amount of water surpasses the capacity of decentralized water management. (Fig. 4-1-1) Each element creates its own water cycle simultaneously joins a larger water chain. (Fig. 4-1-4) Most importantly, the water cycle does not work on its own. Social and cultural attributes always attach to technical solutions. (Fig. 4-1-3 and Fig. 4-1-5) By integrated social and cultural perspectives with technical water management, local natural structure can be emphasized, cultural identity of the city will be strengthened, and water management will be more feasible and acceptable through social considerations. (Fig. 4-1-2 and Fig. 4-1-3).

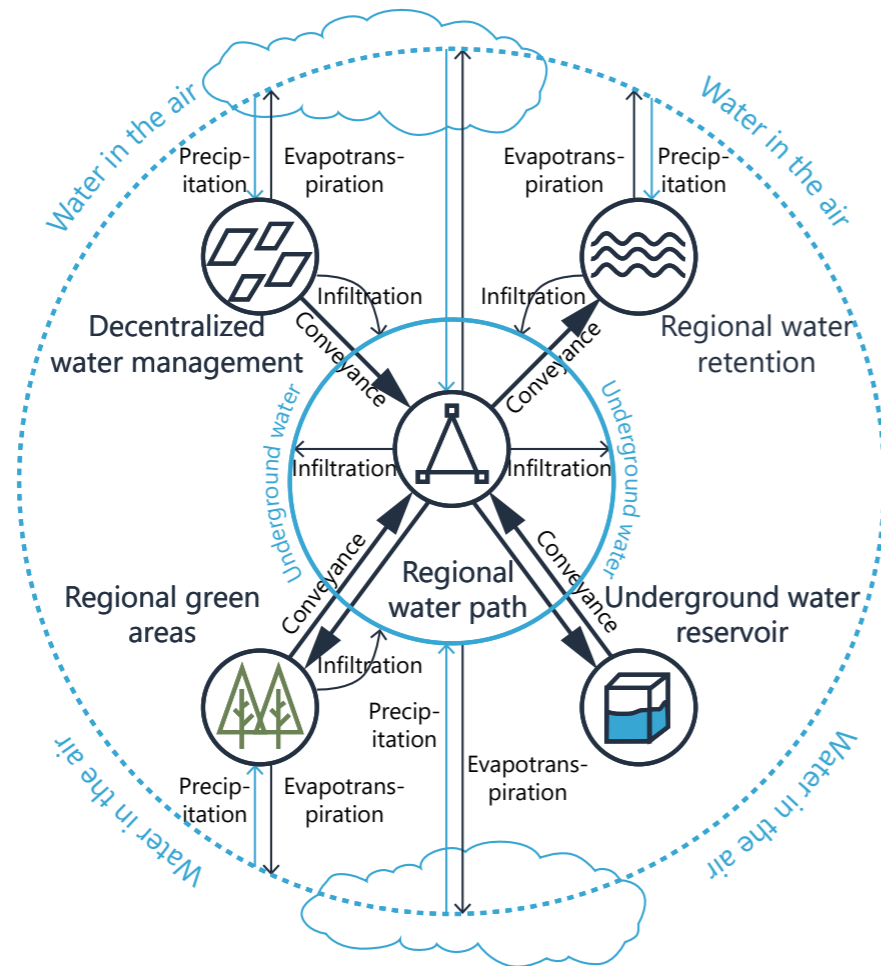


Fig. 4-1-4 System mechanism of water circle
Source: Drawn by author

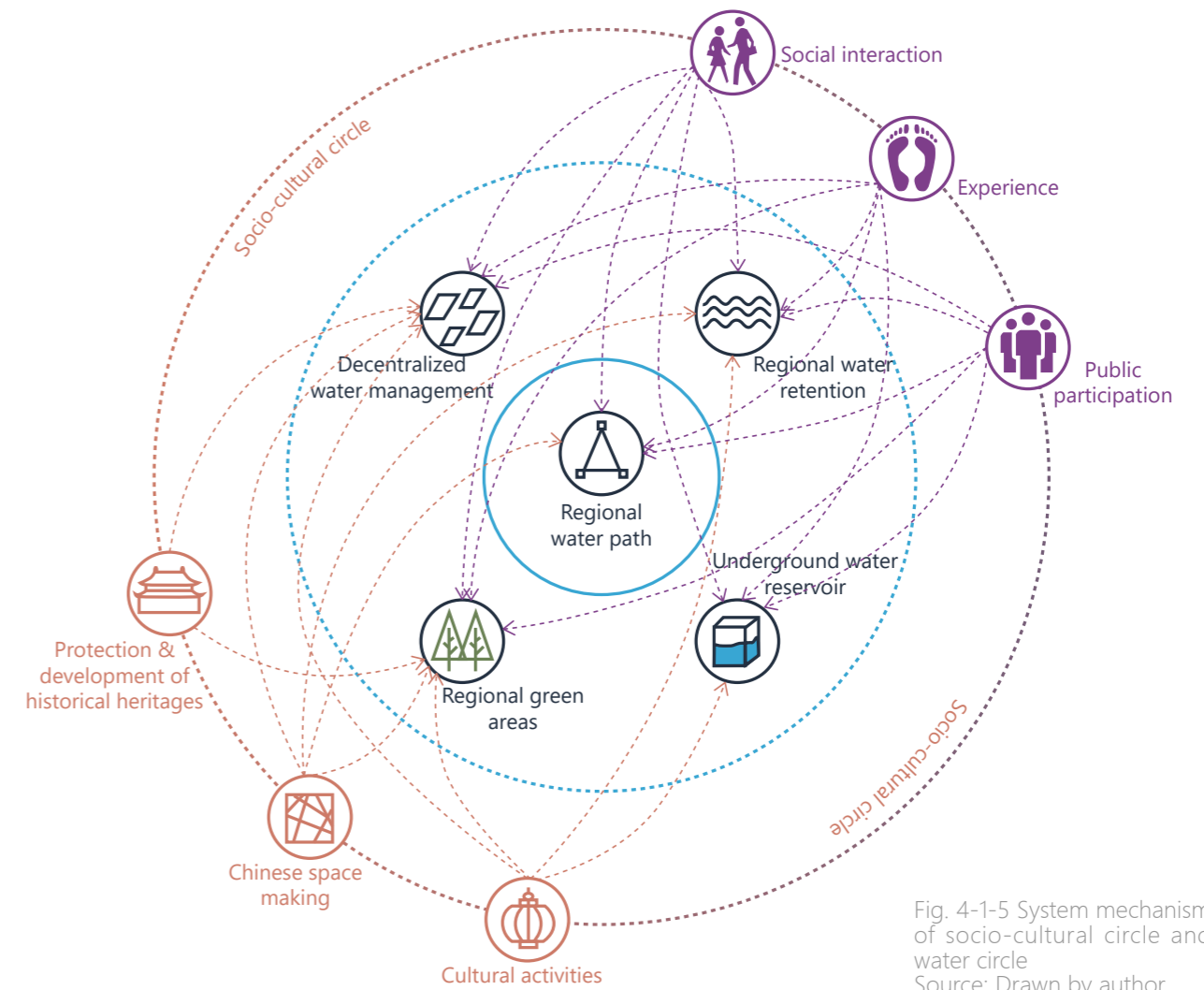


Fig. 4-1-5 System mechanism of socio-cultural circle and water circle
Source: Drawn by author

4.2

VISION AND STRATEGY

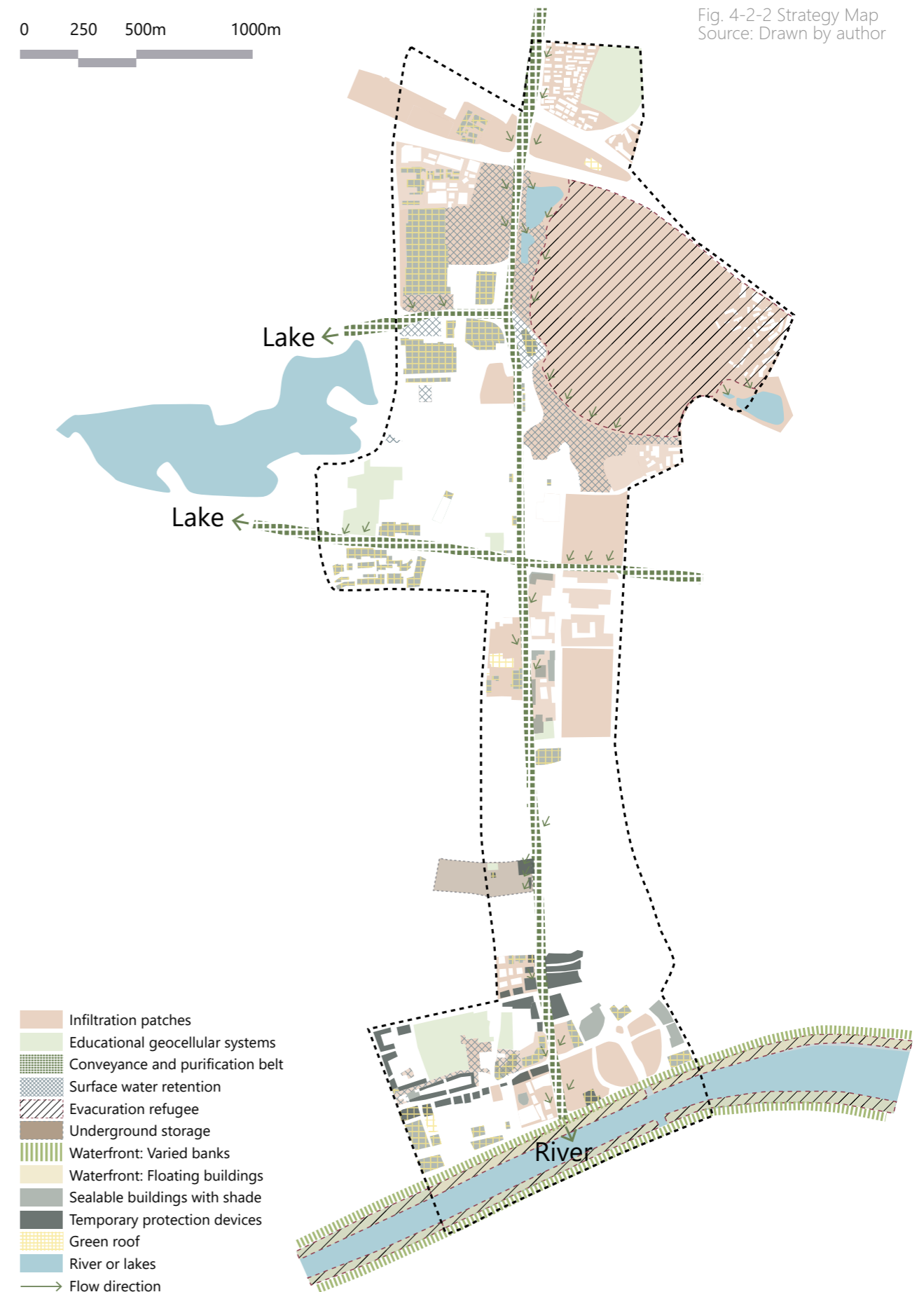
If the cultural-socio-technical approach applied in cities, better vision can be foreseen. For quantities, a lot more public spaces can be developed through transforming indoor public spaces with accessible roofs to green roof gardens, which really benefits urban dense areas. Public spaces not only harvest, lean and recycle water, but also are vital and dynamic reflecting city culture and filled with people's activities throughout the day. The water cycle of the city is improved so the city is resilient to face flood issue, fewer and fewer waterlogging spots. Even cultural heritages and historical spaces are also protected in case of water disturbances. The public awareness regarding water management can be significantly raised through the development on schoolyards and the incorporation of stakeholders. And more and more investments come in to facilitate the construction of socio-cultural water sensitive public space.

