WATER RESILIENT AND ADAPTIVE DEVELOPMENT OF PAZHOU ISLAND

THESIS REPORT
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TU Delft

WATER RESILIENT AND ADAPTIVE DEVELOMENT OF PAZHOU ISLAND

Adaptive landscape transformation
Pearl River Delta graduation lab
Graduation Report

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ABSTRACT

The Pearl River Delta (PRD), as one of the fastest developing deltas in terms of land expansion and urban development in the world, is facing serious challenges related to Urban expansion & densification, urban flooding, and identity crisis. **The objective of this research is to design a landscape framework and explore adaptive design principles for water resilient urban development of Pazhou.** Applying a layered and landscape-based approach, the design uses a method of building up a fundamentally water resilient landscape structure, following with adaptive development structured by TOD principles and high-quality urban space principles.

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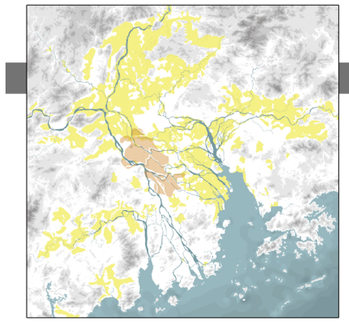
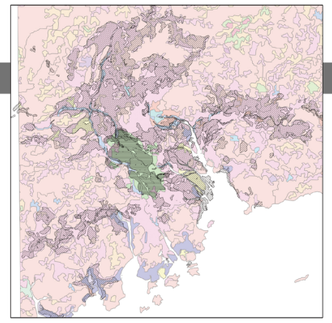
CHAPTER 01

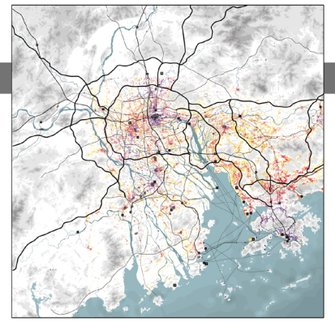
INTRODUCTION





A **AGRICULTURE**
TOPOGRAPHY
LITHOLOGY

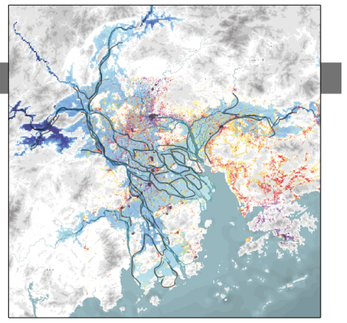
Intergrated
agriculture-aquaculture in PRD
and the **dike-pond system**



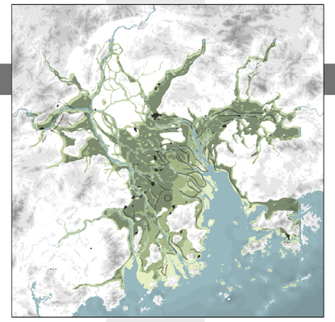
B **INFRUSTRUCTURE**
URBAN EXPANSION
TOPOGRAPHY

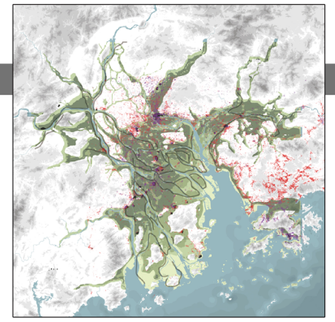
Chinese economic reform, led by Deng Xiaoping and started in December 1978.

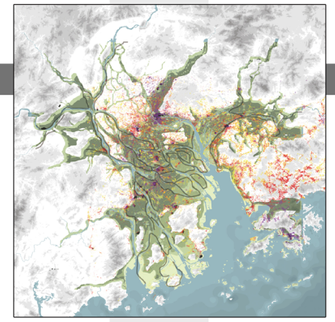
C **FLOODING AREA**
DIKE SYSTEM
URBAN EXPANSION



3. **URBAN EXPANSION**



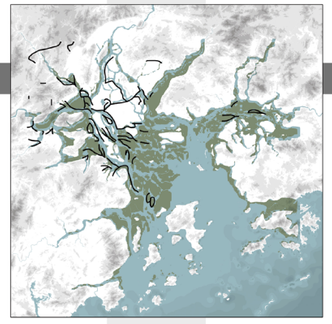


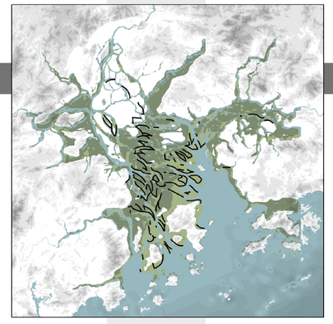


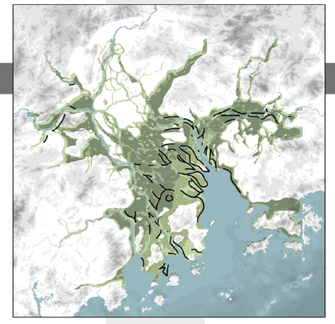
In the most dynamic section of the river the land owners enforce d the natural levee to protect their farmland.

The dike system developed towards the newly formed part of the delta region, scaling up from local to **semi-regional scale.**

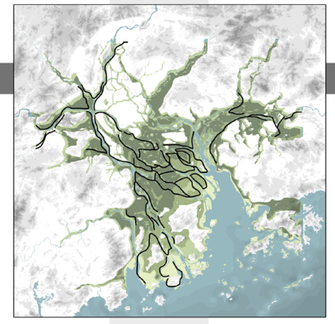
2. **DIKE SYSTEM**
RELOCATION &
INTEGRATION



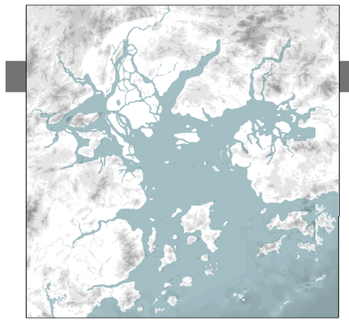


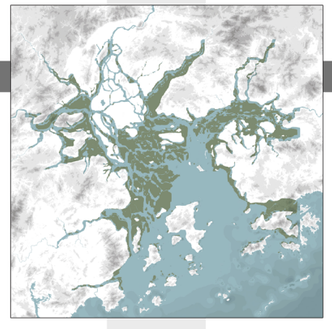


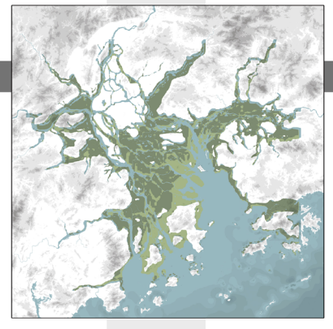
Since 1950 AD the dike system has been scaling up towards a **regional** level, resulted in an integrated regional dike system.The number of dike rings shrink from over **1000** in 1900 to **218** in 1982

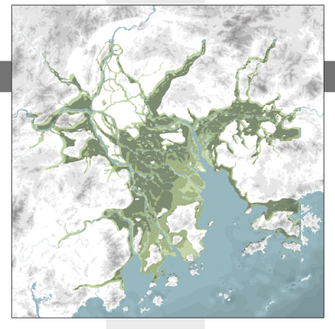


The spatial scaling resulted in an integrated regional dike system



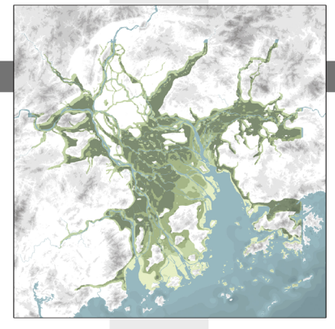






1. **DELTA FORMATION**
SEDIMENTATION &
LAND RECLAMATION

88.72 million tons
annual average
sediment carriage and
20% deposited



6666.7 hectares
of land reclamation
untill 2007
(3 Delft)

20 40 60 80 100km

4000B.C. 4000B.C. -**1600** 1600 -**1900** 1900 -**1950** 1950 -**2015**

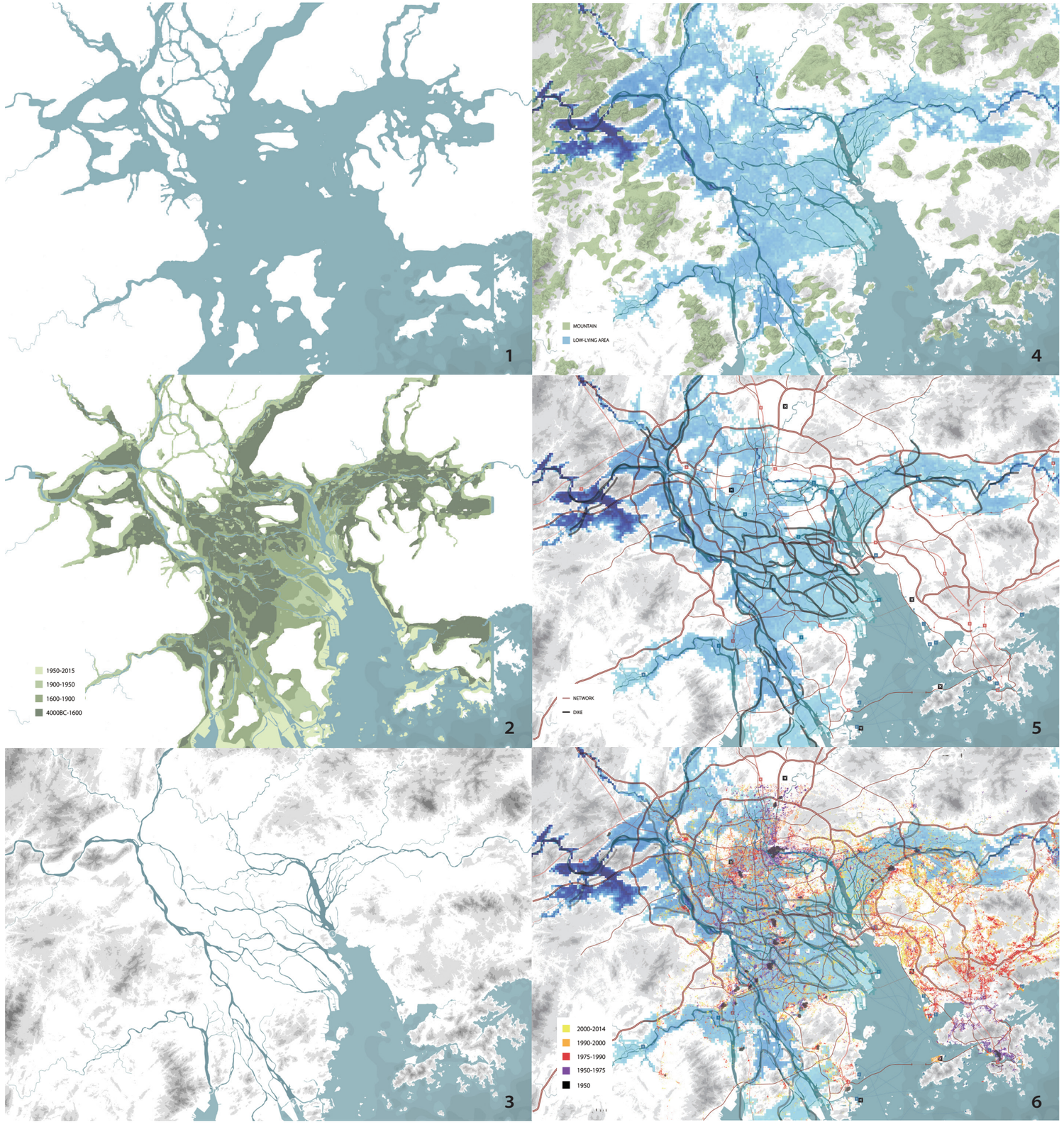
1.1 THE DEVELOPMENT OF PRD

The Pearl River Delta (PRD) changed dramatically in the last centuries.

Back in the 4000 b.c., the large area of the center delta didn't exist. Due to the great process of natural sedimentation and land reclamation by human activities, the coastline expanded almost 100km towards the sea, creating large areas in the middle delta that later become the core development areas. Looking into the elevation of the region, the expanded middle area is apparently very low and the surroundings are much higher. It is a blessing of protection by the surrounding mountains and cures by the risk of floodings.

Still, the locals choose to develop in the lower-lying expanded areas. They gradually built up a regional dike system for the protection of farmlands and cities. And also a circular network structure was created, strengthened the linkage between the cities separated in the whole region.

Since the condition for urban development has been created, in terms offlood protection and communication. The cities gradually expanded in the plain areas, and greatly densifying when there is limited space to expand. Thus, the PRD becomes one of the fastest and well developing deltas in the world.



Left
Series drawings of the development of PRD and important historical events

Right
1. PRD in 4000 b.c.
2. Growing by sedimentation & reclaimation
3. Elevation
4. Lower-lying areas and mountains
5. Infrustructures of dikes and networks as condition for development
6. Urban expansion process

(Data source: Nijhuis S, Hellendoorn D)

1.2 PROBLEM STATEMENT

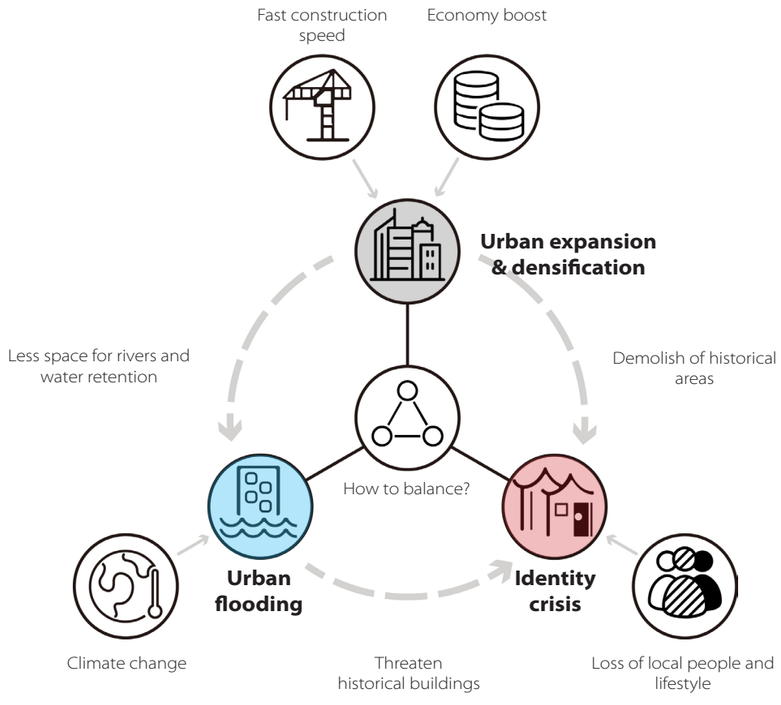
THE THREE PROBLEMS IN CLOSE RELATION

Learning from the development process of PRD, some main problems that are inter-related can be defined: **urban flooding, urban expansion & densification and identity crisis.**

As one of the fastest developing deltas in the world, the urban expansion in the PRD region is requiring more and more land which results in great densification in urban areas as the land reclamation speed is much slower in comparison. Since the land amount is limited, the space for rivers outside and for water retentions within the dike will be taken over, resulting in severer urban flooding issues that also influenced by climate change and sea-level rise.

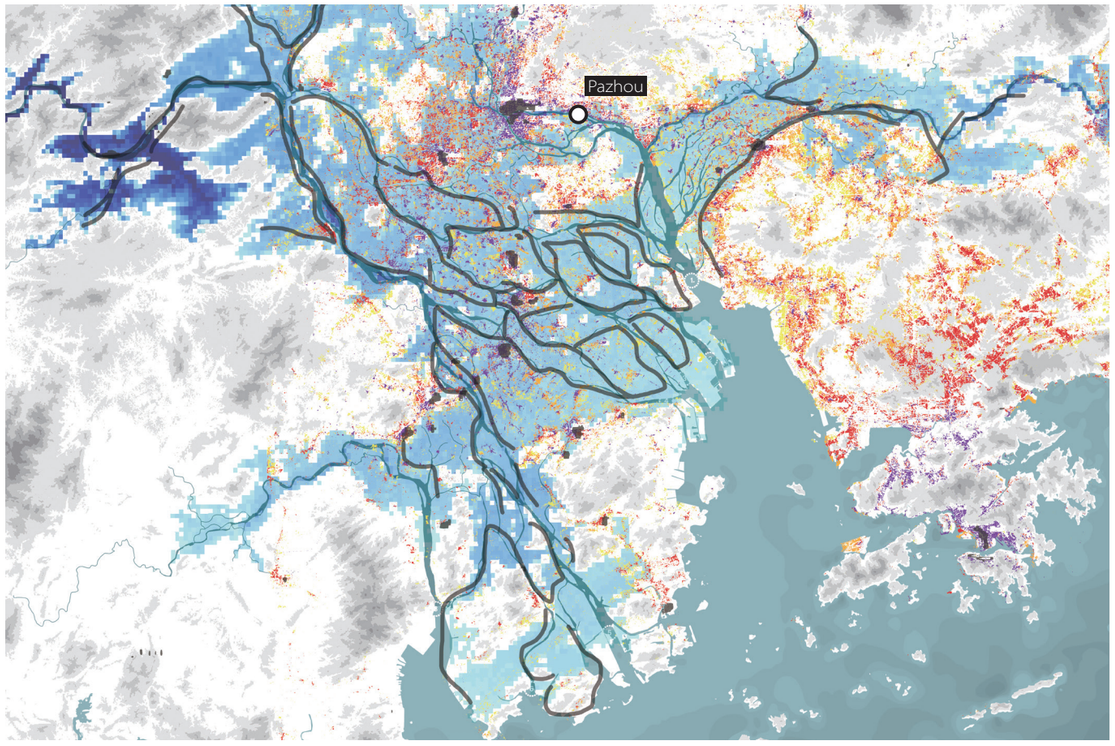
On the other hand, urban expansion requires more land for residents, service, public space, economy, etc. Some of the historical areas in the PRD region have been taken over to meet new development needs. The urban floodings are also threatening the historical buildings since the traditional retention structure cannot meet the continuously rising water level. What's more, the identities of the PRD region is not only about the spatial entities, but also the intangible culture and lifestyle of the locals such as the Tanka people (fishermen) are culture living on the boat. Due to the loss of their original living areas and the hardship for them to join the new economic system, many of the locals aren't able to preserve their traditional culture and lifestyle anymore.

In conclusion, these problems raise challenges for us landscape architects. How can we design in such a way that urban resilience can be assured while preserving the local identity in the background of the inevitable fast urban development and great densification?



URBAN FLOODING

The Pearl River Delta is an estuary impact plain. The location of the low altitude and the sea-land junction determines its own ecological vulnerability (Meyer, 2014). According to historical data, there have been 100 major and minor floods in Guangzhou, once every 20 years (Qingzhou, 2009) from the completion of Panyu to the end of the Qing Dynasty. Since the 20th century, there have been two major floods with more than 100,000 casualties (Qingzhou, 2002).



Overlay of: urban expansion, dike system, flooding risks area in the PRD region
(Data source: Nijhuis S)

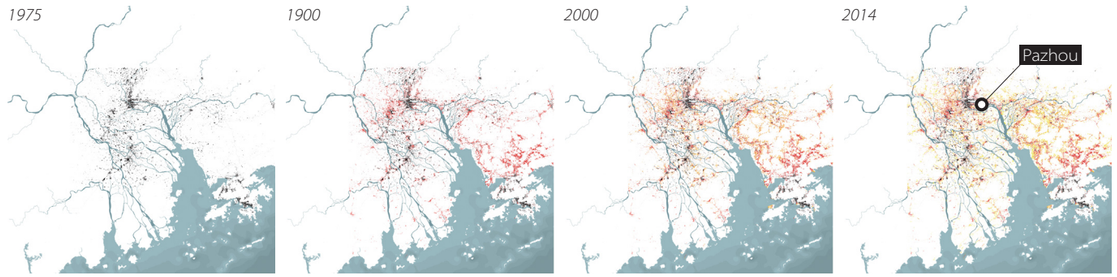
Inner dike rainwater flooding in Pazhou on 2015-08-14
(source: sohu)

Outer dike river water flooding in Pazhou on 2018-09-16 Super typhoon "Mangkhut"
(source: kknews)

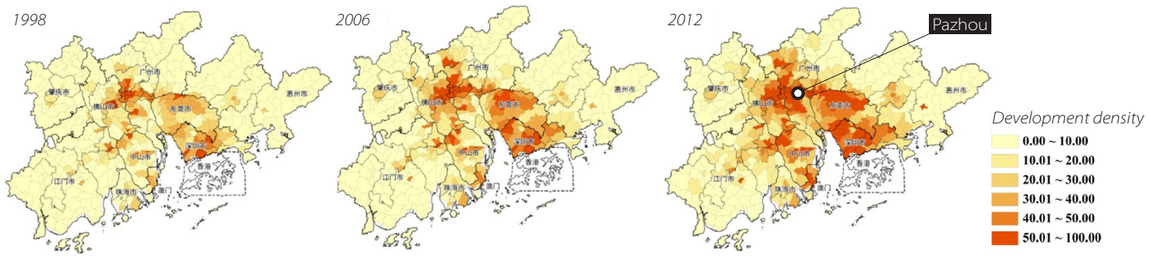
URBAN EXPANSION & DENSIFICATION

Land development density refers to the ratio of total construction land to the administrative area.

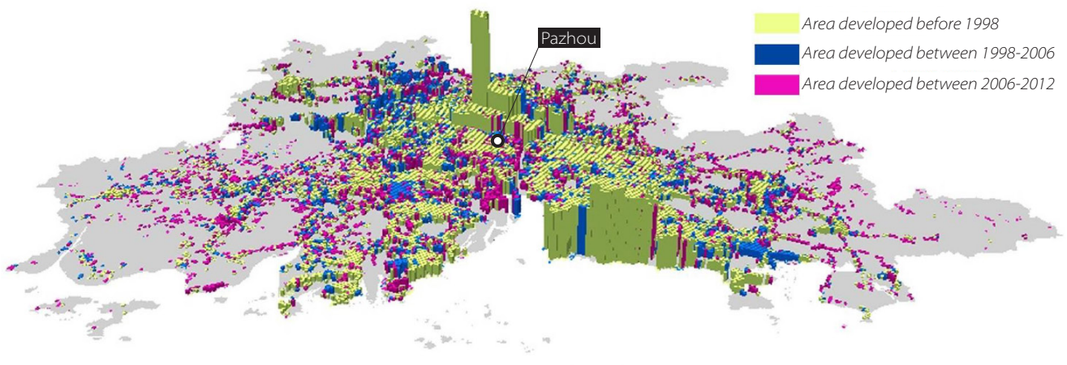
The shortage of land resources in the region is prominent. The developed area in the PRP region has increased by nearly five times in the past 30 years. In 2013, the intensity of land development has reached 16.5%, of which Shenzhen has the highest development intensity, close to 50%. Guangzhou has nearly approached 30%, (Wenpeng F, 2018) the warning line beyond which the human living environment will be affected according to international practice.



Urban expansion history in the PRD region
(Data source: Nijhuis S)



Changes of the development density of PRD region at township scale during1998-2012
(Source: Ye, Y., Li, S., Zhang, H., Su, Y., Wu, Q., Wu, K., & Liu, K. (2017).)



Development density at 1 km grid in PRD region during1998-2012
(Source: Ye, Y., Li, S., Zhang, H., Su, Y., Wu, Q., Wu, K., & Liu, K. (2017).)

IDENTITY CRISIS

The PRD region has a long history and various identities related to water. Due to the urban expansion and loss of locals, some of these identities are facing crisis, in which the specific ones related to Pazhou are listed below.

The history of shipping and trading of Guangzhou

As one of the starting ports and hubs of the Maritime Silk Road, the prosperity of Guangzhou once reached its peak. From 1757, Guangzhou was the only trading port with foreign countries in China, historically known as "one port trade". Its international popularity increased rapidly, becoming the third largest city in the world. (wikipedia)

Left: Guangzhou as the starting point of the Maritime Silk Road
Middle/Right: Guangzhou as the only trading port of China in Qing dynasty. View of trading boats around Pazhou island and Pazhou tower
(Source: Wikipedia)

The historical villages and water retention structure within

There are lots of historical villages in the region, in which most of them have close relation with water. They were either built near the rivers or have waterbodies within for rainwater retention and stroage.

Left: Histirocal temples and Fengshui ponds in the front, Huangpu village, Pazhou
Right: Urban villages and water retention ponds, Huangpu village, Pazhou
(Source: club.huawei, gz.leju)

The Tanka people (fishermen) and their lifestyle living in the boat on the river.

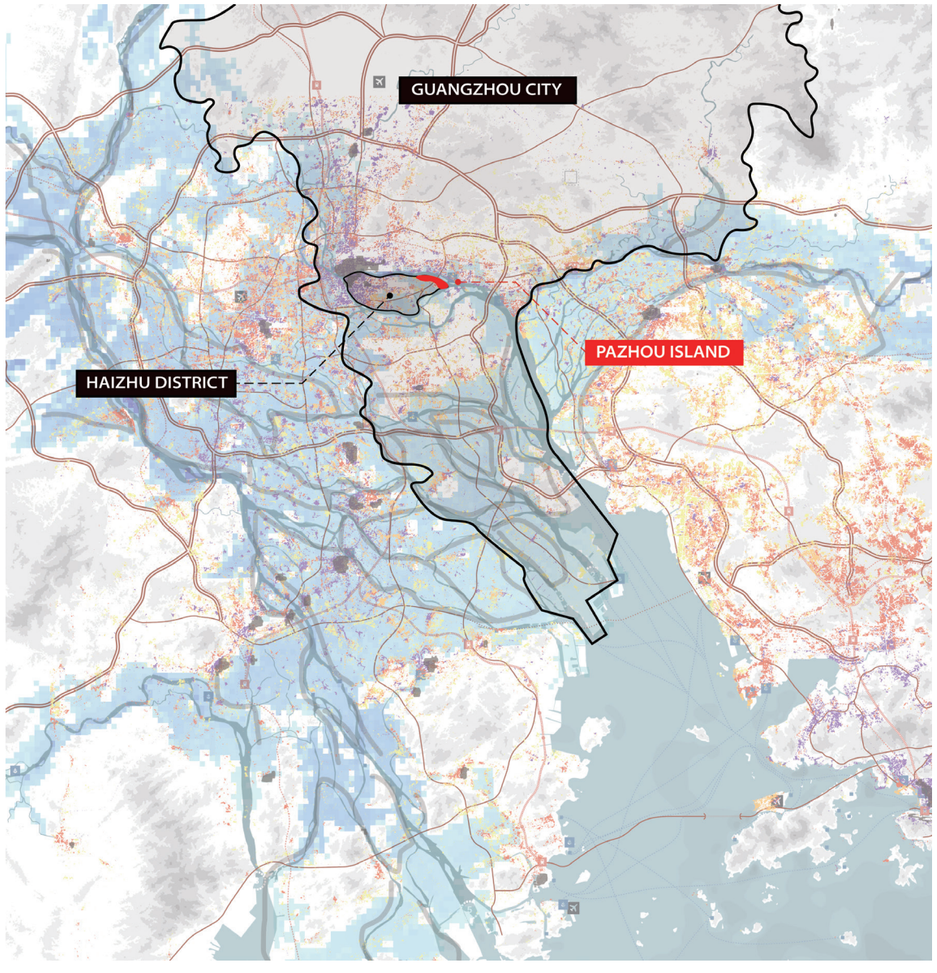
Left: The Tanka people settlement on the Pearl River a century ago, has now disappeard
Middle: The Xinzhou fishing village on Pazhou and the constructing highway that will demolish the village
(Source: zhihu)

1.3 SITE FOR RESEARCH AND DESIGN

LOCATION

Base on the problem statement, the chosen research site for further research and design exploration is Pazhou island in Haizhu district. In terms of urban development and administration, the site is located in the urban center of Guangzhou city, the capital city of the region. And in the perspective of landscape condition, it is in the very center of the lower-lying areas with flooding risks. Also, this area is the cultural origin of PRD, so there are lots of historical heritages and the identity crisis issues are severe.

All these existing conditions make the site an ideal place for research and design that can become a nice example to apply to the rest of the PRD.

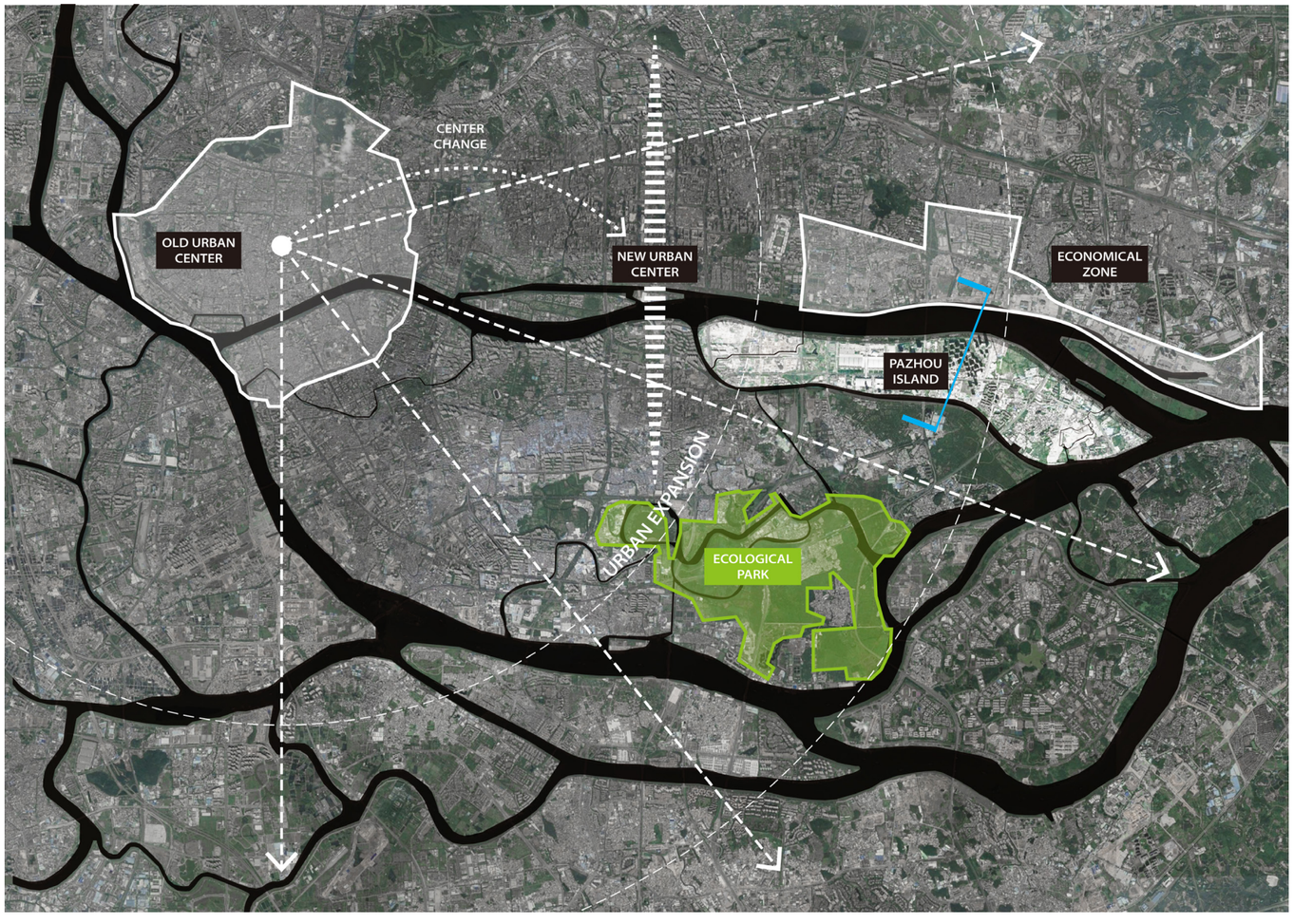


Location of Guangzhou city, Haizhu district and Pazhou island in PRD (source: self-drawing)

RESEARCH AND DESIGN SCOPE

The exact design will be on the scale of Pazhou island and will have a detailed focus on the east corner of the island. The research scope expands towards the west to show the relation between Pazhou and Guangzhou urban centers.

To start with, this area has the historical urban center of the whole PRD, just 15km away from Pazhou island. A lot of historical heritages exist here along the rivers and are disappearing. Urban development expands towards the east gradually. And the actual urban center has been shift from the old one to the new axis. The west and middle part of Pahzou has already been influenced by this expansion and developed into high-density urban areas, while the east part is not yet being influenced. This is one of the reasons that the east part of the island will become the design site for it has the opportunity to be tested. The north bank of Pazhou island across the Pearl River is an economical zone, and lying at the south of Pazhou is a large ecological wetland park of the Haizhu district. All these surrounding conditions imply the complexity of the positioning of Pazhou island. It is a challenge to keep a balance between high-dense urban development, flood protection, ecology, and preservation of identity.



Relation between Pazhou island and surroundings and a section for further explaining of argumentation (source: self-drawing)

EXISTING PLANNING PRACTICE

This research area is a typical example of the previously stated problem of Urban expansion & densification, urban flooding, and identity crisis. However, the government's present and coming plan to deal with these problems will not be effective as expected. The further argumentation will be explained in a series of sections.

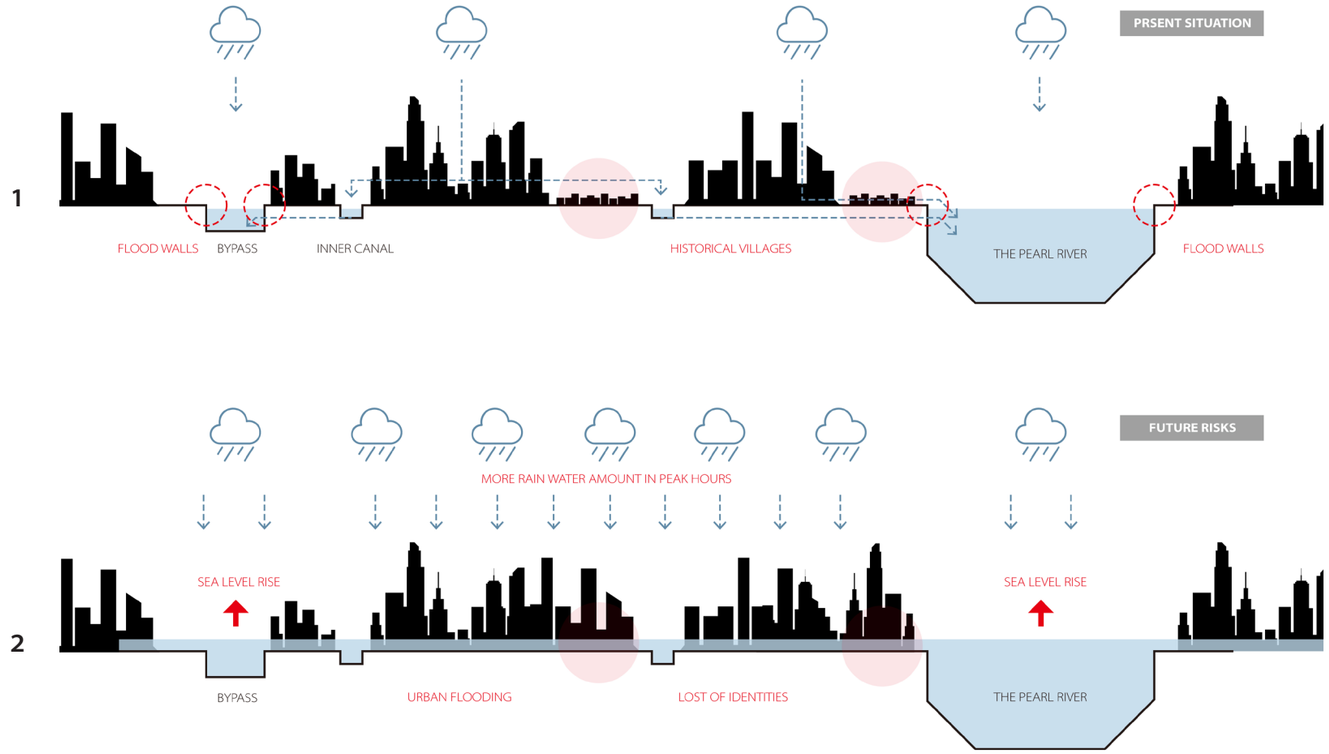
First, in the current situation, floodwalls are built all around the river borders as flood protection, and there are some existing retention systems such as inner canals inland. The whole system is functioning well for now, but the situations will not last forever.

In the future, the sea-level will rise due to climate change and restricted capacity by the hard river borders. There will be more rainwater amount in the peak hours. The city will be flooded by both river water and rainwater if no measures to be taken. Also, urban development is requiring more land and high density, threatening the existence of the historical villages.

The government's following plan as known, for now, is to engineer a way out. The flood walls will be lifted up to a higher standard of flood protection, and the sponge city strategy will be taken inland for more rainwater retention capacity. There will also be measures on the historical preservation of the villages.

These measures are indeed effective, but just for some periods. Because the situation will always be changing. There will be even higher sea-level or more rainwater coming down, and the plans will fail someday. Then the whole system of protection together with a large area of the city needs to be redesign again to meet an even higher standard, bringing huge financial burdens. As long as the measures are based on construction resilience, this cycle will always exist.

Then the question arises that if there is a way to create a fundamentally water resilient landscape structure, providing conditions for further development that is adaptive to possible future challenges? By studying related theories, there is an answer.



