Retrofitting Panyu

Adapting green-blue infrastructure to sustain waterlogging and regenerate Panyu by industrial transformation

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Landscape Architecture MSC 2020

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ABSTRACT

The Pearl River Delta region includes nine cities in Guangzhou, Foshan, Zhaoqing, Shenzhen, Dongguan, Huizhou, Zhuhai, Zhongshan and Jiangmen in Guangdong Province, with a total area of 56,000 square kilometers. It is one of the three largest urban agglomerations in China with the most developed industry and the densest population. Among them, Guangzhou is a representative city.

In this project, Guangzhou, one of the most representative cities in the Pearl River Delta region, is selectedas the research area. The main goal is to solve the problem of waterlogging. After conducting literature research, site visit, and case study, this project will focus on solving the problem of waterlogging by constructing green-blue structures. At the same time, in the design project, the multi-scale design is carried out, from the Guangzhou scale, Panyu district scale, neighborhood scale to chosen site scale, more detailed planning and design are carried out step by step. Some industrial transformation sites are selected to expand the new green-blue structure.

Because the entire Pearl River Delta region has things in common in the terrain and development model, this method can be used as a reference for solving similar problems in other cities.

Key words: Pearl River Delta, multi scale, waterlogging, green-blue structure, landscape architecture

Chapter 1

INTRODUCTION

This chapter will introduce the reason and original intention of the author to choose this graduation project. It will introduce the Pearl River Delta region in terms of geographic location, natural landscape, climate characteristics, urbanization and industrialization, understanding based on the above information, and the main problem statement is proposed.

1.1 Fascination

The experience of growing up in a heavy industrial city, Shenyang, China, prompted the author to choose this project. During the 1970-80s, Shenyang was one of the largest heavy industrial bases in China, and economic development also developed rapidly due to the benefits brought by industry. But in the 1990s, China's economic system began to transform, and some industrial types faced huge challenges in the process.

Because of the consequence of the transformation, empty industrial areas, dilapidated factories, and land polluted by heavy industry have become indelible marks in the city. And this situation does not only exist in this city. Many light industries in the Pearl River Delta and Yangtze River Delta regions have similar situations. At the same time, waterlogging happens in the city regularly. These two problems are the legacy of rapid urbanization and industrialization. The rapid development has prevented planners from making sufficient considerations, and city builders do not have the experience to complete the urban infrastructure that should be the top priority. With the sequelae of this rapid development now exposed, how to improve, and how to govern has become a topic of concern.

Various ways are existing to solve the problem, but the landscape can undoubtedly consider the quality of the living environment while improving the problem. When people focus on these superficial issues, they also need to realize that the reasons behind these phenomena are important. Because of urbanization, many natural green spaces have built houses and rivers have been filled. The fragmentation of the landscape caused by these acts has weakened the ability to deal with nature. Then improving the landscape current situation will provide new solutions for the above problems.

1.2 Context introduction

General Information

The Pearl River Delta urban agglomeration is one of the most dynamic economic zones in the Asia-Pacific region. With 70% of Guangdong's population, it creates 85% of the province's GDP. It is an advanced manufacturing base and modern service industry base with global influence, a gateway to the south that is open to the outside world, the main area for China to participate in economic globalization, a national base for scientific and technological innovation and technology research and development, and an important engine for national economic development. The leader in the development of Central, Southwest, and Southwest China is one of the three regions with the largest population concentration, the strongest innovation ability, and the strongest comprehensive strength in China (the other two are the Yangtze River Delta and Beijing-Tianjin-Hebei).

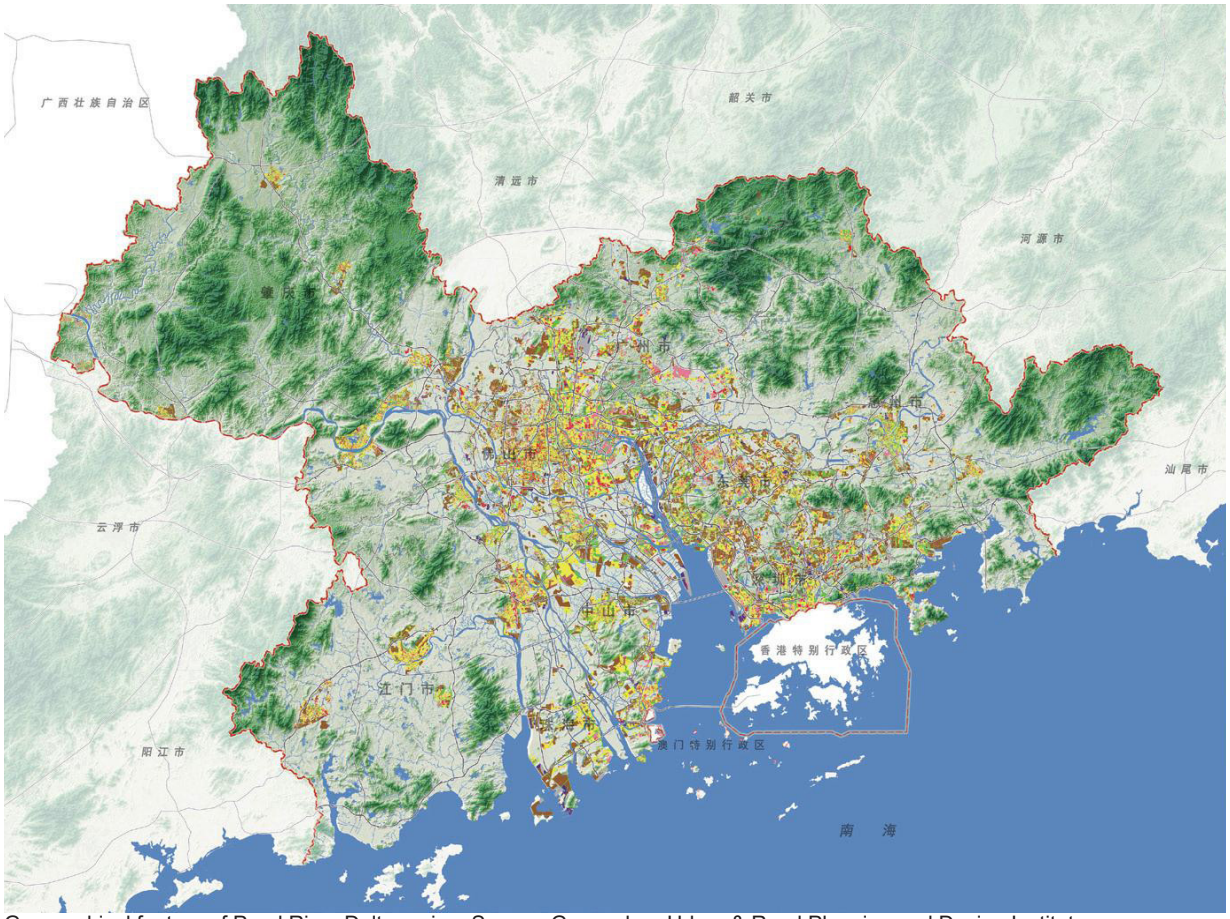
Since 1978, the Pearl River Delta area has experienced rapid economic development. As the most rapidly developing delta region in China, the industry has contributed to the major economic growth. The Pearl River Delta industrial zone is one of the four major industrial bases in China. In the whole area, Guangzhou, as the central city of the region, has experienced the process of urban expansion and explosive construction and transformation of industrial zones during this period. After going through such a stage dominated by economic development, the locals want to solve the current problems and look for future development direction while preserving the local culture and development advantages.

Pearl River Delta region Source: Arcgis storymaps

Natural Landscape

The Pearl River Delta is located in the central and southern part of Guangdong Province and the lower reaches of the Pearl River. It is adjacent to the South China Sea, with longitude 112 ° 45'-113 ° 50 'east longitude 21 ° 31'-23 ° 10' north latitude. The sediments brought by the rivers, Suijiang and Zengjiang are compound deltas built in the estuary of the Pearl River Estuary, with 1/5 of the hills, platforms and remnants covered by scattered hills. The west, north and east are surrounded by hills and mountains, forming a natural barrier. To the south is a 1,059-kilometre coastline with many islands.

The Pearl River Delta is located in the lower reaches of the Xijiang River, Beijiang River, and Dongjiang River, including the four major river systems of Xijiang River, Beijiang River, Dongjiang River, and Delta Rivers, with a drainage area of 450,000 square kilometers. The river network area covers an area of 9750 square kilometers, and the density of the river network is 0.8 kilometers per square kilometer. More than 100 river channels are with a length of about 1700 kilometers. The water channels are crisscrossed and interconnected. The dense river network brings abundant water resources, with a total of 374.2 billion cubic meters of water resources.



Geographical feature of Pearl River Delta region Source: Guangzhou Urban & Rural Planning and Design Institute

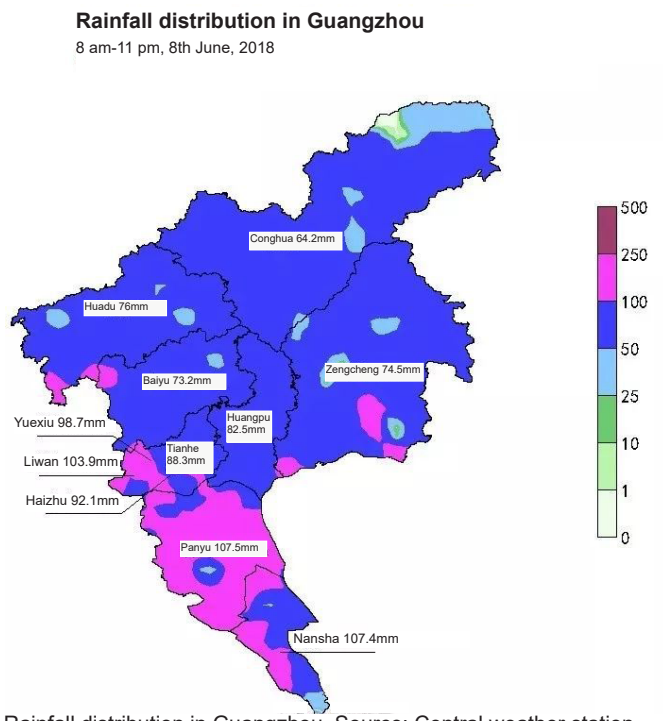
Climatic conditions

Most of the Pearl River Delta is located to the south of the Tropic of Cancer and is located in the southern subtropical zone. It belongs to the subtropical marine monsoon climate, with abundant rainfall and sufficient heat. The annual sunshine is 2000 hours, and the four seasons are evenly distributed. The average annual rainfall is 1600-2300 mm. Due to the monsoon climate, the rainfall is concentrated in April to September. Guangzhou as one of the cities with the highest rainfall in South China, extreme rainstorms occur here.

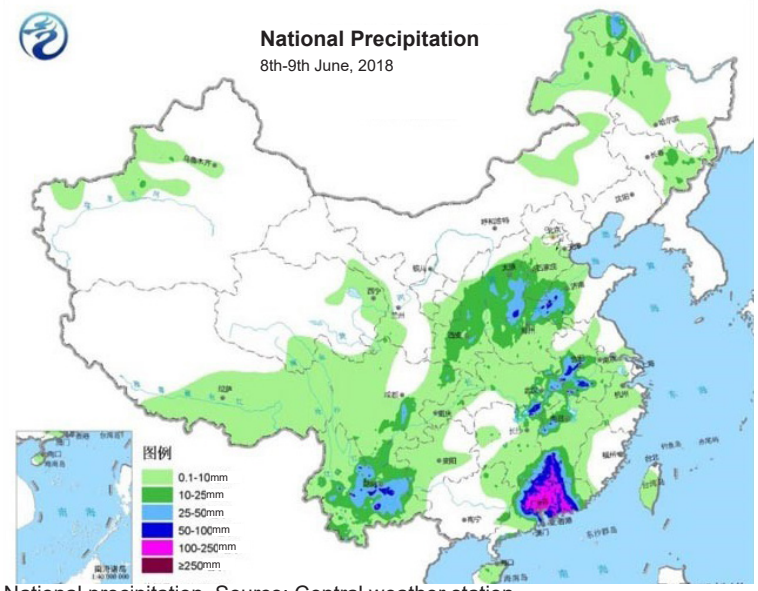
On January 6, 2016, the first heavy rain was rare. The main roads in Guangzhou were congested. There were 204 stations in the city with cumulative rainfall of more than 50mm. Among them, 28 stations had a rainfall of more than 100mm. .

In Guangzhou in 2018, the center of Typhoon Aiyunni (tropical storm level) re-landed on the coast of Yangjiang, Guangdong Province around 20:30 on June 7th. The maximum wind force near the center was 8 (20 M / s). Due to the attack of "Aiyunni", Guangzhou was hit by heavy rains, urban flooding occurred in many places, and roads were flooded.

On June 8, 2018, Guangzhou suffered a long period of continuous rainfall. The heavy rainfall in Yuexiu District lasted nearly 11 hours, with an average rainfall of 249.7 mm and a maximum rainfall of 270 mm. The rainfall reached a historical high. The tide level of the Pearl River has remained above 5.7 meters from 6 o'clock on the 8th, and as of 21:00, the highest tide level has reached 6.8 meters.



Rainfall distribution in Guangzhou Source: Central weather station



National precipitation Source: Central weather station

1.3 Problem statement

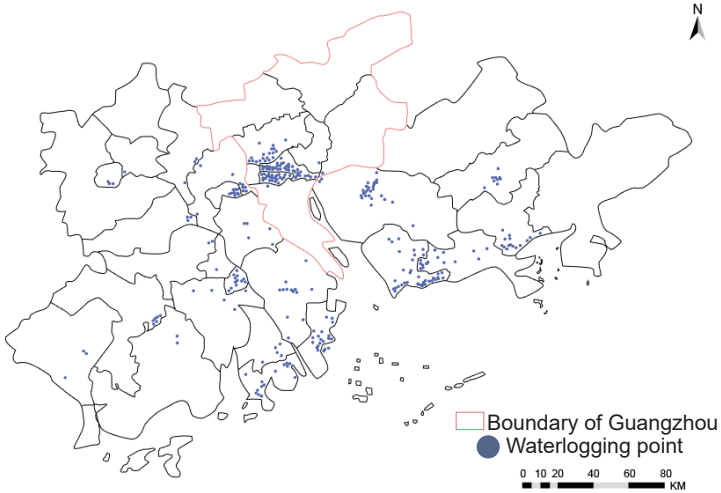
Waterlogging Problem

The locations where waterlogging often occurs in cities are generally referred to as waterlogging black spots. From a spatial perspective, the city 's waterlogging black spots in the Pearl River Delta region are mainly distributed in cities such as Guangzhou, Shenzhen, and Foshan. These cities account for the total number of waterlogging black spots More than 80% and relatively few in Zhuhai, Dongguan, Zhongshan, Jiangmen, Huizhou, and Zhaoqing. The statistics and spatial distribution of waterlogging black spots in various cities in the Pearl River Delta in 2014 are shown in the figure above.

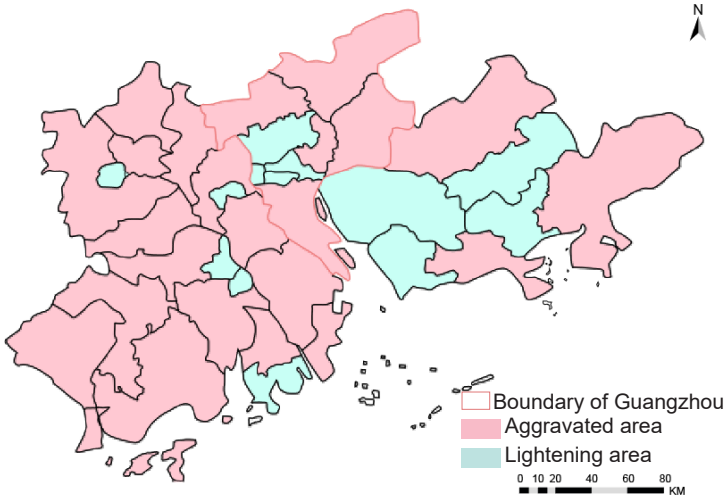
The future development trend of urban waterlogging is mainly related to two aspects.

From the perspective of time development, the next 5 years will still be a period of frequent urban waterlogging in the PRD region. Afterward, with the increase of the importance of various cities, the improvement of management levels, the update of governance concepts and the improvement of technical methods, urban waterlogging will gradually decrease, but it will take time to completely eliminate it. Because climate factors will not improve in the short term, and there will be a trend of further deterioration. At the same time, the urbanization process will continue to accelerate, the area of each city's built-up areas will further increase, and the imperviousness rate will continue to rise, and the reconstruction of urban drainage pipe networks is a huge systematic project, and the problem of insufficient urban drainage capacity cannot be solved recently.

From the perspective of spatial development trends, Guangzhou, Shenzhen, and Dongguan, which are currently suffering from severe waterlogging in the Pearl River Delta, will have less waterlogging in the future, while the waterlogging in Zhuhai and Zhongshan will increase, and the urban waterlogging in Jiangmen, Huizhou, and Zhaoqing will also increase. From the perspective of different areas of each city, urban waterlogging in the old urban area will gradually decrease, and urban waterlogging in the new urban area and suburbs will gradually increase and deepen.[18]



Distribution urban waterlogging points in PRD in 2014
Reference: [18]



Development trend of urban waterlogging in PRD
Reference: [18]

Waterlogging in Guangzhou Source: China Daily

Urban waterlogging refers to the phenomenon of waterlogging disasters in cities due to heavy precipitation or continuous precipitation exceeding urban drainage capacity. [18]

Waterlogging refers to the phenomenon of water accumulation disaster caused by heavy precipitation or continuous precipitation exceeding urban drainage capacity. The objective cause of waterlogging is rainfall intensity and concentration. Water form in places where the rainfall is particularly intense, or form in places where the rainfall intensity is relatively large and the time is relatively long. [18]

First, in terms of where it happened. Waterlogging used to happen mainly in low-lying coastal areas and often in inland cities. In the past, the urban construction land area is small and the optional area is relatively large. Generally, the higher terrain is chosen for construction. However, the urban land is tight and the optional space is less. In addition, the incidence rate is higher in certain parts of the city, such as overpasses. With the construction of modern cities drainage waterlogging also appeared many new problems. For example, places under the overpass, after the rain will accumulate water. A similar situation exists in the underground passage, railway bridge and highway bridge.

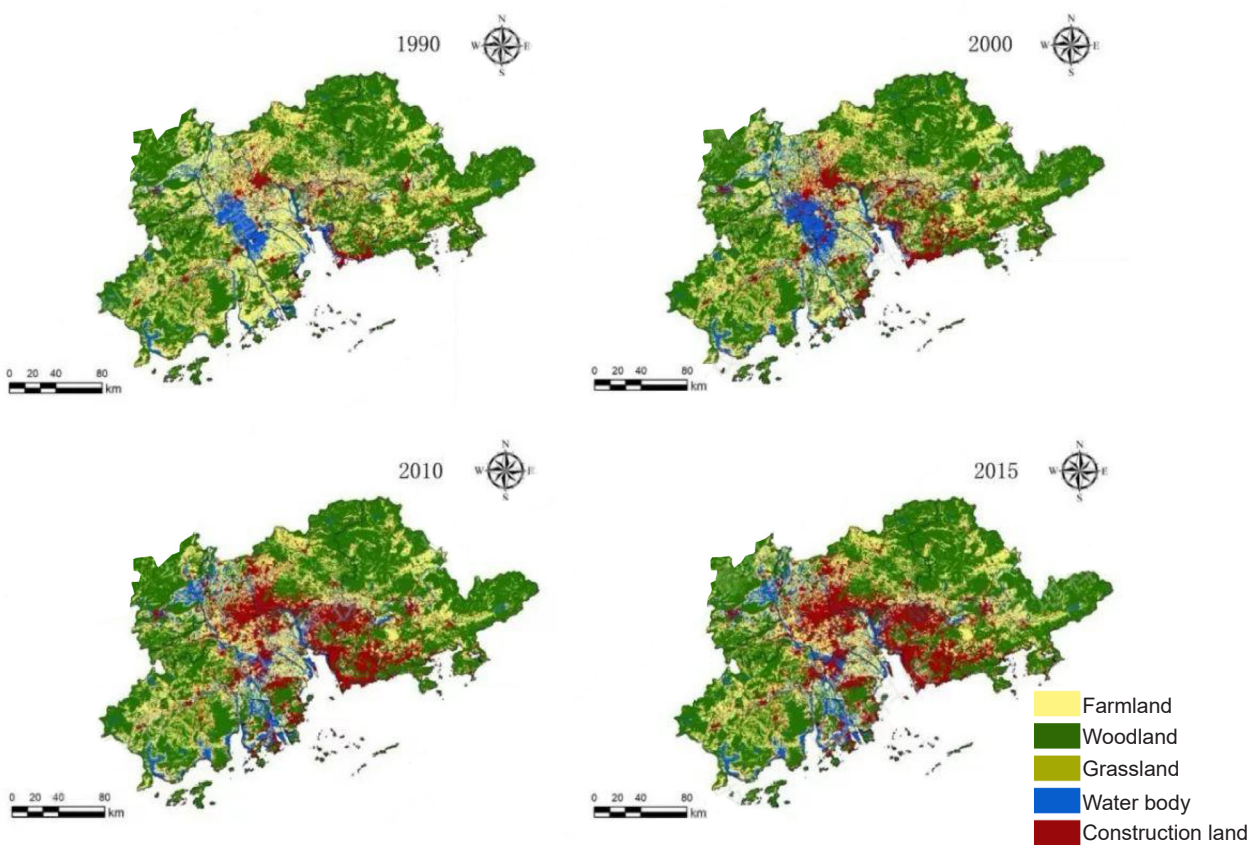
There are two main reasons for urban waterlogging. The first is the topography. Low-lying areas within the city are prone to waterlogging. Second, the drainage system. The drainage pipe network in Guangzhou was constructed early, the pipes were aged and the drainage standards were relatively low. In addition, the city of a large number of hard pavement, such as asphalt, cement pavement, water permeability is not good when rainfall, not easy to infiltrate, but also easy to form this section of the road water.

Rapid Urbanization

The development of the Pearl River Delta urbanization can be divided into four stages: the first traditional agricultural stage was before 1978. The second stage, from 1978 to 1992, was the stage of rural industrialization. With capital inflows from Hong Kong, Macao and Taiwan, factories in rural areas have begun to enter the stage of rural industrialization. At this time, urbanization developed rapidly, and the level of urbanization in the Pearl River Delta reached 43%.

The third stage is the stage of urban industrialization. At this stage, city-focused industrialization entered, and more development zones were established during this period. Urbanization in the Pearl River Delta region reached 72%, and the distance between cities was shortened by 9.8 kilometers. From 2000 to the present, it is known as the stage of metropolitanization. The surrounding cities have developed around big cities, and the level of urbanization has reached 84%.
[24]

In this rapid urbanization process, land use has also changed dramatically. Since 1990, agricultural land has been reduced from 24.1% to 16.9%, dry land has been reduced from 10.4% to 6.34%, and woodland has been reduced from 47.6% to 45.4%. On the contrary, construction land increased to 17.1% from 7.21%.[19]

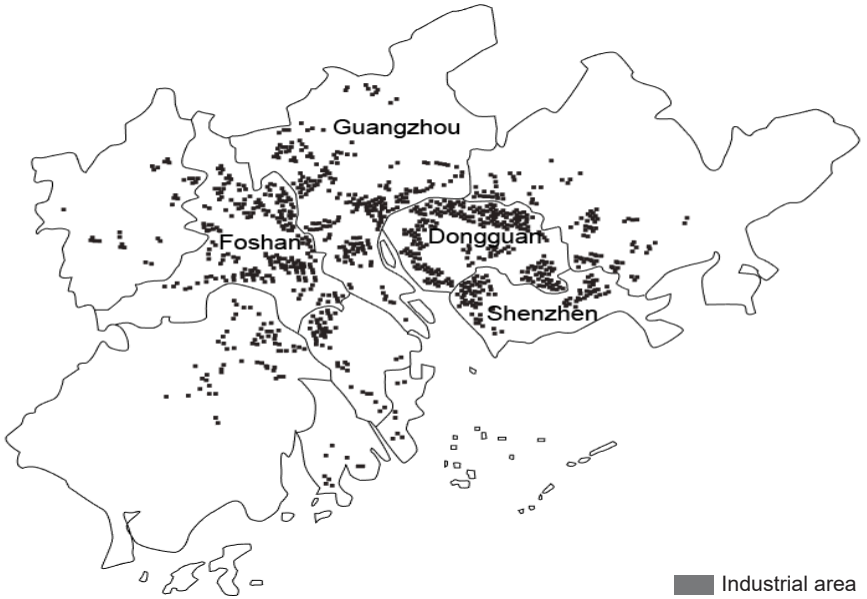


Land-use in the Pearl River Delta region, 1990-2015 Source: Guodi Technology

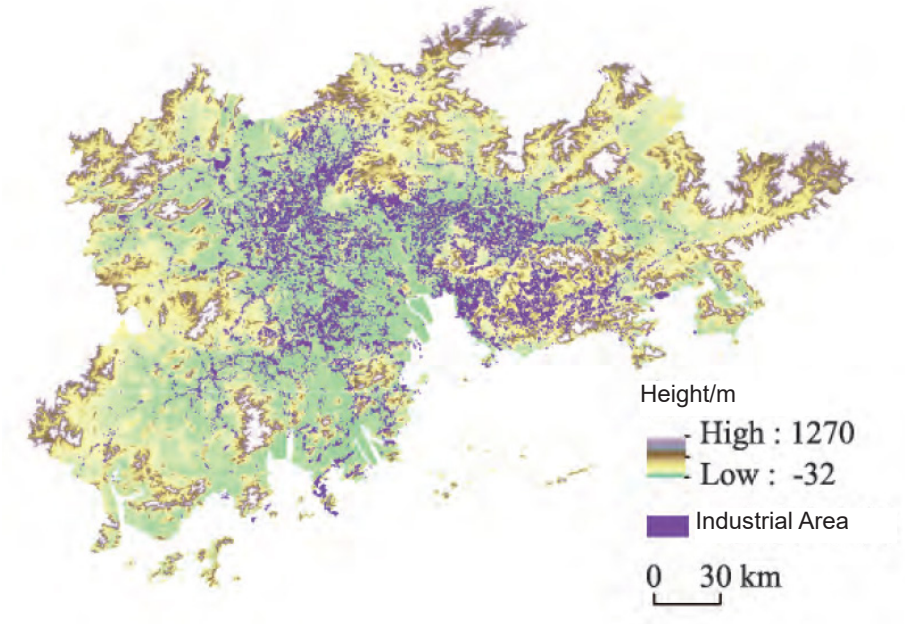
Industrialization

Since the reform and opening up, the Pearl River Delta urban agglomeration has gradually developed bottom-up industrialization and urbanization by encouraging developed township and village enterprises to take the lead in development, forming many highly specialized industrial towns and scattered small factories. After more than 30 years of development, the industrial production space of the Pearl River Delta urban agglomeration has gradually formed a unique distribution pattern. The overall layout of the region can be seen directly (Fig.1). The industrial production space of the Pearl River Delta urban agglomeration is most densely distributed on both sides of the Pearl River estuary. In the peripheral areas of the Pearl River Delta urban agglomeration, the spatial distribution of industrial production is relatively scattered, and only a small-scale agglomeration is located along some of the better or important transportation routes. In addition, most of the industrial production space of the Pearl River Delta urban agglomerations are spatially arranged around the city's core nodes. The closer to the city's core nodes, the more concentrated the industrial production space distribution and the larger the scale; the further away from the city's core nodes, the industrial production space distribution is relatively loose. In conclusion, the distribution pattern of industrial production space in the Pearl River Delta urban agglomeration presents a more typical “core-periphery” structure. The inner circle layer is an industrial production space-intensive area, and the outer circle layer is an industrial production space loose zone.

Affected by the topographical conditions, the industrial production space of the Pearl River Delta urban agglomeration is basically distributed in plains and shallow mountain areas with flat terrain, lower elevations (Fig.2), in order to facilitate the rational layout of industrial production activities and people's lives and transportation.[5]

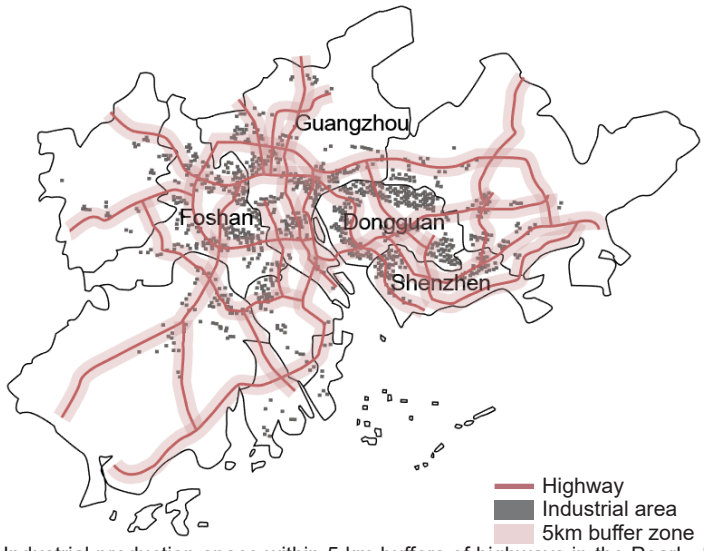


Overall distribution of industrial zones in the Pearl River Delta region. 2016
Reference: [5]

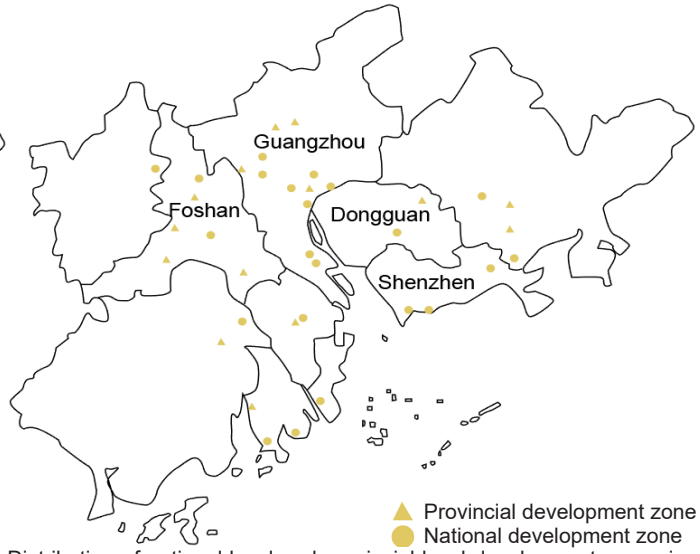


Topographic Map of the Pearl River Delta region Source: [5]

Industrial production space within the 5 km buffer of the Pearl River Reference: [5]



Industrial production space within 5 km buffers of highways in the Pearl River Delta region Reference: [5]



Distribution of national-level and provincial-level development zones in the Pearl River Delta region Reference: [5]

Analyze the distribution of industrial zones in the Pearl River Delta region. First, because industrial production requires a large amount of water, the Pearl River, as a major river in the Pearl River Delta region, also has an important impact on the distribution of industrial production space. Studies show that the industrial production space distributed within 5 km on both sides of the Pearl River reaches 951.31 k m^2 , accounting for 36.52% of the total area.

Secondly, the industrial production space of the Pearl River Delta urban agglomeration has a close symbiotic relationship with major transportation arteries. Good traffic conditions can easily form a competitive location advantage, attracting industry and population concentration, especially on the two sides of some major transportation arteries, where industrial production is most densely distributed. Taking the highway as an example, the industrial production space distributed within 2 km on both sides of the highway is 1041.79 k m^2 , which accounts for 40% of the total industrial production space.

By the end of 2013, the Pearl River Delta urban agglomeration had a total of 27 national development zones of various types, 20 provincial development zones of various types, and hundreds of city-level industrial parks (Figure 9). It can be seen that many industrial enterprises are clustered in various development zones and industrial parks, and the concentration of industrial production space is also consistent with the location of development zones and industrial parks.

Industrial Transformation

During the rapid industrialization process, a large number of village-level industrial parks and big factories were established. Because of the low labor and land prices in the Pearl River Delta region, a special development model of village-level industrial zones has emerged. They are usually invested and built by the village themselves and mainly produce simple goods which means most of them are are traditional manufacturing factories. In Guangzhou, 30%- 40% of the factories are of this type. They occupy about 40% of industrial land but only produce 10% of the economic benefits of the entire city.