Fig. 4-2-1 Vision Map
Source: Drawn by author



0 250 500m 1000m

Fig. 4-2-2 Strategy Map
Source: Drawn by author



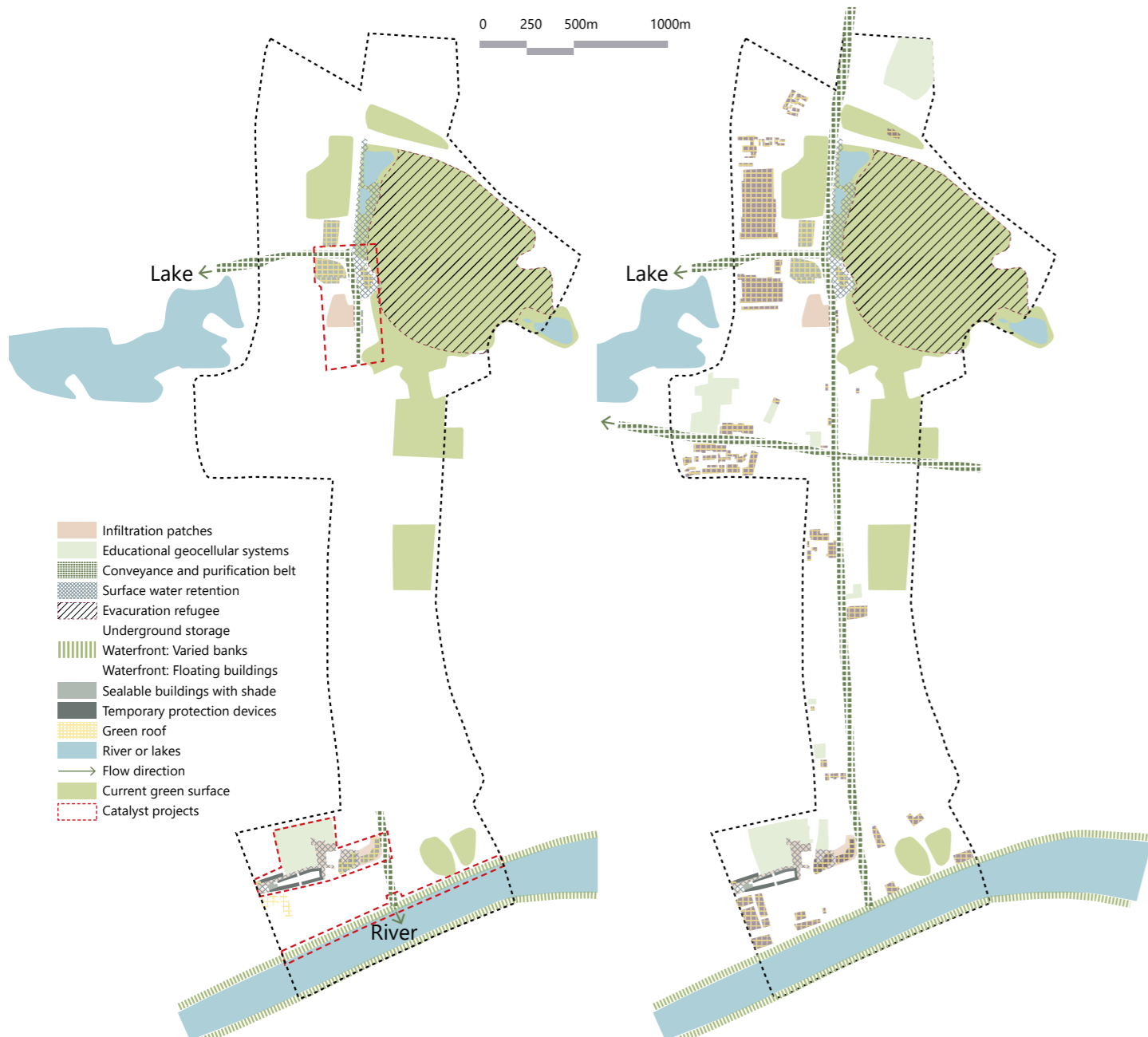


Fig. 4-1-3 Action process of Phase 1
Source: Drawn by author

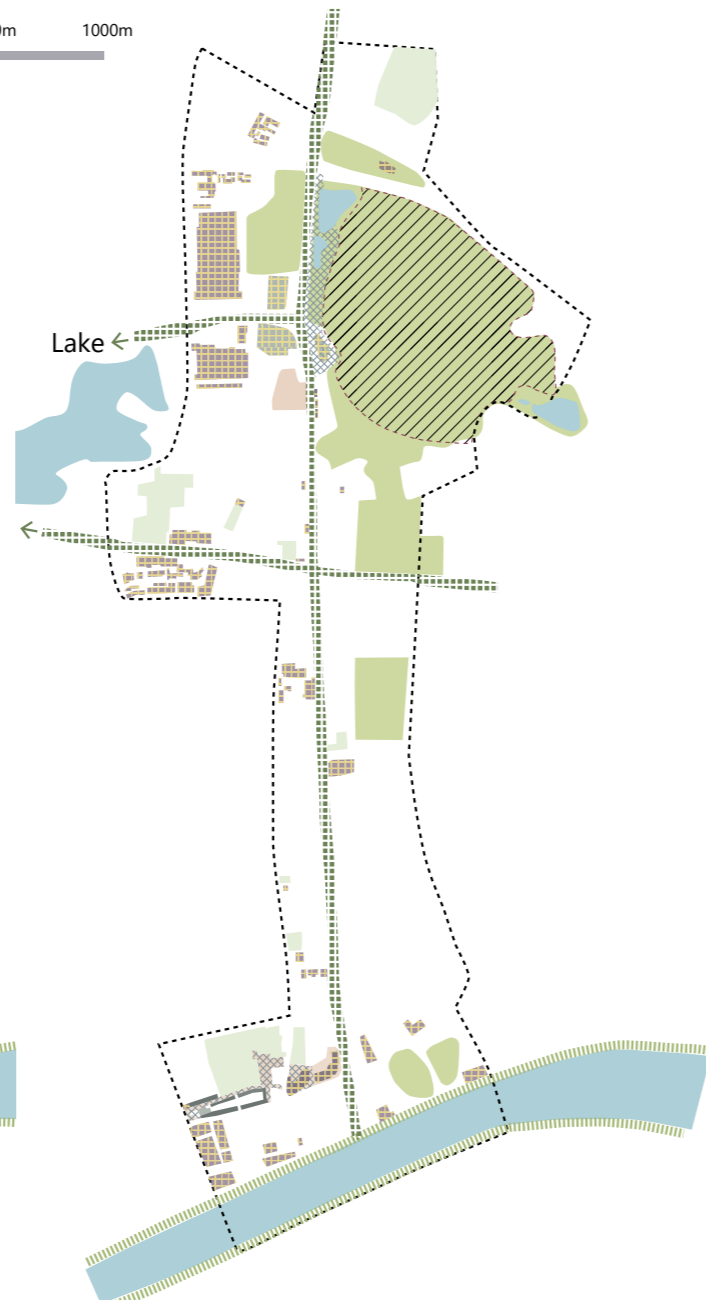


Fig. 4-1-4 Action process of Phase 2
Source: Drawn by author

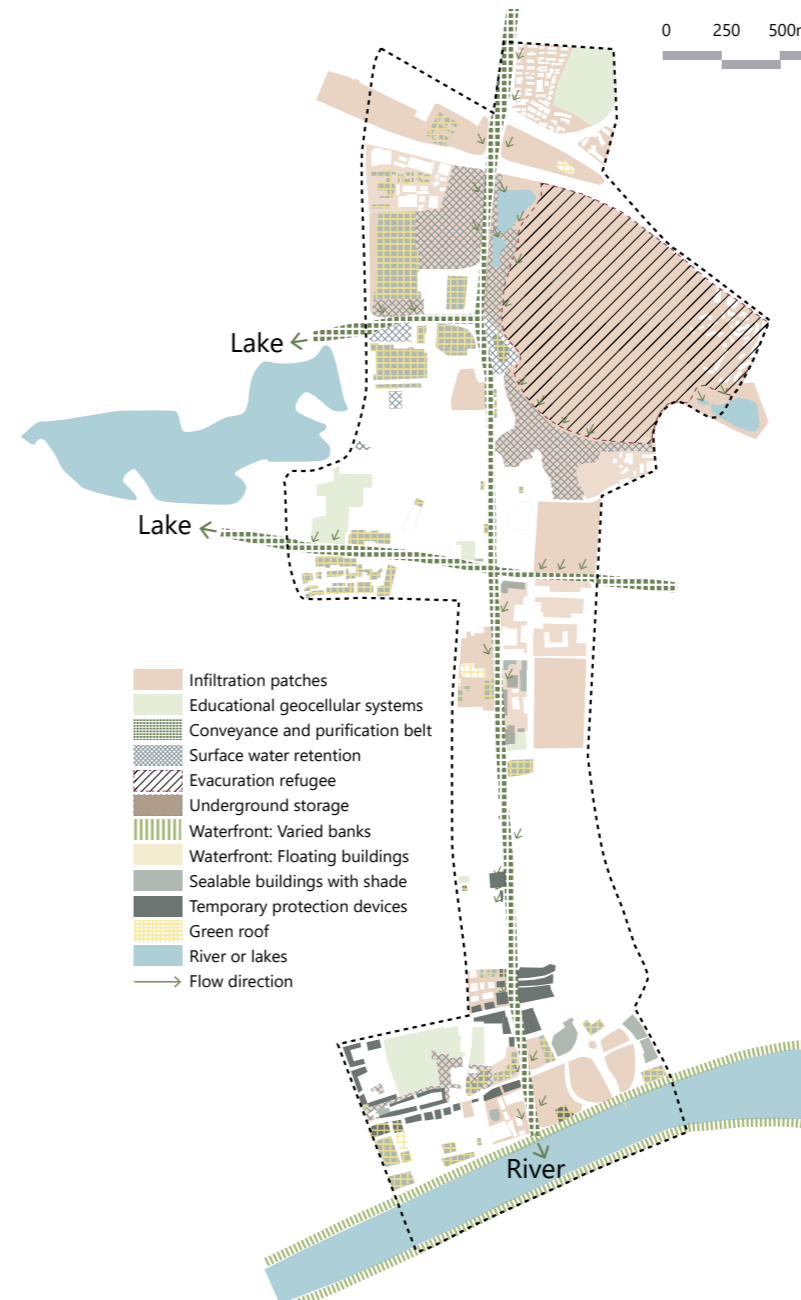


Fig. 4-1-5 Action process of Phase 3
Source: Drawn by author

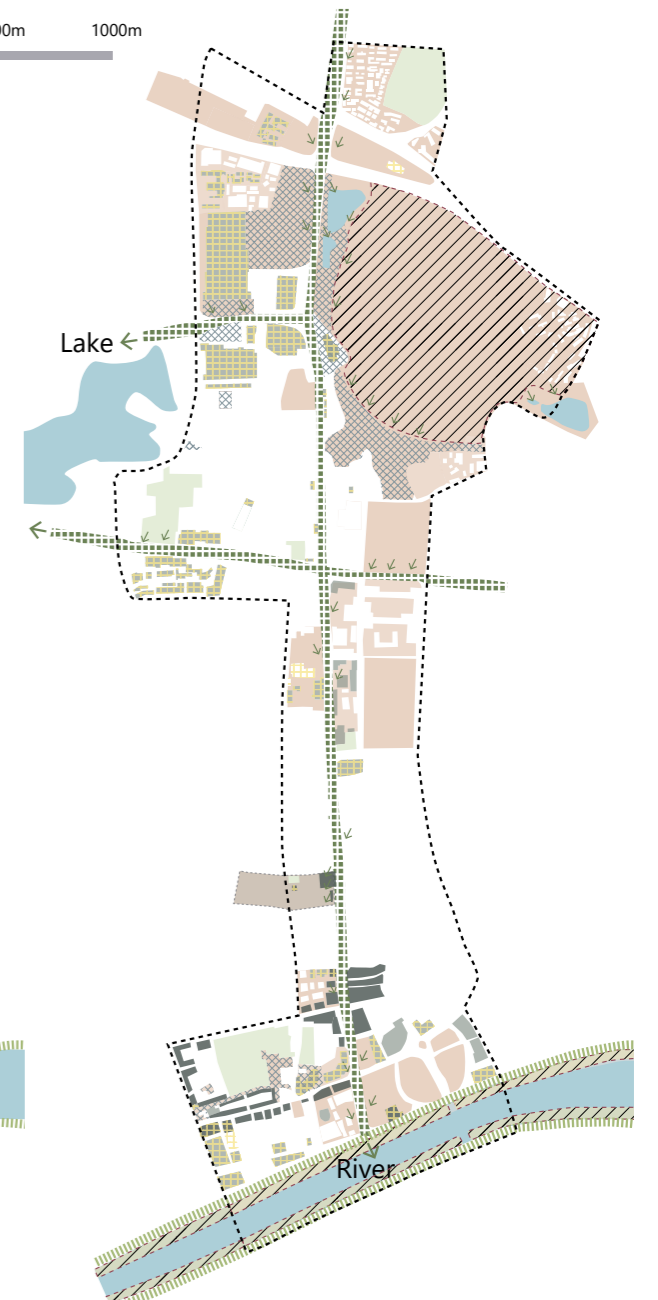


Fig. 4-1-6 Action process of Phase 4
Source: Drawn by author

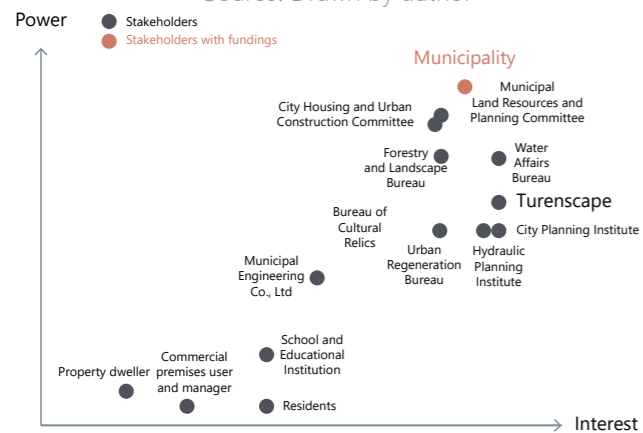


Fig. 4-1-7 Involved actors of Phase 1
Source: Drawn by author



Fig. 4-1-8 Involved actors of Phase 2
Source: Drawn by author



Fig. 4-1-9 Involved actors of Phase 3
Source: Drawn by author



Fig. 4-1-10 Involved actors of Phase 4
Source: Drawn by author

To apply the design principles and meet the shared vision put forward before, several spatial strategies need to be implemented: (Fig. 4-1-2)

- Try the best efforts to improve ground permeability even in urban dense areas. To reach this objective, impermeable pavements in not-intensively-used roads, car parks, pedestrian space including parks, squares and cultural public spaces with well-drained ground need to be substituted by porous pavements complemented by infiltration technical measures such as infiltration median strip, bioswale, etc.
- Take full advantage of schoolyards in primary school, high school and universities especially in urban dense areas with little residual surface space. Geocellular infiltration system can be implemented under school playgrounds with not very high ground water level. Besides, schools play a role to pass through water management knowledge to descendants, so green roof in educational buildings and surface water management exhibition zones in schoolyards can deliver practical knowledge regarding water management for education, research and exhibition.
- Main roads with enough space can be equipped with median infiltration strips and roadside ditches helping to build up water drainage network. They can collect water alongside and transport water from different nodes towards lakes or rivers. In addition, some pollutants can be diminished on the way.
- Pedestrian public spaces such as neighborhood parks, squares on basin with high ground water level are applicable for surface water retention. It is notable that there should be no historical heritages nearby.
- In case of emergency, several places are suitable for becoming evacuation refugees. These are mounds and floating areas at the waterfront.
- Areas with very low ground water level and situated far from historical heritages are applicable for underground water reservoirs. However, the feasibility of this strategy requires further consideration in terms of investment and house demolition.
- Waterfront in Guangzhou is like a name card which gathers public life so waterfront should have more flexible banks with height differentiation and varied planting zones in order to face uncertainties of water disturbances.
- Important indoor public spaces including shopping malls, stores, hospitals, etc. with high qualities on low-lying areas should be transformed to sealable buildings to prevent economic losses and human casualties.
- And important indoor public spaces with low qualities or in possible torn-down areas should be equipped with temporary protection devices.
- High-quality indoor public spaces with accessible flat roofs especially in urban dense areas should be transformed to green roofs in order to increase public spaces and water infiltration and storage areas.

In the same time, there will be mainly four action phases to reach the final result. Each of the phases is influenced by actors and their interest and power.

