HYDROLOGICAL HERITAGE LANDSCAPE

Designing a resilient landscape framework to ensure preservation of the cultural history and sustainble development of the Ningshao Plain

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Hydrological Heritage Landscape

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ACKNOWLEDGEMENT

First of all, I would like to thank my first mentor, Steffen Nijhuis. I am very grateful to him for always helping me clarify the logic and inspire me when I lost my way in the research process. Secondly, his planning helps me to master the progress of my research, know what to do at each step, and the significance of doing this step to the whole research. This kind of overall view of the whole process makes me more confident in completing my project. He is also very responsible and patient, we have regular lab meeting nearly every weeks and also rehearsal before each presentation, which really help me a lot. He also prepared some gifts or snacks sometimes for us, and really concerned about our state of mind. I feel really lucky to have such a nice mentor.

Then I feel also lucky to have my cute classmates in the Resilient Coastal Landscape lab, Ayesha, Benz, Yuqi and Jay. I have learned a lot from them, I think their creativity and hard work inspire me very much . We will generously share our respective projects, give each other some suggestions, and encourage each other. These are all wonderful experiences in this graduation year. I am really happy and proud of we all graduate on time finally!

I also would like to thank my second mentor Gregory Bracken and all the teachers who have taught me at TU Delft. I feel that I have learned something from each teacher. These are not only important foundations for helping me to do my graduation project, I believe that they will also benefit me for life, thank them for their kindness and help.

Finally I would like to thank my family, who give me the important psychological and economic support. I couldn't fulfill my dream without them.

Hydrological Heritage Landscape

ABSTRACT

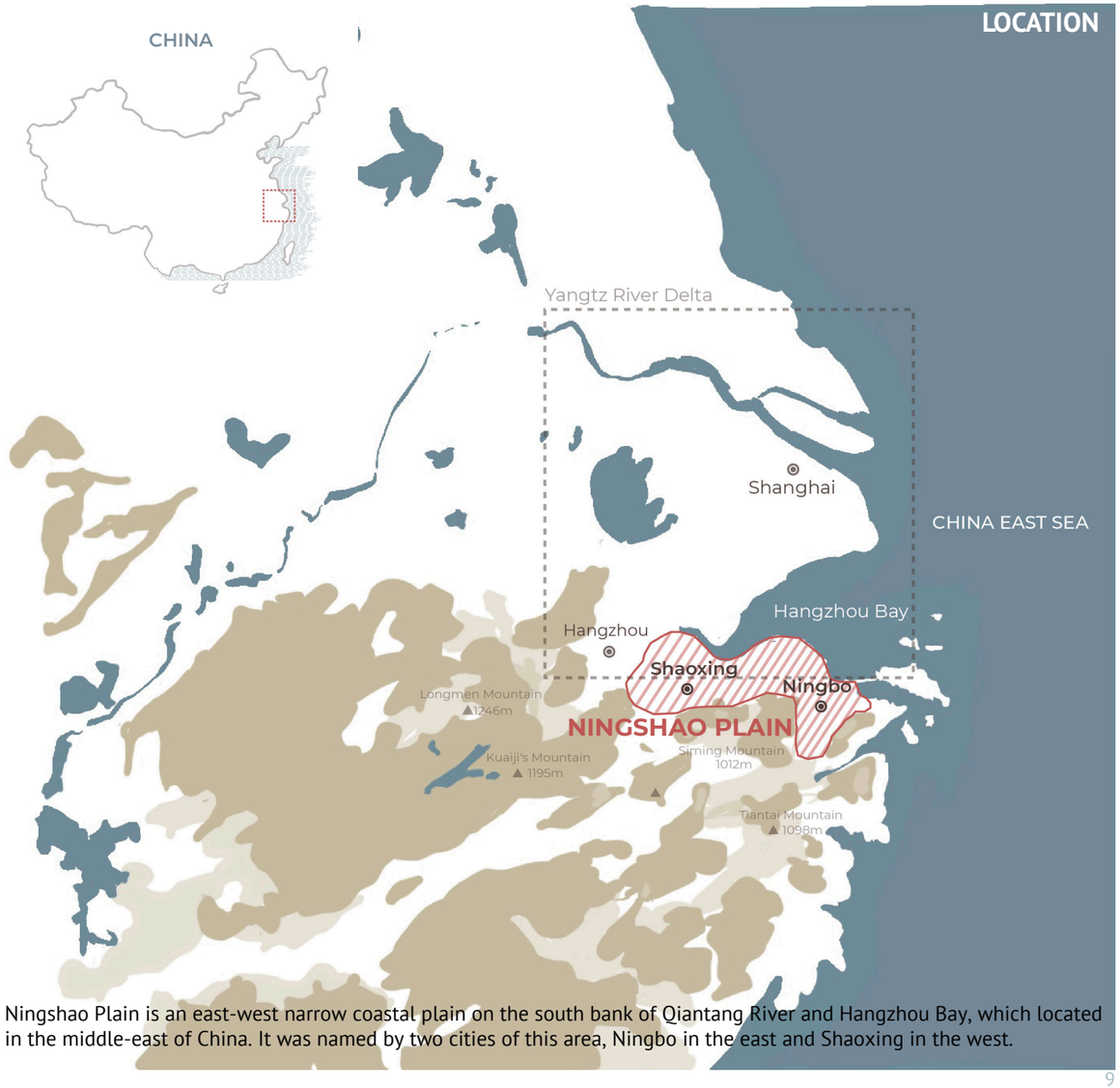
Key words: Cultural landscape; Polder grammar; Resilient landscape framework ; Research by design

As one of the essential elements in the ecosystem, water often plays a key role in the formation process of the landscape. The polder landscape is one types of hydrological heritage landscape formed by the interaction of water and human beings. However, with the influence of climate change and human activities, the unique polder landscape has been severely challenged recently. This project will take the polder landscape of the Ningshao Plain, which is situated near the mouth of the Qiantang River in middle-east of China as an example to research how the design can protect the cultural landscape and be adaptive to development at the same time.

The Ningshao Plain is one of the oldest polder areas in China. It is a long and narrow plain developed between the mountains and the sea, which is the result of residence creating arable land conditions for agriculture and struggling against sea invasion for thousands of years. Due to the needs of freshwater storage, transportation, and so on, the area eventually formed a landscape with the dense canal network and multi-level water conservancy systems. Although the system can quickly discharge water from the canal into the sea, when extreme weather such as typhoon comes every summer, cities are still often threatened by floods due to their poor surface discharge capacity; the rapid development of urbanization and the deterioration of the ecological environment also further damaged the morphology of the polder landscape, A large amount of agricultural field was replaced by building blocks so some traditional hydrological system has gradually lost its original function and be abandoned. The large potentials of the polder as cultural landscape was neglect.

Therefore, the design objective is to build a resilient framework taking hydrological heritage landscape as the basis to ensure the preservation of cultural history and sustainable development of Ningshao plain. And the design assignments concludes three aspects:1)increase rainwater recycle capacity 2)build a robust blue-green network 3) Rejuvenate water-related public spaces.

According to the guiding theory of this project, 'Protecting with planning', the core design strategy is to taking the historical polder landscape structure as the basis of the framework. So this project focuses more on the research of the spatial characteristics and development process of the polder landscape in the Ningshao Plain, and tries to explore the potentials of the polder landscape. Some principles of form and resiliency will be concluded from the site itself during the analysis process, which are the 'polder grammar', and will be experimented in the design of different scales. These design principles will also be combined with some other resilient strategies studied from cases. Finally, this project will provide a reference for how resilient strategy can be applied in design in a way of more adaptive to the local conditions and cultures.



Ningshao Plain is an east-west narrow coastal plain on the south bank of Qiantang River and Hangzhou Bay, which located in the middle-east of China. It was named by two cities of this area, Ningbo in the east and Shaoxing in the west.

FIG1.1 Mountain to polder landscape in Shaoxing area
Source: https://farm9.staticflickr.com/8253/8705636207_06fd76cbea_b.jpg

01

INTRODUCTION

In this chapter, I will introduce why I am interested in this project, and the problem fields it addresses, from which I formulate my research objective and research questions, and build a methodological structure for my research.

1.1 FASCINATION

1.1.1 Unique polder Landscape

The Ningshao Plain is one of the oldest polder areas in China, about 4800km², formed by the dynamics of water and land, and human intervention through thousands of years. A great variety of polder forms also cause diverse water conservancy culture, settlement system, etc., which are the core source of the cultural identity of this place. My fascination starts with the interest on how does this unique polder landscape was formed, how the settlements are formed near the watersystem, and how the residents interacts with water through long history.

FIG1.2 agricultural polder
Source: http://img-arch.pconline.com.cn/images/upload/upc/tx/photoblog/1010/22/c10/5603245_5603245_1287749355718.jpg

FIG1.3 water town
Source: https://weibo.com/1222135407/IheU78Ob

FIG1.4 historical mannual lake heritage
Source: https://photo.gmw.cn/2019-06/22/content_32939732.htm?s=gm-

1.2.2 Live with water

FIG1.5 leisure time near water
Source: https://www.douban.com/note/772811846/?ivk_sa=1024320u

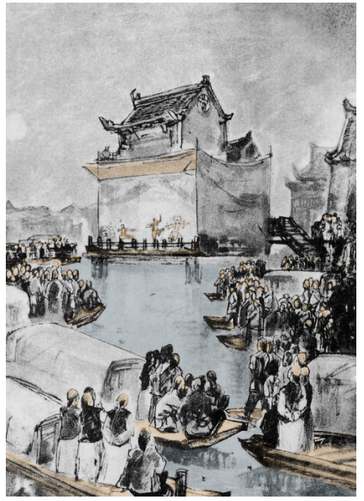


FIG1.6 local opera performance on water stage
Source: https://www.sohu.com/a/116583765_498199

FIG1.7 rice plantting
Source: https://www.photophoto.cn/show/08993628.html

The unique polder landscape and water conservancy system have created a unique living environment, where people's clothing, food, housing and transportation are all closely related to the water. For example, residence here live and spend leisure time by the water and work in wet fields. But some unique activities like taking boat to watch local opera performance on water stage has almost become a childhood memory, so restoring the prosperity of water culture here is my second point of interest.

1.2 PROBLEM STATEMENT

1.2.1 Water safety

However, flooding, water shortage and other water safety issues threaten the security of Ningshao plain.

FIG1.8 Droughts in Shaoxing

Source: https://www.chinanews.com.cn/tp/hd2011/2014/07-31/384228.shtml

FIG1.9 Heavy rainfall causes flooding

Source: https://baijiahao.baidu.com/s?id=1706246489199848845&wfr=spider&for=pc

FIG1.10 Reservior in Shaoxing

Source: https://www.163.com/dy/article/H26ECSDA0541RS8A.html

FIG1.11 Sea intrusion

Source: https://www.163.com/dy/article/H26ECSDA0541RS8A.html

SEA INTRUSION

This area has been affected by sea intrusion for thousands of years, which plays an important role in the transformation of the natural environment. Although people built the seawall defense system to resist the intrusion, in recent years, due to frequent extreme weather happening more often and sea-level rise, coastal areas still face the threat of flooding issues because of sea intrusion.

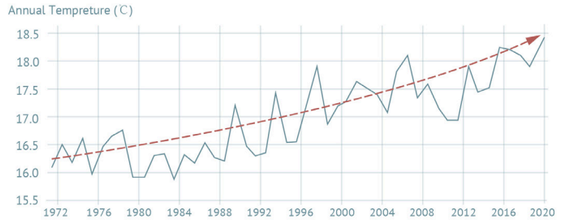


FIG1.12 Annual tepreture change

Data Source: https://www.163.com/dy/article/H26ECSDA0541RS8A.html

WATER SHORTAGE

Because of global warming, precipitation has decreased in recent years, especially in winter, and agricultural drought problems are frequent as the consequence. But even in summer with heavy rains, cities still need to get drinking water from distant reservoirs because the water quality in the city is poor.

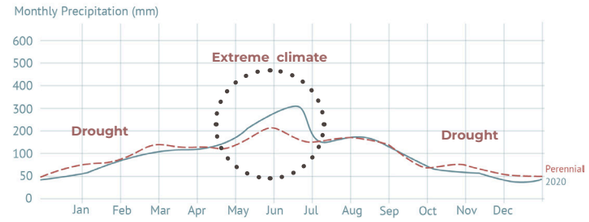


FIG1.13 Monthly precipitation change

Data Source: https://www.163.com/dy/article/H26ECSDA0541RS8A.html

WATER LOGGING

The rainstorm discharge capacity here is very low. When the summer typhoon weather comes, the city lacks the ability to quickly discharge heavy precipitation into the canal system. Therefore, waterlogging problems occur frequently during summertime.

1.2.2 Fragile Ecology

"The fragile ecosystem is difficult to cope with environmental problems. People often only pay a lot of energy and money to repair the problems urgently, which is harmful for long-term sustainable development of the Ningshao Plain."

FIG1.14 Industrial pollution
Source: https://www.sohu.com/a/111405569_362163

FIG1.15 Domestic pollution
Source: https://www.sohu.com/na/483012004_99959988

FIG1.16 Eutrophication
Source: https://www.e0575.cn/read.php?tid=-1122405299959988na/483012004_99959988

FIG1.17 river siltation
Source: https://jx.news.fang.com/2015-09-07/17253503.htm

WATER POLLUTION

Industrial wastewater and domestic pollution contain a large amount of toxins and bacteria, which seriously damage aquatic plants and animals. The eutrophication of water bodies caused by agricultural pollution not only reduces the oxygen environment required for fish life, but also greatly reduces the quality of water use. In short, water pollution destroys the water ecosystem in this area and will eventually endanger human health.

FIG1.18 Deforestation for agriculture
Source: https://www.thepaper.cn/newsDetail_forward_4432955

DEFORESTATION

As reclaiming farmland from the hills in this area has a long history, with the development of agriculture and mining in the modern times , the forest and vegetation on the mountains was further exploited, which seriously damaged the habitats of flora and fauna of this area, resulting in biodiversity continuing to decline; the reduction of forests also exacerbates the problem of soil erosion, resulting in siltation, deteriorating water quality and other environmental problems, making the ecological environment of the region in a fragile situation.

1.2.3 Loss of cultural identity

"Demolition and building a new house and infrastructure are good things, but retaining a little local scenery can feel hometown"

FIG1.19 Urban area change in decades
Source: https://www.163.com/dy/article/EEHTI2MQ05370ELS.html

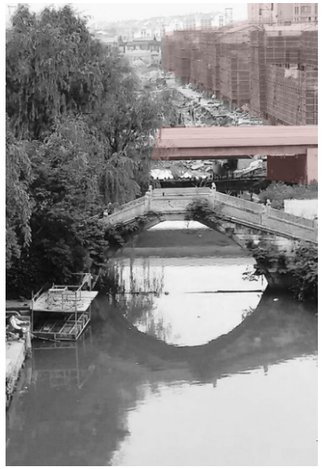


FIG1.20 New infrastructure changed the landscape
Source: https://www.163.com/dy/article/EEH-

DESTRUCTION OF POLDER STRUCTURE

At the same time, the landscape is also under the pressure of urbanization. People have new demands for land due to the need for economic development in recent years. A large amount of arable land was replaced by building blocks so the traditional hydrological system has gradually lost its original function such as irrigation, transportation, and so on. The polder morphology is divided by new built-area and infrastructure like railway, and some rivers and ditches are even buried to create more land. The unique landscape pattern of the polder and the long cultural history accumulated in this area are gradually disappearing.

Wate safty issues, fragile ecology and loss of cultural history are the main problems that make the Polder landscape of Ningshao Plain in the danger of disappearing. However, the enormous potentials of polder landscape to facilitate sustainble development are ingnored.

Source: http://blog.sina.com.cn/s/blog_3df170610102vjos.html
F1.21 Flooding in Ningbo

WATER SAFETY

water shortage
water logging

Source: https://www.thepaper.cn/newsDetail_forward_4432955
F1.22 Deforestation for agriculture

FRAGILE ECOLOGY

poor water quality
less biodiversity

Source: https://www.sohu.com/a/316585508_330740
F.23 Highly urbanized city: Ningbo

LOSS OF CULTURAL HISTORY

polder structure destruction
heitage loss of value/fuction

1.3 OBJECTIVE & RESEARCH QUESTIONS

In order to protect the polder landscape, explore its potentials for development, the objective and research questions are proposes as:

Designing a **resilient landscape framework** with ***hydrological heritage landscape as basis*** to ensure preservation of cutural history and sustainble development of Ningshao area.

?

UNDERSTANDING

1. **What are the landscape structure of the hydrological heritage landscape of Ningshao plain?**
- What are the natural conditions and hydrological structure of the polder landscape of Ningshao plain?
- What is the ecological and cultural value of the polder landscape regarding to landscape design?

2. What are the key factors influence the change of the polder landscape of Ningshao Plain ? How they influence landscape through time?

PRINCIPLES

3. What are design principles based on polder landscape? What strategies and principles are more resilient for the development of Ningshao plain?

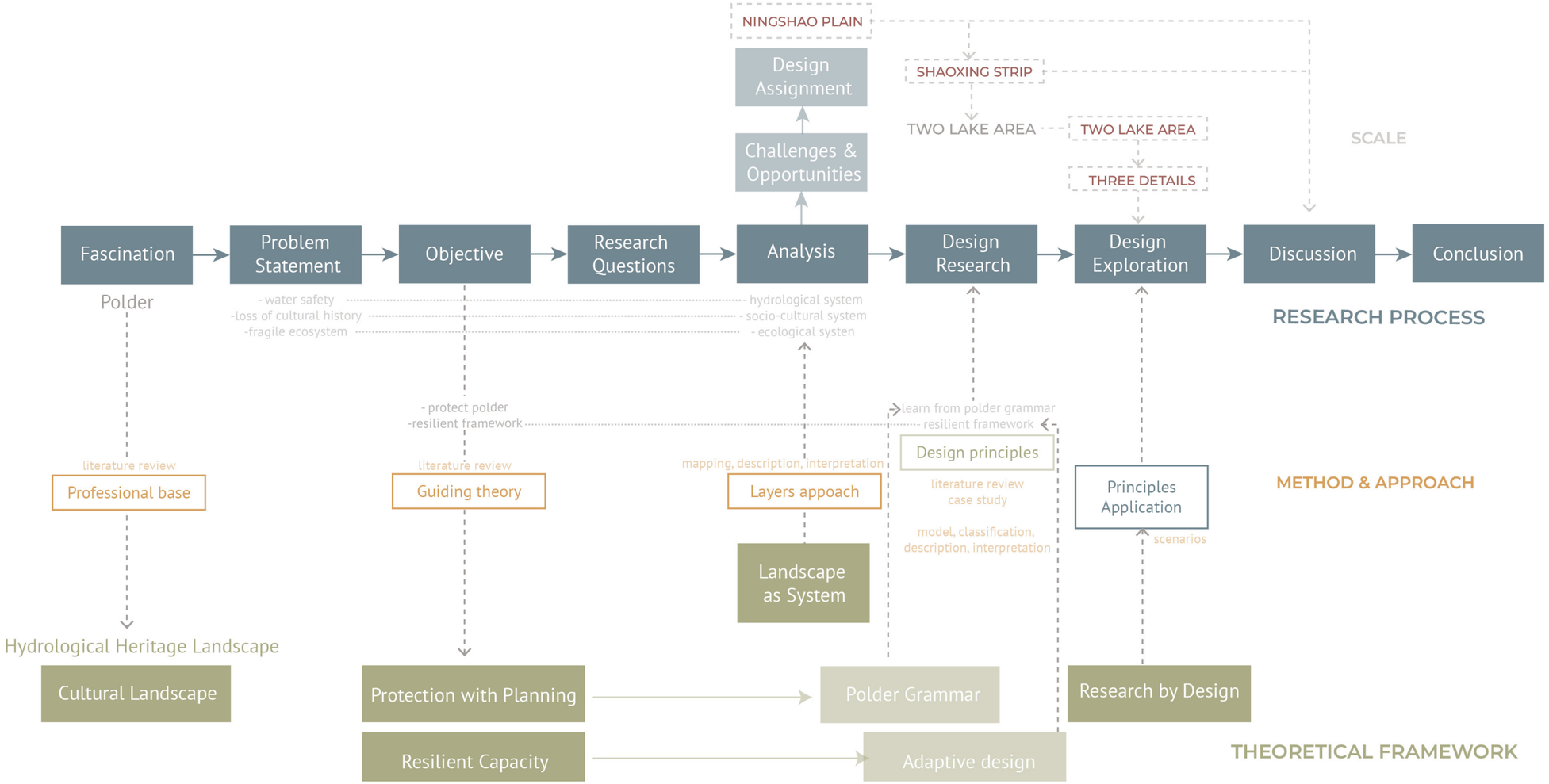
APPLICATION

4. How to apply the principles in a more adaptive to the local way?

REFLECTION

5. Does the design provide new practices for the protection of cultural landscapes? Is there any other relevance value for society?

1.4 METHODOLOGICAL STRUCTURE



The whole research process is closely related to the theoretical framework, which provides the methods for each research stage.

First, a certain professional scope is delineated for research through relevant theories, that is, the polder landscape is regarded as a cultural landscape. After establishing the objective and research question, the main guiding theories 'Protect with planning' and 'resilient capacity' was found to build a landscape-based resilient framework.

Then, the whole landscape of the Ningshao Plain is preliminarily analyzed as a system according to 'Landscape as a system', and the 'layers approach' was introduced to analyze the challenges and opportunities, and draw up design assignments.

In the design research, 'Polder grammar' approach from the guiding theory was used to find design principles from the further analysis of the two lakes area in the Shaoxing strip. Then, 'research by design' part will focus on how to apply those design principles in the local scale and detail scale in the design.

Finally, zoom out back to the strip and the entire Ningshao Plain, discuss the application of design principles on a larger scale, and review the research questions and objective again for reflection. There are four scales in this project totally.

1.5 SCOPE & RELEVANCE

The Landscape Architecture track of TU Delft focus on “Flowscape”, which explores landscape as infrastructure, inspires me that the precious polder landscape in Ningshao plain could have more potential value as the backbone of the urban development besides its historical value as heritage. The architectonic design explorations in the flowscape studio provides the multi-layered understanding of landscape, which guides me to view the polder landscape as a system and understand the system through multiple layers, and explore the dynamic between landscape process and typo-morphological aspects.

This project provides new clues to the protection of polder fields. The polder fields are no longer just protected as agricultural heritage but can be planned in conjunction with urban development so that they not only have historical and cultural value but also can show their huge potential in ecological and social aspects, such as promoting related cultural tourism, improving the ecological environment and public space, etc. The polder landscape could become the base of sustainable urban development.

The outcomes of this project provide some methods for interpreting polder and other hydrological heritage landscapes from the perspective of cultural landscape, multi-scale research can provide some clues and design principles for the design of similar project. The outcome is also a reference project of how to establish a resilient framework based on cultural landscapes to promote the sustainable development of the city, and how resilient strategy can be applied in design in a way of more adaptive to the local conditions and cultures.

FIG2.1 Jian Lake Jianhu Cultural Scenic Area
Source: http://www.cztvworld.com/4606169.html

02

METHODOLOGY

In this chapter, first I will elaborate on my theoretical framework and the methods I learned from it. Then I will introduce the research approach in each stage, and finally, research design, which generally elaborates on how I research by experimenting with the design principles in the design.

2.1 THEORETICAL BACKGROUND

After a preliminary understanding of the Ningshao area, several theories below are introduced to this project to establish a theoretical framework for guiding the research process and provide research and design methods.

2.1.1 CULTURAL LANDSCAPE

A cultural landscape is as an area, as perceived by people, whose character is the result of the action and interaction of natural and/or human factors (Council of Europe, 2020).

The polder in the Ningshao area is often regarded as an agricultural heritage or a hydraulic phenomenon, few studies have focused on its spatial structure and cultural expression (Nijhuis,2020). Considering polder as cultural landscape broaden the scope to explore the value of the polder . According to this theory, the polder was researched as a 'hydrological heritage landscape' in this project this project.

2.1.2 LANDSCAPE AS SYSTEM

According to Murphy, the landscape can be considered as a complex and dynamic system including a number of subsystems (e.g. natural, societal). Through design, these systems are intentionally altered in order to solve problems or bring about improvement of the conditions that we deem lacking(PINAR, K.&OGUZ, Y.,2014).

Therefore, the landscape could be regarded as a layered entity, 'the layers approach' will be used in the analysis of challenges and opportunities of the polder landscape in Ningshao Plain.

As dynamic is the essential character of the landscape system, which is continually transforming under the influence of natural processed and social requirements, the landscape could be regared as a palimpsest where trances that time has covered can reinforce or contradict each other; it is a window into a range of histories, chronologies, events, and meanings connecting the traditional and the contemporary, the tangible and the intangible (Nijhuis, 2020).

Therefore, researching the formation process of the polder landscape in the Ningshao Plain is important. The interaction between the various subsystems and their relationship with the whole in the process also could help to find more opportunities and challenges for the devlopment.

2.1.3 PROTECTION BY PLANNING

The' protection by planning' shows an approach to protect and develop polders as a cultural heritage landscape, it takes landscape development with historical landscape structure as basis (Nijhuis, 2020). The interaction between cultural history and spatial planning, and the recognition of stakeholders, can create the conditions for discovering a new balance between retaining cultural heritage and developing it (Belvedere, 1999).

This process of development can help renew citizens' engagement with cultural heritage. With this polder landscape framework, which based on soil, geography, and landscape history— made space for nature and recreation, enriching the network of roads and villages that urban planners laid over the polder land (Nijhuis, 2020).

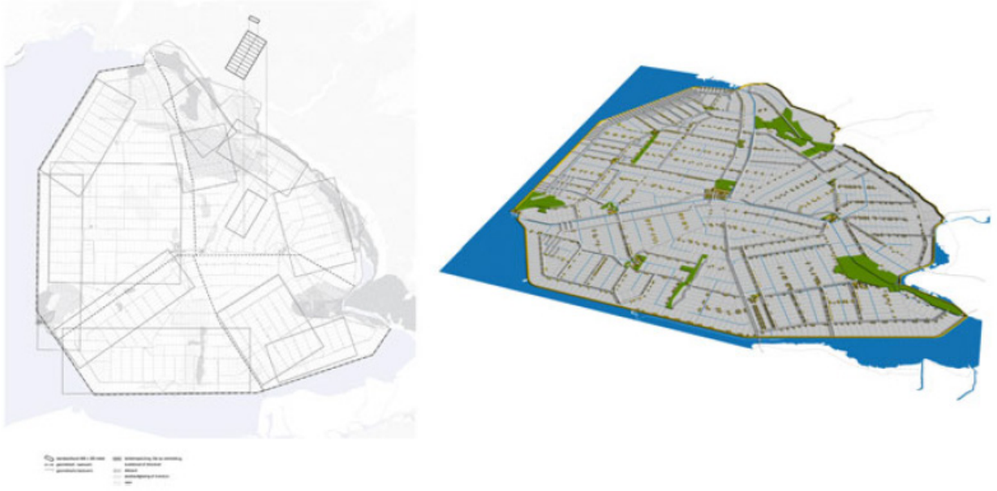


FIG2.2 Some applications of the analytical framework to the Noordoostpolder on the regional scale
(By Nijhuis.S, 2020, TU Delft)

2.2.4 RESILIENCE CAPACITY

Resilience is defined as the capacity of system to respond to change or disturbance without changing its basic state (Walker& Salt, 2006). A framework for long-term development need to be adaptable to possible change, which is also the research objective of this project. So finally, the theory of 'Resilience Capacity' is introduced to supplement the more resilient design strategies and principles. According to the strategies posed by Ahern, there are five strategies as following below. But how to translate these strategies into design principles for multi-scales design and how to combine it with the landscape framework need to be further researched through case studies and design exploration.