Series drawings of argumentation for the existing plan
1. Present situation
2. Future risks if no measures being taken
3. Government's plan
4. The unpected future

(Source: self-drawing)

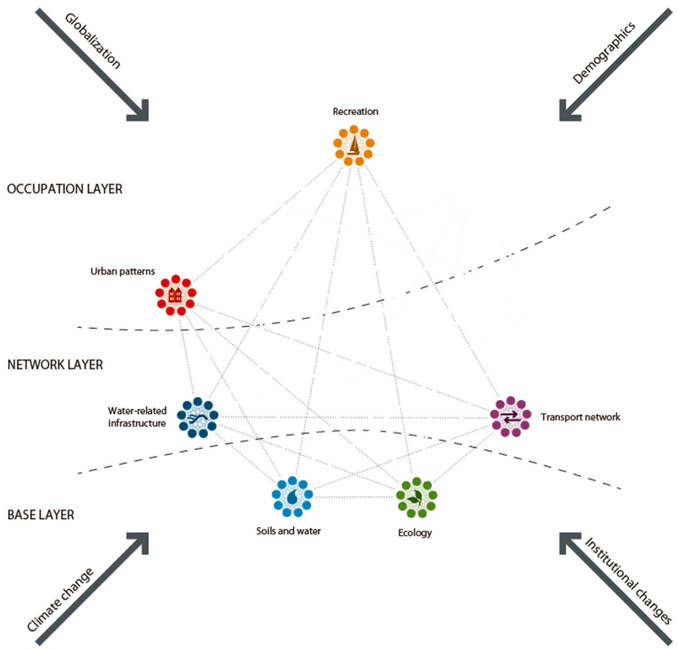
1.4 THEORETICAL BACKGROUNDS

COMPLEX ADAPTIVE SYSTEM (CAS)

The essence of the "CAS" approach is that an urbanized delta is perceived as a complex and dynamic whole made up of different component parts (sectors) which continually influence one another and together as a whole are influenced by many different types of social, biological and physical developments (Giacomoni, Kanta & Zechman, 2013).

In the urbanized deltas, the important components of the CAS should consist of **urban patterns, ports, shipping and transportation systems, water and flood prevention systems, and ecosystems.** (Meyer et al. 2015; Meyer & Nijhuis, 2016)

Under this approach, the Pearl River Delta can be considered as a complex adaptive system. Since this is a contextual project within the range of Pazhou and focus more on landscape base design, some unrelated components such as agriculture, energy, soils, ports and industry can be neglected.



The selected components of the Pearl River Delta as a complex adaptive system

THE LAYERED APPROACH

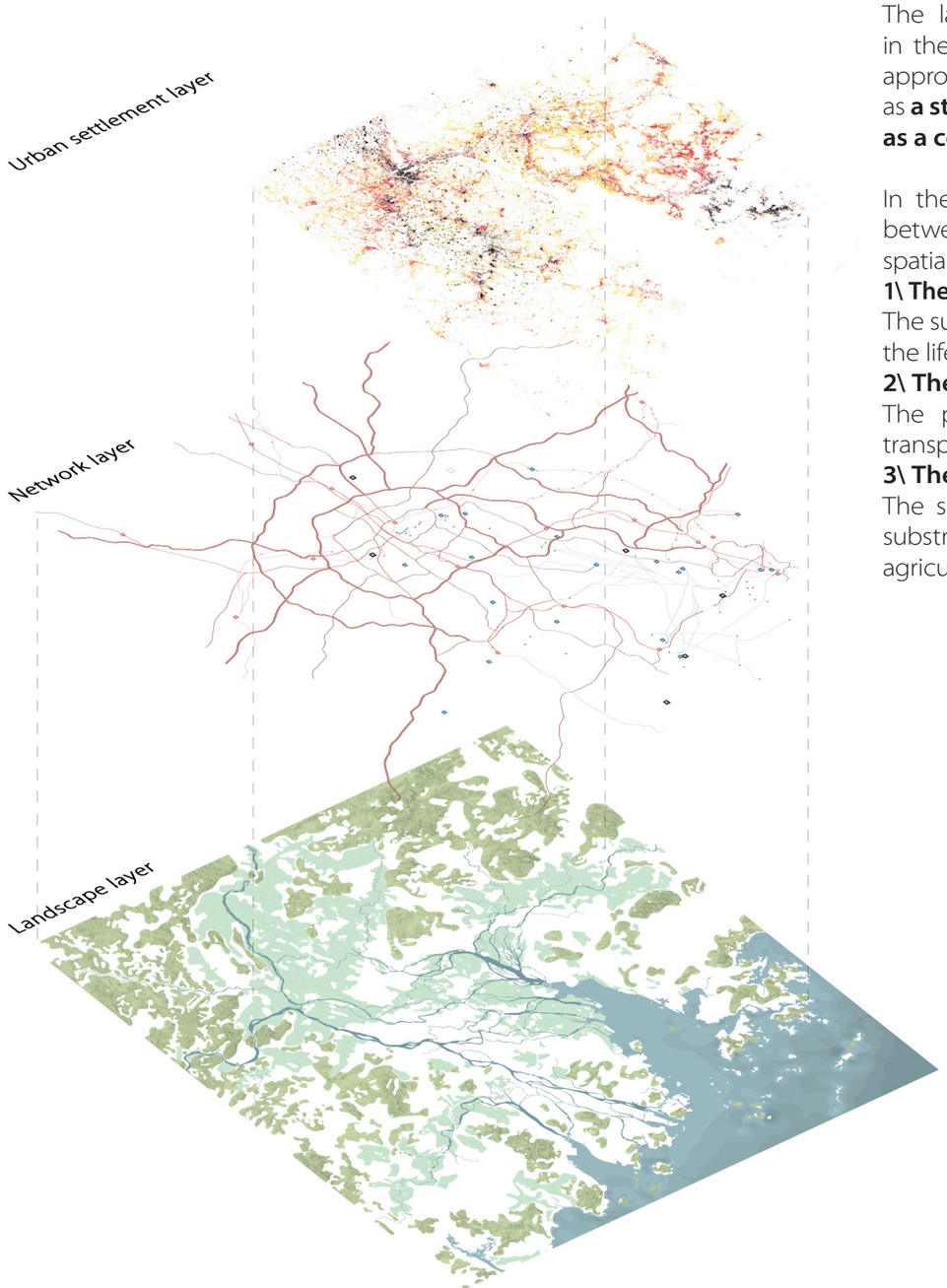
The layered approach initially originated in the USA in the 1960s (McHarg, 1969). In the 1980s, the "layered approach" was introduced in Dutch design and planning as **a step towards visualization of an urban landscape as a complex system.** (Nijhuis & Pouderoijen 2014)

In the layered approach, interactions are investigated between three layers which are said to determine the spatial contours of a region:

1\ The base layer
The substratum, made up of the system of water, soil and the life forms inherent in them;

2\ The network layer
The physical infrastructure of shipping routes, road transportation and railways;

3\ The occupation layer
The spatial patterns resulting from human use of the substratum and networks, for example, urbanization and agriculture.



The three layers of the Pearl River Delta

RESILIENCE

The word resilience was originally derived from the Latin word "resilio", which meant "**to return to its original state**." This word later evolved into "resile" in modern English and is being widely used today (Yiwen S, & Jiang X, 2015).

In 2007, the Rockefeller Foundation released the "Building Climate Change Resilience Initiative" announcement, dedicated to improving social resilience and addressing climate change by focusing on poor and vulnerable people. In this initiative, resilience is defined as **the ability of systems, societies, organizations, and individuals to create, change, and implement a variety of adaptive actions to face unpredictable climate change.** (Martin-Breen P, 2011)

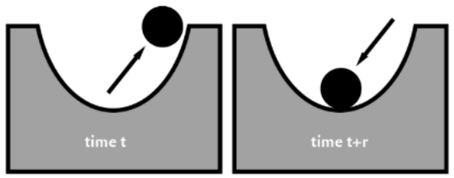
THE EVOVING DEFINITION OF RESILIENCE

The concept of resilience has undergone two revisions. From the initial **engineering resilience** to **ecological resilience** to **evolution resilience**, each amendment enriches and improves the extension and connotation of the concept of urban resilience (Yiwen S, & Jiang X, 2015).

Since the concept of evolution resilience remains in theoretical discussion and hard to translate into spatial language that can apply on landscape design. So in this project, the comparison focus on engineering resilience and ecological resilience.

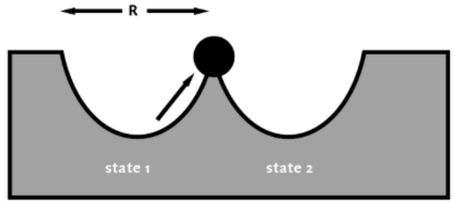
Gunderson use the ball and cup model to explain the difference. Cups represent the stability domains of the system, the ball represents the system state, and single arrows represent disturbances to the system. (Gunderson, 2003)

A. Engineering resilience (r).



Engineering resilience can be depicted by a global equilibrium (ball resting at the bottom of a cup). When the system is disturbed (ball moves up the side of the cup), resilience is defined as the amount of time (r) for the system to return to the equilibrium state. (Gunderson, 2003)

B. Ecological resilience (R).



Ecological resilience is defined as the amount of disturbance that the system can absorb without changing state (stable state 1 or 2), and is measured as the width of the stability domain (R)

Diagram of engineering resilience and ecological resilience (Source: Gunderson, 2003)

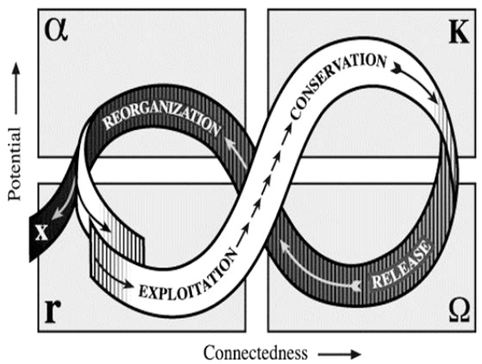


Diagram of evolution resilience (Source: Holling C S, 2002)

CHARACTERISTIC OF URBAN RESILIENCE

During research on the characteristic of urban resilience, various identification from different perspectives by different scholars have been found. These identified characteristics within their own defined structures are independent of the others thus do not provide a comprehensive description of urban resilience. Within these identifications, the ones from Jack F. Ahern are more precise and comprehensive. He conclude **5 main characteristics** of urban resilience. (Ahern, 2011)

1\ Multifunctionality

Urban resilience need to be superimposed with urban functions because the lack of connection between single-function urban elements can easily lead to fragility of the system .

2\ Redundancy and modularization

Urban resilience need certain degree of duplication and spare facility modules. By spreading risks across time, space and systems at different levels, they can reduce losses under disturbance conditions.

3\ (Bio and social) diversity

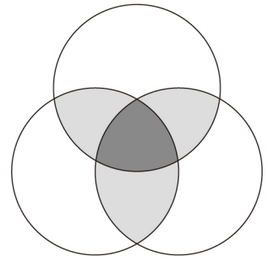
Urban resilience requires biological, social, physical and economic diversity. Each feature adds to the response diversity when facing disburbance and enhancs the overall resilience capacity of that system.

4\ Multi-scale networks and connectivity

Networks provide multi-scale connectivity that build sustainable urban form, often built around blue-green networks that support biodiversity, hydrological processes, pedestrian transportation, climatic modification, neighborhood identity and aesthetic enhancements.

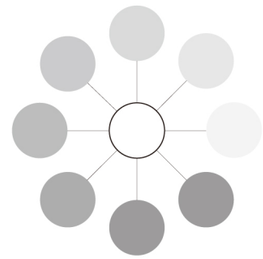
5\ Adaptive planning and design

Adaptive planning and design conceive the "problem" of making decisions with imperfect knowledge about change and uncertain disturbances as an "opportunity" to "learn-by-doing" (Holling, 1978).

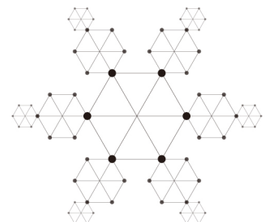


Multifunctionality

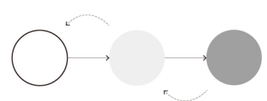
Redundancy and modularization



Bio and social diversity



Multi-scale networks and connectivity



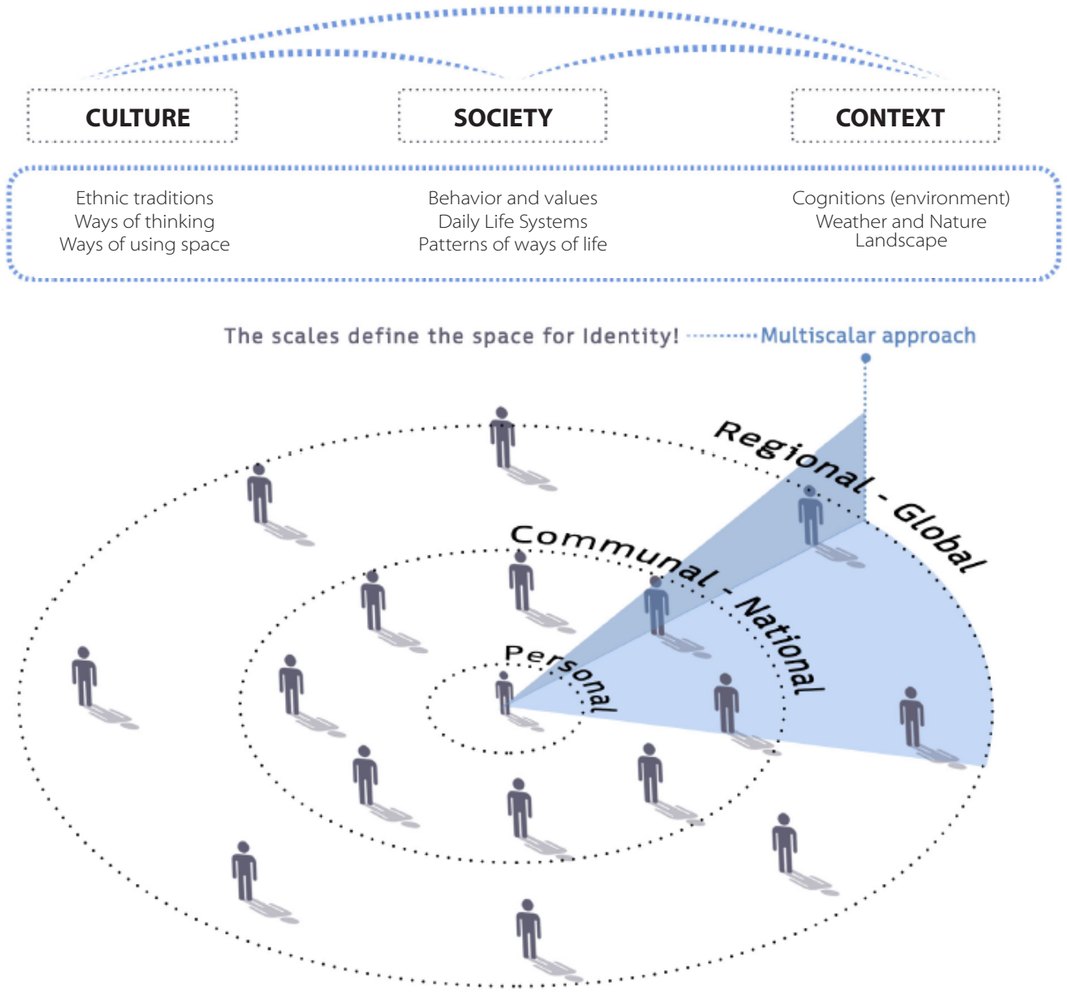
Adaptive planning and design

IDENTITY

The notion of identity is defined by a culture, society and context, in which the different ways of thinking and using space, the daily life systems or the cognitions of the environment are shaping who people are as individuals, but also as a collective.

Identity prevails in different forms - in the individual and the collective, in plural form, reinforcing a strong need for belonging. With the onset of globalisation, the scales of identity range from the individual to a global identity.

Spatial definitions have an implication on identity at different scales, giving spatial planing and governance a big responsibility in the formation of this notion.



Concept of Identity and its multi-scalar manifestations (Data Source: Golubovic, 2010)

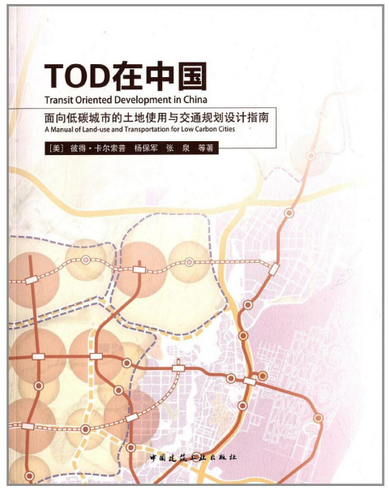
HOW TO SPATIALIZE IDENTITY

Individual or collective identity manifests itself spatially in multiple realms - private, semi-private and public. The constructs of identity such as daily life systems, ways of life, ways of using space, behaviour and cognitions of the environment are expressed through space in these realms. Private space, working space, collective space, networks of interaction and landscape are the spatial indicators that facilitate the expression of identity, and in turn shape identities.

The multi-scalar objectives for spatializing identity

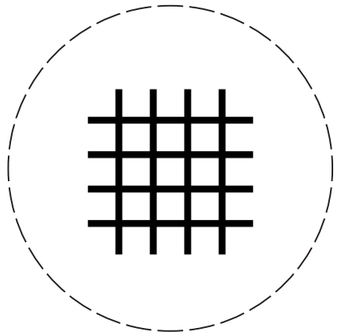
Spatial indicators that shape identity

TOD DESIGN PRINCIPLES

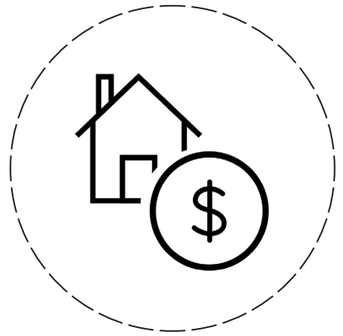


"TRANSIT ORIENTED DEVELOPMENT IN CHINA"

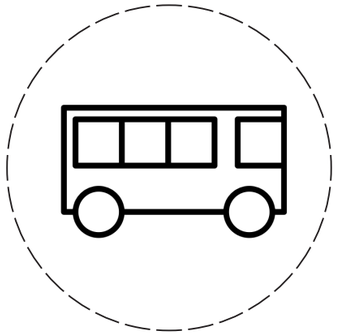
-PETER CALTHORPE



INCREASE ROAD NETWORK DENSITY



CREATING MULTIFUNCTIONAL BLOCKS



DEVELOPINGHIGH-QUALITY PUBLIC TRANSPORT

DESIGNING WALKABLE STREETS AND NEIGHBORHOODS

PRIORITY ON BICYCLE NETWORK

1.5 OBJECTIVE AND SUB-QUESTIONS

OBJECTIVE

Based on the problem statement and the argumentation of the existing situation, the objective of the project is to **design a landscape framework and explore adaptive design principles for water resilient urban development of Pazhou.**

Beyond this objective, the project is not restricted to a site-specific design but to set up an example for the other areas under flooding risk in the future urban expansion areas.

SUB-QUESTIONS

The better understand the site and to achieve the objective, a series of sub-questions need to be answer.

· What is the proper way to understand and analyse the site, and the essential definitions within the objective?

· What spatial conditions determine the spatial structure and identity of Pazhou?

· What are the specific challenges and potentials of pazhou based on the problem statement and spatial analysis?

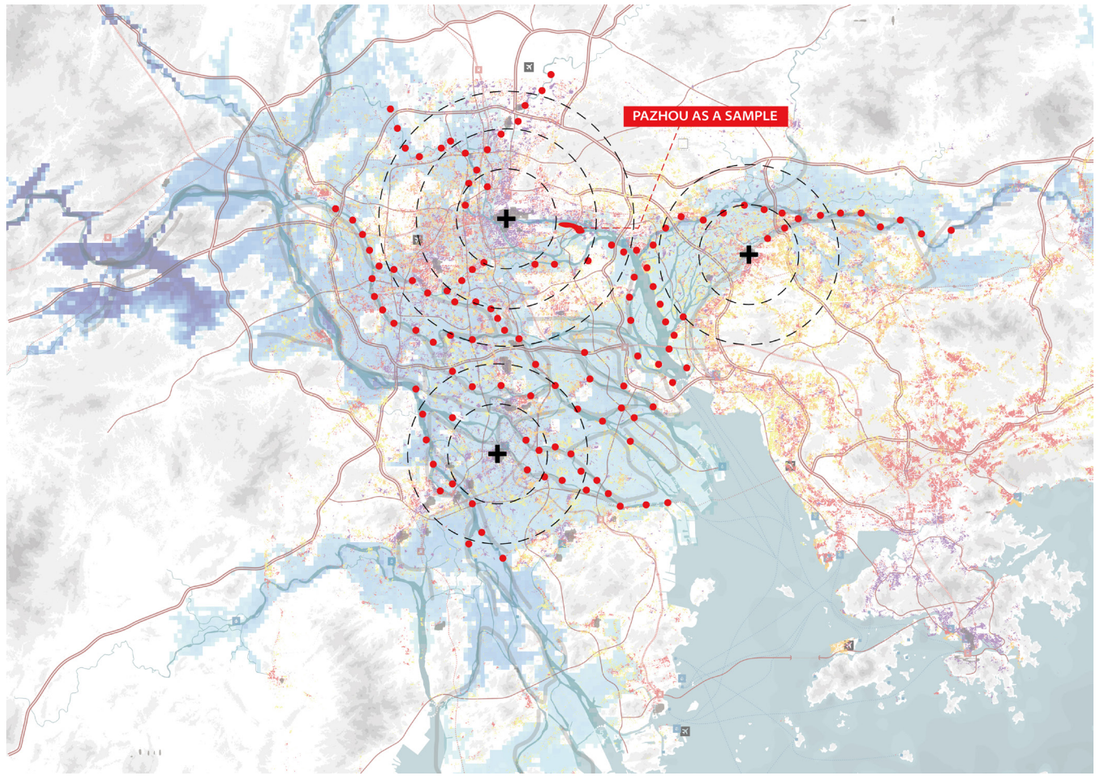
· What are the principles and strategies that can deal with the diagnosed challenges of pazhou, while reflecting on the theorical context?

· How to further select and contextualize the proper principles through design exploration?

· Does the designs work?

· What can we learn from the whole research and design?

These sub-questions can be conclude into four major ones: understanding question, what can we do question, application quesion and lessons learned.



Top: Design objective on Pazhou island
Bottom: Beyond site specific design
(Source: self-drawing)

1.6 METHODOLOGY

RESEARCH BY DESIGN

To understand and answer the series of sub-questions, a method of Research by design is proposed. In this project, the process of research into the site and the design exploration will not be seen as segregated parts of a working process, but a highly integrated system. The two of the process often work in parallel and jump back and forward from time to time.

The research on the site to understand the local conditions and identities will further guide the design decisions. Reversely, the design exploration will help backward to understand the site better. This implies a relationship between research and design where research is seen as an activity to create verifiable knowledge that predicts or explains the physical, behavioral, aesthetic and cultural outcomes of design (Nijhuis, S., & Bobbink, I., 2012, Nijhuis & De Vries, 2020)

THE FRAMEWORK OF RESEARCH BY DESIGN

Based on the research by design methodology, a structure is established to organize the whole working process and to make sure the objective of each step is clear and straight forward. Within the structure, the sub-questions are divided into 6 parts and be filled in a proper position. The working process will keep going back and onwards, and explore between generic knowledge and specific knowledge.

1 THEORETICAL FRAMEWORK
• What is the proper way to understand and analyse the site, and the essential definitions within the objective?

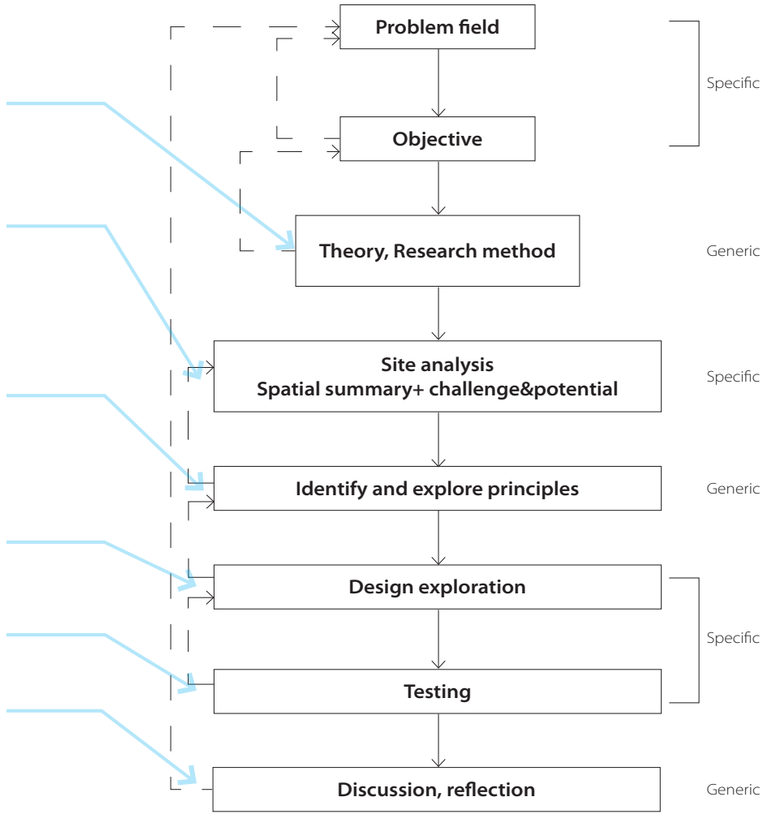
2 SPATIAL ANALYSIS
• What spatial conditions determine the spatial structure and identity of Pazhou?
• What are the specific challenges and potentials of pazhou based on the problem statement and spatial analysis?

3 PRINCIPLES
• What are the principles and strategies that can deal with the diagnosed challenges of pazhou, while reflecting on the theorical context?

4 DESIGN EXPLORATION
• How to further select and contextualize the proper principles through design exploration?

5 TESTING
• Does the designs work?

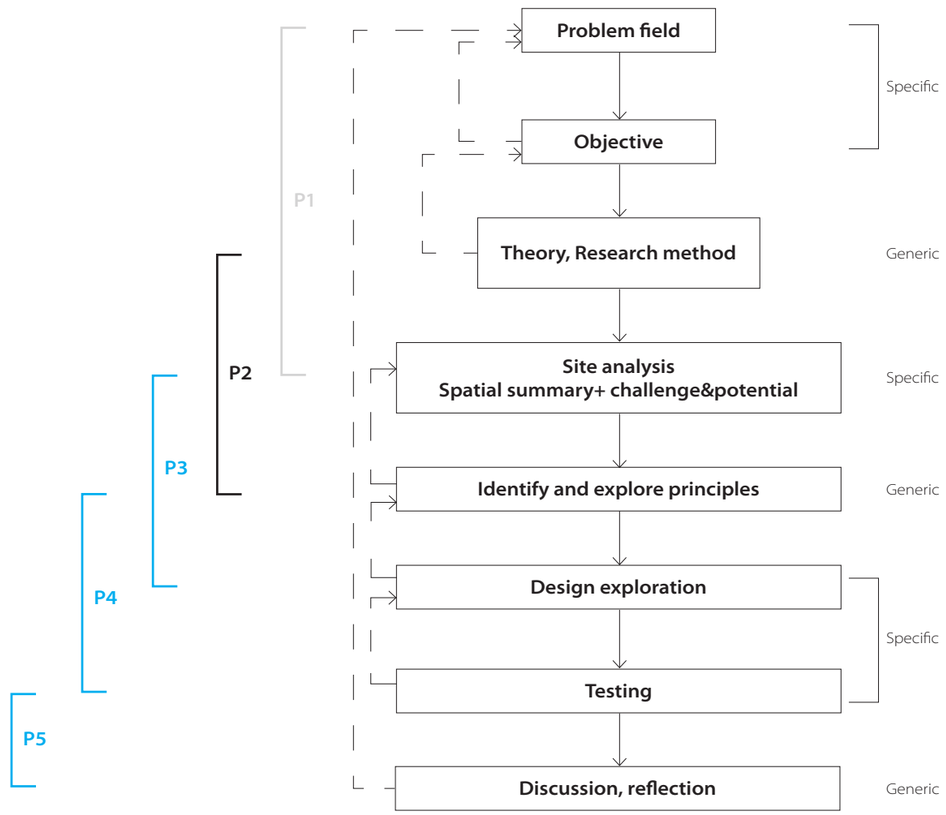
6 CONCLUSION & REFLECTION
• What can we learn from the whole research and design?



1.7 WORKING PLANNING

After setting up a framework of research and design, it is also necessary to organize the whole working process in terms of time planning to fulfill the graduation standard for each coming period.

Left: the framework of research by design
Right: the time planning
(Source: self-drawing)



CHAPTER 02

SITE ANALYSIS

2.1 SITE HISTORICAL EVOLUTION

To understand the conditions that form up the present Pahzou island and its surroundings, also the unique identities, the research into the regional historical evolution is important. Three special periods in history are selected: 1841, 1949, and 2019.

1841 QING DYNASTY

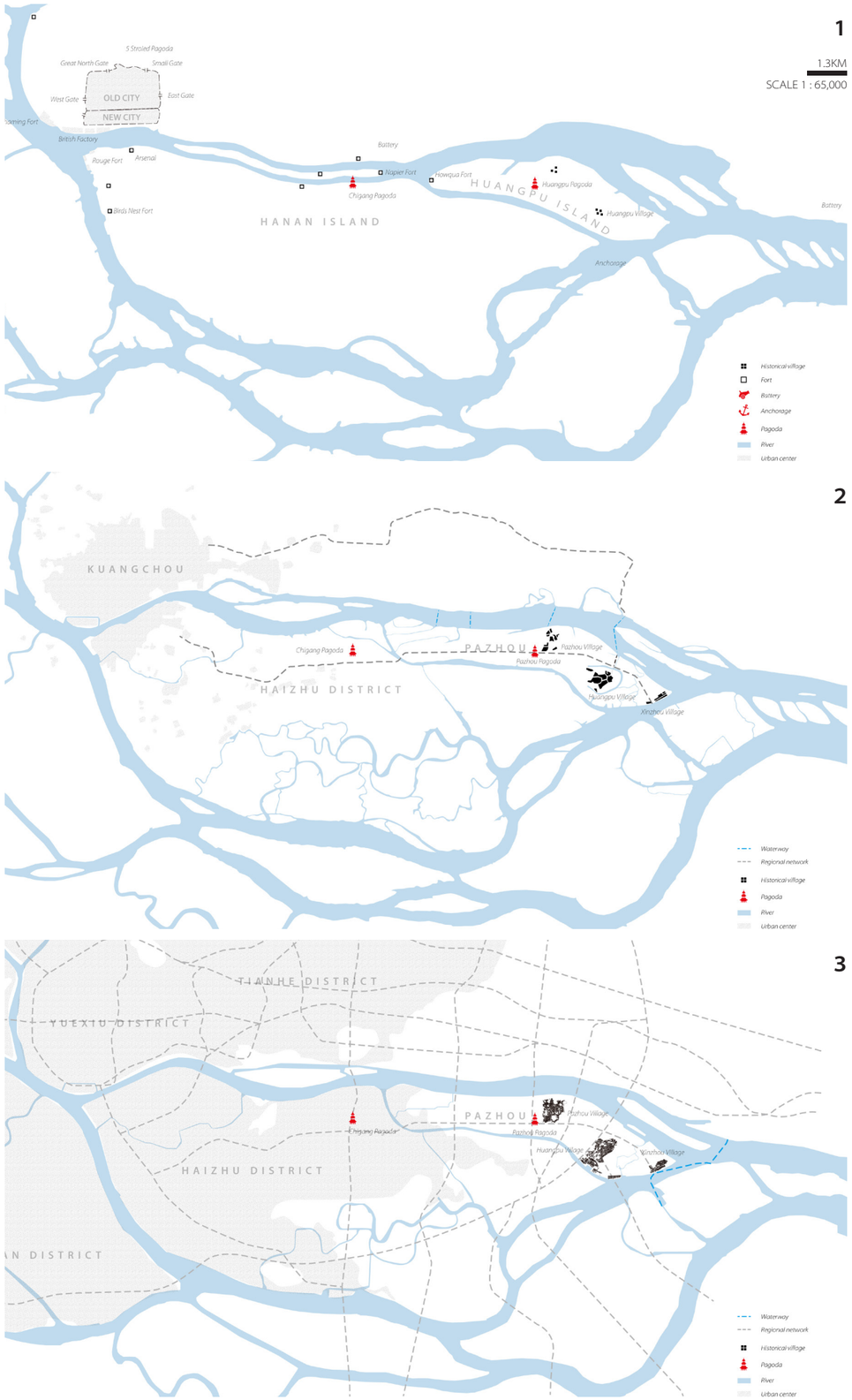
From 1757 to the Qing dynasty, Guangzhou was the only trading port with foreign countries in China, historically known as “one port trade” (Wikipedia). Pazhou island (Huangpu island by that time) is at the front of the trading gate. The anchorage around caused the appearance of the Huangpu historical village for living and trading. The Pazhou tower (Huangpu Pagoda by that time) was built wishing for good luck sailing. Pazhou’s relation with the city center has been close to that period. Along the waterway from Pazhou to Guangzhou city center, there are several defense structures.

1949 MODERN CHINA

In modern times of China, Guangzhou center started to expand mostly towards the east. Yet Pazhou was still out of the center area. The connection between Pazhou and the city center became better since the railway network started to grow. The pagodas in the area had been kept, the same as the historical villages which expanded and developed.

2019 CONTEMPORARY CHINA

In the past half-century, the PRD region experienced great urban expansion, such as the Guangzhou city center. Pazhou is now partly within the central development plan. The regional network has also expanded so Pazhou now has a closer relationship with the city center than ever before. Within Pazhou, the pagoda is well protected by legislation, so as the Huangpu village. The other two historical villages which have also expanded in the past few decades, however, is now facing disappearance.



Series drawinvgs of regional historical evolution
1. 1841 Qing dynasty
2. 1949 Modern China
3. 2019 Contemporary China
(Source: self-drawing)

CONCLUSION FROM HISTORICAL ANALYSIS

Change of river system
In the past two centuries, the regional river system has changed a lot, not only in the shape and location but also in the number of canals. At first, the region became more fragmented by the increasing number of inner canals. But then the regional strategy changed into the integration of the water system, the small islands are integrated into larger ones, so as Pazhou island. Also, the rivers are narrowing down, raising the risk of flooding in the region.

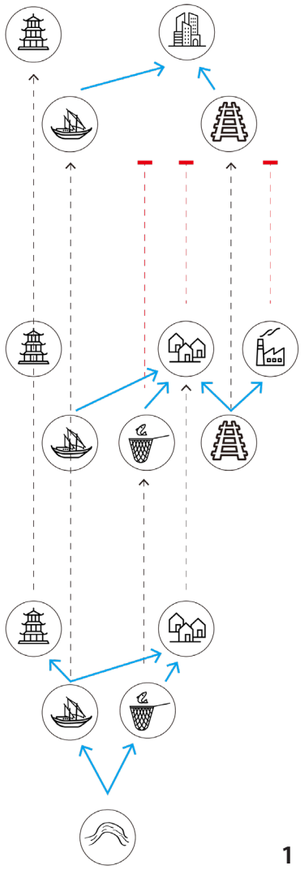
Advanced regional network
In the Qing dynasty, there are only waterways between Pazhou and the city center. Then as the development of regional land transportation such as railways, highways, etc, Pazhou becomes closer and closer related to the city center and also other areas of the region, creating conditions for its urban development.

Urban expansion
Guangzhou city center was once small and fenced by walls. The urbanized areas quickly expanded more than twenty times within two centuries. Pazhou wasn't part of the city center but now it's gaining more and more attention, in which the western part has already well developed and the eastern part has multiple plans for development.

Historical areas
In memory of the long history of trading, marketing, and fishing of the region, the historical areas have great value. Luckily the Pazhou tower and Huangpu village on Pazhou have been well preserved. Still, there are other two villages facing disappearance.

Conclusion
The overlay of the changes in the region shows clearly that the river provides conditions for all of the following development, and the network becomes the second condition that finally leads to the great urban development of the area. The conclusion also appears in the historical analysis of Pazhou island. This is a great proof of the layered theory in which the landscape layer provides the very basic condition for the network layer, then the settlement layer.