PHASE 1

This phase is led by municipality and the funding is from national financial allocation for Sponge City development and locally governmental financial budget. Two spots with severe water logging problem and the waterfront are chosen to apply the technical-socio-cultural approach for water management as the catalyst projects. These catalyst projects reveal the added value of the integrated approach for water management and raise public awareness towards cultural-contextualized sustainable water management. Besides, these projects also attract afterward investments by showing huge environmental, educational, and commercial potentials. (Fig. 4-1-3 and 4-1-7)

PHASE 2

After the first phase, public acceptance of the integrated approach of water management is raised. And this might attract the attention and funding from educational institutions and environmental institutions. In the same time, schools are willing to apply national educational financial supports. Besides, to expand the influence, projects with obviously visible effects should be implemented first so educational geocellular system on schoolyards and conveyance belt would better to be established at this phase. And to raise satisfaction of local residents, based on their eagerness of more public spaces, green roof projects need to be done at this phase. These green roofs also fill the gap in case original ground public spaces are occupied during construction periods at later phases. To balance different interests between commercial premises users and residents, partial areas on green roofs of commercial buildings encourage commercial usages as a compromise. (Fig. 4-1-4 and 4-1-8)

PHASE 3

If the first two phases complete successfully, more investments will come even from some real estate developers. Therefore, projects with unapparent effects but are vital for regular water cycle, economic and human protection such as infiltration patches, sealable buildings and temporary protection devices can be implemented at this phase. And to ensure normal commercial activities during construction periods, nearby open green spaces will be used for temporary commercial zones at day time and return to residential public spaces at night time. (Fig. 4-1-5 and 4-1-9)

PHASE 4

If there is enough capital injection after the first three phases, floating areas can be constructed along waterfront for commercial usage, if feasible, following the resolution of investors. These floating areas will also function as the evacuation refugees in case of emergency. Simultaneously, underground water reservoir can be developed and combined with underground shopping malls depending on the demand of real estate developer under the precondition of solving house demolition conflicts. (Fig. 4-1-6 and 4-1-10)

4.3

CASE STUDY



Fig. 4-3-1 Bird views of the Tanner Springs Park
Source: Hoyer (2011)

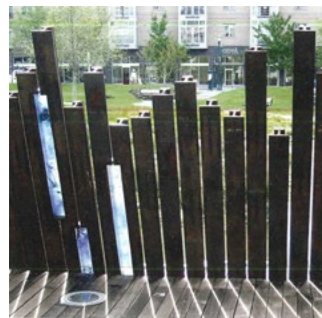


Fig. 4-3-2 The art wall glimmering in the morning light
Source: Hoyer (2011)



Fig. 4-3-3 The pedestrian walkway and the stepped side
Source: Hoyer (2011)

Case 1 Tanner Springs Park in Portland, USA

Type: Public park in urban dense area

Water Sensitivity

Tanner Springs Park is mainly used for water storage and evaporation. A sunken artificial pond which capture nearby sidewalk water and link to several small springs is designed as the key element of the sustainable water management of this area. (Fig. 4-2-1) This park manipulates the water runoff, infiltration and evaporation which contribute to the redevelopment of the urban water cycle. Besides, water stored in the retention pond will be pumped back up to the spring, and then returned to the pond, (Hoyer 2011) which forms a small water cycle, improving the microclimate.

Cultural Inheritance

Tanner Springs Park is situated in the Pearl District. "This area is originally a wetland of the Tanner Creek", (Hoyer 2011) so the natural marshland vegetation design alludes to the original marshlands that once existed. Besides, this area used to have an industrial past which is reminded by an "art wall". The art wall is built up by vertical reclaimed railway tracks randomly inlayed with blue glass arts painted with wetland themes and arranged like reeds in the wind. (Fig. 4-2-2)

Space for people

The art wall inlayed with blue glass arts glimmering in the morning light and the water reflection in the pond contribute to the experience and atmosphere of the park. (Fig. 4-2-2) In addition, the design satisfies different usages. The movement of water from nearby sidewalks towards the pond creates an inviting environment and the chance for children exploration. And a pedestrian bridge across the pond allows people to access to water and it can be used as a performance stage if necessary. (Hoyer 2011) The stepped side of the park creates great social interaction space for residents. (Fig. 4-2-3)

Public Participation

A "steering committee" was formed by local residents, owners, investor, and representatives of the city to contribute to the design and planning process of this park from the very beginning till the end. Therefore, different interests of stakeholders were balanced and the final design was desirable of the majority of people.

Case 2 Donghao Canal Improvement Project in Guangzhou, China

Type: Recreational waterfront

Water Sensitivity

Donghao Canal used to be a drainage branch of the Pearl River. However, because of the city development, the canal was used for convey wastewater, so the biggest problem of it was contamination. Therefore, firstly, adjacent waste water was closed and transported to the water purification plant. Secondly, some water from the Pearl River was transported to the Donghao Canal to connect the branch to the main stream and create a water cycle. (Fig. 4-2-4) (Wu 2012) Besides, varied banks with diversified aquatic plants increase the adaptability in case of water disturbances. And several new-type ecological banks are applied in this project to improve water infiltration and self-purification capacity through ecological methods. (Fig. 4-2-5)

Cultural Inheritance

This project is the improvement of historical canal system, so the canal itself reflects a certain history of Guangzhou. Besides, there are a lot of cultural landscapes designed along the canal to remind people special cultural identity of Guangzhou. (Fig. 4-2-6) For example, many small bridges, water-related landscapes including waterfalls, sculptures, boats and quay or willows along waterfront all remind local people the fishing history and water culture in Guangzhou. And some man-made historical shopping streets near water, arcade buildings and European-style houses connect to the history that Guangzhou used to be a very prosperous seaborne trade city. (Li 2016) These elements all integrate into the landscape design of this project.

Space for people

This project also focuses on creating public space for people. Different types of water landscapes including stream and waterfall provide various experiences for local people. And natural banks, stepping stones, sunken space and water platform invite people to explore. There are also small spaces for different users such as the greenway for cyclists, the square with health facilities for the elderly, etc. (Fig. 4-2-7)

Climate Comfort

Considering local climate, shades are provided through the viaduct, large old trees. And vegetations planted in this area are all local types such as Kapok, Sweet Osmanthus, White Michelia, Fuso, Ficus, Frangipani, Mango trees, Willow, Queen Crape Myrtle, Canna, Chinese Redbud, etc. And for nighttime activities, important landscape nodes install large-scale colorful lights for ornament; entrance and small landscape nodes are equipped with normal strong lights; and pass ways set fundamental light ensuring nighttime security. (Li 2016)



Fig. 4-3-4 The complemented water of the Pearl River swarms into Donghao Canal after purification
Source: Wu (2012)



Fig. 4-3-5 Ecological planting blocks revetment
Source: Wu (2012)



Fig. 4-3-6 Cultural landscape
Source: <https://tonyw20.tuchong.com/1002072/>



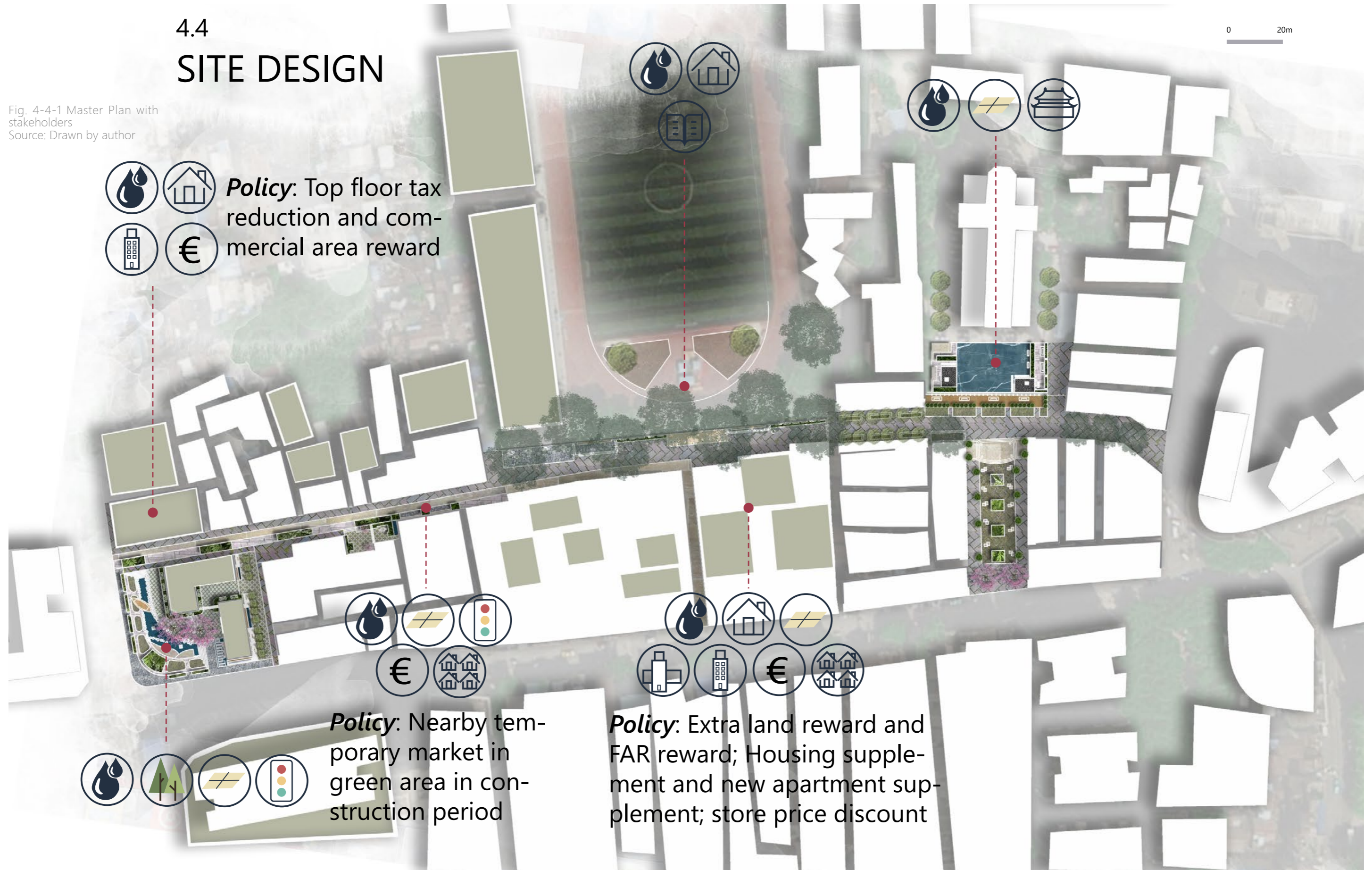
Fig. 4-3-7 Design for people to explore
Source: Wu (2012)



4.4



SITE DESIGN

0 20m

Fig. 4-4-1 Master Plan with stakeholders
Source: Drawn by author



  **Policy:** Top floor tax reduction and commercial area reward

Policy: Nearby temporary market in green area in construction period

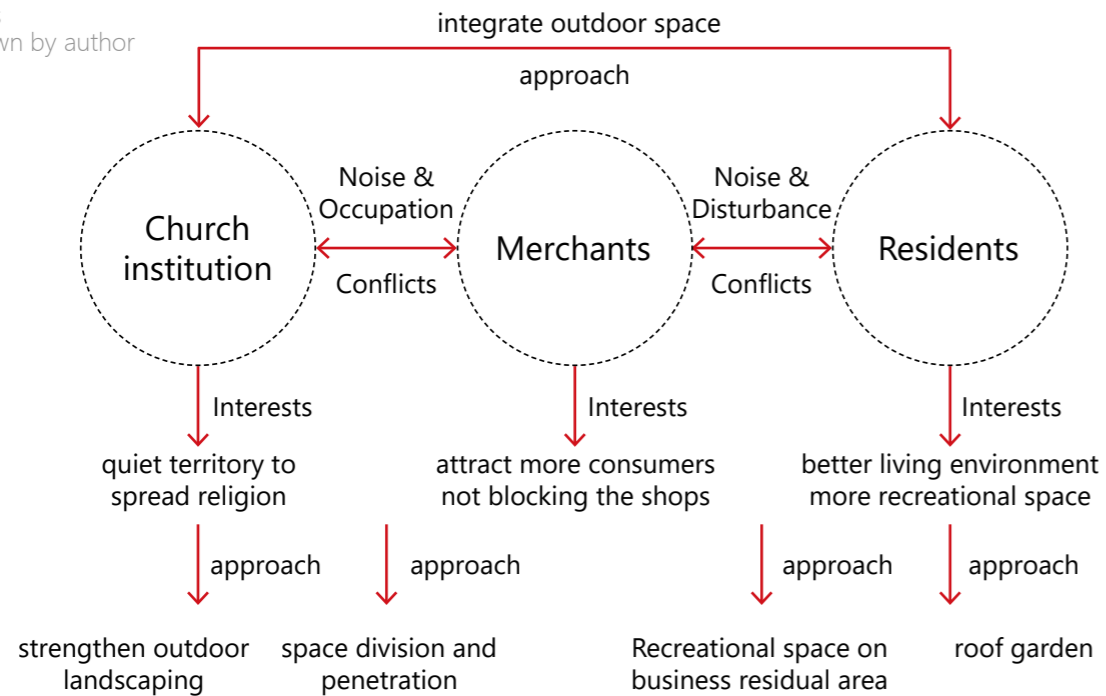
   

Policy: Extra land reward and FAR reward; Housing supplement and new apartment supplement; store price discount

Fig. 4-4-2 Interests and conflicts between down-level stakeholders
Source: Drawn by author

Public Participation

There are mainly three groups of down-level stakeholders and their interests should be balanced because of the existing conflicts. (Fig. 4-4-2)



And to consider implementation, investment and action process is very important. Therefore, low-cost actions and actions interrupt people to the minimal extent should be take place early. And to increase public awareness and have "quick-wins", actions with obvious and visible effects should be implemented first. Finally, if abundant investments are attracted, projects required high costs can be implemented; otherwise, low-cost scenarios should be realized as substitutes. (Fig. 4-3-15)



Water Sensitivity

The site design increase water resilience of the nearby region by improving infiltration, evaporation and manipulate water conveyance and purification. The majority of the surface is paved with permeable materials to increase surface infiltration to the maximum extent. Water retention pond with purification buffer zone is design near street market and car roads where polluted water is from. This pond also has large water surface to increase evaporation and improve microclimate. Besides, accessible roof of indoor public space is transformed to roof residential garden to not only store water but also add possible public spaces. And every water element in this site is connected to a sub water cycle, which contributes to the flexibility of the design.

Cultural Inheritance

The site is situated at the intersection of two historical seafood wholesale streets so fishing history is important to be memorized and reflected in the design. Therefore, cultural landscape methods are applied to create landscape in the reflection of the fishing history. Stone natural banks are designed to connect to old-time lifestyle in Guangzhou. Open pattern clinkers on the square are designed with fishnet texture to remind people the fishing history. And city tree-Kapok is set in the center as main view. Moreover, the world fourth biggest stone-made Christianity church is also located inside the site. Taken this into account, the scope near the church building is not taken huge constructions, only repaved the ground. The arcade building streets adjacent to the church is also protected and equipped with temporary protection devices along building columns. The landscape is more geometric to fit in the surrounding.