1) Multifunction

Multifunctionality can be achieved through intertwining/combining functions, stacking or time-shifting. It is inherently efficient spatially and economically, and benefits by support from the social constituents and stake-holders associated with the multiple functions provided (Ahern,J. 2011).

2) Redundancy

Redundancy and modularization are achieved when multiple elements or components provide the same, similar, or backup functions. Redundancy and modularization spread risks – across time, across geographical areas, and across multiple systems (Ahern,J. 2011).

3) Multi-scale networks and connectivity

Networks are systems that support functions by way of connectivity. When an urban landscape is understood as a system that performs functions, connectivity is often the critical parameter.Complex networks build resilience capacity through redundant circuitry that maintains functional connectivity after network disturbance(s)(Ahern,J. 2011).

4) Bio&social diversity

Biodiversity along with social, physical, and economic diversity, are important and effective strategies to support urban resilience. Response diversity in biological systems refers to the diversity of species within functional groups that have different responses to disturbance and stress (Ahern,J. 2011).

5) Adaptive design

Under an adaptive model, urban plans and designs can be understood as hypotheses of how a policy or project will influence particular landscape processes or functions and implemented planning policies or designs become "experiments" from which experts, professionals, and decision makers may gain new knowledge through monitoring and analysis (Ahern,J. 2011).

2.2 RESEARCH APPROACH

2.2.1 LAYERS MAPPING

In order to identify key locations, critical driving forces and impacts of different dynamics, the spatial relationships between environmental conditions and human responses and interventions can be explored via cartographic research and mapping, employing analytical operations such as map dissection and map comparison. Map dissection decomposes the landscape into different layers, stratifying them according to the level of influence and dynamics of change (Meyer,H.& Nijhuis, S, 2016).

This approach was used throughout the whole project, starting from the three problem fields, regards the Ningshao Plain as composed of three sub-systems of hydrology, ecology and socio- culture, map them layer by layer an obtains the structure map of the key elements which affect the landscape. Then comprehensively put the maps in a time axis to analyzed the interaction between these key elements and the dynamics of each and the whole. In design research part, according to the design assignments, the shaoxing two-lakes area is analyzed by five layers mapping from water, green structure, building blocks, public space and transportation, and the final three-layers design concept of the framework is a combined result of five layers analysis.

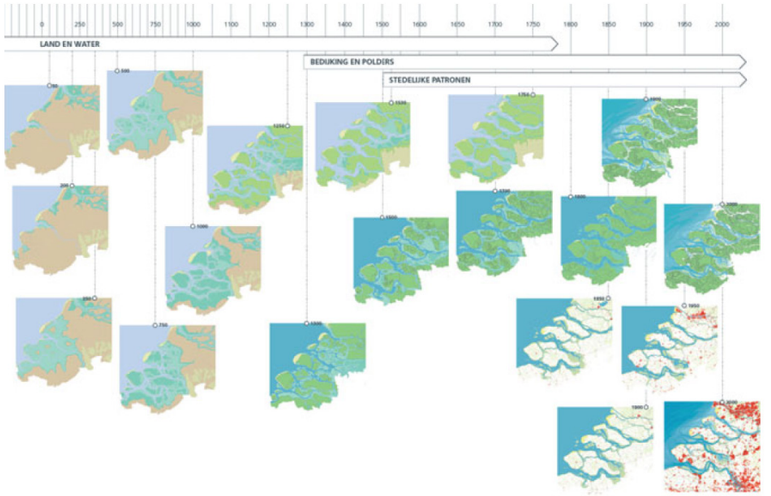


FIG2.3 The different dynamics of natural land-making, diking and polder-making, andurbanization in the Dutch Southwest delta (Maps by Nijhuis and Pouderoijen, TUDelft)

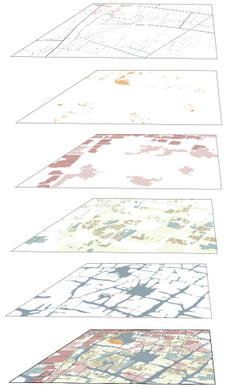


FIG2.4 Five layers in two-lake area. (Maps by Author)

2.2.2 POLDER GRAMMAR

Construction

Formal characteristics derived from:

1. Natural landscape
2. Drainage technique
3. Technique of occupation
4. Pattern of settlement

Expression

Formal characteristics derived from:

1. Plan type or concept (latent /explicit)
2. Landscape architectonic form
   - *basic form*
   - *spatial form*
   - *symbolic form*
   - *programmatic form*

FIG2.5 Analytical framework for the identification of the polder grammar
(S. Nijhuis, Delft University of Technology)

In the Ningshao Plain, development means adapting the polders to the needs of urbanization, such as housing, new infrastructure, water needs, etc. The 'protection through planning' theory proposes a planning tool that can guide design and landscape changes, the polder grammar. The 'polder grammar' is the set of structural rules and principles that determines the characteristic composition of the landscape: the complexity of the pattern, the morphology, the visual qualities—and with that, the cultural identity of the polder while providing clues for spatial development in the form of design principles (Nijhuis 2020).

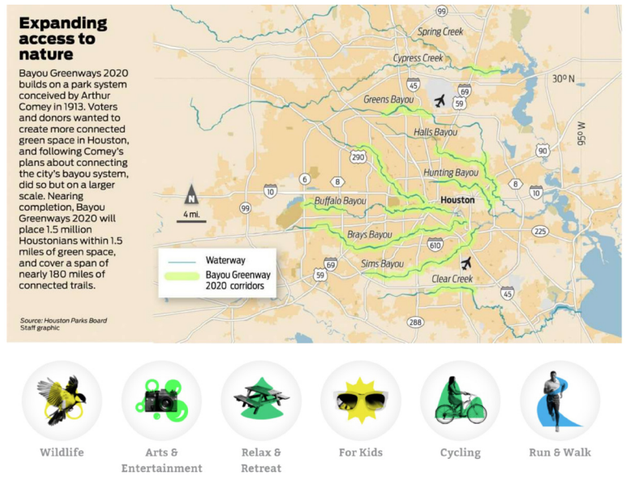
There is an analytical framework to identify and delineate polder grammar systematically (Nijhuis 2016). It employs historical maps, newly drawn maps, and photographs to identify the constructive characteristics and the expressive characteristics of the polder form. The constructive characteristics are the formal aspects of the historical transformation of the natural landscape into a habitable and exploitable agricultural landscape. The expressive characteristics are the implicit and explicit visual and formal elements, the compositional, aesthetic, and cultural motifs of polder making (Nijhuis 2020).

This analytical approach is mainly used in the design research part, finally, the 'polder grammar' belonging to the Two-lakes area of Ningshao Plain will be obtained from the analysis of the current and historical polder landscape, as guiding design principles for the design experiment in the next.

2.2.3 CASE STUDY

The case study in this project are mainly related to 'resilience capacity' theory. I try to find the specific application of five strategies in practical projects. The selection of cases is mainly related closely to the problems and potentials analyzed in the design research part. In the first case, Greenway, I can learn how to build a robust blue-green network under urban background based on the current water system. From the second case, Green Alley, I can learn some new approaches to face the climate problems that have appeared in recent years. The third case is a lake transformation to wetland also located in the Ningshao Plain. It has similar conditions to the design site, so I can learn a lot design experience from this case. In conclusion, from the case study, some resilient design principles can be learned and summarized as supplement to design principles of the polder grammar.

(1) GREENWAY | Bayou Greenway 2020, Houston, USA



Bayou Greenways 2020 is creating a continuous park system along Houston's major waterways, transforming more than 3,000 acres along the bayous into linear parks and adding more than 80 new miles of hike-and-bike trails (Bayou Greenway, n.d.). I use this project as the reference for building a robust blue-green network taking waterways as the basis, connecting scattered green spaces, and creating high-quality watefront public space.

The project is being implemented across 150 miles of bayous, and when complete, 60 percent of Houstonians will live within 1.5 miles of a Bayou Greenway. With new trails, pedestrian bridges, wayfinding, educational signage, benches, and landscaping, Halls Bayou Greenway creates spaces for exploration and play. Along the greenway, you'll find diverse activity spaces. Further upstream is Keith-Wiess Park, a 500-acre space with old growth forest, playing fields, trails, and a large, scenic detention basin with wetlands designed for flood control (Bayou Greenway 2020, n.d.).

FIG2.6 Walking road along river
FIG2.7 Park system of Greeen way
(Bayou Greenway 2020 (n.d.) Houston Park Board. https://houstonparksboard.org/about/our-story)

(2) GREEN ALLEY | The Chicago Green Alley, USA

Example Residential Applications

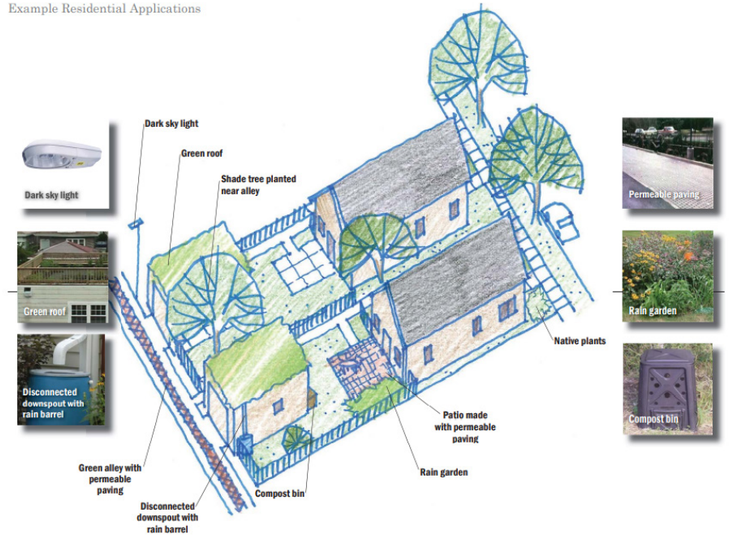


FIG2.8 Principles application in Green Alley

Richard M. & Thomas G. (2010). The Chicago Green Alley Handbook—An Action Guide to Create a Greener, Environmentally Sustainable Chicago.

The Green Alley Program is a new approach to CDOT's existing alley program. The Green Alley Program looks at more sustainable solutions to environmental problems in the city like flooding issues , but not only solves a persistent problem, it also provides an environmental benefit by cleaning and recharging the ground water. Furthermore, by not sending additional water to the combined sewer system a green alley can help alleviate basement and other flooding issues.

There are several design principles and techniques which could be the more resilient strategies for the villages. (Richard M. & Thomas G. 2010)

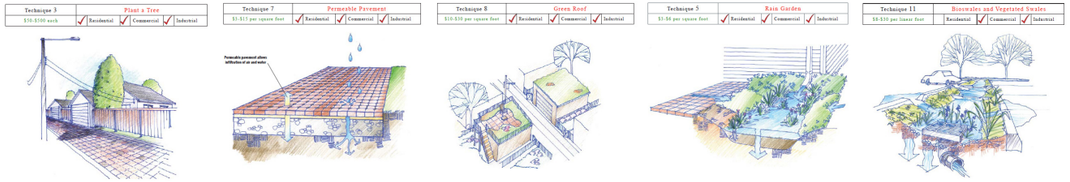


FIG2.9 Design principles of Green Alley

Richard M. & Thomas G. (2010). The Chicago Green Alley Handbook—An Action Guide to Create a Greener, Environmentally Sustainable Chicago.

(3) WETLAND PARK | Shaoxing Jing Hu Wetland Park, China

FIG2.10 Wetland design visulization

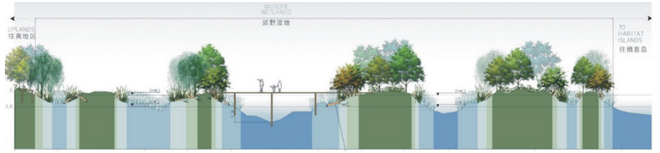


FIG2.11 Section: Educational Wildlife Wetland

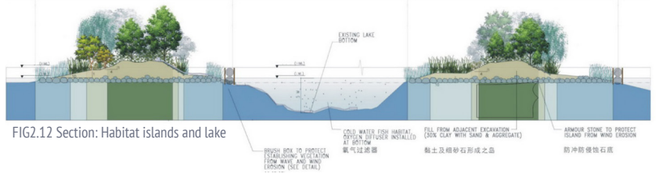


FIG2.12 Section: Habitat islands and lake

FIG 2.13 Masterplan of Jinghu Wetland Park

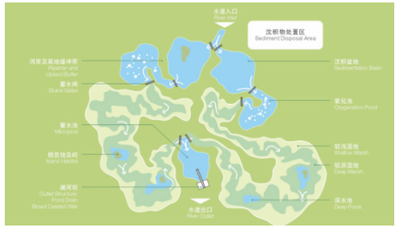


FIG2.14 Standard Constructed Wetland system

Jinghu Wetland Park is located between the three major urban groups in Shaoxing. The park has the largest natural freshwater lake in Shaoxing and many cultural heritages. The project uses the existing natural resources to further create more diverse open public spaces and natural landscapes, and increase biodiversity, giving new vitality to the area and providing a strong ecological service function for Shaoxing (Jing Hu. n.d.). I want to learn how to transform lowland area to a more eclogical-benefit landscape--wetlands, and because the Jinghu park is also in Shaoxing area, so I also can learn some native species form this case.

FIG2.10- 2.14 From Jing Hu. (n.d.). Shaoxing Jing Hu Wetland Park Masterplan. https://wenku.baidu.com/view/1c4c7e533169a4517723a38e.html

2.3 RESEARCH DESIGN

RESEARCH BY DESIGN

In the concept of 'research by design', design is defined as a form of research and identify how design relates to other more conventional definitions of research methods. That is design can be viewed as an exploratory activity that produces knowledge that meets a research goal or answers a (set of) research question(s) (Nijhuis & de Vries, 2020).

'Research by design' explores, identifies, and maps possibilities. This process often informs alternative concepts and ideas. The objective of design exploration is to produce practical-productive knowledge that enhances or at least changes reality (virtually or literally) by means of exploratory models. Such models combine the mechanisms of research and design (Nijhuis & de Vries, 2020).

Three categories of 'research by design' approaches in landscape architecture exist, the choice of these approaches very much depends on the objective of the research or the questions posed (Nijhuis & de Vries, 2020):
1) Design approaches that focus on concept, these approaches center on a form, type, or model.
2) Design approaches that focus on context, these approaches regard the spatial-visual, geographic, ecological, social, or historical context as a foundation for further development.
3) Design approaches that focus on program, these approaches are of a functional or technical nature.

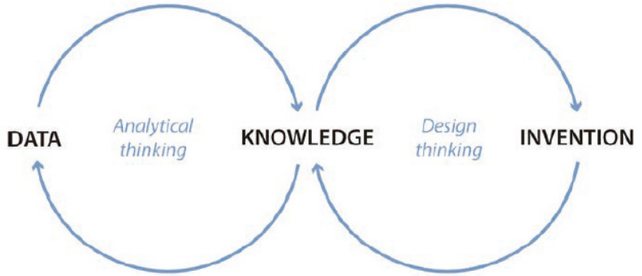


FIG2.15 Analytical thinking is aimed at translating and interpreting data into knowledge (discovery), and design thinking is aimed at developing new knowledge through synthesis and spatial translation (invention).
(Source: After Nijhuis, 2015).

Through design experiments based on the polder grammar, on multiple scale levels, one can investigate which elements from the polder landscapes can be changed to adapt them to economic and climate change without damaging the overall integrity of the polder and how to change them. Research by design, exploring possibilities by spatial design, can help developers, and planners explore the possibilities for spatial development, generating proposals or potential solutions for design problems (Nijhuis and Bobbink 2012). This type of knowledge-based design leads to new, balanced, and coherent polder landscapes with their own identity and spatial qualities (Nijhuis 2020).

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FIG3.1 Lagoon tansformed into a recreation park in the city

Source: http://img-arch.pconline.com.cn/images/upload/upc/tx/photoblog/1010/22/c10/5603245_5603245_1287749355718.jpg

03

LANDSCAPE SYSTEM OF NINGSHAO PLAIN

In this chapter, the polder landscape of Ningshao plain was understood as a system. Through mapping hydrological, ecological and socio-cultural layer of the landscape, the structure map which include the key elements influencing the landscape will be the outcome. Then there is a comprehensive analysis about the dynamics of the system, and challenges and opportunities I found. Finnally I drew up the initial design assignment based on the understaning of the landscape.

3.1 LANDSCAPE SYSTEM ANALYSIS

3.1.1 Natural base

FIG3.2 Natural base of the Ningshao Plain

LEGEND

- sea
- river,canal, water body
- mountain
- Ningshao Plain

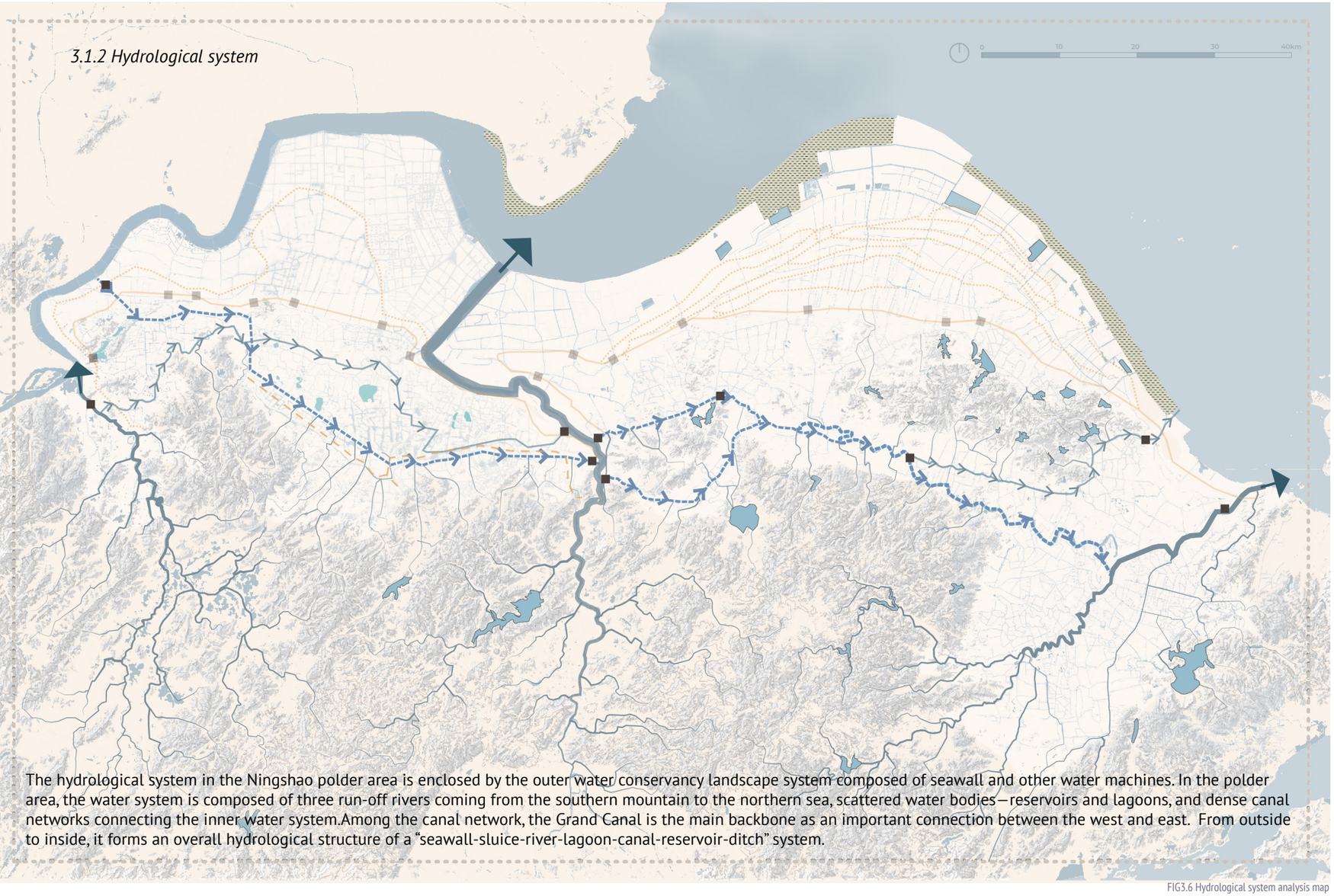
FIG3.3 Qiantang river
Source: http://tuchong.com/1511806/1032421 91/na/483012004_99959988

FIG3.4 Ningshao Plain
Source by Feiyan Zhang: https://www.sohu.com/a/420725440_120220911na/483012004_99959988

FIG3.5 Mountain area
Source:https://www.baike.com/wikiid/5363724094438783262?prd=mobile&view_id=3ztp910i5fo000

Surrounded by oceans, rivers, and mountains, the Ningshao Plain is a relatively independent geographical area. Affected by the tortuous foothills in the south, the Ningshao Plain is divided into four areas from west to east. From south to north, the whole area presents a stepped pattern of mountain-plain-ocean, which is the critical natural base for the development of the plain in the future.

3.1.2 Hydrological system



The hydrological system in the Ningshao polder area is enclosed by the outer water conservancy landscape system composed of seawall and other water machines. In the polder area, the water system is composed of three run-off rivers coming from the southern mountain to the northern sea, scattered water bodies—reservoirs and lagoons, and dense canal networks connecting the inner water system.Among the canal network, the Grand Canal is the main backbone as an important connection between the west and east. From outside to inside, it forms an overall hydrological structure of a "seawall-sluice-river-lagoon-canal-reservoir-ditch" system.

FIG3.6 Hydrological system analysis map

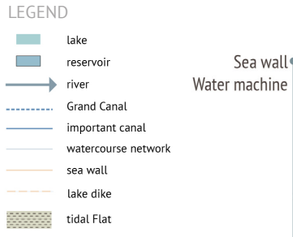
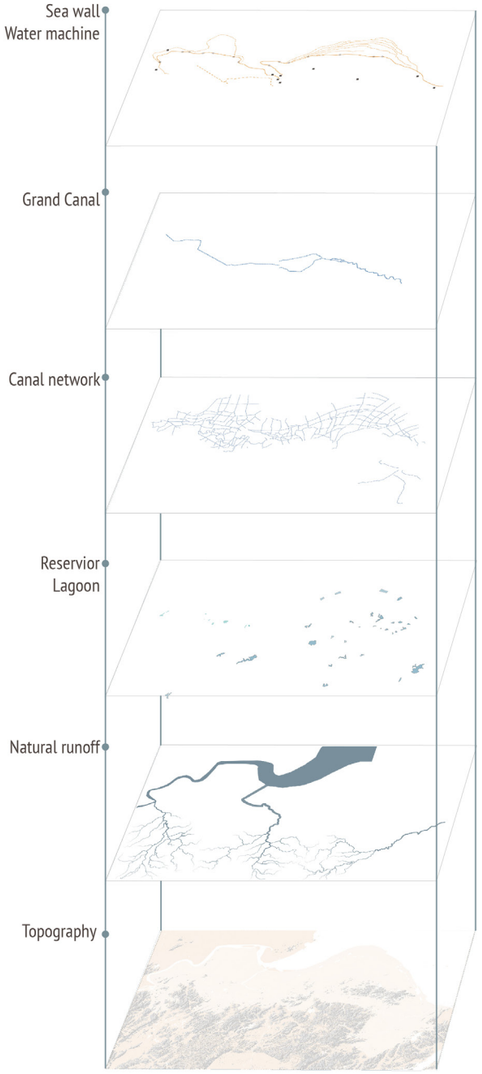


FIG3.7 Hydrological system layers



HYDROLOGICAL STRUCTURE

Hydrological elements such as Sea defense system including sea wall, sluice and dam, watercourse network, reservoir, the Grand Canal, and lagoon are important structural foundations for the landscape of Ningshao polder, but at current situation, all elements are facing different challenges from both nature and human, the potential value of these elements as a landscape has yet to be tapped .

1) sea defence system

The coastal defense system is mainly composed of seawalls, sluices and dams, which are the northern protective barrier of the Xiaoshao Plain. The extrapolation of the seawalls can distinguish the development history of polder reclamation. Although the old seawalls have less functions now, they have huge cultural value, many sluice are still in use along the seawall, which means the sea wall have the potential to be the basis for a linear landscape structure (Shi,X. 2020).

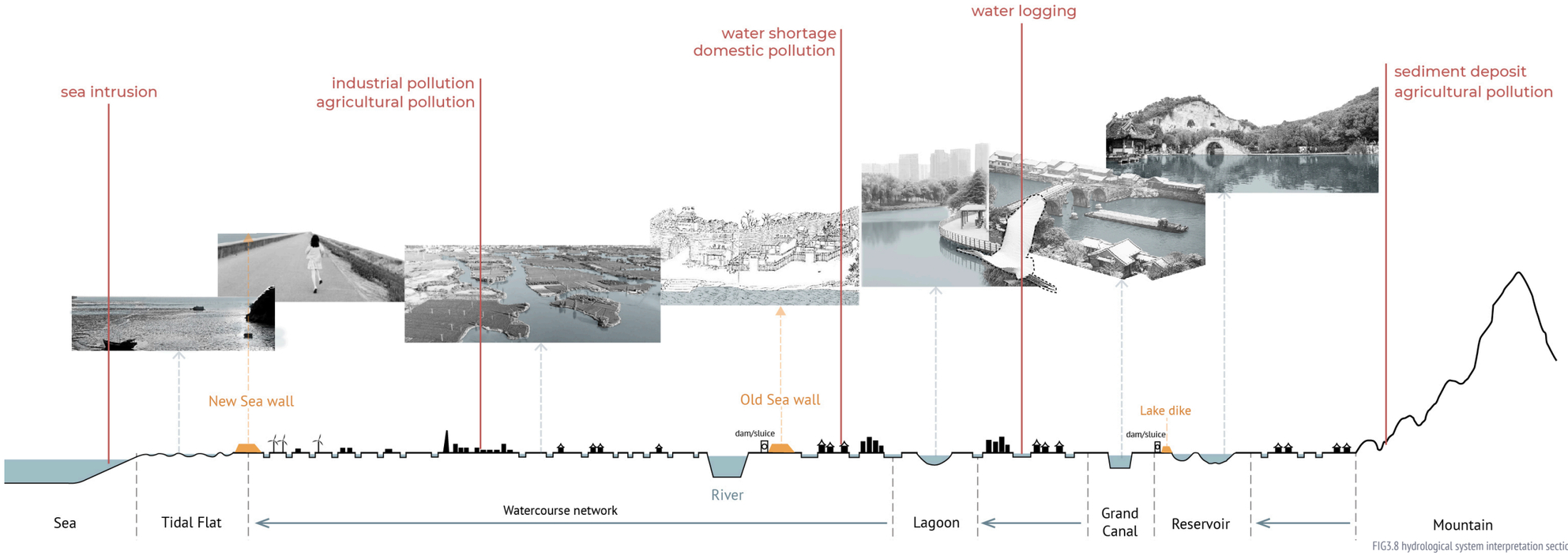


FIG3.8 hydrological system interpretation section

2) watercourse network

The formation of the watercourse network generally stems from the transformation process of lagoons, ponds and related natural river channels (Guo, W & Hou, X, 2018). After a long development process, and finally it becomes a huge, dense and criss-crossed watercourse network with a fishbone-like structure with the Grand Canal as the main east-west backbone and the north-south streams originating from the southern mountain (Shi,X. 2020).

3) reservior

In order to store fresh water and irrigate agricultural field, people have developed many reservoirs in the Ningshao Plain, most of which are near the mountains. Among them, Jian Lake was once the largest water conservancy project of the Yangtze River, whose total area is 189.95 million square meters. Because the water level of the lake is higher than the farmland in the northern plain, irrigation and drainage facilities were set up on the embankment to effectively control the irrigation of farmland (Shi,X. 2020).