Conclusion from the historical evolution analysis
1. the changing elements of the region
2. the relation between three layers
3. the layers conclusion also appears on Pazhou island
(Source: self-drawing)



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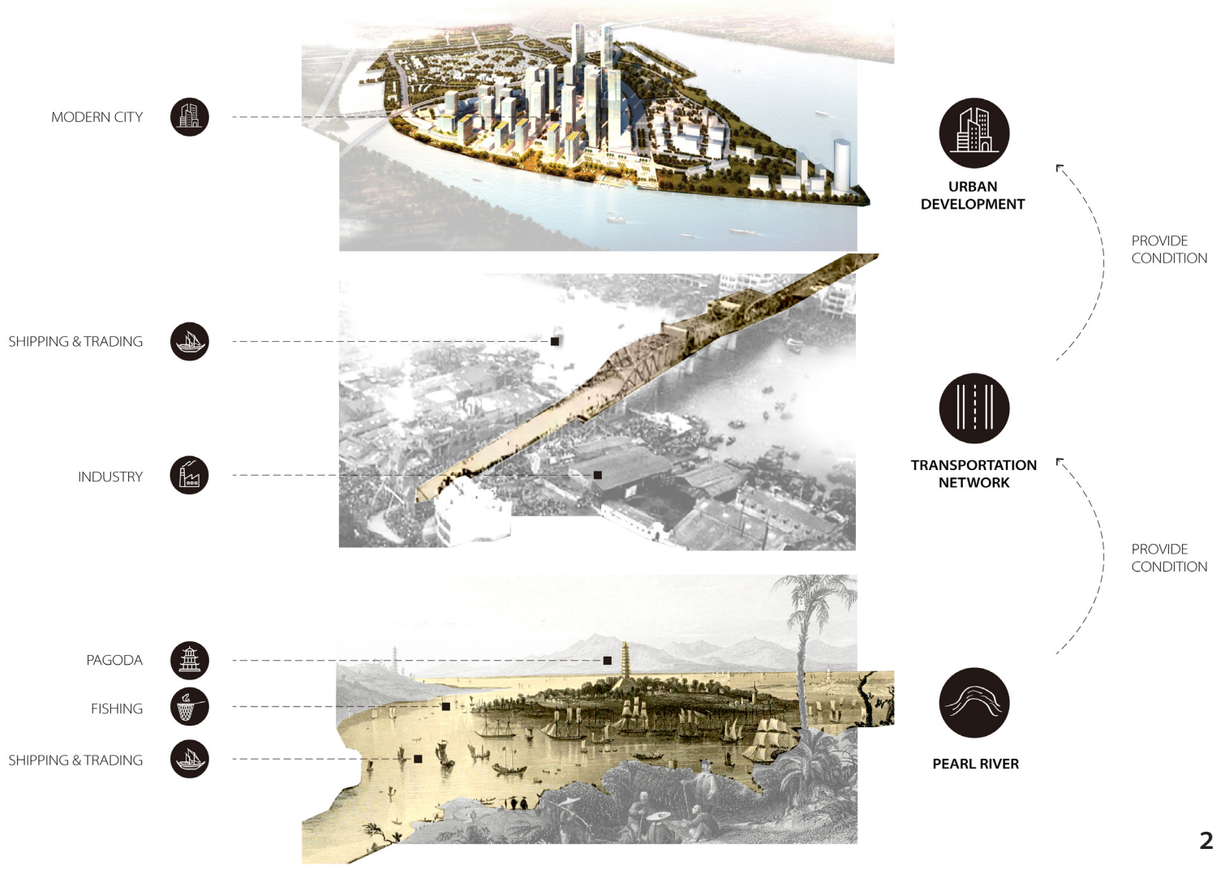

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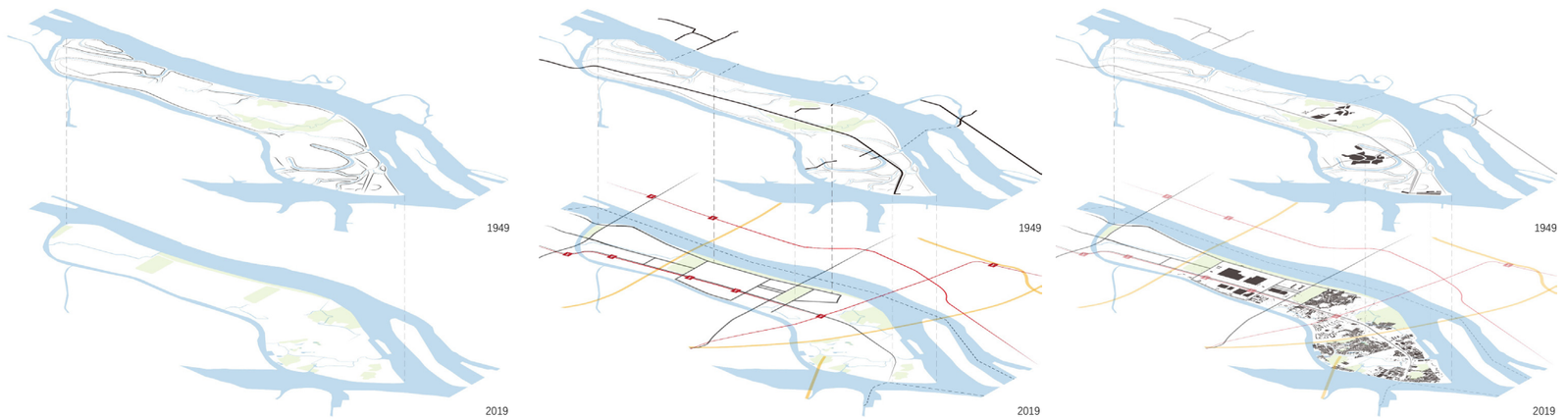
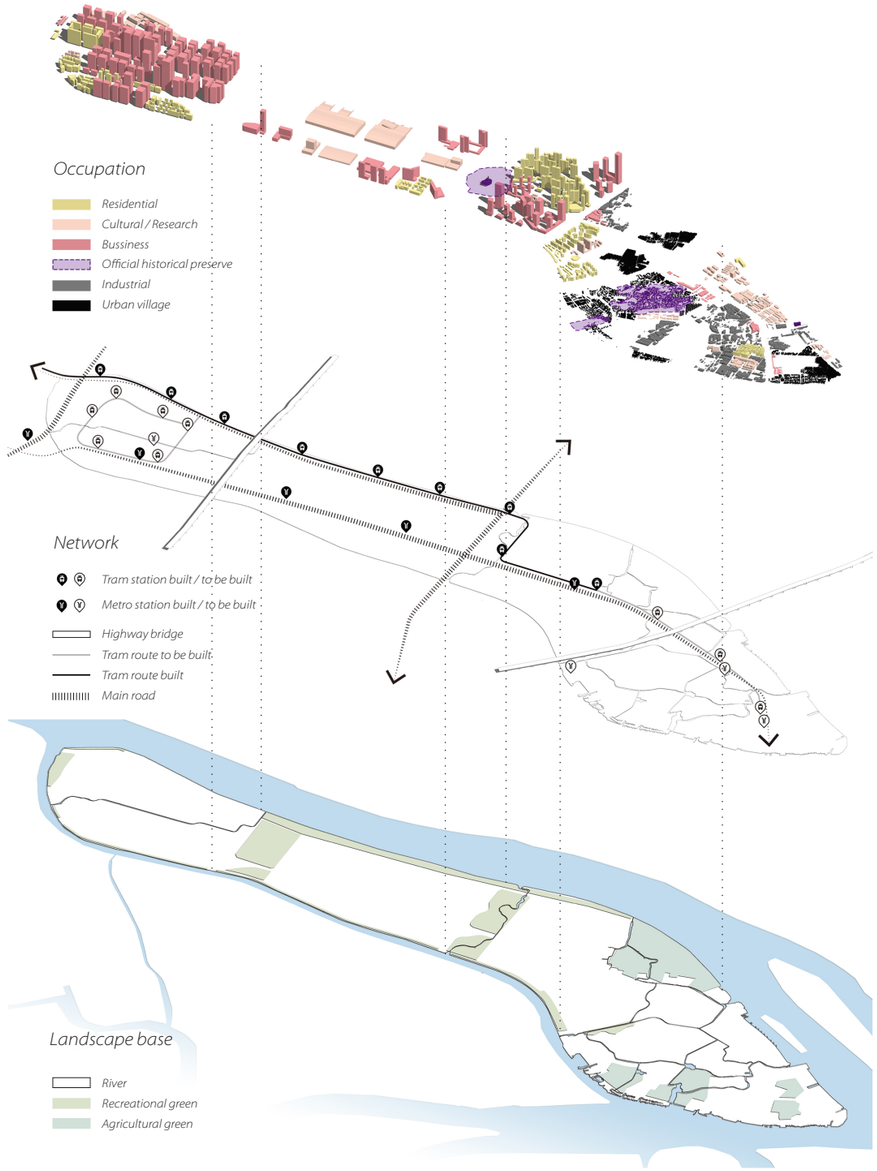


LANDSCAPE BASE → CONDITION **NETWORK** → CONDITION **OCCUPATION**

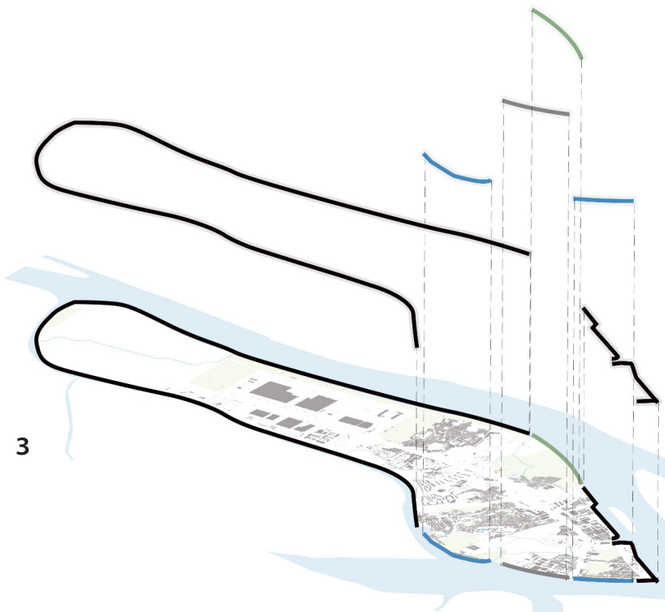
3

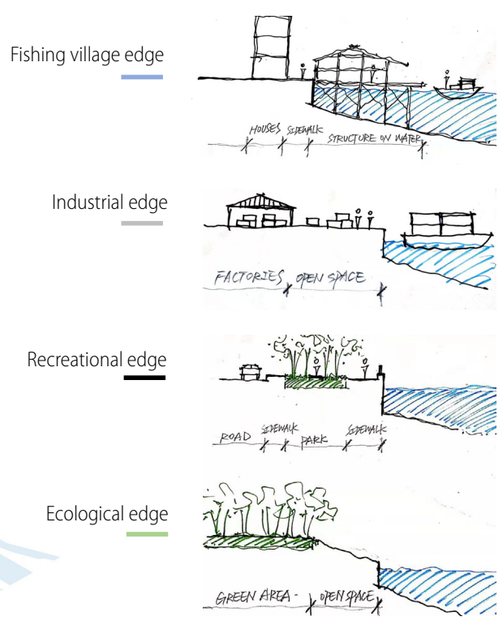
2.2 SPATIAL ANALYSIS OF PAZHOU

The next step is to focus on the design site, the Pazhou island, to looking into the actual condions. The spatial analysis on Pazhou island is also divided into three layers, based on the layered approach, from the landscape, to the network then the settlement.



The three layer spatial analysis of Pazhou island (Source: self-drawing)





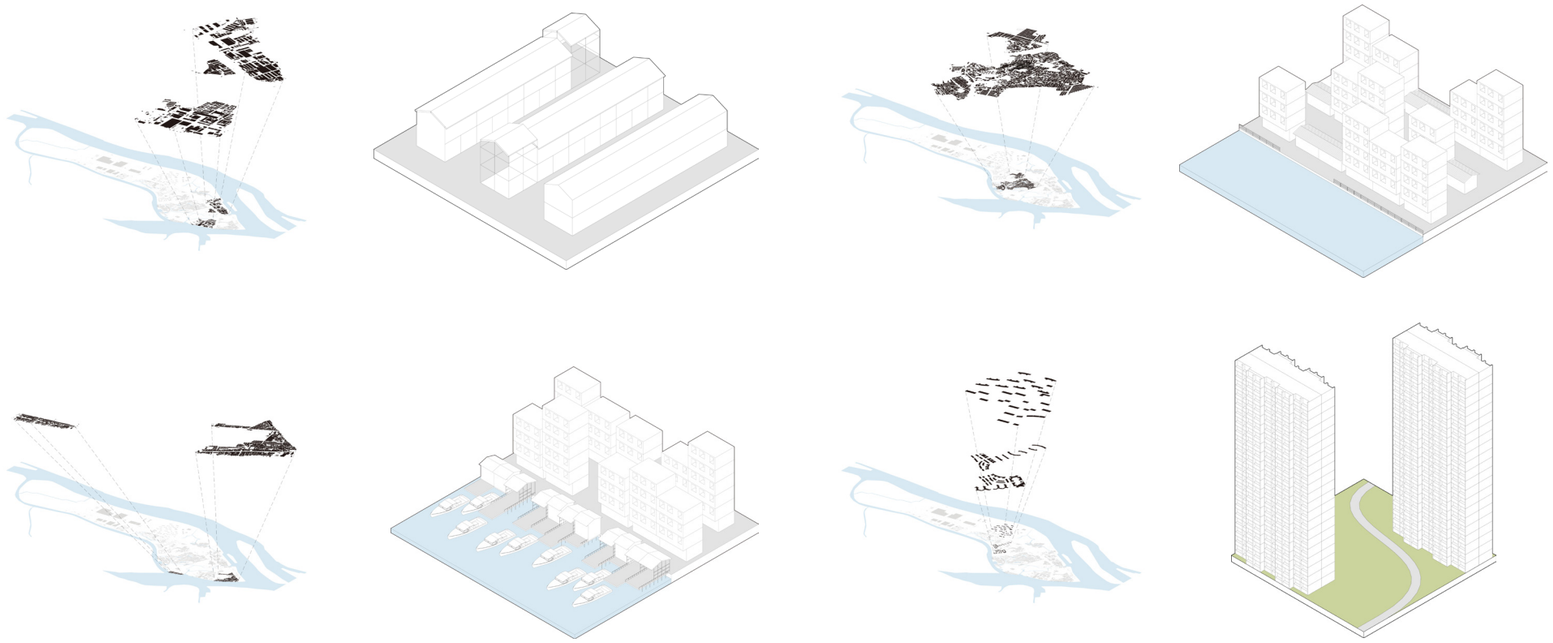
4

5

Landscape layer analysis
1. Elevation
2. Landscape structure
3. Edge typologies

Network layer analysis
4. Fast traffic
5. Public transportation

(Source: self-drawing)



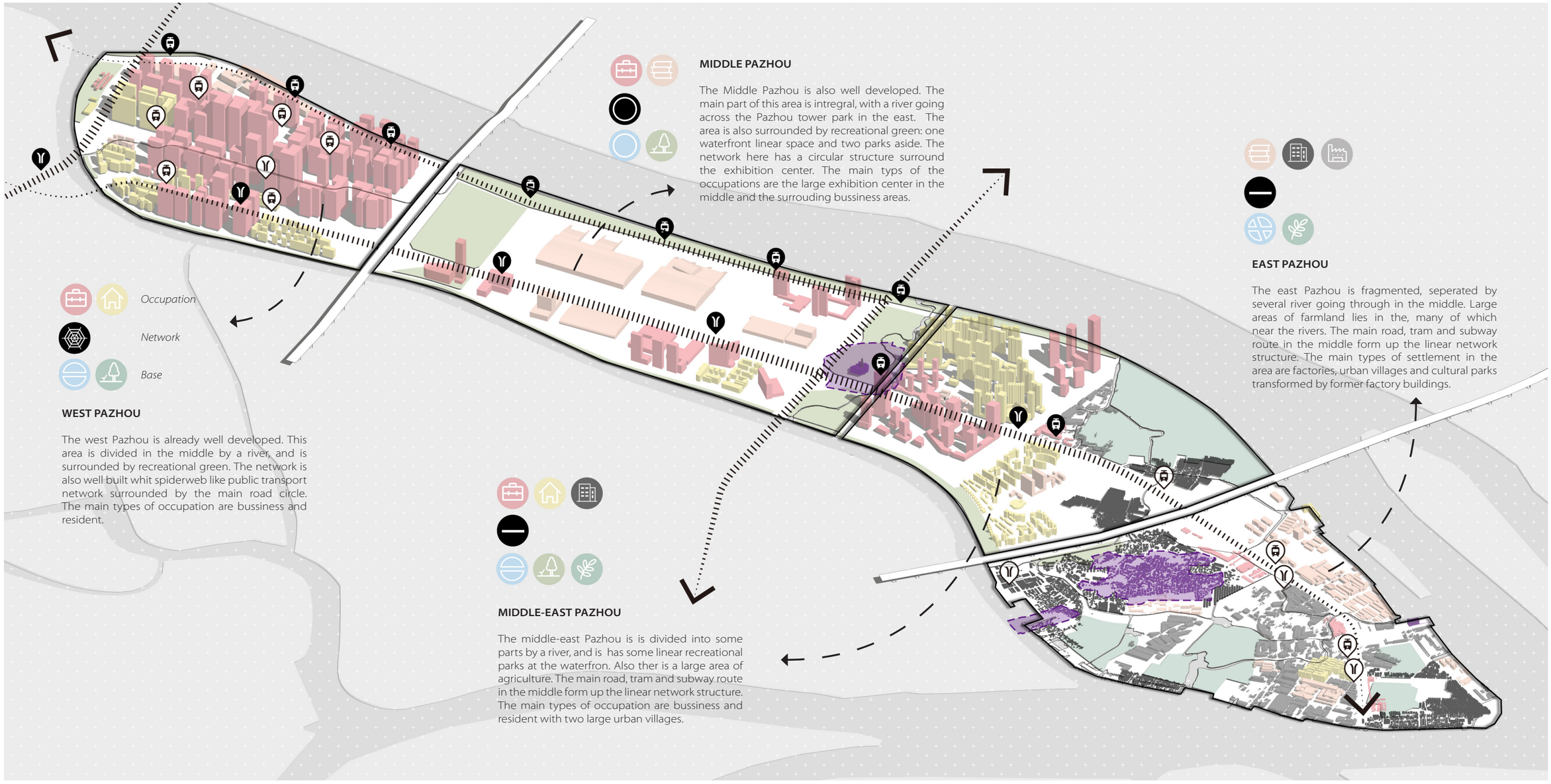
Urban settlement layer analysis
6. Urban typologies
Top-left: Factories
Top-right: Urban villages
Bottom-left: Fishing villages
Bottom-right: High-rise residential buildings
7. Urban funtions

(Source: self-drawing)

SPATIAL CONCLUSION MAP

In conclusion, Pazhou island was mainly divided into 4 parts by the network structure and river structure. The west part is well-developed into a residential and economical area. The middle part is an exhibition center with surrounded parks. The middle-east part is also mainly residential and commercial, with a large area of farmland. The east Pazhou is the most complex and fragmented one. It is not yet highly developed. It is a combination of historical heritages, industrial leftovers, and farmlands. There are lots of rivers going through the east part so the landscape structure is unique and has lots of potentials for resilient development. These become the reason for choosing east Pazhou as the detail design site.

Spatial conclusion map of Pazhou island
(Source: self-drawing)

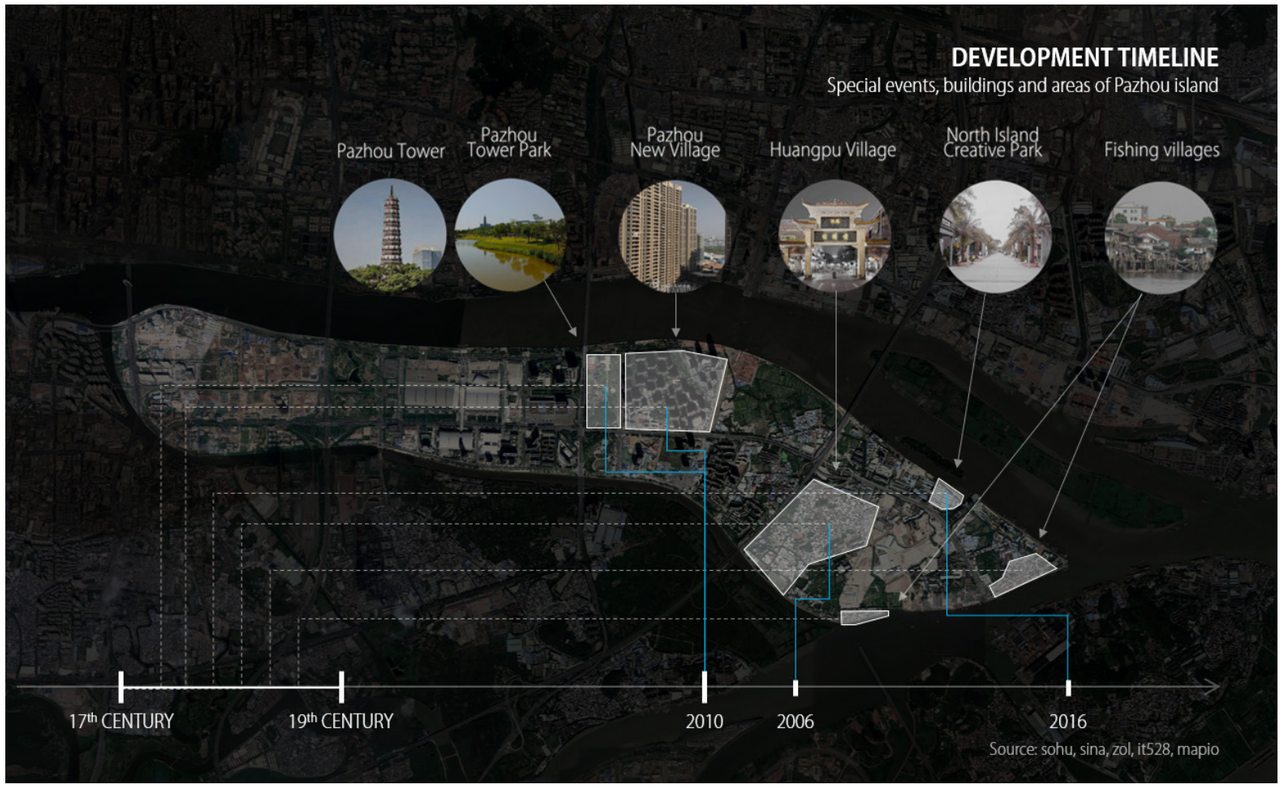


2.3 CHALLENGES AND POTENTIALS

Based on the spatial analysis, it is important to see what are the challenges and potentials that Pazhou island have and will be faced. From the problem statement mentioned above, the two basic challenges of the area are urban flooding and lost of identities. The following question are: what exactly are the identities on Pazhou island to preserve, and what's the exact impact of urban flooding on Pazhou island?

The structure will be based on the previous spatial analysis, adding another layes of flooding and identy to show the impacts on the existing spatial structure.

The three layer spatial analysis of Pazhou island (Source: self-drawing)



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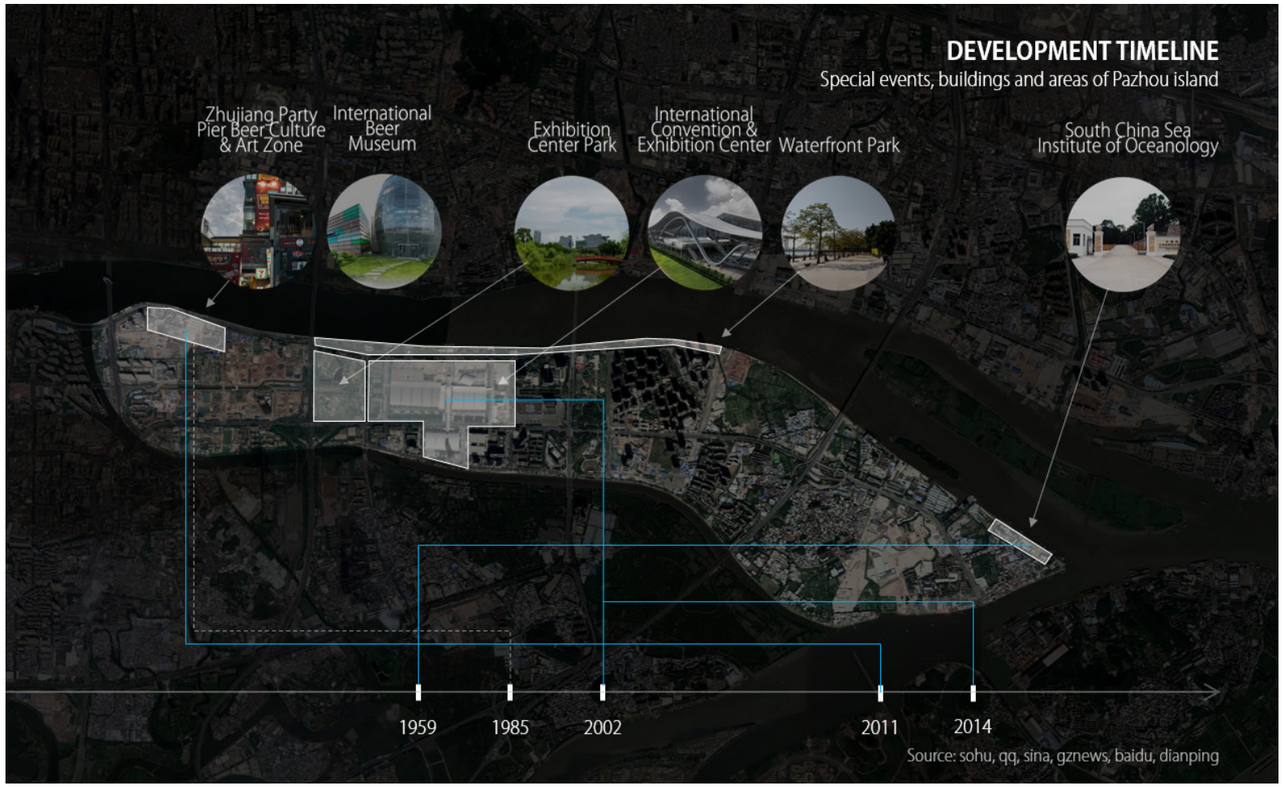

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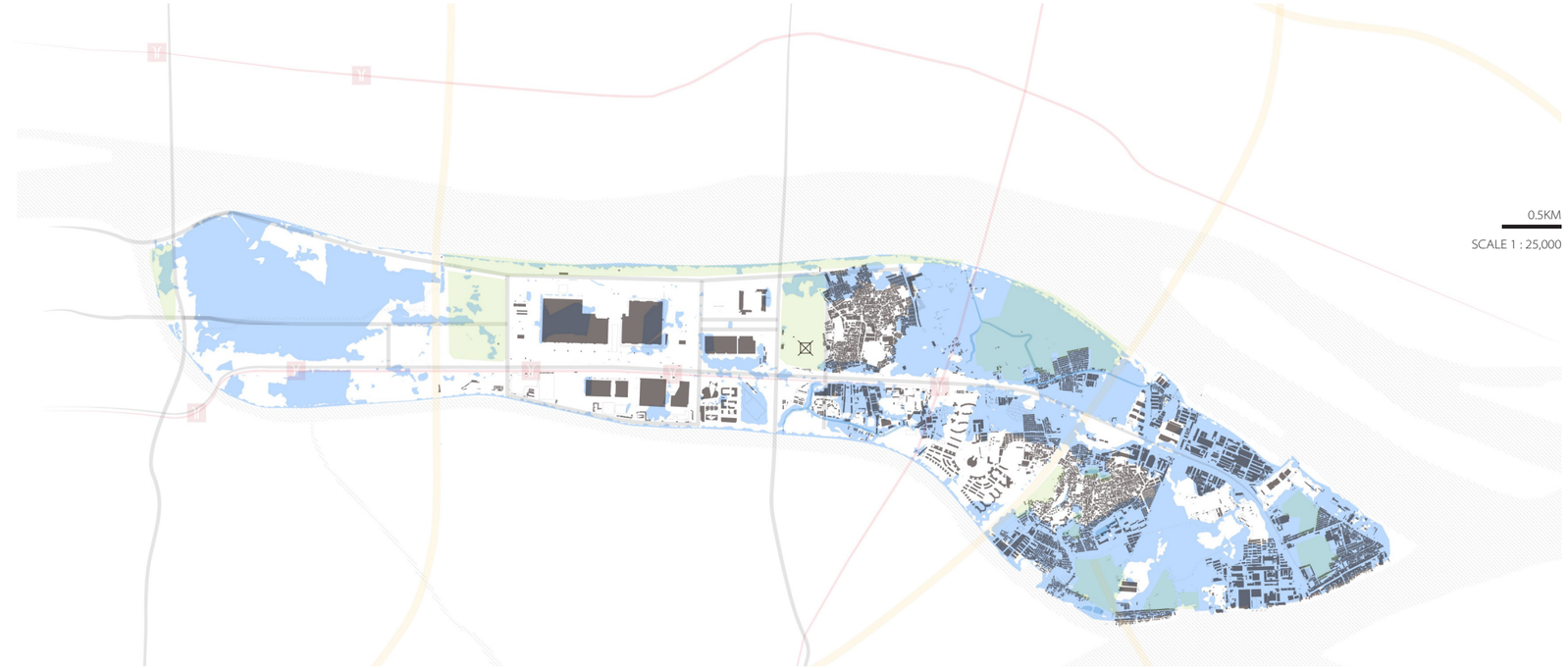

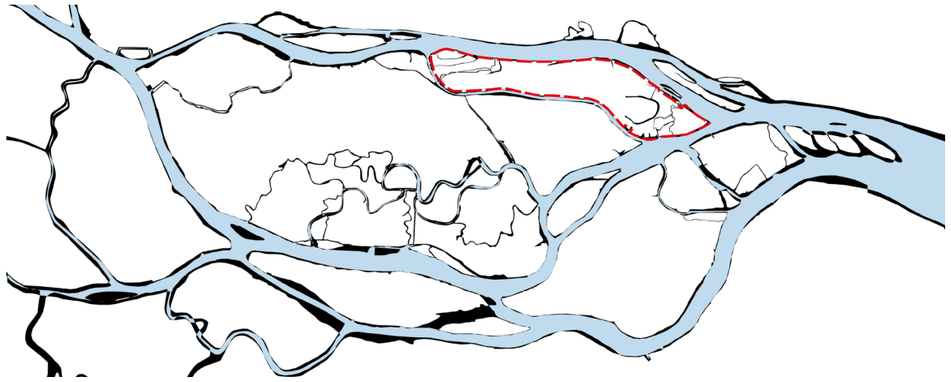

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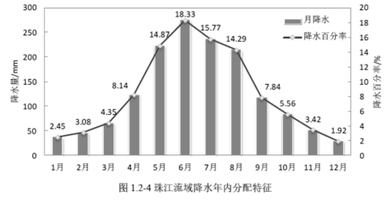


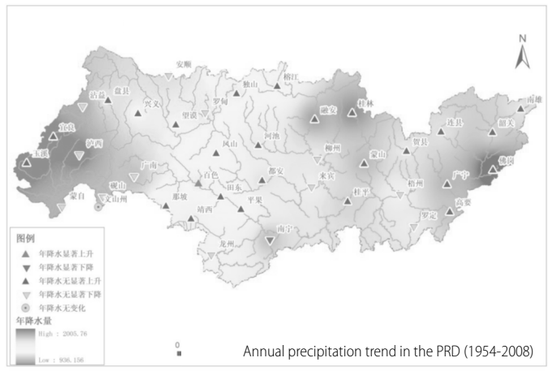
图 1.2-4 珠江流域降水年内分配特征

Rainfall concentrated in March to September, covers 70%~80% of the annual rainfall

测站	1月	2月	3月	4月	5月	6月	7月	8月	9月	10月	11月	12月	多年平均
马口	2.73	2.88	3.80	7.04	11.98	16.91	16.58	14.37	9.90	6.08	4.64	3.09	100
三水	1.55	1.77	2.83	6.46	12.35	20.46	19.96	15.79	9.62	4.37	3.09	1.76	100
博罗	3.97	4.23	5.29	8.03	11.16	17.73	12.10	12.02	10.43	6.23	4.65	4.16	100

Annual runoff allocation table for each station

5



Annual precipitation trend in the PRD (1954-2008)

4

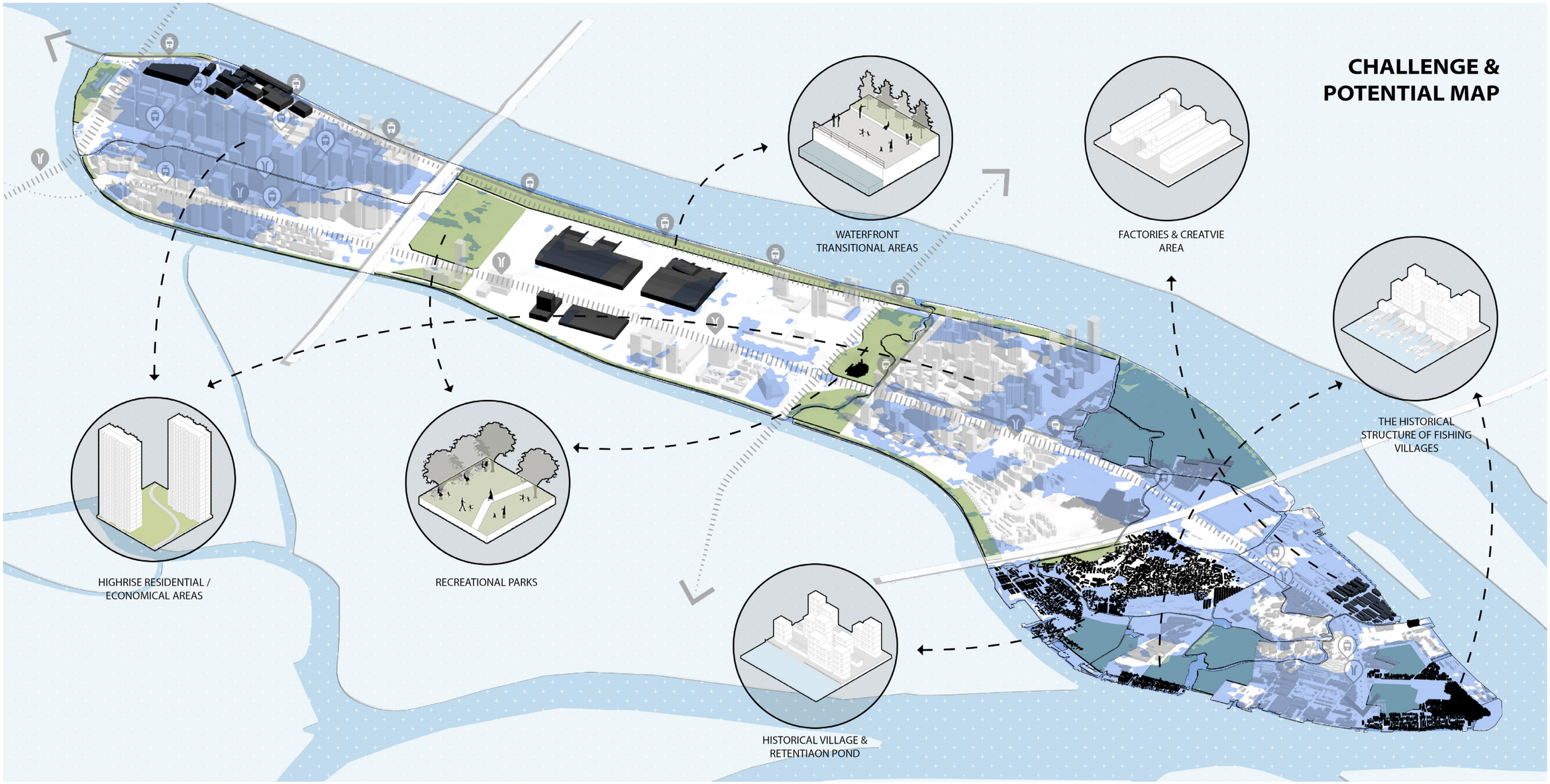
The identities of Pazhou island
1. The historical identities
(Source: sohu, sina, zol, it528, mapio)
2. The new identities
(Source: sohu, qq, sina, gznews, baidu, dianping)

The urban flooding on Pazhou island
3. Reduction of river capacity between 1840-1949
(Source: self-drawing)
4. Statics of rainfall amount increase in shorter periods
5. Images of flooding on Pazhou island
Top: river water flooding
Bottom: rainwater flooding
(Source: sohu, kk news)

CONCLUSION: DESIGN ASSIGNMENTS

In terms of urban flooding, the west and east Pazhou is much lower thus will be under flooding risks. Especially at the eastern corner, almost all the existing buildings will be flooded in the future, including the historical villages and fishing villages. On the other hand, this condition will become a nice potential for not only the integration of resilient design and the preservation of historical identities but also the resilient design of new urban areas and new ecological zones in east Pazhou.

Challenge and potential conclusion map of Pazhou island
(Source: self-drawing)



CHAPTER 03

DESIGN PRINCIPLES

3.1 ADAPTIVE RISILIENT PRINCIPLES

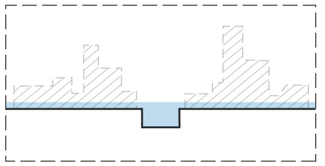
TYPOLOGIES OF PRINCIPLES

Based on the analysis of flooding risks of Pazhou island, there are two sources of coming floods: river water and rainwater. Thus the typologies of water resilient principles should be about river water flooding defense and rainwater retention.

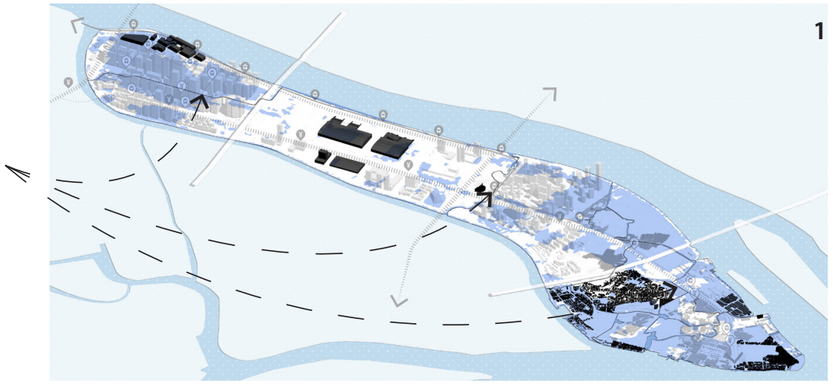
ADAPTIVE RESILIENT PRINCIPLES

In the process of research into the principles, instead of learning the existing principles directly from reading materials or landscape cases, it is important to categorize the principles in certain rules. In the previous argumentation and objective, a fundamentally resilient landscape structure that allows further adaptive development is mentioned. Therefore, in the principles part, the rules should also follow this logic.

Learning and categorizing from all the reading and materials, three basic water resilient principles that are suitable for Pazhou island are defined (it is also a process of working between generic knowledge and specific contexts). The next step is to research how the principles can be transformed into a version to adapt to different situations. Five adaptive principles are defined based on water resilient principles. Then the third step is to research the possible future development demands of the area and five different categorize are defined. Finally, after taking the three steps, and adapted resilient principles are created. It is not only fundamentally resilient in terms of flooding, but also easily adaptive to whatever development focus of the area in the future.