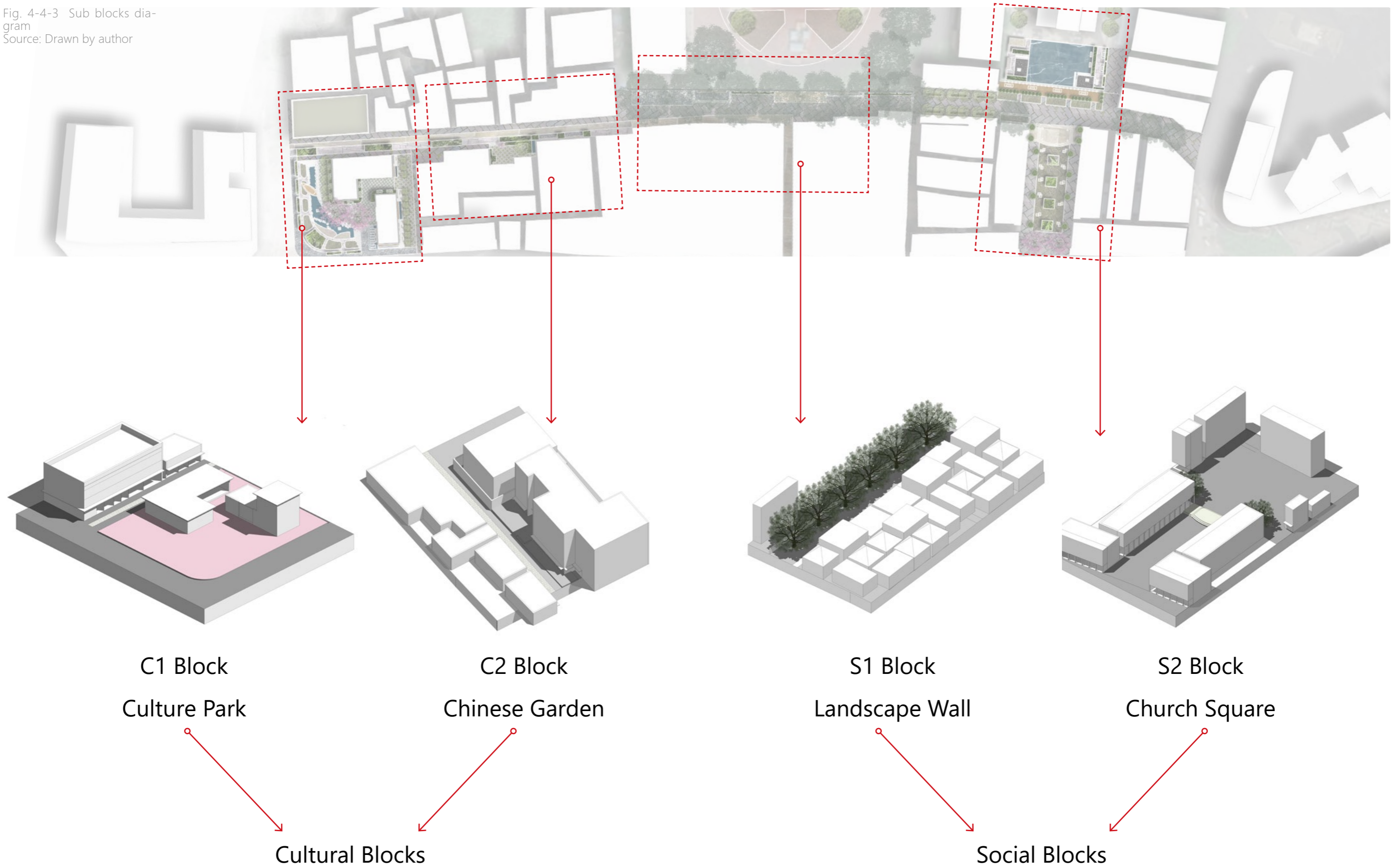
Space for People

The design considers needs of different users and activities. The central part of the street is kept clear and smooth to satisfy the goods transporters' need; a raised photo platform in front of the church is kept for tourists; various meditation spaces are set for both Christians and regular residents; public spaces with enough seated areas are developed for residents or passers-by; infiltration strip with purification filter and vegetation is put near restaurants to half guide the initiatives. Besides, water elements are all designed for both admiration and entertainment.

Climate Comfort

Under the precondition of avoiding important landscape view blockage, shelters, trees and other elements try to provide as much shade as possible for this site. Besides, all vegetation is local types such as fruit trees, subtropical types of trees, etc. These trees not only adapt to local climate but also reflect local landscape feature. And to fulfill local residents' nighttime lifestyle, light setting is carefully evaluated. Last but not least, every water elements including water curtain, waterfall, stream, and fountain are designed with dry & wet scenarios in case water will be dried out in summer to prevent waterborne deceases in Guangzhou.

Fig. 4-4-3 Sub blocks diagram
Source: Drawn by author



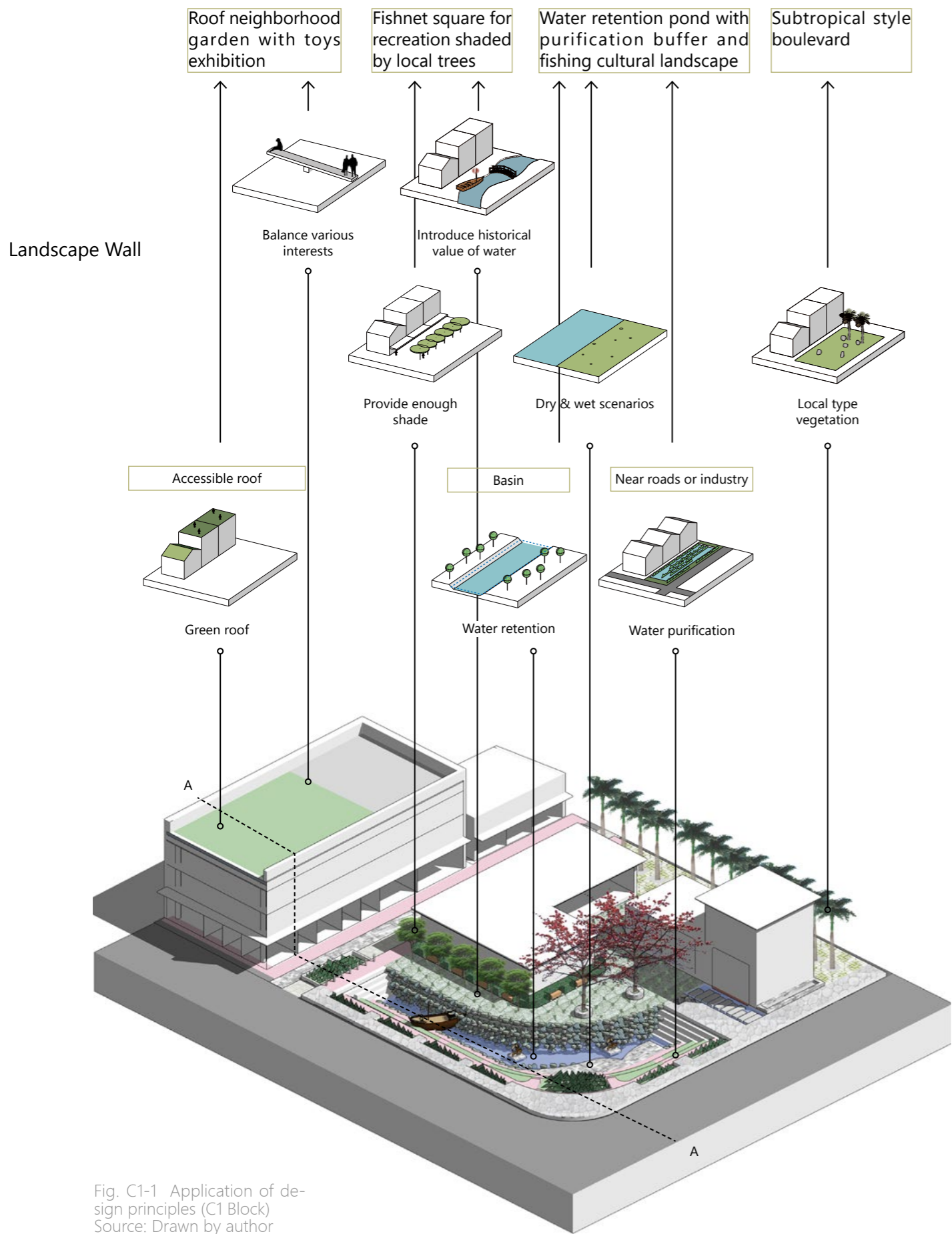


Fig. C1-1 Application of design principles (C1 Block)
Source: Drawn by author

Fig. C1-2 Section A-A
Source: Drawn by author

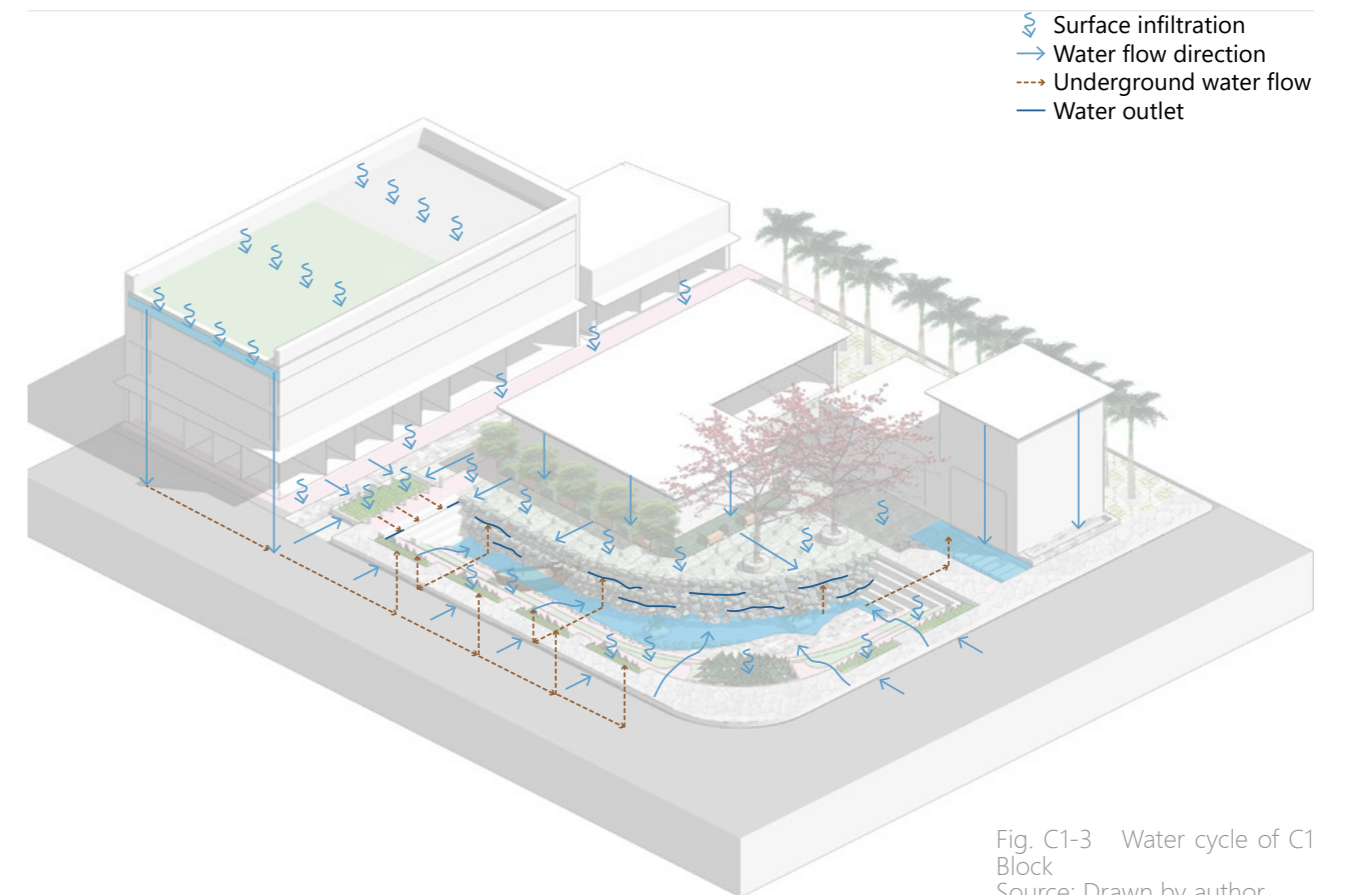
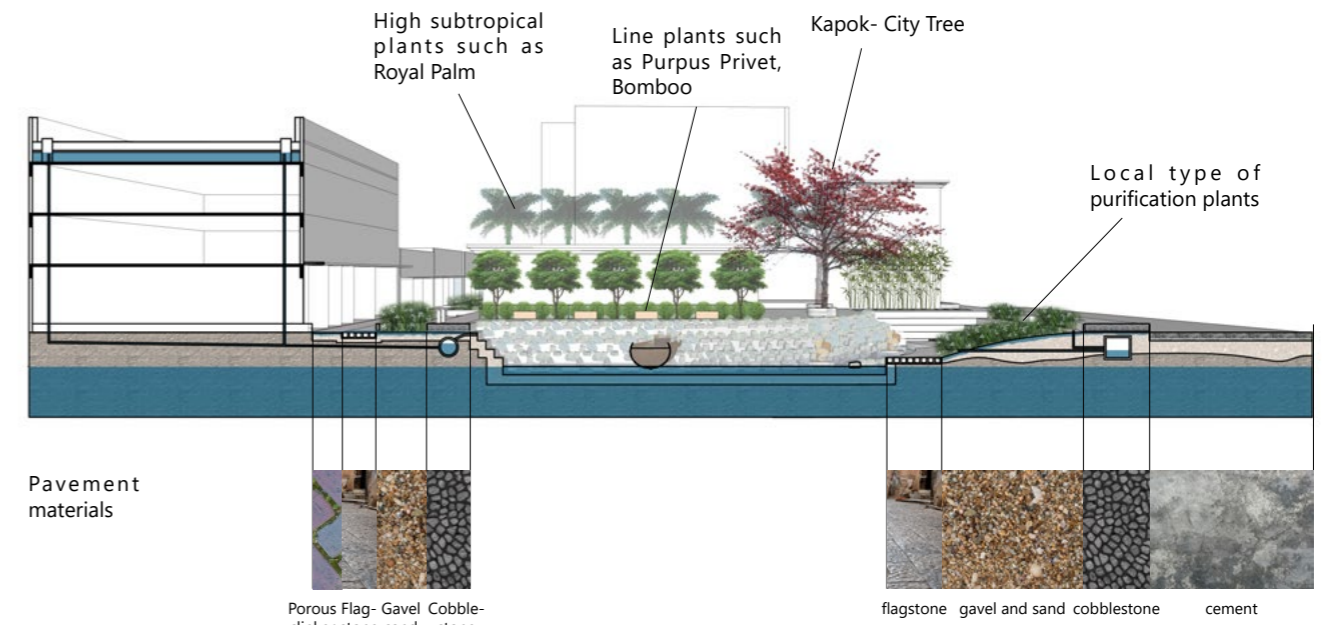