4) Grand Canal

The Grand canal is one of the oldest artificial canals in the China, the Ningshao section starting from the Qiantang River in the west and reaching the East China Sea in the east. In the west of the canal, there were more human chiseled traces, while the east was connected to the Ningbo port on the basis of natural water channels. The east-west Canal needs to cross many natural stream with a large drop, and is deeply affected by the tides of the Cao'e River, so the water level adjustment must rely on sluices and weirs (Shi,X. 2020).

5) lagoon

The process of polder reclamation has gradually transformed the large lake water conservancy project in the southern part into strip-shaped channels and small lakes, resulting in the stream from the southern mountains of the Ningshao Plain being discharged directly into the polder water network due to the lack of lake regulation and storage. The construction of seawalls since the Tang Dynasty blocked the outlet of the inland water channel, and slowed the flow of the internal channel (Shi,X. 2020).

Therefore, the Lagoon (water accumulation area) is formed in the lower part of original terrain between the the northern part of the polder and the seawall. After the establishment of the modern sluice, the water level of these watershed was raised, and they were continuously transformed into the main water storage and irrigation lakes in the northern part of the polder. Different lakes are affected by different environmental factors around them, and undertake different functions such as ecology, recreation, water conservancy, etc (Shi,X. 2020).

3.1.3 Ecological system

FIG3.9 Ecological system analysis map

Needleleaf forests in subtropical zone

Pinus massoniana

Bamboo forests in subtropical zone

Phyllostachus pubescens

Broadleaf evergreen forests in subtropical zone

Cyclobalanopsis glauca *Castanopsis sclerophylla*

Broadleaf evergreen and deciduous scrubs in subtropical zone

Rhododendron simsii *Loroprtalum chinense*

LEGEND

- wetland park
- nature reserve
- coastal agriculture area
- middle plain agriculture area
- mountain agriculture area
- tidal flat
- canal pollution

There are many mountains and hills in the Ningshao area, the climate is humid, the light is sufficient, and it is suitable for the growth of forest trees. Most of the existing vegetation on the hills is natural secondary forest and artificial forest. The main vegetation types are coniferous forest, evergreen, deciduous broad-leaved forest, needle, broad-leaved forest, mixed forests, bamboo forests, thickets and grasses, etc. Waterfront green belts, street trees and scattered hills play an important role in the urban ecological environment (Forest ecology,n.d.).

FIG3.10 Agriculture type map

AGRICULTURE

Ningshao area began to cultivate rice as early as 5,000 years ago. Jian Lake mentioned before was built to promote the development of rice planting and fish farming. After the opening of the canal, the agricultural production was more developed than in the Central Part of ancient China. The Tang Dynasty completed the transition to intensive farming, and agricultural production formed a pattern of grain, mulberry, tea, pigs, fishing, and salt. In the Song Dynasty, due to A large number of people from the north moved to the south, and most of Jian Lake was surrounded by fields, and agriculture began to change from development-oriented to improving land productivity. Double-cropping rice cultivation and cotton planting appeared, grain and cotton gradually prospered, Ming and Qing Dynasties, the agricultural industry structure was greatly adjusted: multi-cultivation of double-cropping rice in the county, introduced rapeseed, corn and sweet potato; the rise of sea flat cotton planting industry, becoming one of the main crops ; After the completion of the Sanjiang Gate, the fish farming industry in outside part developed rapidly; tea entered the international market and promoted the large-scale development of tea. During this period, population increased, arable land expanded, mulberry fields decreased, forests were destroyed, water systems and climate changed, and the production of cocoons, oranges, fish, salt, and aquatic plants gradually decreased. Today, Ningshao area is dominated by food production, with comprehensive development of agriculture, forestry, animal husbandry, and sideline fishing. integrated agricultural area (Agriculture,n.d.).

According to differences in soil and crops, agriculture can be roughly divided into the Mountain area, the Middle plain area and the Coastal plain area (Biology, n.d.):

1) Coastal area

The soil is dominated by saline soil, most of which are artificially cultivated vegetation, and a small amount of salt-tolerant natural vegetation. The artificial cultivation is mainly cotton, hemp and other crops.

2) Middle area

The soil is mainly fluvo-aquic soil and paddy soil. Most of it mainly cultivate crops such as rice,wheet, rapeseed and green manure, also plant fruit, mulberry, tallow and other economic forests around river valleys and farmland.

3) Mountain area

The soil is dominated by red soil, yellow soil and coarse bone soil. Most of the lower areas are developed into tea gardens, or terraced fields to grow crops. The trees are mainly natural, supplemented by artificial planting.

ECOLOGICAL STRUCTURE

The ecological elements of the Ningshao Plain are closely related to water. Based on the hydrological structure, the ecological structure can be roughly concluded into mountain ecosystem covered by forest and shrub, lake ecosystem, canal ecosystem, river ecosystem and coastal tidal flat ecosystem.

Each part of the structure is relatively independent and does not function as an overall ecological network, coupled with the sharp decline of forest trees, environmental pollution, reduction of species diversity, the ecological environment is fragile as consiquence.

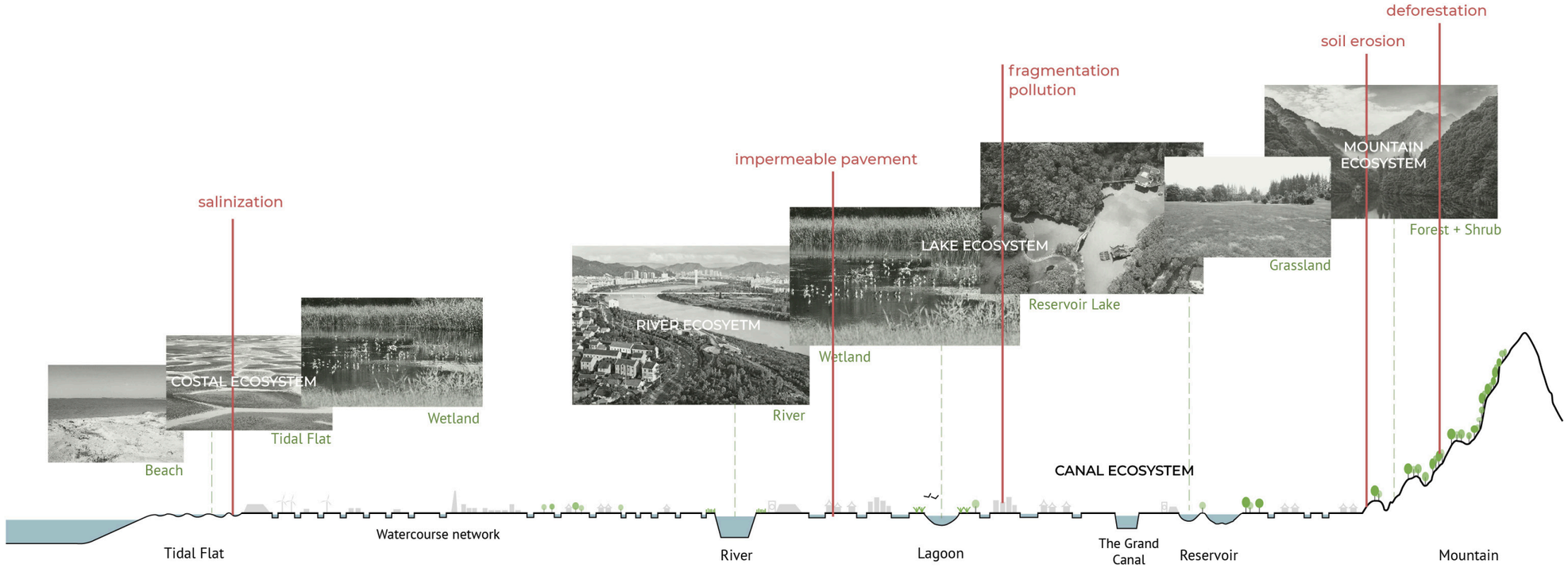


FIG3.11 Ecological system interpretaion section

1) mountain ecosystem

In the mountain area, the evergreen broad-leaved tree species that like warmth and drought resistance mainly include green ganglia, wood lotus, oak, and stone oak. The main tree species of the mixed needle and broad-leaved forest are masson pine, fir, juniper, etc., There is also a large area of bamboo forest (Biology, n.d.). The trees and shrubs of the mountain are the habitat of many wild animals, have the richest biodiversity in Ningshao area, and are an important ecosystem to maintain a good ecological environment for Ningshao Plain.

2) lake ecosystem

The lake here refers to reservoir and lagoon. There are often some wet and aquatic plants around the lake. Some lakes with lower terrain have been transformed into wetlands, which can improve water quality and become the kidneys of cities. Some lakes have been transformed into landscape lakes to improve the urban environment and microclimate.

3) canal ecosystem

Because the canal mainly assumed the traffic function in the past, there were often hard revetments on both sides of the canal, and biodiversity was scarce. Some deciduous tree species were often planted along the banks as decorative trees, often with relatively anti-pollution species, such as camphor trees.

4) river ecosystem

There are often more natural revetments along the natural river channels. Farmers will plant some plants that can prevent floods and consolidate dikes, and aquatic plants that purify water quality. Natural river channels are important habitats and migration channels for fish and amphibians, it is a medium to connect the decentralized ecosystem

5) coastal ecosytem

The natural herbaceous vegetation of costal area are all salt-tolerant plants, and there are large reeds, salty greens, and sagebrush vegetations in the uncultivated areas and seawalls (Biology, n.d).

3.1.4 Socio-cultural system

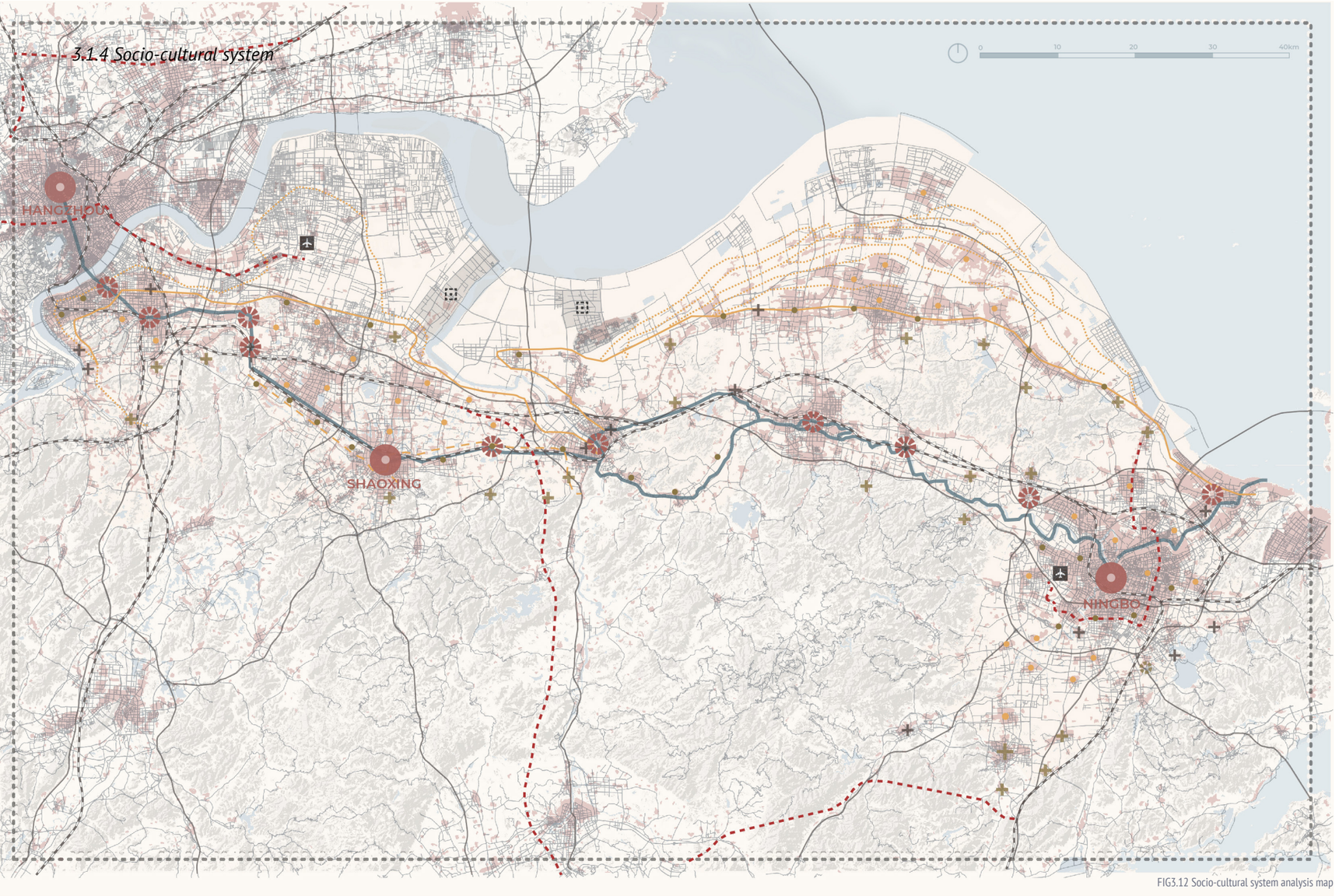
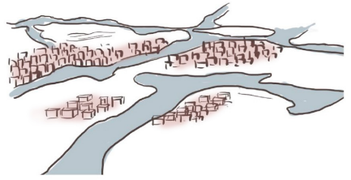


FIG3.12 Socio-cultural system analysis map

+ *Hill setllement*



● *Port settlement*

+ *Dike setllement*

● *Sluice/dam setllement*

FIG3.13 settlement typologies

LEGEND

- city
- important town
- railway
- railway under construction
- highway
- city road
- sea wall
- Grand Canal
- urban area

There are four types of settlements in the Ningshao Plain, namely hill settlements, port settlements, dike settlements and sluice/dam settlements. The major cities are relatively close to the mountains, because the terrain near the mountains is relatively high and is the first polder area to be reclaimed, and the hill settlement is also the oldest type of settlement. Most of the plain area is now covered with dense river networks, so most of the settlements are the second type of settlements, port settlement. In the past, the Grand Canal has been the most important transportation route in this area, as it connected all the important towns to Ningbo port, but with the development of modern transportation methods, the dense road network and railway gradually replaced its transportation function.

CULTURE

Ningshao area has a long and splendid history. Since ancient times, life and culture have been closely related to water. There are many historical heritage and rich tourism resources. The culture could be roughly concluded into three categories, namely water culture, The Grand Canal culture and seawall culture.

water culture

The streets, watercourse, bridges and boats in Ningshao area form a unique water culture. The residents here either relax by the water, row on the water, or work in the wet fields, their lifestyles are closely related to water.Many of customs, such as sacrifices, festivals, markets, etc., are also closely related to water.

Grand Canal culture

There are many bridges and ancient sluices and weirs on the Grand Canal, all of which are historical heritage. In the past, as a section of the Maritime Silk Road, it brought largeprosperity to the region. As a major traffic artery connecting cities, it is the cultural corridor of the Ningshao Plain.

sea wall culture

Due to the reclamation of coastal tidal flats, new seawalls are constantly built, and old seawalls have become backup construction or are directly buried. However, people have recognized the cultural value of seawalls, and through historical research and reuse, they can become local cultural symbols.

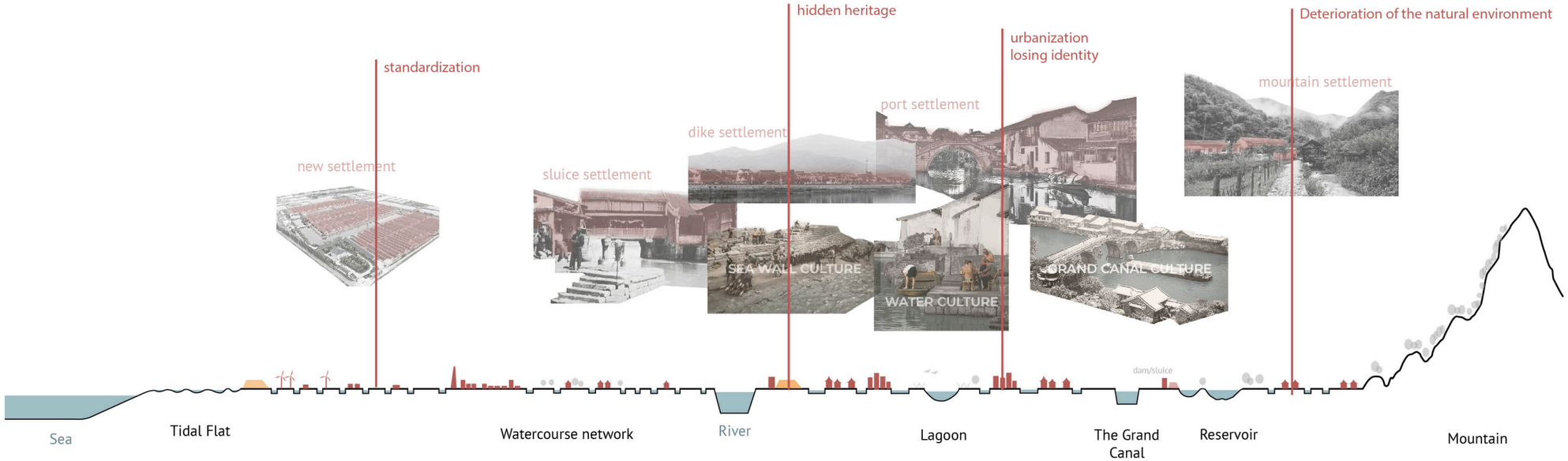


FIG3.14 Socio-cultural system interpretation

SETTLEMENT

1) sulice/dam settlement

The sluice/dam settlements are usually located at the confluence of artificial canals and tidal rivers. The main discharge point of reservoir can also be regarded as a relatively special dike settlement. The layout pattern usually revolves around water conservancy facilities such as Daiba weir gates, typical ones such as Zhangting Town in Yuyao and Qianqing Town in Xiaoshan(Guo, W & Hou, X, 2018).

2) dike settlement

The dike settlements are usually located along the seawall, the sea defense river and the reservoir. The pattern is a linear arrangement along the dike The dike often evolves into the main street of the settlement, such as Guali Town in Xiaoshan and Hutang Town in Shaoxing(Guo, W & Hou, X, 2018).

3) port settlement

Port settlements are a relatively common and takes up large-scale area of Ningshao polder. Its pattern usually revolves around the bank or the port of the polder. Typical examples are Ningbo Zomatang and Jiangshan Town. If the polder evolves into an inland river, the streets along the river will become the main street of the settlement(Guo, W & Hou, X, 2018).

4) hill settlement

The hill settlement is an early type of settlement. Many towns with a long history originate here, such as Ningbo Cicheng Town, whose layout of mountains, cities and lakes reflecting the influence of the traditional city planning way, the layout of the urban water system and Ci Lake is also a transformation and adaptation to the low-lying terrain of the Ningshao Plain (Guo, W & Hou, X, 2018).

3.1.5 Landscape struture

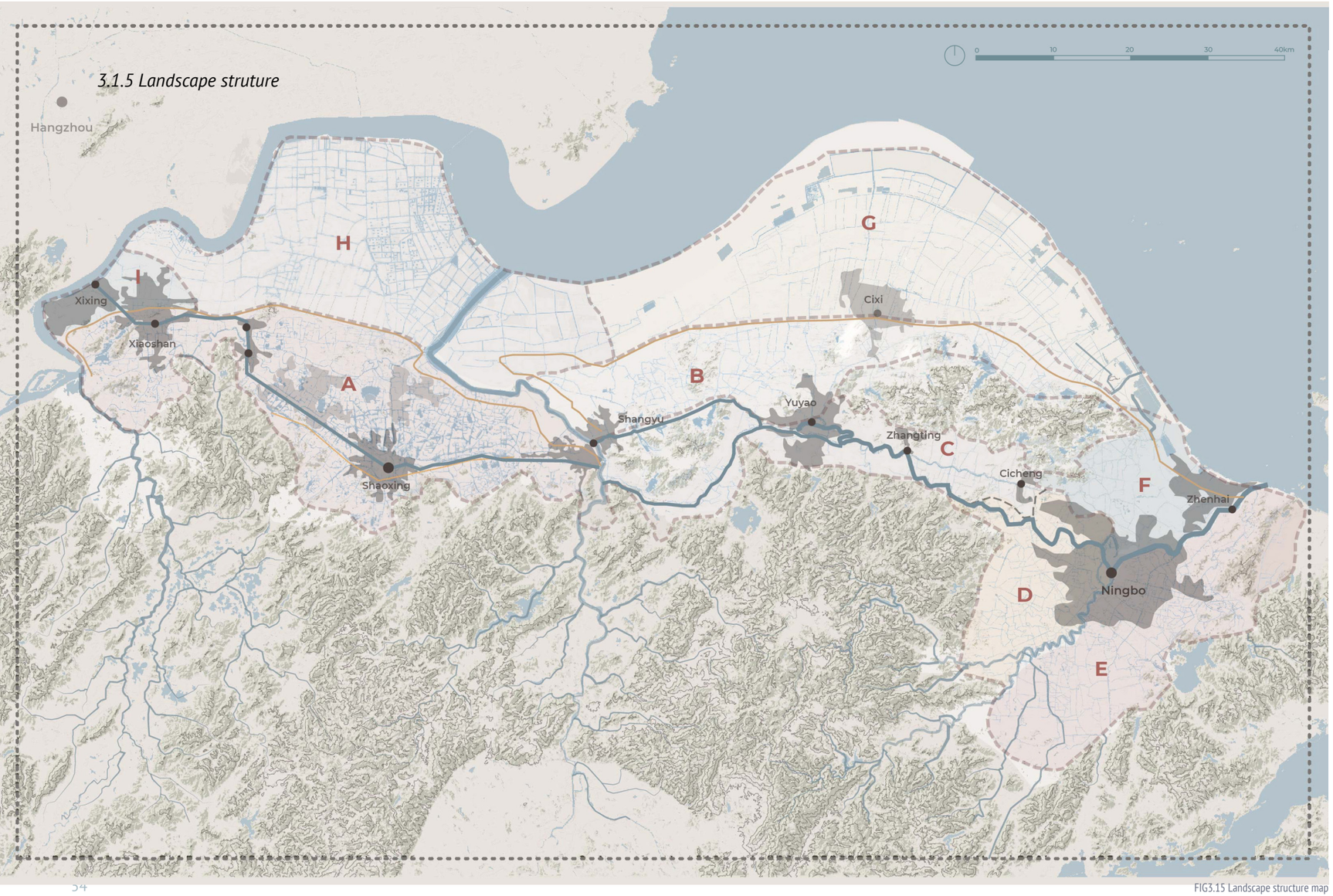


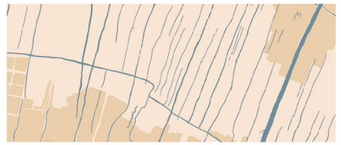
FIG3.15 Landscape structure map

A: lake polder

BDEF: port polder

C: vally polder

G: silt polder



HI: sand polder

FIG3.16 Polder typologies

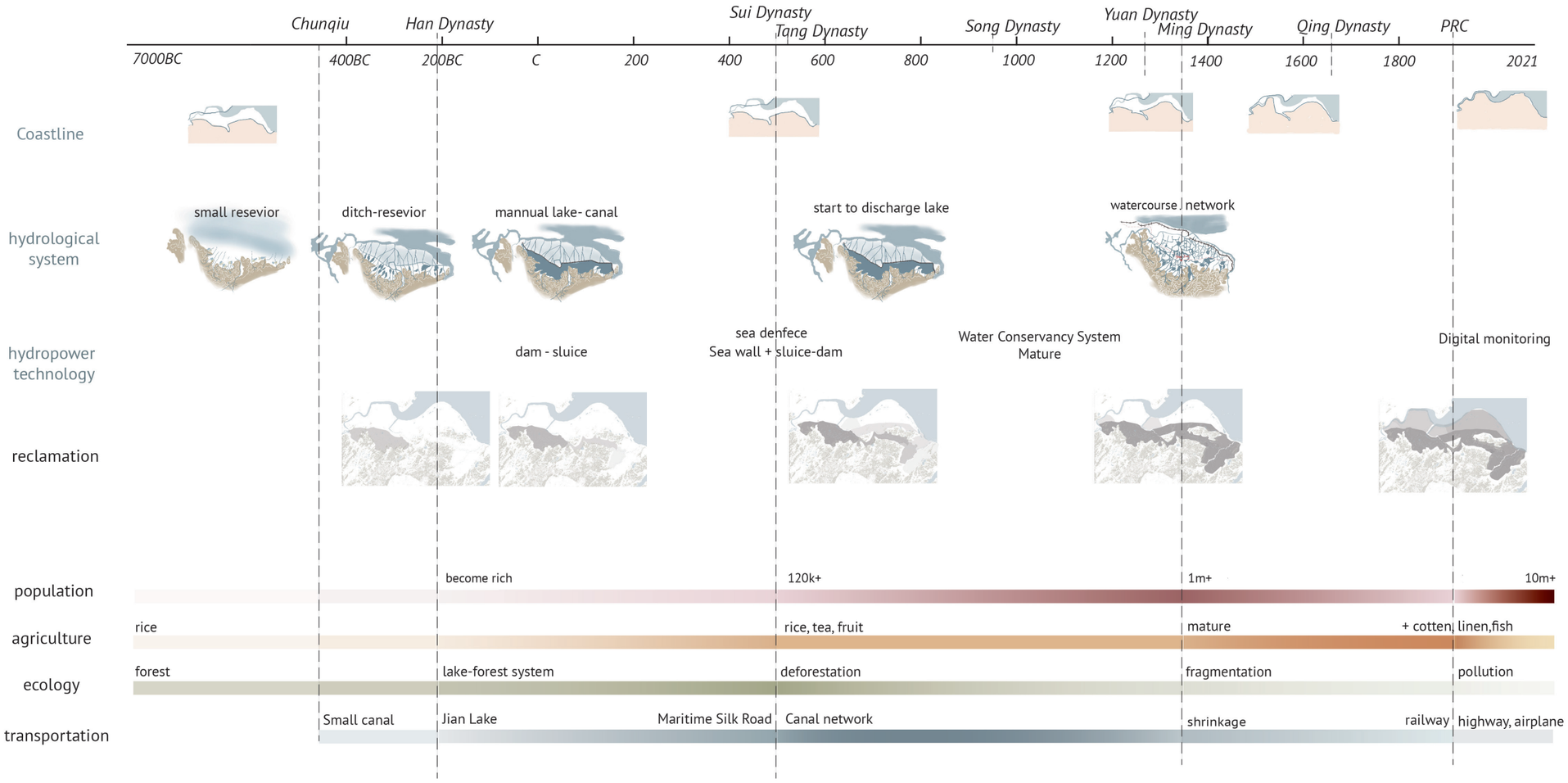
The key elements that constitute the landscape structure extracted from the previous analysis of each layer have been synthesized to obtain the landscape structure of the Ningshao Plain based on the hydrological system, which will be further studied on the basis of this structure in the next. According to different reclamation methods and form characteristics, the polders in the Ningshao Plain can be roughly classified into five types. The first type is reclaimed from lakes, which is the oldest type of polders in the Ningshao Plain. There are many small water bodies which are the lake remains. The second type, port polder is the most common in the Ningshao Plain, which is composed of the narrow and dense water network; the third type, valley polder, is mainly distributed the valley basin along rivers and is the most suitable type for the development of agriculture; the fourth type silt polder and the fifth type sand polder is the modern coastal reclamation area, its form is very different from the traditional polder, and the watercourse is more rational and regular.

LEGEND

- urban area
- sea
- mountain&forest
- city/important town
- lake/reservoir
- watercourse network
- river
- Grand Canal
- sea wall

3.2 DEVELOPMENT OF THE LANDSCAPE SYSTEM

FIG3.17 Development dynamics of Landscape system
Part based on Xiujing, Shi.(2020). Study on Water Conservancy Landscape in Xiaoshao Region. [Dissertation for the Degree of Master]. Zhejiang A&F University.