Nowadays, due to the rising cost of land and the gradual disappearance of the demographic dividend, the survival pressure of these low-end factories is increasing. Faced with such pressure, some companies have gradually changed from processing plants to innovative factories, and products have changed from other brands to self-brands. In short, the low-end industrial types of the Pearl River Delta need to be transformed into innovative industries, and old factories need to be given new value.

Industrial Transformation research based on the assumption that important changes in production and consumption systems will be required in order to meet the needs and aspirations of a growing world population while using environmental resources in a sustainable manner. Reconstruct or upgrade industries that are no longer able to meet the needs of today‘s society. [10]

The purpose of the transformation is to improve the ability of independent innovation, transform and upgrade traditional industries, cultivate and expand new industries, adjust and optimize the industrial structure, and meet the characteristics of innovation, intensive, efficient, environmentally friendly, and sustainable development of the industry.

A village-level industrial area in Guangzhou Source: The Paper

An abandoned factory in Guangzhou Source: China Daily

Conclusion

During the development of the Pearl River Delta region, a large number of natural landscapes and water bodies were converted to construction land, resulting in a reduction in the permeable surface. At the same time, due to the expansion of the city and the increase of population, the climate problem in the region is becoming more and more serious. Floods and waterlogging have also become problems in cities. Then, finding a sustainable development method that can solve the waterlogging has become a top priority.

Simultaneously, the old industrial areas in the city have new opportunities, industrial transformation. Then the industrial transformation area may be able to contribute to the resolution of waterlogging, which will be part of the contents discussed in this article.

Chapter 2

METHODOLOGY

This chapter will focus on research questions, research framework, article structure, and research methods, which will guide the content of the whole article. The analysis in the previous chapter introduces that the main problem that the author is concerned about is waterlogging, and tries to find an opportunity to solve this problem from industrial transformation. In the analysis stage, the method of literature review, case study, mapping, the multi-scale analysis will be used in the analysis, and modeling and multi-scale design will be used in the design part to achieve the expected results.

2.1 Research Question

After the background research above, the main research question is clarified and is broken down into four sub-questions. These sub-questions will be answered after literature reading and case studies, which helps to answer the main question.

Main Question	Sub Questions
How to improve the sponge capacity of the city, using the reassignment of former industrial zones to expand green-blue networks as adaptive & regenerative urbanism strategy?	How to improve the sponge capacity of the city?
	How can industrial transformation support to resolve the waterlogging problem?
	How can a landscape approach be used to improve the sponge capacity of the city?
	How can the new green and blue infrastructure improve the living quality of the city districts?

Method	Theoretical Approach
Analysis Literature review, Case study Positioning and Visioning Mapping, Layer approach, Site analysis	Green-Blue infrastructure Case study - Copenhagen drainage and corrosion prevention Plan
Analysis Literature review, Interview Positioning and Visioning Scenario analysis, Mapping, Site visit, Layer approach	Literature - "Performance Evaluation-oriented" Thoughts on the Integration and Transformation of Low-Efficiency Village-level Industrial Parks: Taking Guangzhou as an Example
Analysis City plan, Case study, Literature review Research by design Scenario analysis, Multi-scale design, Time process	Landscape as infrastructure Green-Blue infrastructure
Analysis Literature review, Case study Research by design Multi-scale design, Time process, 3D model	Case study

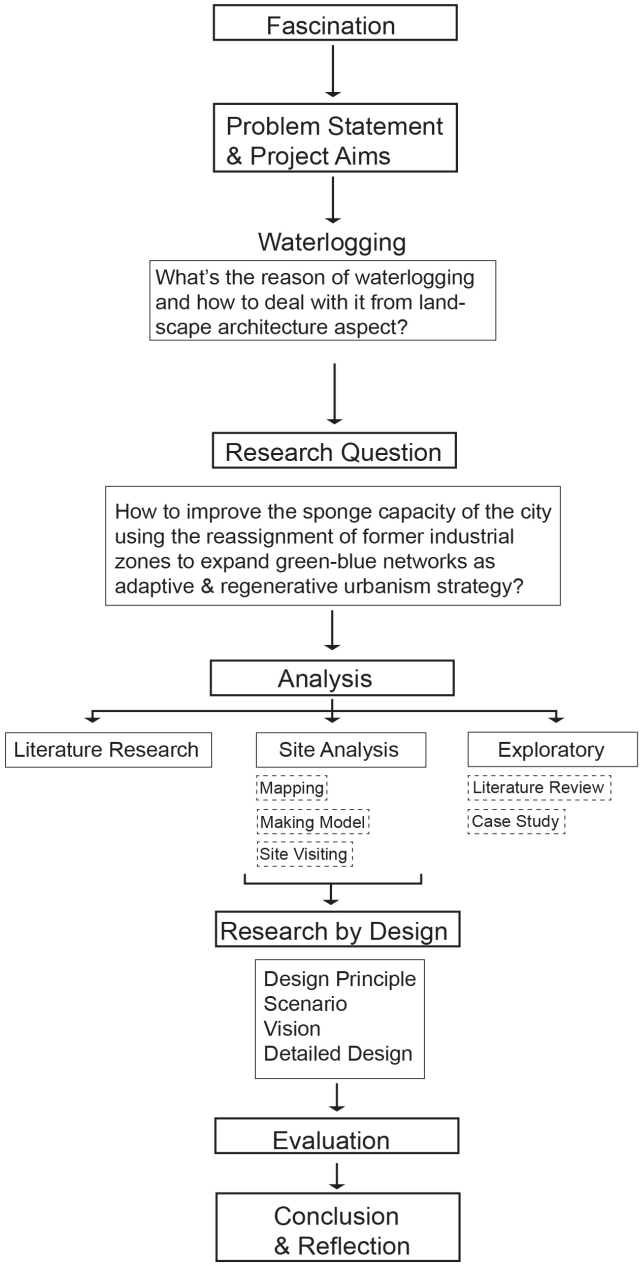
Understanding question:
What are industrial transformation and waterlogging?
What are the features and reasons of industrial transformation and waterlogging problem?

What to do question:
What are the principles about the method of industrial transformation and improving sponge capacity of the city?
How to use the change of industrial land to expand green and blue structure, in the same time, improving the living environment for the local?
What are the design strategies about different directions of industrial transformation and different solution of sponge city?

Application question:
How to apply the principles during the designing and planning process in different scales, to deal with water safety problems(rainstorm, waterlogging and water purification), transforming of industry(upgrading industry and functional conversion industry), and the connecting between industry and surrounding area to find a adaptive and regenerative urbanism method to improve the living quality foe the local?

Reflection question:
How the principles and strategies can be used to other regions which have the similar problems?
What can be learned from the relationship between industrial transformation and spongy city design?
What can be learned from designing as a research method?

2.2 Methodology

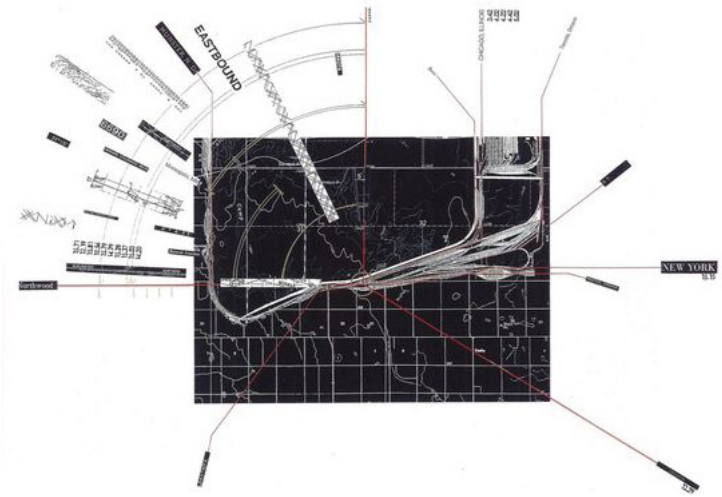


2.3 Research Method

Literature review

Literature mainly includes government documents and theoretical research. Through government documents, the designer can understand the future development direction and specific land use planning of the Pearl River Delta region, which will help control the feasibility of the design direction.

Many scholars have studied some issues in the Pearl River Delta region. By reading the literature related to industrial transformation and waterlogging, the designer can get the basic information of Guangzhou and the model of industrial development and the causes of waterlogging. At the same time, referring to the theoretical methods in the literature is important. For example, the three types of transformation of old industrial areas, industrial upgrading, functional transformation, and ecological control.



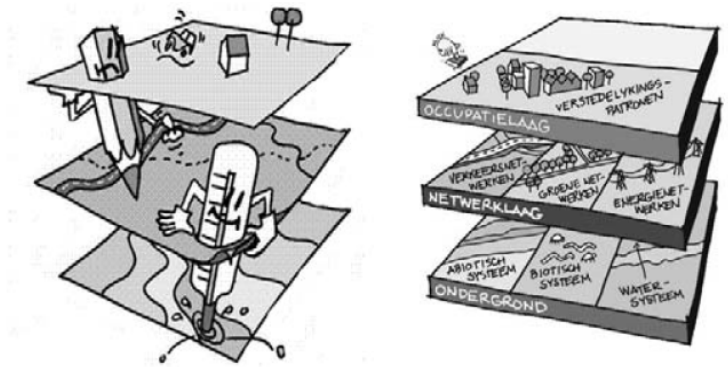
Using mapping to understand landscape
Source: James Corner "The Agency of Mapping"

Mapping

After collecting the data and text, this information will be combined with the map of different scales to visualize them. Mapping the design area, analyze the current land use, industrial area distribution, industrial type, water body and green space, and infrastructure as basic maps. Then combined with other information, design challenges and opportunities are expressed through mapping. Finally, regional and local vision and plan will be shown by mapping.

At the same time, the layered approach will be used which was initially originated in the USA in the 1960s (McHarg, 1969). In the 1980s, the “layered approach” was introduced in Dutch design and planning as a step towards the visualization of an urban landscape as a complex system.[29]

Comprehensive analysis of topographic layer, blue and green structure layer, transportation network layer and behavior layer. Gradually understand the development process of the Pearl River Delta region and the factors that affect development, so as to help the subsequent design.

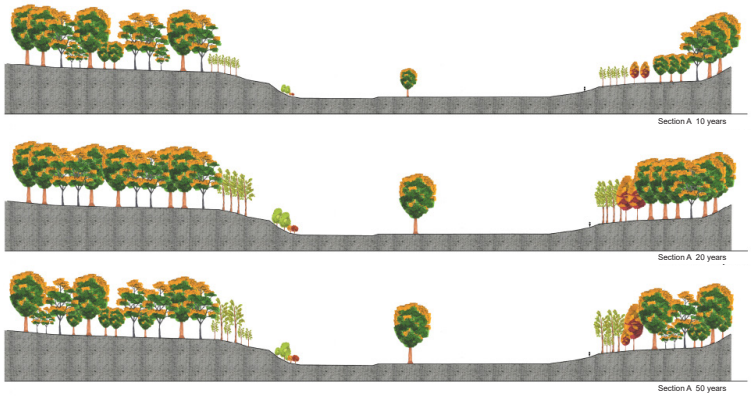


Peter Dauvellier in cooperation with H2Ruimte visualises the layers approach for the urban region Haaglanden as part of a step-by-step cyclical planning process. Right figure illustrates that each layer can be elaborated into detail.
Source: Stadsgewest Haaglanden [29]

Site visit

Through the above methods, a better understanding of the research objectives and research problems and a preliminary idea of the detailed design are got.

However, the information collected is sometimes not up-to-date or sufficiently objective. After visiting and analyzing several important sites, it is helpful to decide the chosen sites because the actual situation of some places is different from that mentioned in the information, and some places are inaccessible which means it is hard to confirm the real situation. Secondly, whether the current factory of the selected site is still in operation, whether the land use has changed and other factors can be clarified, thus leading to the goal and direction of the detailed design.



The change of plants in the design site over time is shown through the section
Source: Drawing by author

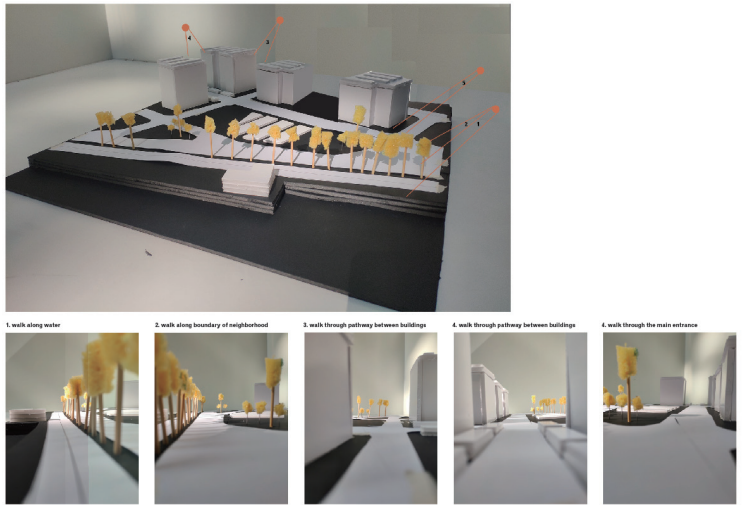
3D model

Models are mainly used in the design process. Modeling the design site and surroundings can enhance the expression of spatial characteristics. For the designer, it is more convenient to check the design, if the relationship between the site and the external environment is suitable, and whether the internal space characteristics meet the local requirements. For the audience, they can more intuitively experience the spatial changes of the site before and after the design

In short, the role of the model lies in a more intuitive representation of spatial characteristics.

Design through time

The implementation of a design must follow the steps. At the same time, the implementation effect of the last step will affect whether the subsequent plan can be implemented smoothly, which means how the design is going to be implemented and in what order need to be thought about.



Explaining spatial relationships through models
Source: Making by author

Scenario analysis

Scenario analysis encourages strategic thinking and helps to overcome thinking limitations by creating multiple futures. By using this method, the future according to the values and desires of society can be shaped. [28]

Taking climate change, the degree of urbanization, the degree of industrial transformation, and densification as uncertain factors, what may happen in Panyu District under various extreme conditions are explored. Comprehensive analysis of the above possibilities, and then come up with a vision that is both ideal and possible. The vision guides the planning and detailed design of Panyu District.

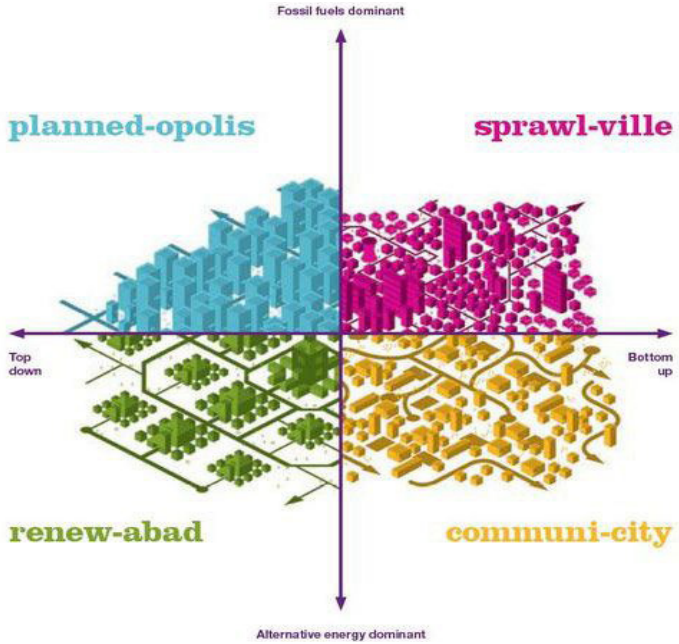
Multi-scale design

Both analysis and design need to encompass different scales. The analysis includes three scales: Guangzhou city, Panyu district, and design site. Different scales can focus on different research contents. The results of the design will also include the plan of Panyu district and the detailed design of the chosen site. The large-scale planning can guide the detailed design, while the detailed design can support the planning.

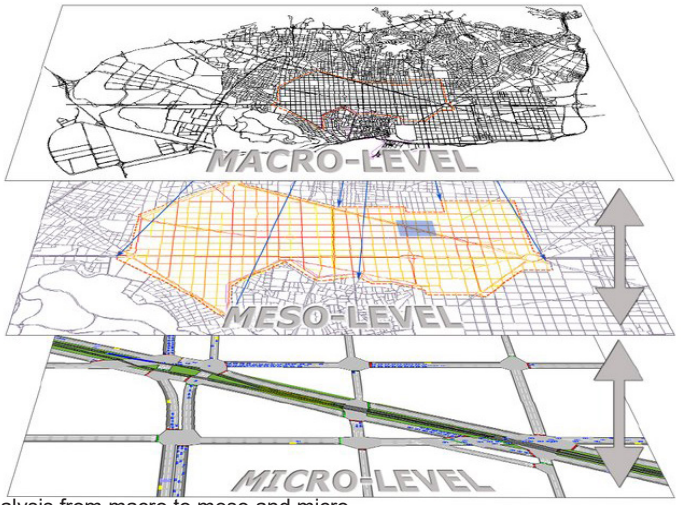
The design of the green-blue structure needs to be carried out on a large scale to have a better effect, but the large scale cannot clearly and specifically reflect the functions and spatial characteristics of the green space or the water body. In this project, the multi-scale design is necessary for the readers to understand the whole story.

Case study

By studying the cases related to industrial transformation, brownfield transformation, and sponge city design, the design principles and strategies are summed up to enrich the tool box.
Design methods in different backgrounds are different. Selecting the suitable ones for this project, and applying them in the design are important.



Four scenarios of Helsinki and sustainable mobility development
Source: Sustainable Cities Collective



Analysis from macro to meso and micro
Source: Jaume Barcelo, 2005

2.4 Relevance

This project mainly focuses on finding adaptive solutions to urban waterlogging and finding the direction of industrial transformation in the Pearl River Delta region. From the perspective of landscape architecture, the blue-green network replanning is used as a bridge between the two problems on a large scale. The blue-green network is designed to alleviate flooding by increasing the permeable surface, and it can also reuse waste factories. On the other hand, the structure can improve the living environment of locals by adding public green spaces, establishing ecological protection areas, and so on. On a small scale, the method of landscape design is used to carry out specific factory reconstruction design.

The past industrial development model of the entire Pearl River Delta region is similar, and the natural geographical environment also has a lot in common. Therefore, the toolbox in this project can be widely used in places with similar problems in this area. The design of chosen sites can serve as an example, they help users understand how to use the tool box with different situations.

2.5 Reading Itinerary

The first chapter serves as an introduction, it is helpful to have a preliminary understanding of this graduation project about the social background, site situation, research objectives and significance of this project. These brief introductions help the reader understand detailed theoretical research and design parts.

In chapter 2, the structure of the project and research methods are mentioned, which are helpful to understand the theory and logic of this project.

In chapter 3, the results of the literature review and case study will be mentioned, including the theory applied in the design process and cases that can enlighten the author. The design principles derived from the research are summarized at the end of this chapter.

The multi-scale analysis and design will be shown in chapter 4 and 5. The author will explain the site analysis in Guangzhou scale, Panyu district scale and neighborhood scale by mapping, site visiting. The reason that why the Panyu district is chosen as the design location will be shown through the analysis. After that, it will come to the conclusion of challenges and opportunities.

Chapter 3

LITERATURE RESEARCH

The purpose of this chapter is to show important theories and principles combined with the design project the author summarized from the papers and cases, so as to help understand the subsequent spatial analysis and planning design.

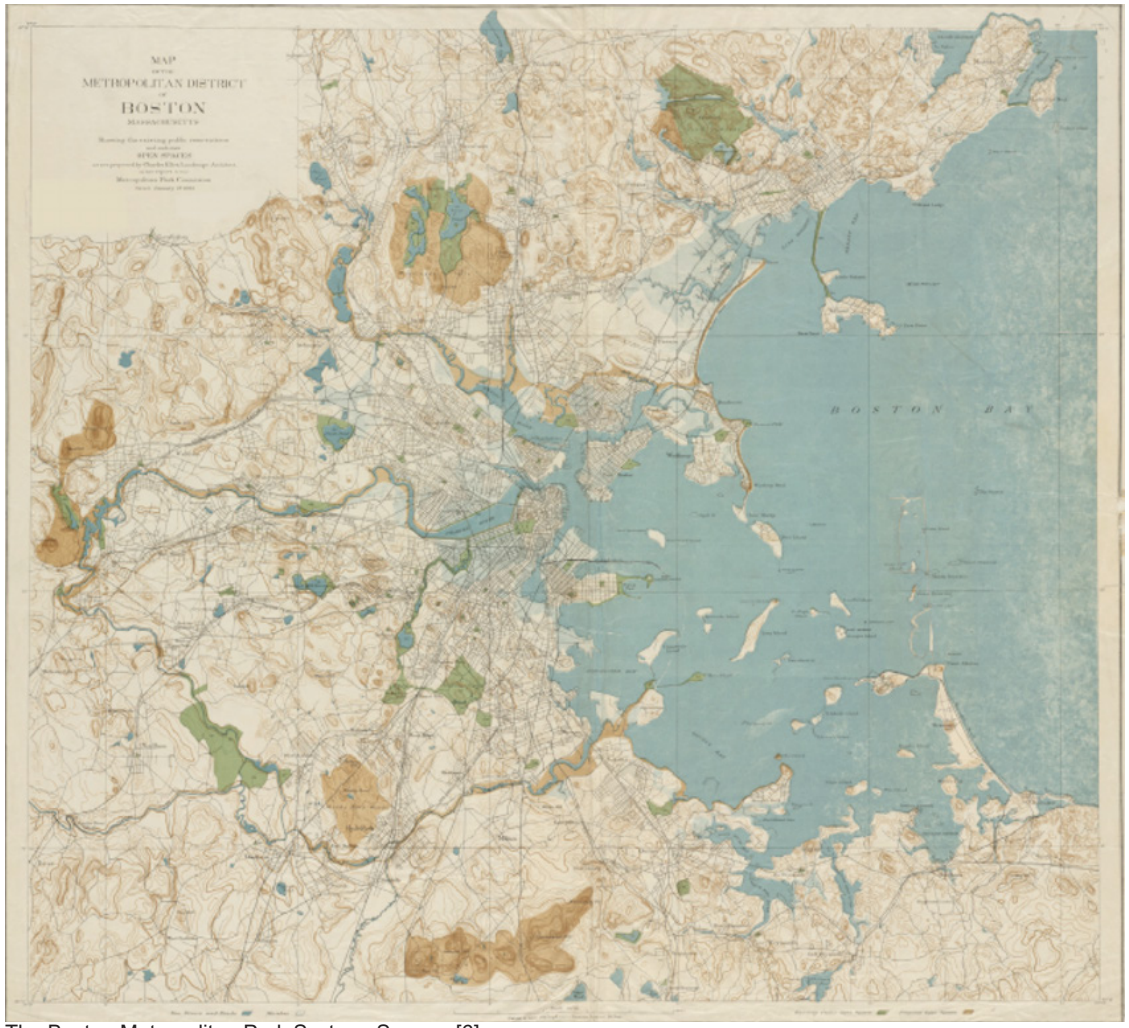
3.1 Theory

Landscape as infrastructure

Parallel to the concept of infrastructure as a landscape is the concept of the landscape that emerges with the development of infrastructure. Conceiving landscape as infrastructure can be characterized as a goal-oriented approach, where the landscape is treated as an operative field that defines and sustains the urban development and ecological and economic processes are employed as formative design tools. This type of thinking addresses the integral nature of the urban landscape as a holistic and complex multi-scale system and the mutual relationship between structure and process.[8]

In this concept, the landscape as the infrastructure itself assumes some of the functions of the city's grey infrastructure. At the same time, it can also be used as a medium to connect other urban facilities, thereby creating landscape projects with multiple functions. The concept enables landscape design to generate sustainable value in urban development

For example, the Boston Metropolitan Park System as proposed in 1893 offered a new vision of how a green-blue system could function as an armature for the rapidly expanding metropolitan area of Boston. The plan exemplifies the potential to shape the urban and architectural form while employing social and ecological processes to establish a local identity that has tangible relationships to the region.[8]



The Boston Metropolitan Park System Source: [6]

Industrial transformation

At present, there are two explanations for industrial transformation. On the macro, which refers to a country or region's adoption of specific industrial, financial, and other policy measures in a certain historical period according to the status and trends of international and domestic economic and technological development, directly or indirectly adjusts all aspects of its existing industrial structure. Including the transformation of industry in many aspects such as structure, organization, and technology. Another explanation refers to the redistribution of resource stocks between industries within an industry, that is, the process of transferring production factors such as capital and labor from a declining industry to an emerging industry.

China's industrial transformation has evolved from industry transformation and has been dominated by industry transformation for a long time. Therefore, this work will focus on the opportunities that China creates for the solution of other issues during the industrial transformation process. For example, the disappearance of industrial types that do not meet the new market requirements and the relocation of factories due to industrial agglomeration have created space for other land-use types.

3.2 Case Study

Copenhagen drainage and corrosion prevention plan

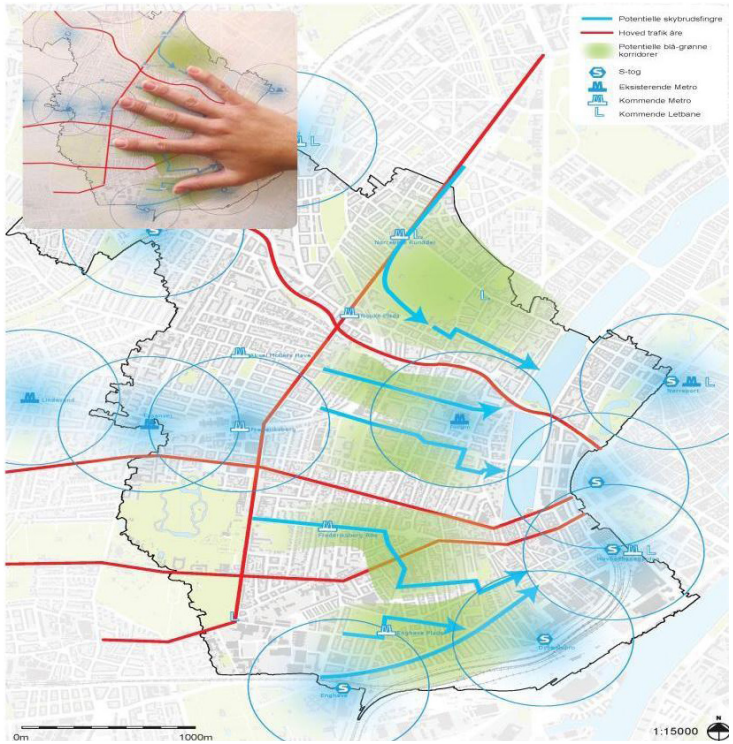
As the world's most sustainable city, Copenhagen is at the forefront of climate change and has experienced more and more heavy rain events in recent years. During the year from August 2010 to August 2011, Copenhagen suffered three heavy rain and flooded major roads and urban infrastructure. Therefore, the Copenhagen government commissioned Atelier Dreiseitl to carry out this urban flood plan.

The storm management plan is planned to be completed in the next 30 years. It fully considers the extreme weather conditions that climate change may bring, and can protect the city of Copenhagen from a century of heavy rain. In response to the once-in-a-century rainstorm, the plan can accommodate an increase of 10 cm in the height of rain on urban roads, and it plans to share 30-40% of the rainwater discharge from the urban drainage system. Such an indicator is determined to address the expected increase in extreme storms caused by climate change 40% of the rainfall.

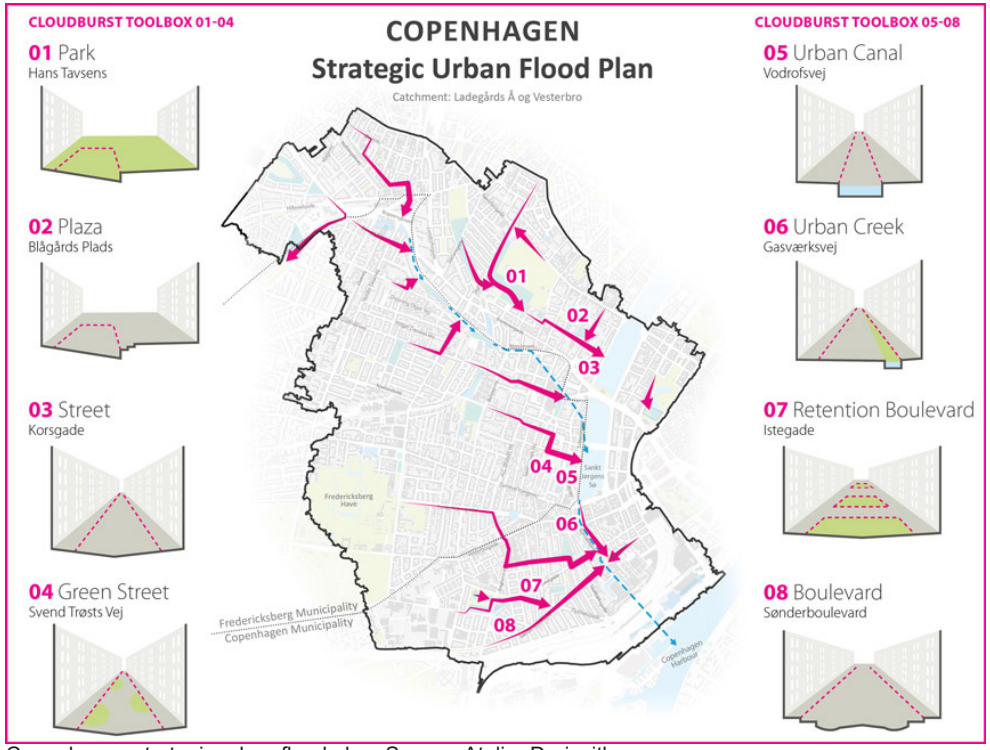
The heavy rain plan is based on simple principles, the main point is to keep rainwater on the ground for management and control, rather than increase the expensive cost of underground pipeline upgrades.

Waterlogging in Copenhagen Source: Atelier Dreiseitl

Waterlogging in Copenhagen Source: Atelier Dreiseitl



Copenhagen green and blue structure plan Source: Atelier Dreiseitl



Copenhagen strategic urban flood plan Source: Atelier Dreiseitl

This plan re-planned the green and blue structure of the entire city on a large scale, mainly following three principles:
1. Retaining rainwater in high terrain areas to protect the safety of low-lying areas;
2. Establishing reliable and flexible stormwater runoff discharge methods in low-lying areas;
3. Building rainwater runoff management in sub-lower areas.

Through these strategic plans, hotspots have been identified, and a series of storm management planning projects have been determined while taking into account other urban planning purposes. In this way, various projects in storm planning are related to, for example, transportation infrastructure improvement planning or urban renewal planning.

This green-blue structure strategy solves the problem of flood management, waterlogging, water pollution, and improves the environmental quality of the entire city and provide local residents with more usable green and blue spaces. At the same time, the entire structure is composed of small green and blue elements, such as boulevards, parks, water squares and so on, this multi-element model suffers the basis for a complex functional elastic system. In short, Copenhagen ’s new green-blue structure can be regarded as an urban infrastructure. It meets the needs of citizens ’entertainment, fitness, and transportation, and also provides a better living environment for other creatures. This is the development of sustainable design methods.

3.3 Literature Review

Green-Blue infrastructure

There are three main ways to solve urban water problems, grey, green and blue infrastructure. And Green-Blue infrastructure is the combination of planning, designing and engineering about green infrastructure and blue infrastructure.

Grey infrastructure refers to the human-engineered infrastructure for water resources such as water and wastewater treatment equipments, pipelines, reservoirs, seawalls and dikes. [26]

Green infrastructure planned networks of natural and semi-natural areas with other environmental features designed and managed to deliver different ecosystem services. (EU Commission 2013)

Blue infrastructure refers to water elements, like rivers, canals, ponds, wetlands, floodplains, water treatment facilities. [26]

Green-Blue infrastructure planned interconnected networks of natural and semi-natural areas, including water bodies and green and open spaces, that provide different ecosystem services. (Voskamp and Van de Ven 2015 and Ghofrani et. al 2016)

Compared with the single use of certain infrastructure, Green-Blue infrastructure combines two of them to plan a more complete urban water management system and ecosystem, thereby achieving the composite function and socio-economic benefits.