Fig. C1-3 Water cycle of C1 Block
Source: Drawn by author

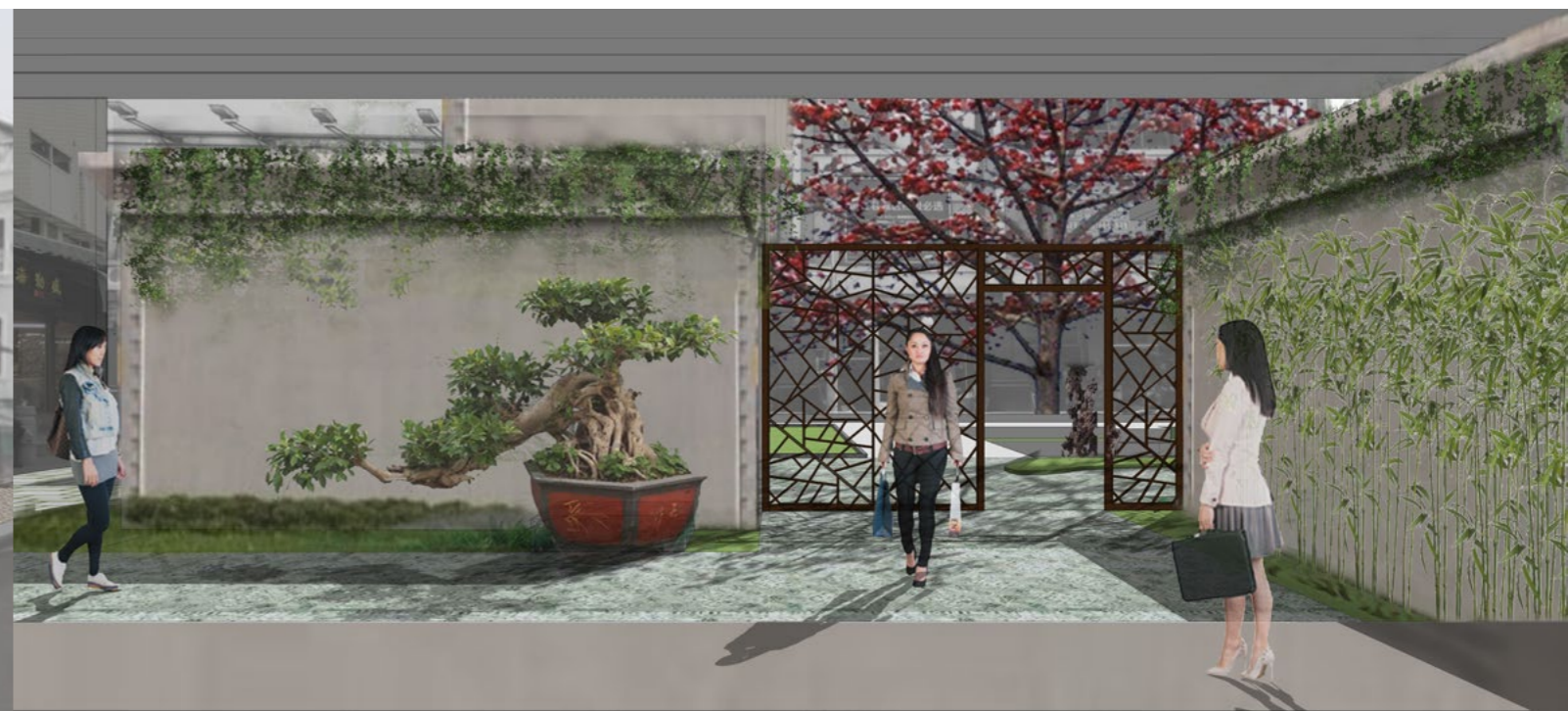


Fig. C1-4 C1 Block original situation 01
Source: Baidu Map street view

Fig. C1-6 C1 Block original situation 02
Source: Drawn by author

Fig. C1-5 C1 Block eye-level vision 01
Source: Drawn by author

Fig. C1-7 C1 Block eye-level vision 02
Source: Drawn by author



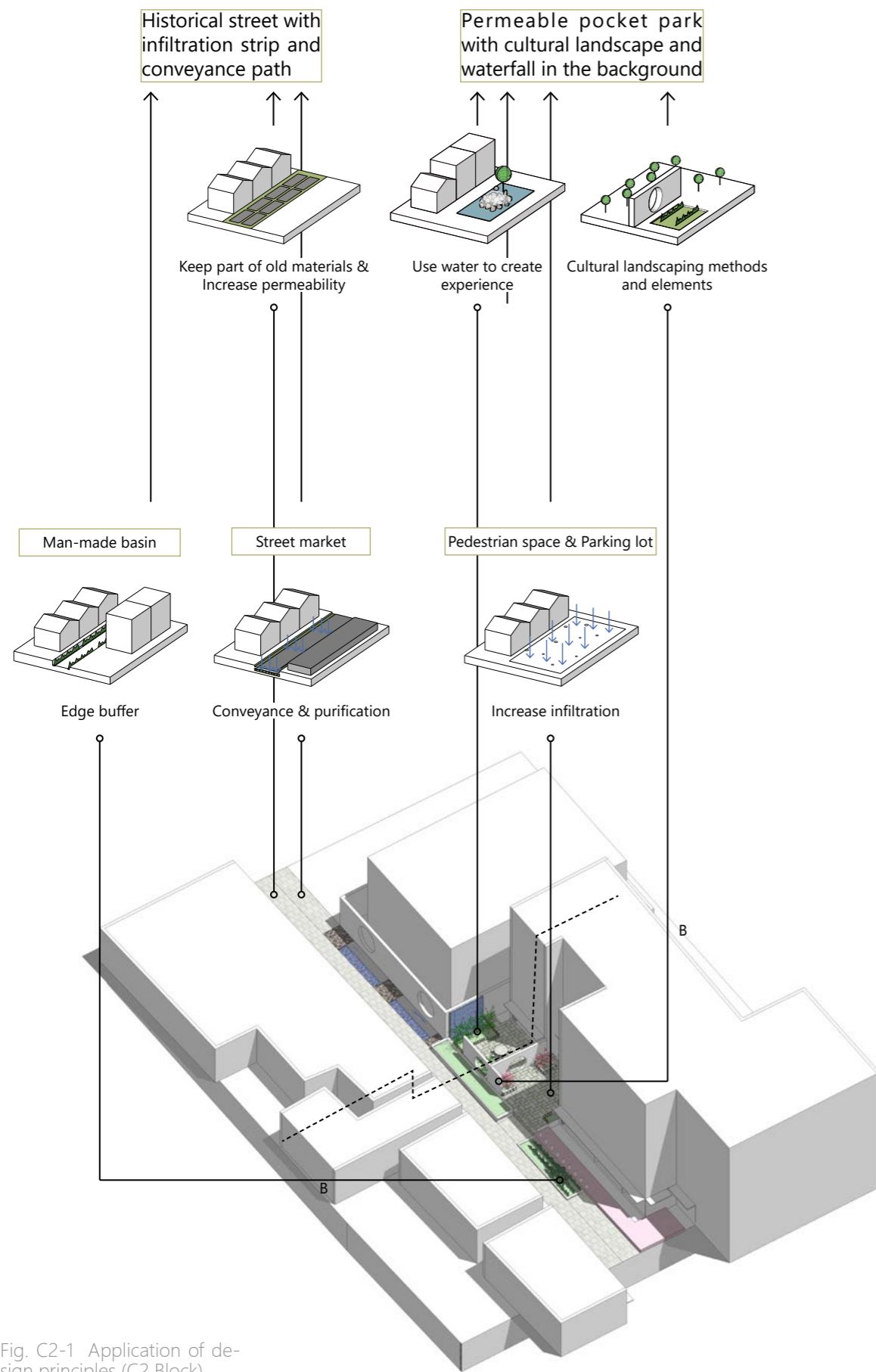


Fig. C2-1 Application of design principles (C2 Block)
Source: Drawn by author

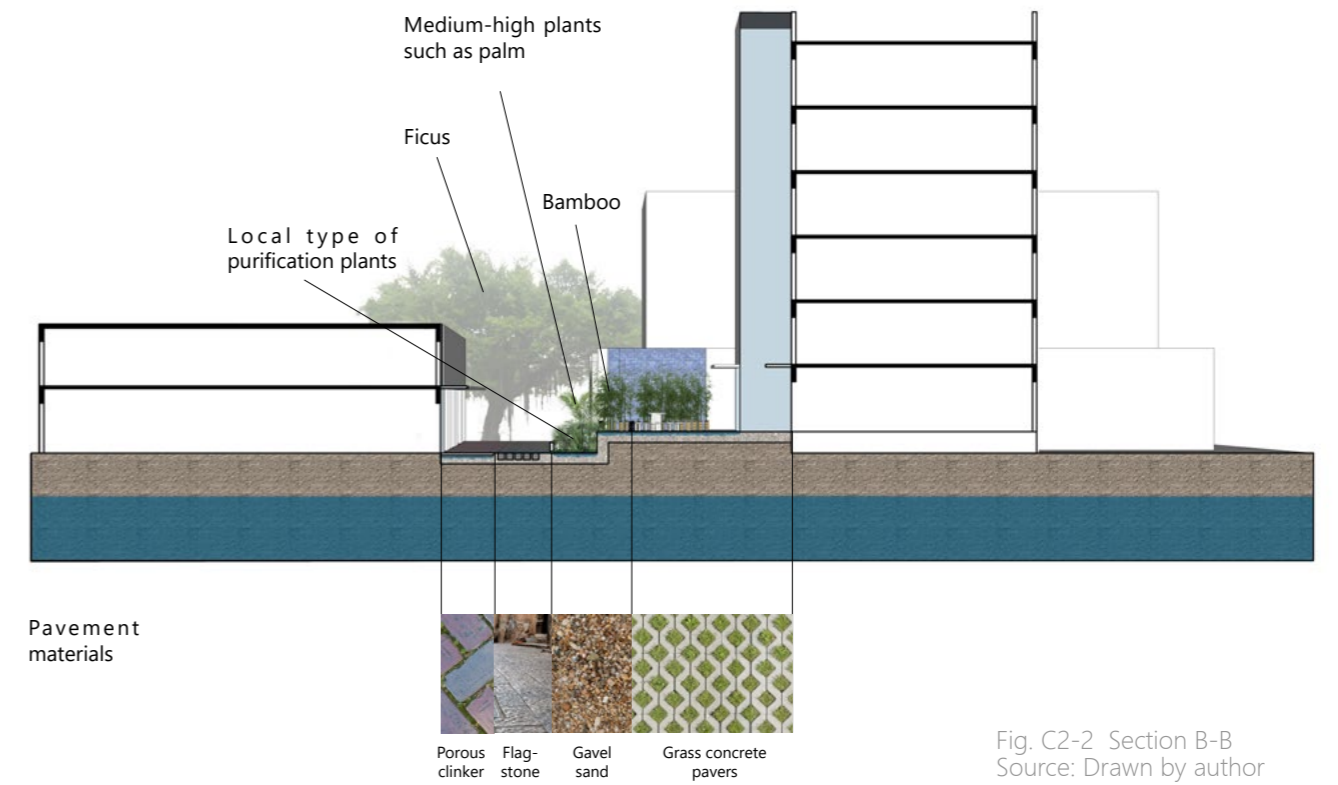


Fig. C2-2 Section B-B
Source: Drawn by author

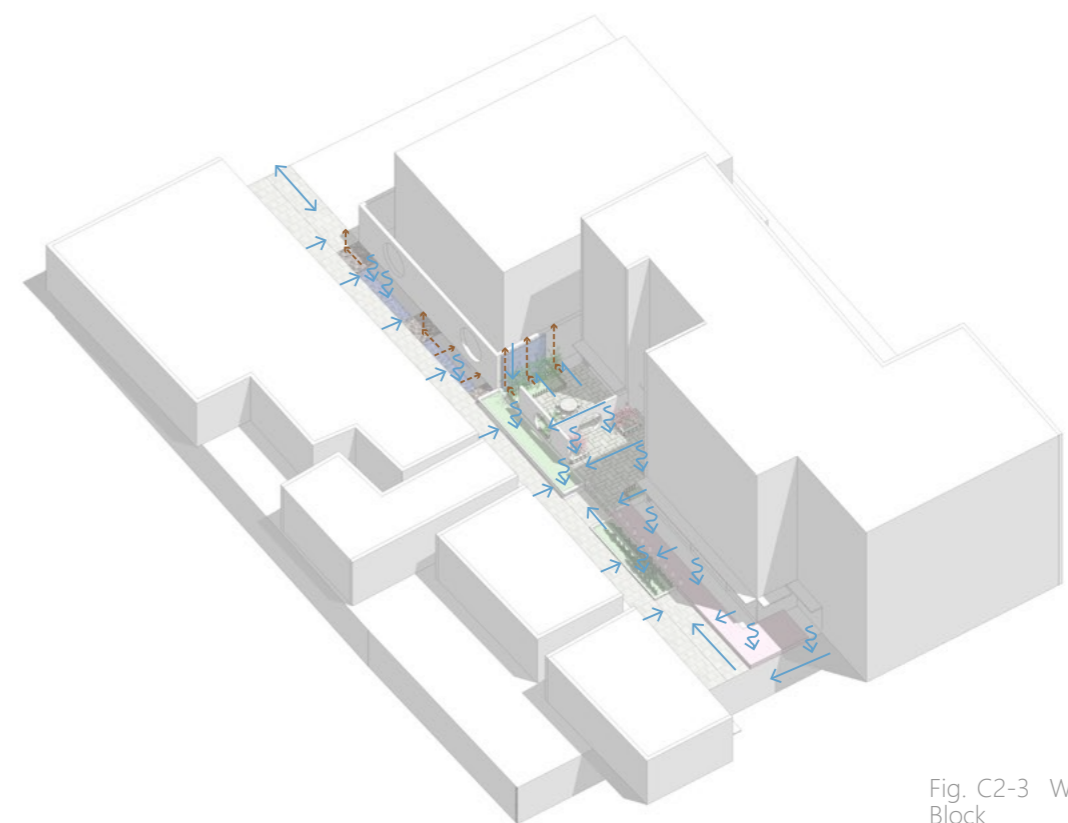


Fig. C2-3 Water cycle of C2 Block
Source: Drawn by author



Fig. C2-4 C2 Block original situation 01
Source: Baidu Map street view



Fig. C2-6 C2 Block original situation 02
Source: Drawn by author

Fig. C2-5 C2 Block eye-level vision 01
Source: Drawn by author



Fig. C2-7 C2 Block eye-level vision 02
Source: Drawn by author

Fig. S1-1 Senario 1 of S1 Block
Source: Drawn by author

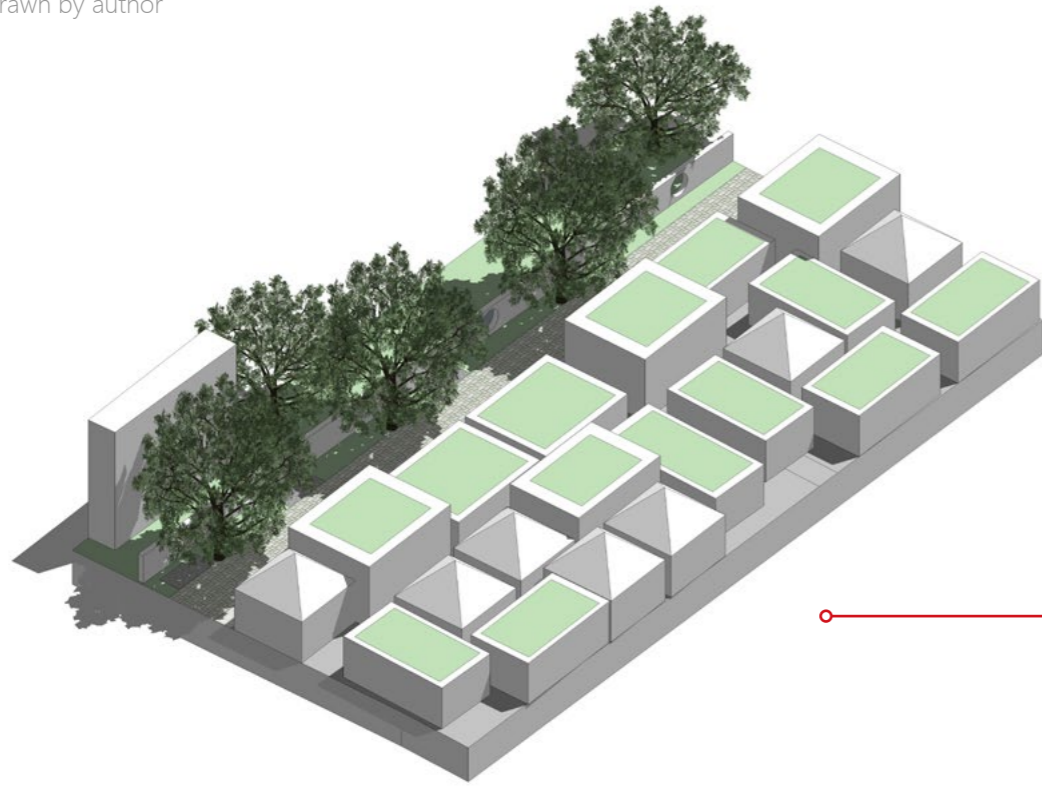


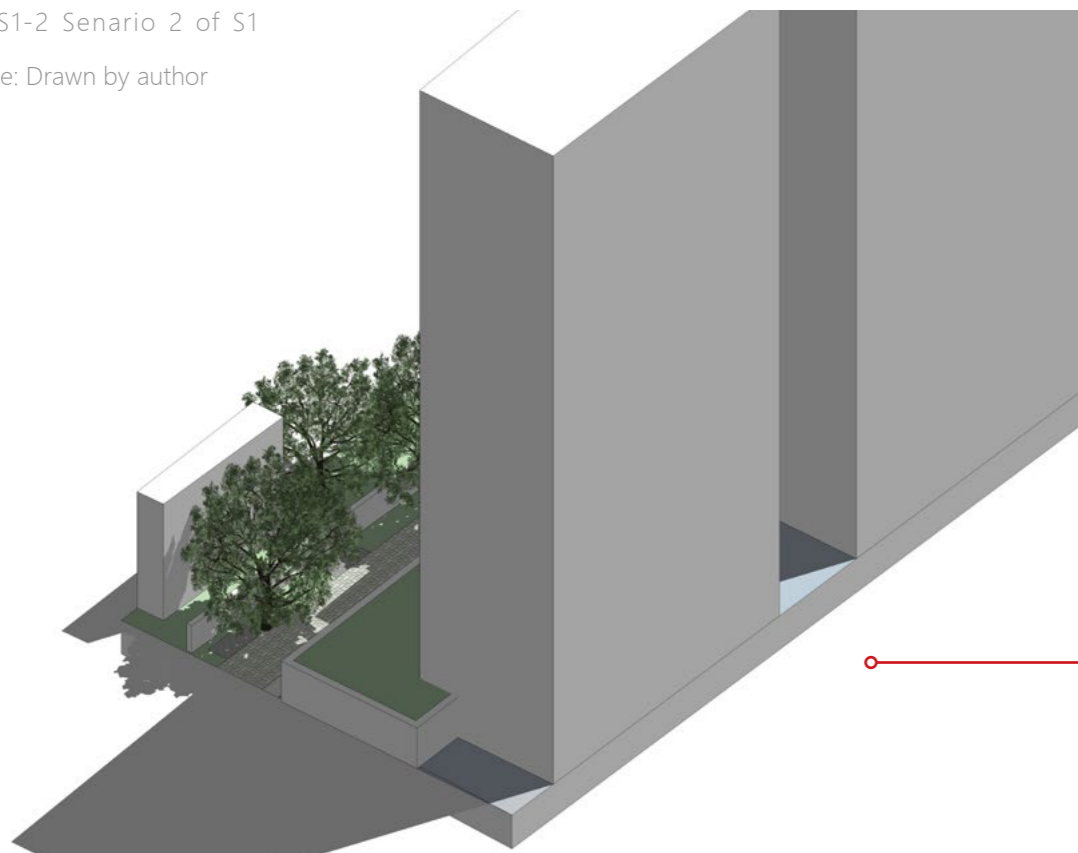
Fig. S1-3 Eye-level vision of
S1 Block scenario 1
Source: Drawn by author