The fundamental driving force that affects the changes in the landscape system of the Ningshao Plain lies in the dynamic relationship between people, land and water. Specific influencing factors include changes in land patterns, agriculture, water conservancy, transportation, etc. brought by human activities, as well as changes of the natural environment (ZHANG,S& WANG,X, 2017). According to these factors, the development process can be roughly divided into four periods: wet fields, lake engineering, lake reclamation, and coastal reclamation.

PERIOD I : WET FIELD

During the transgressive period, the coastline reached the foothills of mountain in the south. With the retreat of the sea water, the coastline of the Ningshao Plain continued to advance northward (Guo, W & Hou, X, 2018). But the plain was really swampy, so people started to build small reservoirs for freshwater storage.

PERIOD II : LAKE ENGINEERING

As the agriculture matured, large lake water conservancy projects were built by pooling water from the southern mountains for agricultural irrigation and navigationin. This project made the Ningshao area prosper quickily and the population began to explode(ZHANG,S& WANG,X, 2017).

PERIOD III : LAKE RECLAMATION

The construction of seawalls has gradually stabilized the coastline. In addition, due to the surge in population, the demand for food and trading has also increased significantly. At the same time, the accumulation of silt at the bottom of the lake has led people to reclaim large areas of lakes into farmland, forming a watercourse network structure (ZHANG,S& WANG,X, 2017).

PERIOD IV : COASTAL AREA RECLAMATION

The modernization process makes the water system gradually lose the functions of water supply and transportation, and the traditional polder landscape is facing a huge threat. At the same time, with the progress of water conservancy technology, further reclamation and development of agriculture in the northern coastal area, new cities are emerging.

3.3 CHALLENGES & OPPORTUNITIES

3.3.1 Challenges & problems

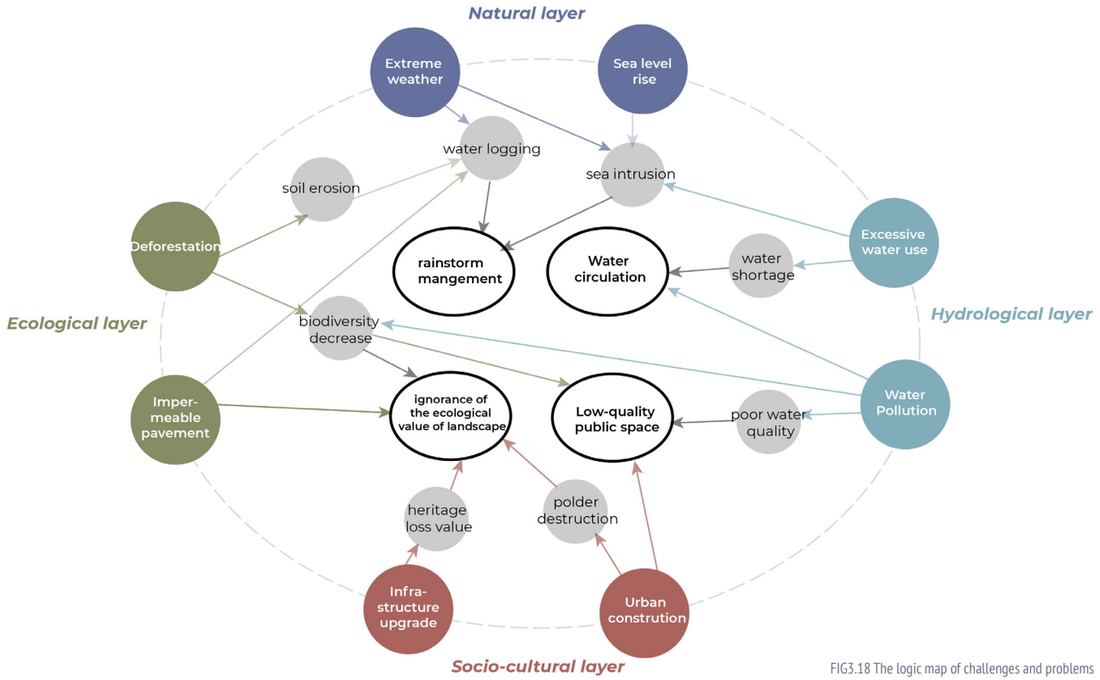


FIG3.18 The logic map of challenges and problems

The challenges come from four layers all influence the development of the landscape system, they could be categorized into five problems finally: 1) poor stormwater management capabilities 2) poor water circulation 3) ignorance the value of landscape 4) low-quality water-related public space

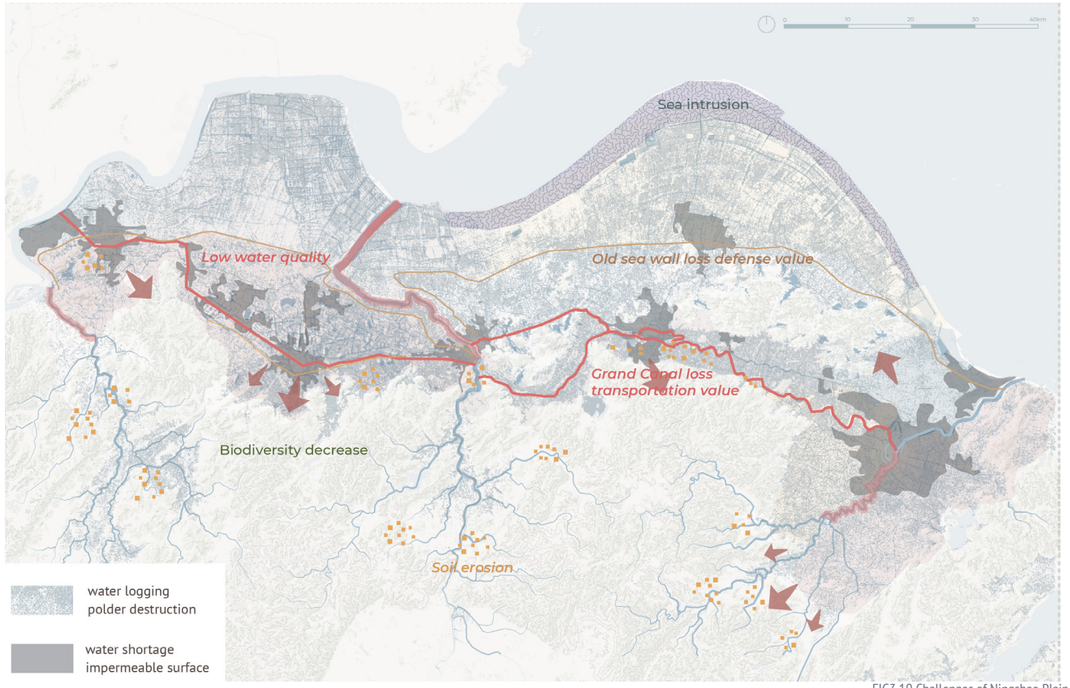


FIG3.19 Challenges of Ningshao Plain

1) poor rainstorm management capabilities

Even though there are a lot of water storage space like lakes and large number of watercourses in Ningshao area, and the water network is able to discharge water quickily, water logging still happen a lot especially when heavy storm come. The urban area too much impermeable surface, and lack of capacity to discharge the stormwater to the water network effenciently, the rainstorm manegement capcity needs to be strengthened.

2) poor water circulation

The water shortage issues happen in the dry season a lot while flooding happens in the wet season, the large amount of precipitation in rain seasons was not used effiently by circulation to balance the the water use in the different times. The water quality also needs to be improved by good water circulation.

3) ignorance the value of landscape

The polder landscape is not only a cultural heritage, the water system not only has the functions of irrigation, transportation, or flood discharge, the huge potential of the landscape has been ignored.The polder landscape is disppearing under urbanization. Re-establishing a landscape-based network is beneficial to sustainable development of ecological environment in Ningshao Plain.

4) low-quality water-related public space

Different from the public space of traditional water network that the cities relying on the water network, the contemporary urban public space basically takes commercial centers or public service centers is connected by roads. This model has greatly changed the livestyle of people in the polder landscape area. People's lives are getting farther and farther from water (ZHANG,S& WANG,X, 2017).

In coclusion, the problems are main about water safty issues and traditional environment changes.

FIG3.20 Canal was filled to road

Source: https://www.sohu.com/a/346750916_688695

Source: https://baijiahao.baidu.com/s?id=1629406471206820832&wfr=spider&for=pc

FIG3.21 Old seal wall defense system

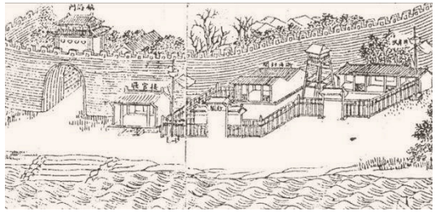


FIG3.22 Sea wall lost its defence function

Source: https://www.sohu.com/a/482143658_121117480

FIG3.23 Waterfront pubic space is decreasing

Source: https://www.sohu.com/a/346750916_68869

3.3.2 Opportunities & potentials

FIG3.24 Potentials and values map

1) water system function as water circulation system

There is huge potential for water systems of Ningshao plain to collect more rainstorm in the rainy season or the street drainage water, recycle after purification to cope with the water shortage issues in the dry season and improve the water quality at the same time.

2) water network as the basis of blue-green network

As the area already have a huge and dense water network, it is much beneficial to build a more robust blue-green network based on it. The blue-green network could connect the fragmented green spaces, and provide a high quality environment framework for the city sustainble devlopment.

3) Grand Canal as Cultural corridor

As the Grand Canal connects the important cities with splendid culture and heritage in Ningshao Plain, the public space and green space along the Grand Canal has large potential to be developed to rejuvanate the Grand Canal again. The resident of Ningshao plain who shared the common culture history background could be reconnect again through this cultural corridor.

4) Reservoir&lagoon as biodiverse habitat

Most of reservoir and lagoon function as water storage body or recreation facilities, but as the large natural base in the urban area, they have large potential to be devloped to be a more biodiverse habitat as the stepping stone for animals and improve the microclimate and environment quality of cities.

5) Sea wall provides unique public space

The old sea wall seems lost its value after deprecation, but it acutualli has the potential to transformed as new public space with educational value and could increase cultural identity for the old sea defense area.

FIG3.25 Lagoon develops recreational lake
Source: https://www.sohu.com/a/530170128_100124242

FIG3.26 The Grand canal gradually lost transportation fuction
Source: https://baijiahao.baidu.com/s?id=1629406471206820832&wfr=spider&for=pc

3.4 DESIGN ASSIGNMENT

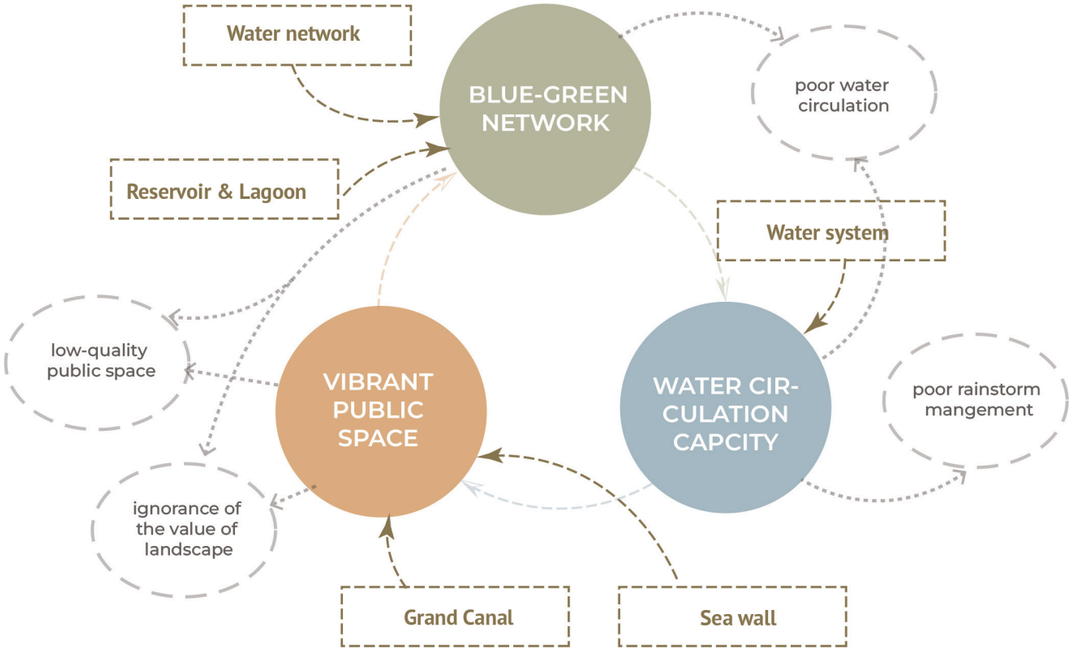
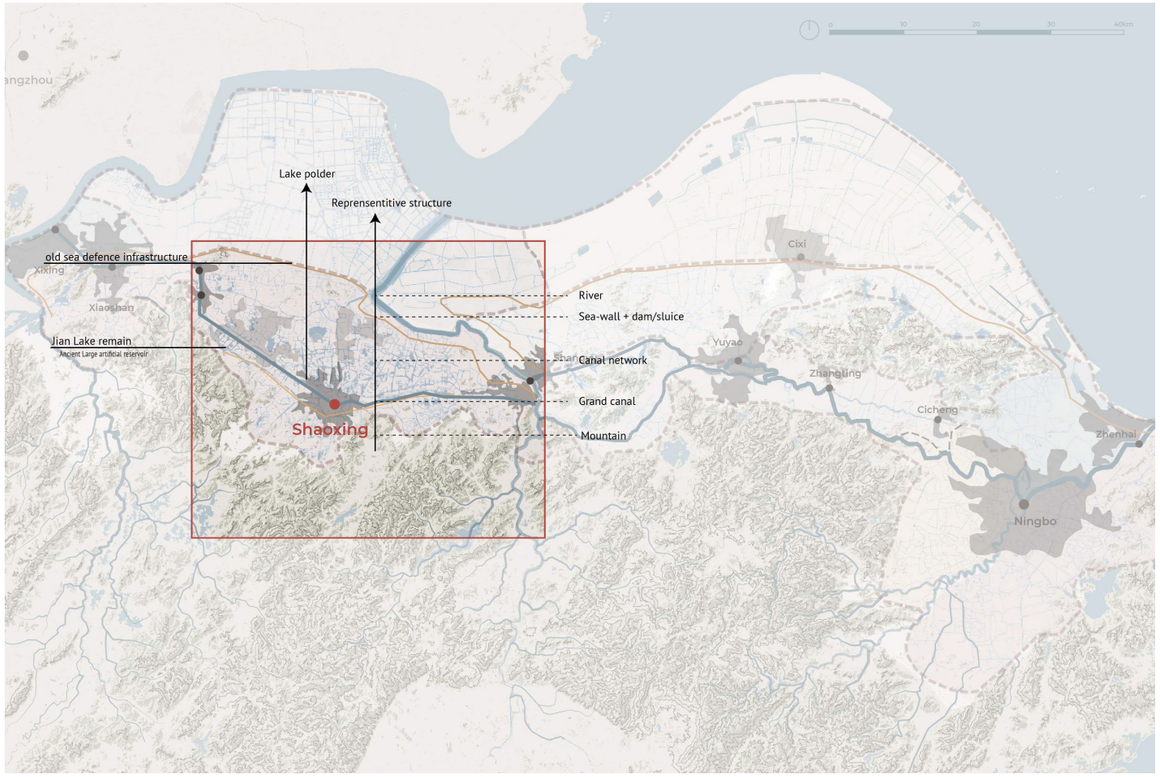


FIG3.27 The logic of propsing design assignment

According to the challenges and opportunities, three design assignment area drawn up:
1) increase rainwater recycle capcity 2) build robust blue-green network 3) create vibrant public space

FIG3.28 Design research scale foucs on Shaoxing area



According to the research objectives, the spatial structure and characteristics of the polder will continue to be studied further, namely the “polder grammar”. As analyzed above, there are roughly five types of polder in the Ningshao Plain, and this project selects one of them for design exploration. The polder located in the Shaoxing area belongs to the lake polder type with the longest history in the Ningshao Plain. It has profound cultural history and rich historical heritage, and holds the key structural elements of the Ningshao Plain obtained in the previous analysis, as well as various types of settlements, which can be used as a representative polder.

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ZHANG,S& WANG,X. (2017).The Formation, Evolution and Contemporary Landscape Architecture Practices of the River Network in Ningshao Plain. Landscape Architecture.

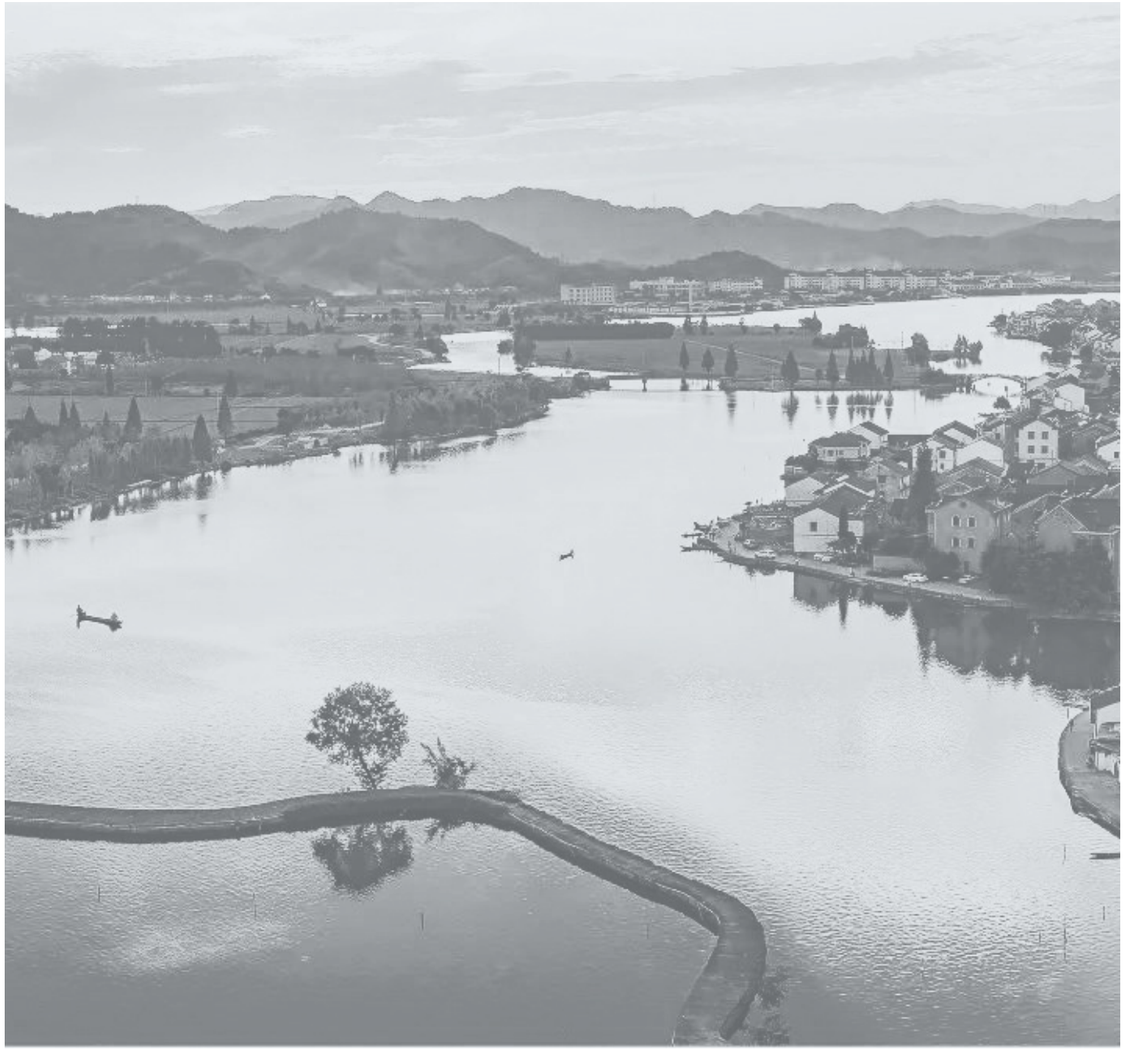


FIG4.1 villages and agricultural field in Shaoxing
Source: http://www.shaoxing.com.cn/p/2898629.html

04

EXPLORING SHAOXING STRIP

In this chapter, I will focus on the lake polder type in Shaoxing area, and chose a strip area to further research the polder landscape structure for design, the 'polder grammar' of the research site will be summarized which provides design principles for the design experiments in the next chapter.There is also some case study supplementing resilient design principles.

4.1 INTRODUCTION

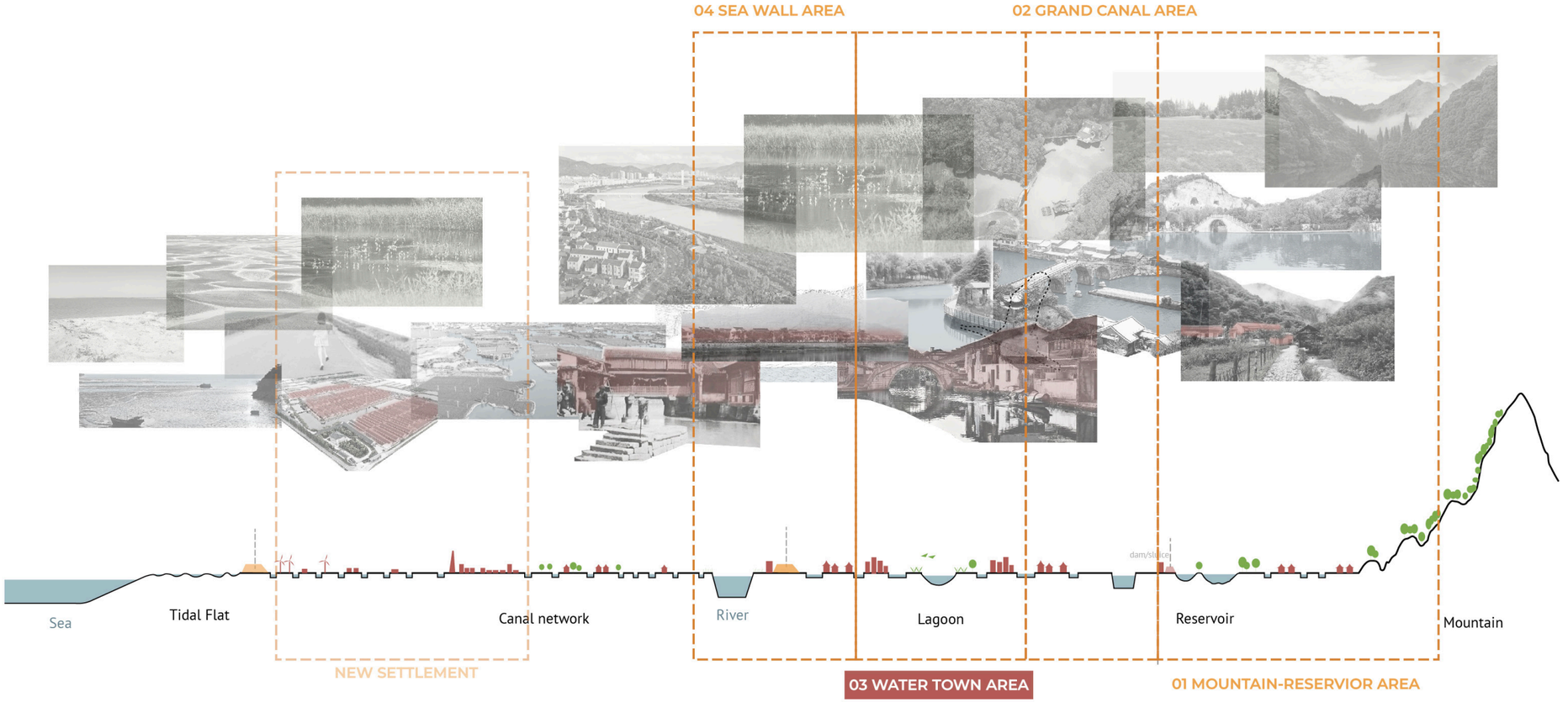
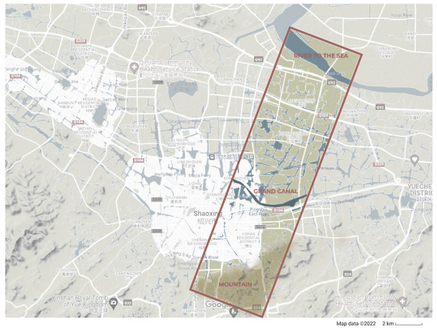


FIG4.3 Landscape structure of the Shaoxing strip

Based on Google maps: https://www.google.com/maps/@29.9929308,120.5176457,12z

FIG4.2 Shaoxing strip



As mentioned in the previous chapter, the Shaoxing area has a representative landscape structure. So I chose a strip area with this structure and integrated the main elements of the hydrological, ecological, and socio-cultural layers, classify the characteristics of this structure, and finally, it is roughly divided into five areas from the mountains to the sea. In addition, because the newly reclaimed land is a really new form that is almost completely different from the traditional polders, so it is not taken into account. The other four areas are the mountain-reservoir area, the Grand Canal area, the water town area, and the sea wall area, among which the water town area faces the biggest challenge of urbanization, so it will be zoomed in as the main site to further research.

SHAOXING STRIP

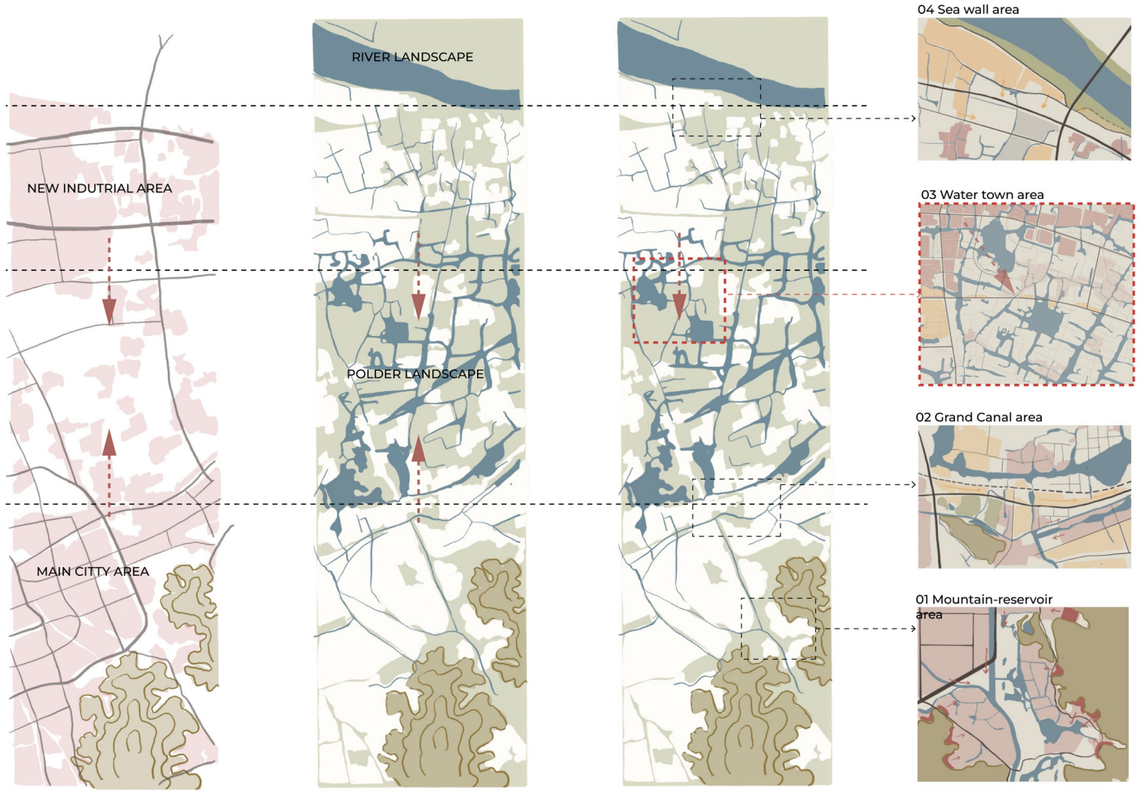


FIG4.3 Landscape structure analysis of the Shaoxing strip

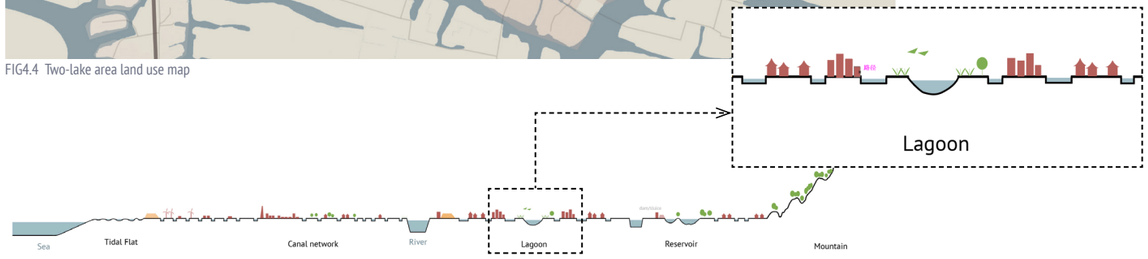
The strip area near the mountains and near the river is urbanized more. Because the city originated at the foot of the mountain, the main city area is close to the mountains, and the area near the river is a new urban area due to the development of the industry. The polder landscape in the middle area is still well-preserved but is being squeezed by urbanization on both sides. Among the four areas of this strip, the water town area has the most polder landscape, which can be better used to further research the structure of the polder landscape, and is just beginning to be encroached by the city, this area is more in line with the research objective.