Grey infrastructure: Houtrib dike in the Netherlands Source: Van Oord

Project of Blue-Green infrastructure: Rotterdam's visionary flood and water management infrastructure Source: University of Nottingham

Blue-green infrastructure vision for a flood-resilient Juan Diaz watershed in Panamá City
Source: ONE Architecture & Urbanism

Compared with other methods, Green-Blue infrastructure has the following benefits:

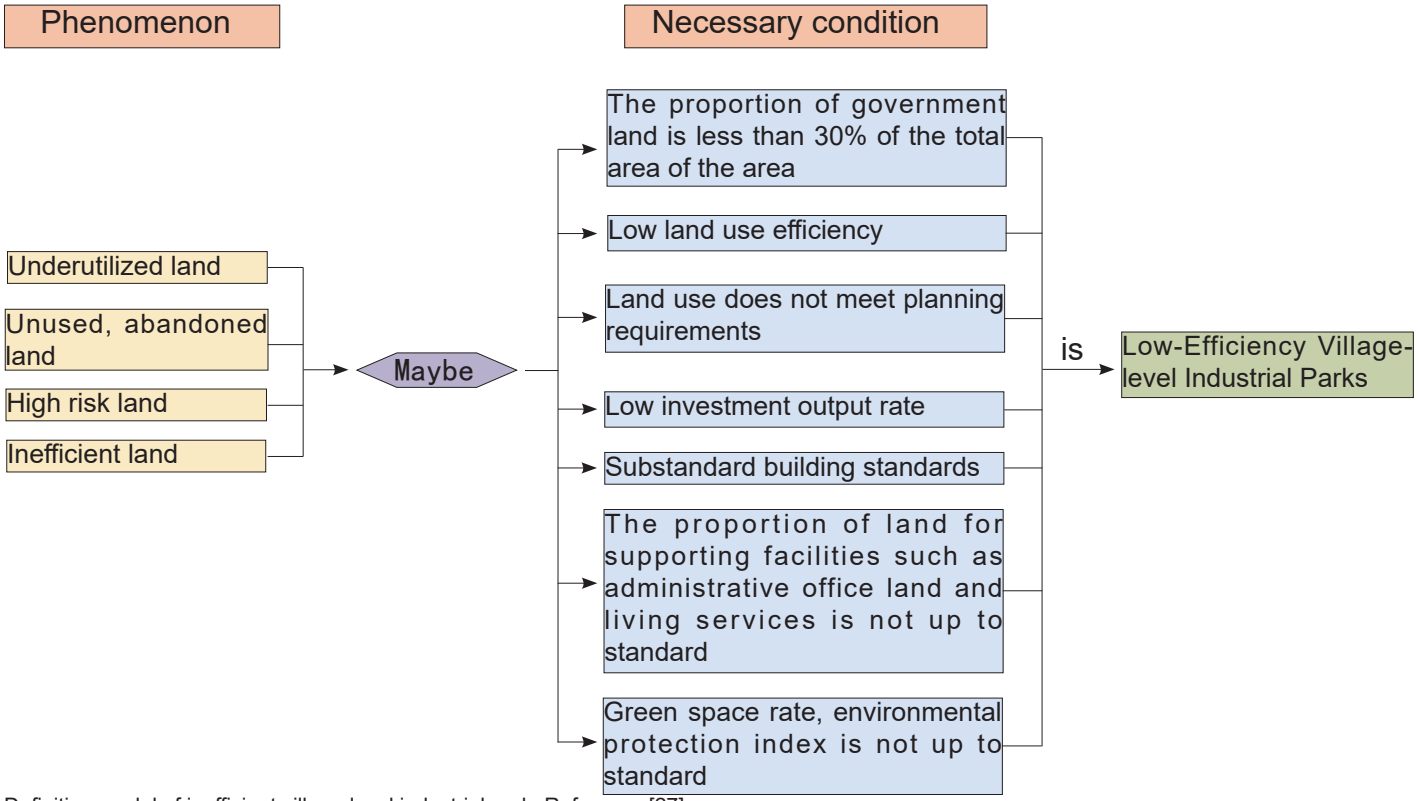
Economic aspect:
- Low investment and high return
- Construction is less difficult
- Energy saving
- Increasing the value of land in the surrounding area

Environmental aspects
- Improving the quality of the ecological environment
- Rich species diversity
- Improving water quality
- Strengthening water management and sewage management
- Improving air quality
- Regulating the urban microclimate

Social aspects:
- Creating a green entertainment space
- Landscape design improves city appearance
- Improving the quality of public space

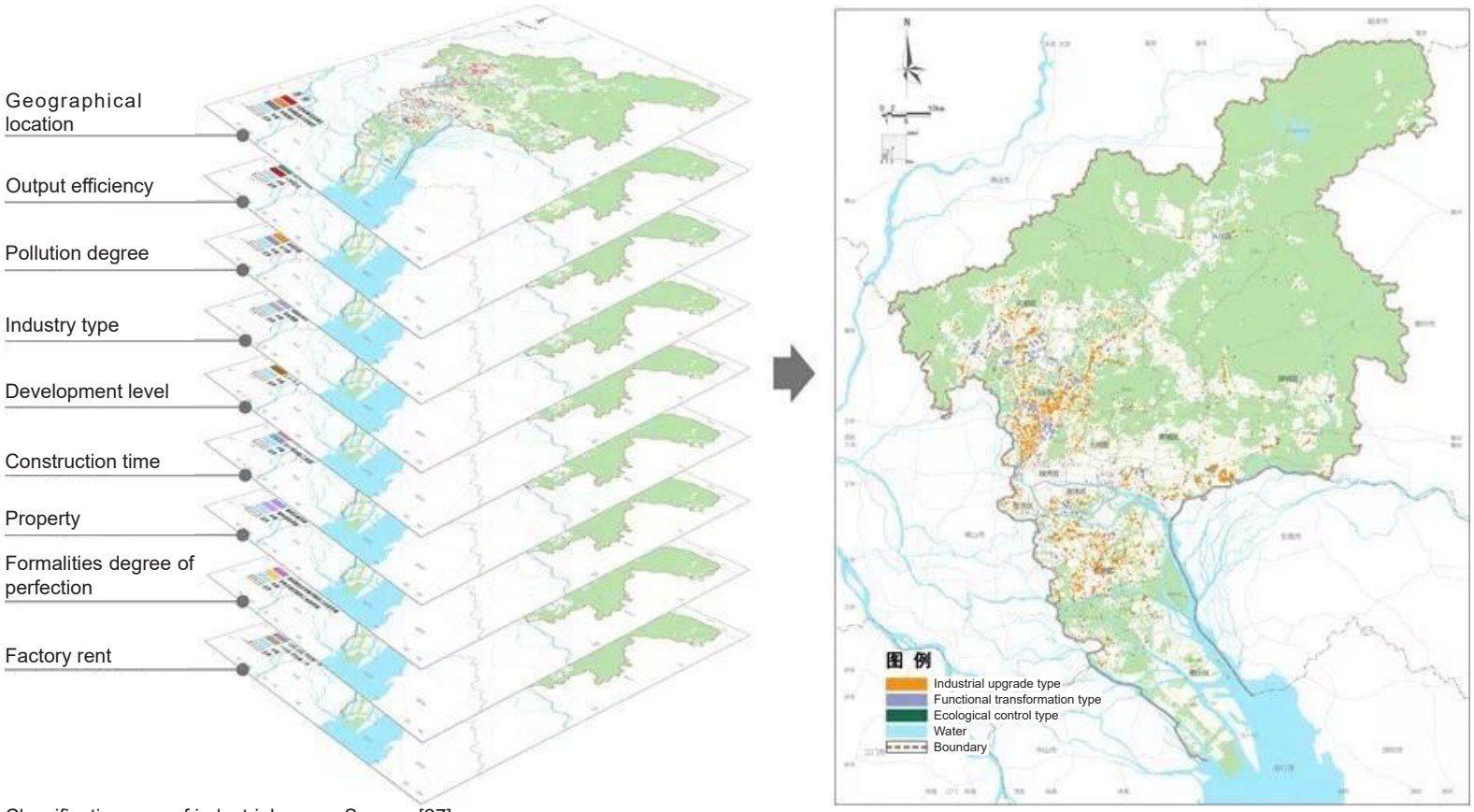
Simultaneously, Green-Blue infrastructure is a comprehensive idea, including planning, design, construction, and management. It is also a cross-scale concept, and people can find ways to adapt to this concept at different scales. The most important thing is that it integrates aspects of land use, landscape design, public management, transportation planning, etc. to achieve comprehensive, functional planning and design.

"Performance Evaluation-oriented" Thoughts on the Integration and Transformation of Low-Efficiency Village-level Industrial Parks: Taking Guangzhou as an Example



Definition model of inefficient village-level industrial park Reference:[27]

After assessing the village-level industrial zone, it will be divided into three categories: industrial upgrading, functional transformation and ecological control in combination with the space reform policy, and then develop differentiated planning measures. Among them, the comprehensive industrial performance of the industrial upgrading type is in the middle; the comprehensive industrial performance of the functional transformation type is low; the comprehensive industrial performance of the ecological control type is the lowest, and it is located in the main ecological control area. [27]



Classification map of industrial zones Source: [27]

Industrial upgrade: mainly located in important industrial blocks, it is a gathering area for future industrial development in each district. Independent upgrades are encouraged. The focus is on the upgrading industry, which promotes the improvement of land output efficiency and industry type.

Functional transformation: mainly located in the area of residential, office, commercial and other land use in the urban master plan, with good location and high land value. It is a gathering area for future service functions in various districts. Functional replacement is encouraged to be included in the whole village transformation. Changing industrial areas into commercial, residential, or public areas to promote the improvement of urban functions and improve the supporting facilities of urban public services.

Ecological control: mainly located in the gathering area where the future ecological land is continuously distributed in each district. The expansion of the village-level industrial park should be strictly controlled. For village-level industrial parks with scattered distribution, heavy pollution, and low output value, they should be mainly demolished and relocated, and methods such as the transfer of equity area and ecological compensation should be allowed to encourage the conversion of such village parks. [27]

3.4 Conclusion: Guiding Principle

Guiding principles for the establishment of a green-blue infrastructure:

1. Building a sufficiently large and well connected green-blue structure that supports the natural drainage system can relieve urban drainage pressure.

- On a large scale: Expand connecting green and blue network to retain rainfall
  Increase the green and water space at higher places and upstream to leave a part of rainwater to relieve the drainage pressure of low land.
  Increase the storage space (pond, water square...) and the permeability of the ground in low areas and downstream areas that are prone to water accumulation.

- On a smaller scale: Each green or blue space establishes flexible rainwater runoff discharge methods according to its own characteristics
  Sites with pollution problems also assume responsibility for purification.
  Sites lacking public spaces nearby also assume the responsibility of entertainment.

Guiding principles for industrial transformation:

1. Classified managing inefficient industrial areas.

- Industrial upgrading: Industrial areas mainly located in important industrial blocks.

- Functional conversion: Industrial areas located within the range of city expanding area. They have the location with convenient transportation and high land value, they are gathering areas for future service functions.

- Ecological protection: Industrial areas located in the future ecological protection area or have pollution. This type of conversion will give industrial sites the task of managing pollution and water purification.

2. Reuse functional conversion area and ecological protection area to build new green-blue structure.

Chapter 4

SPATIAL ANALYSIS

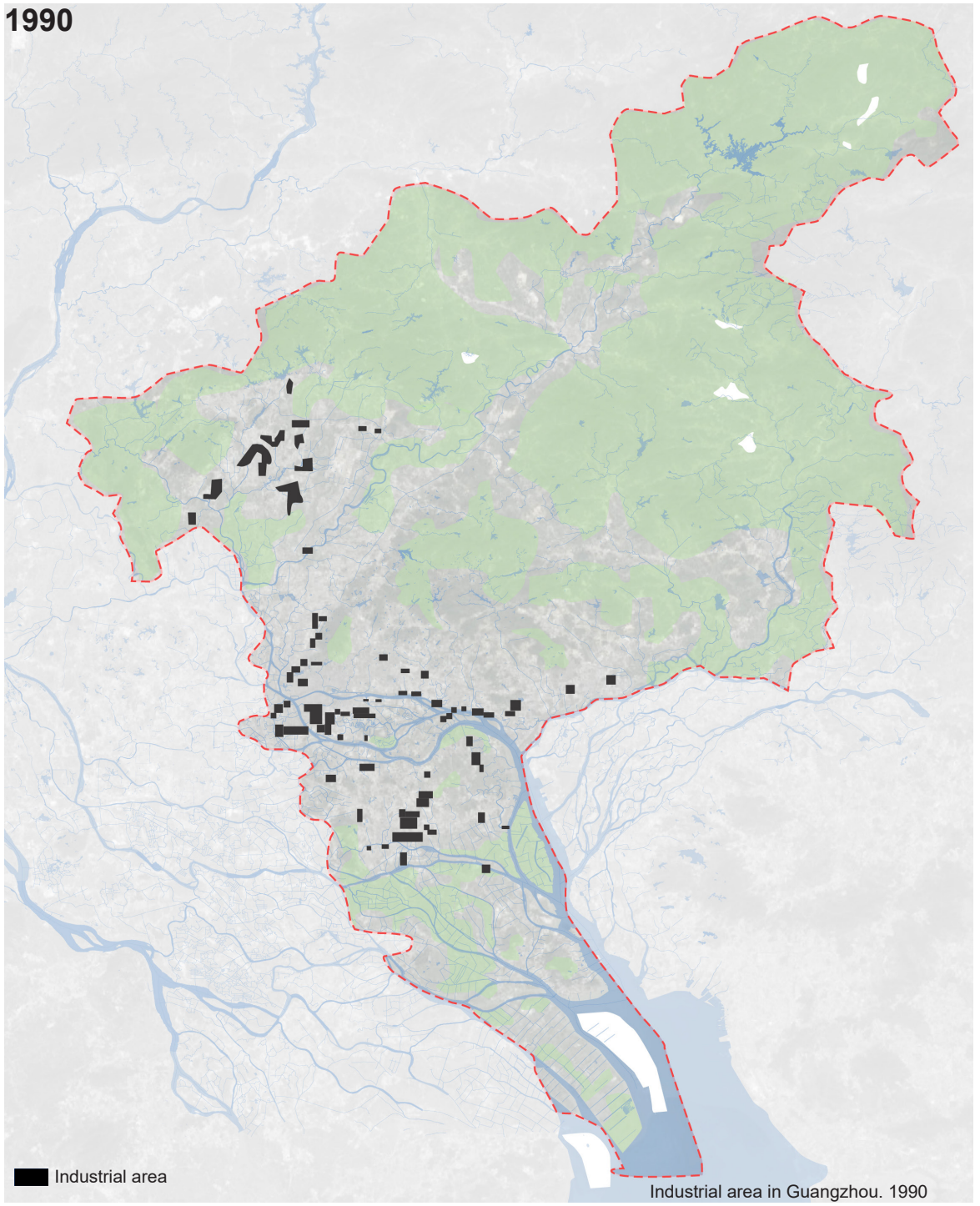
This chapter will conduct a cross-scale spatial analysis from the two scales of Guangzhou City and Panyu District. The analysis content includes the development process of the region, the detailed analysis is made from the perspective of waterlogging, industrial transformation, and urban expansion. Therefore, the cause of the waterlogging problem is analyzed and the design part is prepared.

4.1 Regional Scale- Guangzhou

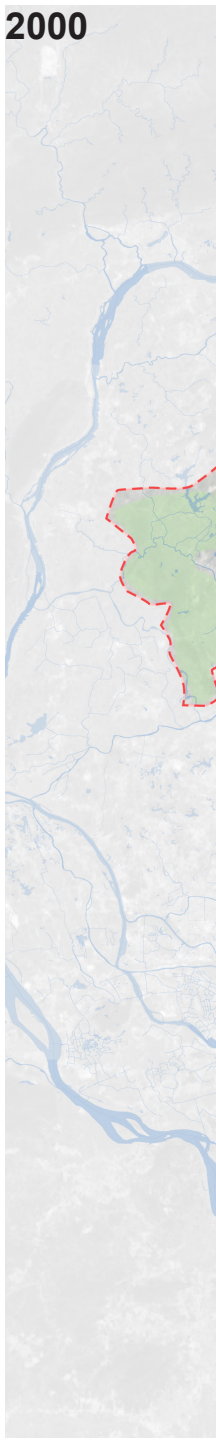
Industrial development

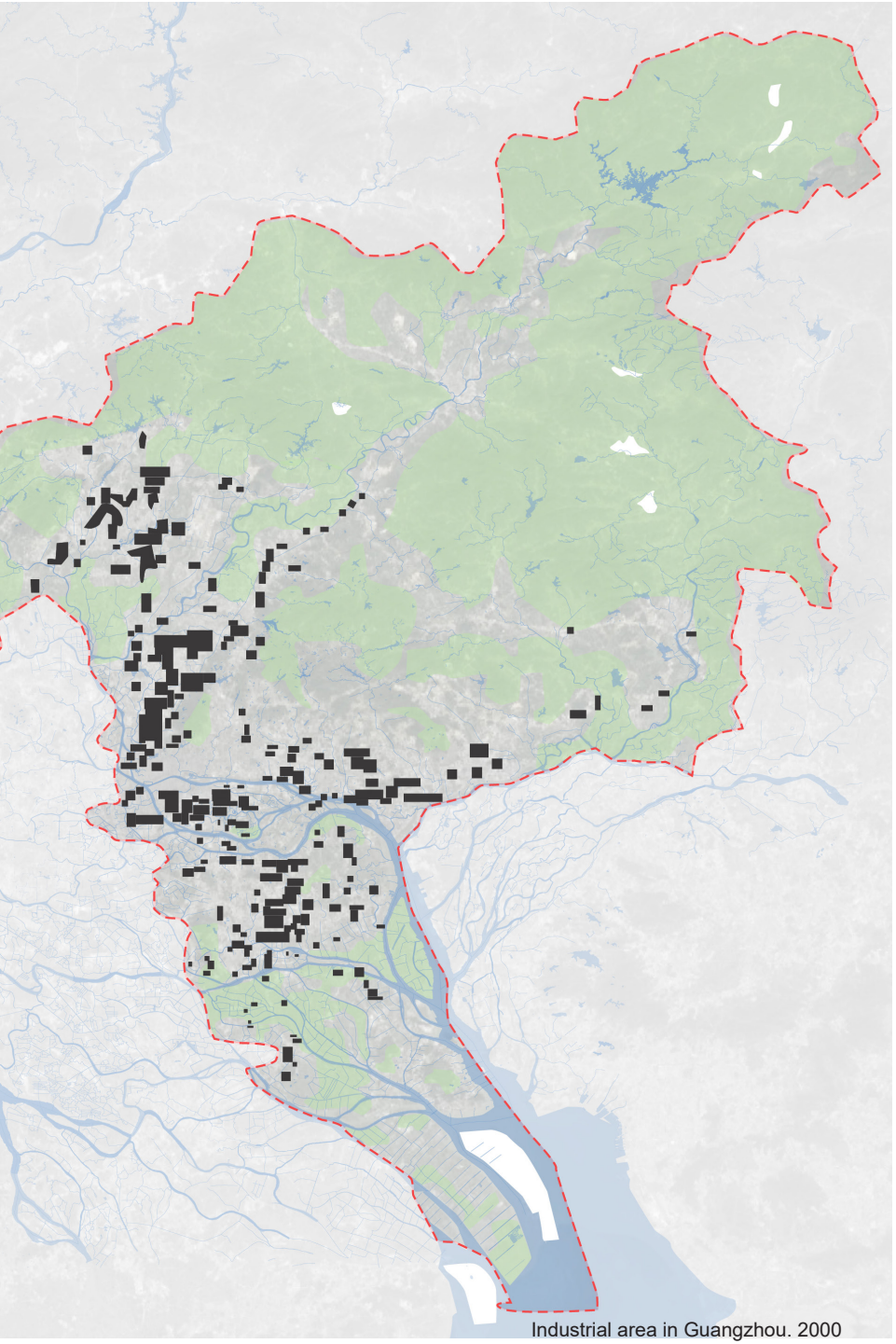
Guangzhou is the capital city of Guangdong Province, and it is one of the cities with the fastest urbanization and the fastest industrialization in the Pearl River Delta.

The figures show the distribution of industrial zones in Guangdong from 1990 to 2020. In 1990, the industrial zone was mainly constructed on the outskirts of the central city and along the Pearl River. The number of industrial zones continued to grow in 2000 and 2020 and continued to spread outside the central urban area.

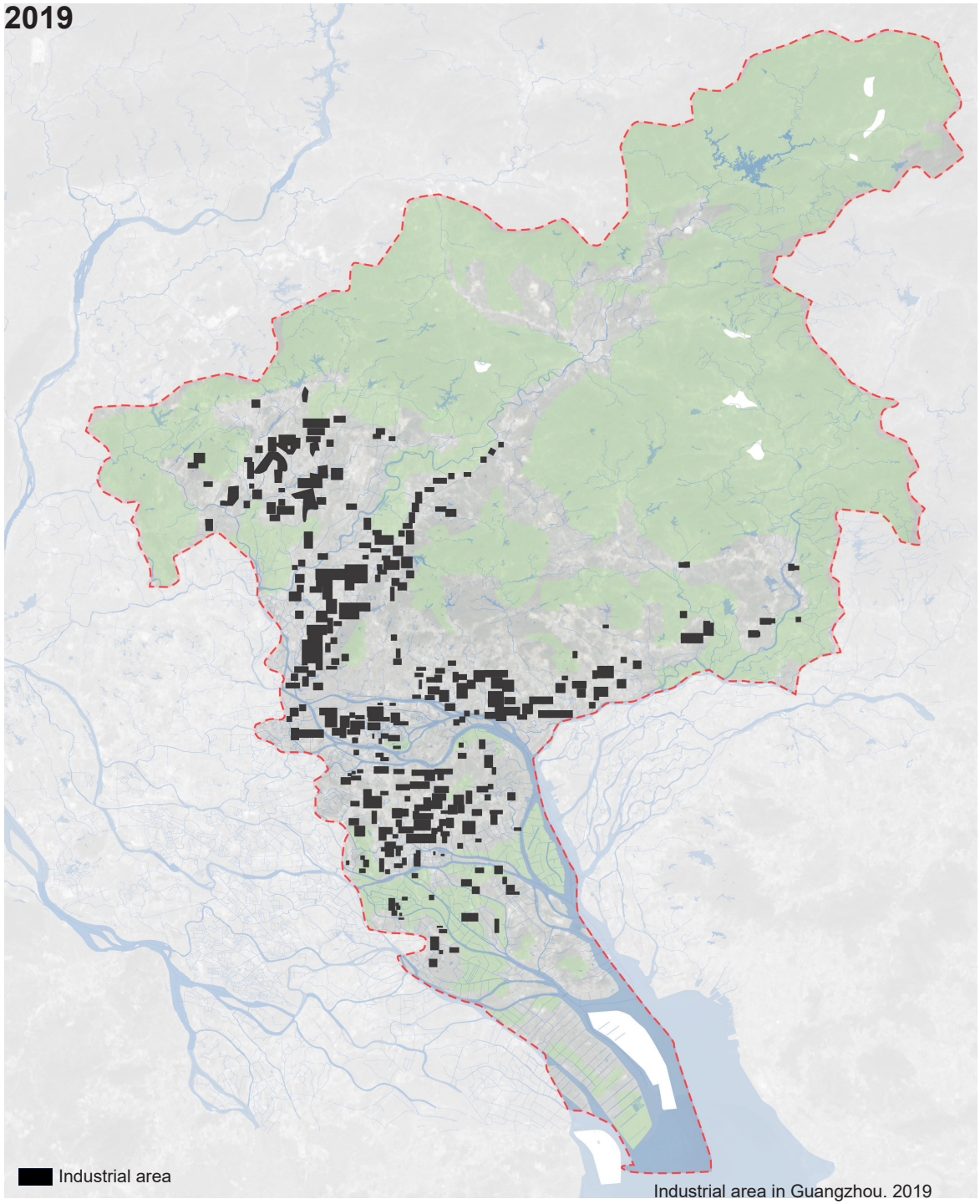


Industrial area in Guangzhou. 1990





Industrial area in Guangzhou. 2000

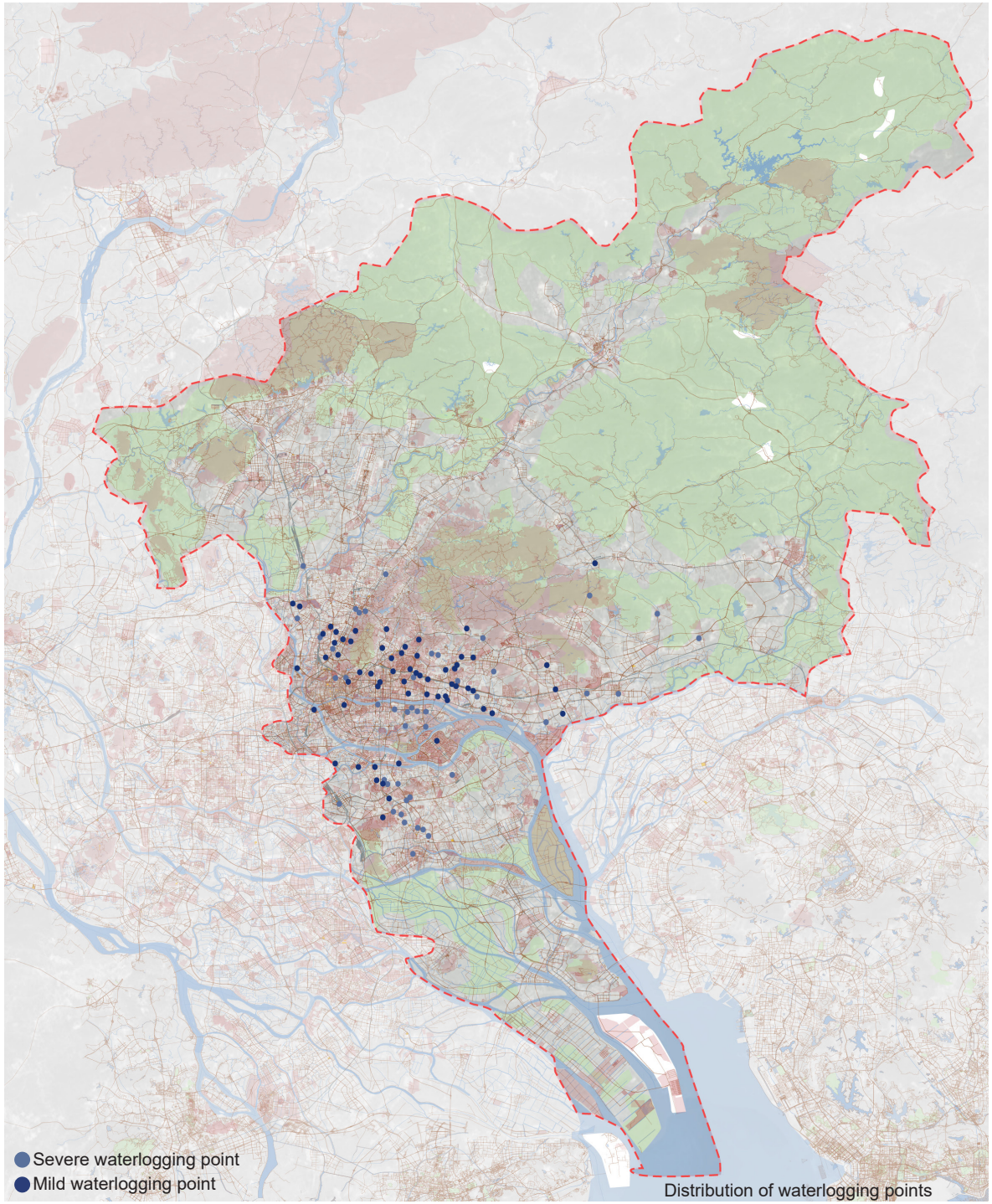


Industrial area in Guangzhou. 2019

Waterlogging

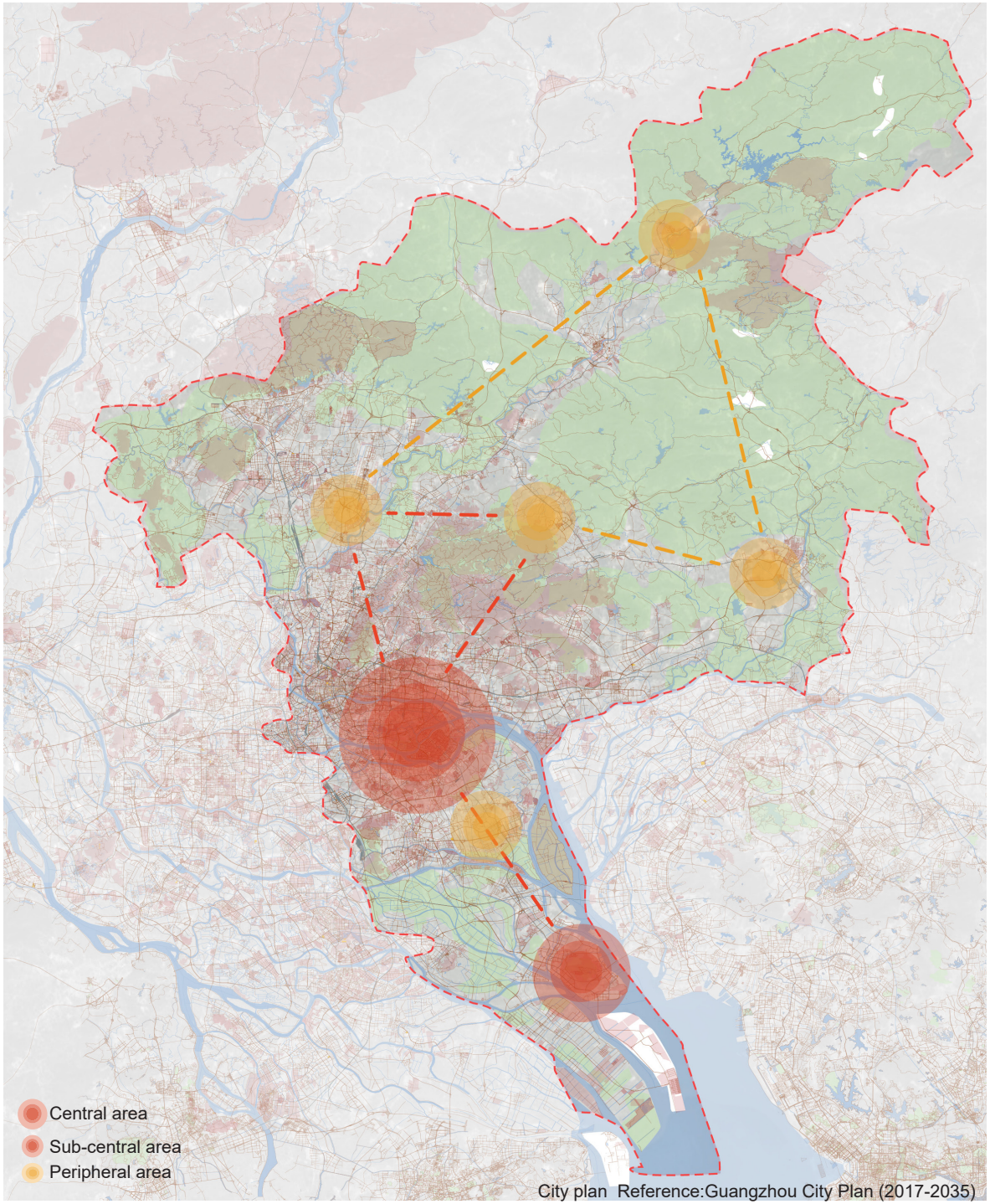
Source: China Daily

The figures show the distribution of waterlogging points in Guangzhou. The waterlogging points are mainly concentrated in the most densely constructed areas in the city center, Haizhu District and Tianhe District. In comparison, they are also distributed in other districts, but mostly lighter and along main roads.



Urban expansion

According to Guangzhou's urban planning, Guangzhou will develop in the form of a central area and multiple sub-centers, thereby strengthening cooperation and liaison among the various districts in the city. Simultaneously, the sub-center can also ease the land use pressure and population density of the center. Compared with the previous version of the urban plan, the center of Guangzhou has expanded from the original Haizhu District and the southern part of Tianhe District to the former two plus the northern part of Panyu District. The rapid urban expansion will increase waterlogging problems, especially in time of climate change.