Fig. S1-5 Original situation of
S1 Block
Source: Photo by author



Fig. S1-4 Eye-level vision of
S1 Block scenario 2
Source: Drawn by author

Fig. S1-2 Senario 2 of S1
Block
Source: Drawn by author



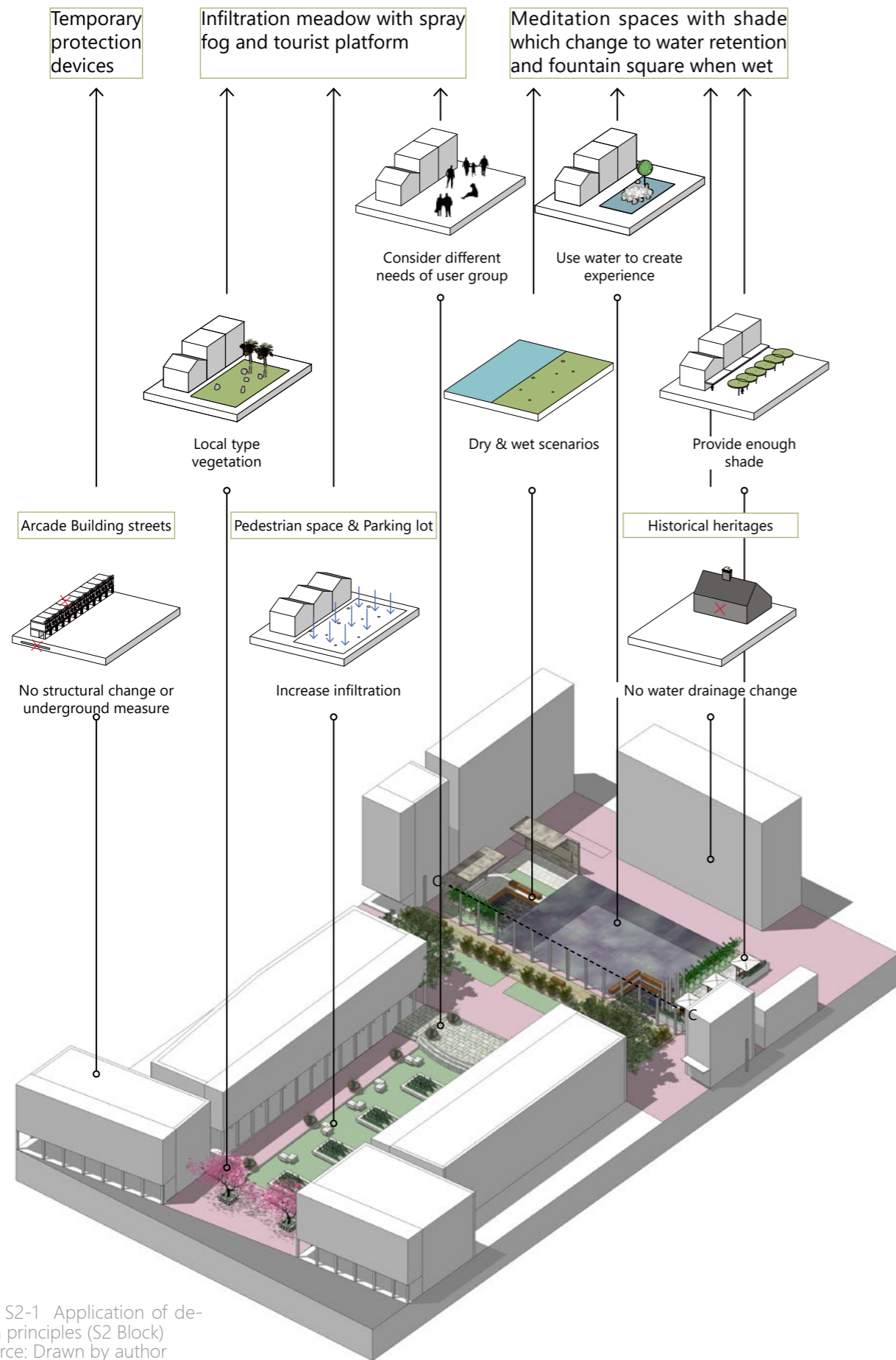


Fig. S2-1 Application of design principles (S2 Block)
Source: Drawn by author

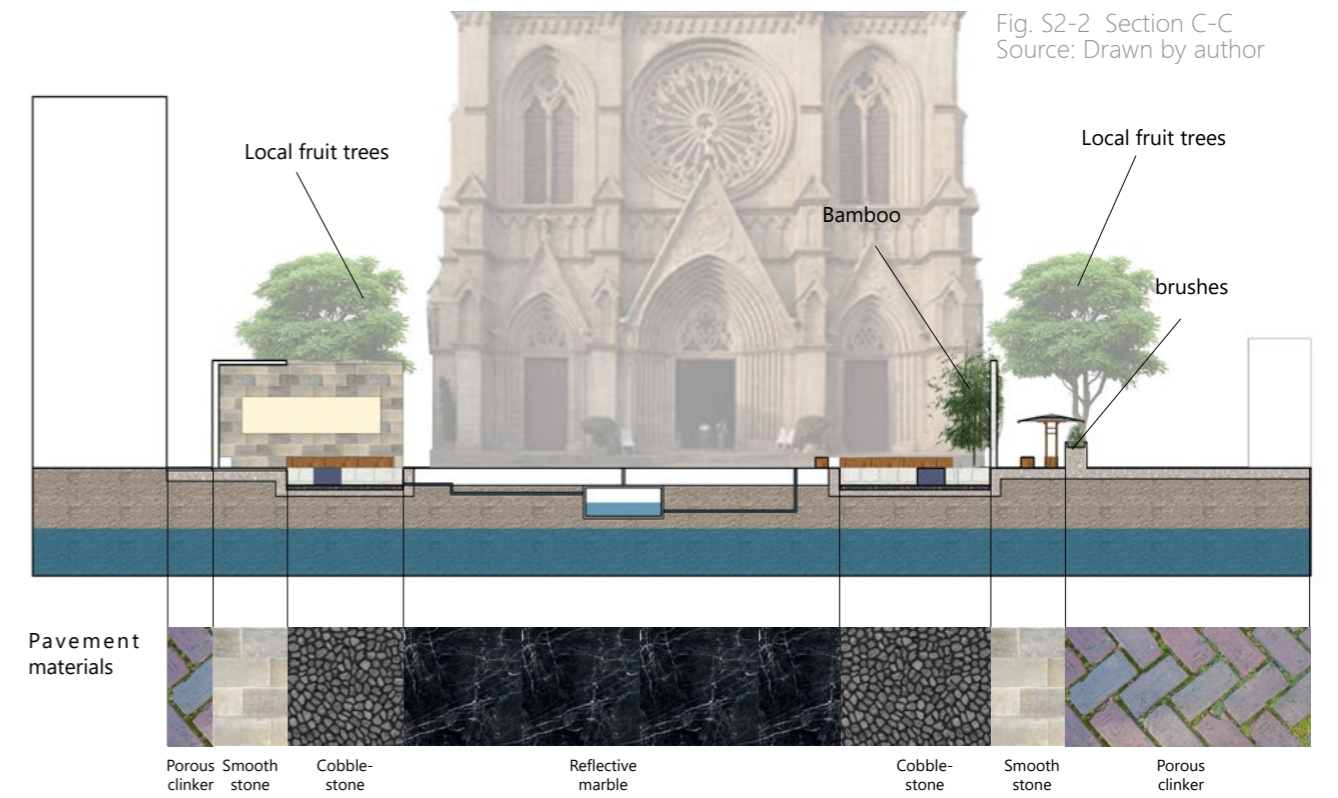


Fig. S2-2 Section C-C
Source: Drawn by author

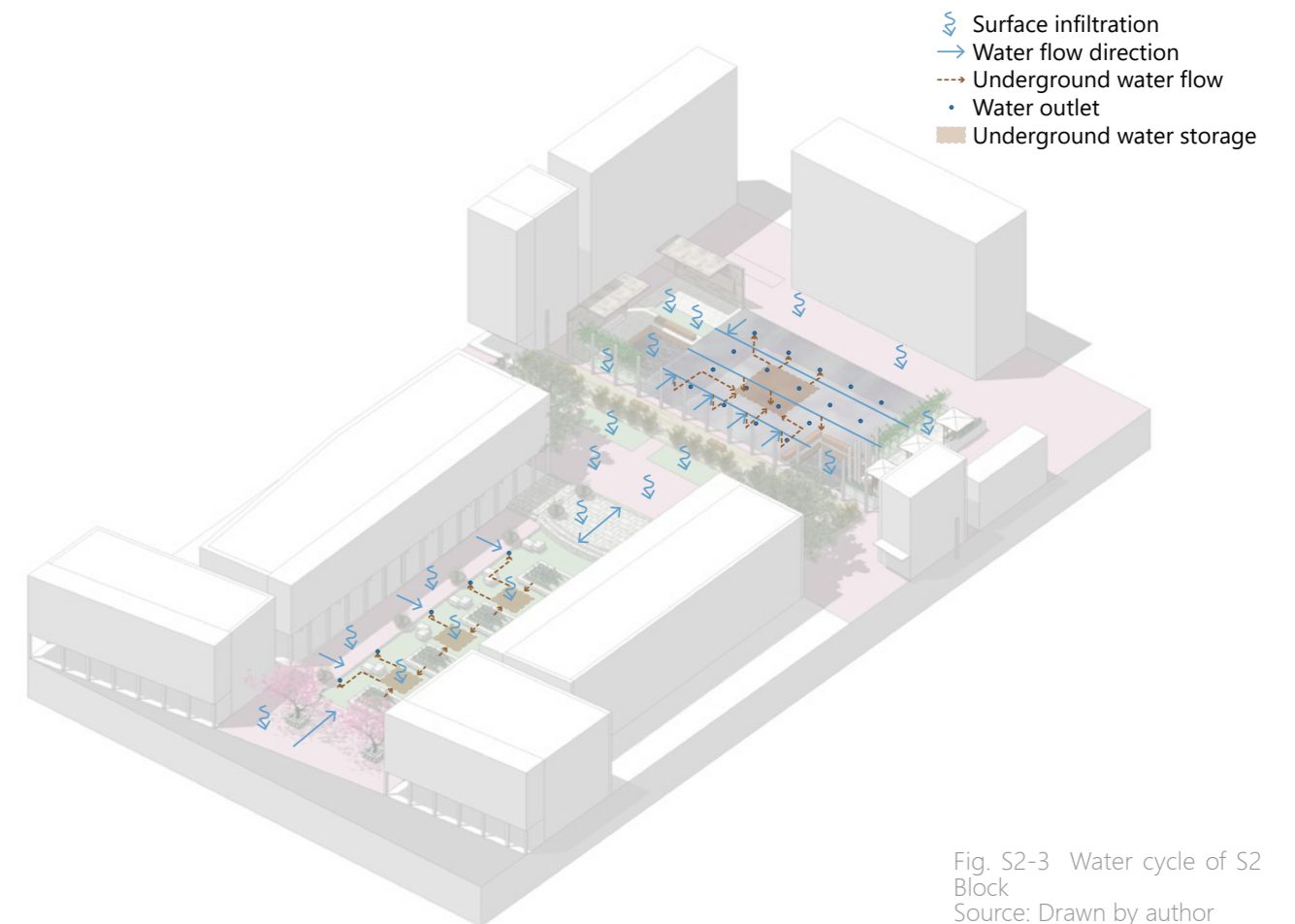


Fig. S2-3 Water cycle of S2 Block
Source: Drawn by author



Fig. S2-4 Eye-level vision of church square (dry)
Source: Drawn by author

Fig. S2-6 Original situation of S2 Block
Source: Photo by author



Fig. S2-5 Eye-level vision of church square (wet)
Source: Drawn by author



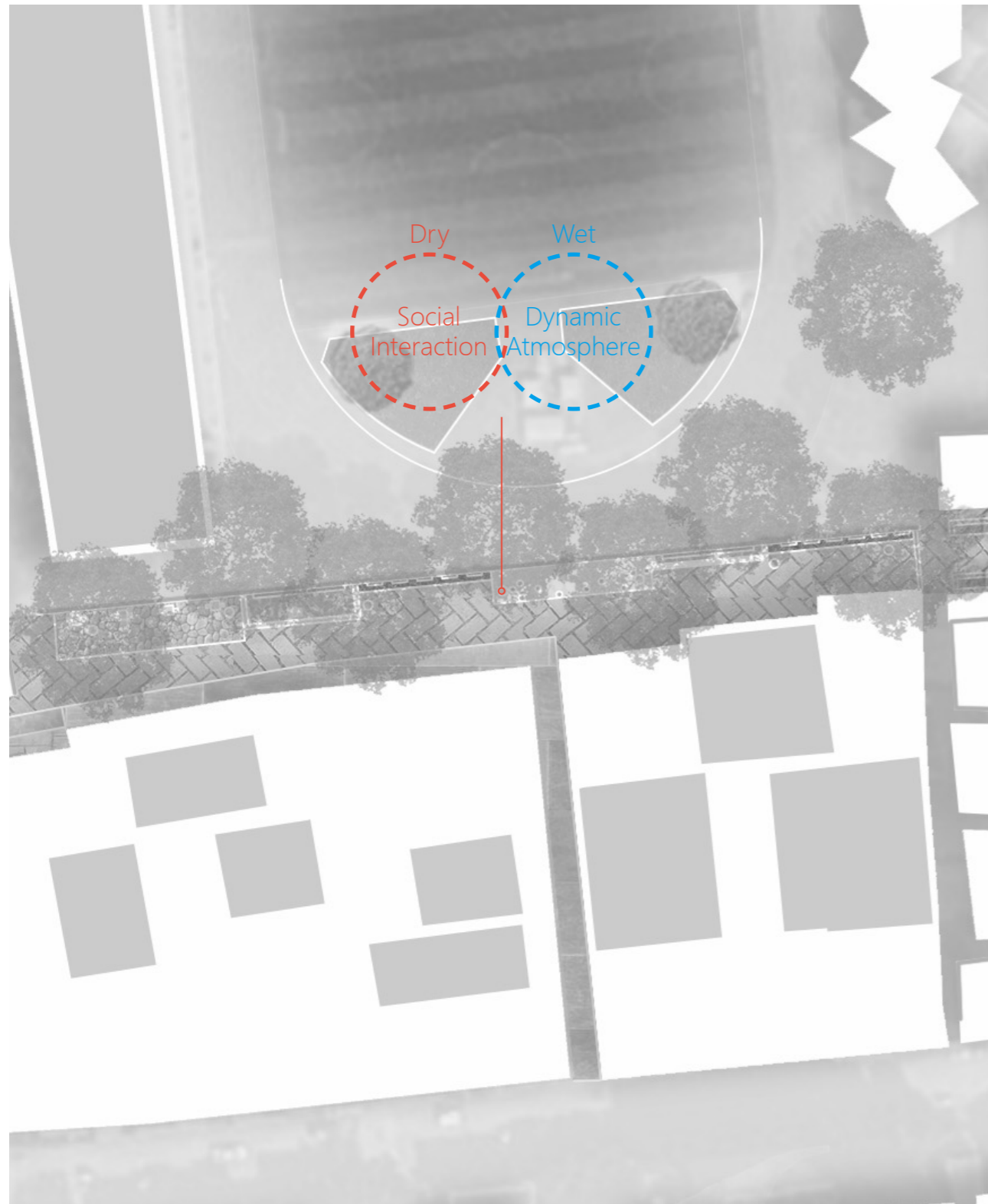
Fig. 4-4-4 Map of wet scene and analysis of water experience (Part 1)
Source: Drawn by author



0 10 20m

- Water
- Hightlighted landscape

Fig. 4-4-4 Map of wet scene and analysis of water experience (Part 2)
Source: Drawn by author



0 10 20m

- Water
- Hightlighted landscape

Fig. 4-4-4 Map of wet scene and analysis of water experience (Part 3)
Source: Drawn by author

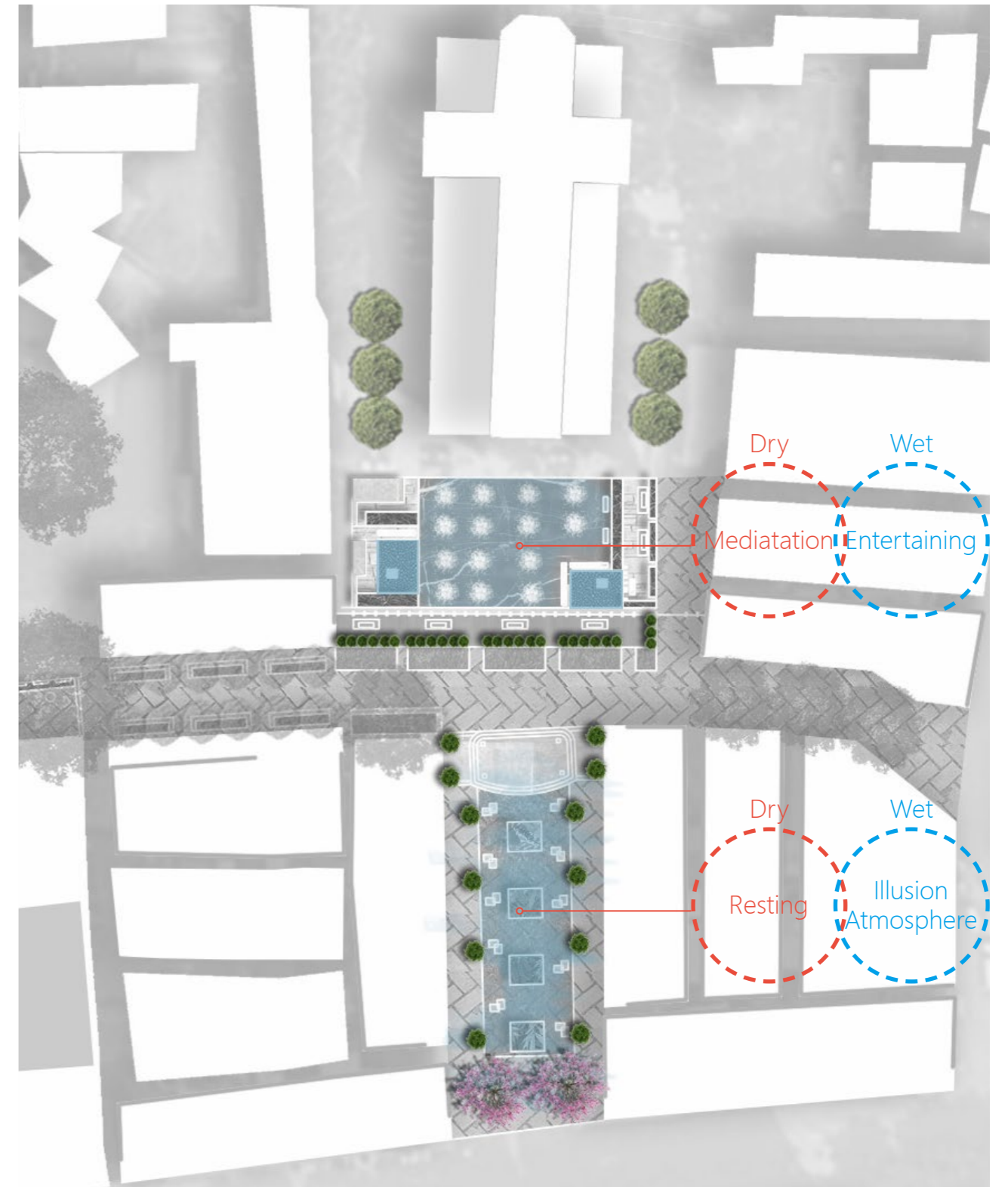


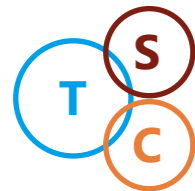
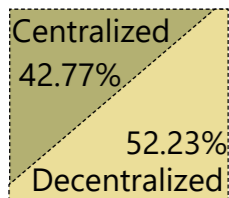
Fig. 4-4-5 Light Plan (night-time)
Source: Drawn by author



EVALUATION

After applying CSC approach on the site, the water management capacity of this area is largely improved. (The calculation is as the following :)

Site area: 38,930.5m²
 Decade recurrence rainstorm intensity in Guangzhou: 52.7mm/h
 24h rainstorm: 24h × 52.7mm/h × 389=30.5m² = 38,930.5 m³
 Water retention: 472 m² × 2.4h = 1,180 m³
 Roof garden: 2m × 10100 m² = 20,100 m³
 Underground storage: about 1,000 m³