TWO LAKE AREA

FIG4.4 Two-lake area land use map

villages
dense residential area
water area
industrial area
agricultural area

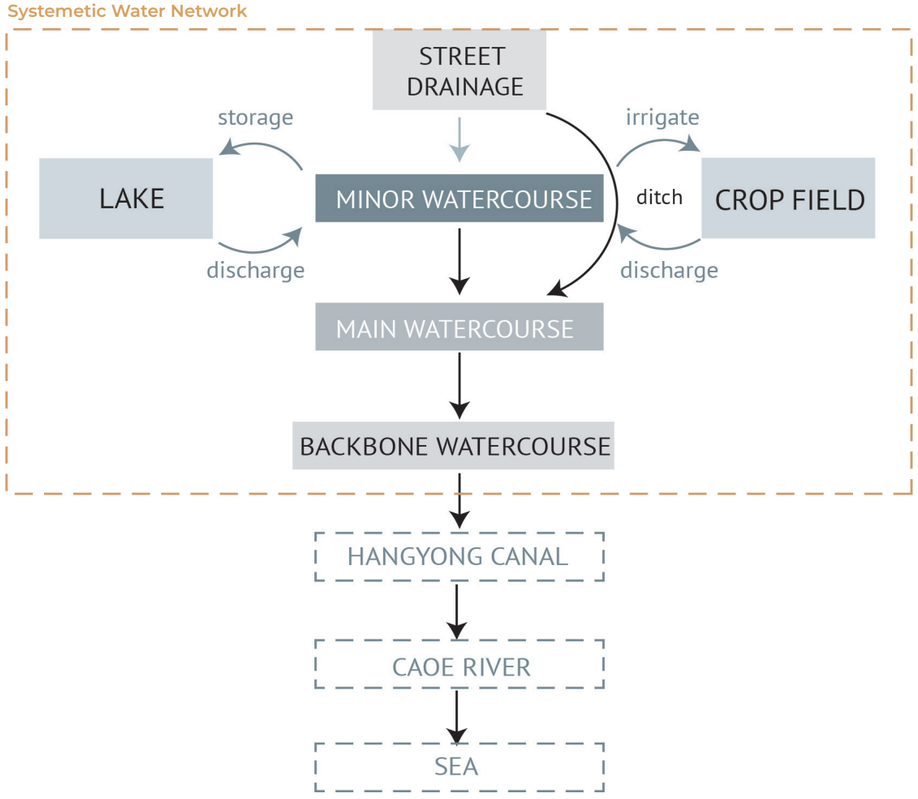
There are two lakes in this area, both of them are the lagoon type mentioned in the previous chapter. Because Yangjing Lake has been developed into a park and is the main recreation public space in this area, the Banze lake has not been developed yet and is still mainly used for water storage and agricultural irrigation. The 'Two-lake area' will be used to refer to this area throughout the report.



4.2 WATER SYSTEM

4.2.1 Historical water system

FIG4.5 Historical water system



Historical water system: The water system in this area has four hierarchies. First, the street drainage system and the ditches in the crop field collect rainwater into the minor and main watercourse. During the rainstorm season, the water can be quickly discharged to the backbone watercourse, then through Hangyong Canal, goes to the Cao'e River and arrived the sea finally. The lake is an important water storage structure in this area, which can provide water for crop field through this water system during the dry season.

4.2.2 Current water system

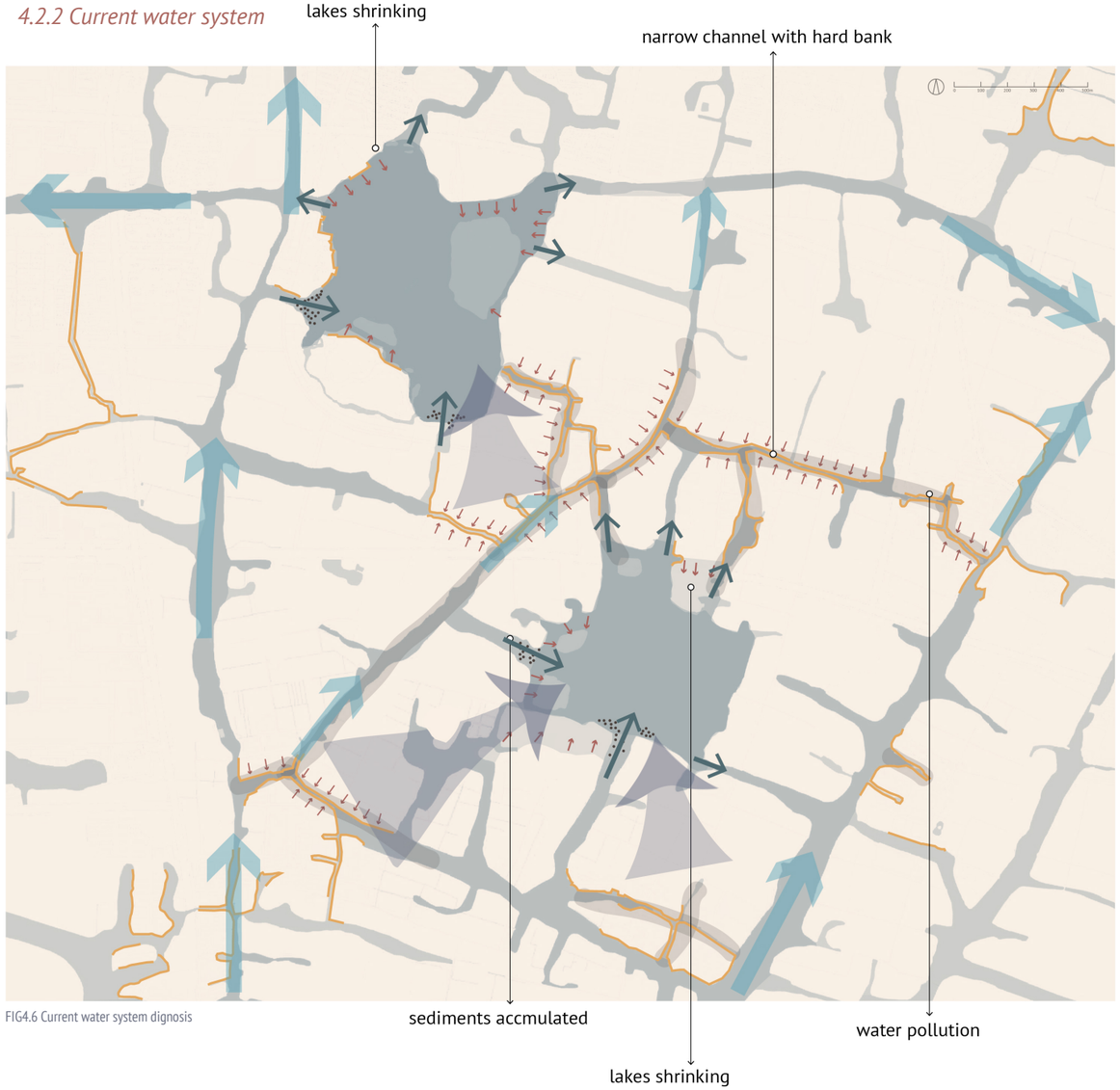


FIG4.6 Current water system dignosis

Source: Jing Hu. (n.d.). Shaoxing Jing Hu Wetland Park Masterplan.

FIG4.7 new reclamation near the lake

Source: http://k.sina.com.cn/article_2810373291_a782e4ab020024i8f.html

FIG4.8 waterlogging in the city

Source: Jing Hu. (n.d.). Shaoxing Jing Hu Wetland Park Masterplan.

FIG4.9 polluted water

DECREASED WATER STORAGE CAPACITY

The size of the lake is shrinking due to urbanization's demand for land, and many channels are getting narrower or even buried, which has been reducing the capacity of the region's water network to store water.

POOR SURFACE WATER CIRCULATION

The urban area has too much impermeable surface, the capacity of discharging surface rainwater to the water system of urban area is really poor, flooding issues seriously threaten the water safety of this area.

LOW WATER QUALITY

Most of the watercourse in the urban area are hard revetments, so the self-purification capacity is weak. In the rural area, due to pesticide and industrial pollution, as well as domestic garbage, the water quality is getting worse and worse.

Lake flow direction
Channel flow direction
sheet flow

natural bank
artificial bank

Source: http://www.shaoxing.com.cn/p/2898629.html

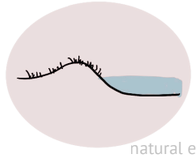
4.2.3 Polder Grammar

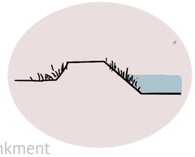
WATER STRUCTURE / FORM

FIG4.9 water pattern of the polder

Source: http://img-arch.pconline.com.cn/images/upload/upc/tx/photoblog/1010/22/c10/5603245_5603245_1287749355718.jpg

irregular shape





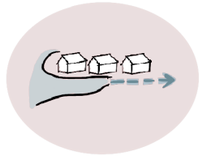
natural embankment

WATER MANAGEMENT

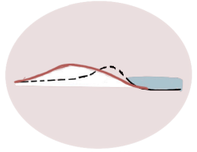
1) water capacity regulation

systemetic network

enhance dike

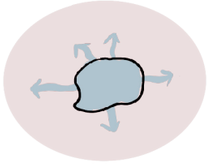


extend the channel

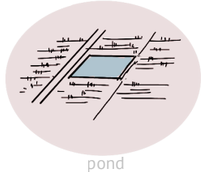


widen the dike

2) water retention



lake



pond

3) water purification

aquatic plants

Most of the traditional polder watercourses are formed by artificial intervention on the basis of natural water bodies. So the shape is meandering and irregular, and often there is a relatively natural embankment. These are important formal features of the polder landscape.

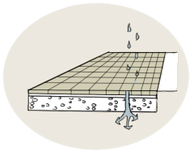
There are a lot of local way to manage the water by residents, they use the systematic water network to regulate the water amount effectively. By strengtening the embankments with accumulated sediments, extending canals, widening polder dike and so on to increase the water storage capacity . The water usually is stored through small ponds in the agricultural fields, the lakes are the most important water storage body in this area. For a better water use, some aquatic plants with purifying effects are often planted on the shore to maintain a better water quality.

4.2.4 Design principles from case study

However, due to the more pollution in modern times and the serious destruction of aquatic plants on the shore, introducing wetlands strategies further help purifiy the water quality and increases more resilient water storage space. Regarding the issue of street drainage recycling, which is a missing part in the water system of the area, the Green alley strategy was introduced to promote rainwater collection and reuse through rain gardens or bio-swamps and permeable pavement in the neighborhoods.

rain garden

bioswale



permeable pavement

welands

4.3 GREEN STRUCTURE

4.3.1 Current green structure

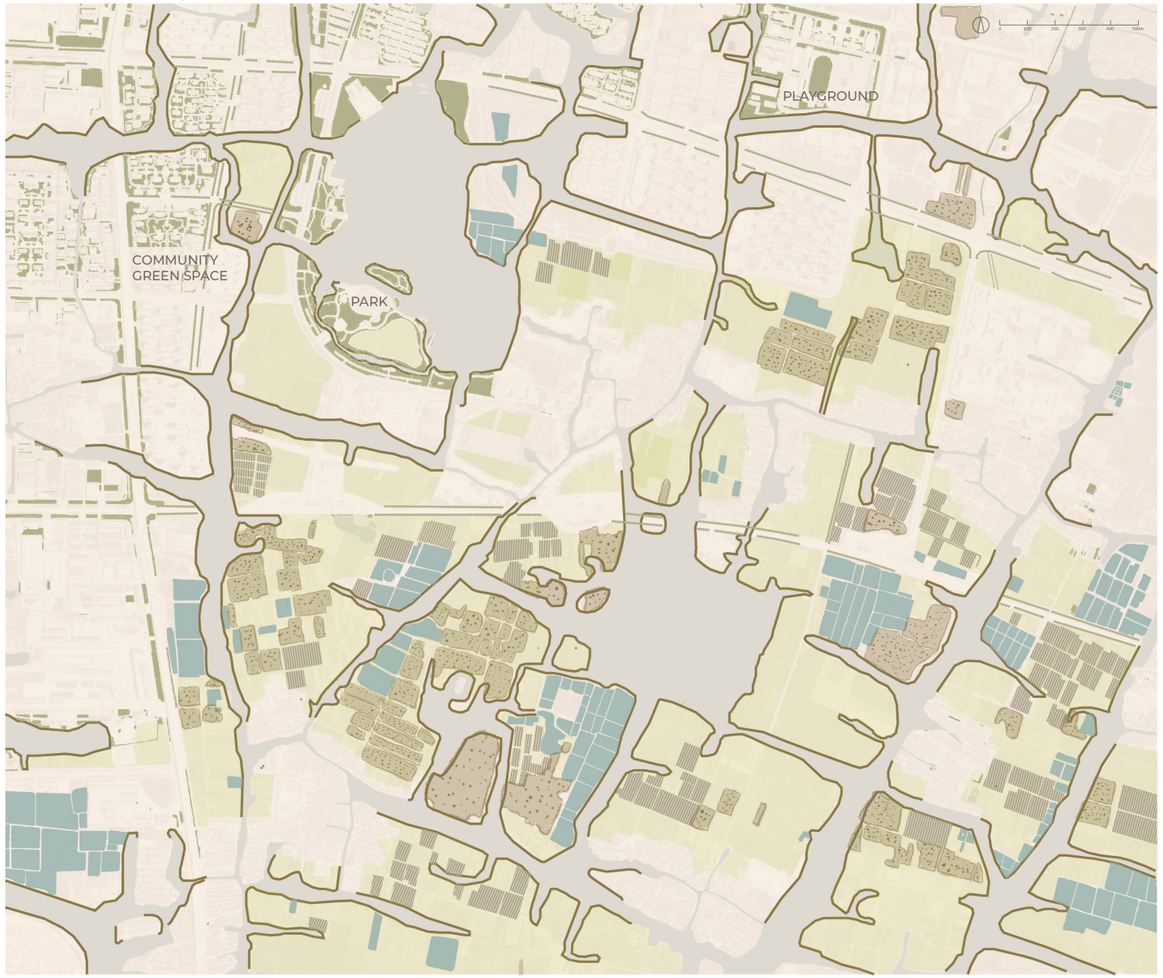


FIG4.10 Green structure of two lake area

planting bank
tree lines
fish pond
greenhouse
woods
cultivated field
city green space

FIG4.11 Rich agricultural types
Source: https://www.e0575.cn/read.php?tid=11465434

FIG4.12 Aquatic plants
Source: https://www.photophoto.cn/sucai/09578607.html

FIG4.12 Yangjing Lake park
Source: https://baike.baidu.com/item/%E5%88%99%E6%B0%B4%E7%89%8C%E6%9D%91r

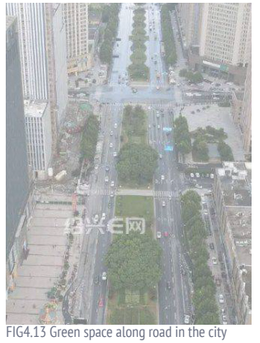


FIG4.13 Green space along road in the city
Source: https://www.sohu.com/a/489885432_121123888

The agriculture in this area is diverse. Fish ponds, woods, greenhouse agriculture and rice fields are scattered distributed. Because Yangjing Lake has been developed into a park, the surrounding vegetation are more abundant and has more biodiversity, so it becomes the core ecological environment of this area. There are still various agriculture distributes around Banze Lake, and its ecological benefits have not been developed. In the city, the green structure is basically street green and pieces of small green space scattered in the community. On the whole, there is no green structure that can connect urban green space and rural green space.

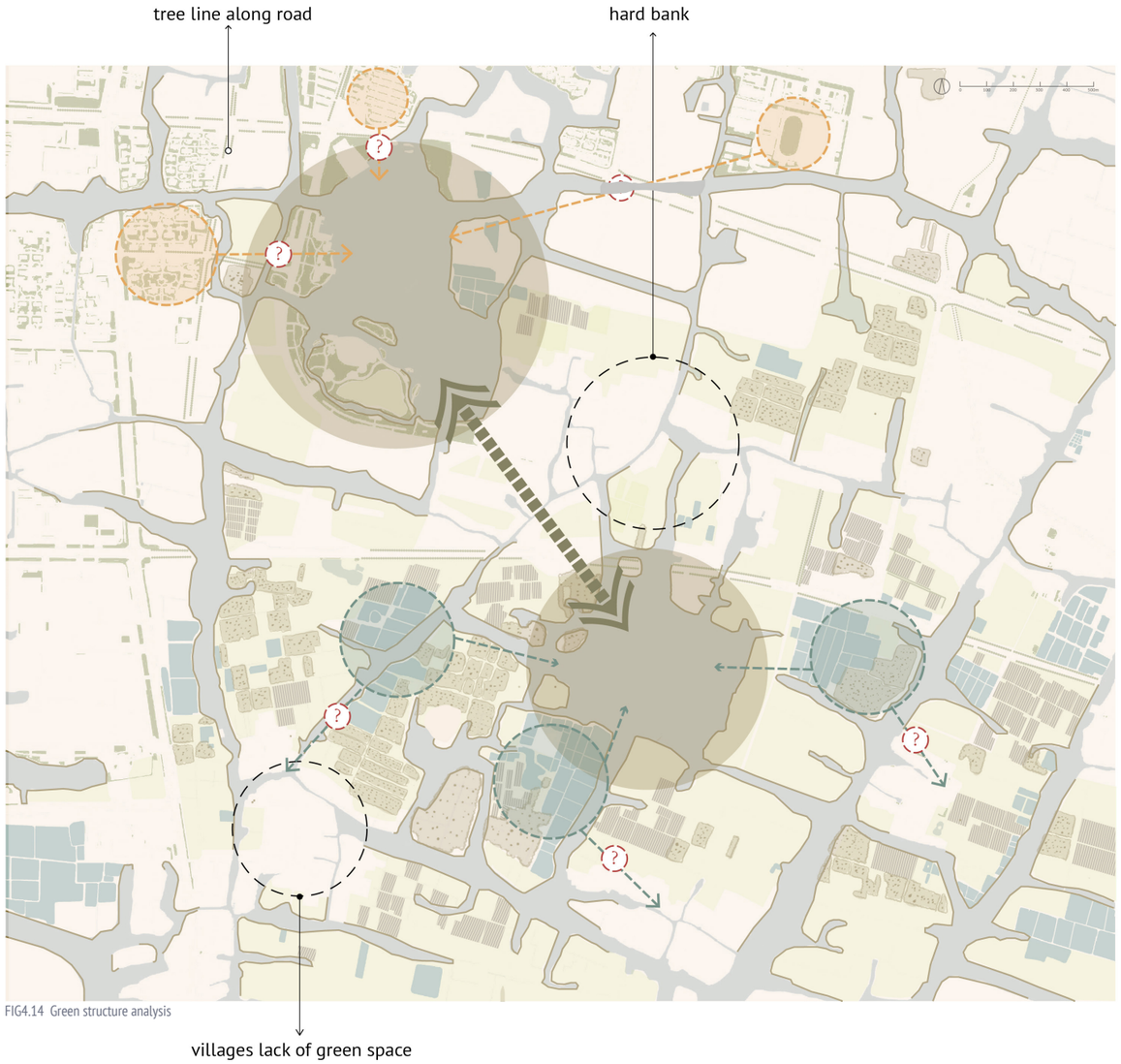


FIG4.14 Green structure analysis

Source: https://baijiahao.baidu.com/s?id=1664205560238399102&wfr=spider&for=pc

FIG4.15 fragmented green spaces in the city

Source: https://www.e0575.cn/read.php?tid=538119

FIG4.16 hard bank in the built-up area

Source: https://baike.baidu.com/item/%E5%88%99%E6%B0%B4%E7%89%8C%E6%9D%91

FIG4.17 crowded village

SCATTERED GREEN SPACES

The urban area and the park are mainly connected by roads rather than green structure. The green space scattered in the urban area and the various eclogical agriculture scattered in the countryside have the potential to be connected by the blue-green network based on the water network. The ecological potentials of banze lake is underestimated, the two lakes can be connected by creating green corridor between them .

HARD BANK

There are often very hard revetments on both sides of inland watercourses in cities or villages, which are not conducive to a healthy water ecological environment.

VILLAGES LACK OF GREEN

Athough the residential areas of the villages are not far from the green field, residential buildings are concentrated and dense, the streets are narrow and there are less green spaces. The living environment is not so plesant.

lake habitat

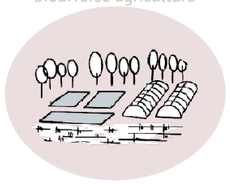
fish pond- wood ecosystem

community green space

4.3.2 Polder Grammar

PATTERN

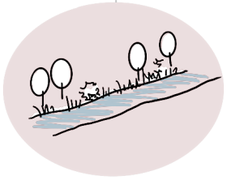
biodiverse agriculture



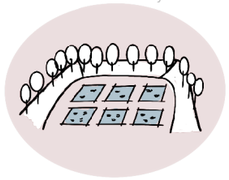
fish pond near the canal

ECOLOGY

local species



fish-orchard ecosystem



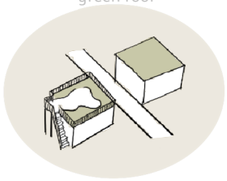
As mentioned above, diverse agriculture distribution is the basic characteristic of the green structure of this area. Most of the scattered fish ponds are located on low terrain and close to lakes or watercourse for water intake, and woods are often planted around the fish ponds, forming a kind of productive Organic agriculture, which is a sustainable agricultural model; some local aquatic plants are often planted on the banks of watercourse, and some local local tree and shrub species are often planted around villages and roads to improve the ecological environment.

greenway

wetlands

4.3.3 Design principles from case study

green roof



green courtyard

The Two-lake area lacks a green framework planning, so the case study adds a strategy 'Greenway' to build an green space system based on river channels. For the transformation of Banze Lake, the wetland strategy can make it play a huge ecological value, which benefits increasing ecological diversity of the region. For the improvement of the residential area of the village, the 'Green Alley' strategy gives an example of how to increase the green space when the space is limited.

4.4 BUILDING BLOCKS

4.4.1 Current building blocks

FIG4.18 Building blocks distribution and devlopment

FIG4.19 Modelization building blocks near Yanjing Lake Source: https://www.sohu.com/a/438042105_594400

FIG4.20 Traditional villages near Lake Huze Source: *https://www.e0575.cn/read.php?tid=11465434*

The traditional villages are scattered on the banks of the watercourse, and devloped along water, and the residential areas are connected by diverse stone bridges, forming a unique water town. The living environment is quiet and convenient. But the mordern urban planning lost connection with the polder structure, but divided by fuctional roads, lost the polder landscape.

The settlement pattern around Banze lake still has traditional polder settlement characteristics, but the surroundings of Yangjing Lake have already been highly urbanized, showing a compeletely diffrent pattern.

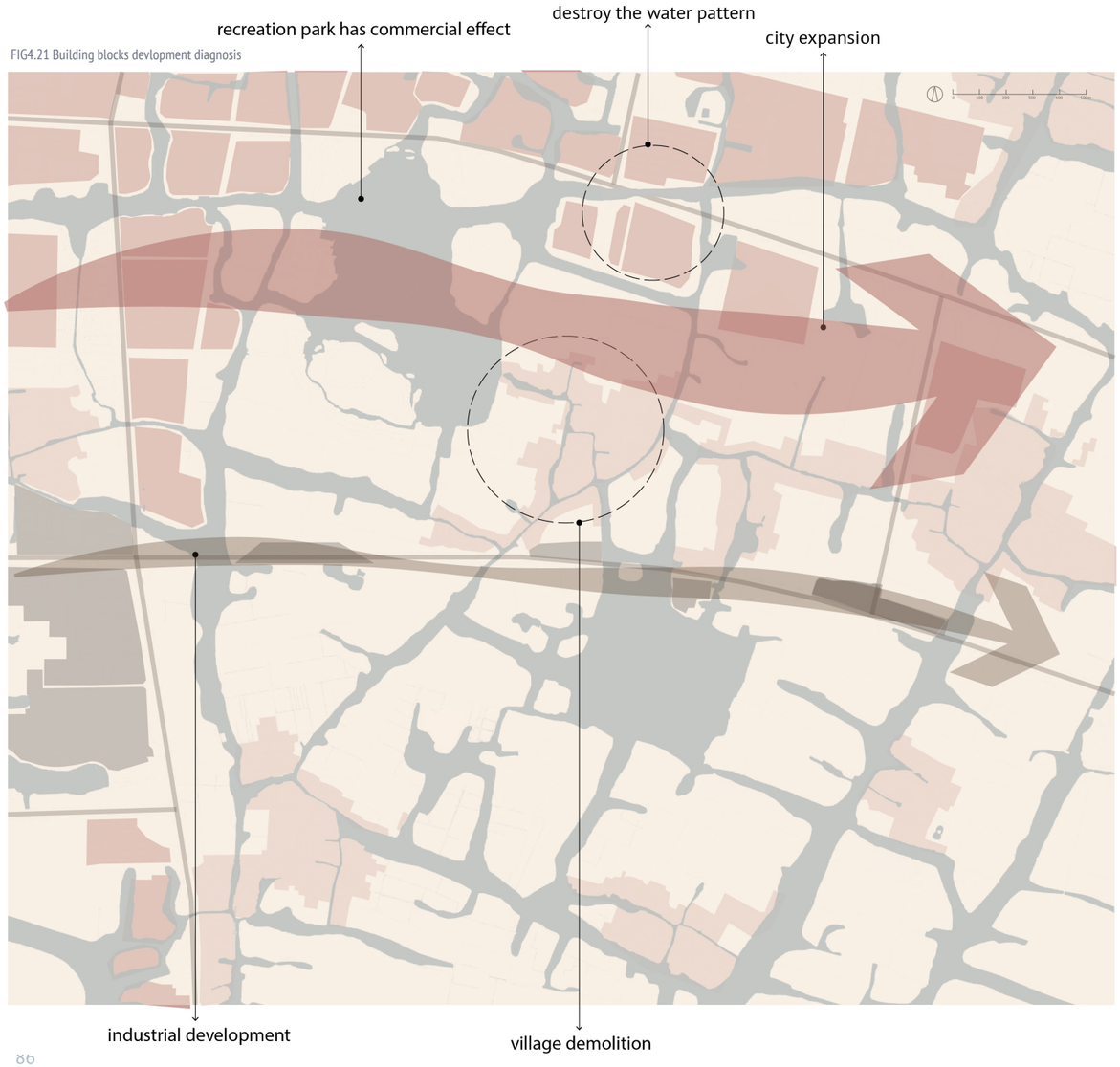


FIG4.21 Building blocks devlopment diagnosis

Source：https://www.sohu.com/a/542760975_121123888

FIG4.22 demolished villages

Source：http://bbs.epday.com/forum.php?mod=viewthread&tid=78344&extra=page=1

FIG4.23 waterfront industrial area

Source：https://news.lianjia.com/sx/xiaoqu/870912976110729 5.html

FIG4.24 modern community in the city

INCREASING HOUSING NEED

With the rapid growth of the urban population, the demand for housing is also growing fast. In particular, Yangjing Lake has been developed into a beautiful recreation park, which has raised the surrounding land prices and attracted many estate developers to develop new commercial residences around. Therefore, many villages around were demolished.