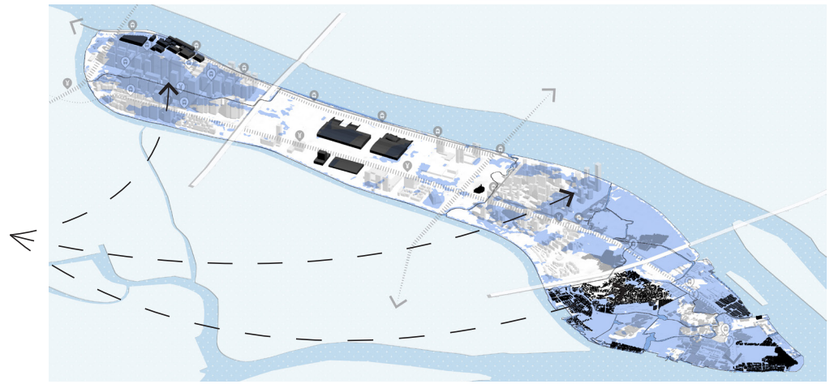


1. RIVER WATER FLOODING DEFENSE



1

2. RAINWATER RETENTION



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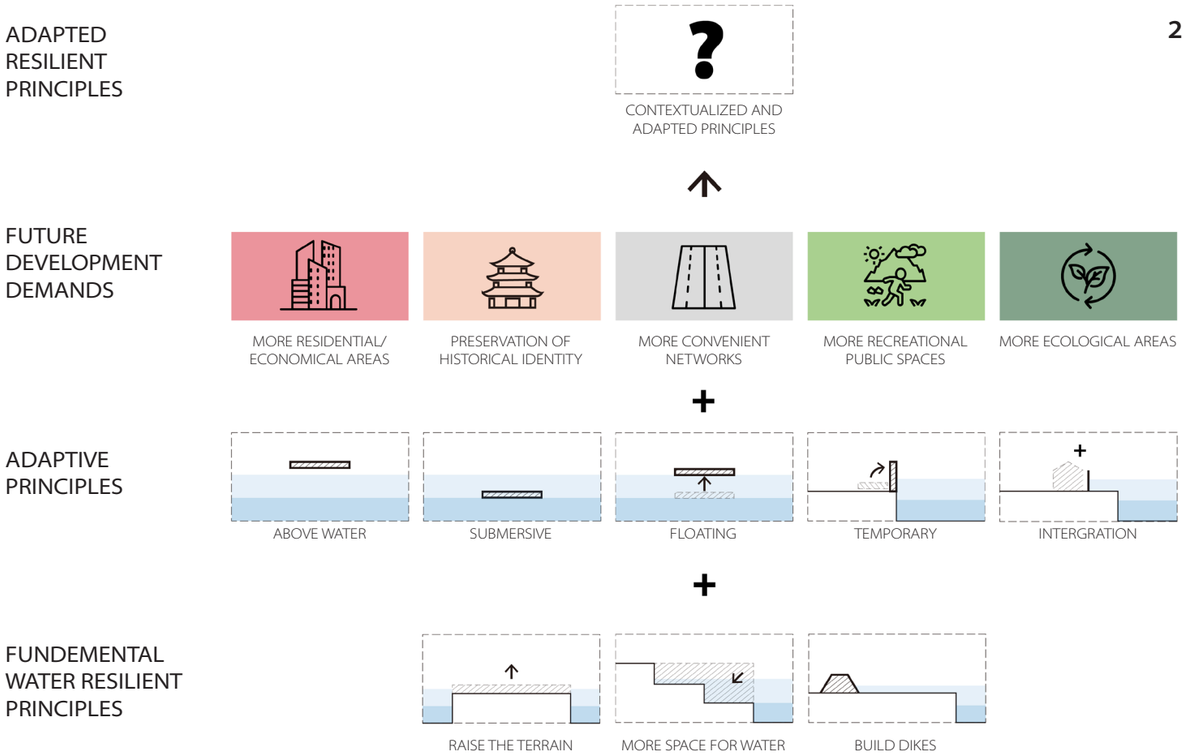
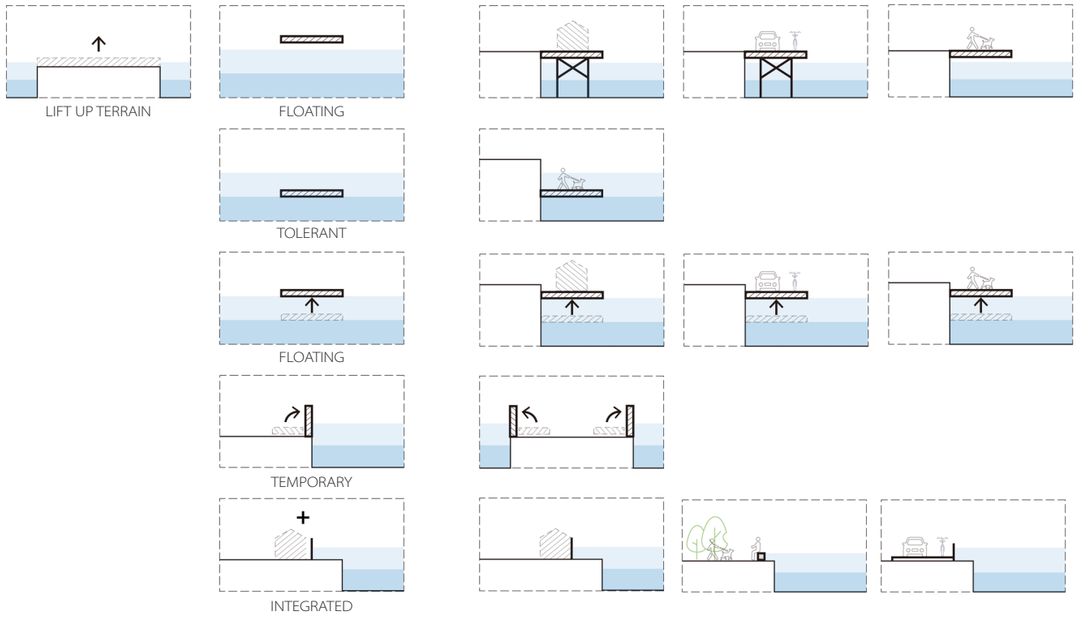
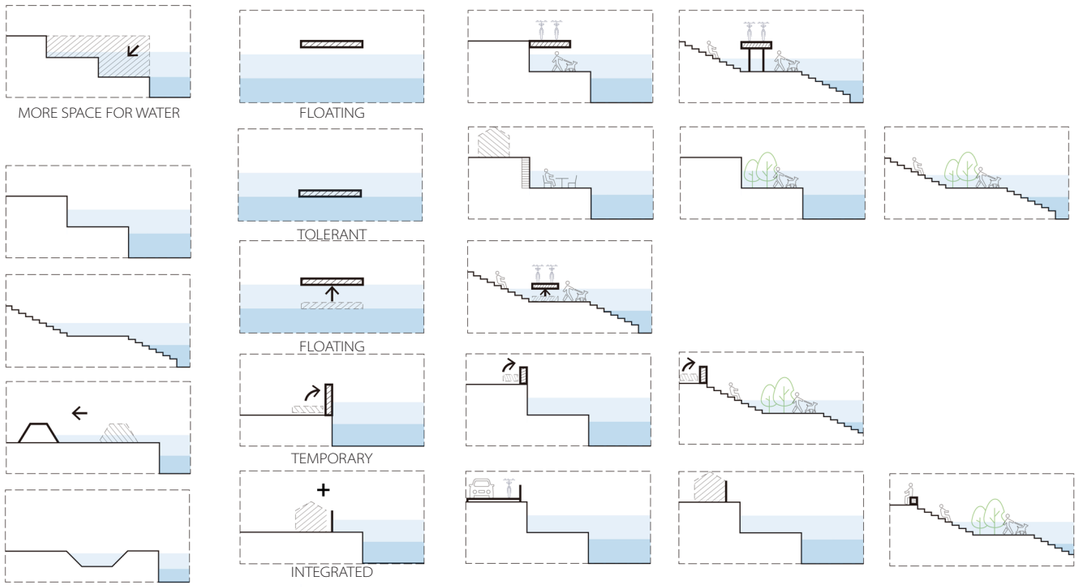
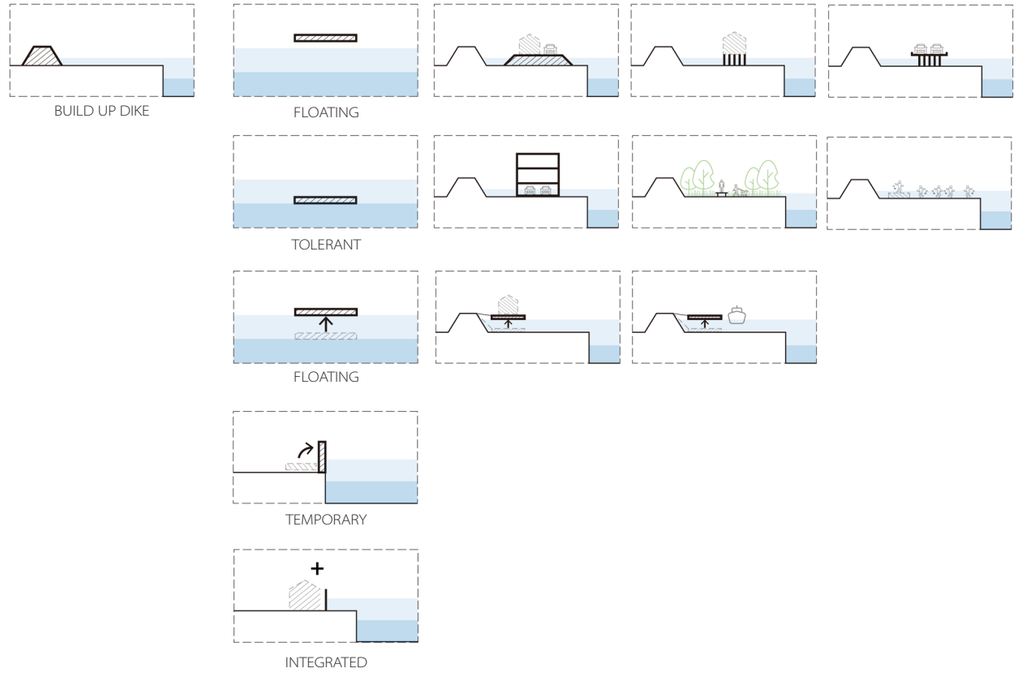


1. Two typologies of principles
2. The rules for creating an adaptive resilient principle
(Source: self-drawing)

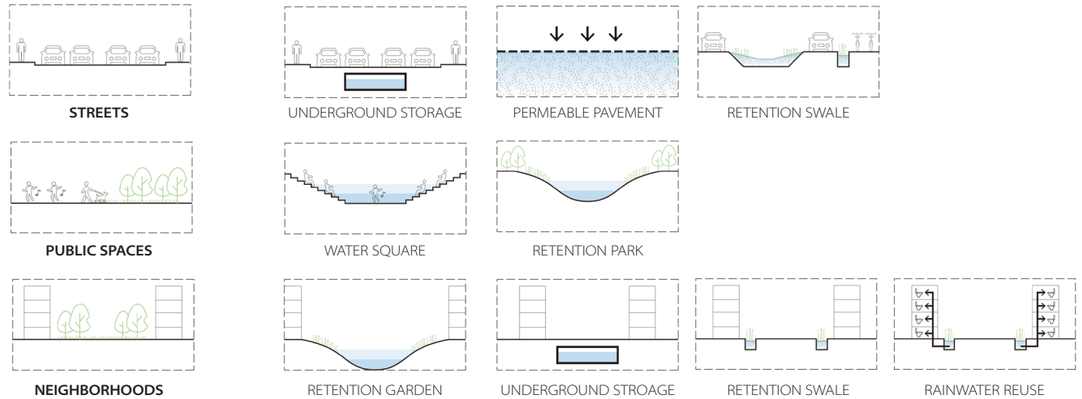
3.2 PRINCIPLES FOR RIVER WATER FLOODING DEFENCE







3.3 RAIN WATER RETENTION PRINCIPLES



CHAPTER 04

DESIGN EXPLORATION

4.1 REGIONAL SCALE

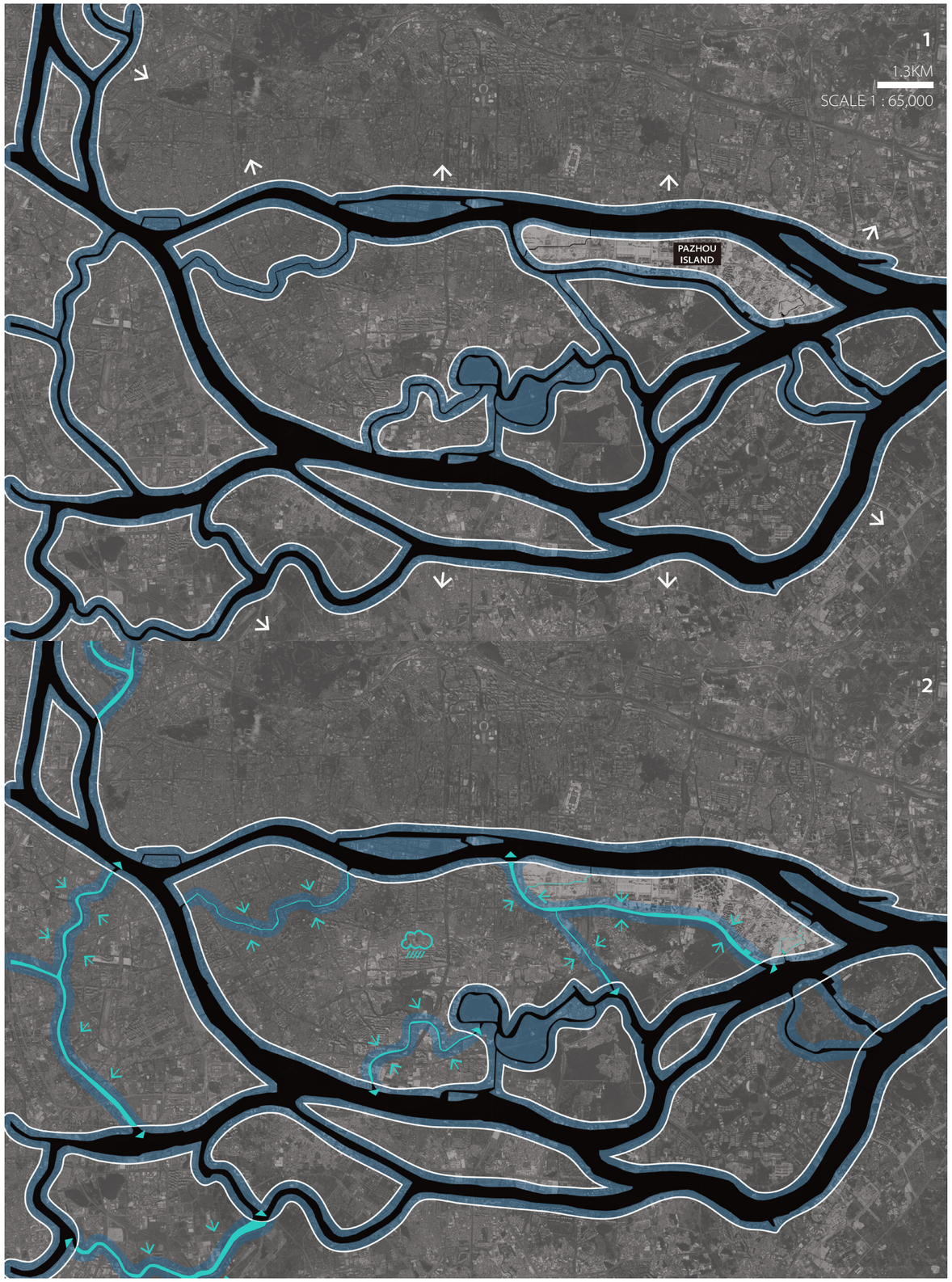
After researching the design principles, the next step is to start the design exploration. The design structure is based on the layered approach and to design through 3 different scales. To be specific, there will be design on the regional scale which is the one that includes Pazhou and surrounding urban center, the island scale which is the Pazhou island itself, and local scale which is the east corner of Pazhou island. On the regional and island scale, the design will focus on building up basic landscape structures and network structures that provide conditions for the detailed designs of three layers on the local scale.

4.1.1 REGIONAL BLUE STRUCTURE

The first step is to design a new regional blue structure.

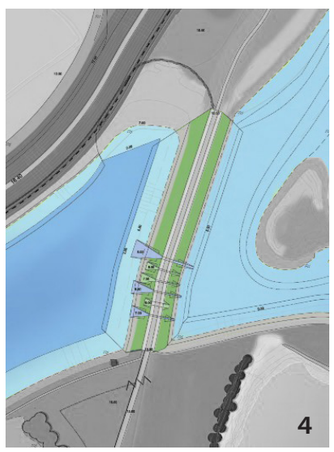
The existing situation of the region is that flood walls surround the edges of all the rivers. Such engineering measure gives no chance for adaption to future flooding risks. The first principle is to build up higher dikes for a higher standard for flood protection, not at the river edges but relocated inland-wards to provide more space and capacity for the river. Large areas of flood plains will be created and they have great opportunities to become the base for different functions of flood-tolerant urban developments. However, such a measure will create segregated islands all over the area and the isolation between the island will be a new problem.

The next step is to combine parts of the dike system so that there will be less isolated islands. It also will reduce the construction of dikes and there will be less financial pressure. Through this step, the connecting part of the dike becomes the inner canal outlet control gate to balance the water levels between the inner retention system and the outer river system.



1. Build up new dike and flood plains
2. Integrate parts of the dike system and create inner canal outlet control
(Source: self-drawing)

3. Reference project, Room for the river, Nijmegen
4. Reference for the inner canal outlet
(Source: hnsland.nl)

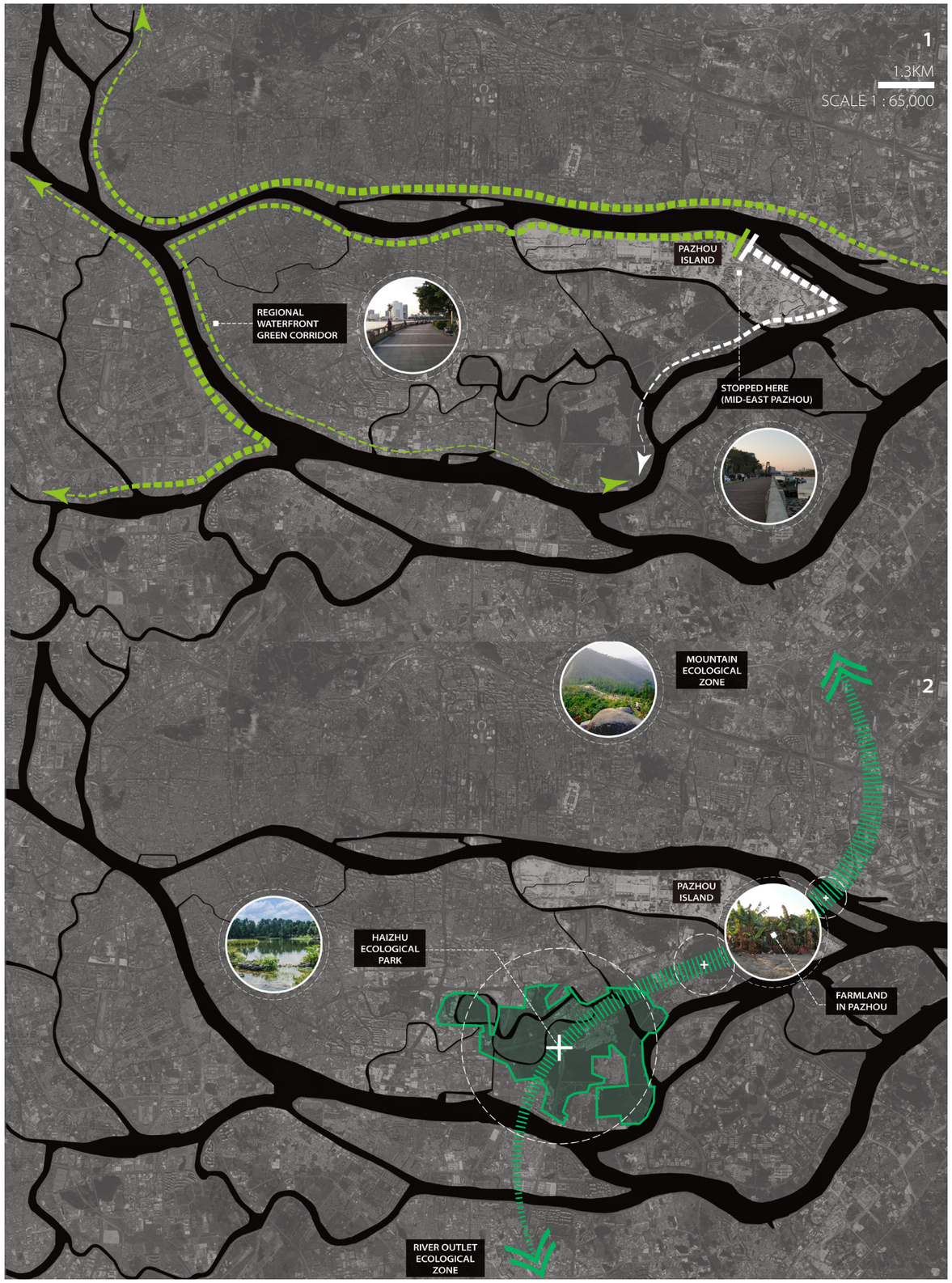


4.1.2 REGIONAL GREEN STRUCTURE

After the blue structure, the next step is to build up the regional green structure. There are mainly two structures in terms of green: the recreational green structure and the ecological green structure.

Looking into the existing recreational green structure, the whole region has a well-connected waterfront green structure surrounds the main rivers that provide great landscape experience and open views of the riverscape. But this green structure stopped in the middle of Pazhou island and the east corner of the island including some areas towards the south is not connected with the waterfront recreational green structure. So the strategy is to reconnect, and the reconnection can be combined with the previously planned new dike structure.

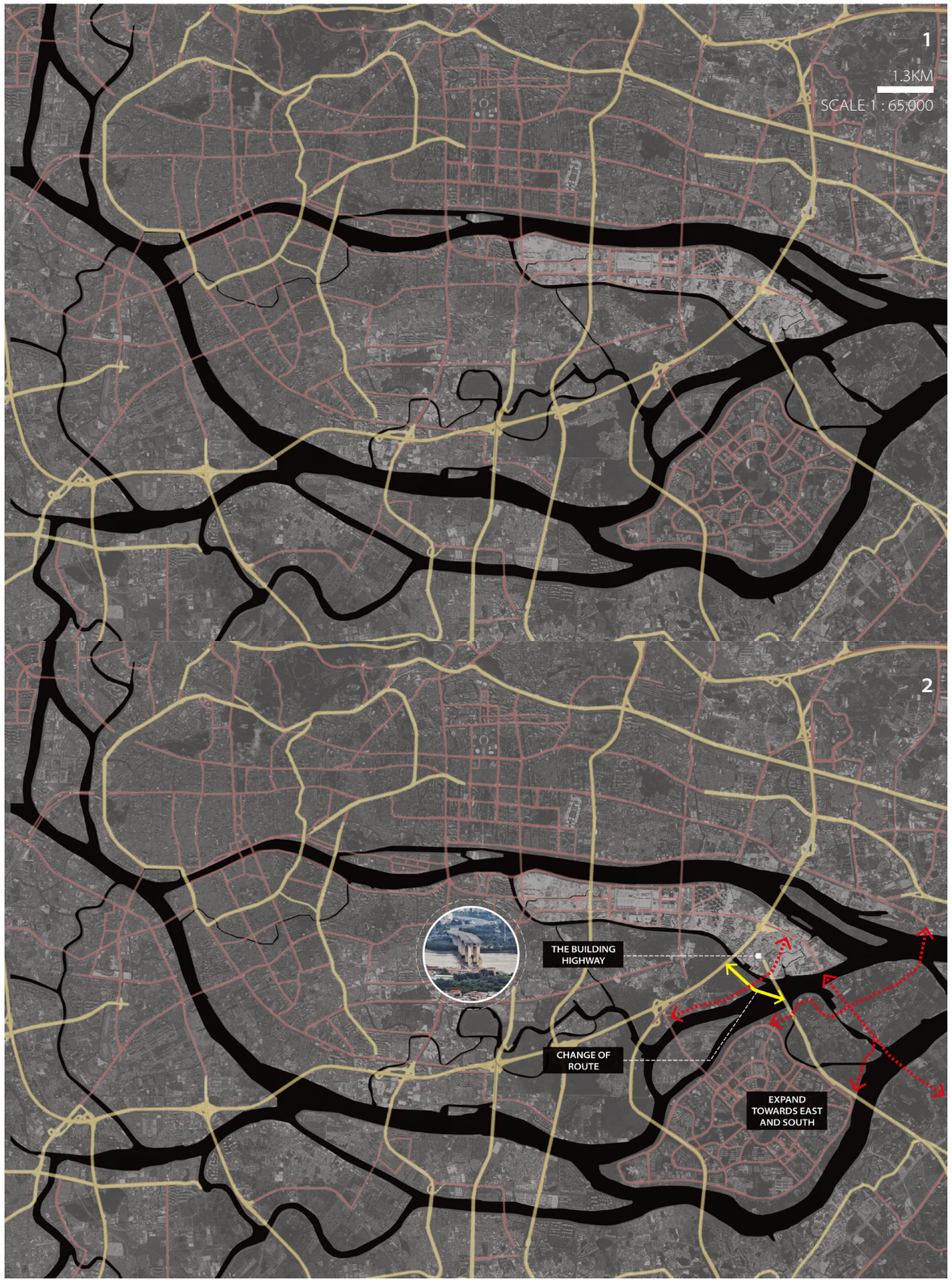
In terms of the ecological green structure, this regional is in the middle of the PRD which means it is among different types of the natural landscape. In the north, there are large areas of mountainous green, while in the south there is a large natural wetland park. This ecological axis continues towards the south to the large areas of the river outlet landscape of the PRD until into the sea. The east of Pazhou island, in the middle of this ecological axis, has the potential to become part of it, considering the large areas of farmland on the island that is not being used efficiently. So the strategy is to join Pazhou east with the ecological axis.



1. To reconnect the waterfront recreational green structure
2. To join the ecological axis
(Source: self-drawing)

4.1.3 REGIONAL NETWORK STRUCTURE

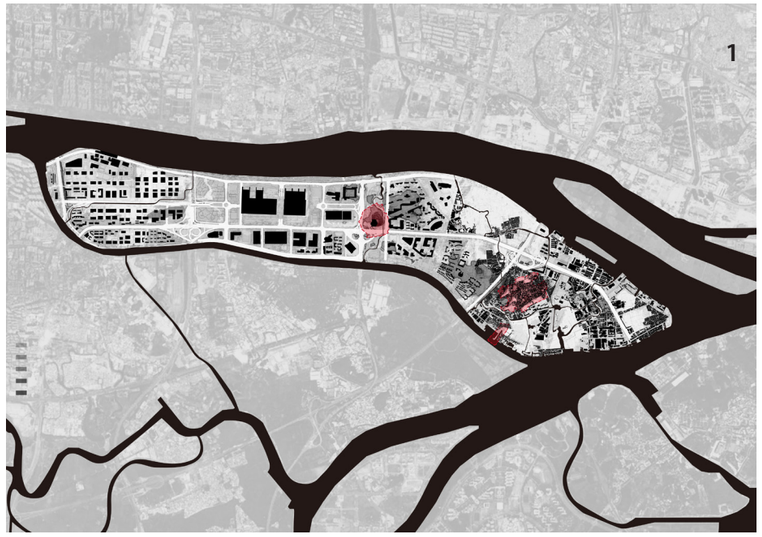
The existing network structure of the region is already well-developed. The network contains roads, highways, and public transportation systems like tram and subways that linked Pazhou with the north, the west, the south, except the east. Due to this context, the improvement of the network structure will be extending the road of Pazhou east towards the east to provide conditions for further urban expansion. Also, there is a newly built highway that has planned to go through the historical village on Pazhou and have been built halfway. The strategy is to redirect this new highway, keep the connection but avoid going through the village.



1. The existing network structure
2. The strategies of improving the network structure
(Source: self-drawing)

4.2 ISLAND SCALE

After building up the regional strategies for both landscape and network, the next step is to zoom in into Pazhou island for the island scale design. In this scale, the design will also be the focus on building up a water resilient landscape structure, and a network structure based on TOD principles, to provide conditions for further adaptive development for the island and the following local scale.



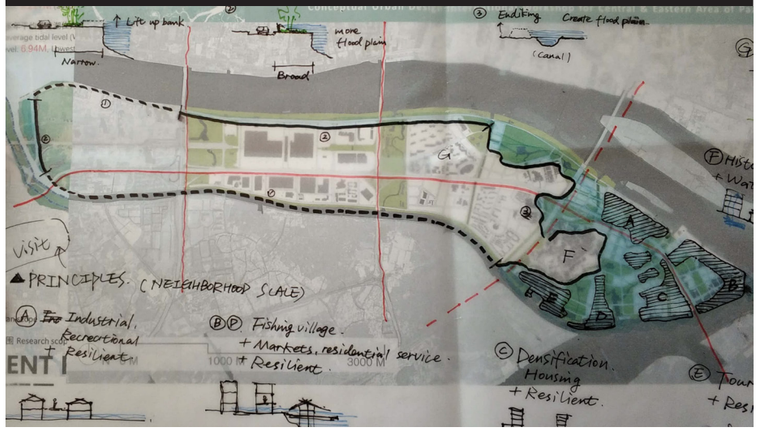
4.2.1 LANDSCAPE STRUCTURE DESIGN OPTIONS

Based on the spatial analysis and challenges of Pazhou island, the design considerations are to find a balance between the areas to protect, the existing elevations, and the potential areas to transform into floodplains. The decision-making process is not straight forward, instead, there are lots of options in every step. So the method of comparison between multiple design options is essential.

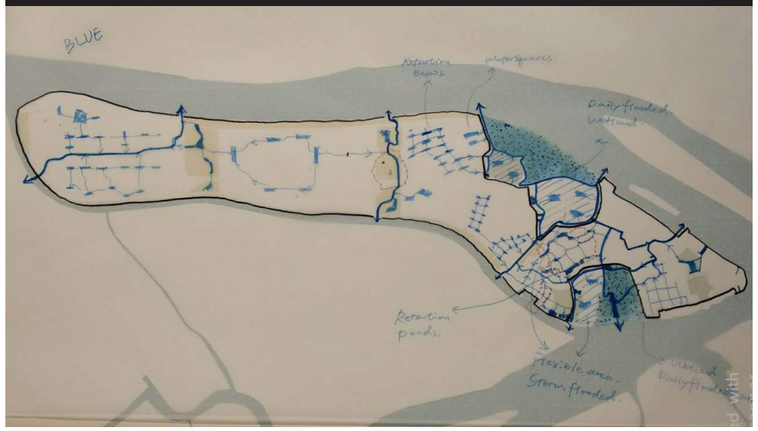
The design options can be categorized into 3, based on mainly the percentages of areas that are excluded out of the dike and transformed into floodplains. Option 1 is balance in the area of flood plains, and the key is the fragmented island structure at the east corner to revive the historical memory of the PRD. Option 2 is more subtle in terms of flooding areas, and the island will still be largely connected in the east corner for a more complete identity of the island itself. Option 3 has the most dramatic decision of creating large areas of flood plains that go through the east of the island in the lower-lying areas, while at the same time keeping the east corner as a whole for new development.

Finally, option 3 has been chosen. The large floodplains are ideal to create a multifunctional wetland to join the ecological zone, and the complete areas at the east corner are more suitable for further high-dense development.

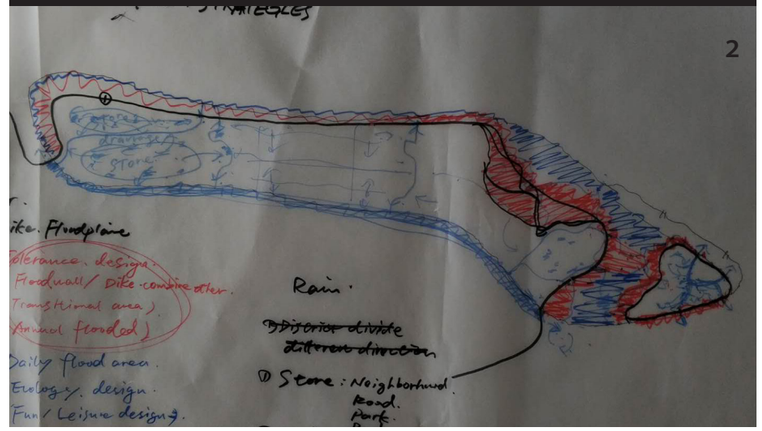
STURCUTURAL DESIGN OPTION 1

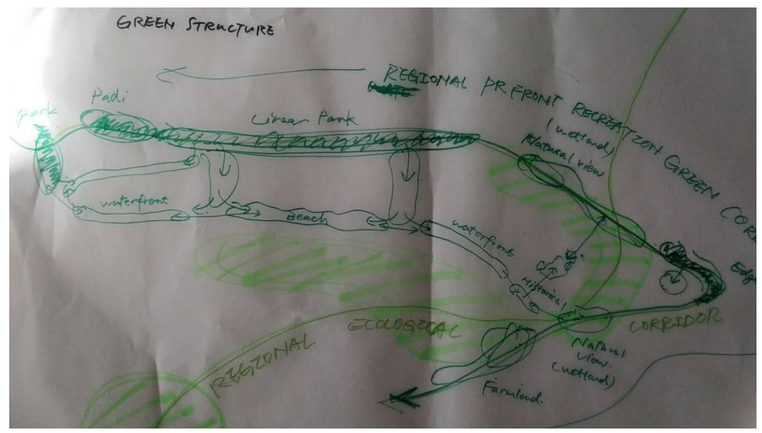


STURCUTURAL DESIGN OPTION 2



STURCUTURAL DESIGN OPTION 3





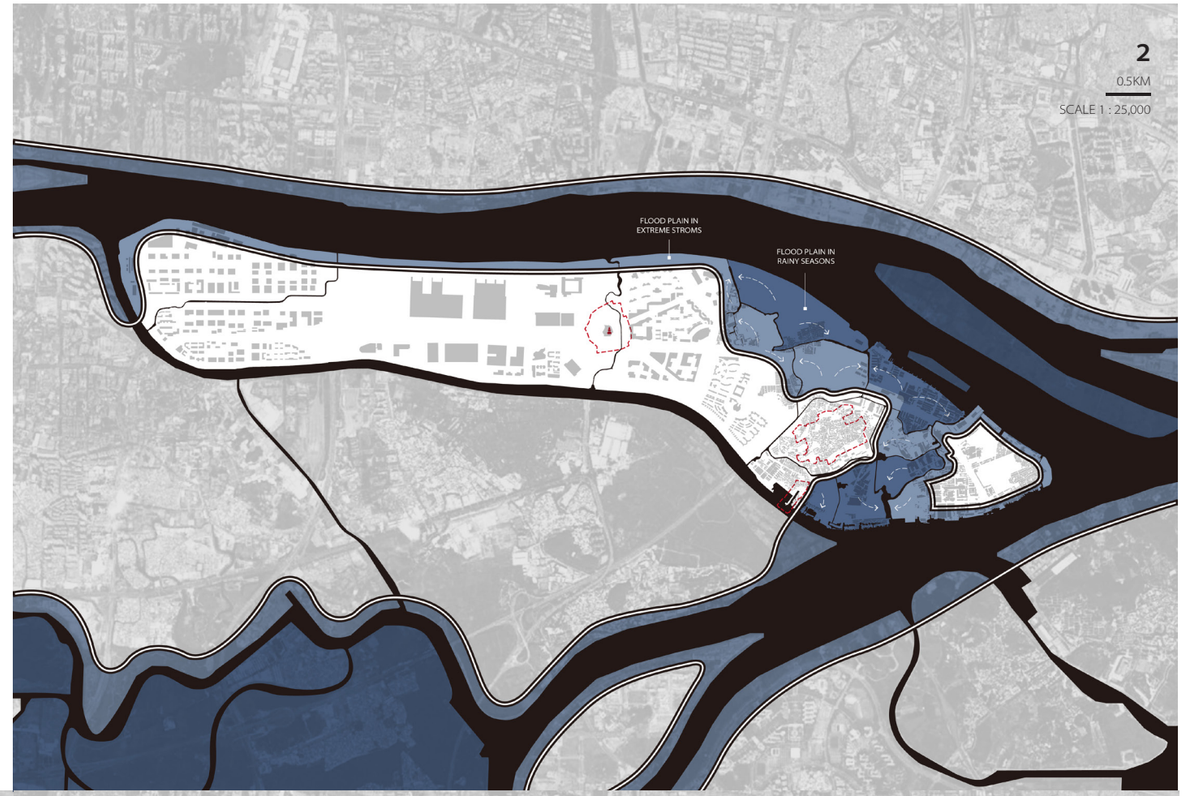
4.2.2 LANDSCAPE STRUCTURE FOR PAZHOU ISLAND

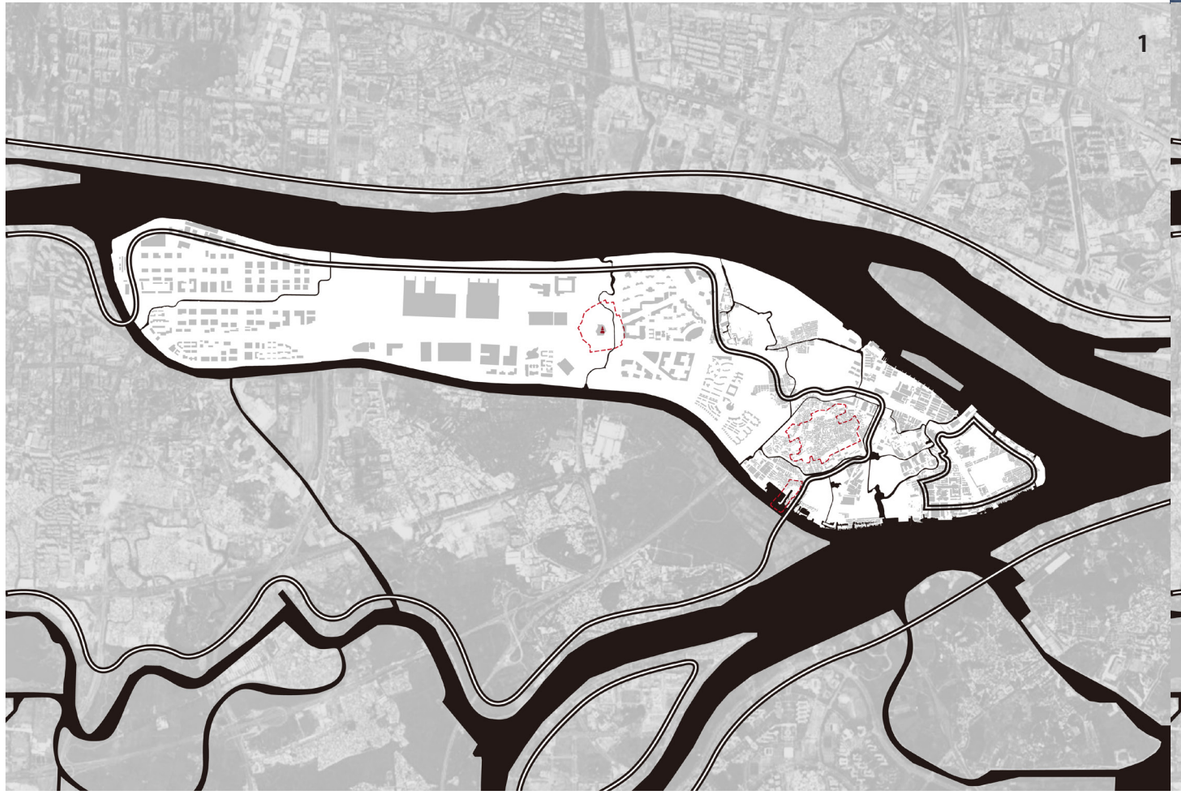
Based on design option 3, the next step is to build up the exact resilient landscape structure with different principles.