 Total increased water capacity: 22,280 m³
 Decentralized water management: 57.23%
 Centralized water management: 42.77%



As we can see from the calculation result above, after applying the CSC approach in the site, the water management capacity of this area is at least 50% raised and decentralized water management surpass centralized water management, becoming the main water management approach in this site. Besides, green roof is proved to be the most effective way in urban dense area to increase water capacity if the majority of possible roofs are transformed to be green roofs.

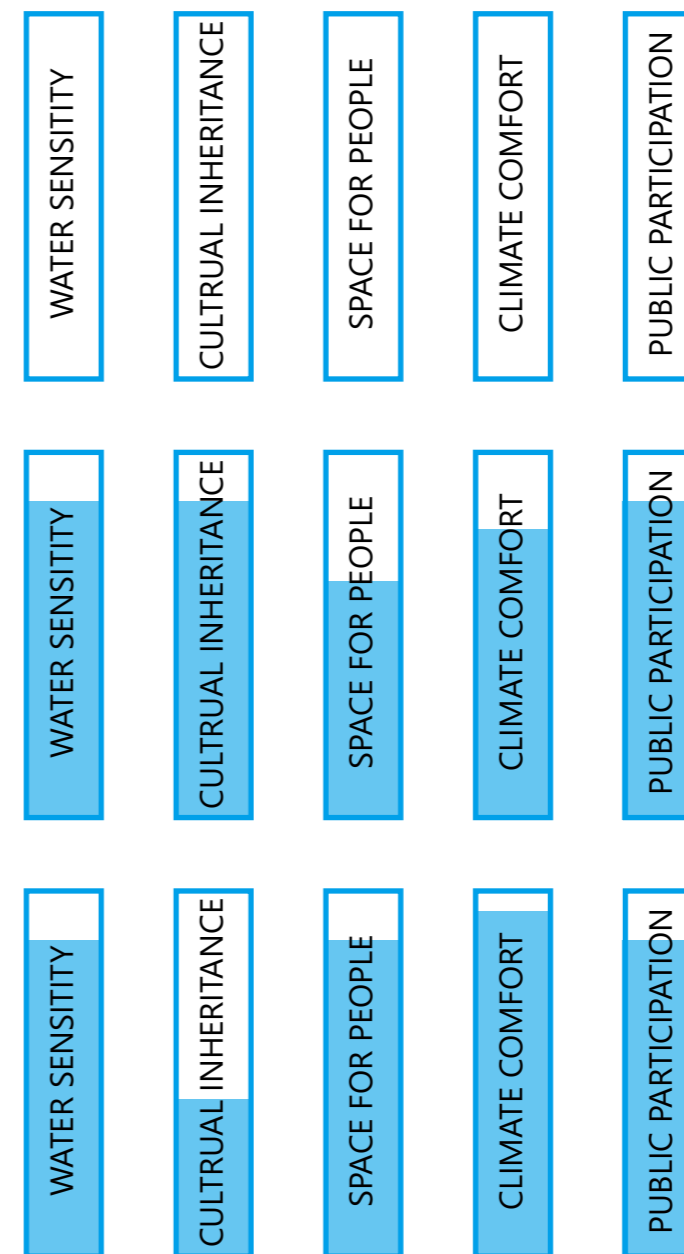
Social and cultural factors are always considered along CSC approach . And through spatial design we can see that these factors can greatly complement water management. By integrating social and cultural factors into technical solutions, water management project has added value and is more feasible for implementation and more acceptable by the public, which increase the sustainability of developing water management in China.

By combining cultural factors, city identity and diversity can be reinforced and water projects will be easily accepted by local people due to the respect of local lifestyle, cognition, aesthetic value, and natural context. However, the application is somehow limited because the region with historical element is the place with maximum potentials but also required a lot of protections. So sometimes if cultural factors take too much space, it weakens the effect of water management. And because added value need to be revealed by region with historical or cultural background, mostly historical regions can largely benefit from it. In contrast, newly developed area with few history accumulations can hardly take advantage of it.