INDUSTRIAL AREA BECOME AN INTERFACE BARRIER

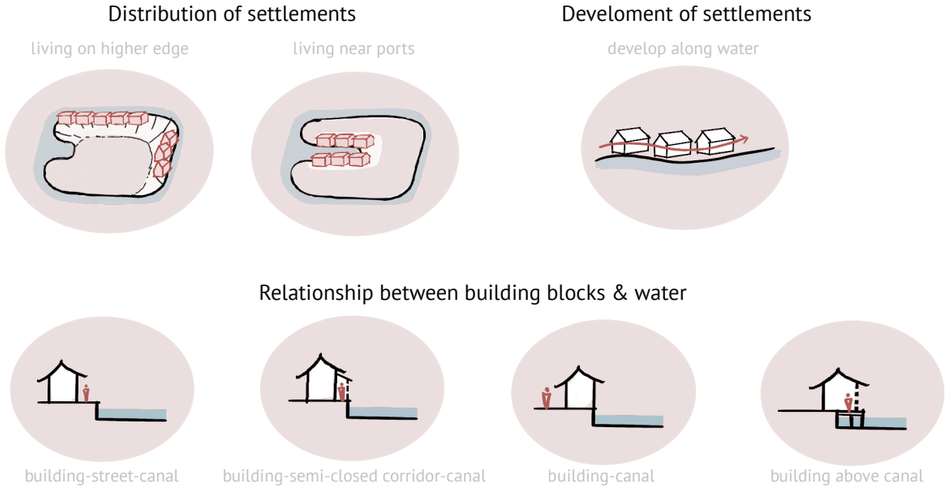
The industrial area lying between the residential area and the watercourse or water body becomes an barrier between the built-up area and the natural landscape.

LOST CONNECTION WITH WATER

The main street of the newly built community is no longer set along the watercourse like traditional villages, and the residents have lost the connection with the surrounding water. The living environment is very different from traditional polder settlements.

traditional village
dense residential
industrial area
main road

4.4.2 Polder Grammar



Most of the settlements in this area belong to the port settlement type or the dike settlement type, so they are mostly distributed around the port or on the dike of the polder. The settlement usually develop along the watercourse, sometimes extending the water from the port to form a new inner watercourse finnally. The water-facing side of the building may become the main street of the village, or there may be no street, directly closed to the water, or a part of the extended building is supported on the water with pillars. There are various ways for the building facing the water.

Source: https://baijiahao.baidu.com/s?id=1732973014209471036&wfr=spider&for=pc
FIG4.25 buildinng-street-canal type

Source: https://baijiahao.baidu.com/s?id=1697555040175589415&wfr=spider&for=pc
FIG4.26 canal-building type

FIG4.27 building-semi-cloed corridor-canal type
Source: https://www.meipian.cn/23h98bqb

FIG4.28 building above water
Source: https://www.meipian.cn/19qzlyib

4.5 PUBLIC SPACE

4.5.1 Current public space analysis

FIG4.29 Public space diagnosis

SCATTERED PUBLIC SPACE

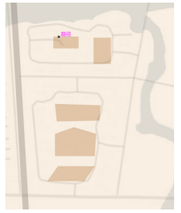
The public spaces are scattered in this area.The public space in the villages, urban public space and the largest park in the region can be all connected by waterways to form a regional recreation network.

COMMUNITY PUBLIC SPACE FAR AWAY FROM WATER

In the newly built community, in order to be more accessible for all the residents of ommunity, the public spaces are often in the center of the community, which is integrating green space, recreation and social functions. People's activities have less connection with the watercourse surrounding the community .

VILLAGES LACK OF HIGH QUALITY PUBLIC SPACE

Compared with cities, the public spaces in the countryside are scattered in the villages, and most of them are close to the waterfront, mostly piers or parking spaces. People rarely stay here, and water-related activities are limited to boating and washing things. Not a dynamic public space.



concentrated
keep distance with water

scattered
waterfront

Source: https://www.photophoto.cn/pic/27866289.html

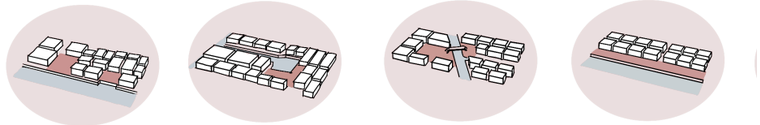
FIG4.30 community public space

FIG4.31 waterfront public space in the past

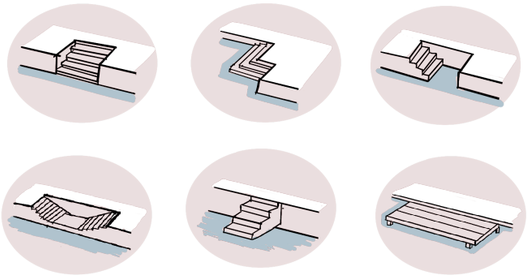
Source: https://www.sohu.com/a/438042105_594400

4.5.2 Polder Grammar

WATERFRONT PUBLIC SPACE

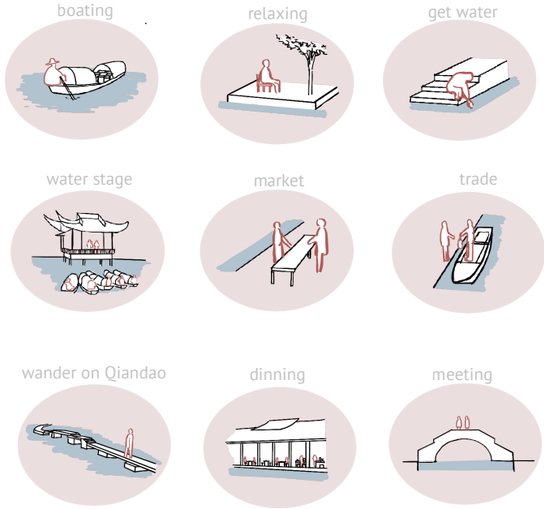


INTERFACE FORM



There are several ways of public space by the water. There is one type that a whole commercial street by the water; there are also a type that some small squares by the water; the space near a pier is also often formed a small public space; as the bridge is often the place where people meet each other, it often becomes a public place for market transactions. As many water channels are narrow, the pier is not necessarily large, and it is only a few steps sometimes. This kind of interface for boating also has many forms.

WATER-RELATED ACTIVITIES



In the past, people had a lot of water-related activities. Entertainment, trading, social interaction, relaxing, and transportation were all carried out by the water. Today, activities such as traditional dramas on the water stage have become intangible cultural heritage. The Qiandao built for boaters to pull boats have been a cultural heritage of walking on water. There is large potentials to add some interventions in public spaces to make these activities happen again and rejuvanate the waterfront public spaces.

4.6 TANSPORTATION

4.6.1 Current transportation analysis

The roads connecting the urban area and industrial area, but the villages are mainly connected by waterways.

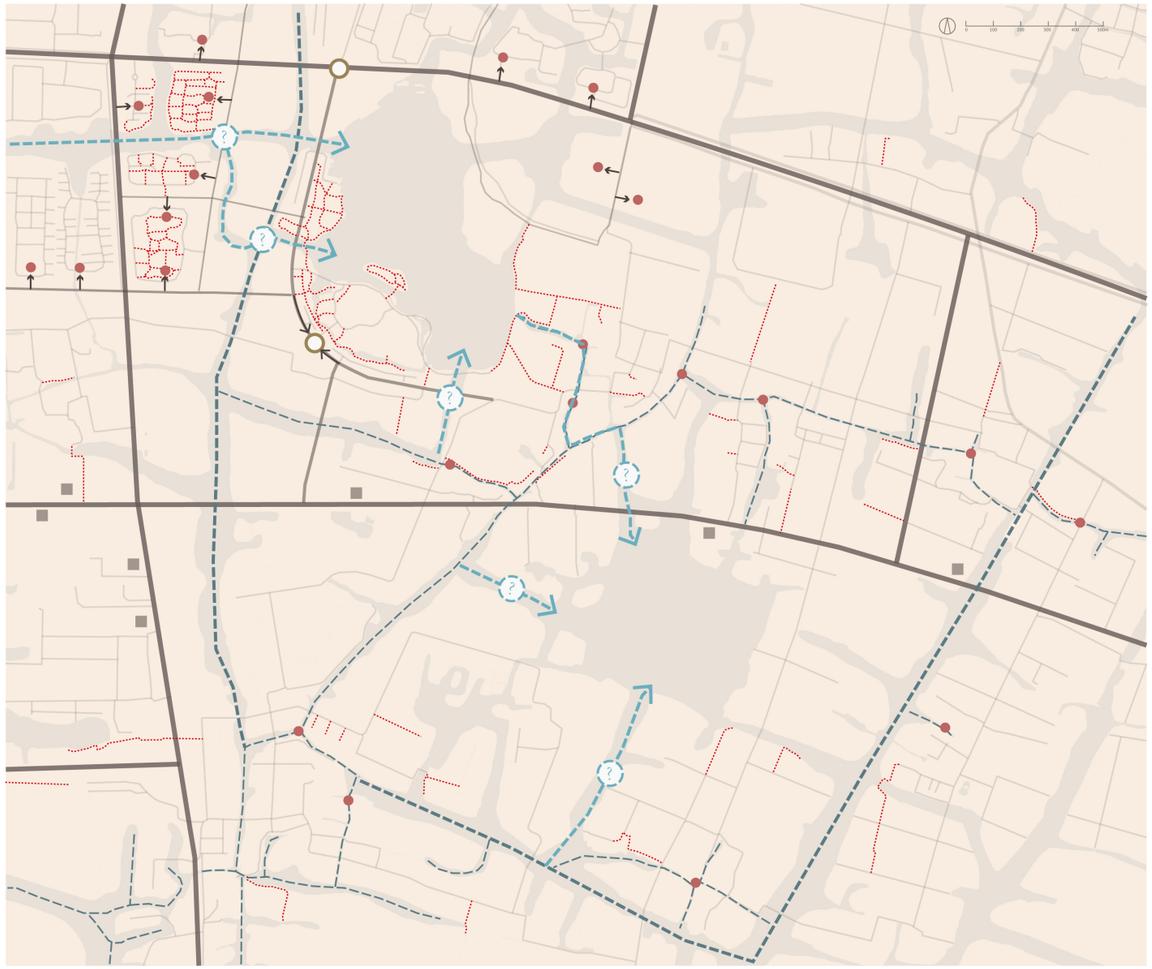


FIG4.32 Tranportation diagnosis

MULTI-MODEL ACCESSIBILITY NEEDS

The modernized area requires public transportation, and more modes of transportation are accessible. As a new urban area in Shaoxing, the subway lines have been on the government's schedule.

ROADS REPLACED THE WATERWAY

The city road directly crosses the water, which greatly improves the traffic efficiency, so the function of the waterway is largely replaced, but at the same time, the road also greatly destroys the structure of the traditional polder landscape. Some water systems were partially cut off and changed to the underground, and some waterways were even buried directly.

LACK OF HIGH-QUALTY SLOW ROUTE

There are no continuous high-quality walking routes between public spaces, landscapes and residential areas. There is also no waterway route planning and stop docks, so people cannot directly take a boat to travel around this area. The area is very lack of slow travel routes.

FIG4.33 Road above water
Source: *Jing Hu. (n.d.). Shaoxing Jing Hu Wetland Park Masterplan.*

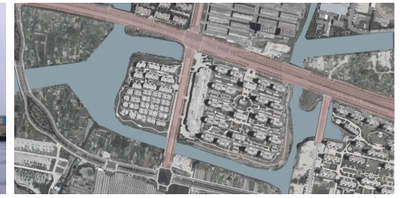


FIG4.34 Road cut the watercourse
Based on *Google Earth*

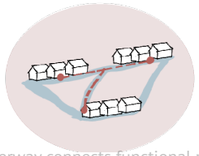
FIG4.35 low-quality walking path
Source: *https://baijiahao.baidu.com/s?id=1685476905239126121&wfr=spider&for=pc*

Main road
Secondary road
Tertiary road
Walking road

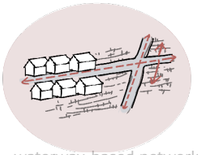
Settlements
Industry
Park entrance

Main fairway
Minor fairway

4.6.2 Polder Grammar



waterway connects functional places



waterway-based network

In the past, between villages, residential areas and working areas were all connected by waterways. Waterways are the most convenient transport way that time . The places where various functions are connected by waterways are the fundamental driving force for people to use waterways.

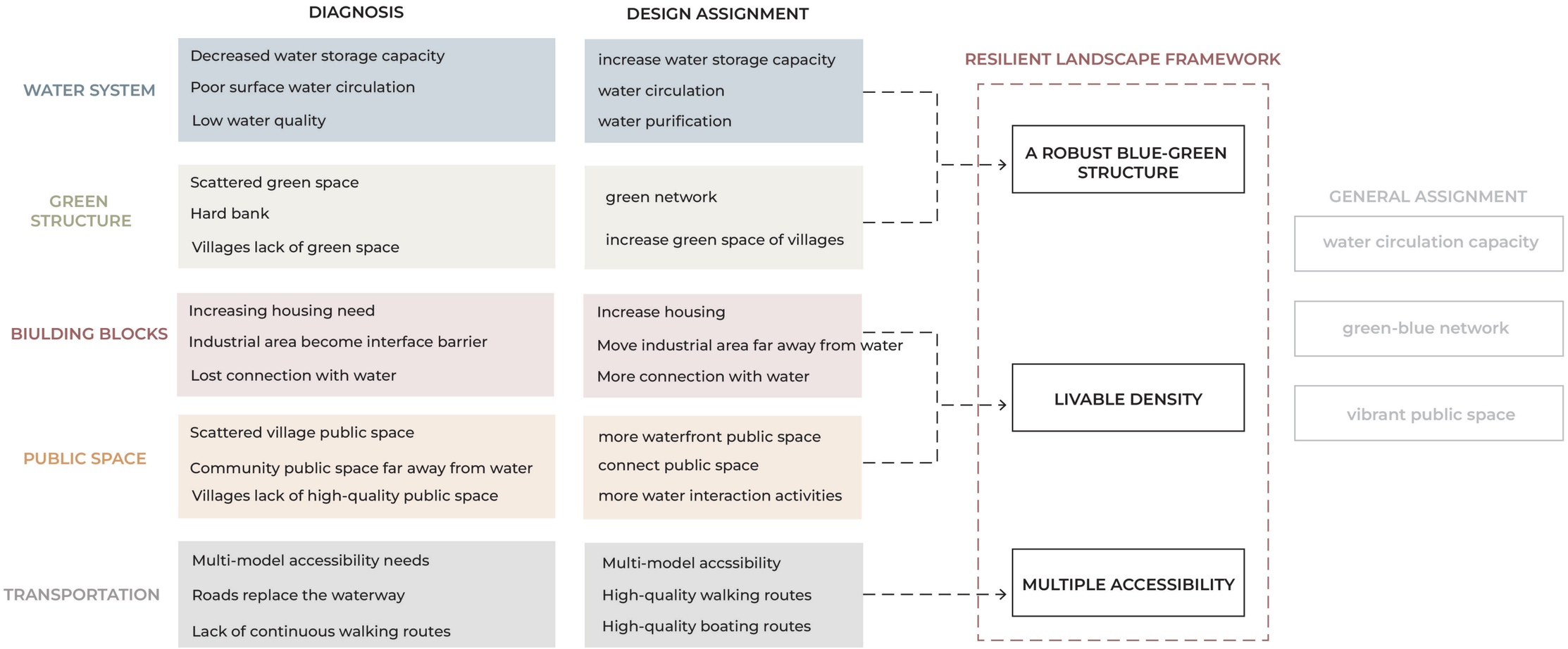
4.6.3 Design principles from case study

high-quality walking routes along water

Greenway strategy provides an example of a slow-moving system that develops along waterways.

4.7 DIAGONOSIS

Combined with the specific diagnosis of the five layers, the more specific design assignments are obtained. Compared with the previous general design assignments. The landscape framework on this scale can be concluded to three layers, which are the combination of water and green to create a robust green- blue network, building blocks and public space combine to create livable density, and multiple accessibility from transportation aspect.



4.8 CONCLUSION

As the the analysis in this chapter is from fiver aspects, the result of polder grammar also ragarding to this five aspects: water system, green structure, building blocks, public space and transportation. These ' polder grammar' will be the guiding design principles in the design exploration part. However, there some problems in the diagnosis that polder grammar are unable to solve, so there are also some strategies or principles supplemented from three case studies,which all related to the resilience theory, and these principles can also be classified according to the above five aspects.

POLDER GRAMMAR

water form

water management

WATER SYSTEM

pattern

ecology

GREEN STRUCTURE

distribution

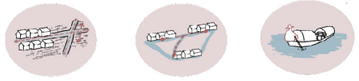
waterfront building form

BIULDING BLOCKS

waterfront public space

water-related activities

PUBLIC SPACE



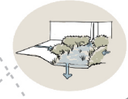
TRANSPORTATION

CASE STUDY

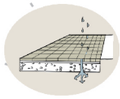
GREENWAY

Bayou Greenways 2020 is creating a continuous park system along Houston's major waterways. It's a good reference of constructing multifunction networks along the water(Bayou Greenway, n.d.).

GREEN ALLEY



The Green Alley Program looks at more sustainable solutions to environmental problems in the city like flooding issues, but not only solves a persistent problem, it also provides an environmental benefit by cleaning and recharging the ground water(Richard M. & Thomas G. 2010).



WETLAND

The project uses the existing natural resources to further create more diverse open public spaces and natural landscapes, and increase biodiversity, giving new vitality to the area and providing a strong ecological service function for Shaoxing (Jing Hu. n.d.).

RESILIENCE THEORY

NETWORKS

REDUNDANCY

BIO/ SOCIO DIVERSITY

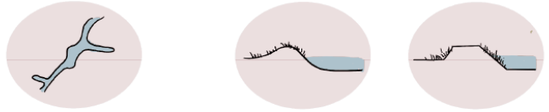
MULTIFUNCTION

ADAPTIVE DESIGN

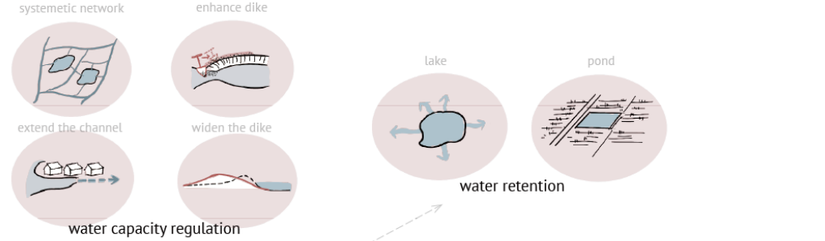
DESIGN PRINCIPLES

WATER SYSTEM

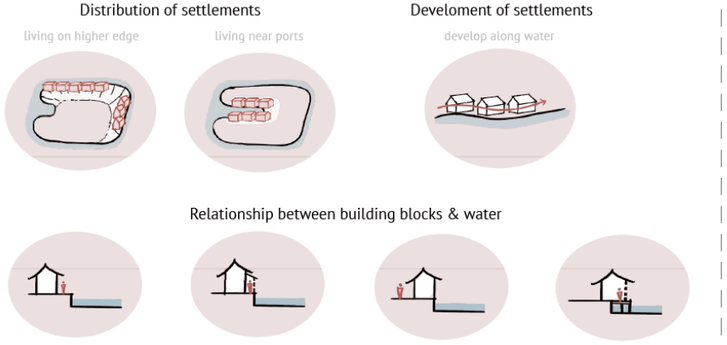
Water structure form



Water management



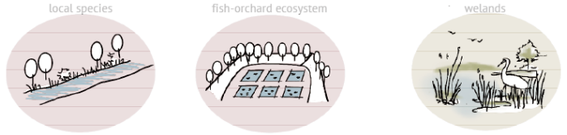
BUILDING BLOCKS



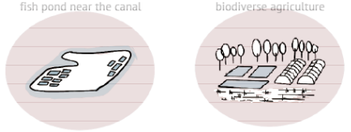
In summary, through the analysis of polder grammar and case study this project finnaly has a toolbox of design principles directed by polder grammar and can be divided into five categories. In the design exploration part, which principles are suitable to be selected in specific locations from toolbox largely depends on the which aspects of the five that specific design assignments invloved.

GREEN STRUCTURE

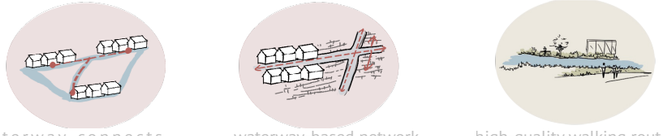
Ecosystem



Pattern

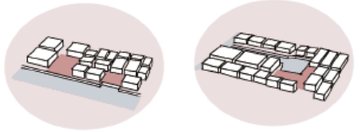


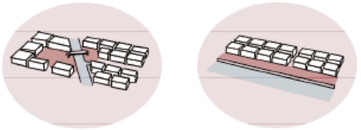
TRANSPORTATION



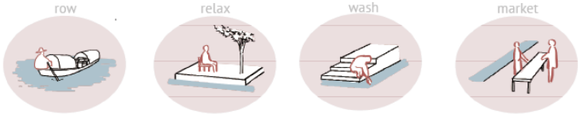
PUBLIC SPACE

public space distribution





waterfront activities



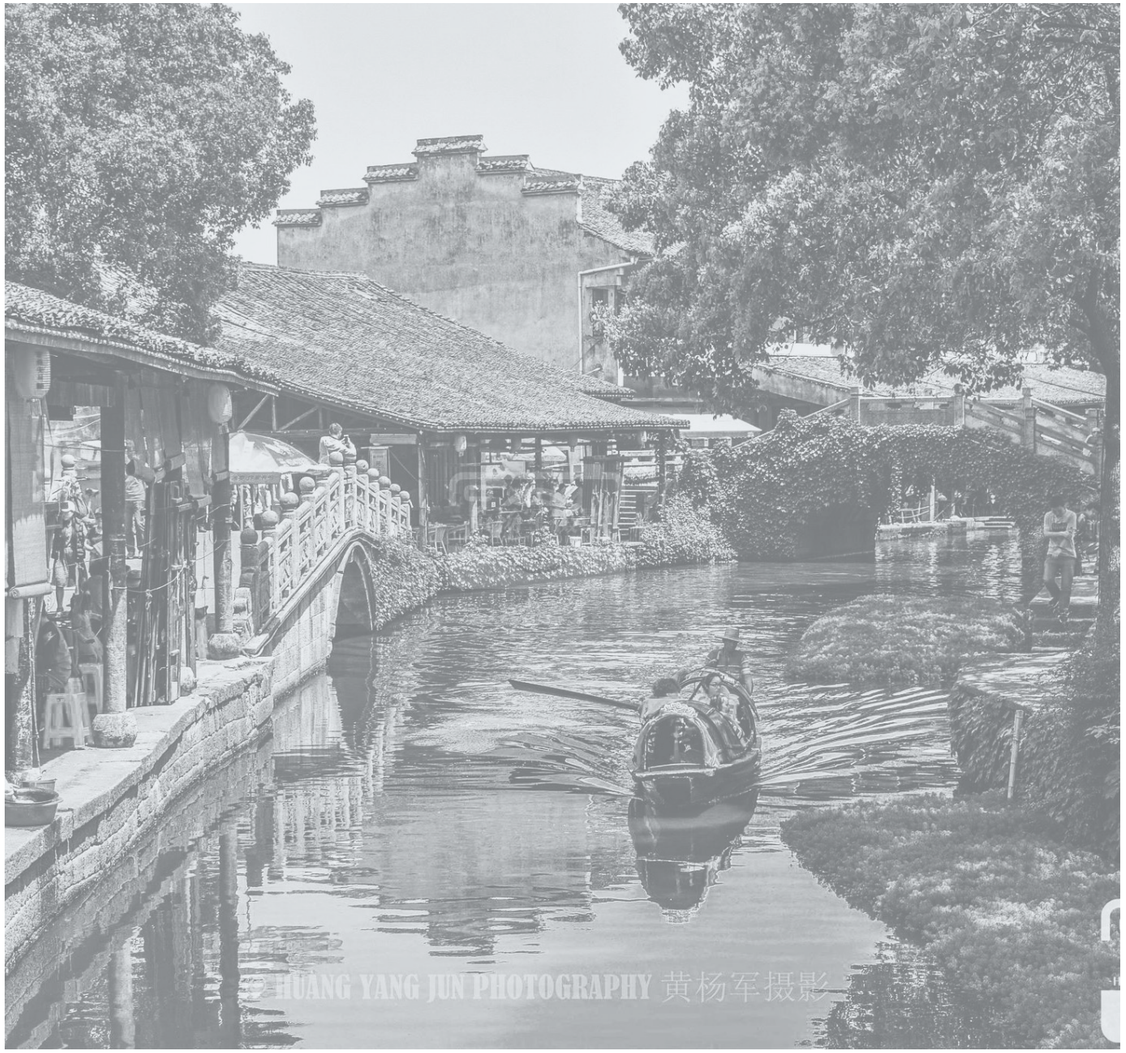


FIG5.1 traditional water town
Source: https://n.sinaimg.cn/sinacn10121/215/w2048h1367/20191103/486e-ihuuxuu4715613.jpg

05

DESIGN EXPLORATION IN TWO-LAKE AREA

In this chapter, I will explore how to the principles and strategies from the polder grammar and case study to the Two-Lake area to build the resilient landscape framework, and select three locations to elaborate the application on loacal scale and eye-levels.

5.1 SPATIAL STRATEGY

The main spatial strategy is building the resilient landscape framework from three layers, each of which has its assignment as the response to the diagnosis in the last chapter.

FIG5.2 spatial strategy concept

A ROBUST BLUE -GREEN SYSTEM

A system with more resilient water system and ecosystem to cope with environmental challenges.

1. build green corridor
2. transform the lake to wetland
3. expand woods area
4. increase channel capacity
5. divert water to the community

LIVABLE DENSITY

Enough housing with an appropriate density with pleasant public space.

6. increase housing
7. increase waterfront public space
8. improve community public space

MULTIPLE ACCESSIBILITY

A transportation network that can meet both high-speed traffic and high-quality slow travel.