City plan Reference:Guangzhou City Plan (2017-2035)

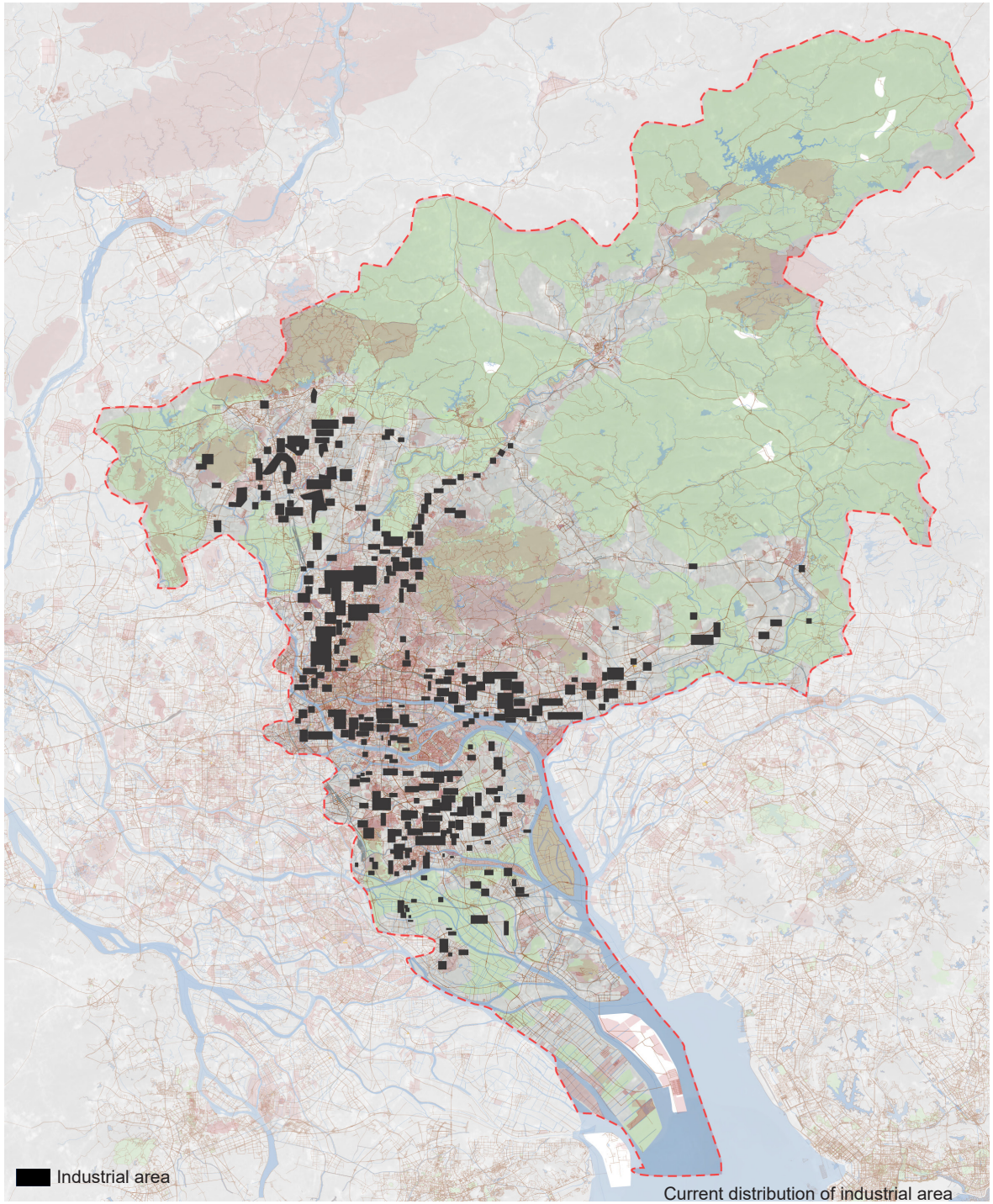
Industrial distribution

Source: China Daily

The main types of industrial development in the Pearl River Delta can be divided into two types according to scale, one is the industrial park of large enterprises, and the other is the village-level industrial zone.

The industrial park is mainly constructed in the suburbs, away from residential areas, covers a large area, has high land-use efficiency, and has complete supporting facilities and is mostly distributed near main roads or ports. This type of industry has high technological content, mostly for advanced manufacturing or technological innovation industries.

The village-level industrial zone is dominated by the collective investment model of the village collective. These industrial zones lack long-term planning for industrial upgrades and related supporting facilities. Most of the industrial enterprises that are introduced are low-level and uncompetitive industries. In the past, more than one village raised funds for joint construction. Due to the low cost of land and labor, it developed rapidly in the industrialization stage in Guangzhou.



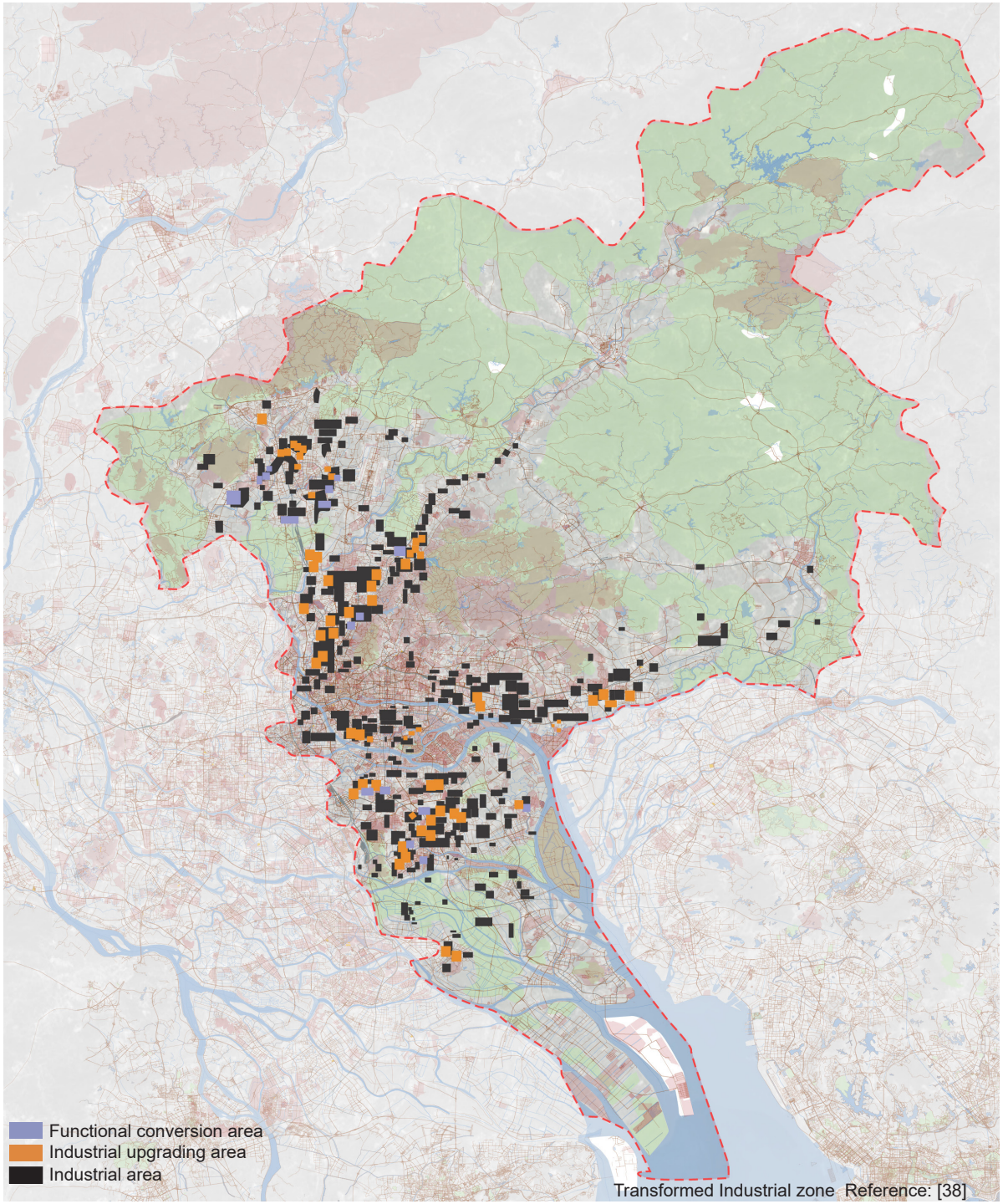
Industrial transformation

Source: China Daily

By analyzing the village-level industrial zones from the aspects of output efficiency, industrial type, pollution degree, development intensity, the village-level industrial zones that require the industrial transformation in Guangzhou are comprehensively obtained. [27]

These village-level industrial zones are in line with the above-mentioned construction characteristics of the industrial zone in the Pearl River Delta region. Due to convenient transportation, they are usually close to roads or rivers, and their location is affected by local policies. As can be seen from the map, most industrial transition areas are along the Pearl River. At the same time, due to restrictions on the construction of factories in central Guangzhou, most industrial areas are located in the suburbs, such as Panyu district in the south.

The location of the village also has the above-mentioned characteristics. Most of the industrial transformation areas are invested and constructed by the village. Therefore, the distribution of industrial transformation areas is what it looks like on the map.

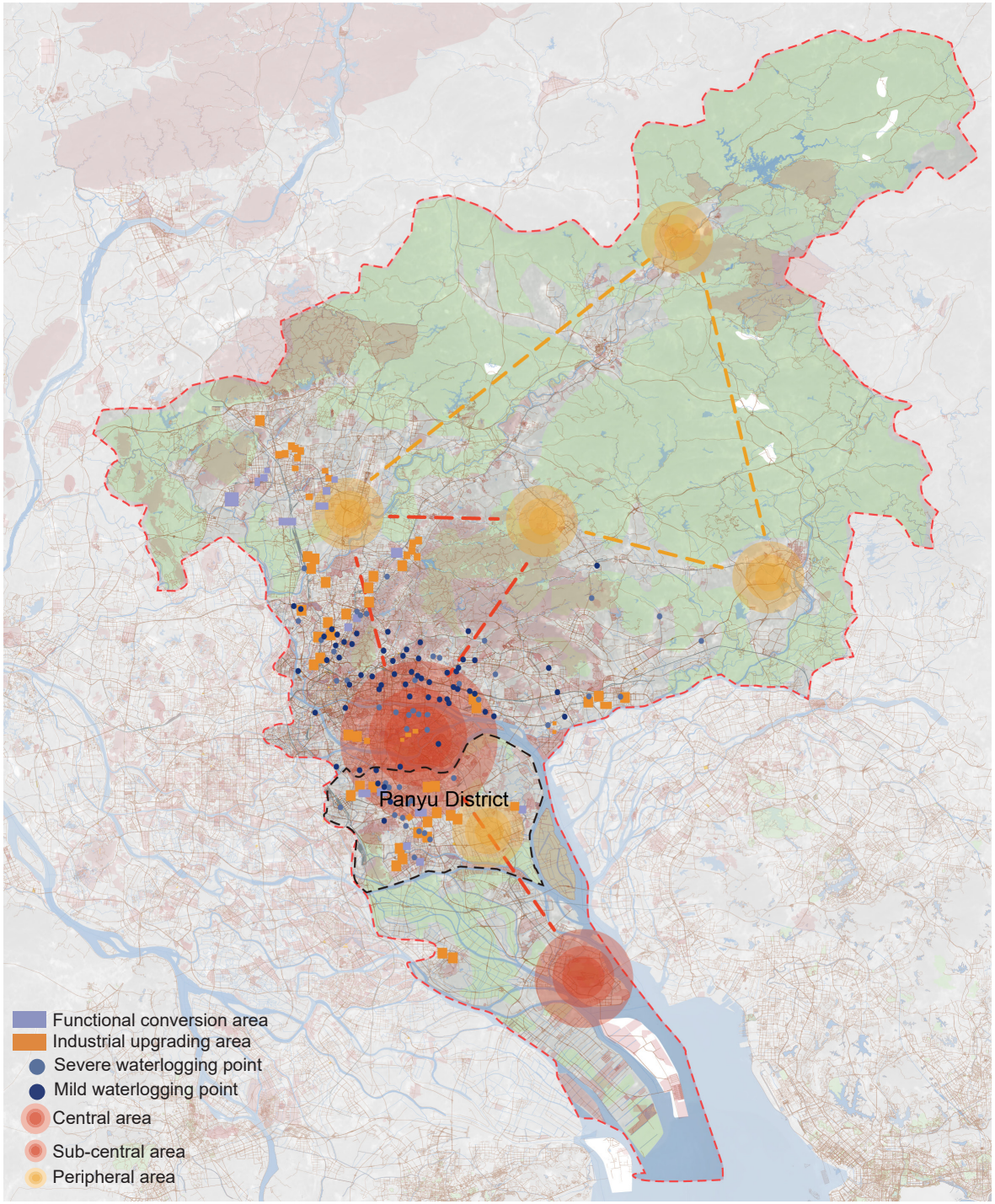


Transformed Industrial zone Reference: [38]

Summary

Based on the above analysis, Panyu District was once a suburb, and there are many village-level industrial areas that need to be transformed. Panyu is also an area where the waterlogging problem will increase. Finally, northern Panyu will become part of the central area. In this context, Panyu District is a place where opportunities and challenges coexist.

Waterlogging is existing and increasing due to urbanization and climate change. Industrial transformation is apparent and can be employed to establish a green-blue network to sustain the metropole. One of the districts that are dealing with these issues is Panyu. It is centrally located, shows a rapid urbanizing process and therefore faces increasing waterlogging and industrial transformation. Therefore, in future development, it is necessary and meaningful to find an adaptive development direction that can adapt to the needs of urbanization and reduce the cost of natural water bodies and green spaces.

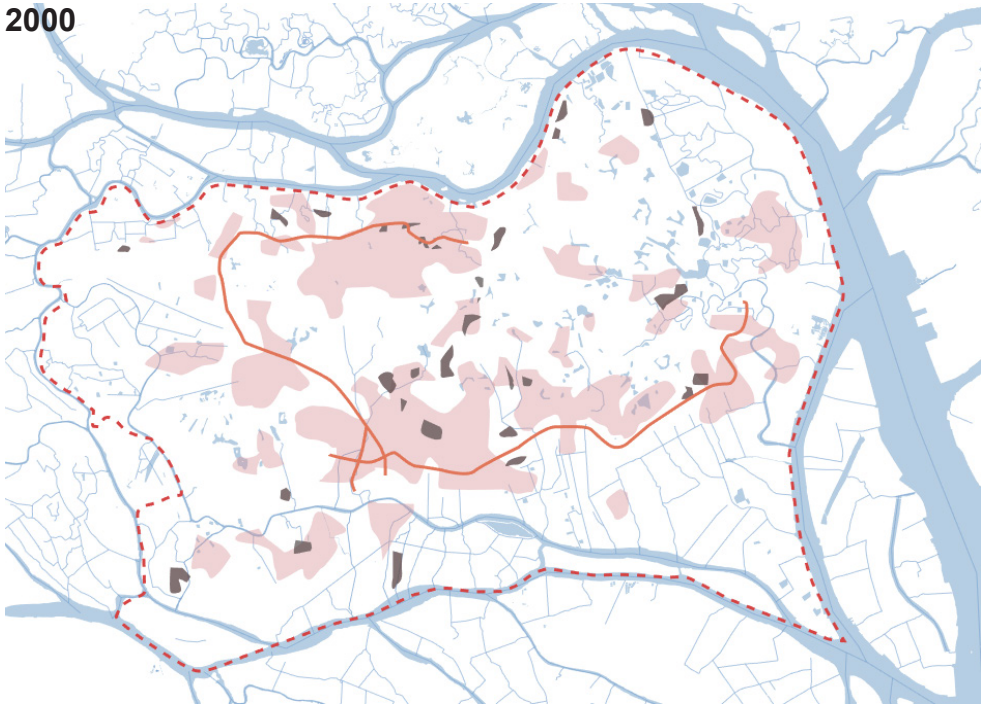


4.2 District Scale- Panyu

Panyu District, Guangzhou, is located in the southwest of Guangzhou, Guangdong province, close to Hong Kong, Macao, with a land area of 529.94 square kilometers and a registered population of 836,000. It has 11 sub-district offices and 5 towns under its jurisdiction. Panyu is a traditional industrial area with an early start and rapid development. The industry has developed rapidly since the late 1980s. Since 2000, the city was separated into districts and incorporated into Guangzhou, it has gradually become an important industrial area and product exports base of Guangzhou. Preferential policies of reform and opening up, low land price and advantages of close proximity to Hong Kong and Macao have created powerful conditions for the economic development of Panyu district in Guangzhou, but also brought the district, town, and village to run their own affairs and develop industrial parks, thus forming multi-level development.

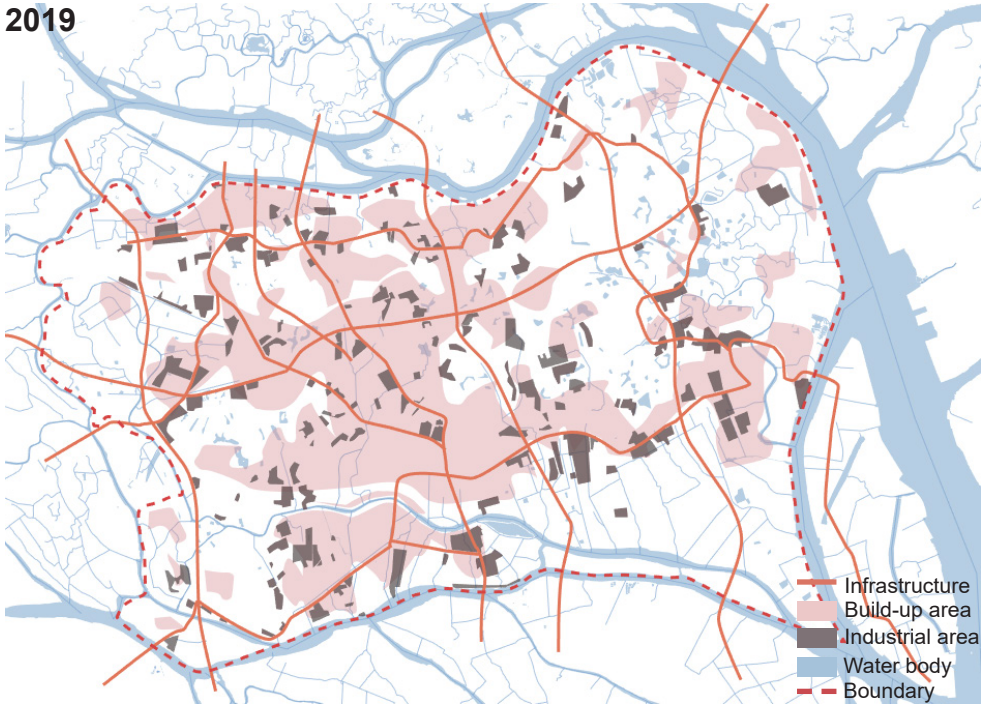
In May 1992, Panyu was set up as a city instead of the county, and in May 2000, it was set up as a district instead of the city. In 2005, Panyu area was divided into the new Panyu district and Nansha district. With the change of administrative division, the area of Panyu district has been shrinking. As a necessary condition for economic development, the land has become a scarce resource.

Urbanization and industrial development in Panyu



In this development process, Panyu's positioning has changed from an agricultural county in southern Guangzhou to a part of the Guangzhou metropolitan area, and its economic development model has also shifted from agriculture to mainly relying on industry and the tertiary industry. Panyu's industry has experienced several obvious changes. Initially, changing from light to heavy industry, before the 1970s by more than 90% is light industry, the light industry of the 1970s and 1990s than decline gradually to around 70%. In 2018, the percent of light industry has plunged to 23.9%.

The second period is from decentralized operation to concentrated development. In 2018, the output value of industrial enterprises above the scale of Panyu motor city totaled 61.423 billion yuan, accounting for 33.5% of the total industrial output value above the scale of the whole region. The third is the shift from labor-intensive to technology-intensive. Labor-intensive industries, such as garment manufacturing and textile printing and dyeing, are gradually decreasing, while high-tech industries, such as automobiles, electrical machinery, general equipment, communication equipment, and chemical industry, are gradually increasing.



Simultaneously, due to the failure to properly plan the village-level industrial parks at the beginning, the layout of the parks was chaotic and pollution was a problem. In general, in the face of the continuous development of market economy and regional competition, Panyu district has higher and higher requirements for economic development, not only the pursuit of speed but also the pursuit of quality. However, the development status of Panyu village-level industrial park is far from meeting the development needs of Panyu as a core metropolitan area.

The four pictures through time reflect the rapid urbanization and industrialization of the Panyu District in the past three decades. The Panyu District in 1990 looked like an island dominated by natural landscapes. Around 2000, Guangzhou began to promote the transfer of industrial areas from the center to suburbs, and Panyu began rapid development. In the next two decades, Panyu has changed from a natural island to a city today due to the continuous expansion of Guangzhou and the expansion of the city center.

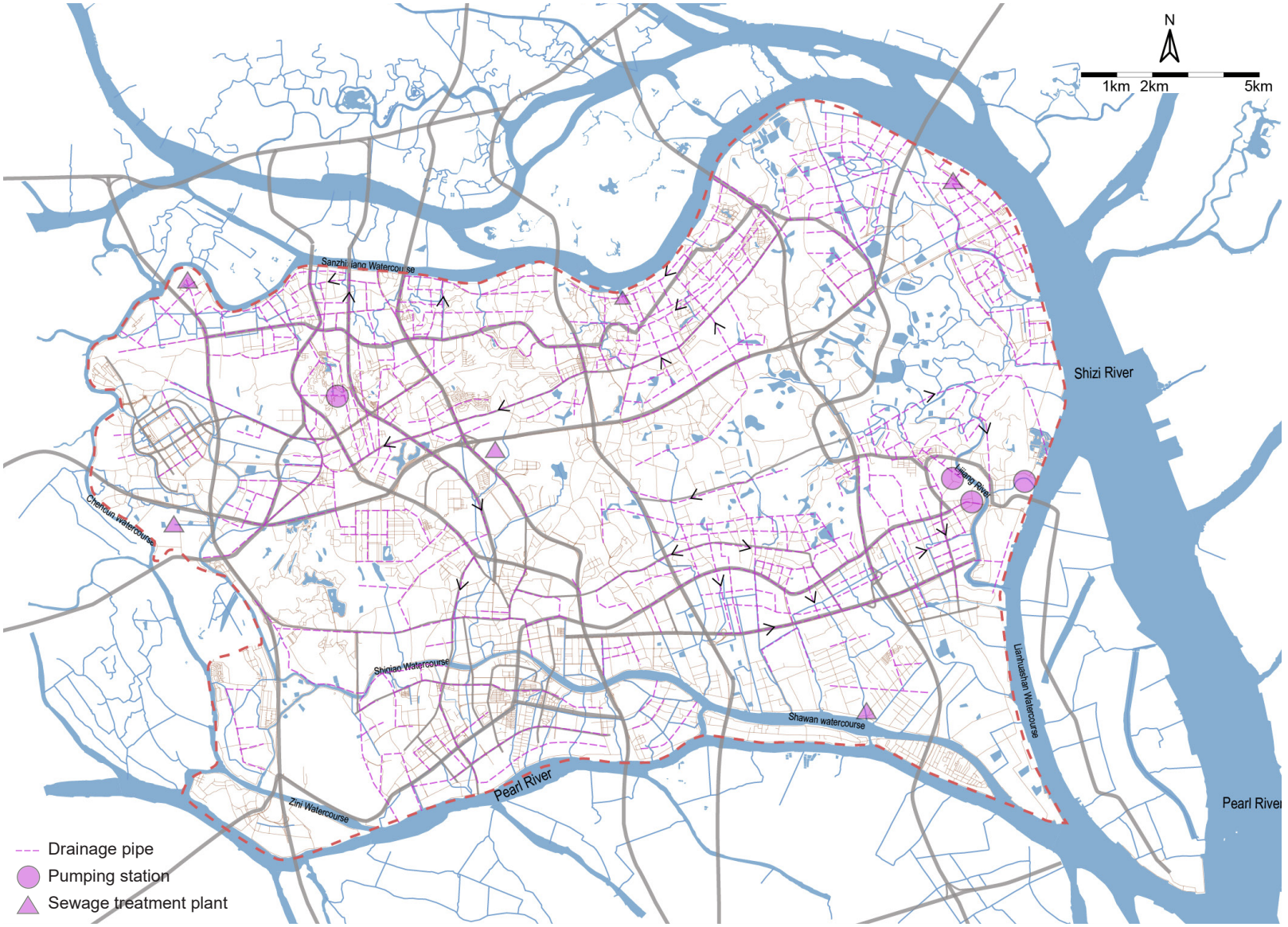
Waterlogging problem analysis- Natural landscape

Due to urbanization, some green spaces in Panyu District were converted to construction land.

The current green coverage rate in Panyu is 37.8%. Among them, forests account for 18.9%, agricultural land and wetlands 66.1%, and parks and green buffer areas 15%.

Compared with the previous green space coverage rate of more than 80%, the current green spaces and water bodies are not enough to carry the rainfall.

Waterlogging problem analysis- Drainage facility



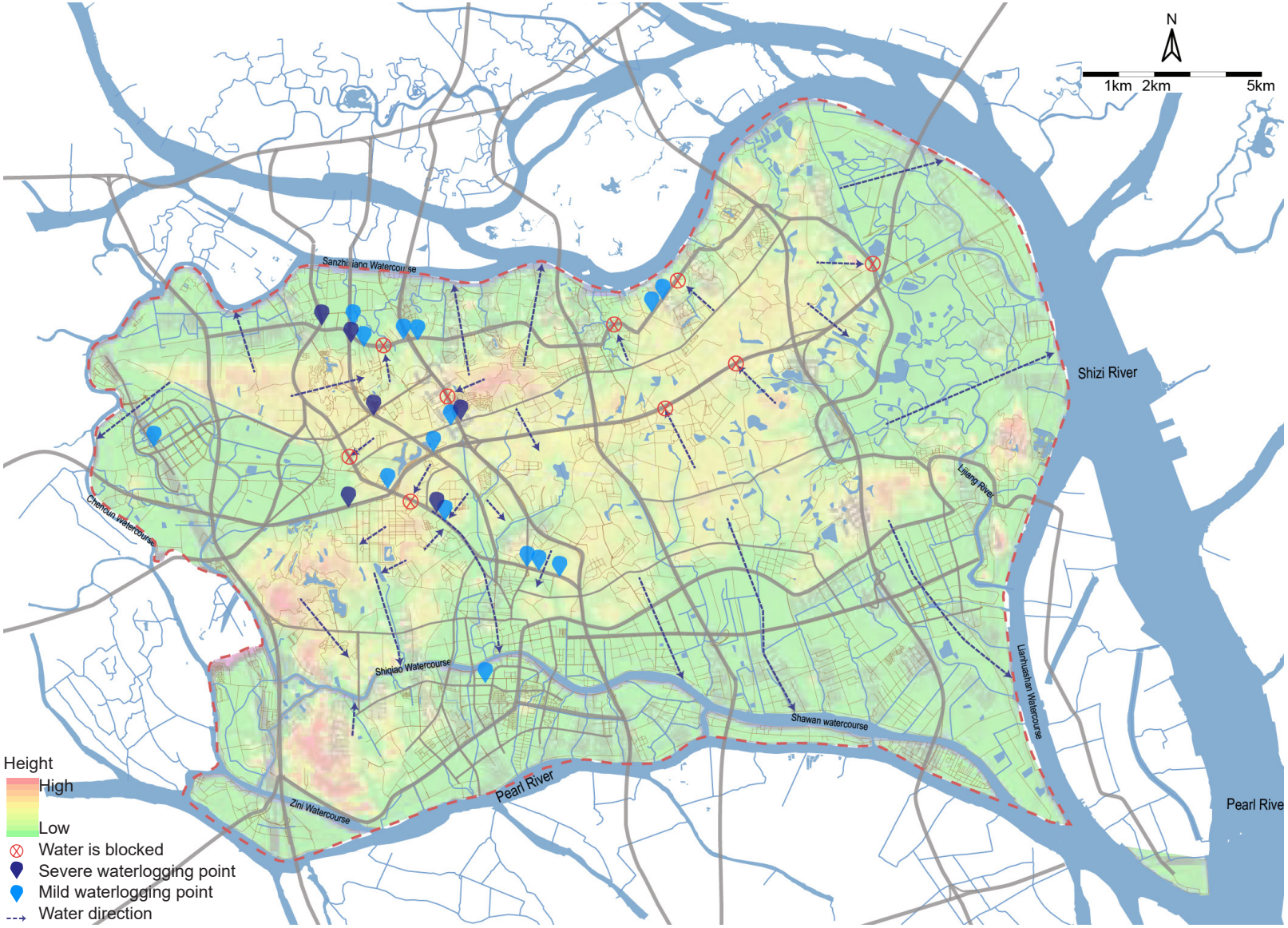
Panyu's underground drainage network and sewage treatment plant were constructed recently decades, due to the limited planning and construction capacity at the time of initial construction, the underground drainage system is mainly based on pipelines rather than underground drainage tunnels, so the underground drainage capacity is limited.

What's more, the pipelines are mainly distributed in areas with high building density, which means other areas are lack of underground drainage planning.

Waterlogging problem analysis- Water flow with natural topography

The map illustrates the natural drainage following the terrain when the ground is unobstructed. Most of the water will flow to main water valleys. From the hills, rainfall is gathered streams in the valleys and transported to the river.

Waterlogging problem analysis- Natural water flow blocked by highway

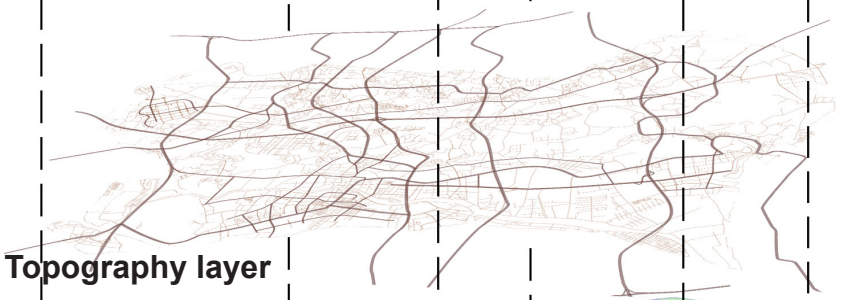


Different from the previous picture, the road infrastructure on the ground obstructs the natural drainage direction and cause the waterlogging phenomenon.