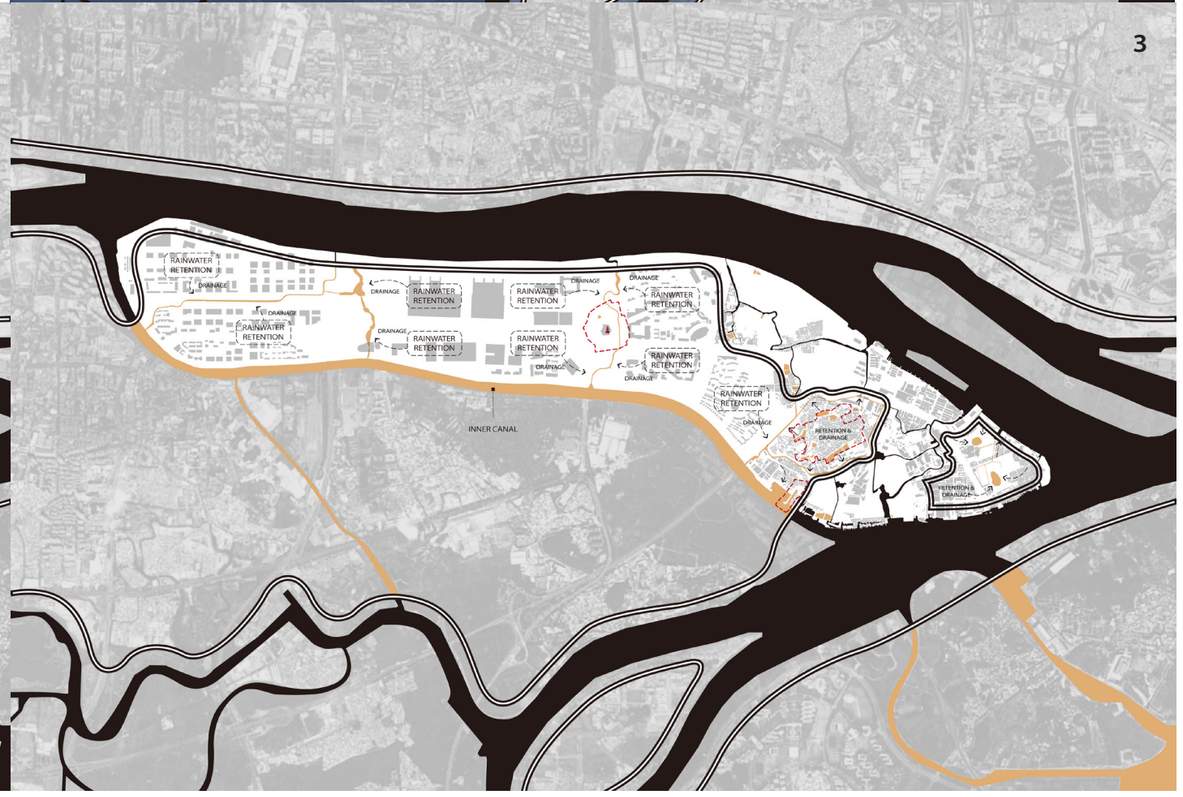
The first step is to decide the exact location of the dike system. It needs to protect the existing developed areas and also the historical villages. Also, it needs to become the element that connects Pazhou island with the other parts of the area, towards the west and south. On the east corner of Pazhou island, a circle dike structure is also needed to surround the core development areas for the future.

The second step is to look into the outer dike flood plains. According to the existing elevation, the flood plains can be now roughly defined into two types: flood plain in rainy seasons and flood plain in extreme storms. The previous parts are much lower and can be frequently flooded over the years, and the later parts are higher to provide capacity for the rivers only in extreme storm scenarios.

The third step is to look into the inner dike areas where a system of rainwater retention and drainage should be designed. The strategies are to first divide the neighborhoods into several retention zones and drain to the nearest directions separately to reduce the drainage stress in peak hours. Then it is important to make full use of the existing inner canals for drainage, and through the water, an outlet to control the water level between inner and outer dikes.





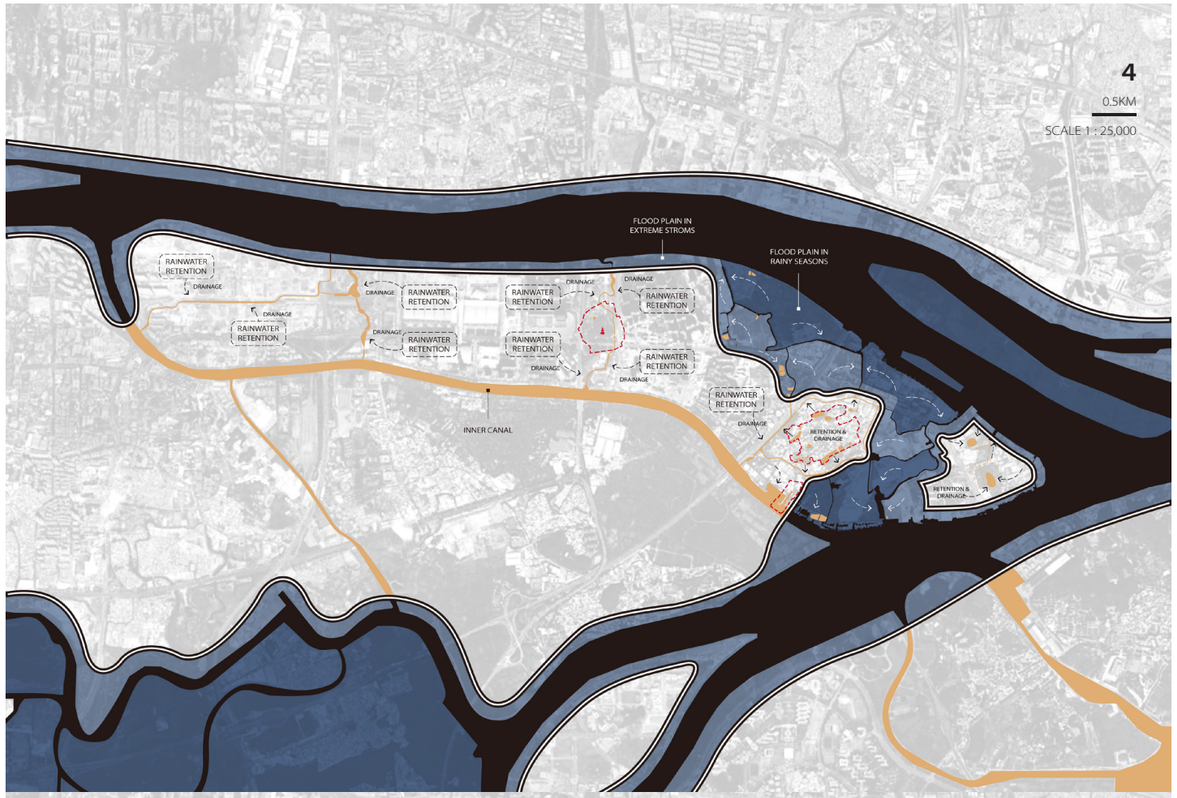


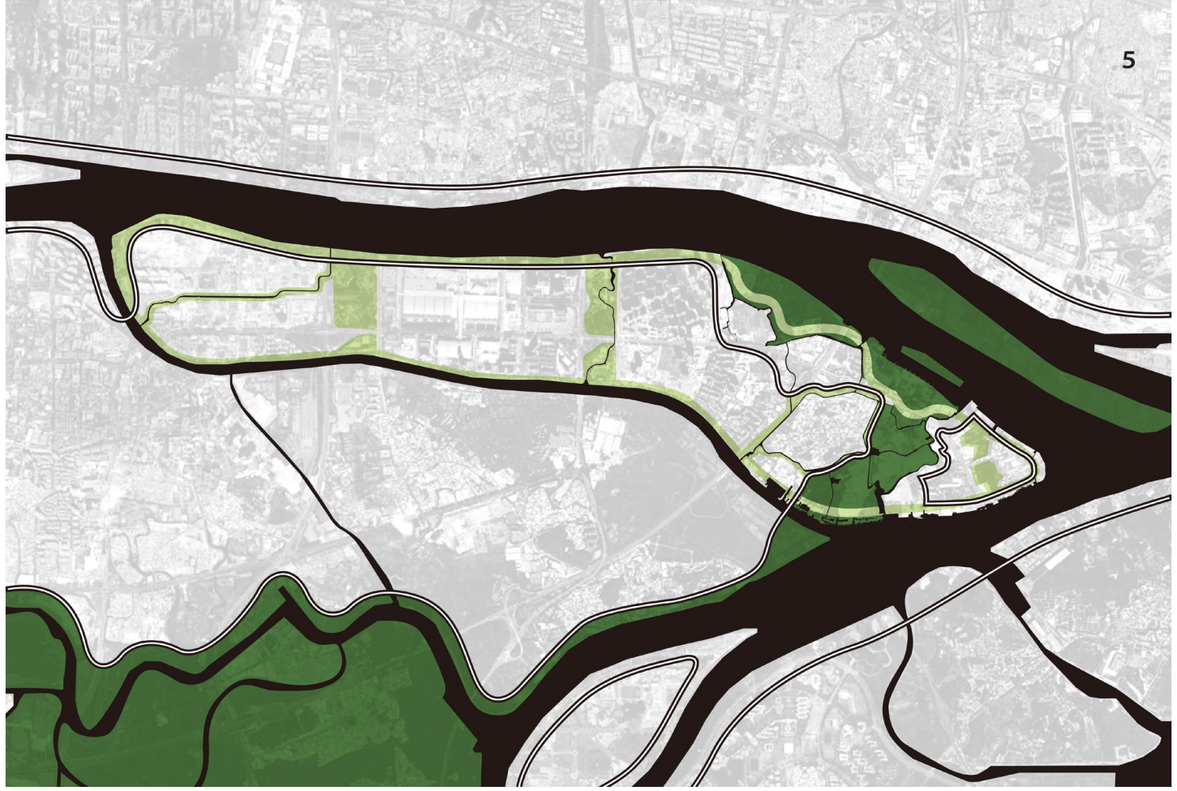
After these three steps, a resilient blue structure for Pazhou island and also the surroundings is created. And the green structure can be designed upon it.

First, the recreational green structure follows mainly the new dike structure, connecting the waterfront areas of Pazhou and surroundings. It also connects the existing parks, like the linear waterfront park on the north, the Pazhou tower park, and the exhibition park in the middle. And the connection extends towards east within the flood plains, in the form of green paths lifted up in the air, and connect to the east corner. There will also be waterfront parks along the coast of the southern inner canal. Then a circular structure of recreational green surround Pazhou island and connect to other areas is designed.

Then, the ecological green structure is also design based on the new blue structure. The flood plains going through Pazhou east provide a nice condition for creating an ecological zone. In consideration of the positioning of Pazhou island in the very urban center, there will be commercial concerns of such large areas of none economically profitable areas. So this floodable zone should be an integration of both ecological benefits but also urban functions. A wetland park with different functions will be a nice idea. In the lowest areas, the function can be inaccessible wetland areas and in the higher areas, there can be new urban housing typologies or place for outdoor activities.

By then both the basic blue and green landscape structures have been build up.



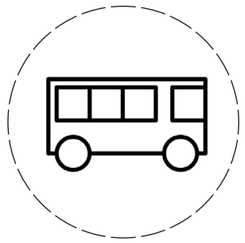


1. The exact location of the new dike system
2. The structure of the outer dike flood plains
3. The structure of the inner dike rainwater retention and drainage system
4. The complete resilient blue structure
5. The green structure based on the blue structure and the existing green
(Source: self-drawing)

4.2.3 TOD STRUCTURE FOR PAZHOU ISLAND

In the Pazhou island scale, after building up the resilient landscape structure, the next layer is the network structure. Back in the theoretical context, the TOD theory and related principles have been studied. These principles will become the leading structure.

There will be four steps, in the concern of both public transportation, fast traffic network, walkable neighborhoods, and slow traffic. Also, the design is an improvement based on the existing transportation network of Pazhou island which has been analyzed in the spatial analysis part.

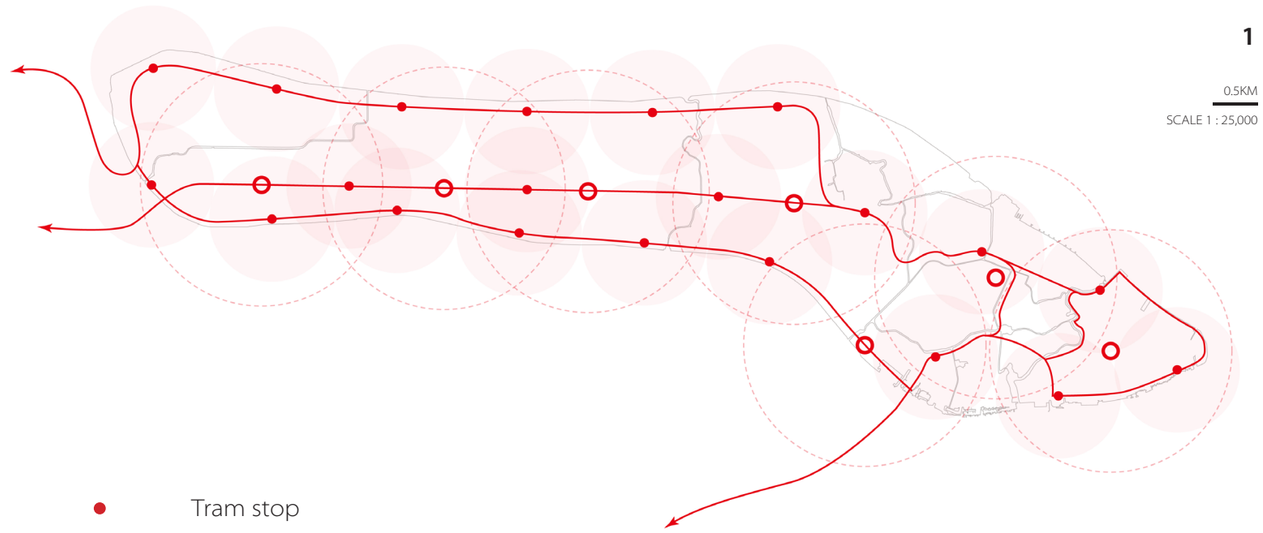


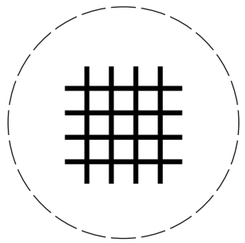
DEVELOPING HIGH-QUALITY PUBLIC TRANSPORT

1km service range regional public transport centers

400m service range local public transport stops

1





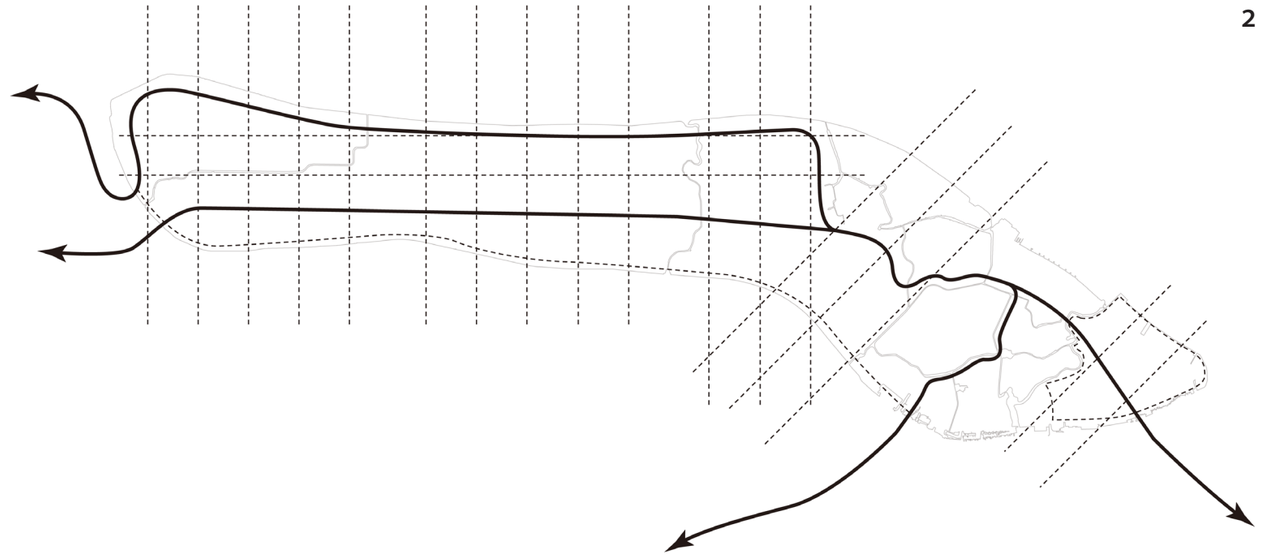
INCREASE ROAD NETWORK DENSITY

300m Module

≤45m road width

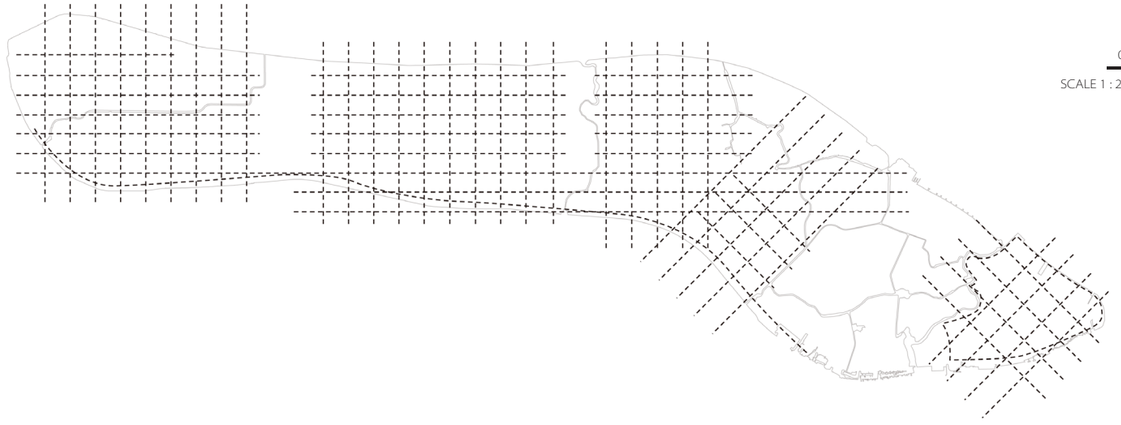
≥50 crossroads / km2

2



DESIGNING WALKABLE STREETS AND NEIGHBORHOODS

150m walkable
neighborhood size (2.5min)



3

0.5KM

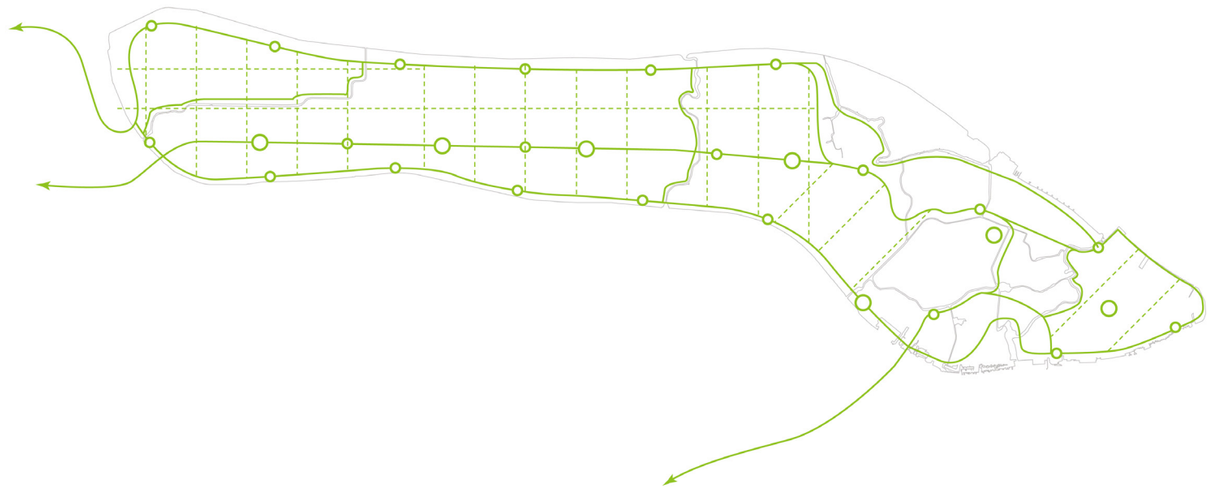
SCALE 1 : 25,000

PRIORITY ON BICYCLE NETWORK

≥3m road width

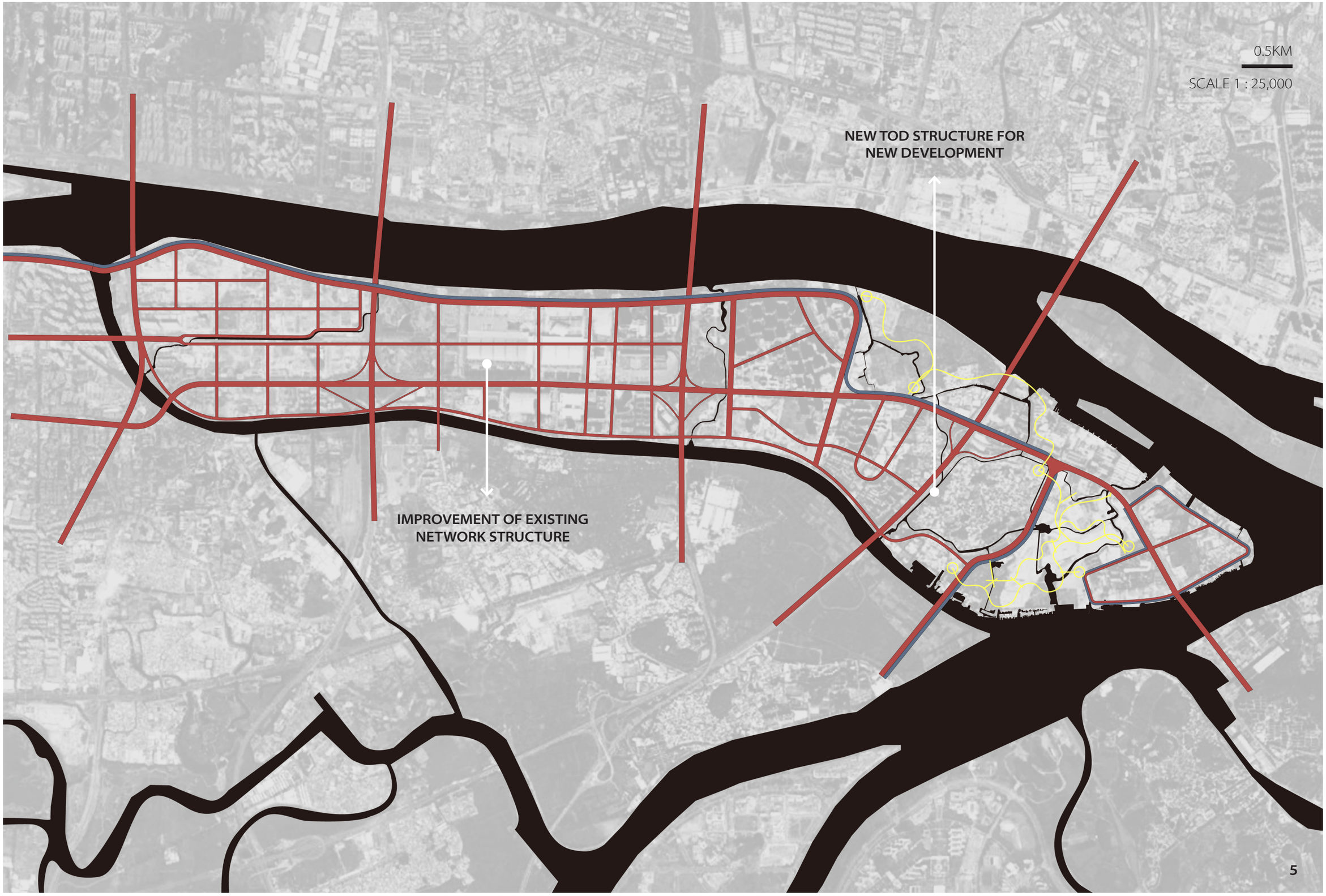
bicycles stops beside public transport stations

Along the green & blue structure



4

1. Developing high-quality public transportation
2. Increase road network density
3. Designing walkable neighborhoods
4. Priority on bicycle network
5,6. The proposed TOD network
(Source: self-drawing)


0.5KM
SCALE 1 : 25,000
NEW TOD STRUCTURE FOR
NEW DEVELOPMENT
IMPROVEMENT OF EXISTING
NETWORK STRUCTURE
5

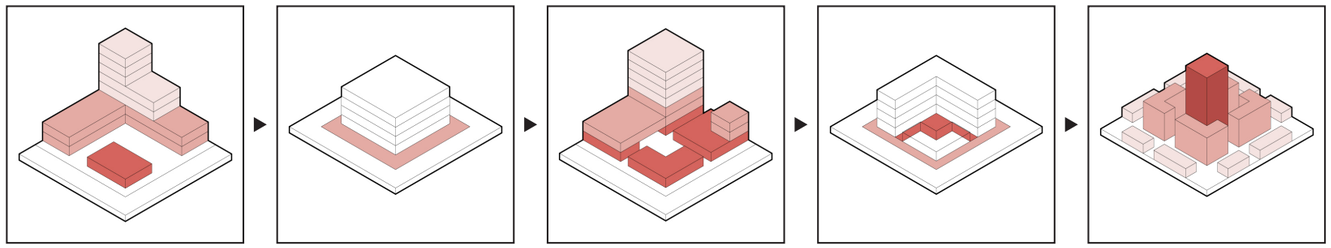
4.3 LOCAL SCALE

After building up the landscape and network structures in both regional scale and Pazhou scale, there are now enough clues and conditions provided for a detail spatial design in the selected site: Pahzou east.

In to the local scale design, the design structure is still base on the layerd approach, and this time adding the urban settlement layer. In each layer there will be a series of principles set up, from water resilient principles to TOD principles to urban spatial quality principles. Layer by layer, step by step, the design will be naturally build up.

Beyond this contextualized design process on Pazhou east, the more important part of the design is actually this structure of layers and the related principles. It is a a generic design structure that can be applied to other areas in the PRD.

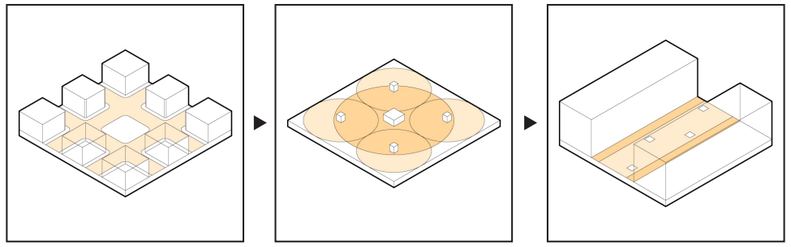
PRINCIPLES FOR URBAN SPATIAL QUALITY



MULTIPLE FUNCTIONAL NEIGHBORHOODS | SPATIAL CONCESSION | MIX TYPE OF BUILDINGS | SEMI-PUBLIC SPACE | HEIGHT & VIEW CONTROL

▲

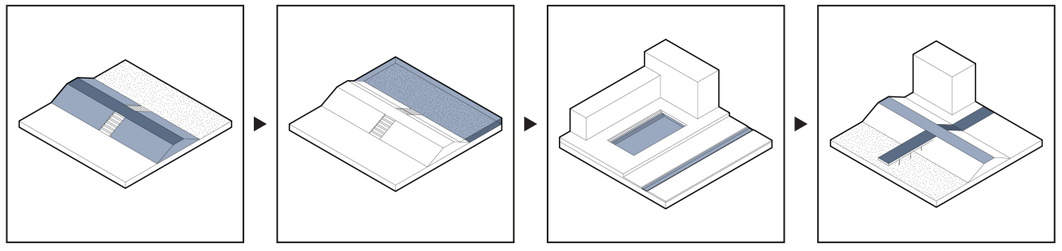
PRINCIPLES FOR TOD NETWORK



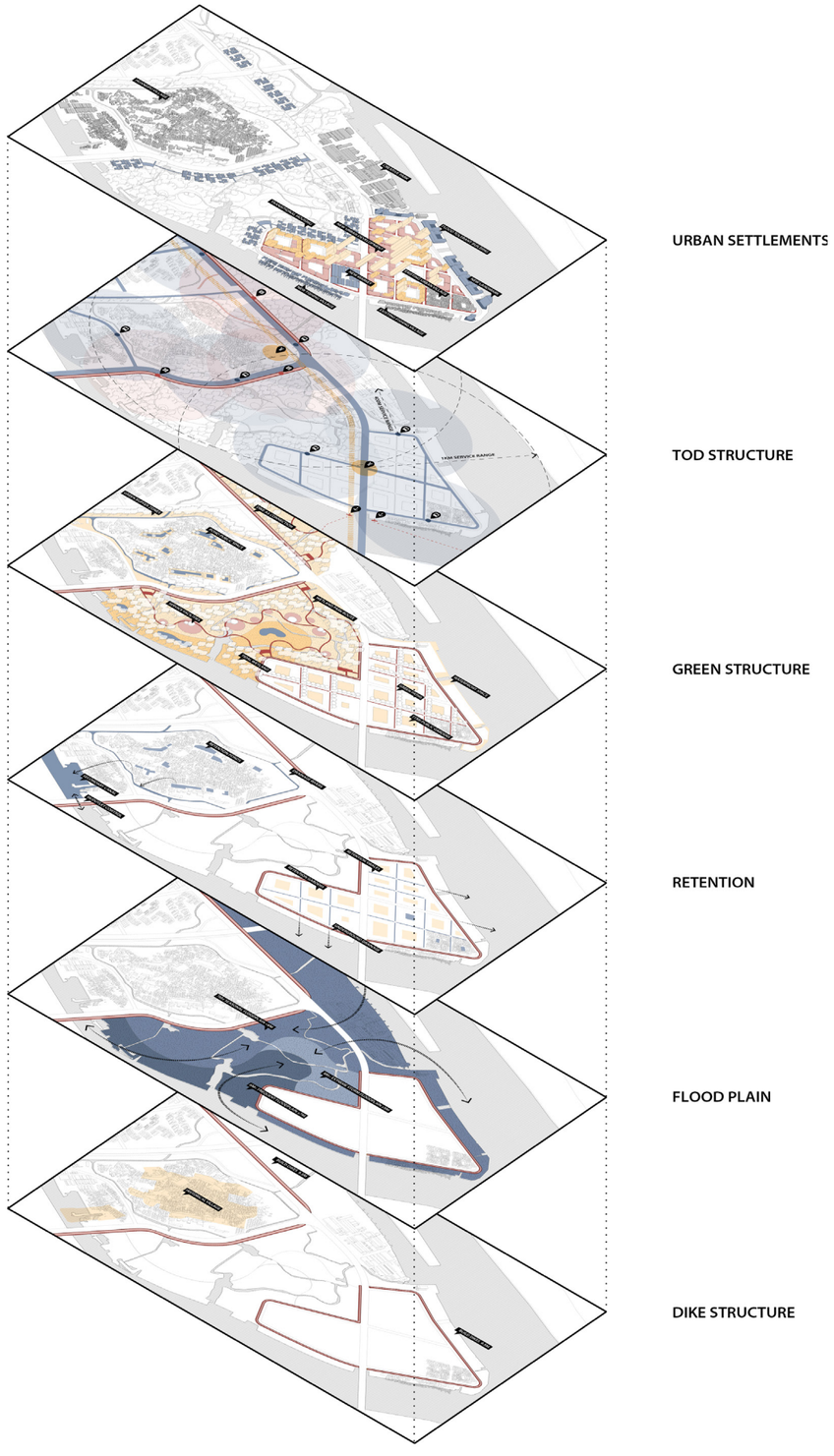
INCREASE FAST TRAFFIC NETWORK DENSITY | MULTIPLE PUBLIC TRANSPORT NETWORKS | SLOW TRAFFIC & WALKABLE NEIGHBORHOODS

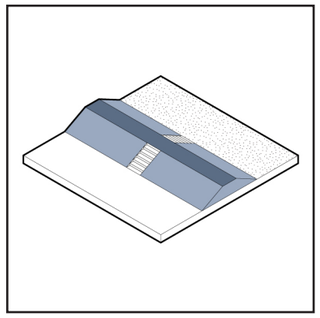
▲

PRINCIPLES FOR WATER RESILIENT LANDSCAPE STRUCTURE



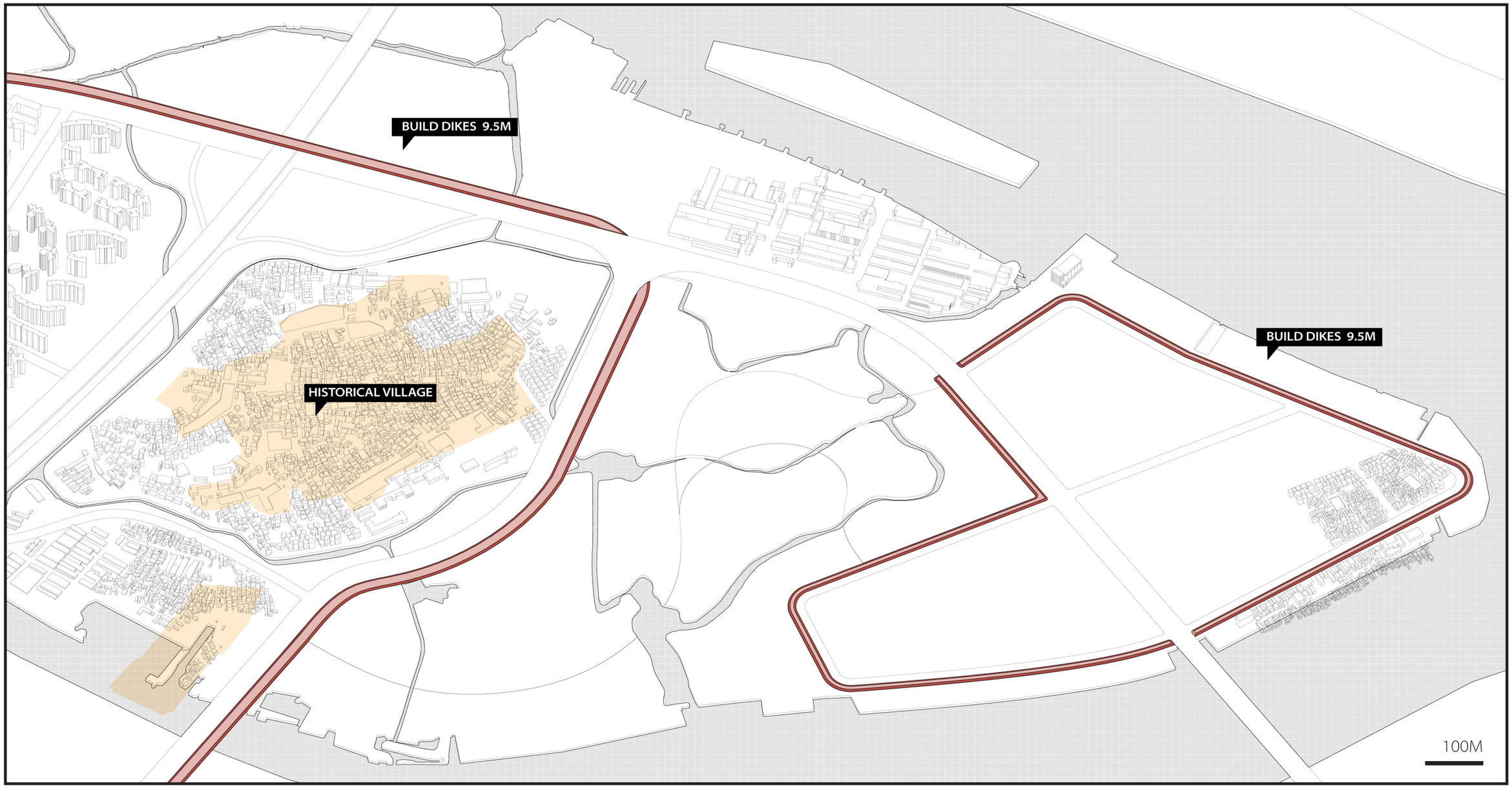
BUILD NEW DIKES INLAND-WARDS | CREATE FLOOD PLAINS | RAINWATER RETENTION & DRAINAGE SYSTEM | GREEN CONNCETION

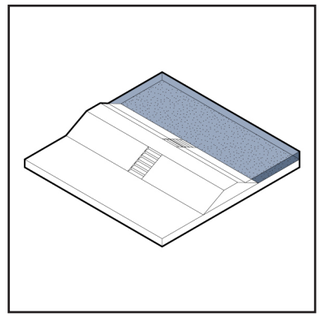




4.3.1 BUILD NEW DIKES INLAND-WARDS

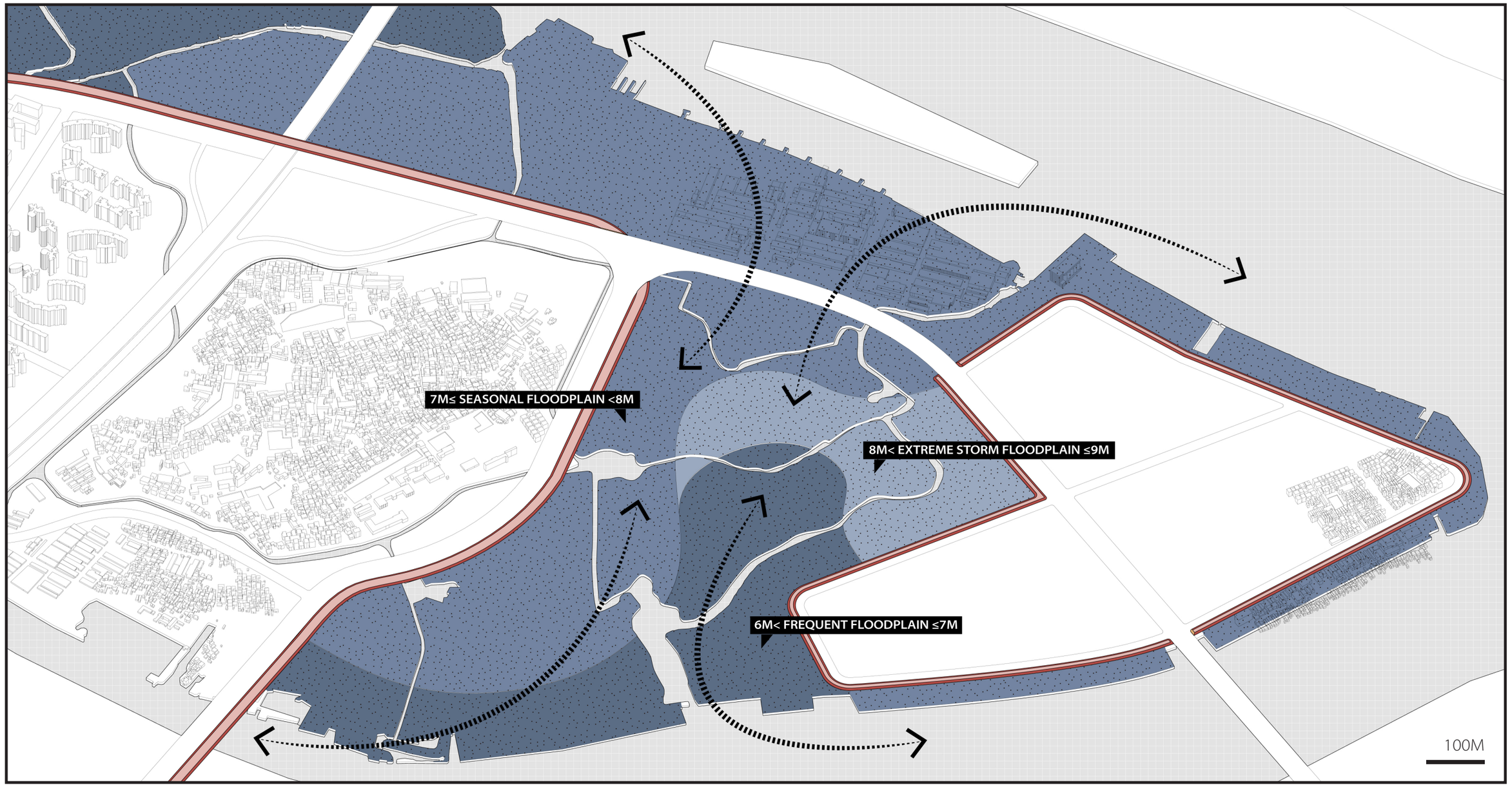
The existing flood defense system is at an average height of 7 meters that cannot meet the requirement of future flood defense standards. Thus, building up a new dike system with higher elevation is an important measure. What's more, the location of the new dike system should not be at the river borders just as the traditional engineering resilience measures did before. They should be located inland-wards to create more space for the river in case of higher water level, while creating more flexible outer-dike areas for different types of urban development.