9. road redesign
10. connect public space
11. mutiple routes design

GENERAL PLAN FOR LANDSCAPE FRAMEWORK

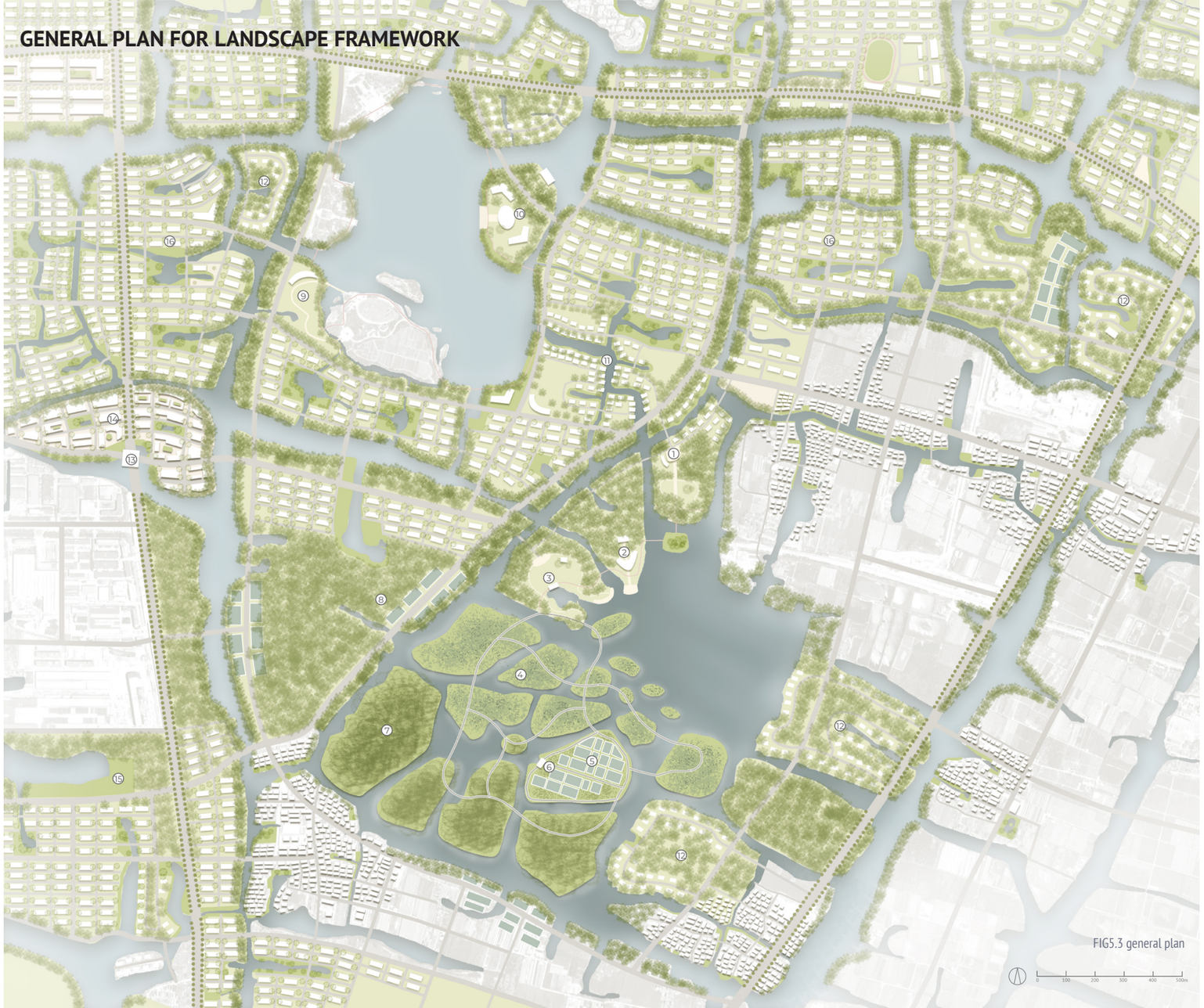


FIG5.3 general plan

1. Wetland park entrance square
2. Wetland park visitor center
3. Wetland park port
4. Wetland area
5. Educational fish-pond reserve
6. Wetland education center
7. Forest reserve area
8. Ecological agriculture
9. City park entrance, sport area
10. Recreation center
11. Commercial water town
12. Ecological community
13. Transportation hub
14. Central business district
15. Community park
16. Residential Community

- City main road
- Secondary road
- Tertiary road
- Neiborhood road

The general plan creates a resilient landscape framework by three-layers structure, which retains the key elements and essential features of the polder landscape to protect the protect identity, also provides local residents with a high-quality living environment and a recreation system, and improves the local ecological environment, increase biodiversity, and enable the site to cope with water safety issues and urbanization development in the future resiliently. The plan will be explained layer by layer more elaborately.

5.2 RESILIENT LANDSCAPE FRAMEWORK

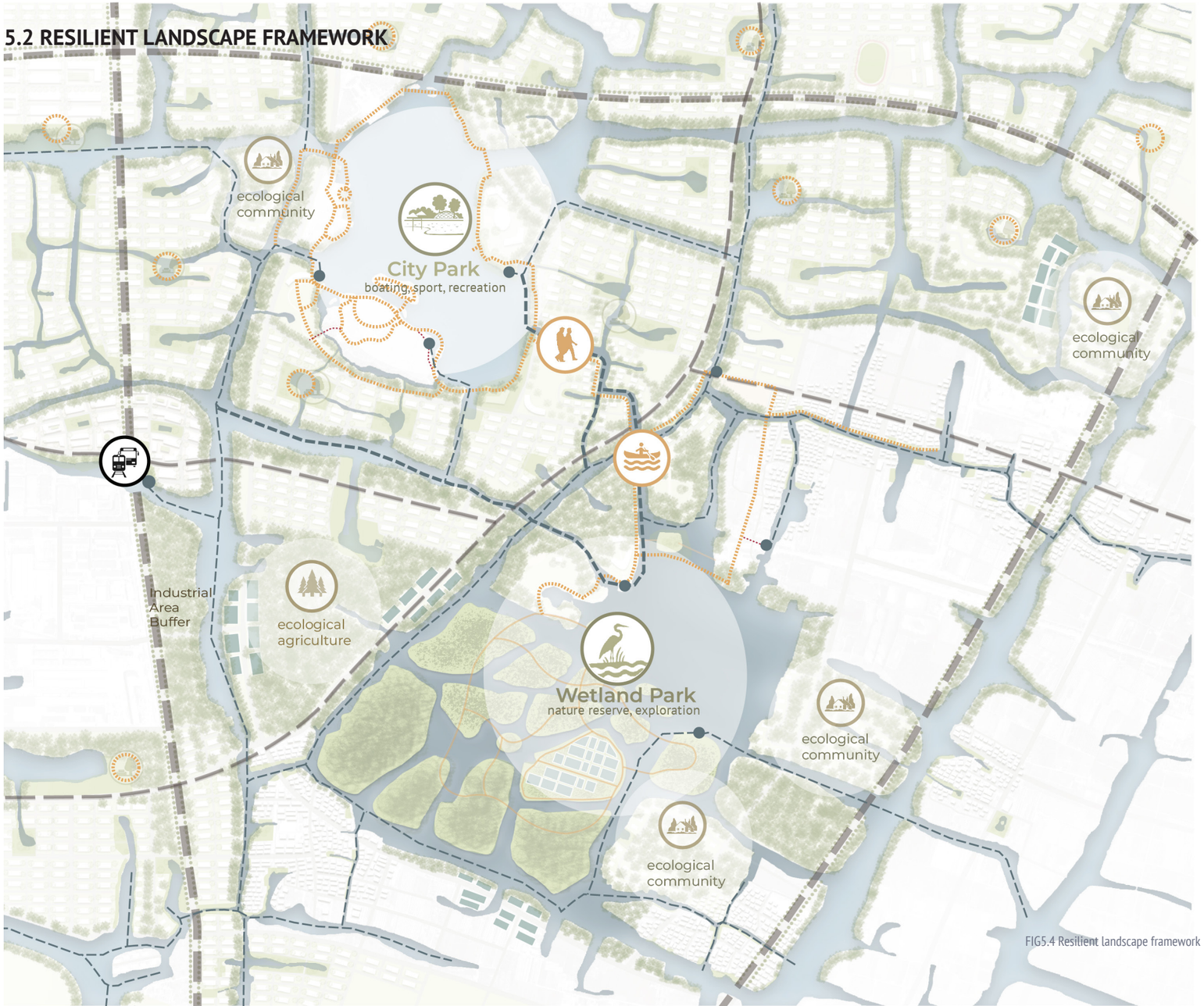


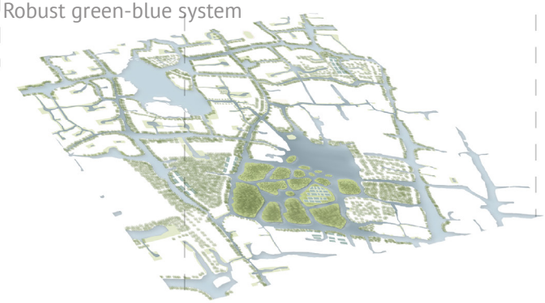
FIG5.4 Resilient landscape framework

FIG5.5 three layers of the landscape framework

Multiple-accessibility

Livable density

Robust green-blue system



The framework takes polder landscape structure as the basis, highlight the lagoon and watercourse network to create a more robust green-blue system, then livable density and multiple accessibility adds more potentials and social functions for this area. In conclusion, the framework protects the cultural value of the polder landscape, and add ecological and social value at the same time.

5.2.1 Robust green-blue system

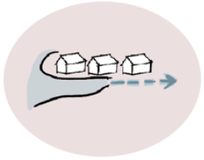
A robust green-blue system means a ecological system which is more resilient to environmental challenges like water safety issues. It is established on the basis of the existing water system to increase the space for water storage, support water circulation, biodiversity, pedestrian routes and connecting public space. The strategies related to water system and green structure in the polder grammar guide the planning of this layer.

FIG5.6 robust green-blue system layer interpretation

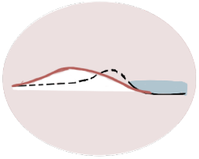
WATER STRATEGIES

The most important landscape elements in the two lake areas are the Lagoon and the dense water network. The lagoon closed to the city has been transformed into an urban park with recreational functions, and the other lake, which is still dominated by agricultural irrigation function, the design proposal is to transformed this lake into an ecological wetland, so that It becomes a more resilient water storage space for this area, and at the same time, it can improve the regional water quality through the purification plants in the wetland, and also add new regional public space.In order to increase the capacity of the watercourse network, the main strategy is using the water management strategy from polder grammar, which is extending the canal along with settlements or widening the dikes.

wetland



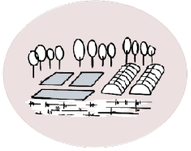
extend the canal



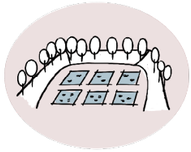
widen the dike

GREEEN STRATEGIES

The main green strategy is to respect the main feature of the green structure, which is the biodiverse pattern, formed by woods, fish ponds, rice fields, etc. On this basis, maximizing their ecological value of them, like expanding the existing woods area, and rebuilding the traditional ecological-benefit agricultural model, which is to combine woods with fish ponds. The natural bank along the water network can be used to create a green corridor to connect various green spaces, which is more resilient to benefit the regional flora and fauna and also can create a high-quality waterfront environment and public space for residents.



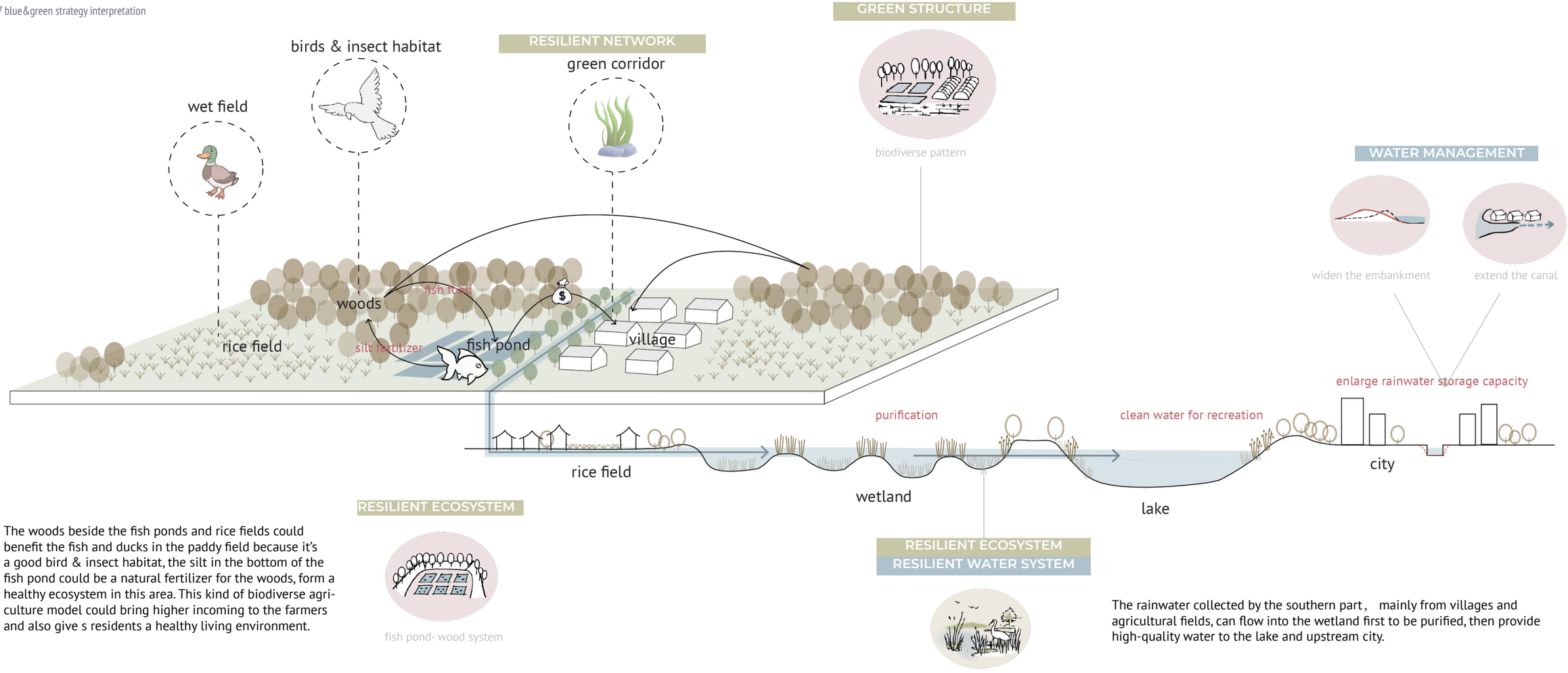
biodiverse pattern



fish pond-wood ecosystem

greenway

FIG5.7 blue&green strategy interpretation



The woods beside the fish ponds and rice fields could benefit the fish and ducks in the paddy field because it's a good bird & insect habitat, the silt in the bottom of the fish pond could be a natural fertilizer for the woods, form a healthy ecosystem in this area. This kind of biodiverse agriculture model could bring higher incoming to the farmers and also give s residents a healthy living environment.

The rainwater collected by the southern part , mainly from villages and agricultural fields, can flow into the wetland first to be purified, then provide high-quality water to the lake and upstream city.

5.2.2 Livable density

Livable density means with a appropriate building blocks density with high quality living environment. The main idea is to move the industrial area to an area with convenient transportation but far from the water, plan diverse types of waterfront buildings with vibrant waterfront public spaces by building blocks and public space strategies from the polder grammar.

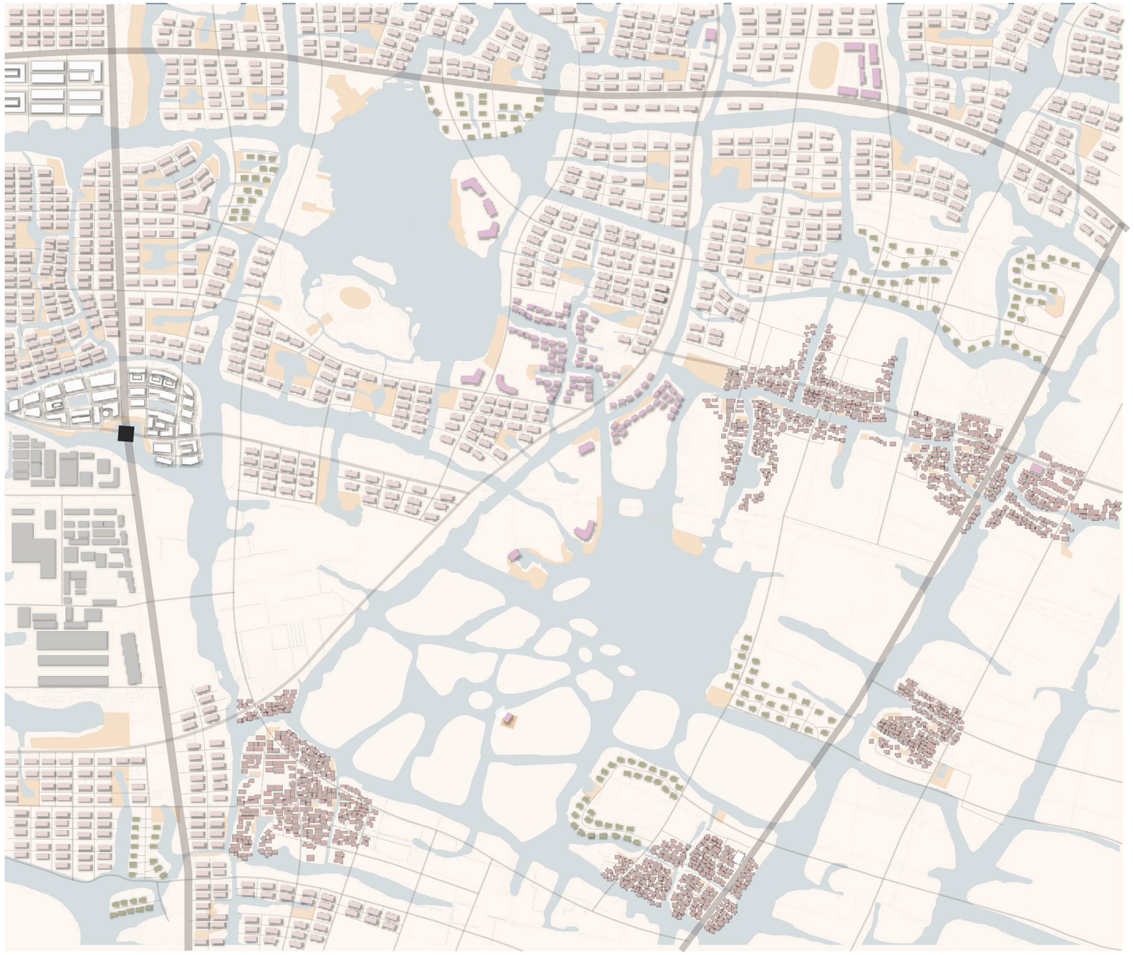
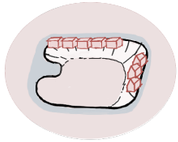


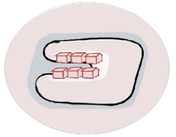
FIG5.8 livable density layer

BUILDING BLOCKS STRATEGIES

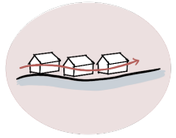
According to building blocks layer analysis, different from planning with the road, the new housing was planned following the logic of traditional settlements, along the water. And more types of waterfront housing are introduced for different areas. Mix-used housing around transport hubs, low-density housing in the more ecological areas, etc.



living on higher edge



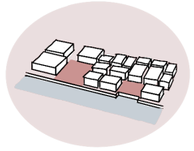
living near ports



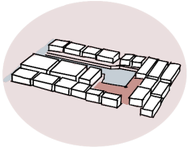
develop along water

PUBLIC SPACE STRATEGIES

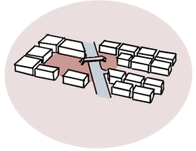
The livable density means holding enough high-quality public spaces among built-up are. According to the traditional public space types, the new public spaces in the dense residence area are all waterfront in different forms.



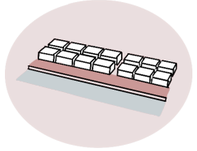
pocket waterfront square



square around port



square near bridge



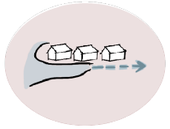
street along water

LIVING ENVIRONMENT TYPOLOGIES

FIG5.9 building with diverse waterfront public space typologies

middle-rise community

pic refence：https://www.cgmodel.com/model/220362.



extend the canal to the community

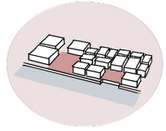
square near bridge

Like traditional settlements developing along the water, extending the canal to the community to create waterfront residential building, and add public space around the bridge.

dense village

pic refence：https://a.app.qq.com/o/simple.

plants alone water

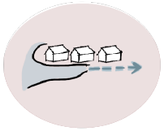


pocket public space

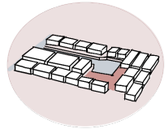
As space in dense villages is limited, so improving the village public space quality by adding more green space along the water to connect scattered pocket public spaces.

low density ecological community

pic refence：https://www.pena-architecture.com/wp-content/gallery/eco-villas/eco-005.jpghtmlhtml



extend the canal to the community

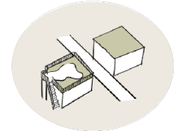


square around port

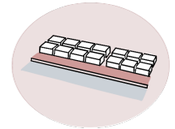
The ecological community also apply extending the canal along with the residential area methods to create a more biodiverse living environment and adds public space around the port.

high-rise mix-used area

pic refence：https://www.designboom.com/architecture/oda-new-york-bayshore-proposal-lakeshore-toronto-03-17-2016/htmlhtml



green roof



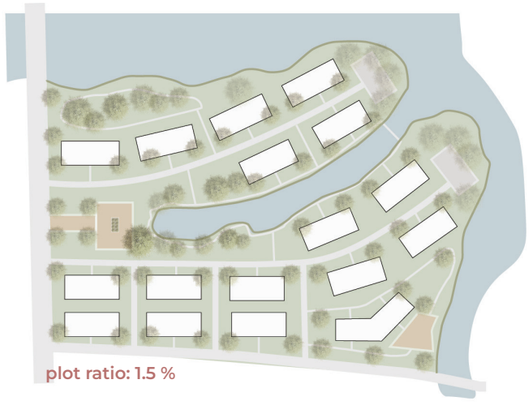
street along water

High-rise areas apply a more resilient way, which is adding green space on the building roof. Streets along with water could be developed into a mix-used public space.

FIG5.10 building with diverse density typologies

1) Mid-rise community

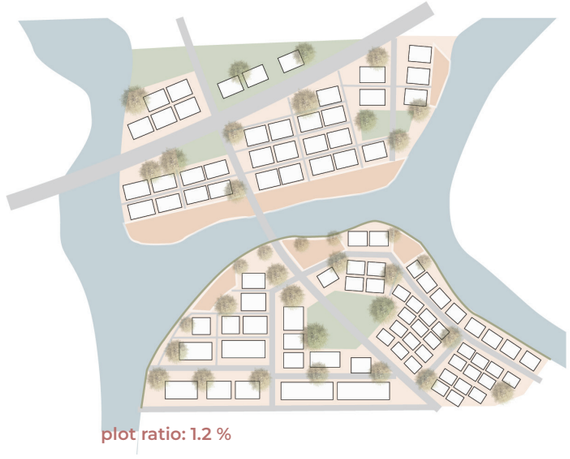
Most of the newly added housing are middle-rise with livable density residential types, and the introduced watercourse is the central public space and green space of the whole community. Most places except for roads can be improved into biodiverse green spaces.



plot ratio: 1.5 %

2) Dense village

The living environment of the village is the most traditional, but the building distribution is relatively compact and the public space is limited. The scattered green space between dense buildings could be developed into new public spaces. Scattered pocket public spaces in the village are more adaptive to the village conditions. The green network could connect these scattered public spaces to a recreational system.

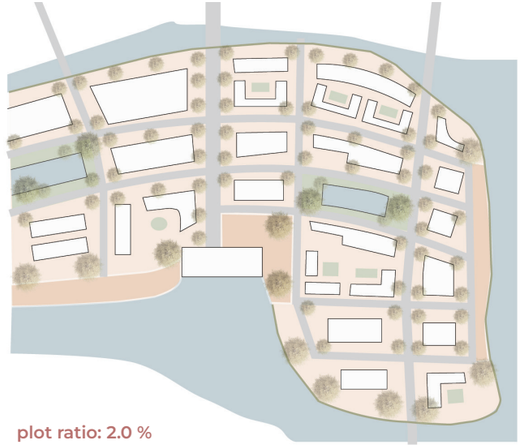


plot ratio: 1.2 %

plot ratio: 0.5 %

3) Low-rise ecological community

The ecological community has the lowest living density and the best ecological environment. Low-rise buildings are scattered among the woods, and most of the buildings are built near the water with their own private waterfront space, the public space situated near the port.



plot ratio: 2.0 %

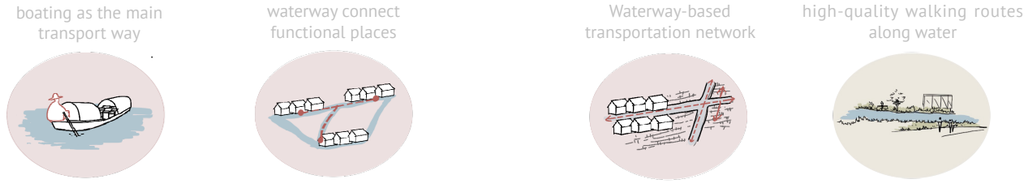
4) High-rise mix-used building

High-rise buildings are concentrated near the transportation hub, which is the place with the highest building density in this area. Most of the buildings here are mix-used with commercial, residential, office, and other building types. By setting up waterfront streets, a water square between the buildings, and tree lines along roads, green public spaces are added to this place to create a livable environment.

5.2.3 Multiple accessibility

Multiple accessibility means there are both high-speed route and high-quality slow travel routes to meet econmic development and recreation needs. The main idea is on the basis of transportation strategies from polder grammar, to rearrange the road system to make it accessible without too much disruption to the continuity of the landscape while adding high-quality slow-travel networks such as boating routes and high-quality pedestrian routes for the area.

FIG5.11 Multiple accessibility layer



ACCESSIBILITY STRATEGIES

The accessibility strategy is to make the waterway the backbone of the transport network, connecting transportation hub, public spaces, and residential areas, Boating routes design and adding pier and dock allow people to travel this area by boat. The road design follows the shape of water, to meet the modern speed needs, while not destroying the structure of the water. Developing high-quality walking routes along the water, especially between public spaces, provides people with more accessibility way.