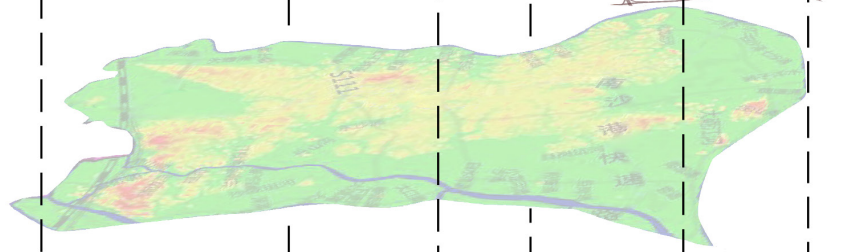
Waterlogging problem analysis- Summary

Built-up area layer

Infrastructure layer

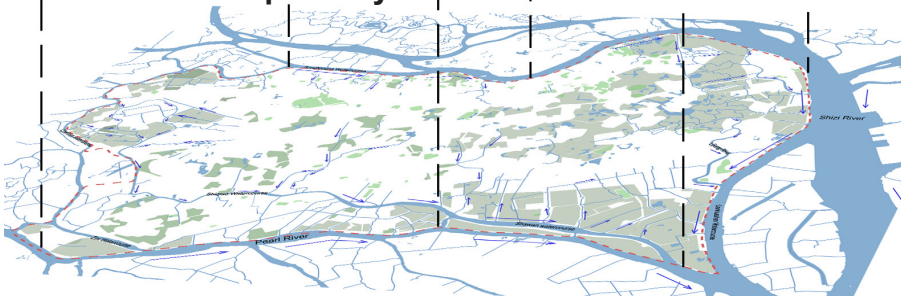


Topography layer

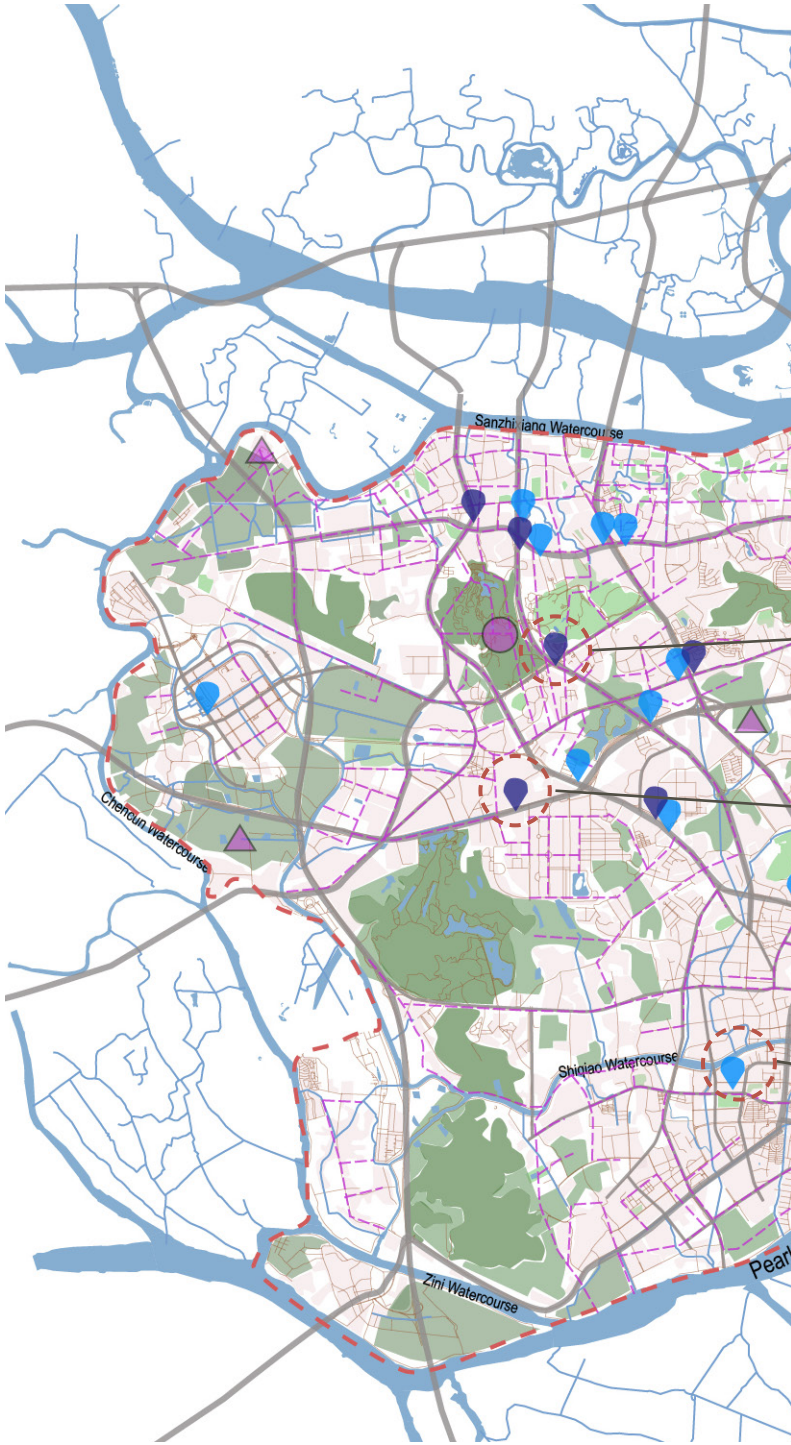


Drainage facility layer

Green and blue space layer

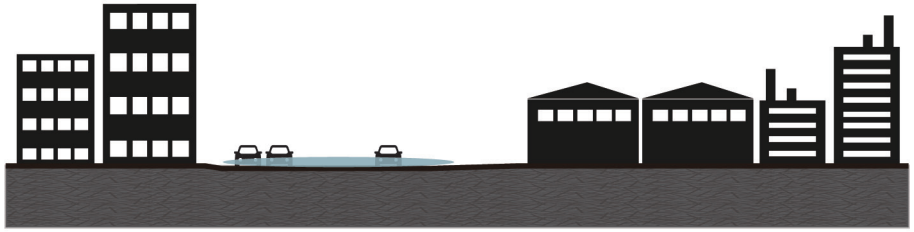


Layer analysis shows several factors that affect waterlogging. Among them, the topography and infrastructure are the two major factors causing waterlogging. The water flow that should flow from high to low and finally into the river is obstructed by roads, forming waterlogging. In addition, the built-up area has accumulated water due to impervious ground.

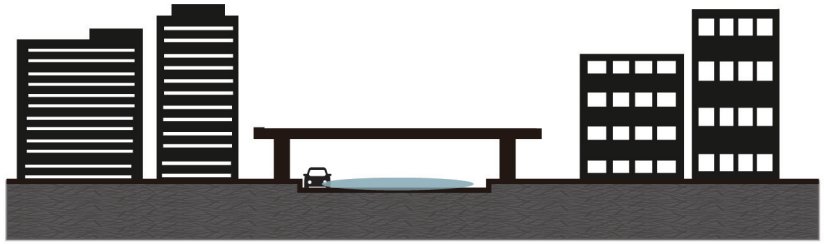


Typical waterlogging situations in Panyu

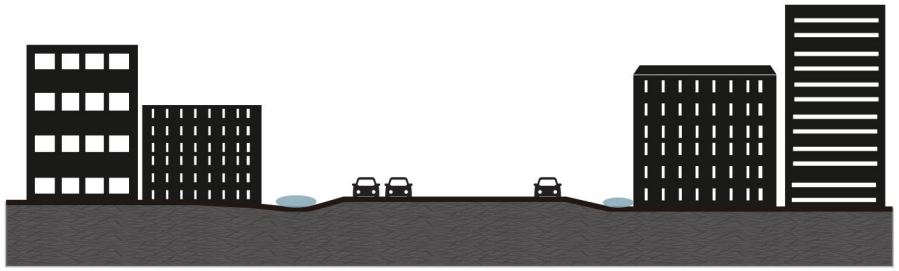
Waterlogging on the lower road



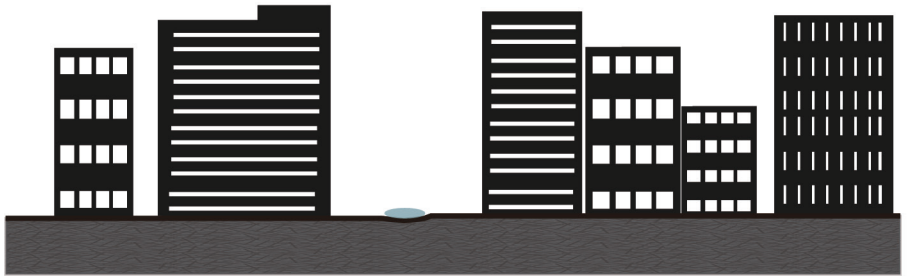
Waterlogging in the tunnel



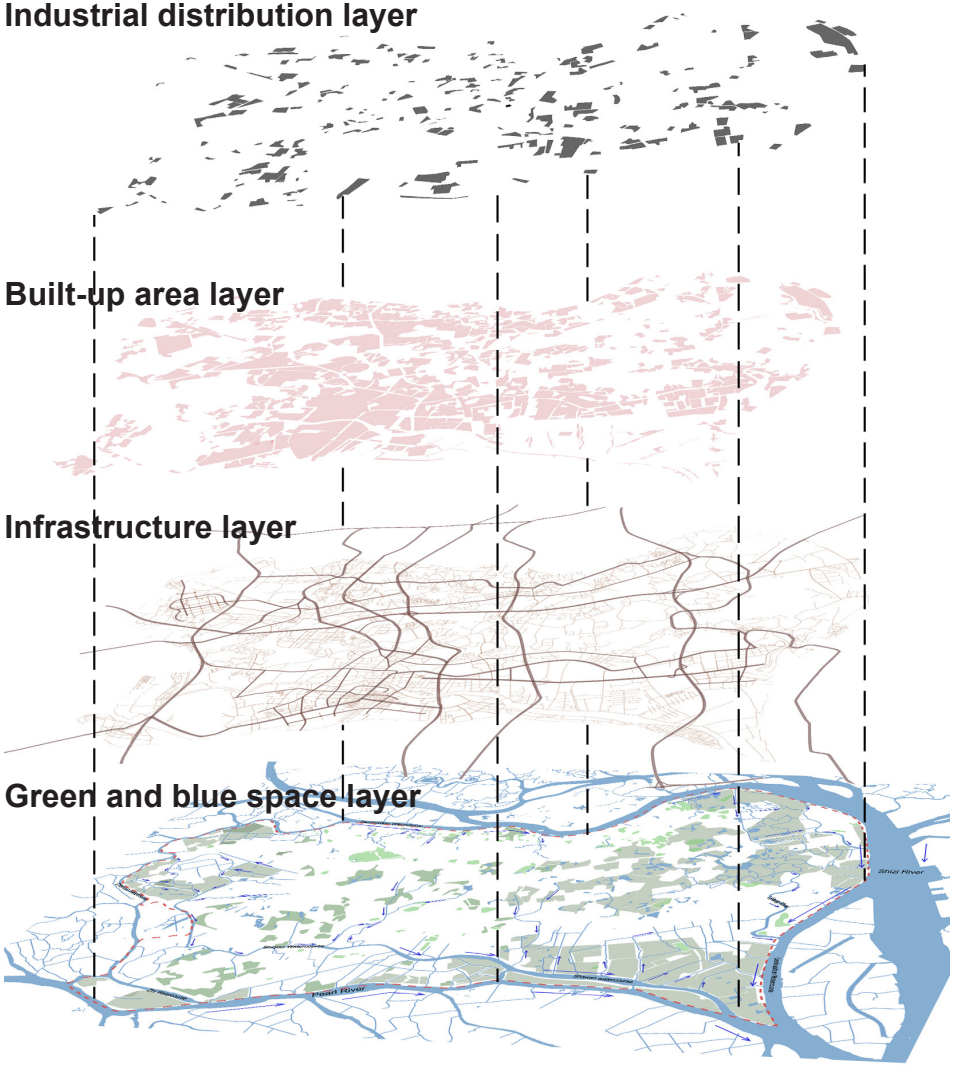
Waterlogging on sides of the road



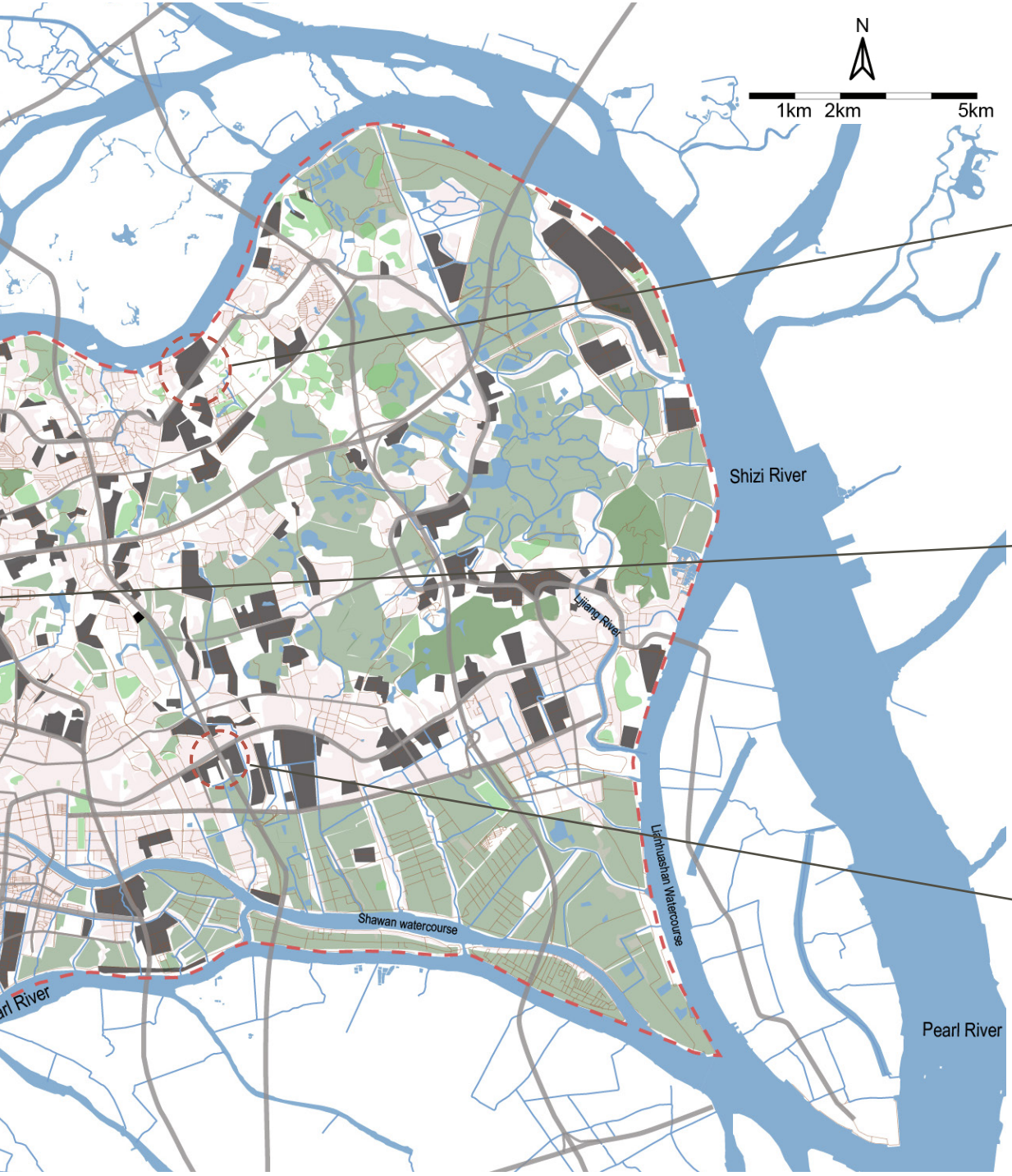
Waterlogging in areas with dense construction



Industrial distribution



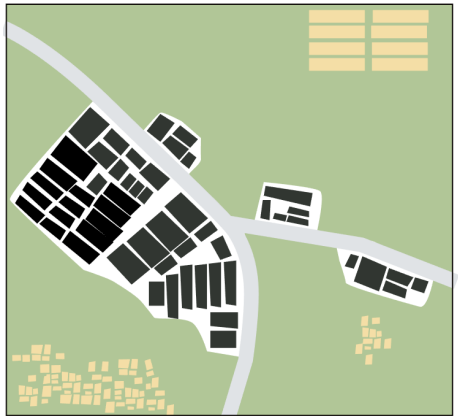
In this map, all the existing industrial areas are mapped. The distribution of industrial areas is mainly affected by traffic and water systems. Large-scale industrial parks are generally far away from built-up areas, and smaller scales are scattered among built-up areas.



Industrial park near the dock

Village-level industrial zone close to the road

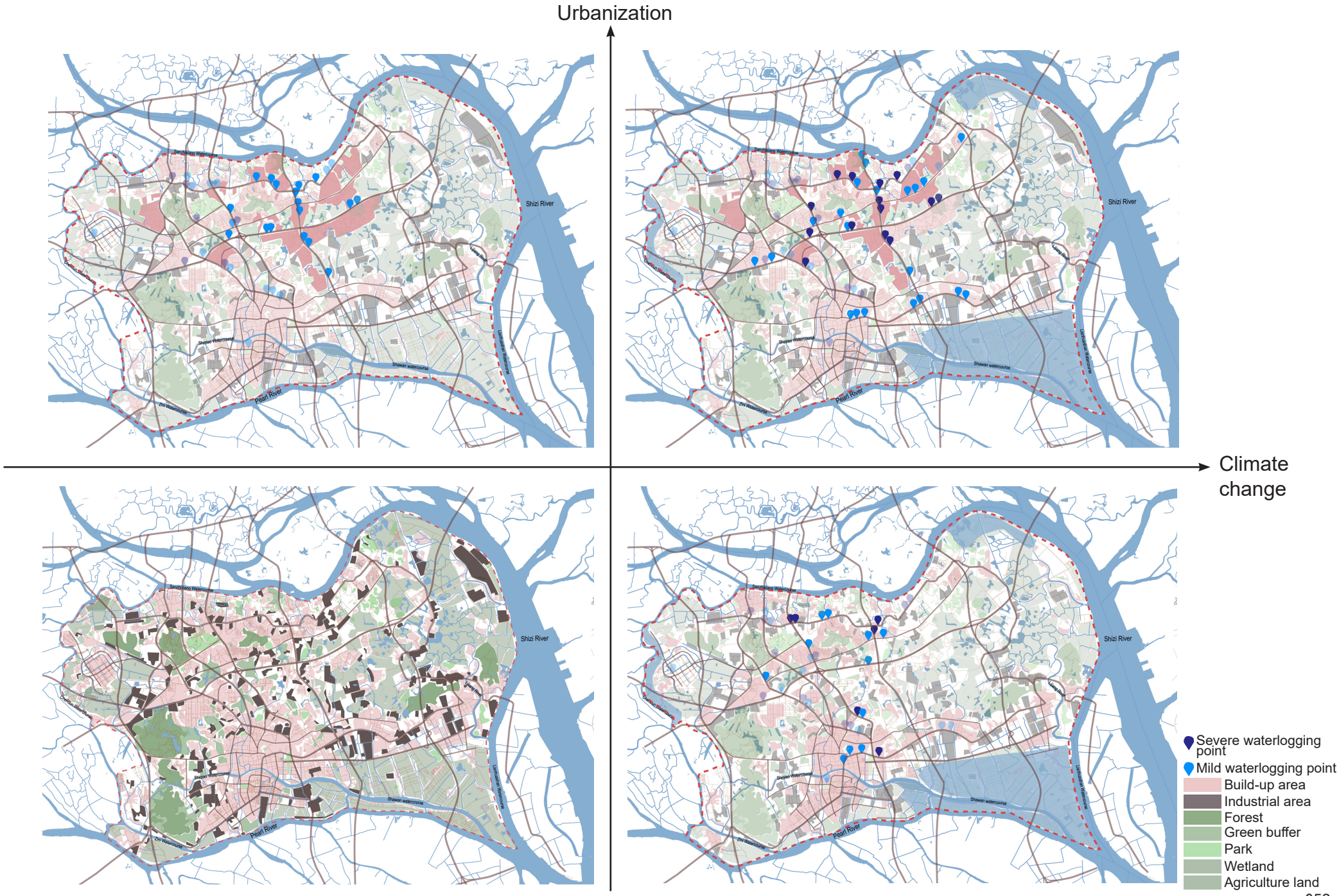
Industrial park near the road



Scenarios of development in Panyu

The future development direction of Panyu District will be affected by many factors, urbanization and climate change are two of the most important factors. At the same time, the different development directions of the two will make Panyu's future have different possibilities. The necessity of scenario analysis is to show the extreme possible futures. Although only one of them is the most likely in the end, other scenarios can show more ideal or worse possibilities which help the author to find the future directions that need to be avoided or need to be promoted. Addressing and testing extreme scenarios will give more insight into the tipping points for spatial design and therefore make the final design more robust.

Taking urbanization and climate change as the two main factors affecting the future development of Panyu District, four development directions are analyzed. Case 2 is most likely to occur because urbanization in Guangzhou continues and climate problems will increase. Compared with other cases, case 2 needs to face the dual challenges of urbanization and climate. In this envisioned future, the built-up area will still increase and occupy the original green space. Increased extreme weather and reduced permeable surfaces will cause more and more serious waterlogging problems. Sea level rise will cause flooding areas in low-land in Panyu.

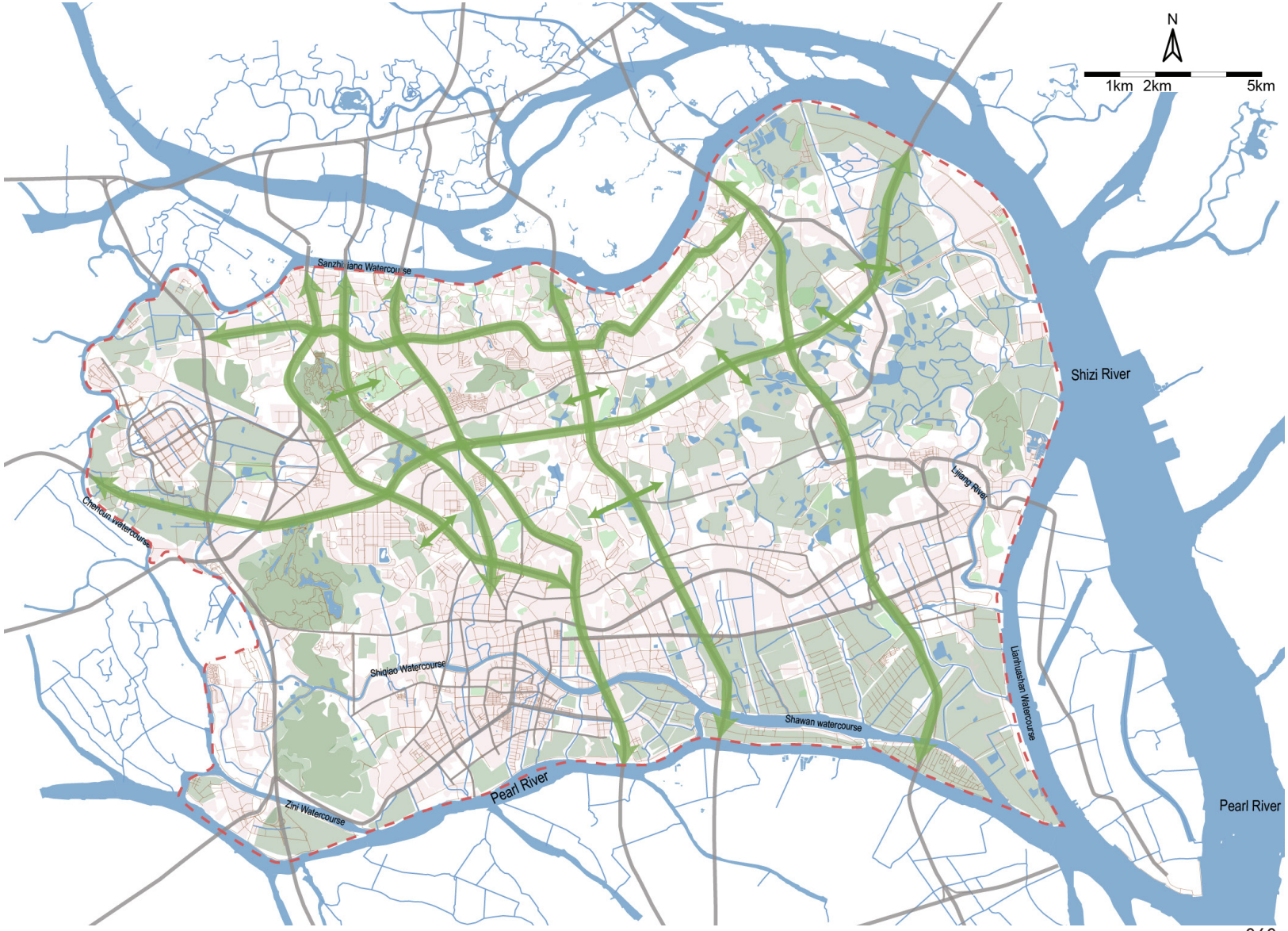

Urbanization
Climate change
Shizi River
Pearl River
Shawan watercourse
Severe waterlogging point
Mild waterlogging point
Build-up area
Industrial area
Forest
Green buffer
Park
Wetland
Agriculture land

4.3 Design Strategy

Expanding and connecting Green-Blue infrastructure

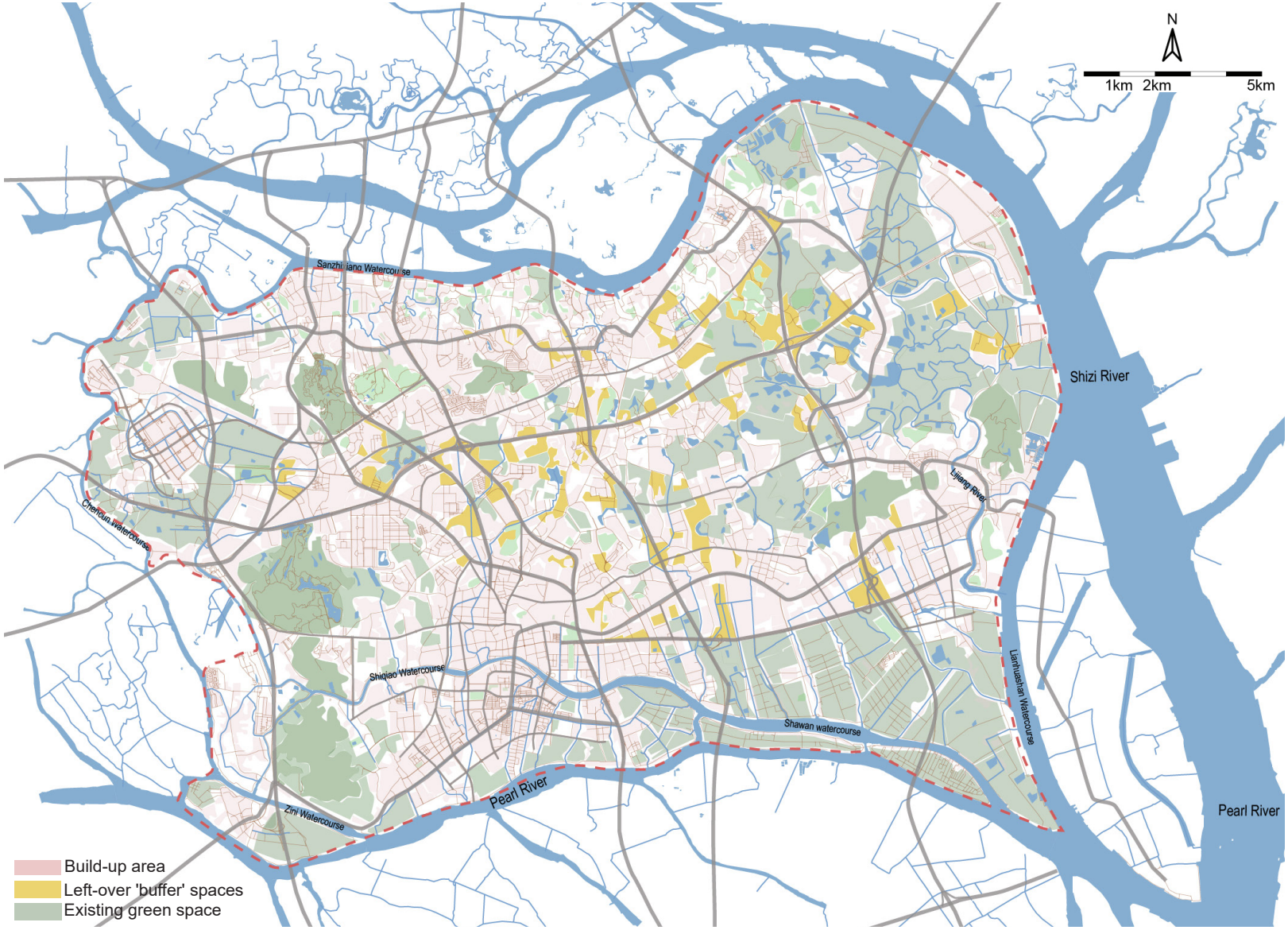
After the previous analysis, it can be seen that most of the waterlogging occurred near the main roads. Therefore, the new green-blue structure first needs to find potential spaces along the main road following the guiding principle of 'landscape as infrastructure'.

After having the basic linear structure along the main road, add some structure to cross the obstacles(roads) and connect the green spaces on the sides of roads to ensure the smooth flow of water.



A brief explanation and research question: how and where can the Green-Blue infrastructure be expanded?

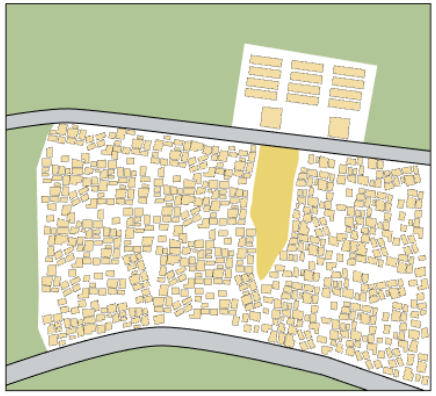
Potential space 1:
Left-over green buffer spaces



The figure shows the existing left-over buffer spaces are found.

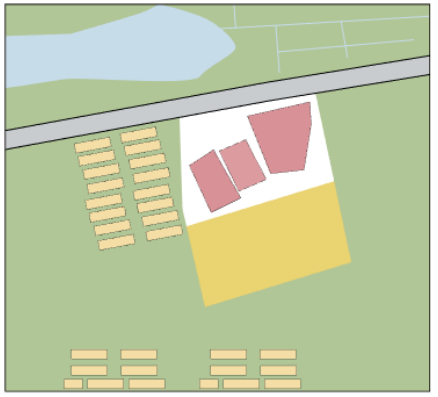
By activating current left-over 'buffer' spaces in some low dense area, like between neighborhoods and along roads, around road crossing, green spaces can be created to increase water capacity and slow down runoff in the upstream area and green buffer along the road is good for drainage, water purification, and noise reduction.

Pictures of left-over green "buffer" spaces Source: The Paper



"Buffer" space between villages

"Buffer" space between roads

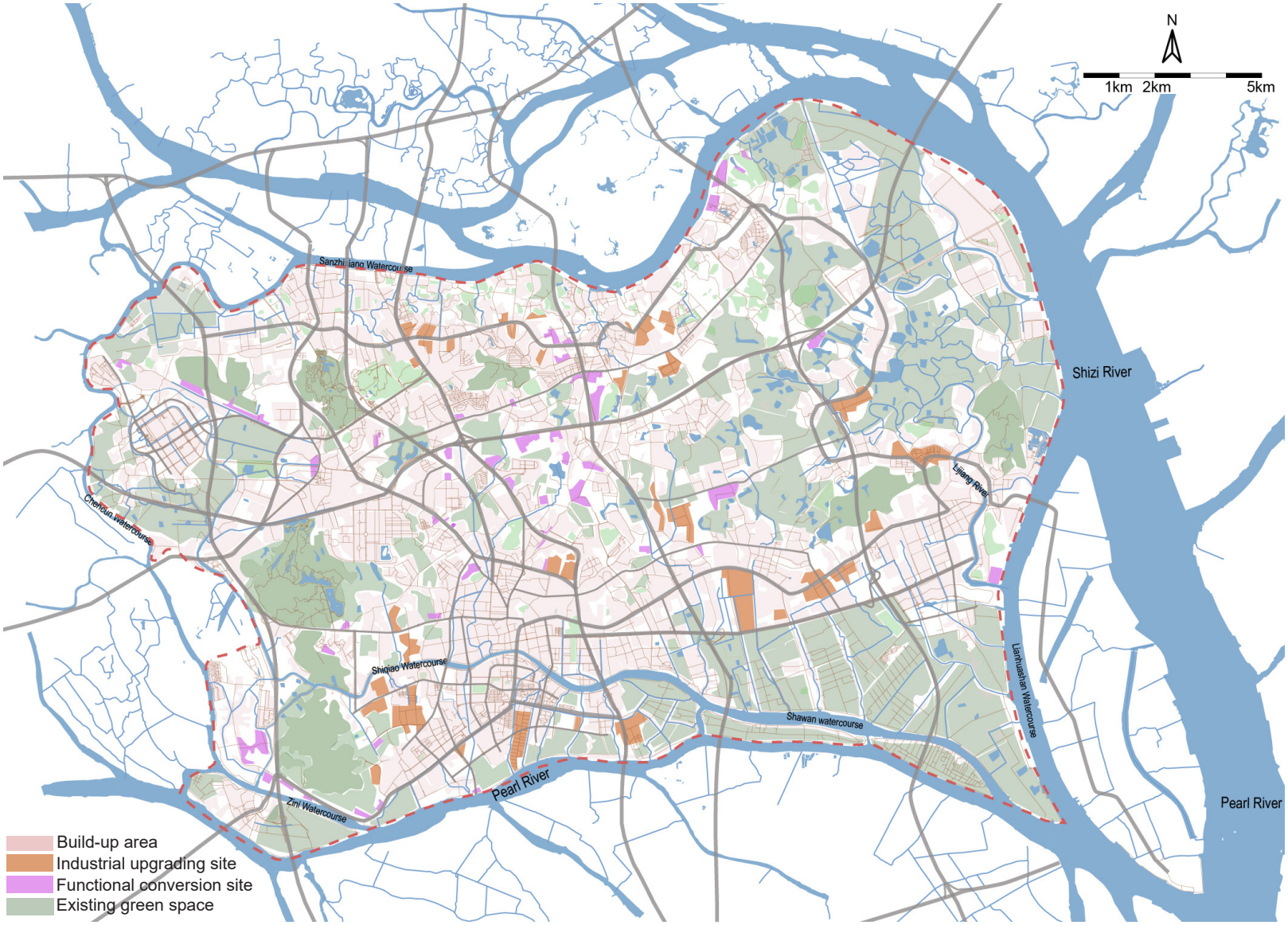


"Buffer" space between built-up area and green space

Left-over spaces can be understood as some unused wasteland, and some space that has been used but now has been abandoned. This type of space is mainly located between villages or residential areas, because the construction of each residential area is relatively independent, and there is a lack of overall planning for the surrounding area. Therefore, there are buffer areas between the villages, because of the lack of interest-driven, few people will concern and use these spaces. Some buffer zones distribute near roads, the most common being at complex intersections where some sites are not well utilized.