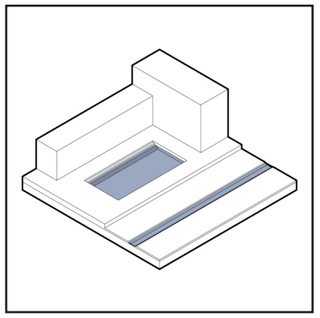




4.3.2 CREATE FLOOD PLAINS

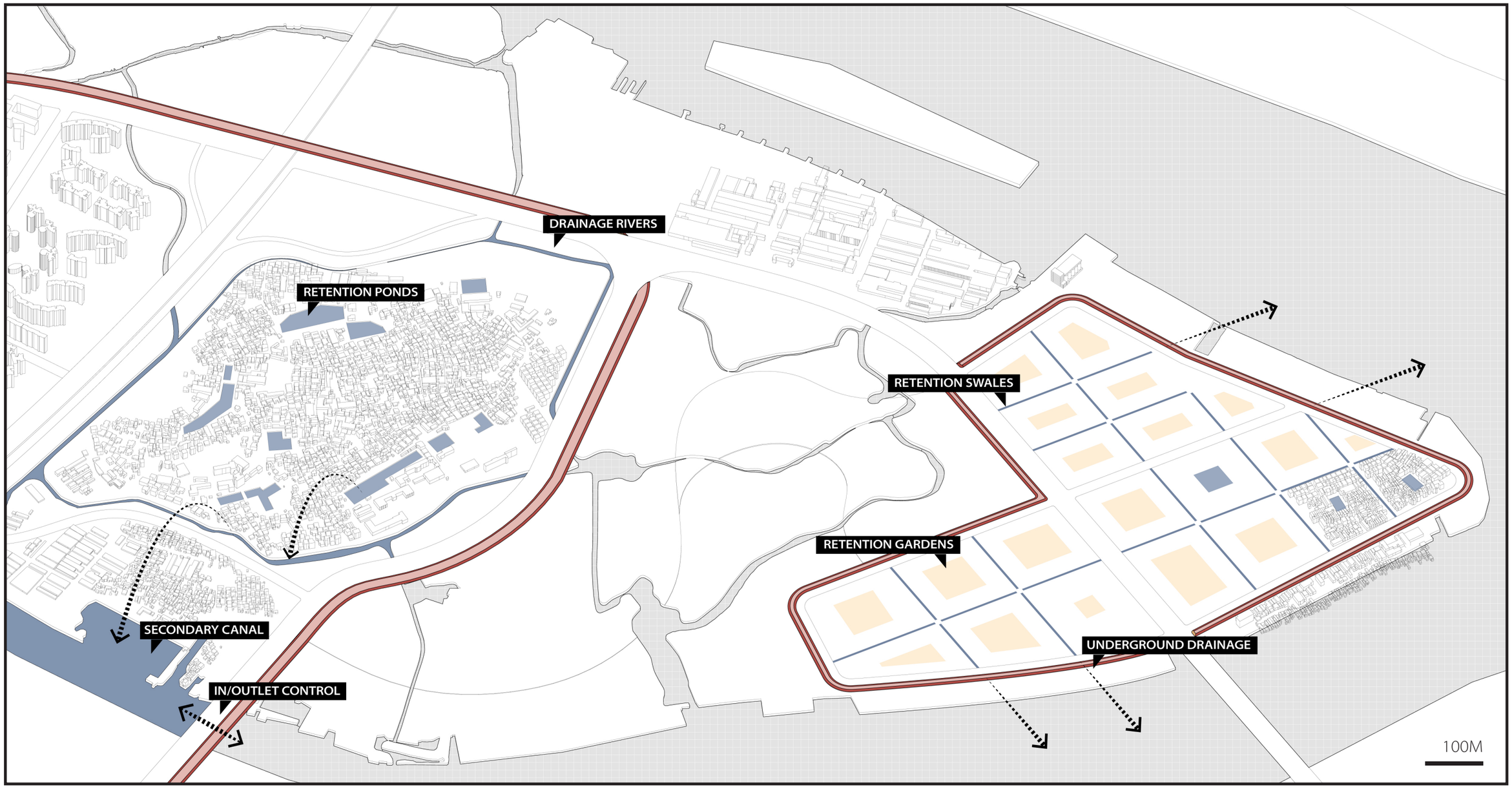
The location of the new dike system creates a large area of outer-dike flood plains. There are 3 different levels of elevations of the flood plains, and adjustments of the borders of each level are made based on the existing elevation, creating 3 different spatial effects and related development strategies accordingly. The lowest part in the south between 6-7 meters is defined as ecological wetland areas that people can't access. The larger area in the middle between 7-8 meters are the most flexible parts allows both flood-tolerable urban development or wetland park area. The highest part between 8-9 meters in the middle is the core area that can stay dry feet most of the time except extreme storms.

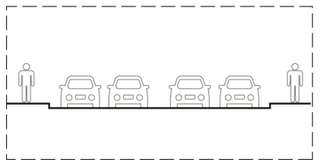




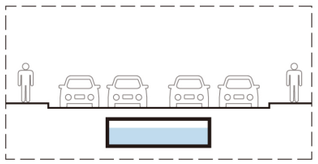
4.3.3 RAINWATER RETENTION & DRAINAGE SYSTEM

In the inner-dike areas, the main principles are to deal with the rainwater flooding issues. The first step is rainwater retention that requires the creation of ponds, gardens, swales, and underground storage that can hold rainwater in a short period to reduce the pressure of the city rainwater pipe during the heavy rains. The second step is about rainwater drainage, linking the segregated retention systems and making full use of the existing rivers to drain the rainwater out after the heavy rains. Together the retention and drainage systems increase the capacity of rainwater within the dikes to face the future challenge of the increase of the amount of rainfall.

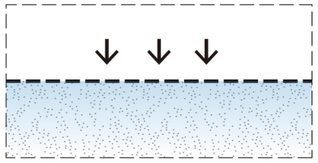




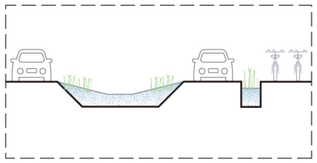
STREETS



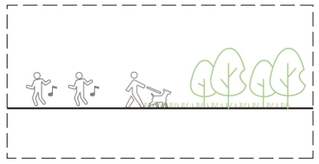
UNDERGROUND STORAGE



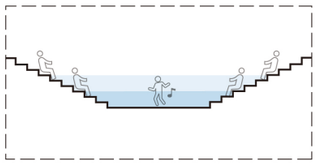
PERMEABLE PAVEMENT



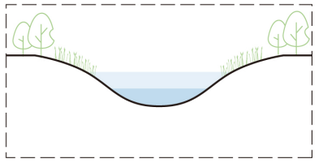
RETENTION SWALE



PUBLIC SPACES

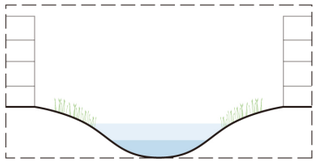


WATER SQUARE

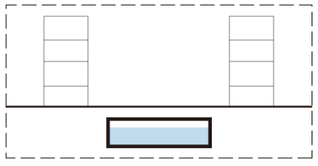


RETENTION PARK

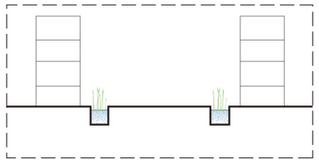
NEIGHBORHOODS



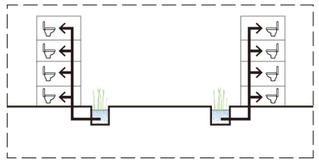
RETENTION GARDEN



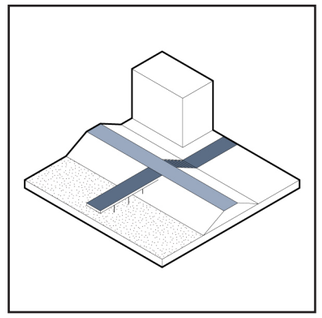
UNDERGROUND STROAGE



RETENTION SWALE

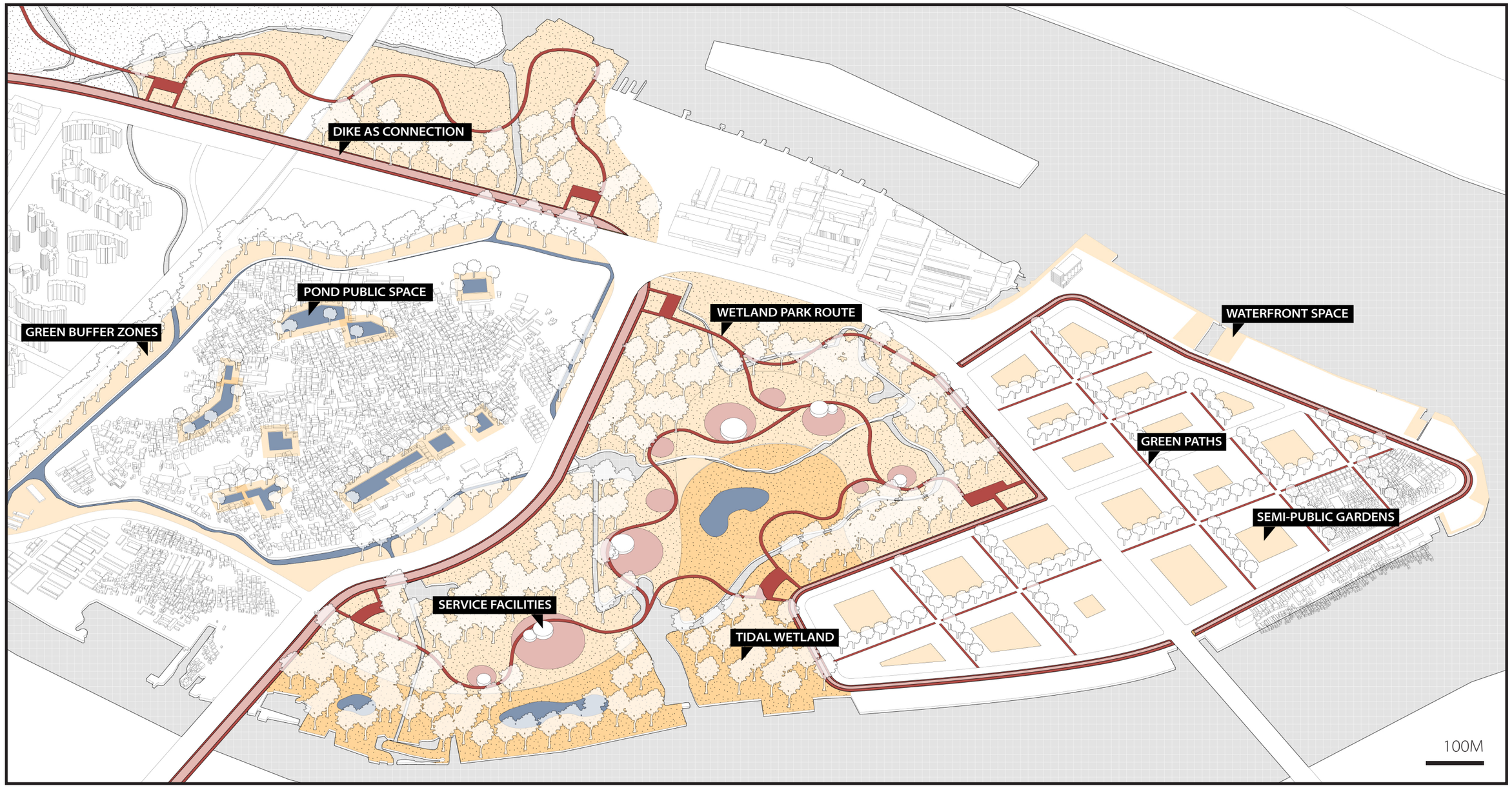


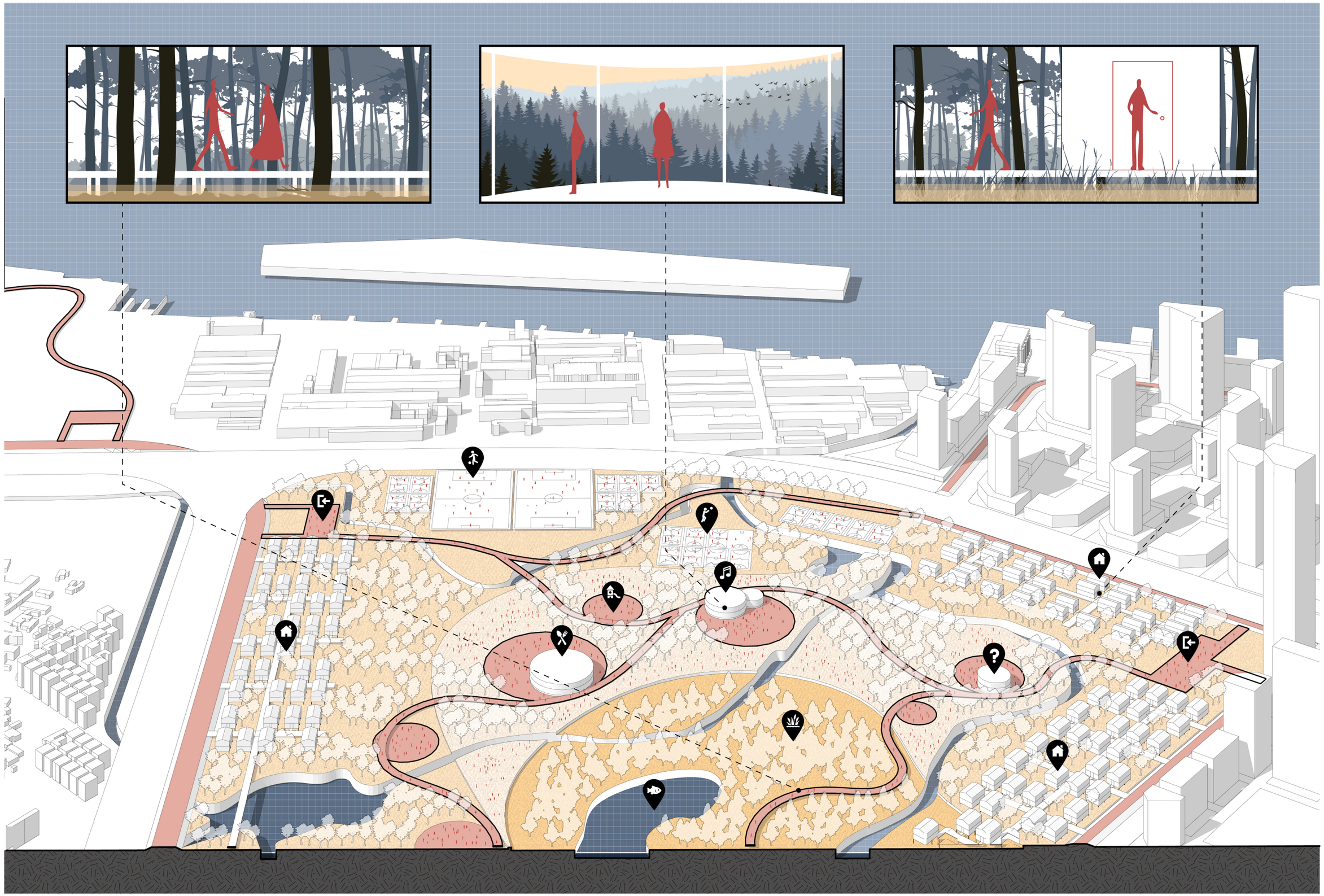
RAINWATER REUSE



4.3.4 GREEN CONNECTION

The green structure is another essential element of the landscape. The basic principle is to make use of the new dike system as the main connection of the green both within and outer the dikes. The green inside the dikes is mainly public spaces within neighborhoods and walkable green paths. They are guided towards the dike, then connect directly with the route of the wetland park outside the dikes. Within the wetland park, the route which is lifted up in the air to keep dry feet connects a series of spaces for activities and supporting facilities. In the Huangpu historical village, the green structure is surrounded to create buffer zones for the protection of the peaceful environment.





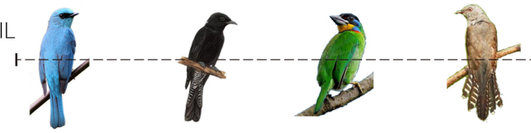
JANUARY — DECEMBER

RESIDENT BIRD

Copsychus saularis · *Spilopelia chinensis* · *Acridotheres cristatellus* · *Sturnus sericeus* · *Zosterops japonicus* · *Pycnonotus jocosus* · *Pycnonotus sinensis* · *Garrulax perspicillatus* · *Hirundo rustica*

SUMMER MIGRATORY BIRD

APRIL — JUNE



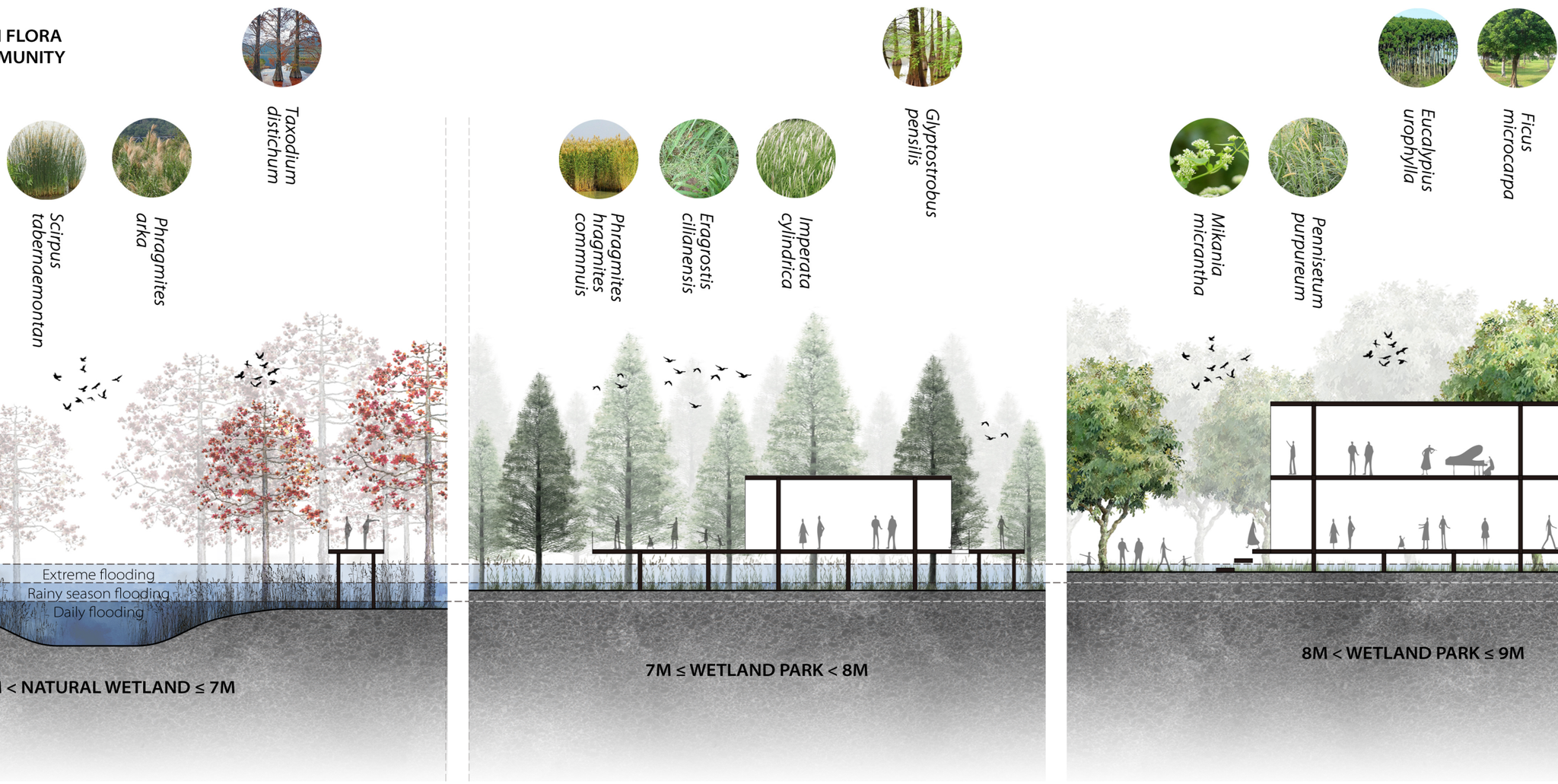
Eumyias thalassinus · *Surniculus lugubris* · *Megalaima oorti* · *Cacomantis merulinus*

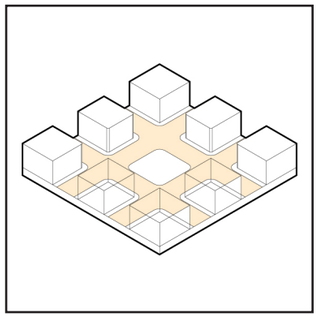
AUTUMN / WINTER MIGRATORY BIRD

AUGUST — DECEMBER

Anthus richardi · *Ardea purpurea* · *Numenius phaeopus* · *Chlidonias leucopterus*

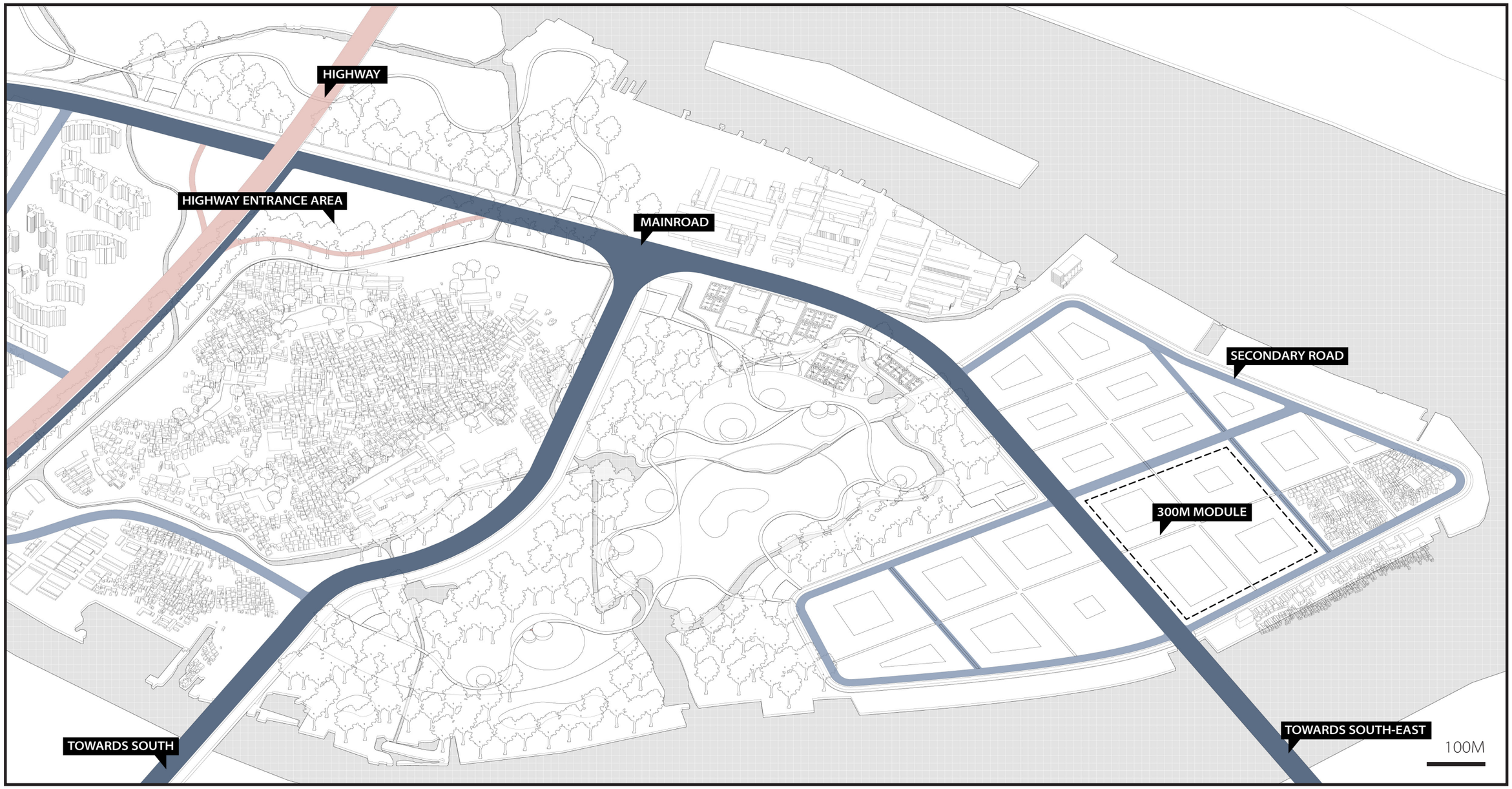
MAIN FLORA COMMUNITY

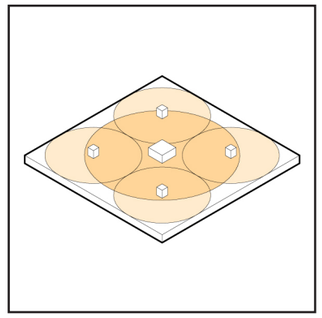




4.3.5 INCREASE FAST TRAFFIC NETWORK

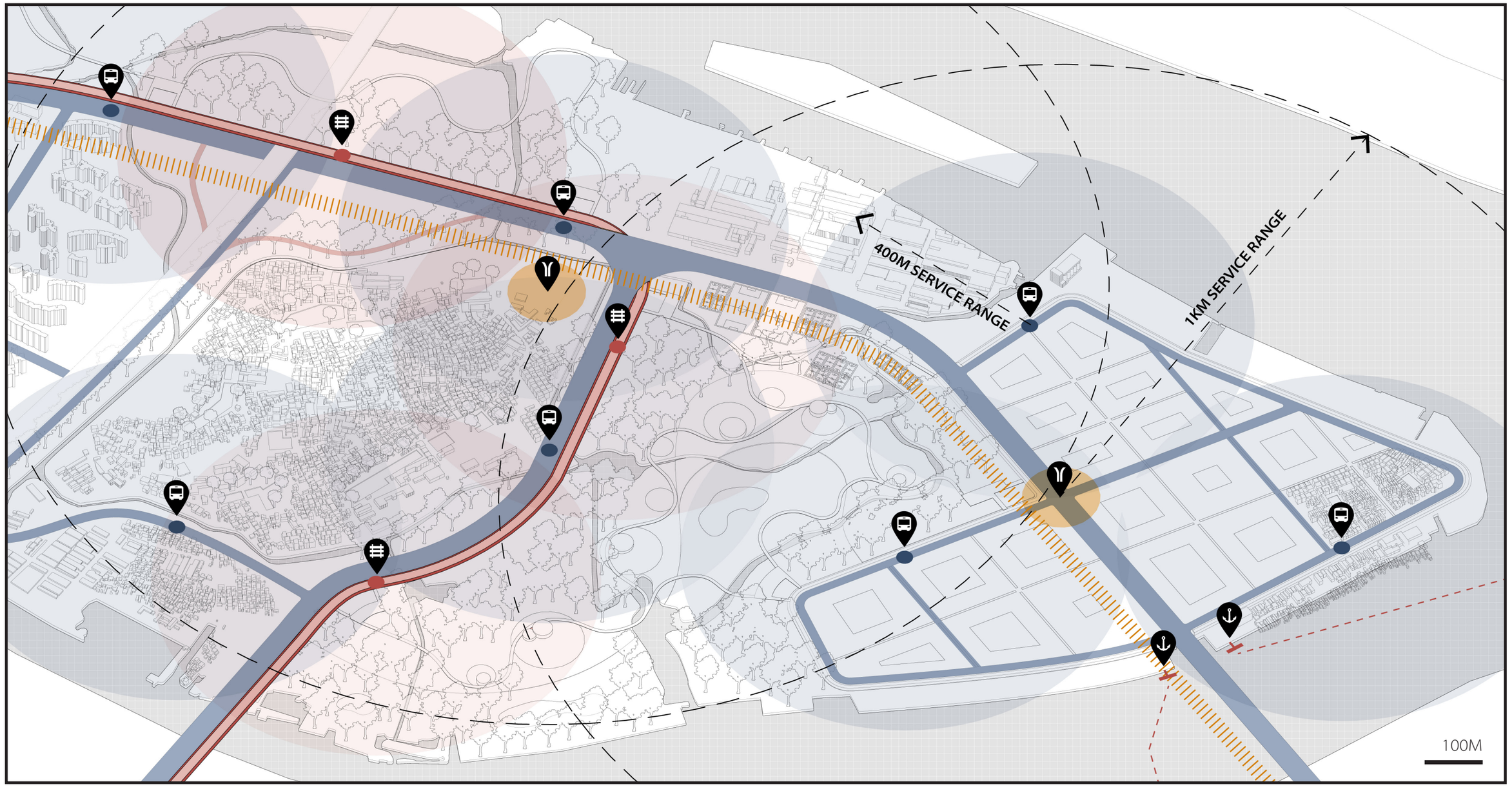
The new TOD fast traffic network is mainly based on the existing main road that goes across the middle of the island. The new fast traffic network at the east of the island follows the principle of smaller grids to create not only a better traffic condition for the cars which will result in less fuel consumption but also safer streets for the pedestrians to go across. The road width is limited to less than 40 meters and the module of the grids is 300 meters, which also forms up the scale of the walkable neighborhoods. Space for sidewalks and bicycle paths are alongside the roads to provide various traffic options.

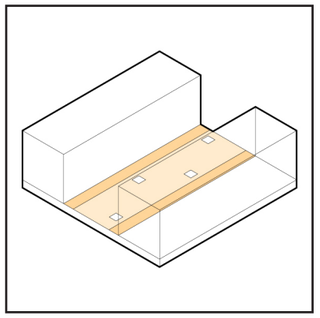




4.3.6 MULTIPLE PUBLIC TRANSPORT NETWORKS

The establish of a multiple public transportation network is the key to the TOD structure. In this area, the main types are the tram railway runs on the dike, the bus stops that spread on the whole island and the metro stations as the regional transportation core. The public tranportation nods share a service range of 400 meters, while the metro station have a range of 1 kilometer. The design of this network is to try as possible to cover the whole area within the service range of at least 1 type of public tranportation.





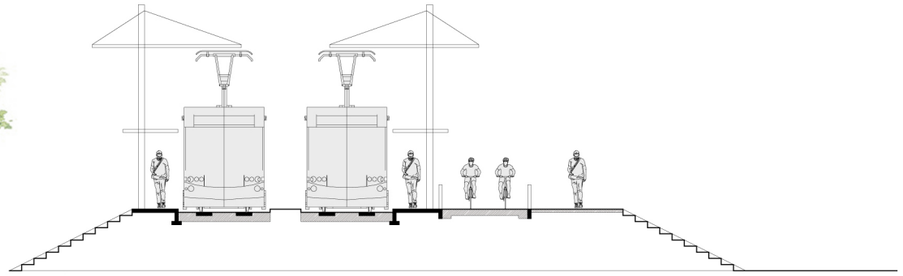
4.3.7 SLOW TRAFFIC & WALKABLE NEIGHBORHOODS

Slow traffic network of sidewalks and bicycle paths is also essential in the TOD structure because it decreases the reliance on cars and reduces fuel consumption. In the design it is highly overlayed with the green structure thus will better connect the urban areas with the natural landscape. The design of walkable neighborhoods creates a safe and vigorous environment for people to live in. The walkable neighborhoods follow a module of 150 meters.