Social factors should always be integrated with water management as long as there are people gathering. Social consideration connects technical projects with people, their needs, their interests, the conflicts, etc. Because of these kinds of thinking, water management will be accepted by users, stakeholders, and then investments push sustainable

water management moving forward.

This research demonstrates the importance and application of CSC approach. Five main design principles are concluded. And these principles can be manipulated according to users' needs. Different combination will produce different spatial quality or design proposals. And each perspective may have conflict with the others. So the relationship between these design principles required further research and the possible scenarios of different combination also required deeper exploration.



different combination of design principles lead to different proposals

REFLECTION

The relationship between research and design

Because of the severe climate hazards, people are raising their concentration on sustainable water management, which also happens in China where cities under huge water challenges. However, as cities moving forward, original solely ecological or technical approach is not that satisfactory. Therefore, depending on the importance of cultural and social dimensions towards water management, this report put forwards a cultural-socio-technical approach for water management. By defining the criteria and indicators of this approach, the outcome of the research is design principles of cultural-socio-technical approach in terms of typology of spaces. So at one hand, the research supports the afterwards design. It determines both possibilities and limitations of different types of spaces when using cultural-socio-technical approach for water management.

Moreover, because this approach is integrative, which requires cross-level thinking, it is not always linear or logical. To put forward final design principles cannot success without the preliminary design. Design helps to mix up different theoretical knowledge. So on the other hand, design is a tool for integration. Finally, design shows how to apply the research results and in this case, demonstrates this added value of applying cultural-socio-technical approach on future water management.

The relationship between the theme of the graduation lab and the subject/case study chosen by the student within this framework (location/object)

The theme of the chosen studio is design of the urban fabric or public spaces. The main subject of this research is public space which fit the theme. Besides, water as an important element of public space, play a double-side role. On one hand, it adds extra value to public space as landscape; on the other hand, it destroys normal function of public space in case of water disturbances. Therefore, a cultural-socio-technical approach dealing with water contributes to better performance of public space or urban design.

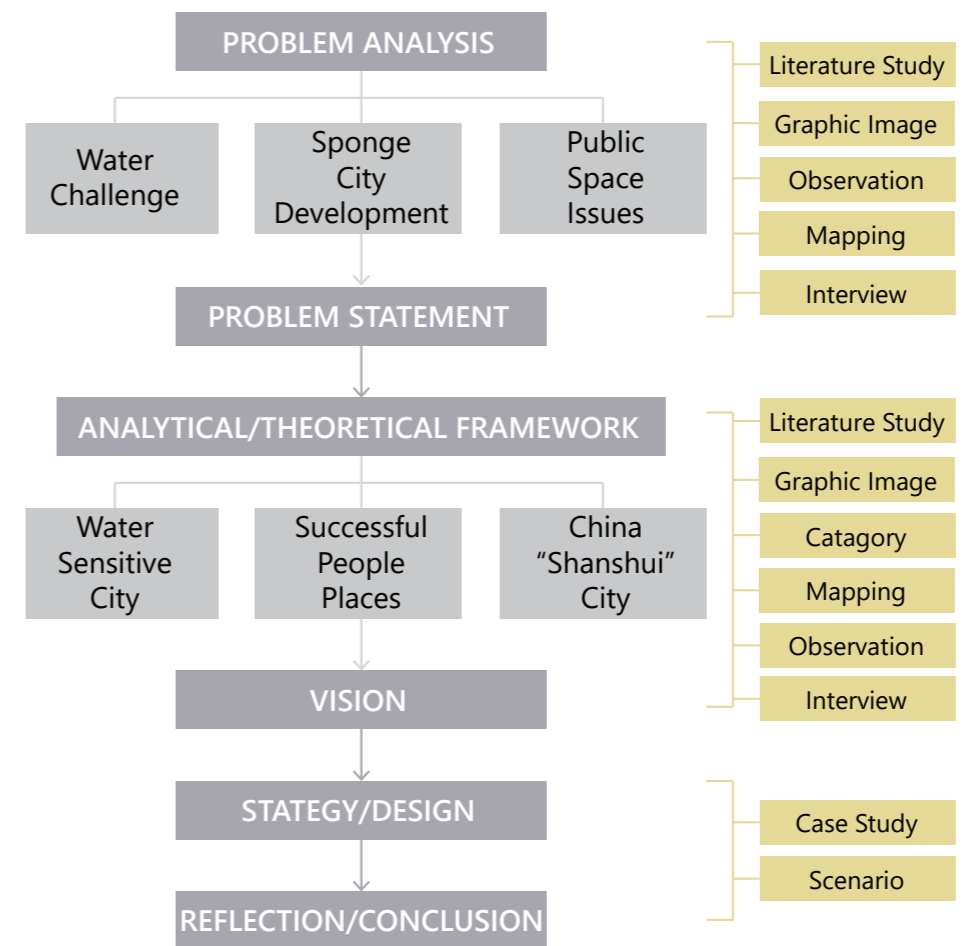
The relationship between the methodical line of approach of the graduation lab and the method chosen by the student in this framework

The studio design of the urban fabric motivates student to study urban pattern in order to find solutions. And in this framework, urban pattern in Guangzhou is analyzed through scales and types. These methods help to figure out the spatial quality and heterogeneity of Guangzhou and

contribute to coming up final design principles and design proposals. In addition, the studio also encourages future-oriented study. And in this framework, scenario building is applied in design to deal with future uncertainties in terms of water hazards.

The relationship between the project and the wider social context

In China, many cities suffered from waterlogging or flood for many years, it remains as an un-solved problem in the whole country. And because of climate change, this problem will pose more challenge on urban planning and design in the future. So the society is asking urban planner and designer to look for more sustainable approaches to face water issues. So the approach developed in this project can also be applied in other cities with water problem. Besides, because this approach is cultural-socio-revised, it is also applicable for other European or American cities with relatively advanced water management experiences.



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APPENDIX 1 LOCAL VEGETATION

Tall Trees


























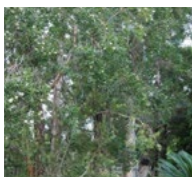



































































Name	Shade	Height	Fragrance	Main View	Road Tree	Special Usage	Color
 Albizia Chinensis		30-45m					spring  summer  fall  winter 
 Grevillea Robusta		20m					spring  summer  fall  winter 
 Acacia Confusa		6-15m					spring  summer  Legend fall  winter 
 Cajeput		18m					spring  summer  Legend fall  winter 
 Corymbia Citriodora		40m					spring  summer  fall  winter 


Table 1 Usage of local type of tall trees
Source: Drawn by author
































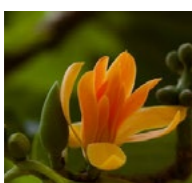


























Legend
 Provide Shade
 With Fragrance
 Main View
 Road Tree
 Hedge

















































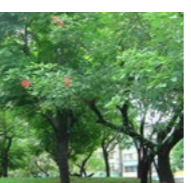







Tall Trees

Table 1 Usage of local type of tall trees
Source: Drawn by author

Name	Shade	Height	Fragrance	Main View	Road Tree	Special Usage	Color
 Anubias		15m					spring  summer  fall  winter 
 Water pine		8-10m					spring  summer  fall  winter 
 Black Pine		30m					spring  summer  fall  winter 
 Yacca		20m					spring  summer  fall  winter 
 Camphor Tree		30m					spring  summer  fall  winter 
 Elm		25m				metaphor stubborn man	spring  summer  fall  winter 
 Hoop Pine		60m					spring  summer  fall  winter 




















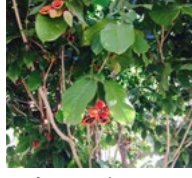
































Legend
 Provide Shade
 With Fragrance
 Main View
 Road Tree
 Waterfront
 With Stone












































Name	Shade	Height	Fragrance	Main View	Road Tree	Special Usage	Color	Tall Trees
 Kapok		10-25m					spring  summer  fall  winter 	Table 1 Usage of local type of tall trees Source: Drawn by author
 Ebony		4-12m					spring  summer  fall  winter 	
 Renmian		10m					spring  summer  fall  winter 	
 White Michelia		17m					spring  summer  fall  winter 	
 Michelia Champaca		10m					spring  summer  fall  winter 	Legend
 Ficus		15-25m					spring  summer  fall  winter 	 Provide Shade  With Fragrance  Main View  Road Tree
 Ginkgo		10-30m					spring  summer  fall  winter 	















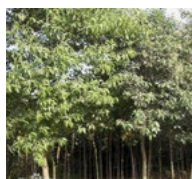







Tall Trees	Name	Shade	Height	Fragrance	Main View	Road Tree	Special Usage	Color
Table 1 Usage of local type of tall trees Source: Drawn by author	 Jackfruit		10-20m					spring  summer  fall  winter 
	 Palm		3-10m				 air purification	spring  summer  fall  winter 
	 Queen Crape Myrtle		7-25m					spring  summer  fall  winter 
	 Alexandra Palm		20-30m					spring  summer  fall  winter 
	 Royal Palm		10-20m					spring  summer  fall  winter 
	 Chinese Fan-palm		5-20m					spring  summer  fall  winter 
	 Erythrina		20m					spring  summer  fall  winter 


















Legend












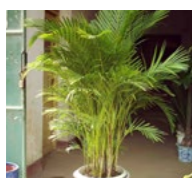

















-  Provide Shade
-  With Fragrance
-  Main View
-  Road Tree
-  With Stone
-  Subtropical Scenery














Name	Shade	Height	Fragrance	Main View	Road Tree	Special Usage	Color	Fruit Tree
 Orange		3-10m					spring  summer  fall  winter 	Table 2 Usage of local type of fruit trees Source: Drawn by author
 Guava		13m					spring  summer  fall  winter 	
 Papaya		5-10m					spring  summer  fall  winter 	
 Phoenix Eye Fruit		10m				used for sacrifice ceremony	spring  summer  fall  winter 	
 Naseberry		15-20m					spring  summer  fall  winter 	Legend
 Sand Pear		7-15m					spring  summer  fall  winter 	 Provide Shade  With Fragrance  Main View  Road Tree
 Longan		20m					spring  summer  fall  winter 	

Fruit Tree	Name	Shade	Height	Fragrance	Main View	Road Tree	Special Usage	Color
Table 2 Usage of local type of fruit trees Source: Drawn by author	 Mango		2-10m					spring  summer  fall  winter 
	 Peach		3-8m					spring  summer  fall  winter 
	 Carambola		3-12m					spring  summer  fall  winter 
	 Rose Apple		10m					spring  summer  fall  winter 
Legend	 Loquat		3-5m					spring  summer  fall  winter 
	 Wampee		3-12m					spring  summer  fall  winter 
	 Lychee		10m					spring  summer  fall  winter 




Name	Shade	Size	Fragrance	Main View	Road Tree	Special Usage	Color	Small Trees
 Sweet Osmanthus		3-10m				similar to "贵" metaphor nobility	spring summer fall winter	Table 3 Usage of local type of small trees Source: Drawn by author
 Plum Blossom		4-10m				metaphor staunch and unyielding	spring summer fall winter	
 Plumeria		5-8m					spring summer fall winter	
 Willow		3-15m				metaphor stay and farewell	spring summer fall winter	
 Glossy Privet		25m				small one as hedge	spring summer fall winter	Legend
 Chinese Redbud		2-5m					spring summer fall winter	Provide Shade With Fragrance Main View Road Tree
 Strelitzia Alba		6m					spring summer fall winter	Traditional Chinese Flower Waterfront Hedge Subtropical Scenery


























Small Shrub	Name	Hedge	Height	Fragrance	Main View	Road Tree	Special Usage	Color
Table 4 Usage of local type of small shrub Source: Drawn by author	 Fernleaf Bamboo		3-6m					spring summer fall winter
	 Bamboo Palm		2-3m				With Stone Subtropical Scenery	spring summer fall winter
	 Wintersweet		4m				metaphor staunch and unyielding	spring summer fall winter
	 Banana Shrub		2-3m					spring summer fall winter
Legend	 Magnolia Coco		1-2m					spring summer fall winter
	 Winter Daphne		1.5-2m				With Stone	spring summer fall winter
	 Frangipani		1-4m					spring summer fall winter












Name	Hedge	Height	Fragrance	Main View	Road Tree	Special Usage	Color	Small Shrub
 Oleander		5m				air purification	spring summer fall winter	Table 4 Usage of local type of small shrub Source: Drawn by author
 Purpus Privet		1-3m				air purification	spring summer fall winter	
 Chinese Ilex		2-13m					spring summer fall winter	
 Butterfly Palm		2-5m					spring summer fall winter	
 Sago Cycas		2-8m					spring summer fall winter	Legend
 Lily Magnolia		3m				 "玉堂春" metaphor jade	spring summer fall winter	 Main View  Road Tree  With Stone  Hedge
 Buddha Bamboo		8-10m				 metaphor perseverance and robust	spring summer fall winter	 Traditional Chinese Flower  Subtropical Scenery

Flower	Name	Hedge	Height	Fragrance	Main View	Road Tree	Special Usage	Color
Table 5 Usage of local type of flowers Source: Drawn by author	 Lily		0.7-1.5m				 metaphor best wish for love and family	flower
	 Chinese Perfume Plant		1.5m				air purification	flower
	 Chloranthus		0.3-0.6m					flower
	 Jasmine		3m				metaphor purity and rustic	flower

Legend

-  With Fragrance
-  Main View
-  Road Tree
-  Traditional Chinese Flower

Name	Hedge Height	Fragrance	Main View	Road Tree	Special Usage	Color	Flower
 Canna	1.5m				air purification	flower red yellow	Table 5 Usage of local type of flowers Source: Drawn by author
 Chinese Enkianthus	0.5-2m					flower purple orange pink	
 Aurantiacus	1-3m					flower red yellow	
 Common Lantana	 1-2m					flower pink red yellow	
 Chrysanthemum	0.3-1.5m				 metaphor integrity	flower red olive purple yellow grey	Legend  With Fragrance
 Papyrus	1.5-3m				 Waterfront	leaf olive	 Road Tree  Hedge
 Chinese Rose	1-2m				 metaphor integrity	flower purple red pink yellow grey orange	 Traditional Chinese Flower  Waterfront

Climbing Plants	Name	Hedge Height	Fragrance	Main View	Special Usage	Color
Table 6 Usage of local type of climbing plants Source: Drawn by author	 Artabotrys hexapetalus	4m				spring summer fall winter
	 Pyrostegia venusta					spring summer fall winter
	 Wisteria				 	spring summer fall winter
	 Bougainvillea					spring summer fall winter
	 Epipremum pinnatum					spring summer fall winter
	Legend					