Potential space 2:
Former industrial sites

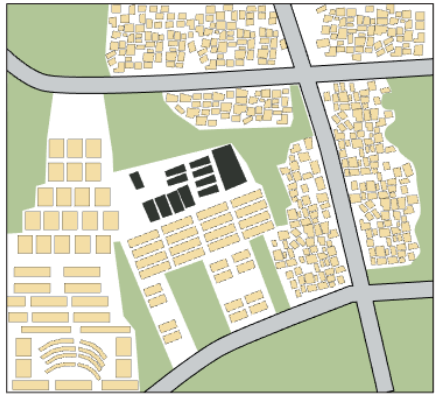
By employing former industrial sites located in some high dense area, like neighborhoods or villages and close to roads, (water) parks can be created to increase water capacity and increase public green spaces and parks for the local and eco-corridor along roads for drainage, water purification, and noise reduction.



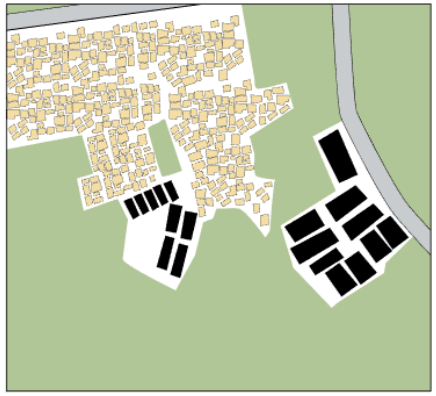


Photos of former industrial sites with abandoned factories

Village-level industrial zone



Village-level industrial zone next to residential area



Village-level industrial zone close to village and road

The previous chapters introduced the characteristics of industrial zones that need to be transformed and how to assess whether industrial zones need to be transformed. The land used for industrial transformation here is based on government documents, literature, and site visits. The original industrial land that will change its function is mainly village-level industrial area. These industrial zones are usually close to the main roads and next to residential areas, so they are distributed in areas with high building density. That is why these lands can help to build new green-blue structures in high-density areas.

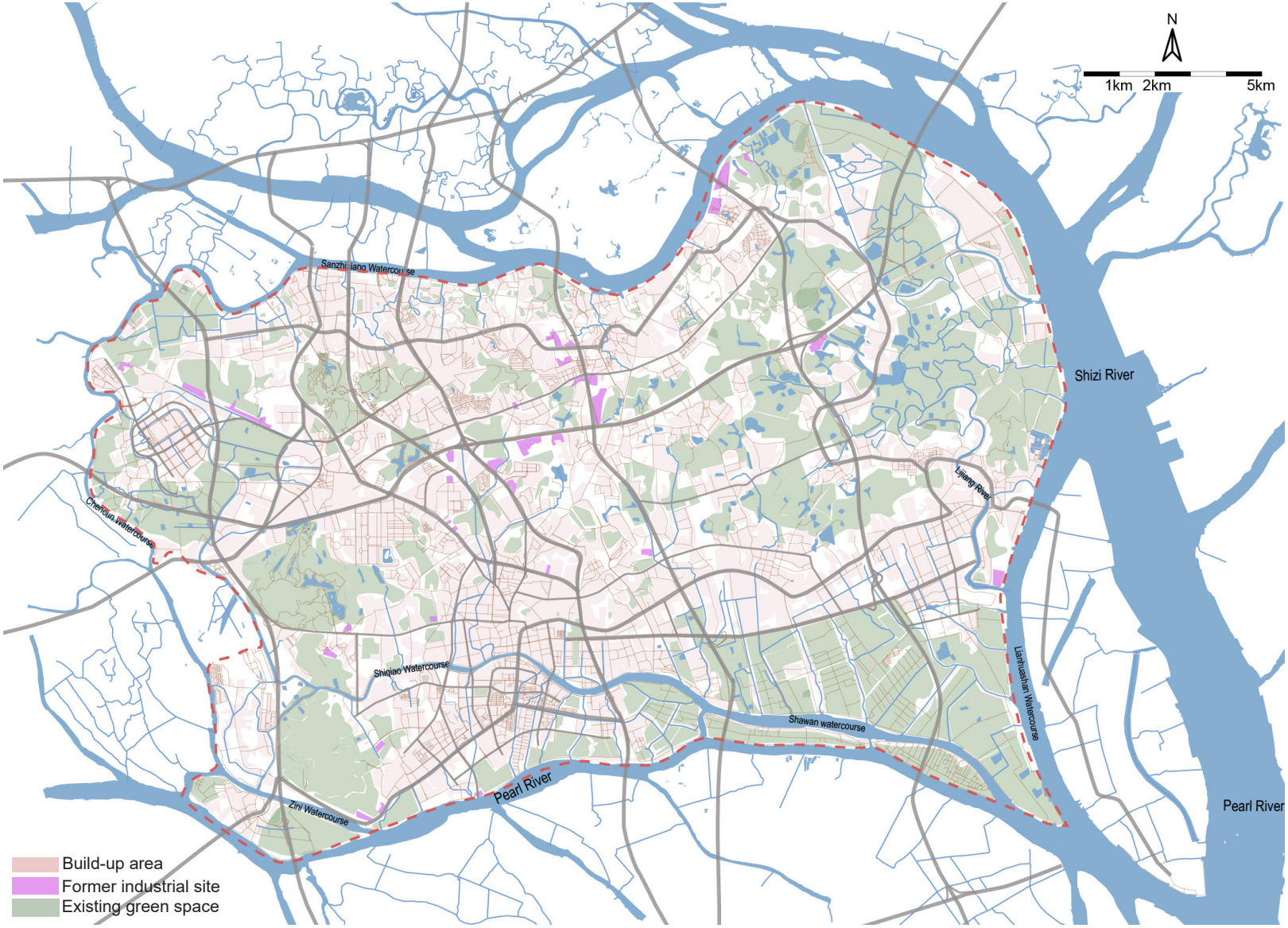
Expanding and connecting Green-Blue structure- Step1. Activate/ preserve existing green and blue spaces

First, making full use of the existing green space and water bodies, which are the basis of the new green-blue structure.

Expanding and connecting Green-Blue structure- Step2. Reclamation of the left-over green "buffer" spaces

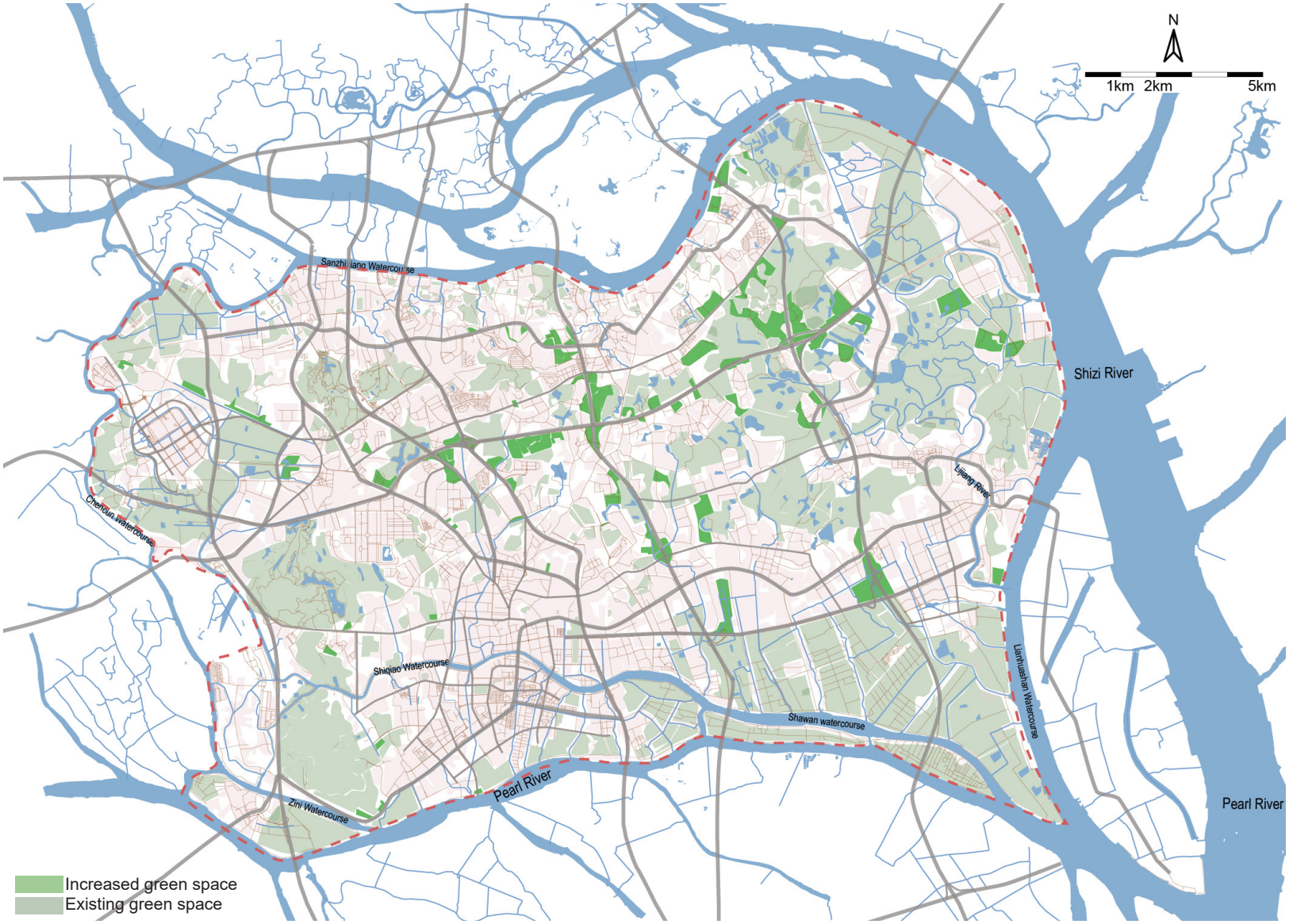
Reclamation of the left-over buffer spaces between villages, especially at the higher and more densely built areas and along highways where waterlogging occurs.

Expanding and connecting Green-Blue structure- Step3. Reclamation of the former industrial sites



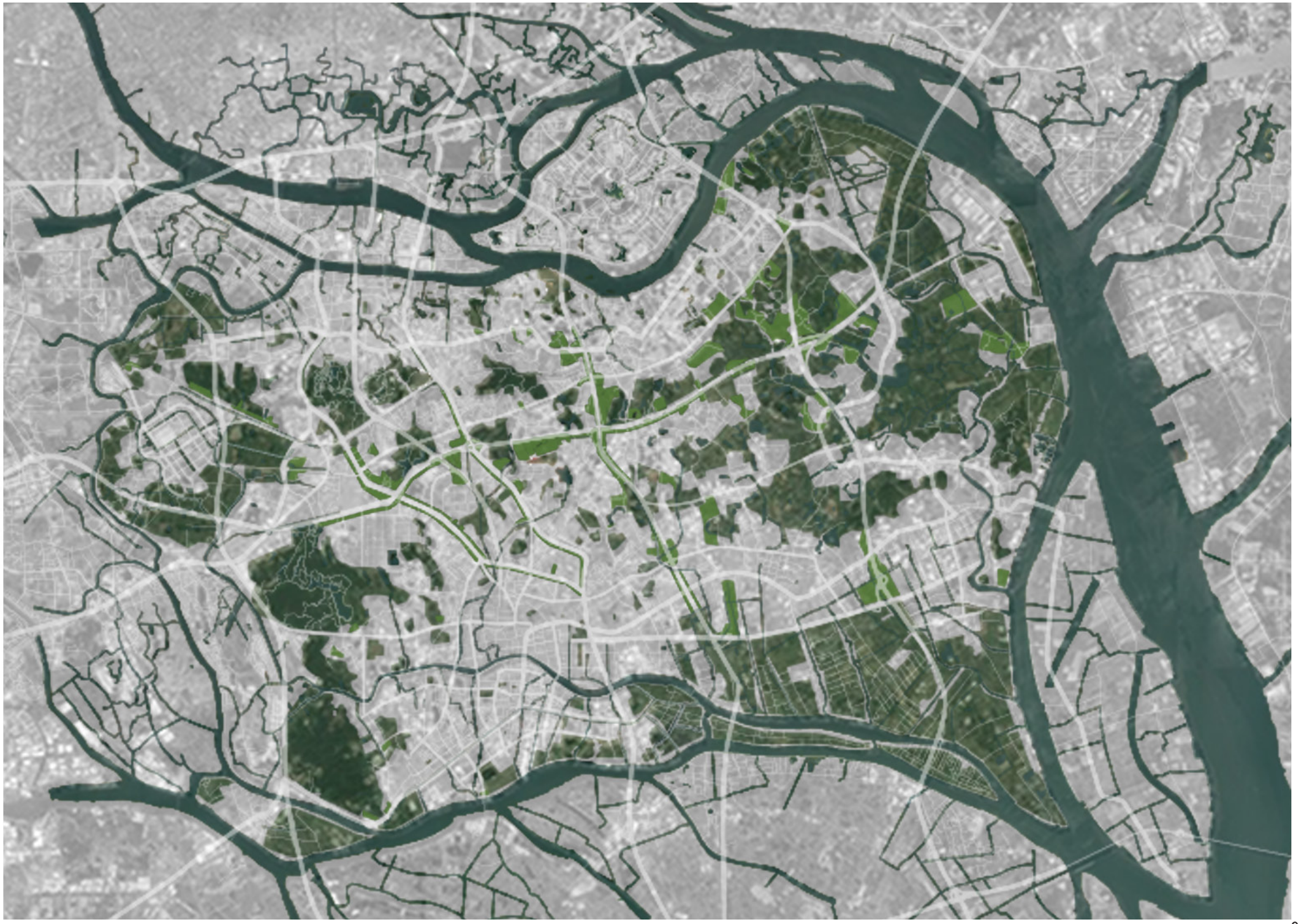
Reclamation of the old industrial sites near roads and neighborhoods where waterlogging is occurring and of importance as new green public spaces for the adjacent neighborhoods.

Expanded and connected Green-Blue structure



After the construction of the new green-blue structure, the green space and water space increased by 49.1 square kilometers, which means that green land coverage has increased from 37.8% to 43.1%. And the green network has been extended towards the waterlogging areas and densely built areas

Expanded and connected Green-Blue structure- Overview

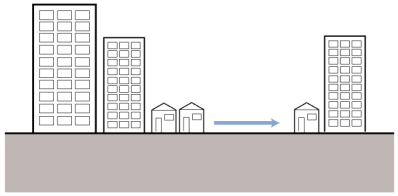


Water strategy: How to increase the Green Blue infrastructure

Current situation

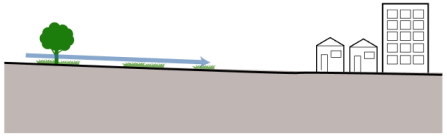
Infiltration

Impervious surface



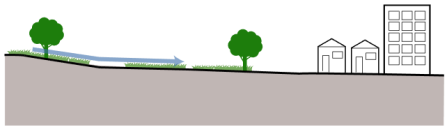
Detention

Fast runoff



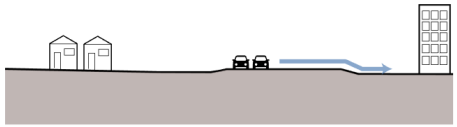
Water Harvesting

Lack of ground storage space



Purification

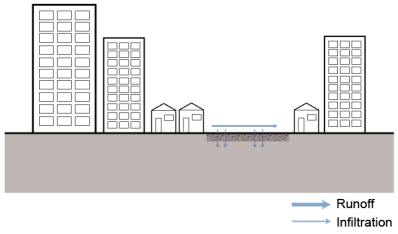
Lack of purification of road sewage



Green- blue strategy

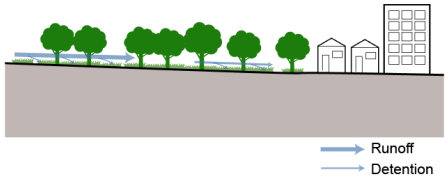
Infiltration

Pervious surface



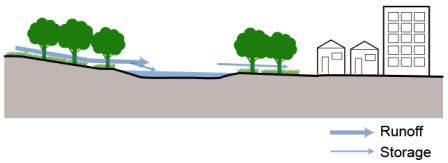
Detention

Slow down runoff



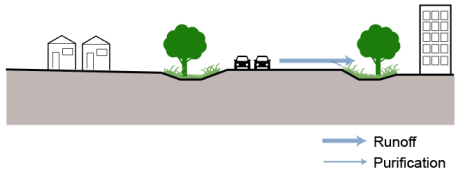
Water Harvesting

Increase seasonal ponds



Purification

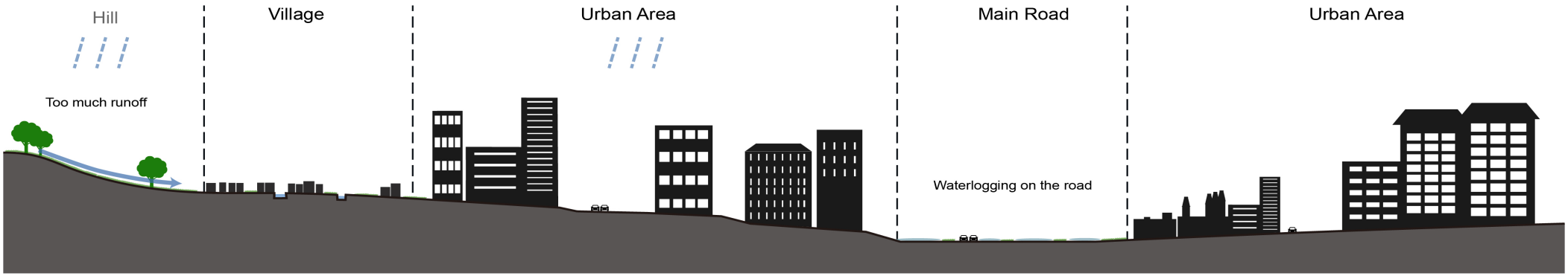
Roadside green buffer zone purify sewage



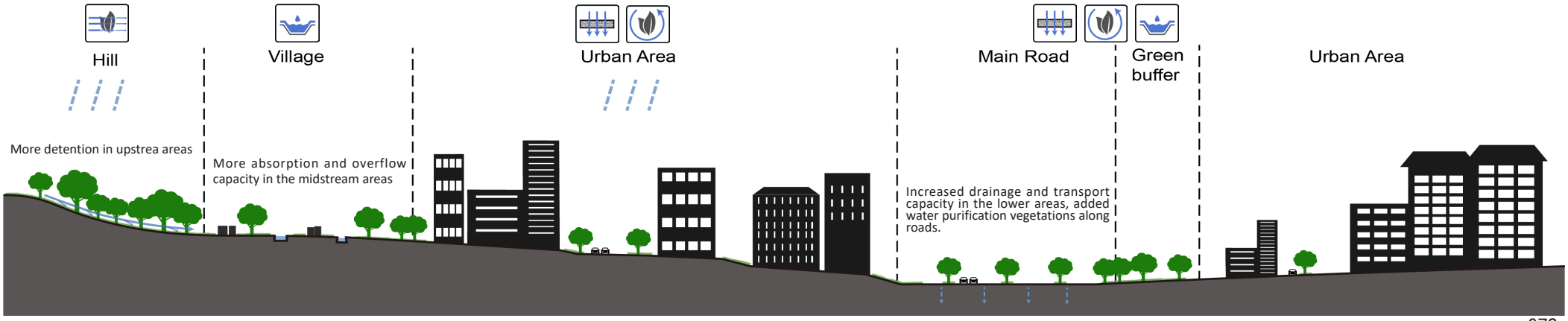
In summary, this chapter has got the main strategy which is to build a new green-blue structure to help Panyu solve the waterlogging problem. The new green-blue structure is based on the existing green space and water body. Then from the left-over space and industrial transformation site, new land is sought to expand the green and blue space. Considering the water strategy, the design of the new green-blue structure will incorporate the four water strategies.

Expanded Green-Blue structure with water strategy

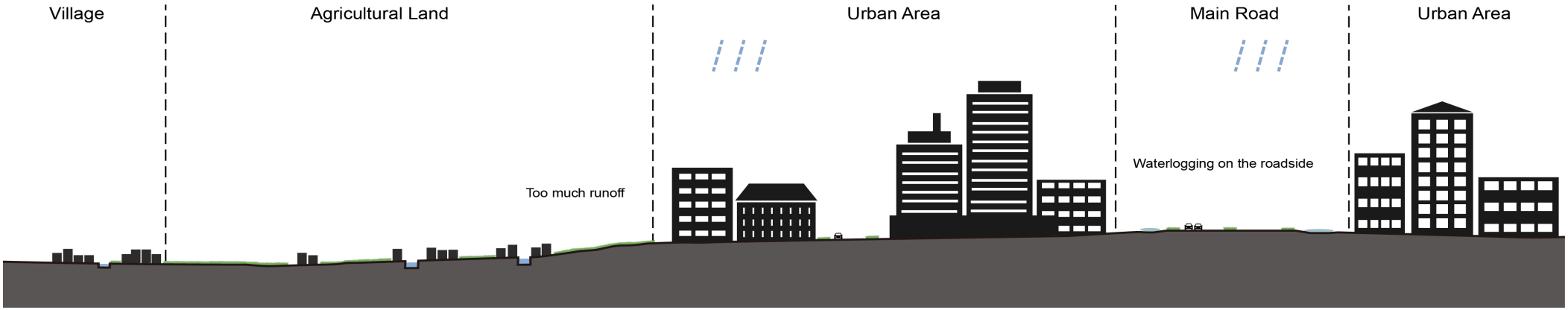
Current situation



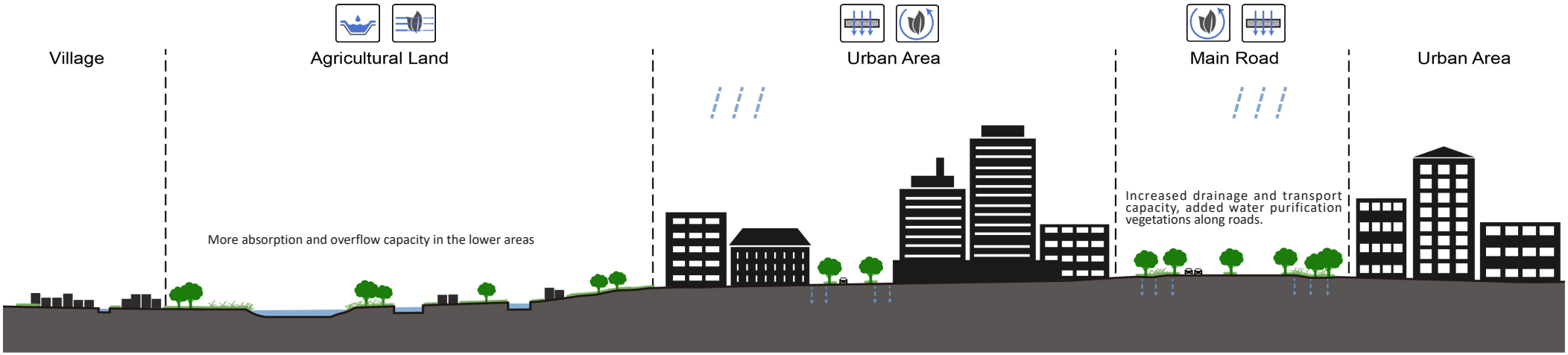
Applying water strategy



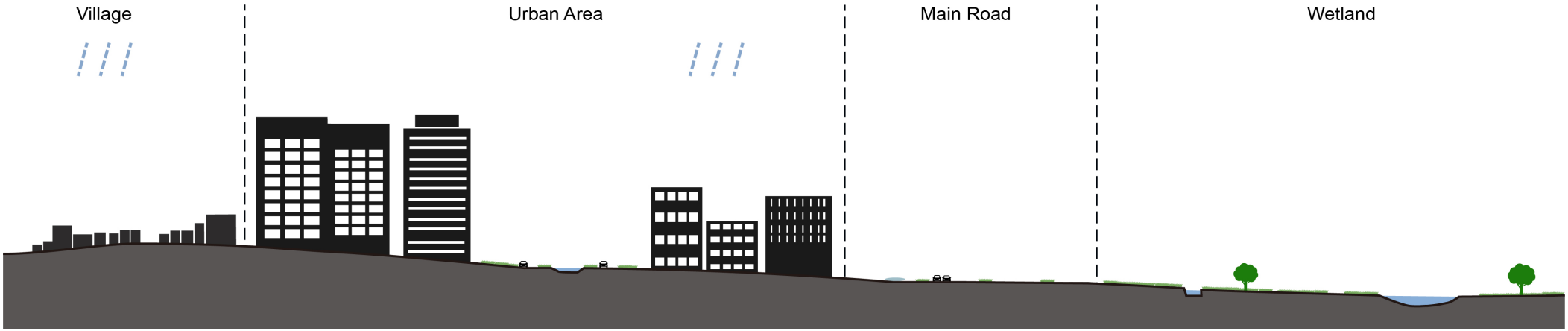
Current situation



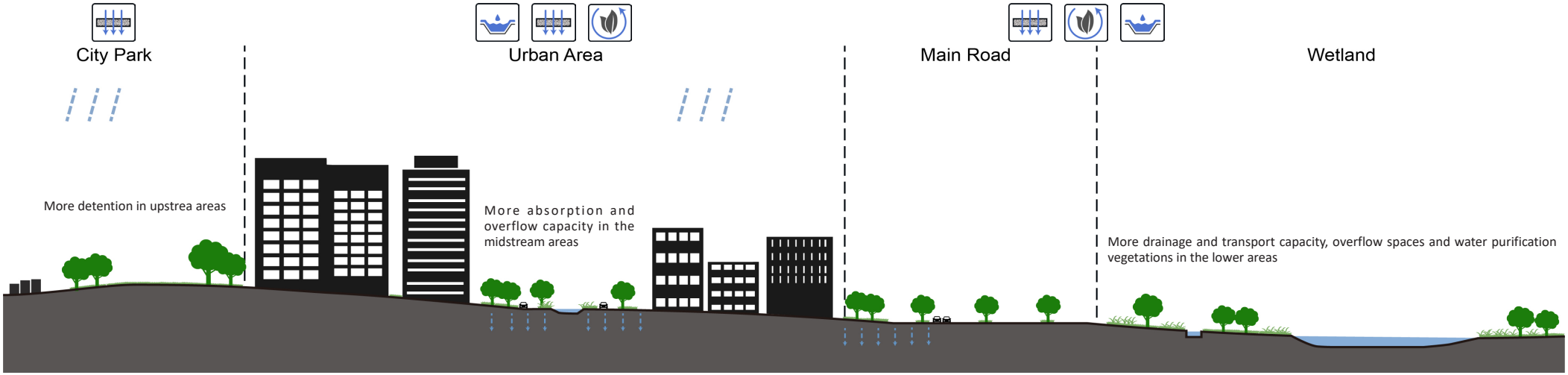
Applying water strategy



Current situation



Applying water strategy



Chapter 5

DESIGN PROPOSAL

From the analysis in the previous chapter, potential lands that can be used to expand the green-blue system and water strategies are obtained.

This chapter will conduct cross-scale planning and design from macro, meso, and micro scales, which are Panyu District, neighborhood, and chosen sites. For macro and micro scale, the construction of the new green-blue structure will be emphasized, and for micro-scale, the more detailed space and landscape design will be mentioned.

5.1 Macro Scale- Panyu District

Summary map- Expanded Green-Blue structure and problem

Comprehensive analysis of the newly added green space and water body (from left-over green "buffer" spaces and former industrial sites) and waterlogging points, the author selected a neighborhood where the two coexist for the next analysis and detailed design.

The building density in this neighborhood is relatively high, the design of the site not only needs to restore the natural drainage system and water storage but also needs to improve the living and public space quality of the surrounding neighborhoods.

5.2 Meso Scale- Neighborhood

Existing Green-Blue structure

This picture is the current situation of the selected neighborhood. The drawing expresses the existing green land and water bodies and underground drainage pipes, which are related to the green-blue structural design. But the existing green spaces are not connected.

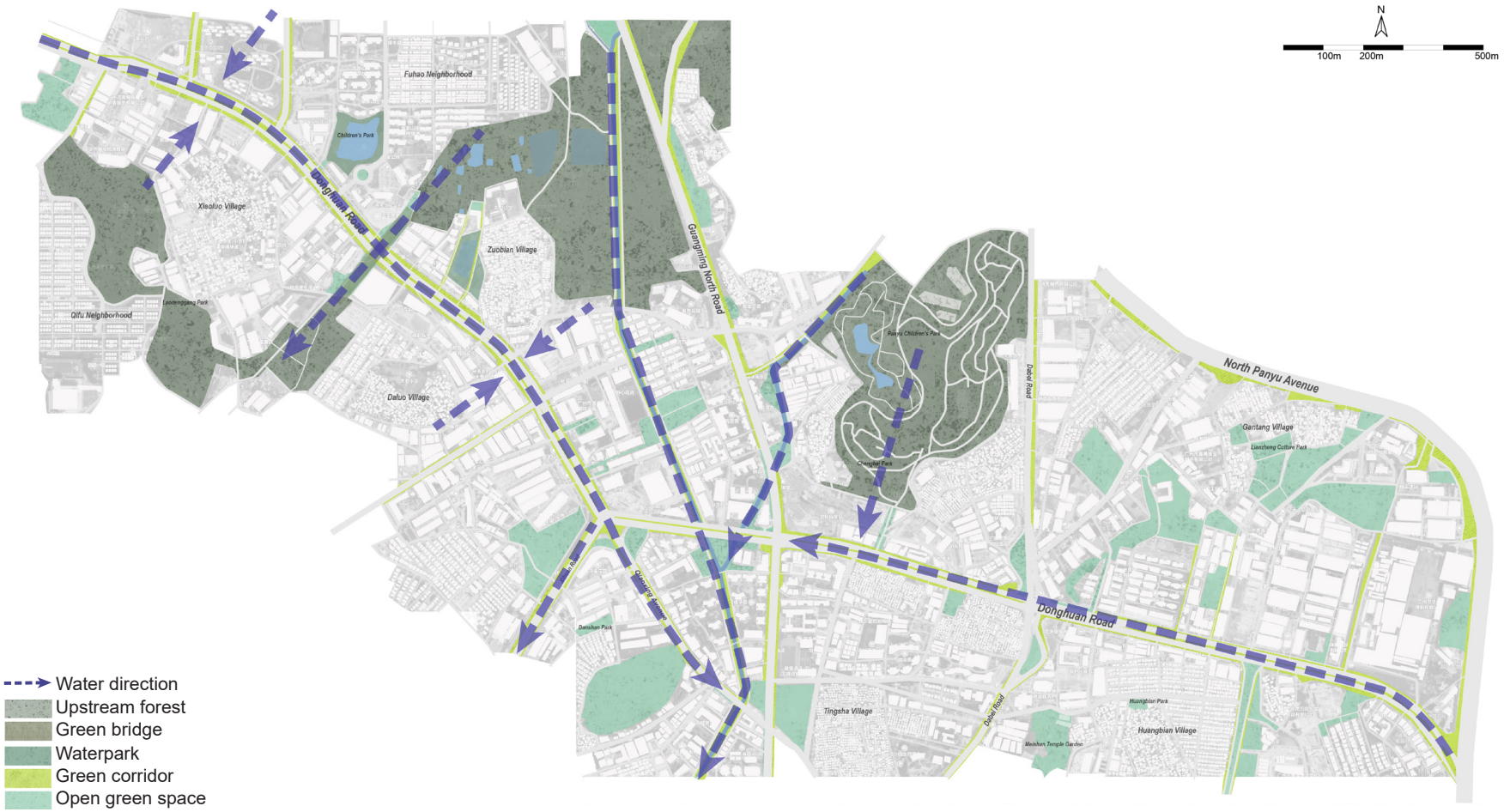
Existing Green-Blue structure- Water flow

The map analyzes the drainage direction of the surface and underground water in the area, as well as the distribution of the waterlogging area. Most of the water in the area flows to the southwest, and part of it will gather on sides of the main road due to topography to form accumulated water.