ROAD SECTIONS

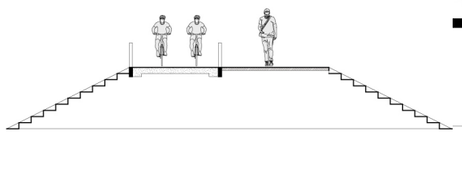
Pedestrian	Bicycle	Retention	Bus	Car	Car	Retention	Car	Car	Bus	Retention	Bicycle	Pedestrian
3500	3000	2500	3500	3000	3500	2000	3500	3000	3500	2500	3000	3500
40000												

MAIN ROAD + DIKE
SCALE 1:200



Stairs	Tram	Bicycle	Pedestrian	Stairs
4000	10000	2000	2000	4000
22000				

Pedestrian	Bicycle	Retention	Bus	Car	Car
3000	2500	1000	3000	3000	3000
15500					

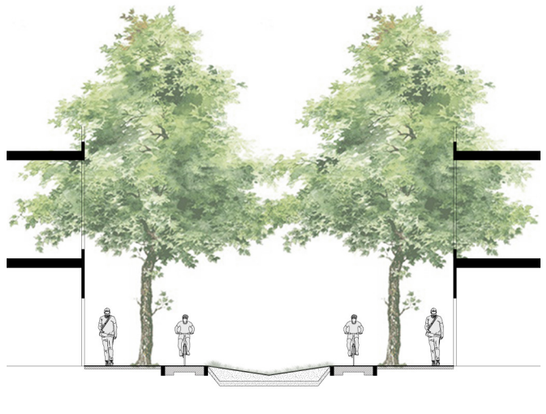


Stairs	Bicycle	Pedestrian	Stairs
4000	3000	3500	4000
14500			

SECONDARY ROAD + DIKE
SCALE 1:200

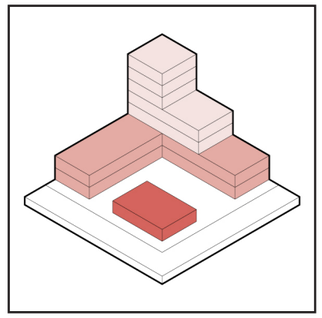
Pedestrian	Bicycle	Car	Car	Car	Bicycle	Pedestrian
3000	2500	3000	3000	3000	2500	3000
20000						

SECONDARY ROAD
SCALE 1:200



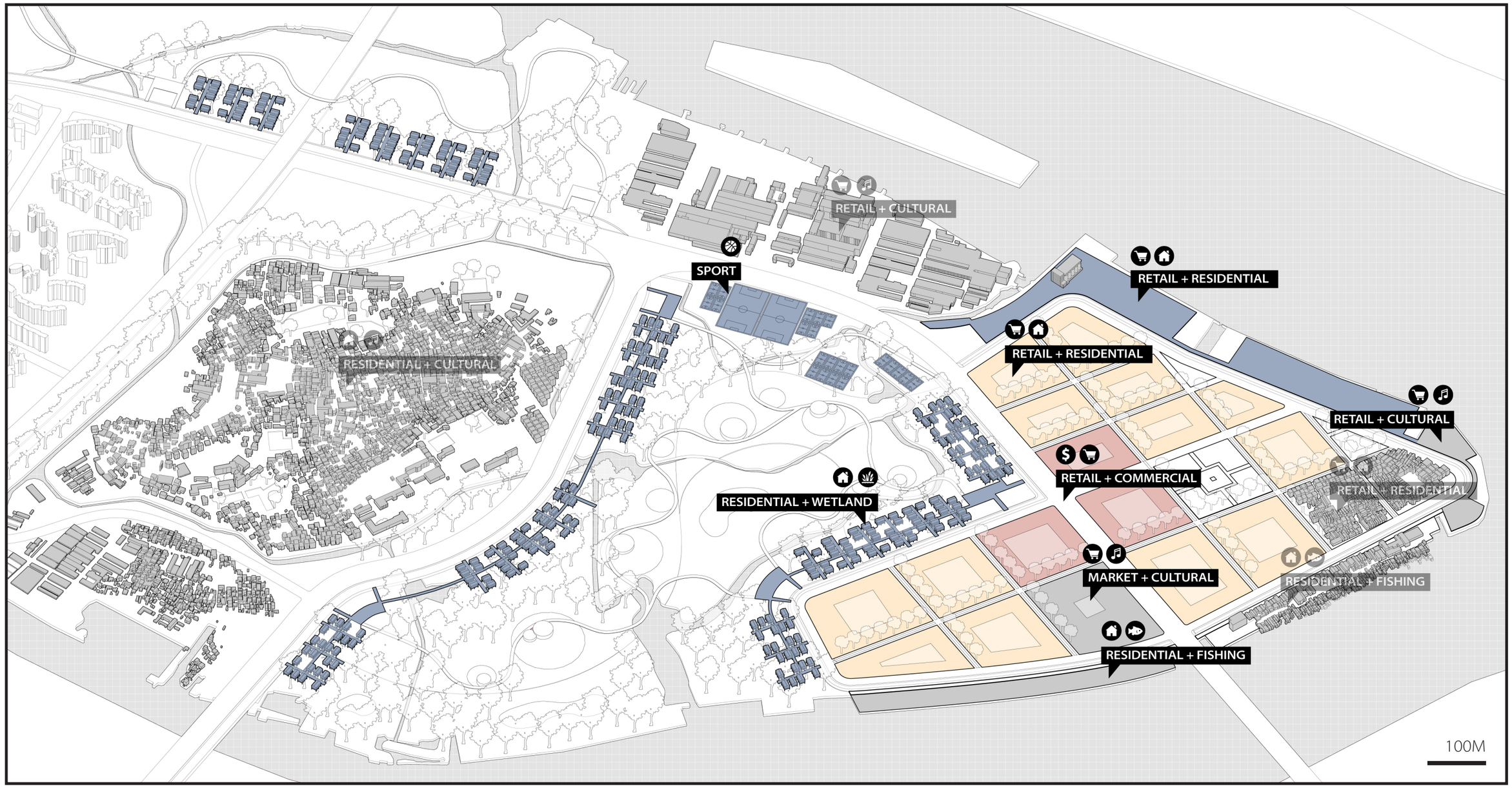
Pedestrian	Bicycle	Retention	Bicycle	Pedestrian
2500	1500	4000	1500	2500
12000				

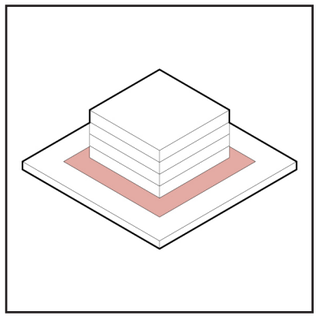
WALKABLE NEIGHBORHOOD
SCALE 1:200



4.3.8 MULTIPLE FUNCTIONAL NEIGHBORHOODS

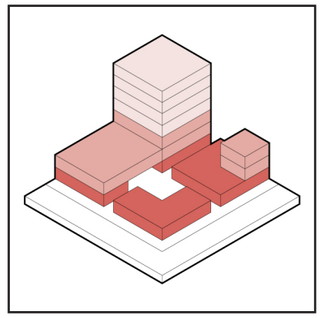
One of the problems of the existing urban planning is the mono-functional zoning method that creates different types of neighborhoods in segregation. The principle of designing multi-functional neighborhoods brings more diversity to both the people in the neighborhoods and also their types of activities. In the design, the function of the new development areas has a large proportion of residential mixed with retail on the first floor. And the areas surround the metro station are defined as high-rise commercial zones but also retail on the streets. In the outer-dike areas, some special flood-tolerant urban types are placed.





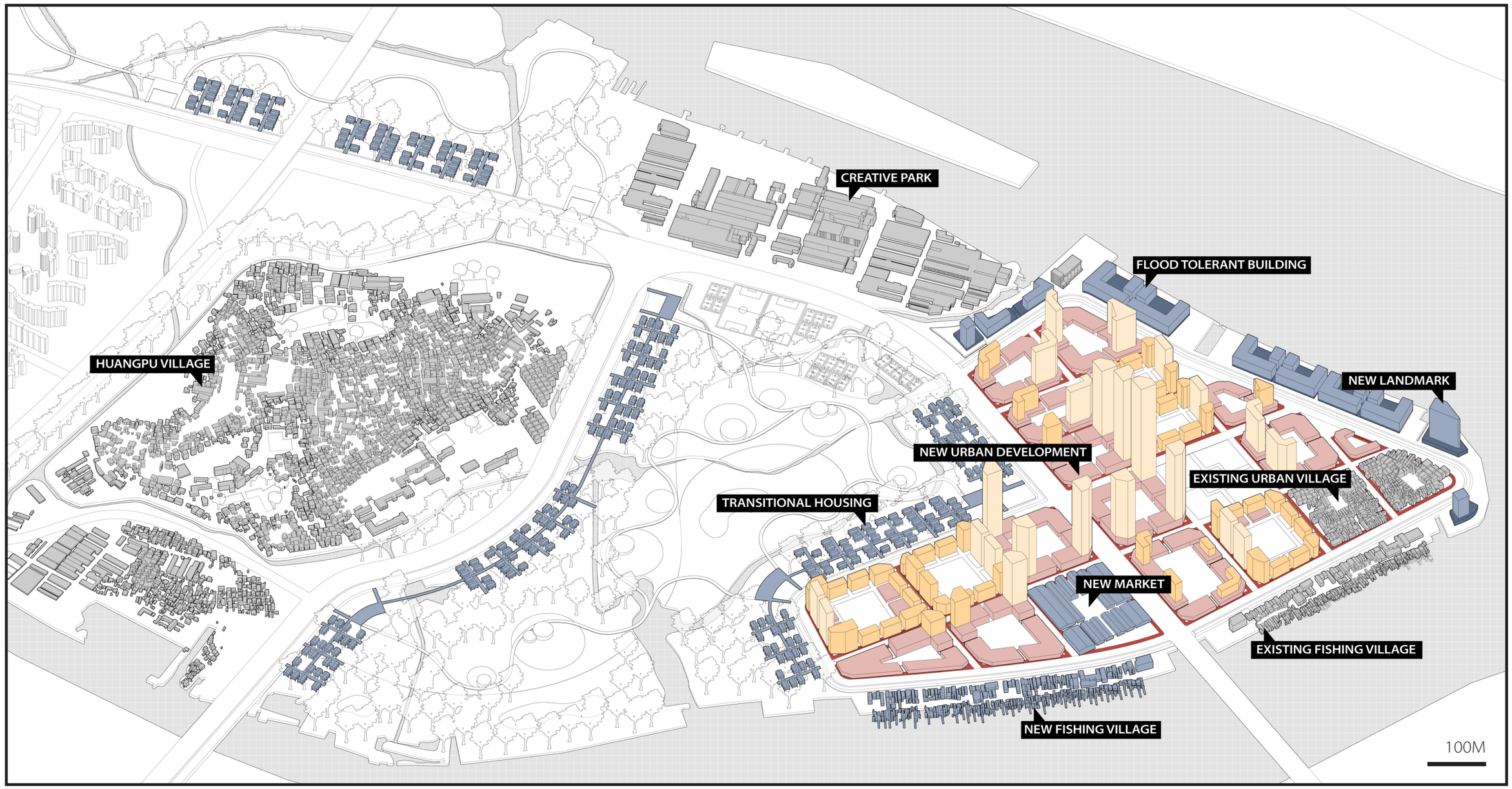
4.3.9 CREATING BUFFER ZONE

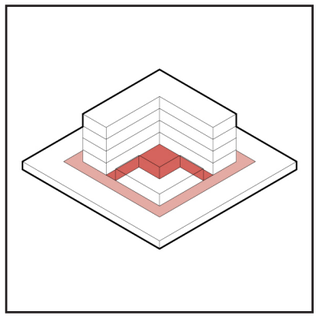
The spatial concession principle aims at creating transitional borders between buildings and roads to reduce the noise and danger of the traffic while encouraging activities in front of the buildings. Also, the accessibility of pedestrians is also increased. The distance is on average 3 meters from the road border. In terms of the Huangpu historical village, the designed green buffer areas can also seem as the spatial concession of the urban areas.



4.3.10 MIXING OF BUILDING TYPOLOGIES

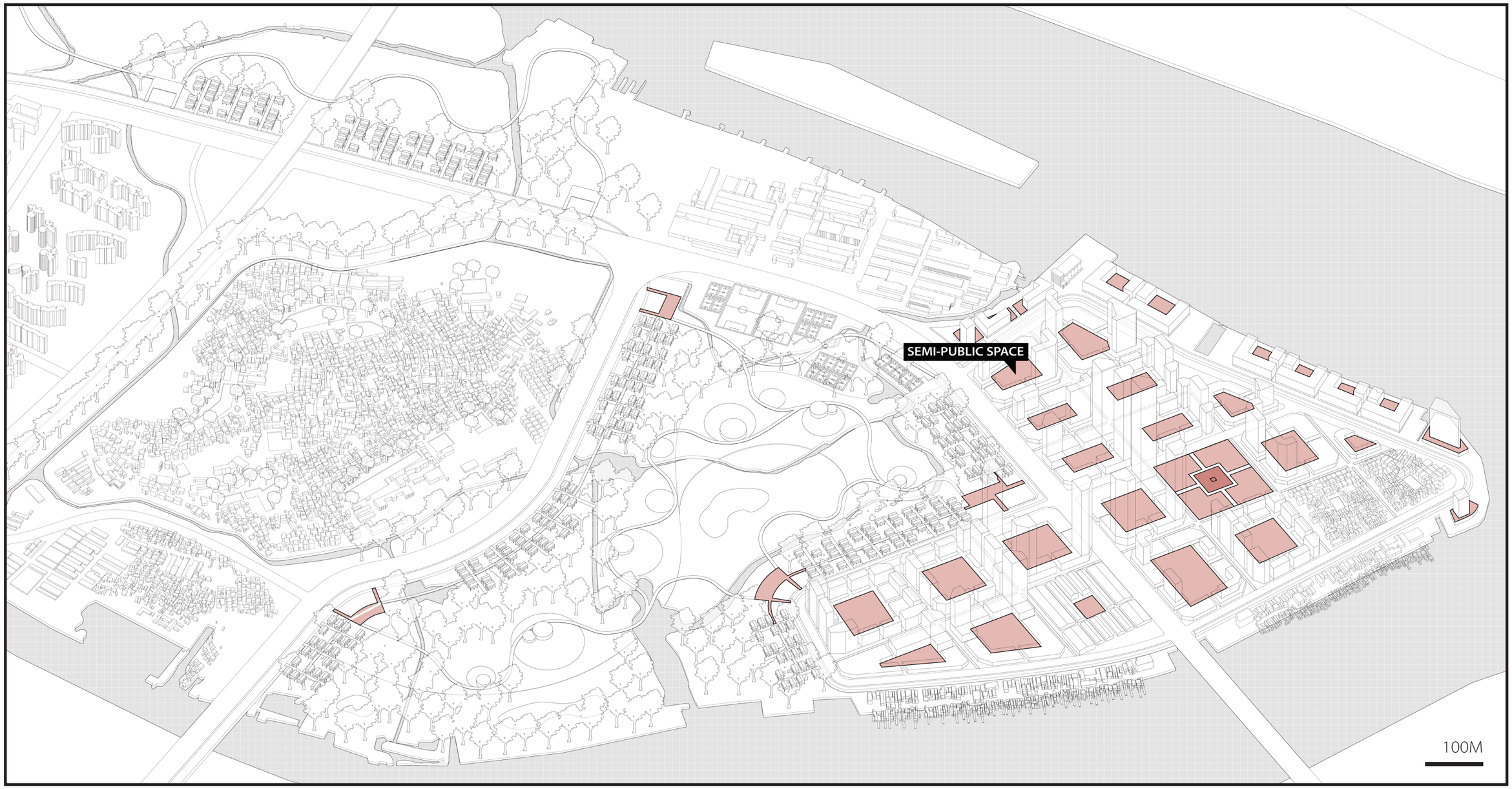
The principle of mixing different types of buildings in terms of shape, height, and density within neighborhoods is an important way to not only increase the development density but also provides more options to welcome different types of people in terms of income into the designed area. Social equity will be strengthened. It is also closely related to the multi-functional neighborhood principle. The building on the first floor is for retail that increases street vitality, ane higher ones can provide different functions as residential, commercial, or other services. From the perspective of the whole area, there are also highly variable in building types like factories, urban villages, fishing villages, etc.

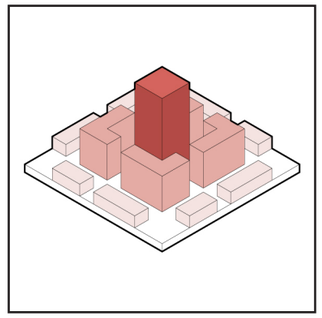




4.3.11 SEMI-PUBLIC SPACE

The design of semi-public space within buildings in the neighborhoods is an important element that creates spaces for urban activities and also increases safety. This measure means taking the neighborhoods as the basic units of the new urban development. The semi-public spaces in between will create new identities for the neighborhood while strengthening people's sense of belonging to it. Also, these small areas are important elements in the rainwater retention system so they are one of the linkages between the water resilience design and urban quality space design.





4.3.12 HEIGHT & VIEW CONTROL

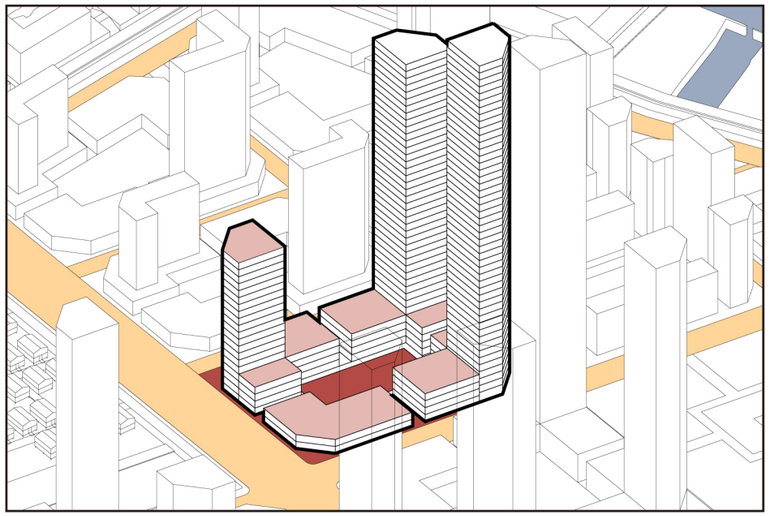
In the new development area, the building is designed higher in the middle as the core area where the metro station is located. And the surrounding areas are designed gradually lower until the river edge or the urban border. This principle ensures nice and open views for all the buildings towards all directions, whether the riverscape or the beautiful wetland scenery. Also, it is a way to control development density. In the center core areas, it should be denser for more financial consideration, and at the surrounding border, it should be less dense to consider waterfront spatial qualities.

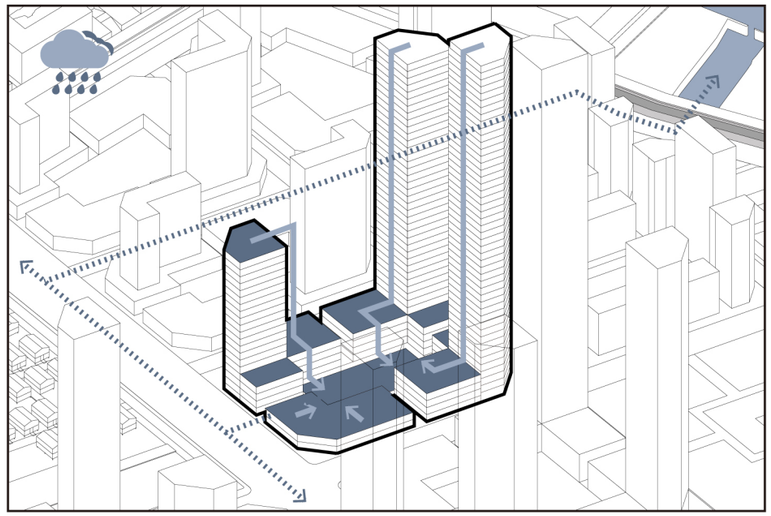
URBAN TYPOLOGIES - INNER DIKE

SPATIAL STRUCTURE

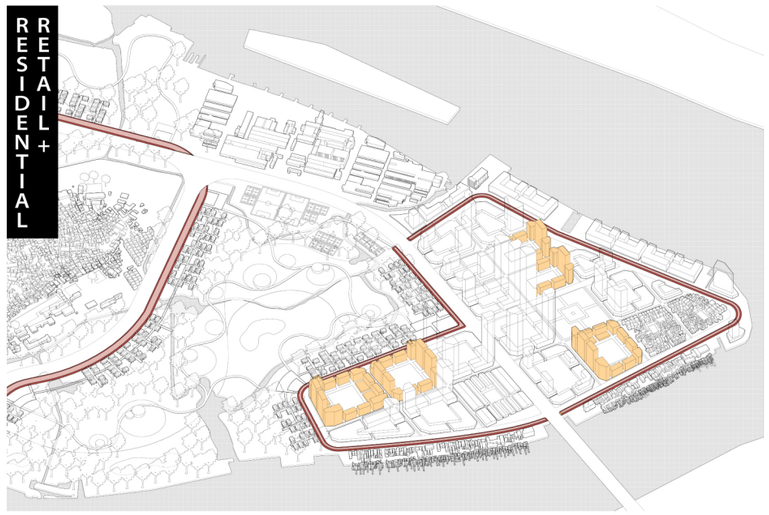
RETENTION SYSTEM

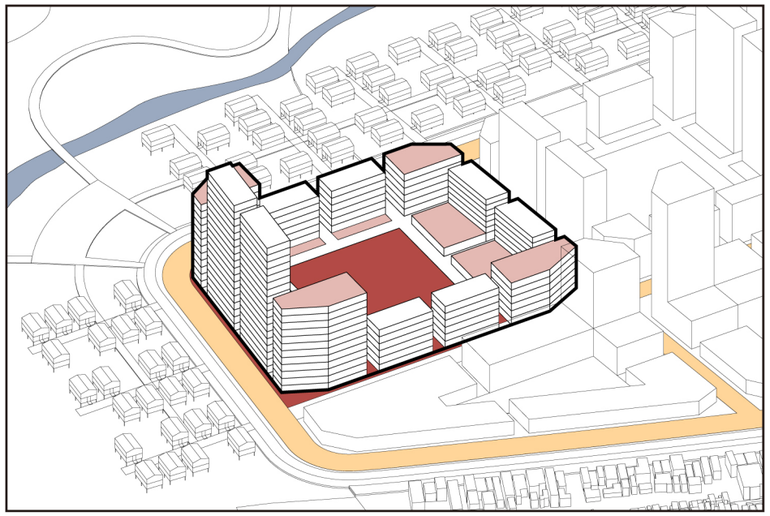
RESIDENTIAL RETAIL+ COMMERCIAL/

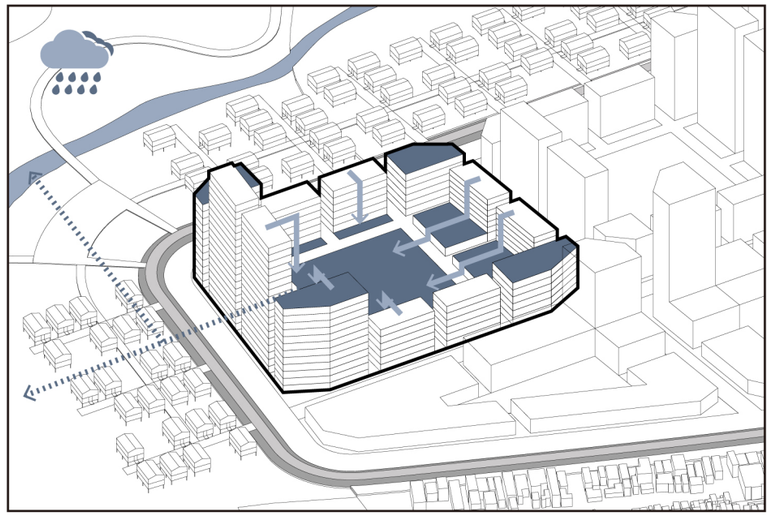




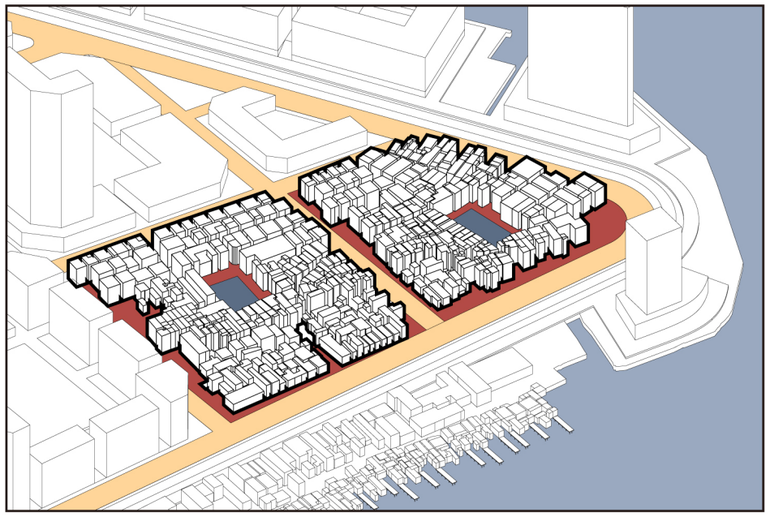
RESIDENTIAL RETAIL+

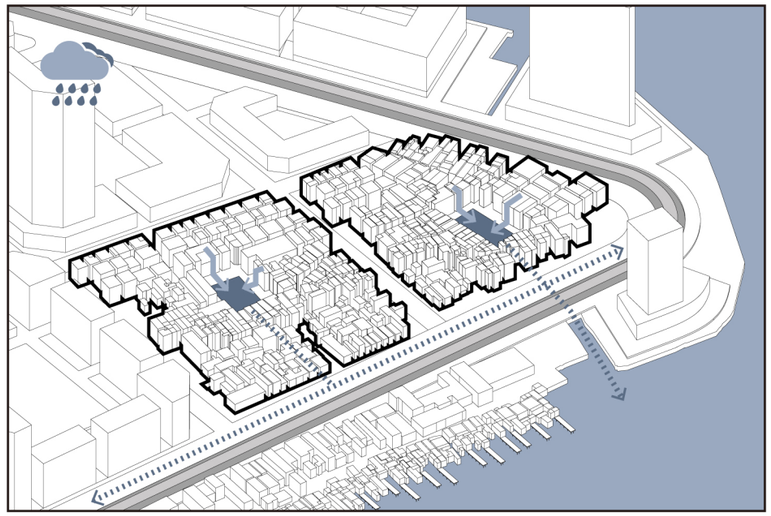






URBAN VILLAGE RETAIL+



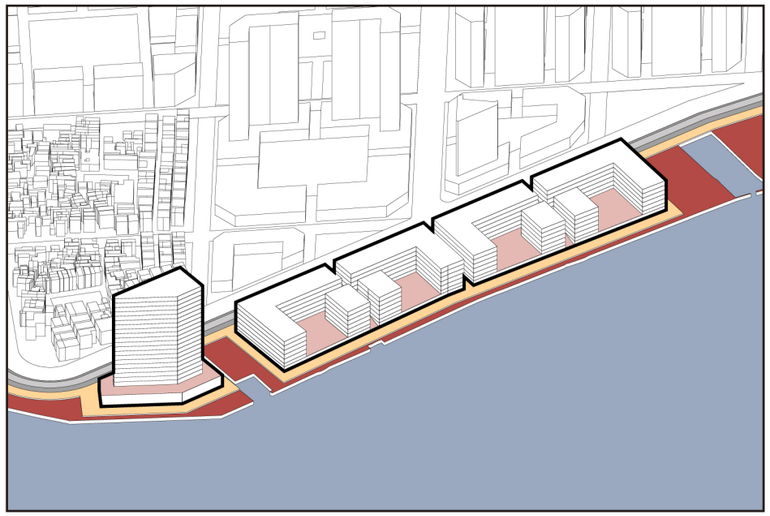


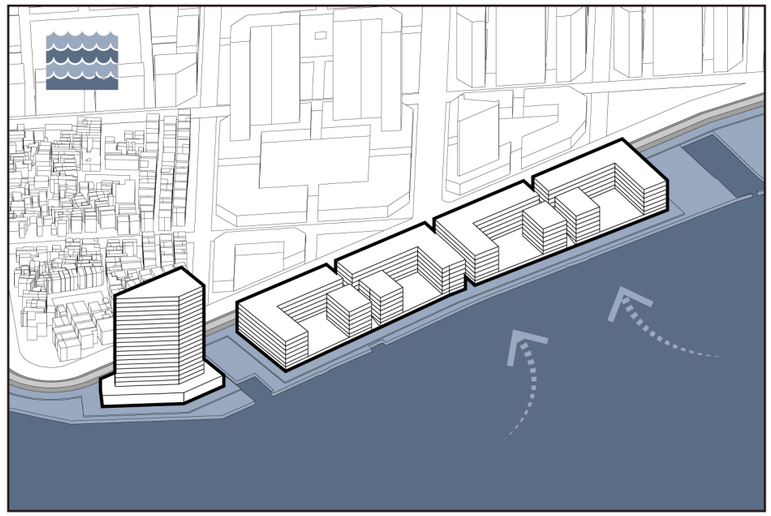
URBAN TYPOLOGIES - OUTER DIKE

SPATIAL STRUCTURE

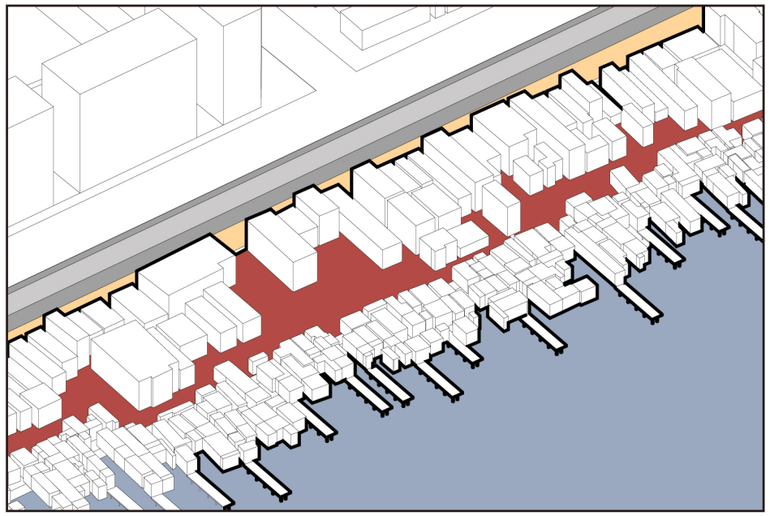
FLOOD TOLERANT

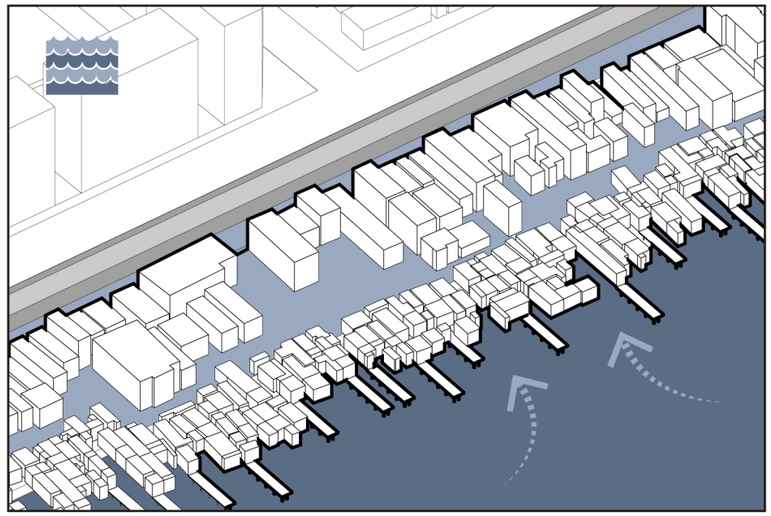
RESIDENTIAL + RETAIL



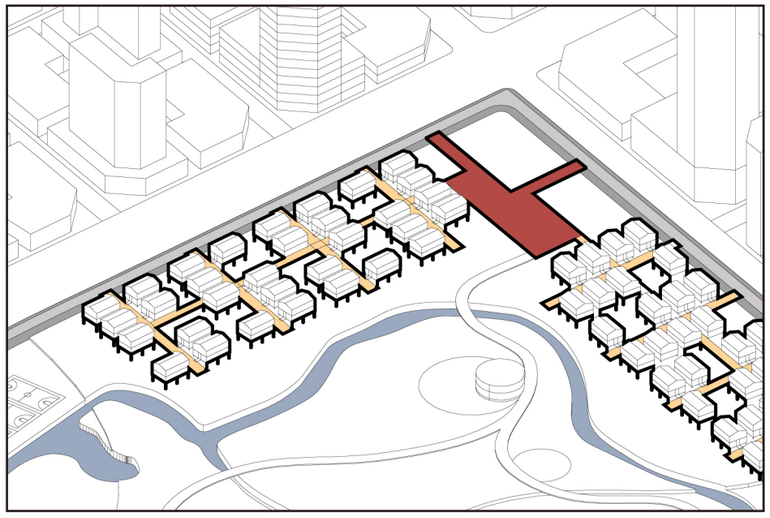


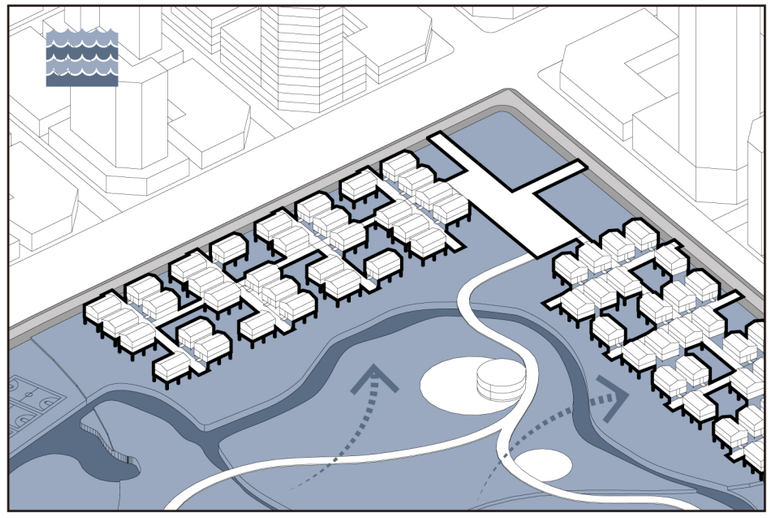
FISHING PLATFORM + RESIDENTIAL





WETLAND + RESIDENTIAL



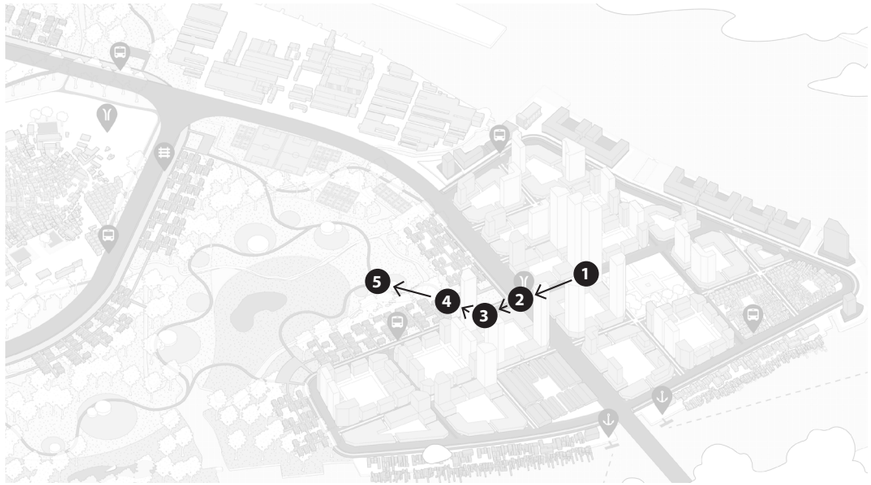


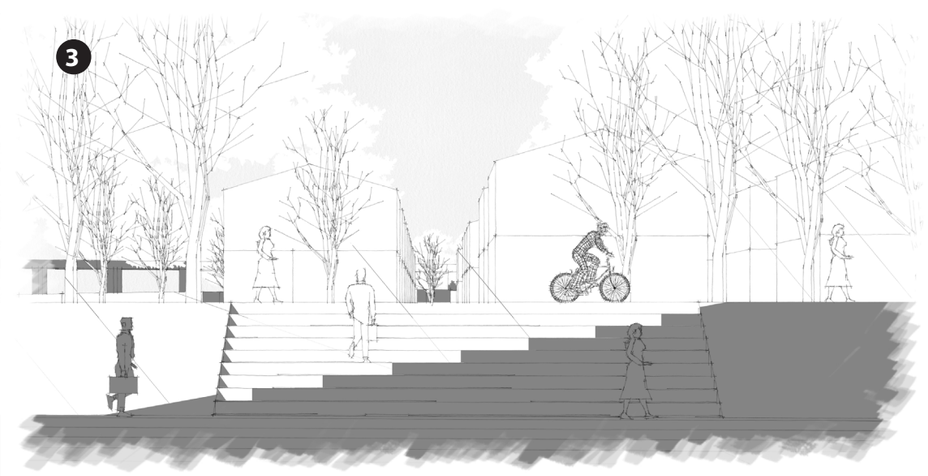
4.4 SPATIAL TRANSITION

In the design, the urban area and the wetland park are two different layers with their design principles and orders. Thus the transition between these two parts is an essential issue.

The main strategy to reduce spatial segregation is through creating transitions between spatial elements and improving accessibilities. In terms of spatial elements, the green elements distributed in the urban areas: trees, gardens, planting ponds, etc, create a sense of nature. And at the border of the wetland park, the special housing typologies create a sense of the urban area. These elements respond to each other, improving the spatial connection.

In terms of accessibility, it is easy to walk from the urban center to the dike since the slow traffic network will guide you wherever you are. And then the scale of the dike makes it easy to climb on, and further guide people to directly walk into the route of the wetland park because they are at the same elevation.