Expanded Green-Blue structure

In the previous chapter, the green-blue infrastructure has been introduced on the district scale (page 70). In this map the network is shown on the neighborhood scale. The green land is classified and expressed according to the drainage function. The brighter spaces are the added green spaces and water bodies.

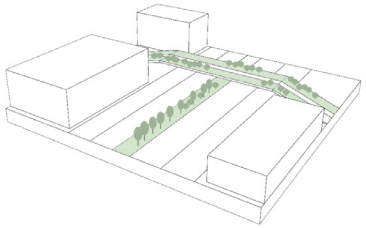
Expanded Green-Blue structure- Water flow



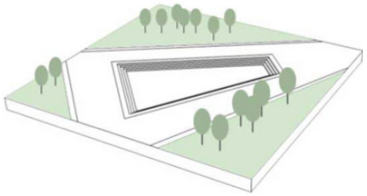
After using the new green-blue structure, the drainage direction in this area has changed. The drainage problem that caused waterlogging was solved.

Expaned Green-Blue structure- Green typology

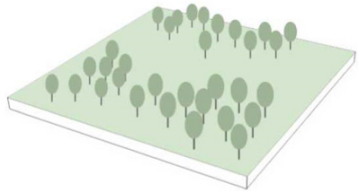
Green bridge to restore drainage



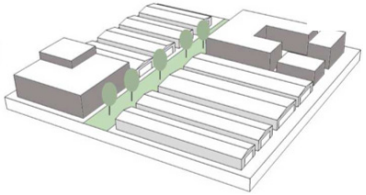
Waterpark



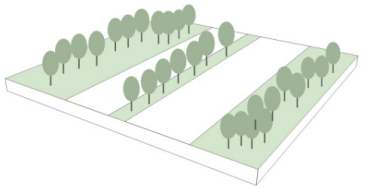
Upstream forest



Open green space



Green corridor

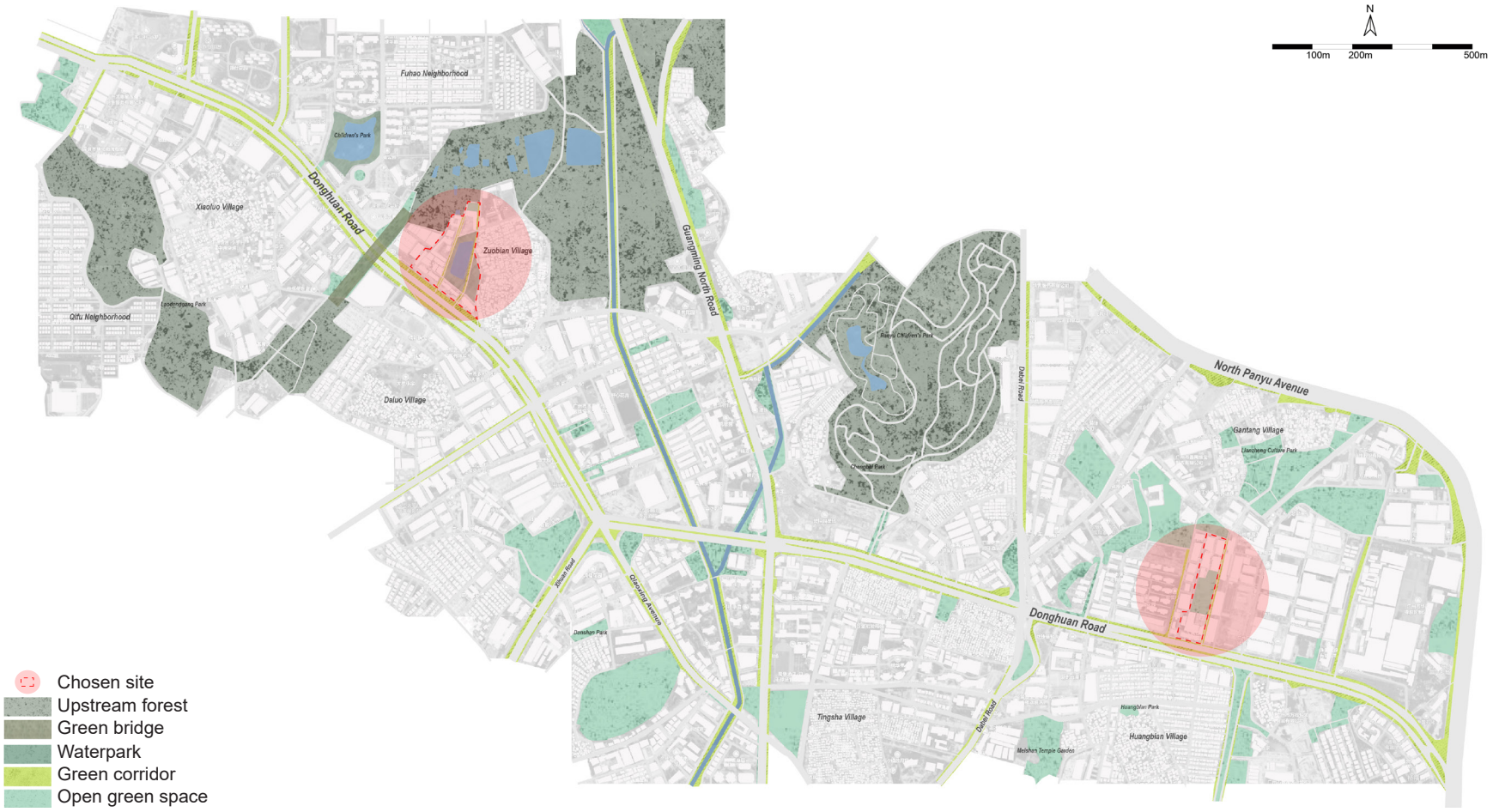


The green spaces in the new green-blue structure can be divided into five categories according to their functions in the system. The following content will introduce the function and design proposals of each green type. The green bridge is used to restore natural drainage and to make sure the animal can pass safely. The other four types can combine with four water strategies and be used by the locals.

Expanded Green-Blue structure- Water strategy

Different patterns represent water strategies applied in different green spaces. **Detention** is applied to upstream forests to stop part of the water flow. **Water harvesting** is applied to low-lying green lands where have the waterlogging problem. Therefore, increasing water storage space can alleviate the waterlogging situation. **Purification** is applied to the green corridor on sides of the road or near water-polluted areas. **Infiltration** is widely used in most green areas to ensure that surface runoff can penetrate underground instead of staying on the ground.

Chosen site



On the neighborhood scale, the waterlogging concentrated around highways, so extra drainage and overflow capacity are needed. The northern site is chosen in the vicinity of the highway to create a waterpark for storage. The site on the east is chosen for detention and purification because it is located close to industry park. With the selection of these 2 sites, all four water strategies introduced earlier are covered. Both sites are declined industrial sites, therefore they will be transformed to become part of the green-blue infrastructure.

Green and blue typology

Upstream buffering forest to slow down runoff

Forest Source: Pinterest

Farmland Source: Pinterest

This type of green space is characterized by relatively high terrain and a large green area. It is usually a forest or wetland with dense vegetation. They can leave some rainwater at high places to reduce the amount of water that needs to be carried in low-lying areas. This part of the green area is dominated by existing farmlands and hillsides. The brighter blue spaces are the added water bodies.

Green corridor along roads/ canal for storage and purification

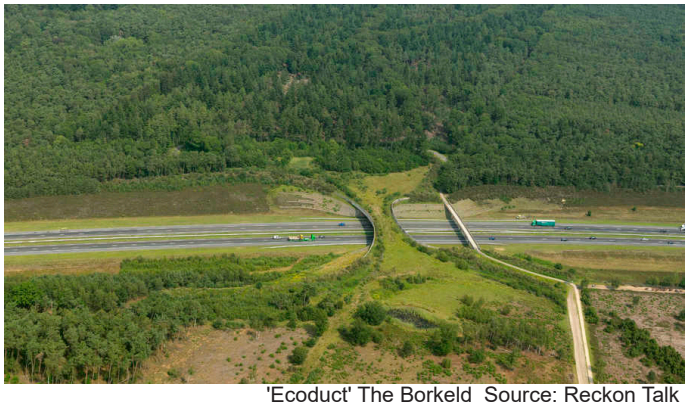
Taichung green corridor Source: mecanoo

Green corridor Source: Natural Walking Cites

The waterlogging problem is more serious near the roads. Therefore, one of the functions of the green corridor is to use the terrain which is slightly below the road to collect the accumulated water. At the same time, because the gas emitted by vehicles will pollute the water on the road, the water purification plants in the green corridor will initially purify it. The brighter spaces are the added green spaces.

Green “bridge” for the connection of G&B structure

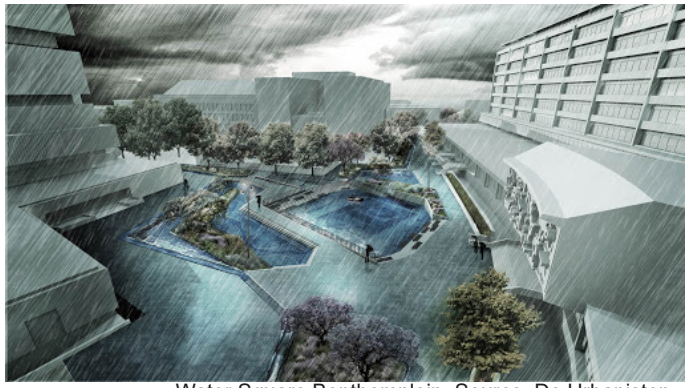
Green bridge over Naarderweg Source: Reckon Talk



'Ecoduct' The Borkeld Source: Reckon Talk

The main function of the green bridge is to connect the green spaces on both sides of the road to ensure the connectivity of the green-blue system. And the green bridge can help animals cross the road without being affected by vehicles. At the same time, due to the slope design of the green bridge, part of the accumulated water that could only be collected on the pavement because of the terrain can flow to the other side of the road through the green bridge.

Waterpark for seasonal water storage and recreation



Water Square Benthemplein Source: De Urbanisten

Water Square Benthemplein Source: De Urbanisten

The water park can be used as a public space for residents' activities while being able to use the lower terrain to collect the surrounding rainwater. Because of the difference in the amount of rainwater collected, it can form various spaces and landscape views. The brighter spaces are the added green space and water body. The circled place is the design site.

Other open green space/ Recreational green space

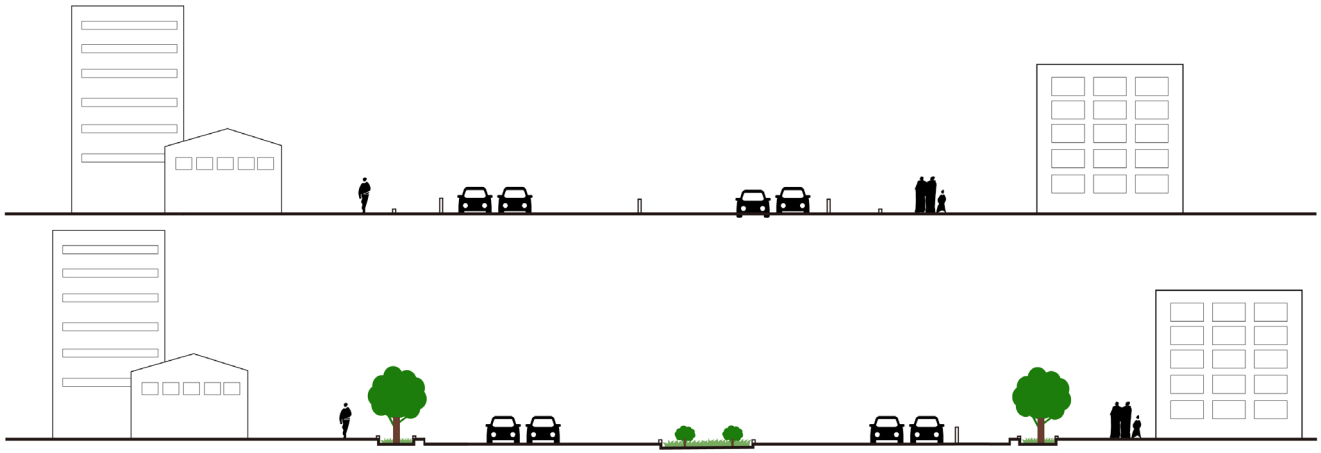
Park Source: Pinterest

Street Park Source: Pinterest

Public green space is one of the important elements of the green-blue structure. They can collect and purify rainwater by plants and they are entertainment places for local residents. The brighter spaces are the added green spaces. The circled place is the design site.

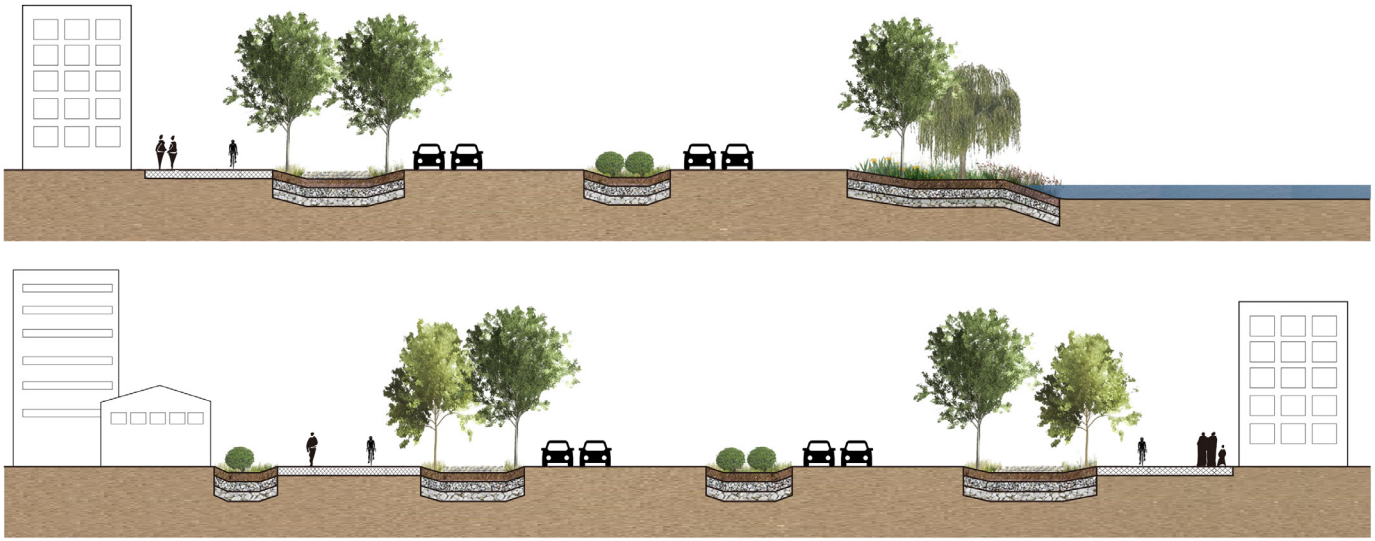
5.3 Micro Scale- Green corridor

Current situation along main roads

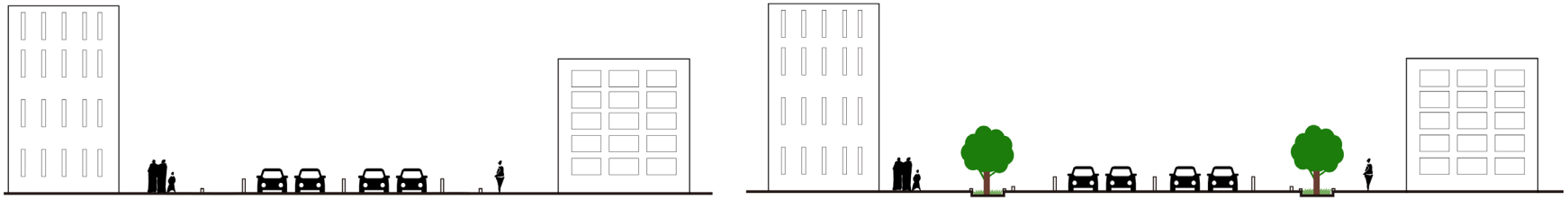


Most of the main roads are surrounded like the first section, and a few are the second. But even if there are green spaces in the middle and both sides of the road, it is not conducive to collecting rainwater because there are obstacles on both sides of the green land.

Proposed green corridor along main roads

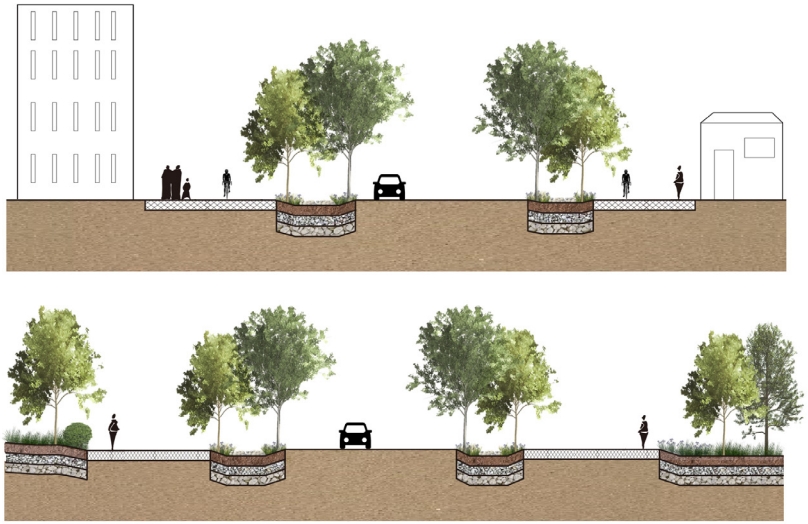


Current situation along secondary roads



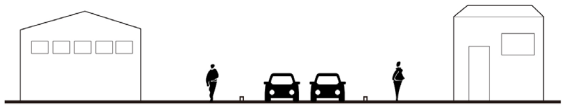
The surrounding conditions of the secondary roads are basically the same as those of the main roads.

Proposed green corridor along secondary roads



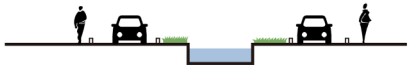
The proposed green corridor includes gentle slopes with water purification plant to ensure the flow of water and purification of sewage. And the paving material of the sidewalk is permeable.

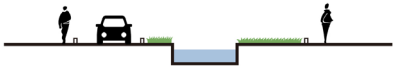
Current situation along single roads



There is basically no green space on sides of the single street, and the separation of the roadway and the sidewalk is not obvious.

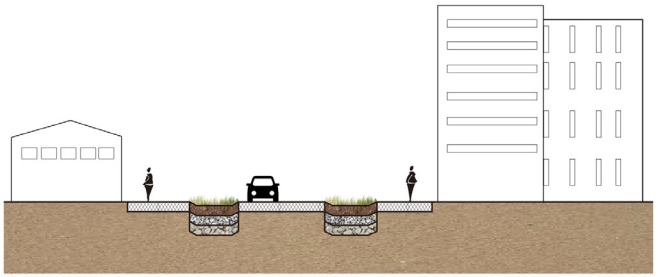
Current situation along canal

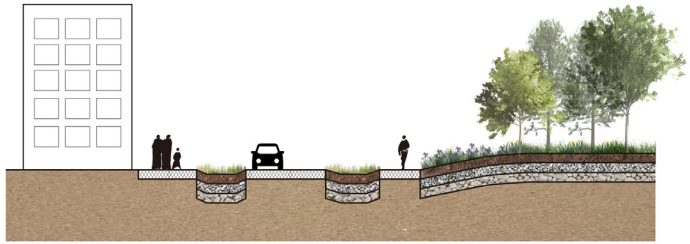




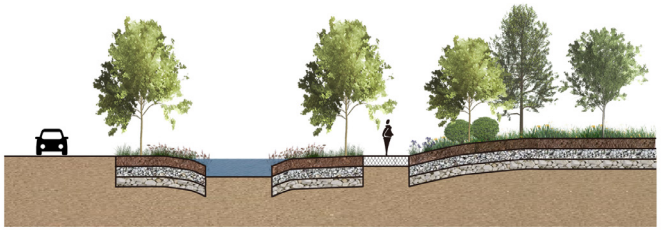
Most of the canal is surrounded by lawns to divide the space. But the lawn has no slope, it is not conducive to drainage, and the plants planted are not purification plants.

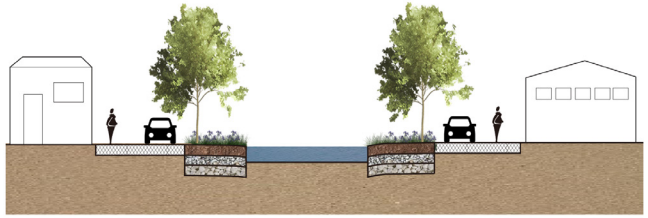
Proposed green corridor along single roads



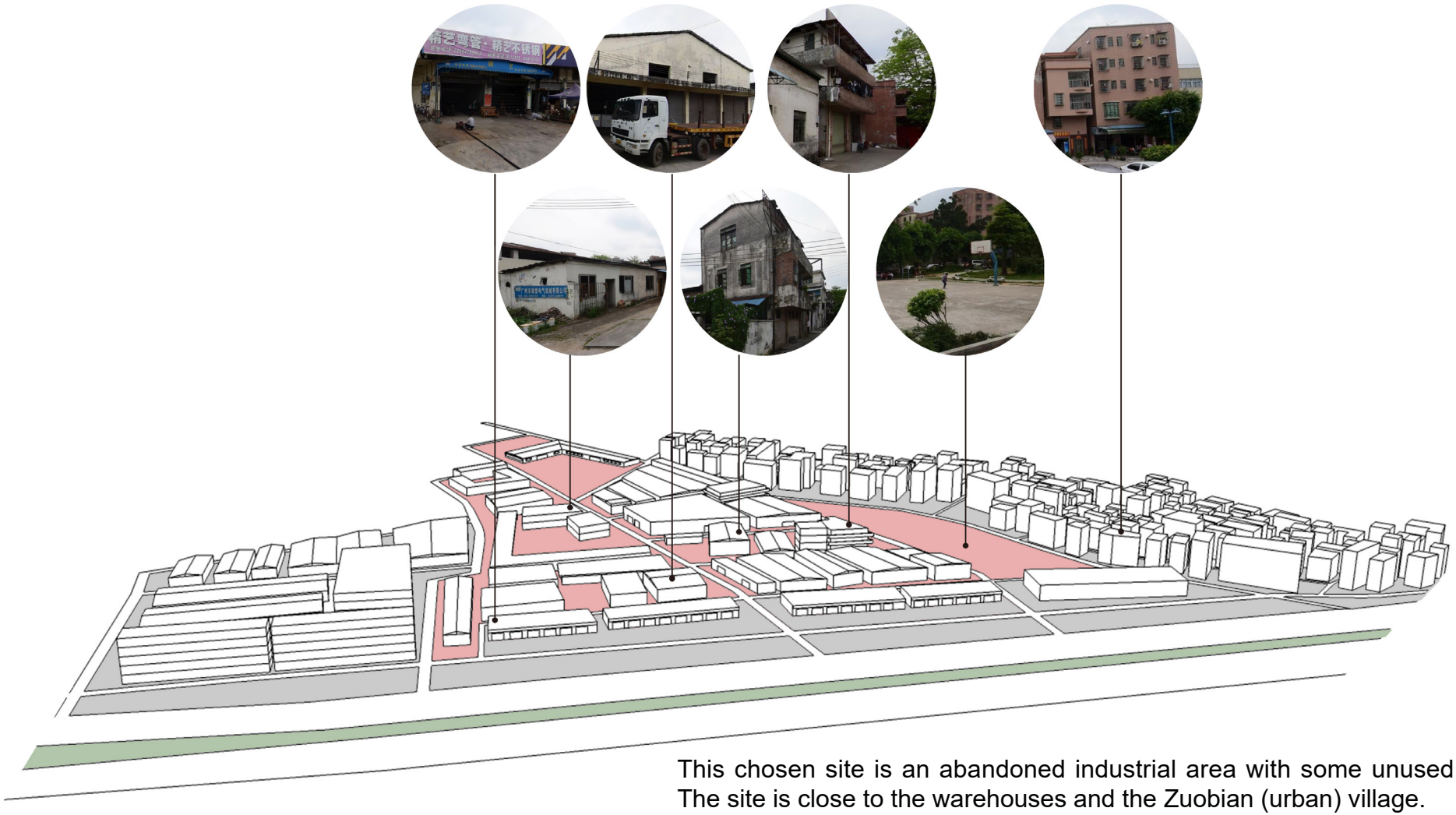


Proposed green corridor along canal





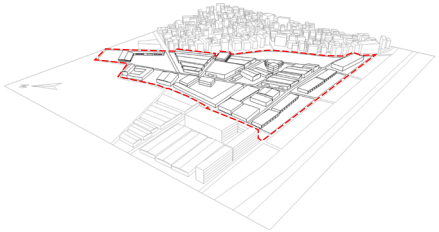
Micro Scale- Chosen site 1



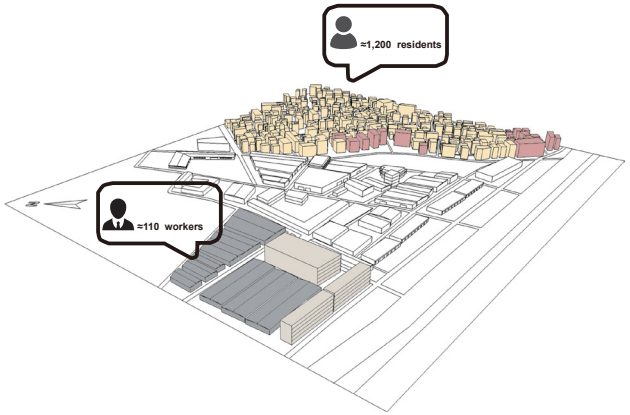
This chosen site is an abandoned industrial area with some unused buildings. The site is close to the warehouses and the Zuobian (urban) village.

Site analysis

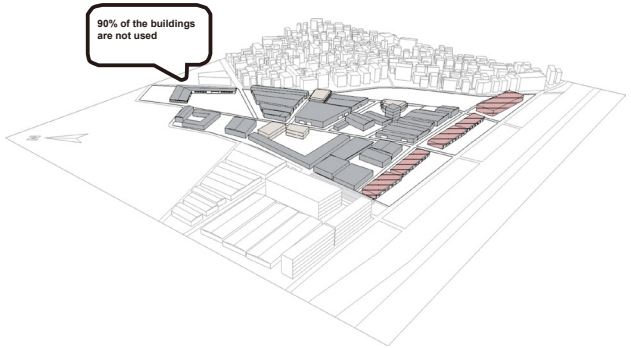
Location



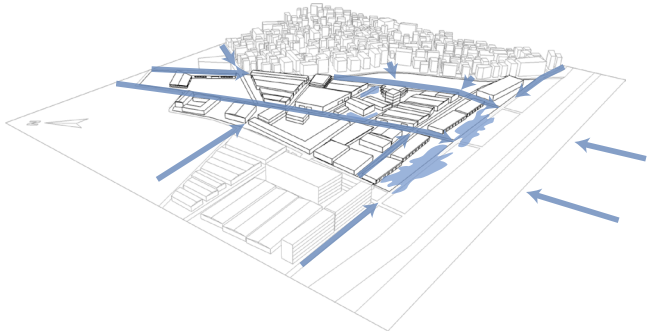
Surrounding



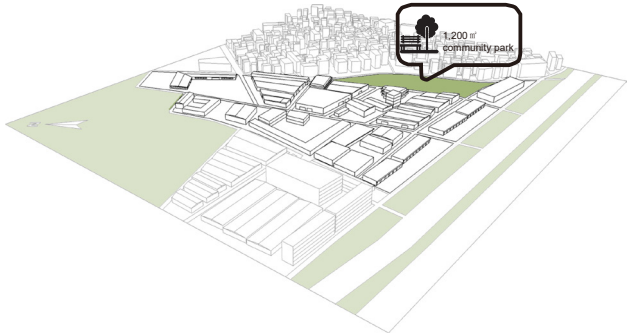
Inside



Water problem

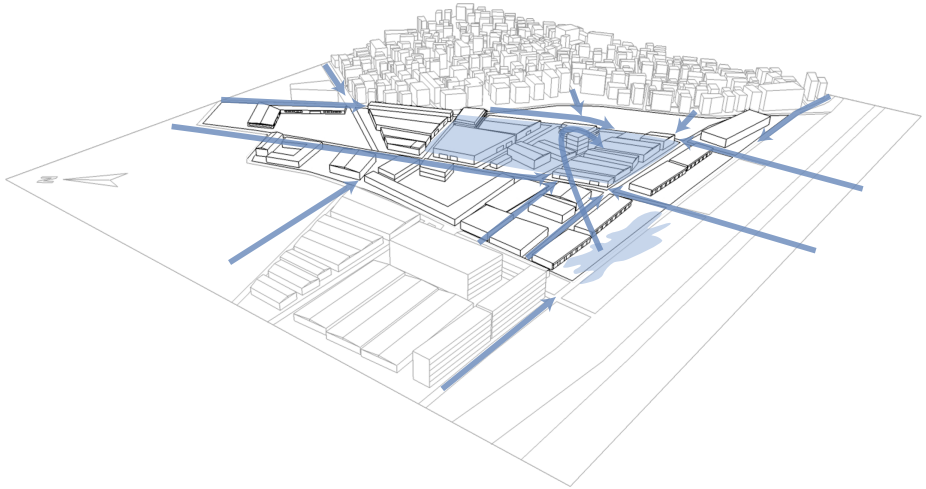


Green spaces



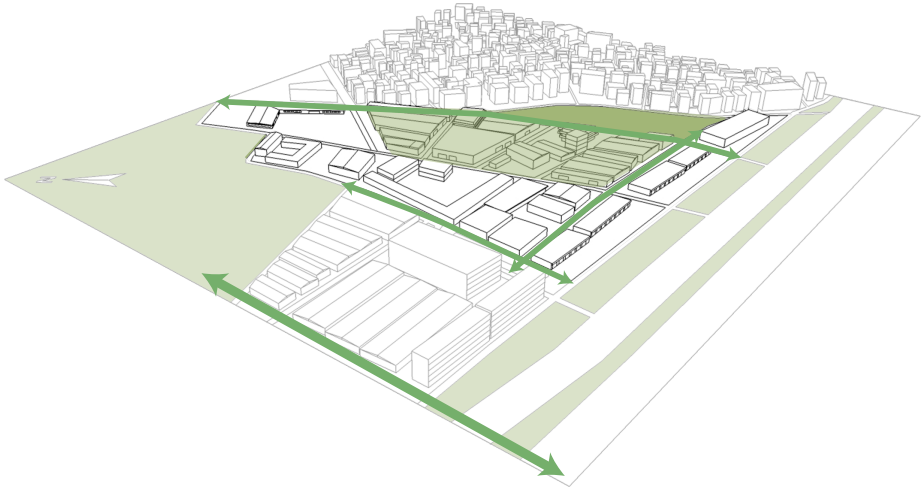
Design concept

Blue concept



Increase the water storage area to alleviate the waterlogging problem.