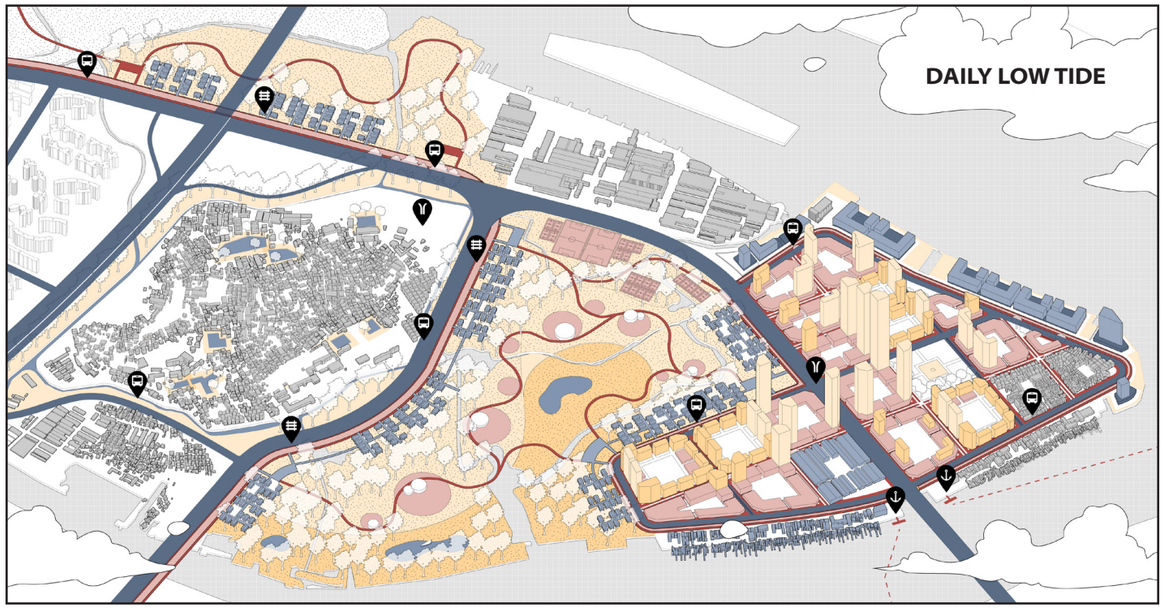


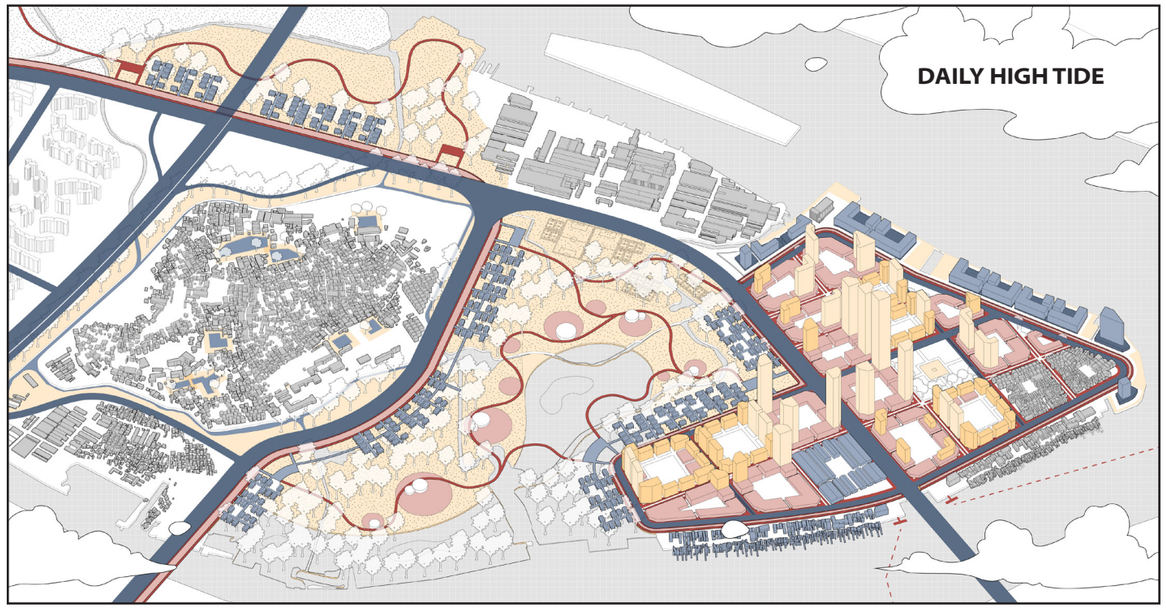


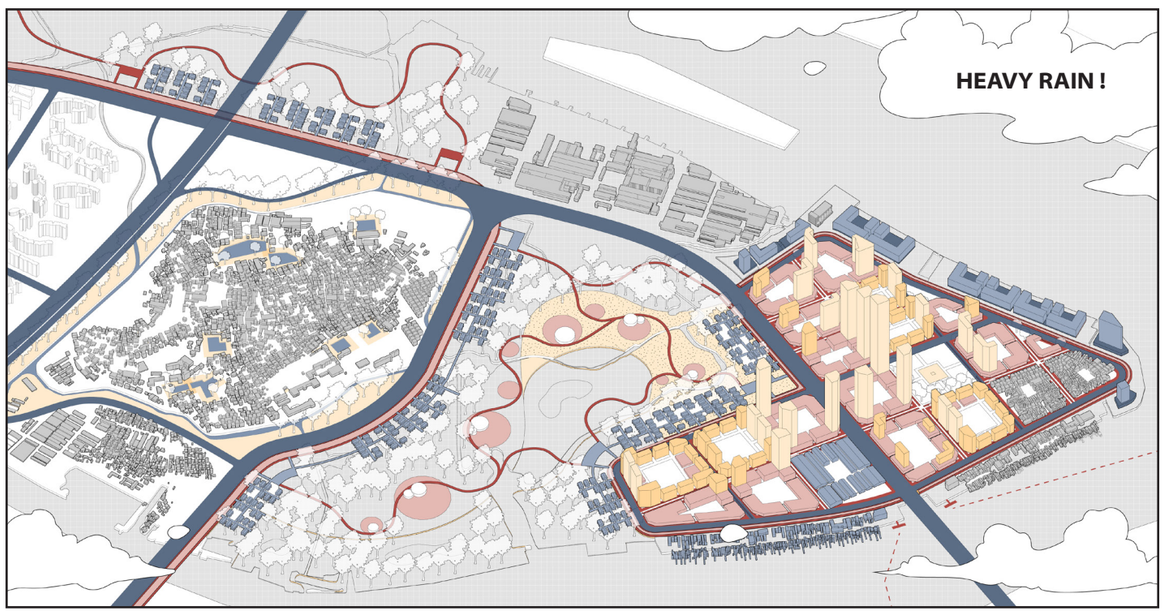
4.5 CHANGING WATER LEVELS

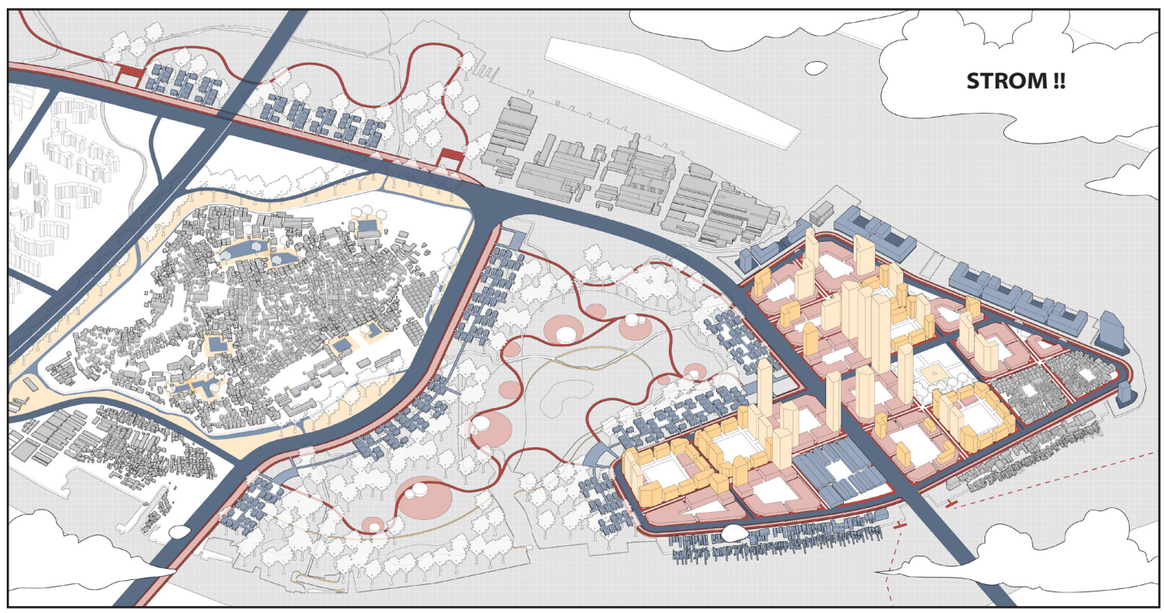
By using serious water resilient principles, Pazhou island east now can adapt to different flooding scenarios.

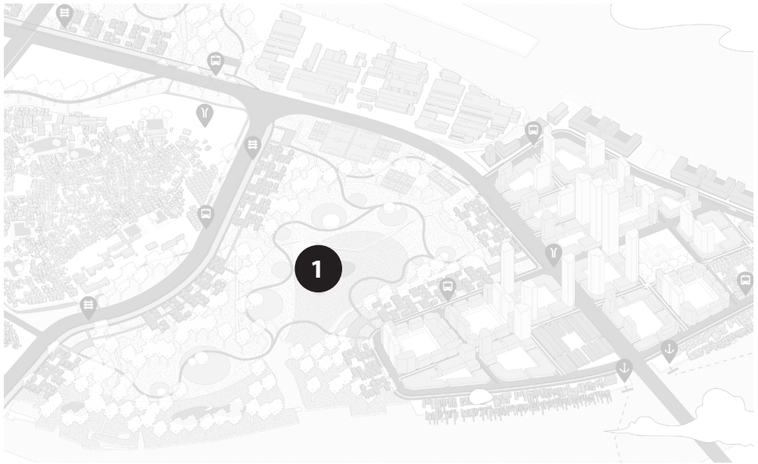
On the island scale, the outer dike areas, whether urban or wetland, can be flooded in different tidal situations while keeping the main urban functions like traffic or activities to go on. There are also lots of strategies applied on the smaller neighborhood scale. In the zoom-in perspectives, the spatial effect of some typical urban spatial typologies during different flooding situations are shown.





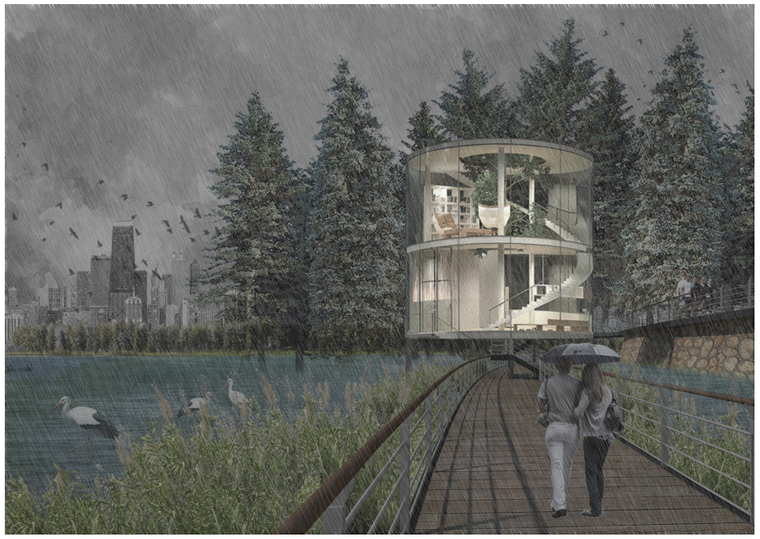






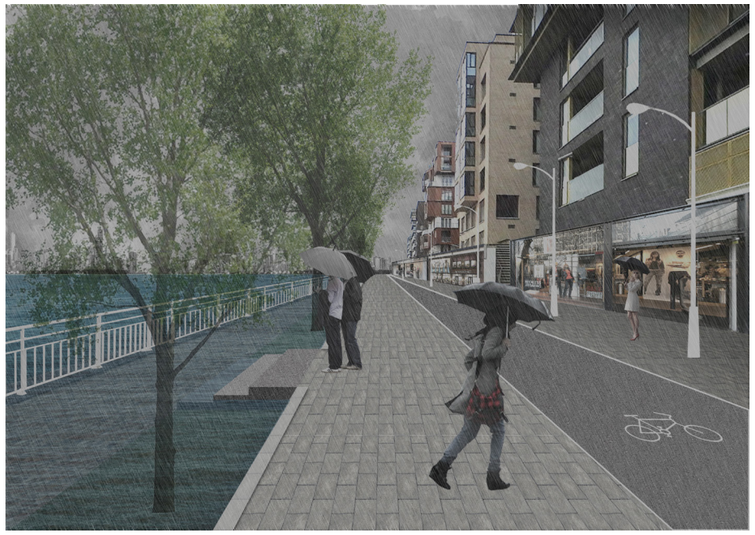
WETLAND PARK

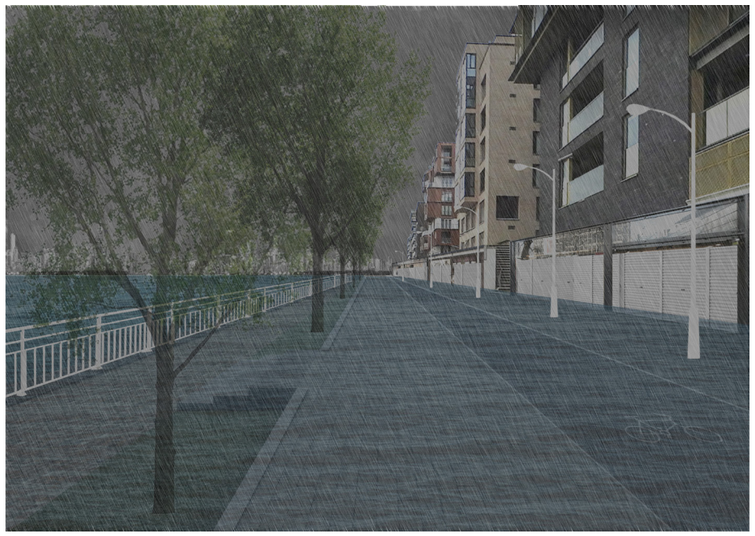
The wetland park is a balance between nature and the urban area. The main route is being lifted to always keep dry feet. In flooding times the whole wetland park will be flooded while still keep its function normally.



OUTER-DIKE FLOOD-TOLERANT NEIGHBORHOOD

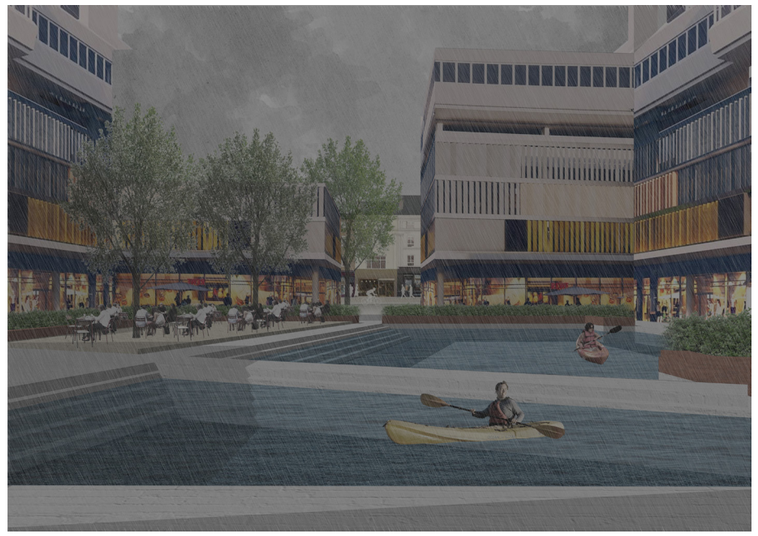
In the outer-dike areas, the flood-tolerant neighborhood is the typology to find a balance between urban development and room for the river. The strategy is about creating spaces with different elevations to be flooding in different flooding scenarios: the waterfront areas, the streets, the first floor retail areas, and the residential areas start from the second floor. The waterfront areas can be flooded in rainy seasons. The streets can be flooded in extreme storm situations and the first floor shops can be closed to prevent water from coming in.



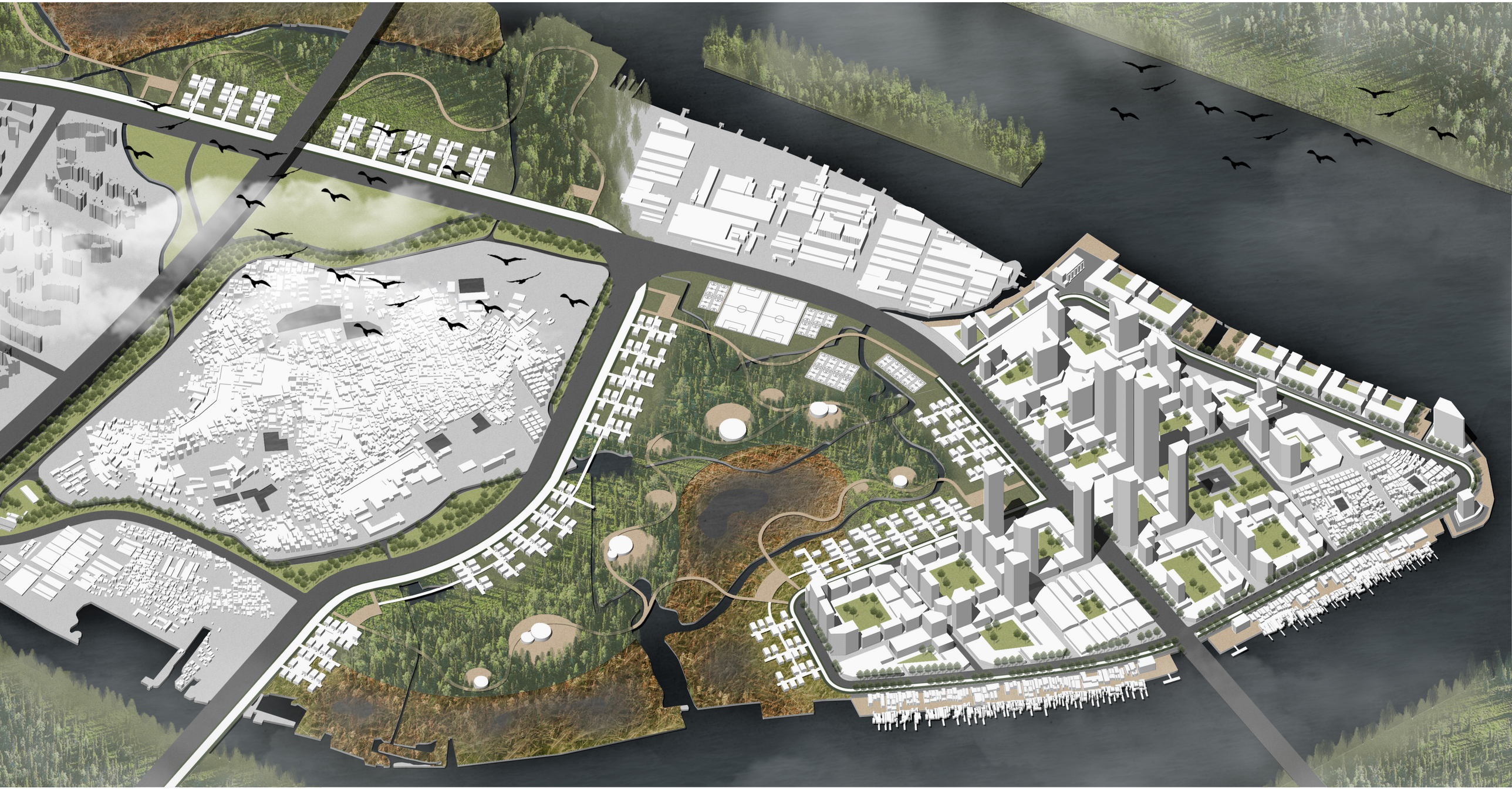


THE RAINWATER RETENTION PUBLIC SPACES

Within the dike, the strategy of preventing rainwater flooding is to create more retention areas. One of the key elements is the public space between each neighborhood. In a normal situation, the area can be used in different functions: sports, gathering, outdoor dining, etc. During rainy seasons or storms, the squares can be used as temporary retention ponds to release the drainage pressure.



4.6 BIRD EYE VIEW



CHAPTER 05

CONCLUSION & REFLECTION

MY PROJECT, THE PRD GRADUATION LAB AND THE MASTER'S PROGRAMME IN TUDELFT

Relation with the PRD lab and the master programme

The objective of my project is to build up a water resilient and adaptive development for Pazhou island. But beyond this contextualized objective, what I am exploring is a universal design method following "the layers approach" (McHarg, 1969) and related principles in each layer that can be applied to other similar areas in the PRD. This is the position of my project within the PRD graduation lab.

Also, in my project, the methodology of working through scales (from the region, Pazhou island to east Pazhou), time (future risks, the evolution of wetland, flood scenarios through time) and different layers and elements (landscape, network, urban development, public space, etc) is a high summarization of the methodology of the Landscape master program in TUDelft (or even my Landscape bachelor program in SCUT).

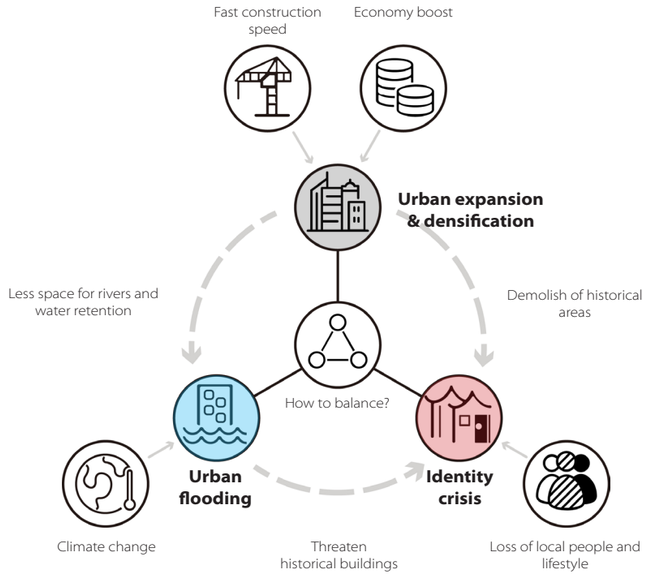
Argumentation of my project

In my project, I define Pazhou as the research and design site to reflect some of the main problems throughout the whole PRD region: Urban expansion & densification, urban flooding, and identity crisis.

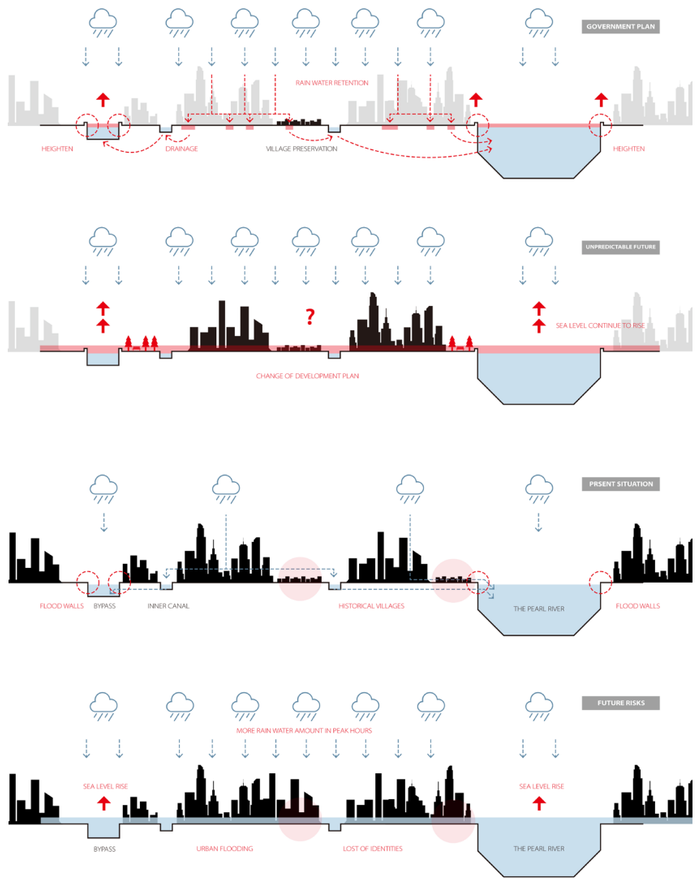
The urban expansion in the PRD region is requiring more land for development so the space for water capacity will be taken over, resulting in severer urban flooding issues that also influenced by climate change and sea-level rise. On the other hand, some of the historical areas in the PRD region have been taken over to meet new development needs. The urban floodings are also threatening the historical buildings since the traditional retention structure cannot meet the continuously rising water level. Thus, the identities of the PRD region, whether the spatial entities or the intangible culture and lifestyle of the locals are in danger.

To deal with the problems mentioned above, however, the government's plan won't function as expected. They have been expanding and densifying PRD areas regardless of the landscape condition in the past century, building flood walls all around the rivers to keep cities from flooding. And when facing the future risk of higher sea level and higher peak of rainfalls, the government's plan to create more retention capacity within the existing urban structure(in which they continue the densification) will not always work. It is almost impossible to construct a way out of the changing future flooding risks.

My argumentation is based on this context. Learning from "the layered approach" (McHarg, 1969), "the complex adaptive system theory" (Giacomoni, Kanta & Zechman, 2013) and theories on "ecological resilience" (Gunderson, 2003), I think it is important to create a design structure that works on creating a fundamentally resilient landscape structure in the very beginning, combining an advance network structure and following high-quality urban development learning from "Transit-oriented development in China" (Calthorpe, P., Yang, B. J., & Zhang, Q. ,2015).



Probem statement for PRD and the site



Argumentation of the expected failure of the existing and future planning under concept of construction resilience.

METHODOLOGY, RESEARCH AND DESIGN APPORACH

Objective, sub-questions and time planning

Through research for the region, I choose Pazhou island as a design example to explore my argumentation due to its high representative to the main characters and risks of the whole PRD area. I set up my objective of building up water resilient and adaptive development for Pazhou island. The objective contains several sub-questions that form up the following methodology. In the time planning, I separate the sub-questions into the time structure of the graduation lab and make a clear realization between generic and specific knowledge that I will gain from each stage.

Looking backward from now, I think this methodology works very well in terms of organizing my working goals in each period. I have been well conscious about what outcomes I need to achieve from the very beginning. But there are still some parts I find unrealistic to achieve during the graduation period, which is the testing part. My imagination of testing my work (for instance water capacity) through computer modeling didn't work out due to time and energy limitations. Still, I sincerely hope to find a chance to finish this part after graduation because I think the temptation to make a design more realistic is important.

The layered approach

The layered approach is the core of both my research and design. In terms of research, through analyzing the historical and present conditions of the landscape, the network, and the urban settlements of the region and Pazhou island, I gained a proper understanding of the whole context. In terms of design, the order from creating a fundamentally resilient landscape structure to a TOD network, then to a high-quality urban development makes the whole design process both logical and meaningful.

Methodology of research by design

Following the layered approach, my methodology is research by design. "..through design explorations, research questions can be answered related to the possible shape of urban, peri-urban, or rural landscapes, as well as how changes in the built environment can be designed or guided while using social or ecological processes." (Nijhuis, S & De Vries, J, 2020).

In my practise, the research on the site, whether through scales or times, helped me to understand the local conditions and identities that further guide directly my design decisions on visions, strategies, and principles. On the other hand, the design exploration process helped me backward to understand the site, which again benefited the design itself. This methodology of research by design is highly addressed throughout the graduation project.

1 THEORETICAL FRAMEWORK
• What is the proper way to understand and analyse the site, and the essential definitions within the objective?

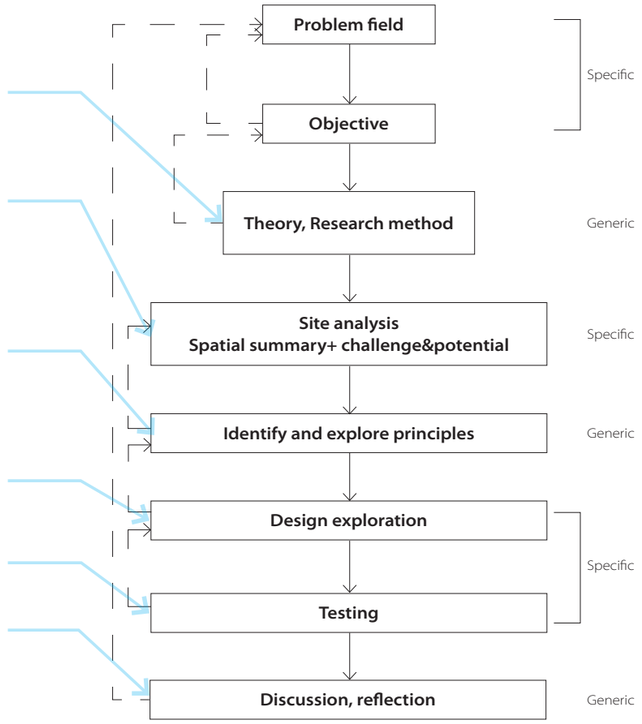
2 SPATIAL ANALYSIS
• What spatial conditions determine the spatial structure and identity of Pazhou?
• What are the specific challenges and potentials of pazhou based on the problem statement and spatial analysis?

3 PRINCIPLES
• What are the principles and strategies that can deal with the diagnosed challenges of pazhou, while reflecting on the theorical context?

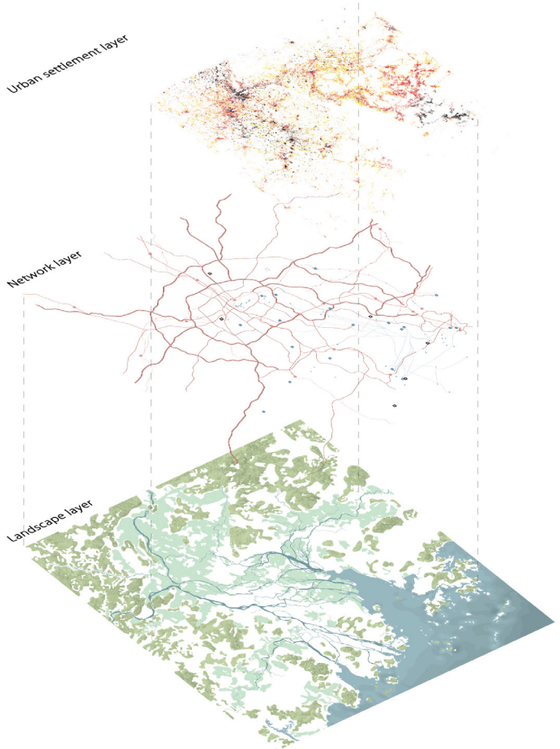
4 DESIGN EXPLORATION
• How to further select and contextualize the proper principles through design exploration?

5 TESTING
• Does the designs work?

6 CONCLUSION & REFLECTION
• What can we learn from the whole research and design?



Sub-questions and methodology



The layered approach in PRD area.

DESIGN EXPLORATION PROCESS, DISCOVERIES AND FINAL PRODUCTS

A logical design structure

Based on the layered approach and the research by design methodology, the design exploration process is well organized and logical. Through defining the proper principles for each layer step by step, the design of both a specific example for Pazhou island and a general design method that can be applied elsewhere in the PRD is formed.

Issues, feedbacks and adjustments

In the design process, I have some issues encountered. For instance the size and scale of the ecological areas within the urban center which will raise financial concern. Also, the integration of the landscape pattern and the urban pattern and the transition between them is a big challenge I have faced.

The feedback about these issues from my tutors are inspiring. I took adjustments into my work based on their suggestions: bring more urban function into the wetland, creating more transitional urban typologies between urban and wetland areas, spending more effort on explaining the transitions through eye-level perspective, etc.

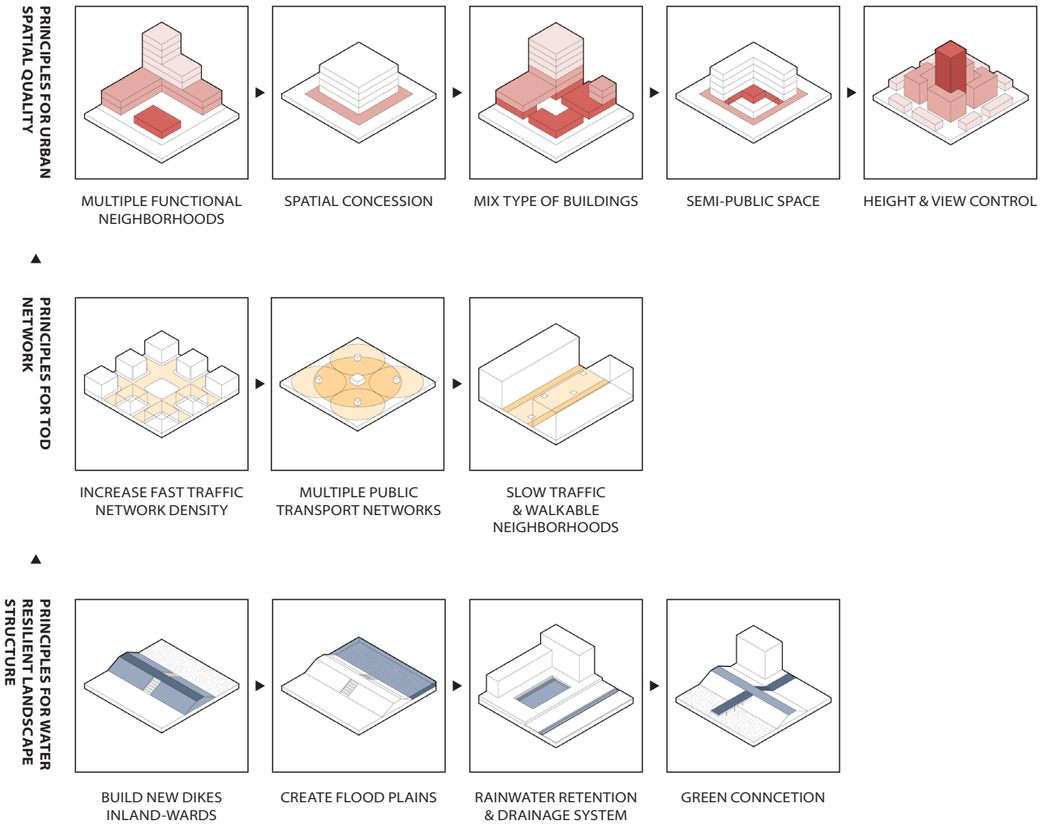
Discoveries

During the design process, I have some unexpected discoveries. Due to my step-by-step design structure, I discovered that there are some design elements highly overlayed with each other in different layers, to be specific, the infrastructures (dike, road) and the public spaces. I realized that the infrastructures are the key linkage between landscape structure and network structure, while the public spaces are the key linkage between high-quality urban development and landscape structure in terms of urban activities and rainwater retention. I think this discovery shows that these two elements should be focused more during the design process following the layered approach.

MY EXPLORATION IN THE WIDER PROFESSIONAL FRAMEWORK

One of my explorations through the project is the application of the room for the river resilient strategy in the very urban center areas. Conflicts between financial matters, development density, and resilient capacity have always been a difficult task, and my project tries to find out a balance between them.

Another exploration is adding the TOD theory into the layered approach. The integration of resilient landscape structure and tod structure and transition between these two patterns has been a difficult part of my design, and I hope my exploration will give an example for this topic.

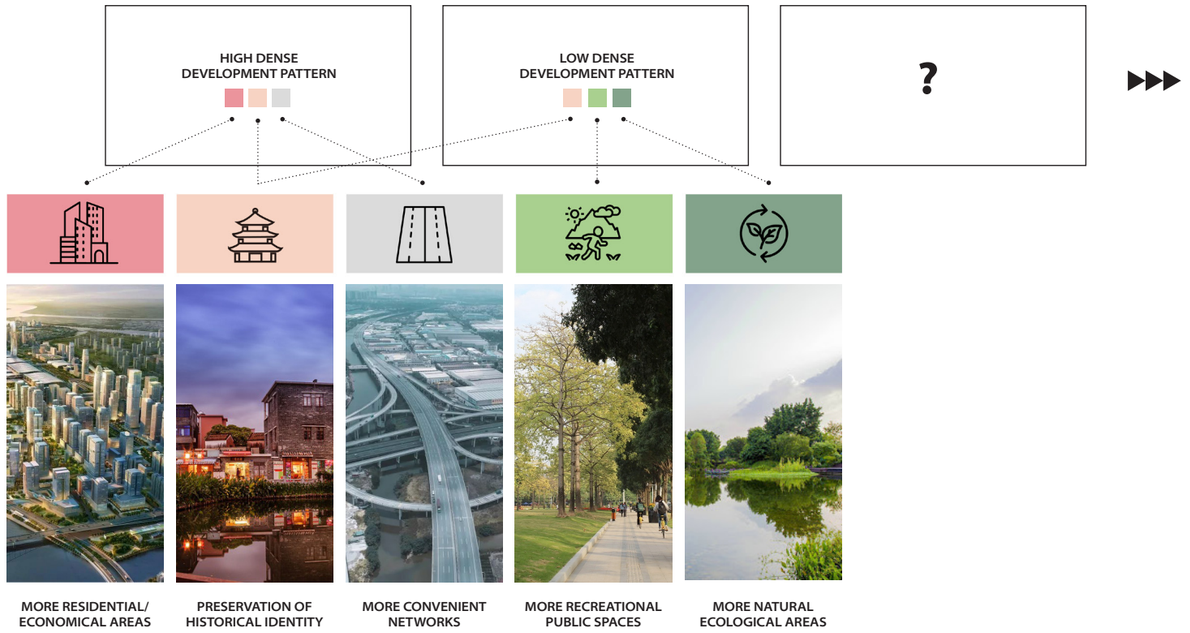


Design structure of layered apprach and principles in each layers

BEYOND THE SITE-SPECIFIC DESIGN

The design exploration doesn't stop as a site-specific design for Pazhou island. It is a process of working between generic knowledge (design principles) and specific design (site context).

Furthermore, due to the complexity and the uncertainty of the future development requirement, one site-specific design is not enough. The design needs to be adaptive. As long as following the proper design principles in each layer and base on the resilient landscape structure, the design itself can be looking different according to the development demands while still keep the resilience and the respect of the local cultural context.



CHAPTER 06

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