Green concept



Increase the connection between green spaces.

Spatial design- Master plan

Current situation

Current situation with pattern

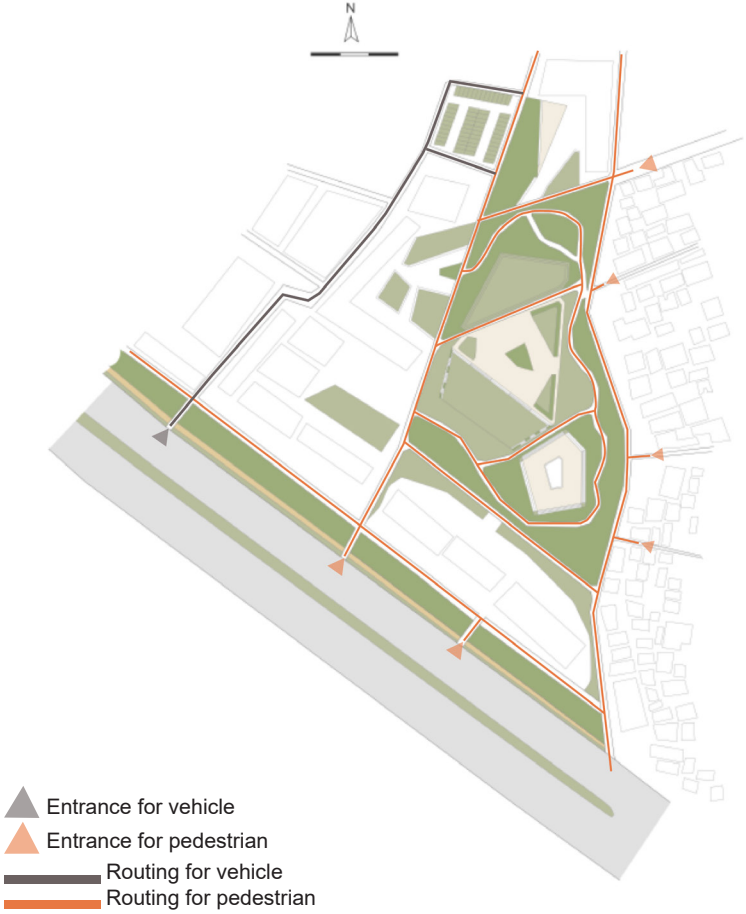
The current pattern of roads and buildings is the source of inspiration for the graphic language in the design. At the same time, keeping the old patterns also preserves the original characteristics and memories of the venue.

Spatial design

Routing

The location of the water square is slightly lower than the surrounding area, and it assumes the function of water harvesting.

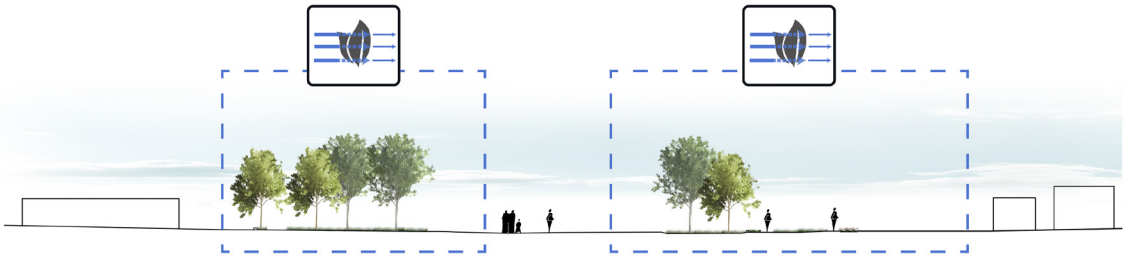
Spatial function



In order to ensure the comfortable experience for tourists, the design ensures the separation of people and vehicles. At the same time, workers and residents can reach the park from different entrances but close to their living areas.

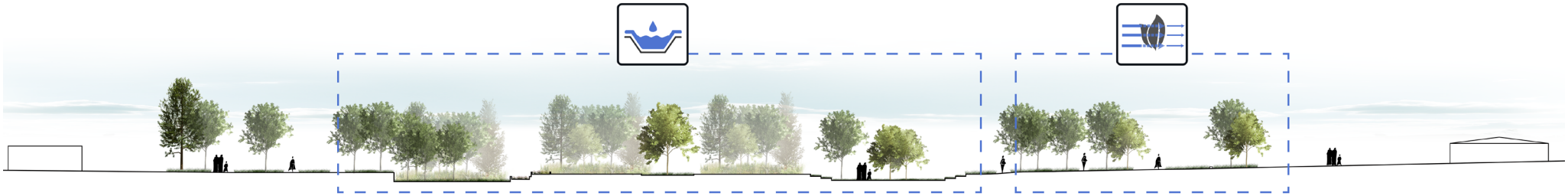
Design with water strategy

Section A-A



The significance of the sections are to explain the height difference of the site and how the spatial design incorporates the water strategy.

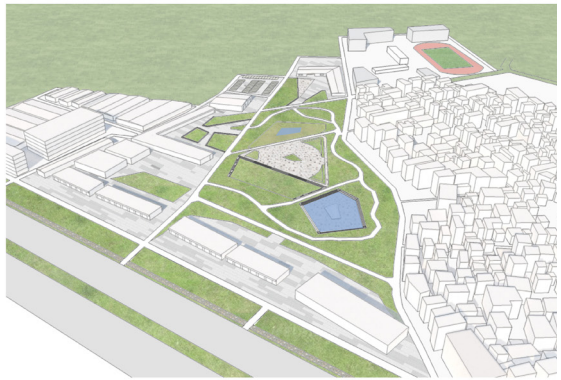
Section B-B

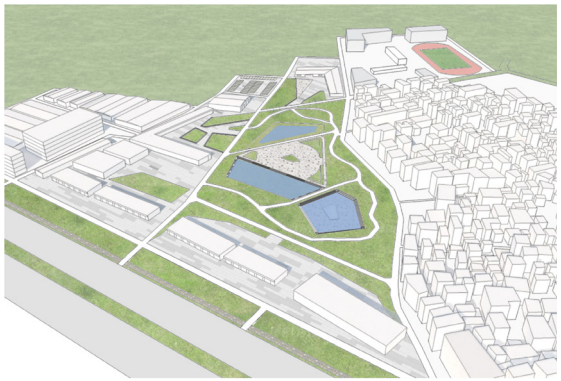


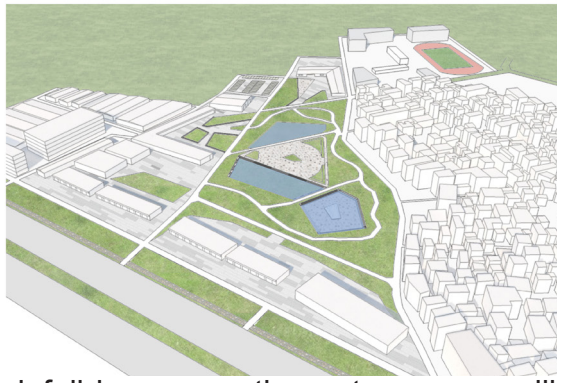
In this design, the water square assumes the function of water harvesting, and the surrounding higher lawns and woods can retain rainwater.

Bird view

Seasonal flooding

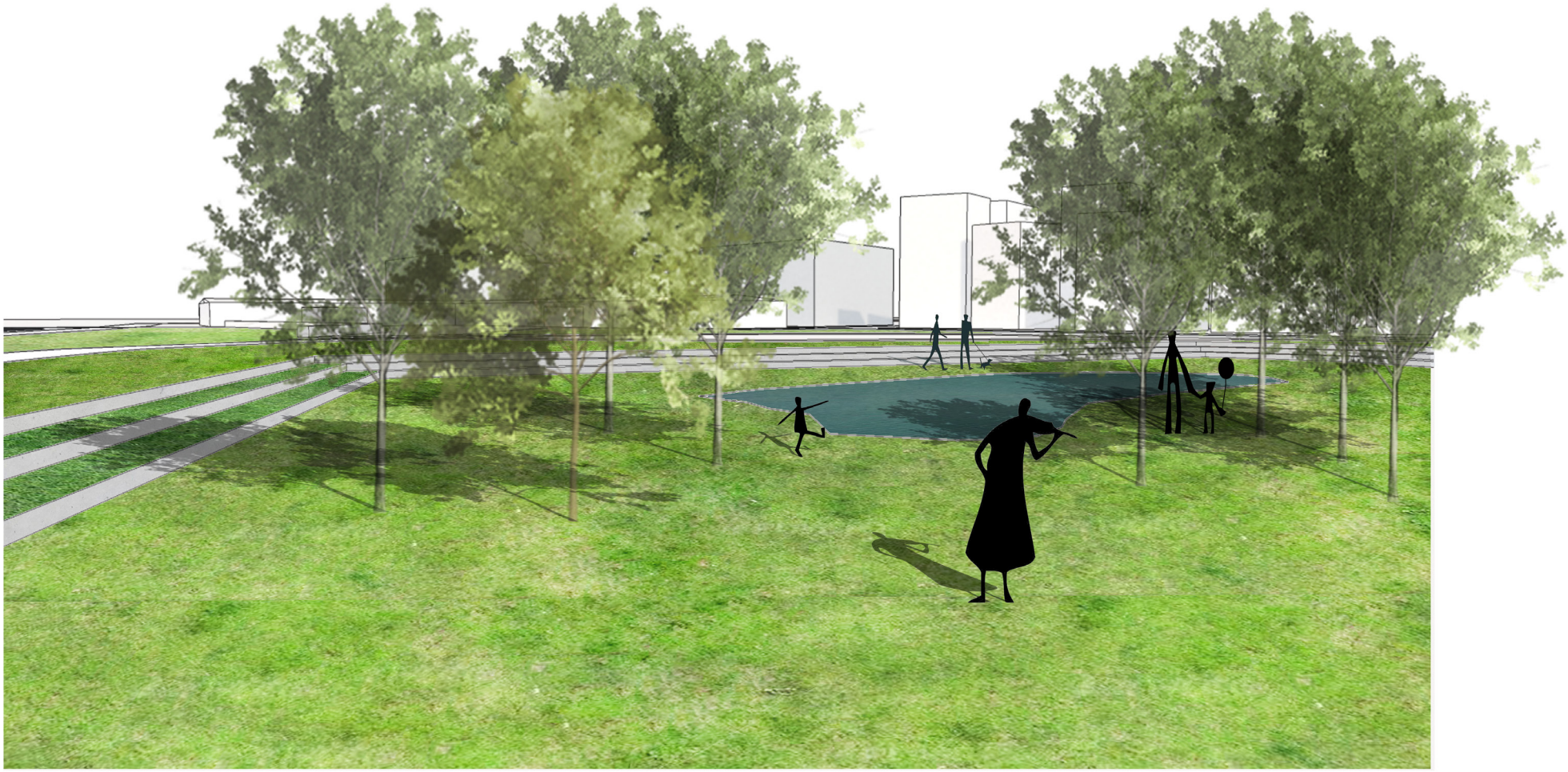




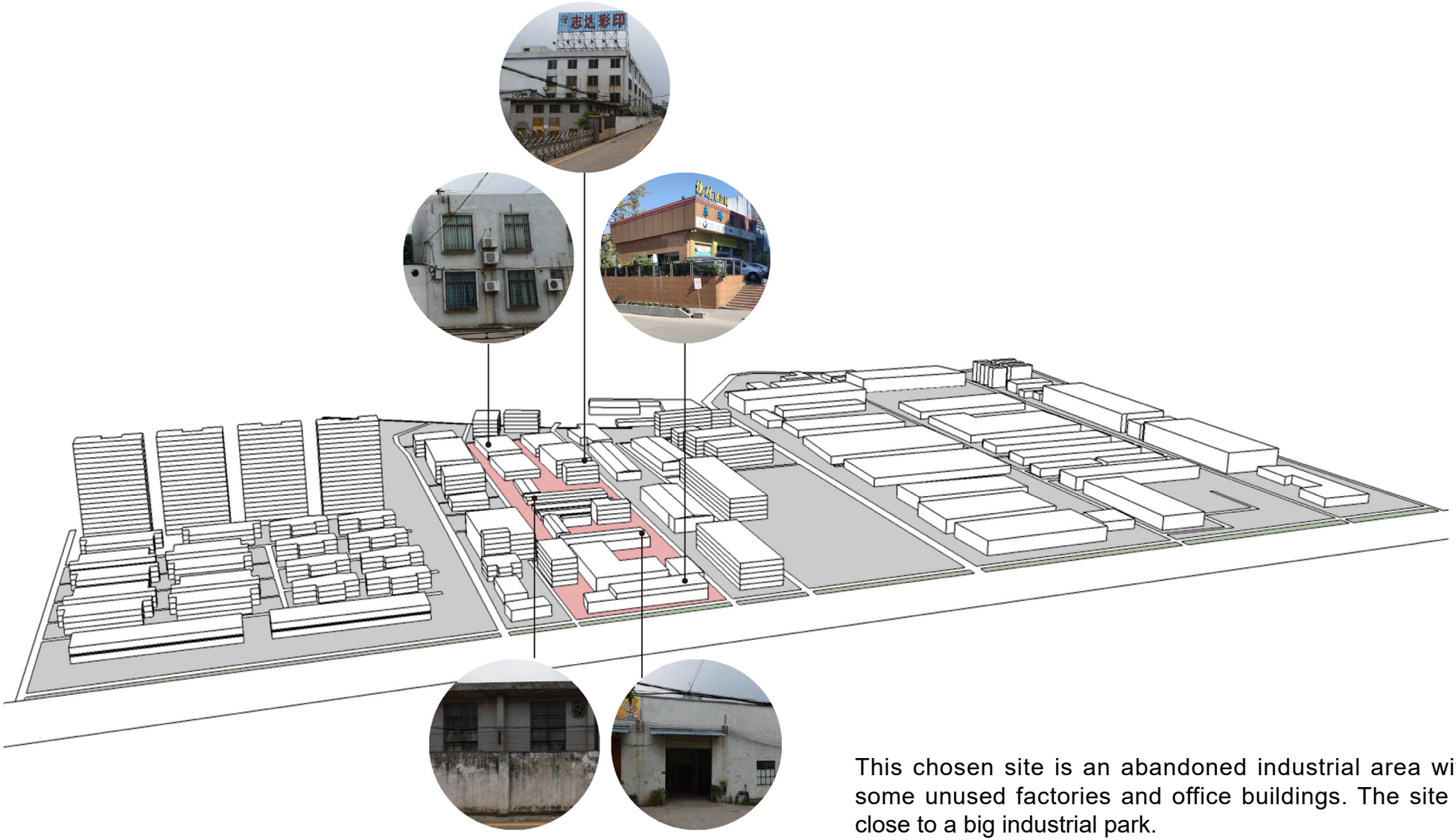


As the rainfall increases, the water square will gradually be submerged from low to high area.

Eye-level perspective



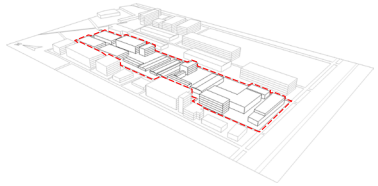
Micro Scale- Chosen site 2



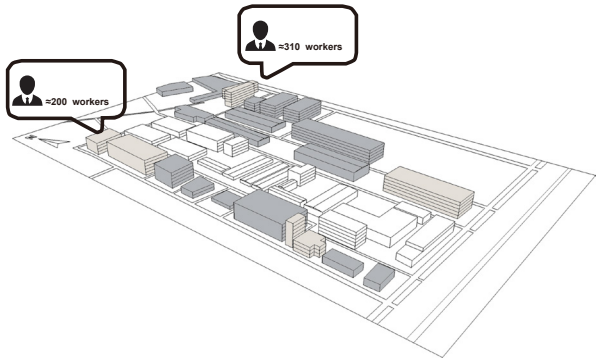
This chosen site is an abandoned industrial area with some unused factories and office buildings. The site is close to a big industrial park.

Site analysis

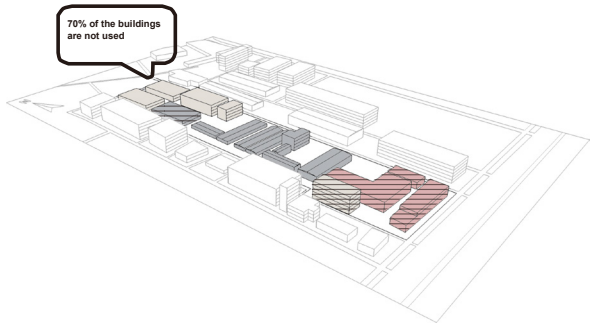
Location



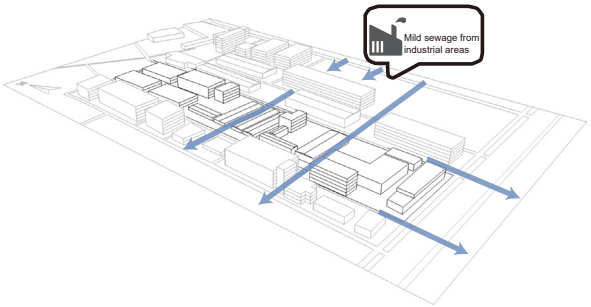
Surrounding



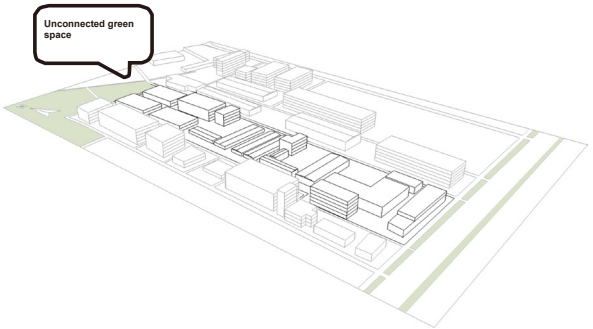
Inside



Water problem

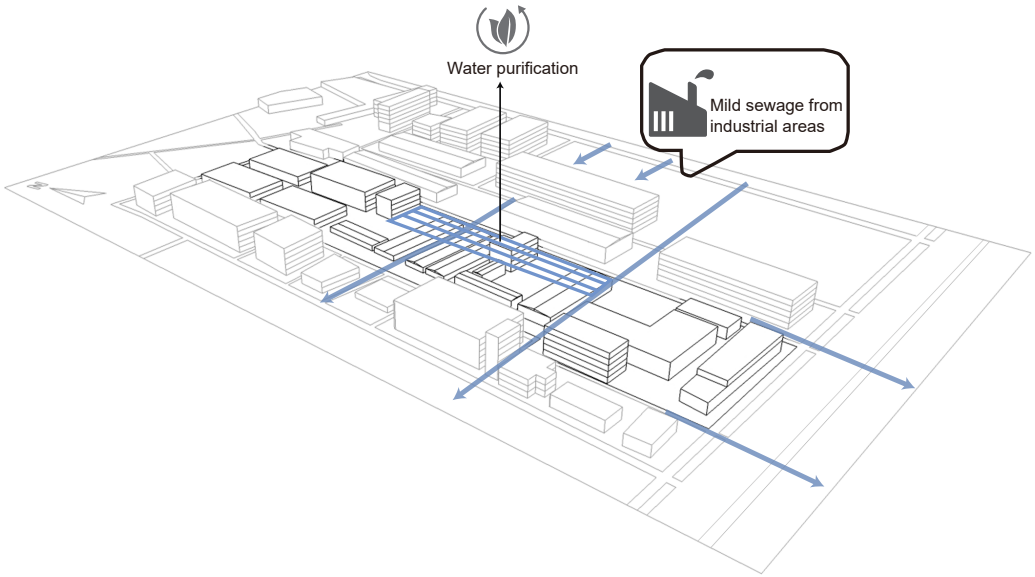


Green spaces

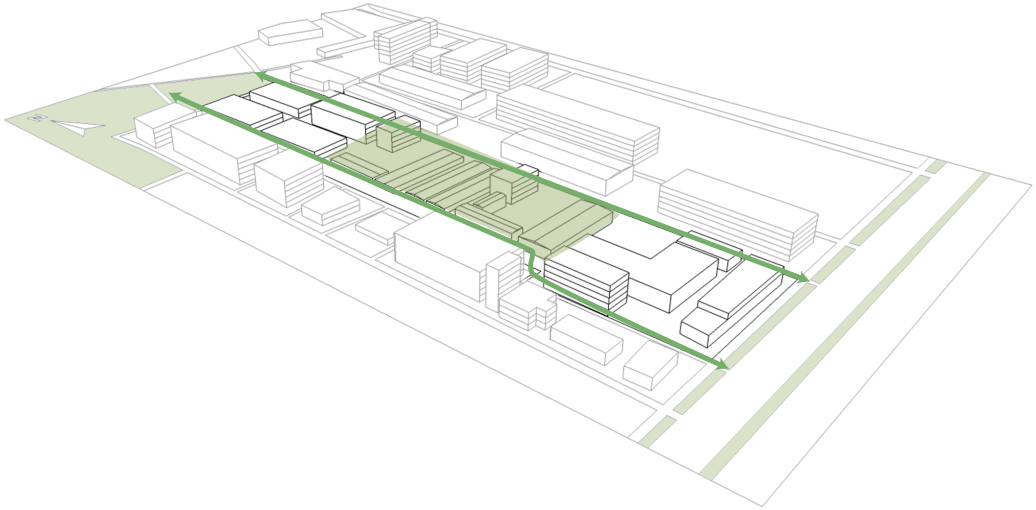


Design concept

Blue concept



Green concept



Increase the water purification area to treat the ground sewage flowing from the factory.

Increase the connection between green spaces.

Spatial design- Master plan

Current situation

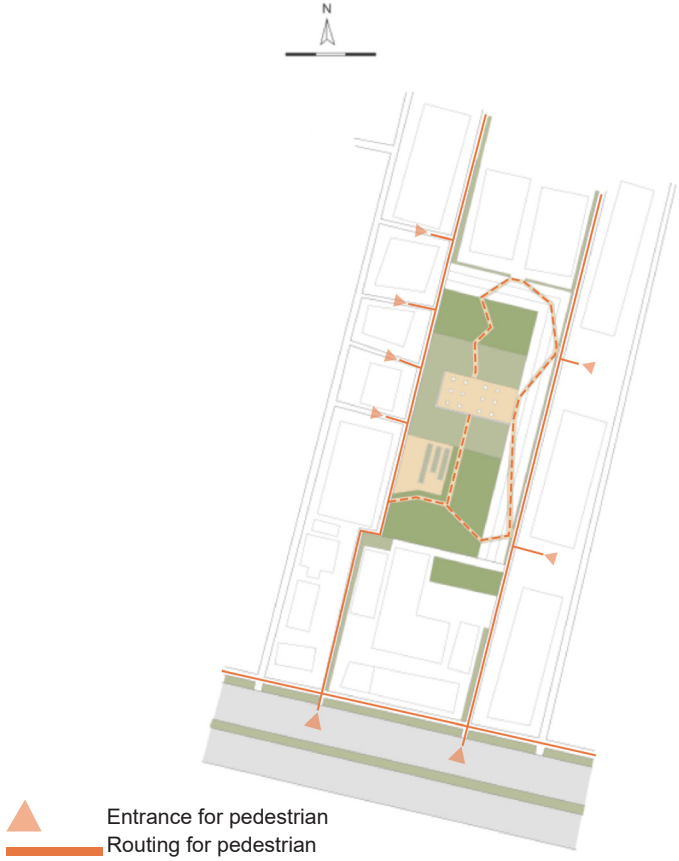
Current situation with pattern

The current pattern of roads and buildings is the source of inspiration for the graphic language in the design. In the design, the original grid-like graphic features are retained.

Spatial design

Routing

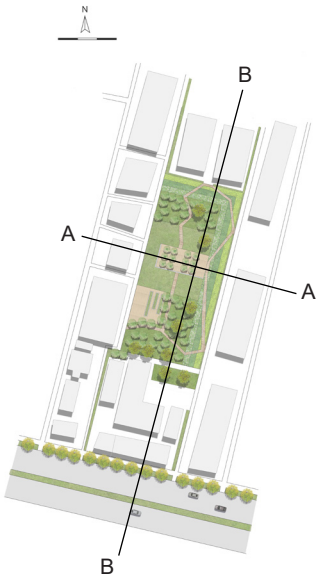
Spatial function



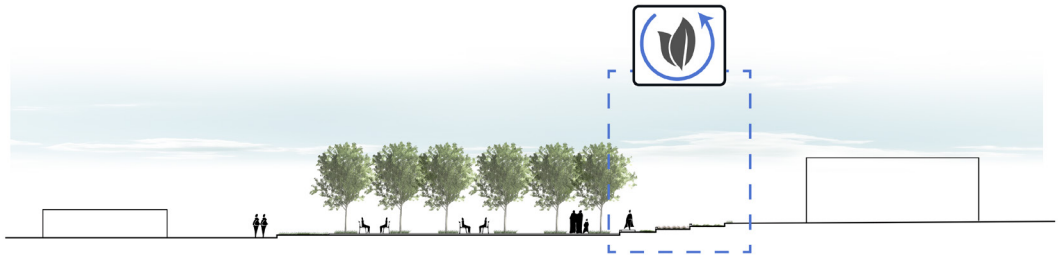
Water purification vegetations are planted in the planting pond in the northeast to purify the sewage flowing through the site from the industrial park. The wooden platform provides rest and lunch space for the surrounding office workers.

Because of the desire to serve the surrounding staff, this site has many entrances, and people can quickly and directly reach the park from all directions.

Design with water strategy



Section A-A



Section B-B

In this site, the stepped planting tank can gradually purify the water, and the lawn in the middle can ensure permeability.

Bird view

Eye-level perspective

5.4 Vision

After reusing the former industrial areas and left-over "buffer" zones to expand the new green-blue network to solve waterlogging, the natural drainage system in this area is restored and the water storage space is increased. At the same time, this connected green-blue structure has become an important landscape viewpoint in the city, which increases public space and improves the living quality of local residents.

Chapter 6

CONCLUSION AND REFLECTION

This chapter is the discussion and reflection on the whole project. It will start from the aspects of the original goals of this project, problems and thinking encountered during the research and design process, discussion of the advantages and disadvantages of the selected design method, scalability of design method, and the final thoughts after the project.

Reflection

Sub Questions	Theoretical Approach	Theoretical Approach
How to improve the sponge capacity of the city?	Green-Blue infrastructure Case study - Copenhagen drainage and corrosion prevention Plan	Finding potential spaces to expand green-blue structure Water strategies
How can industrial transformation support to resolve the waterlogging problem?	Literature - "Performance Evaluation-oriented" Thoughts on the Integration and Transformation of Low-Efficiency Village-level Industrial Parks: Taking Guangzhou as an Example	Reclamation of (functional conversion) former industrial sites to expand the green-blue structure
How can a landscape approach be used to improve the sponge capacity of the city?	Landscape as infrastructure Green-Blue infrastructure	Creating connected Green-Blue structure
How can the new green and blue infrastructure improve the living quality of the city districts?	Case study	Spatial design of chosen sites

Reflecting on the relationship to Flowscapes Studio

This research project belongs to the graduation lab- Adaptive landscape transformation (Pearl River Delta), and the lab focuses on the existing opportunities, challenges, and adaptive transformation methods in the Pearl River Delta region.

The Pearl River Delta region is an area that has developed rapidly over the past 40 years. The development here includes the increase in the size of land reclaimed from land and the economic changes in GDP growth. Today, "Pearl River Delta" is not just a concept of geographic location, but also an overall cooperating economic zone. There are many problems in the Pearl River Delta region, including water security, industrial transformation, urban villages, ecological environment, and so on. And these problems are not existing independently, they can all be regarded as the legacy of urban development, or urban planning and design. For example, in order to obtain urban expansion land, some original water bodies, forests, and agricultural land have become construction land, and the reduction of green land and water bodies has brought pressure on urban water storage and drainage, which indirectly caused waterlogging problems. In order to develop the economy through industrialization, factor ies of various types and sizes were built, but nowadays, many factories have been eliminated because of low output value or inferior industrial types. These empty and abandoned factories have become unsightly, worthless, and unattractive elements in the city.

The studio responded to urban issues such as urban waterlogging, industrial transformation, and urban villages, and proposed projects to build green-blue structure, reuse old industrial areas, and renovate urban villages. The purpose of this studio is to find the landscape approach that can solve the existing problems of the city and adapt to the urban development. The studio hopes that the ultimate goal is to create a better environment for the society through different forms of flow in the landscape, thereby reflecting the value of the landscape in environmental protection and social development.

Reflecting through the process

Stage1. Data analysis and site visit

The initial data collection was difficult, and the lack of mappings and data needed to be overcome. After the preliminary data analysis, the whole group conducted a field survey of Guangzhou and Foshan in December 2019. The site visit made clear that the metropole not only faces water challenges but also with rapid urban transformation.

Based on the above information, waterlogging was selected as the main research object, and industrial transformation may provide some opportunities for problem-solving.

Stage 2. Summarizing and refine the design principle - "Landscape as infrastructure" approach and Green-Blue structure

After comprehensive consideration, the establishment of a new Green-Blue structure based on the theoretical basis of "landscape as infrastructure" was taken as the main design direction. The project hopes to add water bodies and green spaces to form a new connected Green-Blue network that is conducive to urban drainage. At the same time, providing local residents with public green space to improve their living quality.

Stage 3. Applying design strategies in planning and design - Reclamation of left over "buffer" spaces and industrial areas to sustain the metropole

In the process of establishing the new framework, possibilities for abandoned factories are discovered. Because many small factories are close to residential areas and urban roads, and urban roads are the main places where have waterlogging problem. They can become an important part of the new Green-Blue structure. After that, each site itself is designed with its unique functions. These functions can give new meaning to abandoned factories and spaces according to their own problems and needs.

Because each component can combine its own problems and requirements, this new structure is adaptable and flexible. At the same time, this method does not directly limit the development of the city, but explores the possibility of problem areas, and the Green-Blue structure itself can generate value, such as reducing the need for urban grey infrastructure. The public green and blue spaces can bring vitality to the surrounding area.

Reflecting on the outcome

The multi-scale green-blue structural design reflects the above advantages. For the large-scale Green-Blue structural design, the structure must be large enough and well connected to play a role in helping drainage and storage. Neighborhood scale design can be seen as the connection between the macro scale and the micro scale, which can more clearly express the unclear water flow direction and drainage facilities on the macro scale. Miniature design sites are the scale for people to feel the spatial quality. These selected locations not only solved their own problems and paid attention to the needs of the local people around them, but also formed a complete blue-green structure.

Of course, the design of the blue-green frame is somewhat idealized. To truly realize this structure, the project needs the support of local government policies and the cooperation and understanding of local people. But it is a meaningful attempt and a solution that can be considered. For governance, it is important to acquire the Green-Blue structure in a growing metropolitan area. The structure is not the only way to solve the problem, but it is more sustainable and flexible. Green spaces add value to surrounding communities. Because the entire Pearl River Delta region has similar geographical characteristics and similar development models, many cities are facing similar problems, such as industrial transformation and urban waterlogging. If this method proves to be effective and can be implemented, then for the entire region, this is a new possibility that can be widely used.

Reflecting through the social significance of landscape architecture

Landscape architecture not only helps the water strategy but also becomes a 'human' strategy.

From the wildfires in Australia, the locust plague in Africa to the COVID-19 that swept the world, it was difficult by the beginning of 2020, which reminds people that the development of many regions was initially at the expense of the environment. Since the beginning of the Industrial Revolution, every country in the world has gone through a similar process. The vigorous development of industry quickly realized the blowout of economic, cultural and technological development. Next, they must face the pollution problems caused by industrial and urban expansion before they begin to address pollution and protect the environment. The problem people face today is actually paying for past actions. When mankind seeks its own development space only from the perspective of utilitarianism, they should also consider respecting the infinite value of the environment and the environment itself.

After all, human development must depend on environmental resources and space, but the environment does not require humans. Therefore, protecting and respecting the environment is also beneficial to mankind, especially after people have to face serious environmental problems, they should seriously carry out various actions to affect the environment. Landscape architects are happy to address these environmental issues from a landscape perspective in a sustainable and adaptable perspective. For example, landscape architects will be involved in projects that rehabilitate contaminated areas, rainwater management, soil and water purification, and nature reserve design. All of these can contribute to environmental protection and sustainable development.

Reference

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