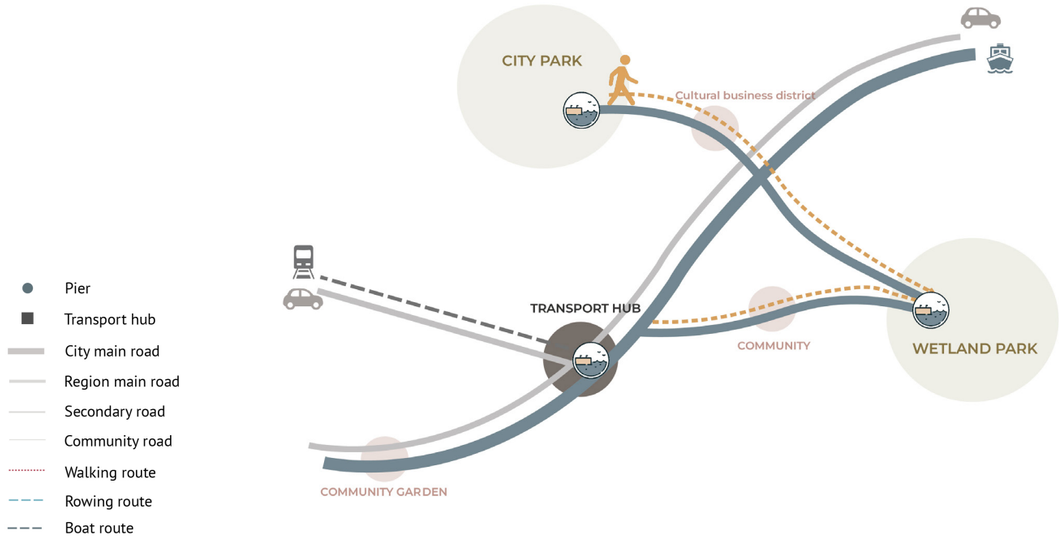


FIG5.12 Accessibility strategies interpretation

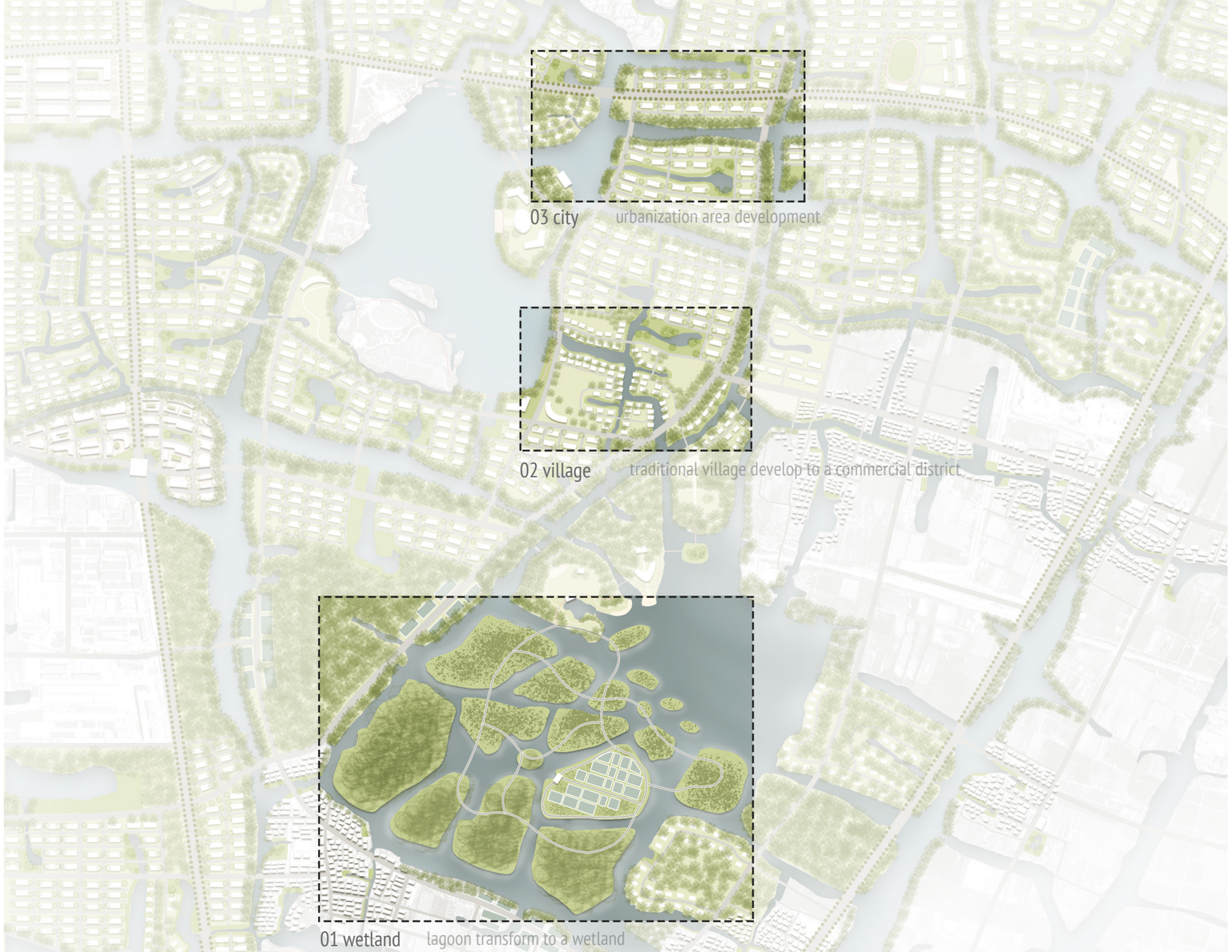


FIG5.13 Three zoomed-in detail places

In the following, three zoomed-in examples will be used to illustrate how the above design strategies and design principles are applied at the local scale and eye level. The three areas are the transformation of the lagoon into wetland, the upgrade of traditional villages, and the city area development.

5.3 EXAMPLE OF A WETLAND DEVELOPMENT

5.3.1 DESIGN ASSIGNMENTS

FIG5.14 Current situation of Banze Lake (from Google Earth)

According to the previous analysis, Banze Lake is surrounded by various agricultural types like fish ponds, rice fields and woods. At present, its main function is to store water for agricultural irrigation, but facing the challenge of shrinking. In order to develop the potentials of the lagoon, taking advantage of the low terrain around the lake, transforming it into a wetland, and maximizing the ecological and recreational value of the surrounding agriculture are the main design tasks.

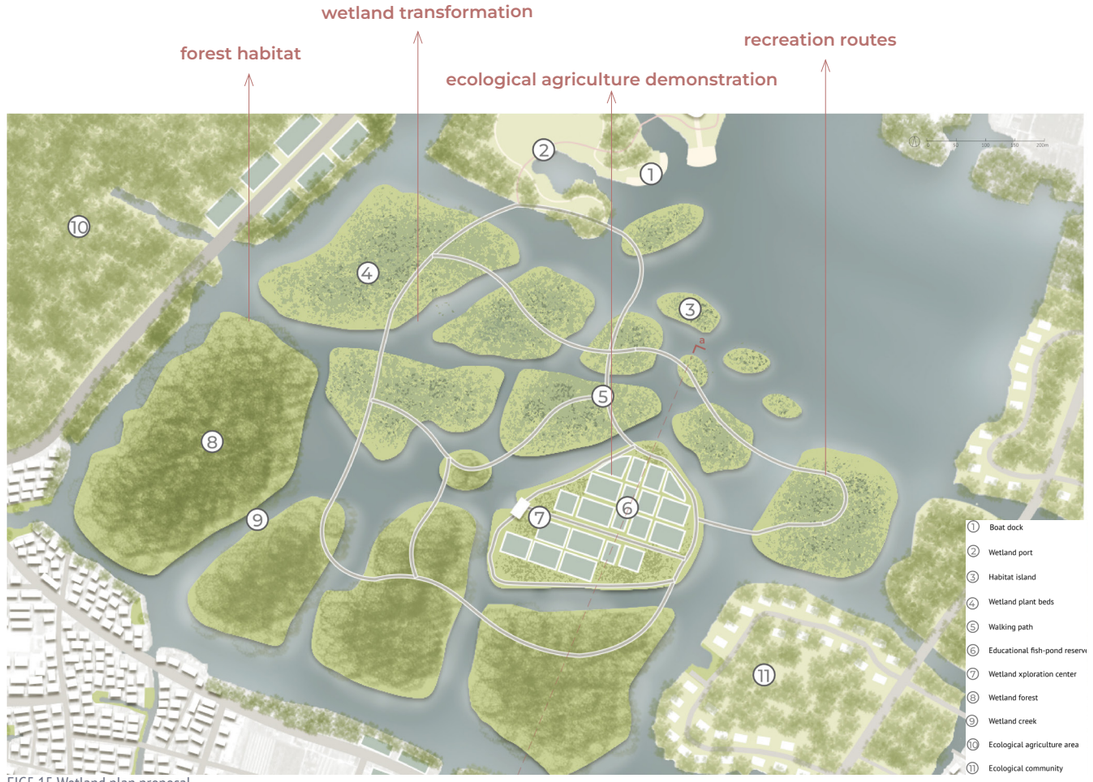


FIG5.15 Wetland plan proposal

In order to increase biodiversity, develop the ecological value of the lagoon, the design proposal is to expand the surrounding woods area, form a forest ecological habitat, transform the lowland into a wetland landscape with purification and resilient water storage functions, and retain some fish ponds for demonstrating ecological agriculture. By designing boat docks and walking routes, the recreational function of wetlands are added. Even Wetland is a new landscape elements for this area, but it alredy have some base in this area and the polder grammar will help to contextualize the form of it to be part of the polder landscape.

5.3.2 LOCAL IMPLEMENTATION

This local implementation will experiment how to apply design principles in the last chapter, especially in water system and green structure aspects, to transform the lake surroundings to wetland and transform steep interface between fish ponds and woods area to a more ecologically-friendly interface with gradient.

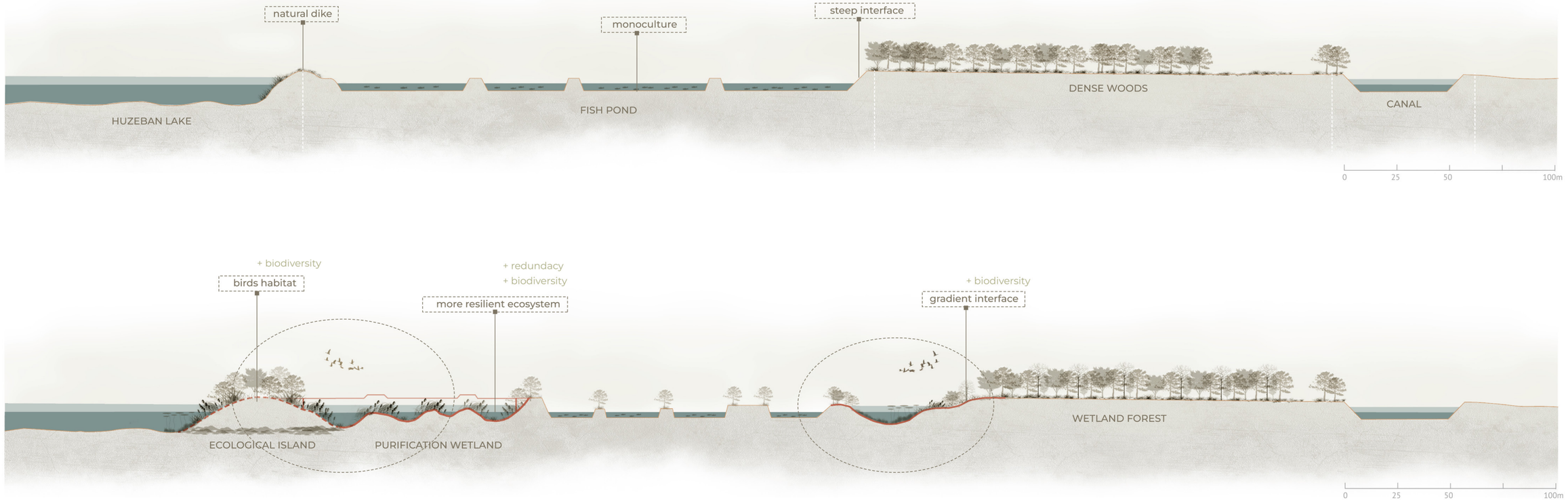


FIG5.16 Section a-a': Wetland transformation

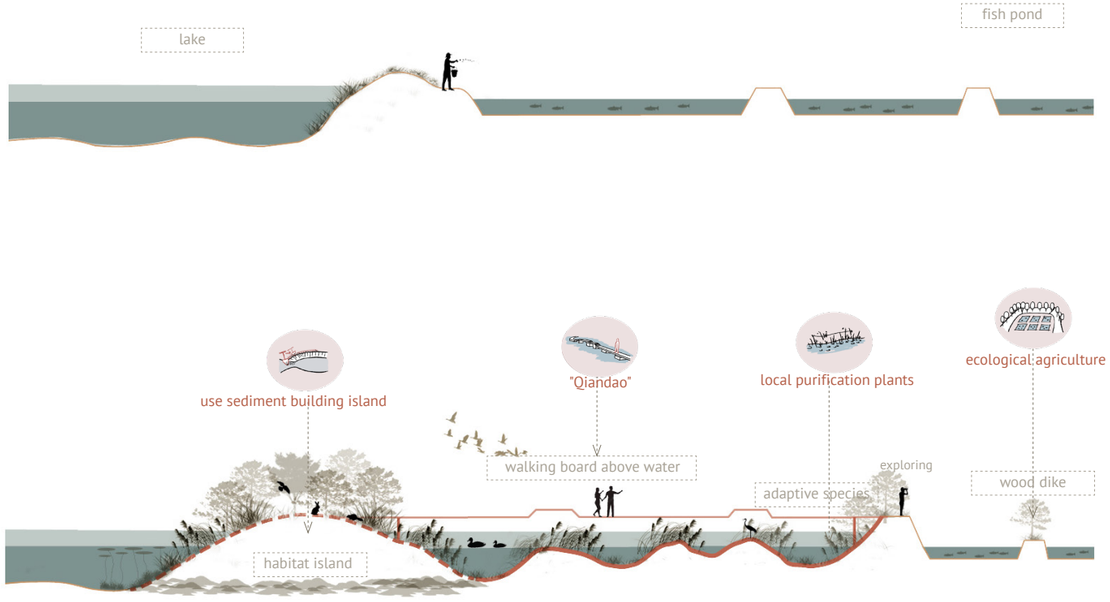


FIG5.17 a-a' section detail 1: wetland and ecological island

Ecological islands between lakes and wetlands can adopt the method from 'polder grammar', using accumulated sediment to build islands, which not only deals with lake bottom sedimentation but also provides ecological habitats for more animals on the lake; The plants in the wetland area are selected from the commonly local purification plants, which are more adaptive to local conditions and easier to manage; The form of the recreational road can also use the "Qian dao", a more traditional form of water trail in this area, to make it more in line with the local cultural characteristics; Planting mulberry trees, fruit trees, etc. on the embankment of fish ponds is not only make the aquaculture more eco-friendly, but also enriches the landscape of the fish ponds area.

WETLAND TRANSFORMATION PROCESS

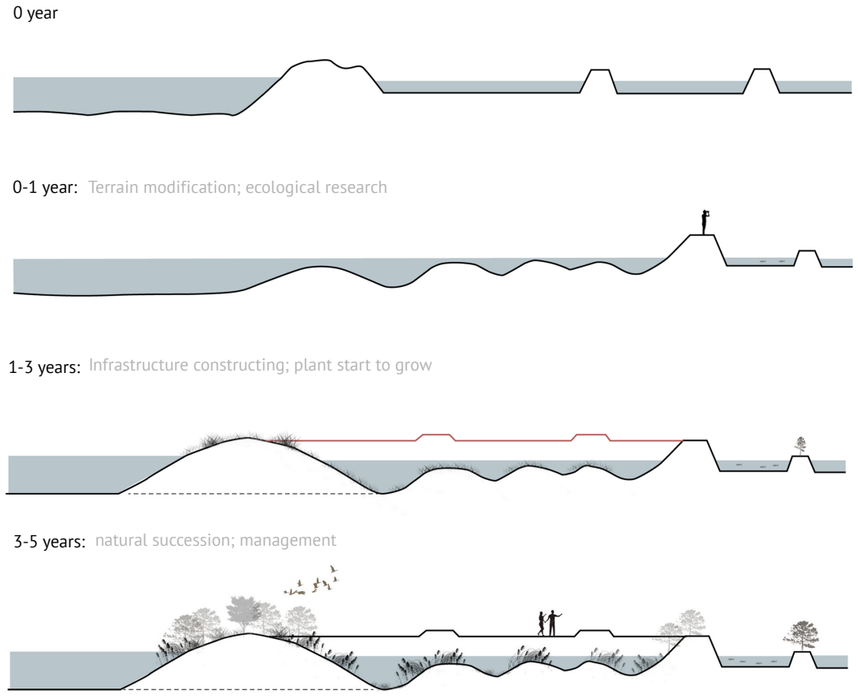


FIG5.18 Process of wetland transformation

The first stage is to start to transform the terrain, build islands and wetlands, and conduct ecological research at the same time to determine the specific conditions required for key preserve areas and flora and fauna habitats; After rainwater accumulating, the next stage the plants start to grow naturally when the ecological condition is right, plant some trees on the dike of the fish pond area, and build roads, venues and other tourist infrastructure ; with the natural succession, the plants will mature after 3-5 years, and they will finnally to realize the function of purifying the water quality of the area, and it need to do some management like regulating the input, monitoring the water quality, and keep research the ecological conditions in the third stage.

CURRENT SITUATION

DESIGN EXPERIMENT

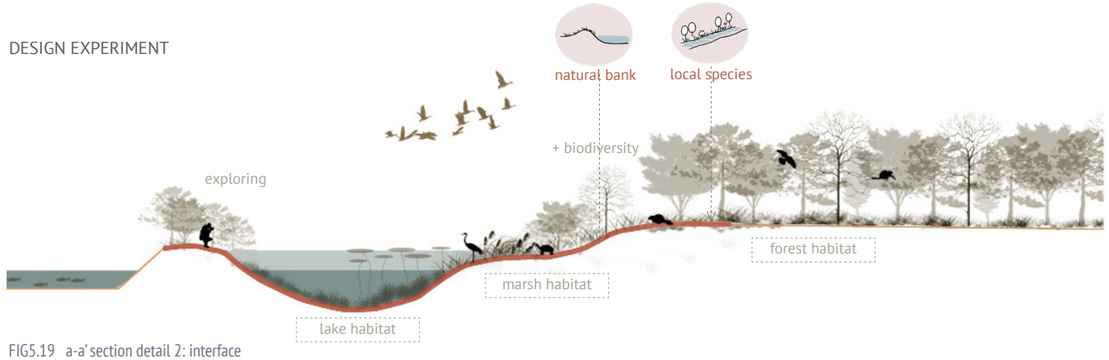
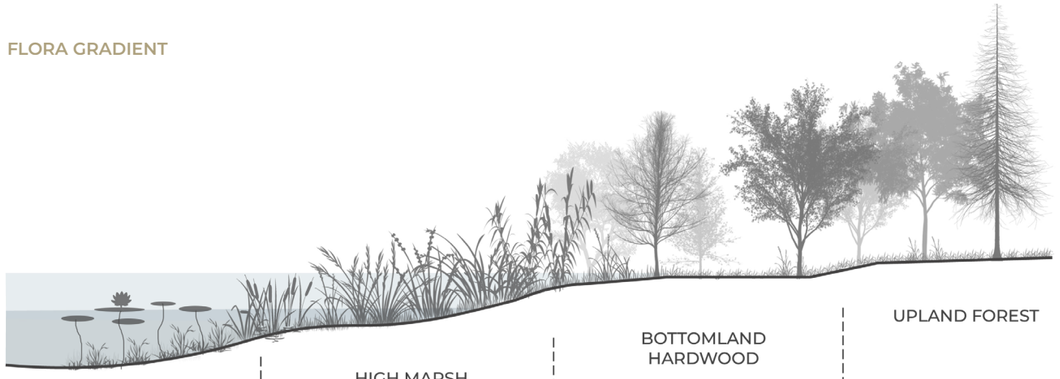


FIG5.19 a-a' section detail 2: interface

The transformation of the interface area between fish ponds experiments with the more natural bank principle from Polder Grammar, changing the steep revetment to a more natural slope, by lengthening the slope and planting native plants, the fish pond transition into a forest can be more natural. The new interface area could provide more diversity of habitat for flora and fauna so the biodiversity is increased, and also provide tourists more layers to explore.

FLORA GRADIENT



LOW MARSH


Nymphaea tetragona


Typha latifolia


Lythrum salicaria

HIGH MARSH


Phragmites sp.


Arundo donax


Artemisia annua


Sagittaria trifolia

BOTTOMLAND HARDWOOD


Metasequoia glypotostroboides


Salix integra


Pinux elliottii


Taxodium ascendus

UPLAND FOREST


Michelia alba


Ginko biloba


Pinus massoniana

FIG5.20 Flora & Fauna of wetland

5.3.4 VISUALIZATION OF THE DESIGN

WETLAND IN DRY SEASONS

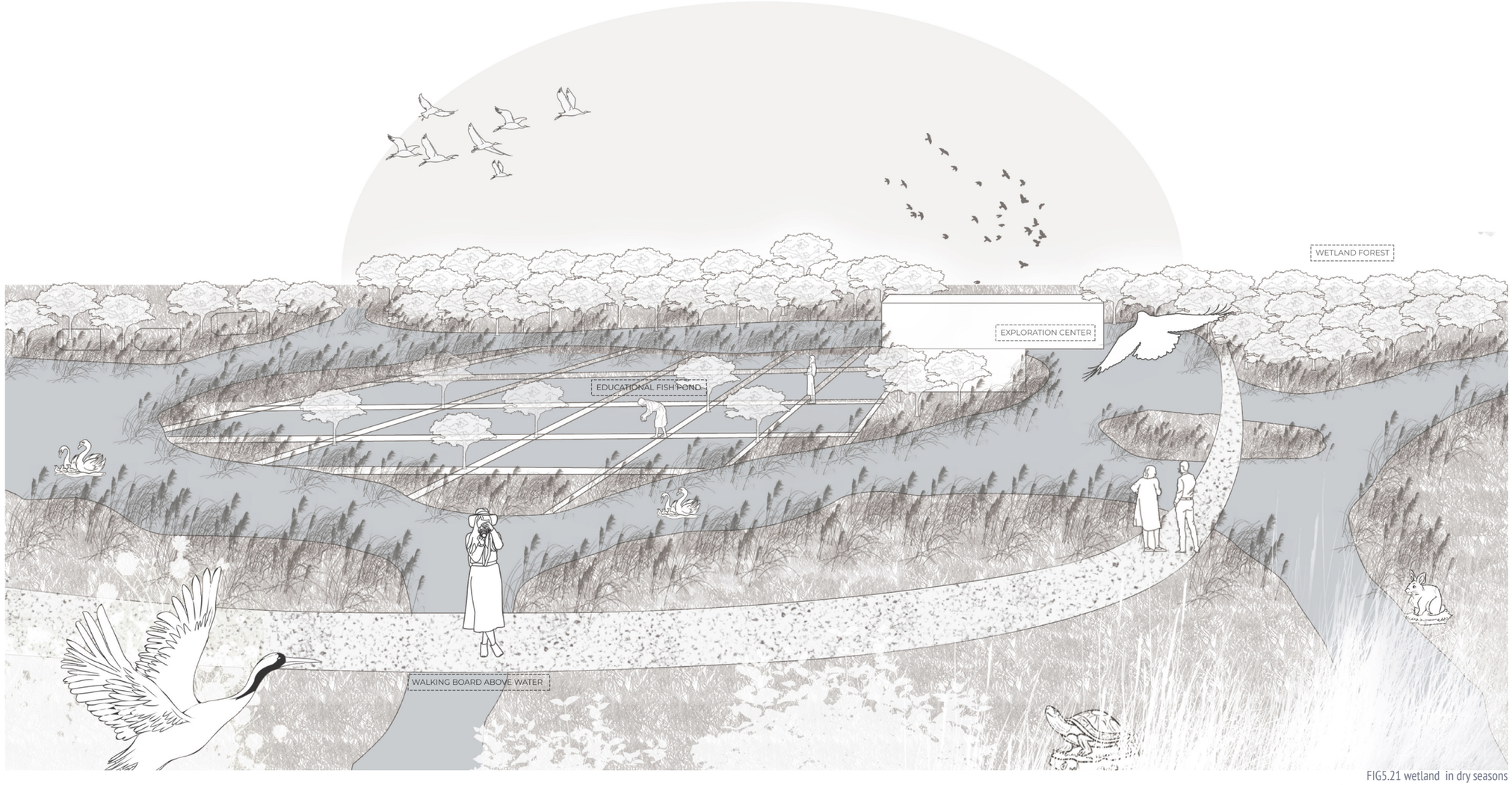


FIG5.21 wetland in dry seasons

Based on: *Jing Hu. (n.d.). Shaoxing Jing Hu Wetland Park Masterplan.*

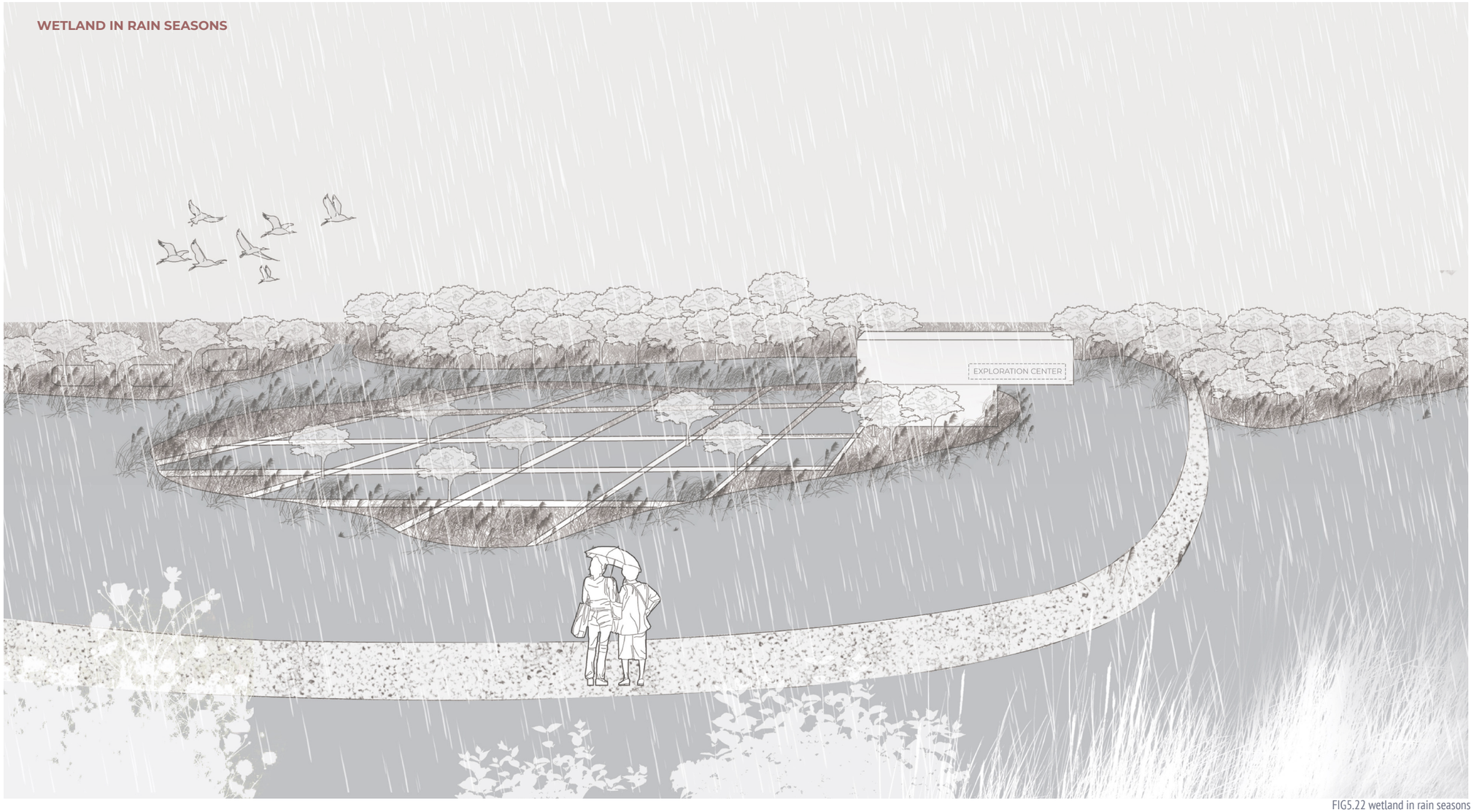


FIG5.22 wetland in rain seasons

Based on: *Jing Hu. (n.d.). Shaoxing Jing Hu Wetland Park Masterplan.*

5.4 EXAMPLE OF TRADITIONAL VILLAGES DEVELOPMENT

5.4.1 DESIGN ASSIGNMENTS

FIG5.23 villages current situation (from Google earth)

Part of the villages near Yangjing Lake have been demolished in to build high-density lakeside residencial community. As the villages in this area are located between the two lakes, which means after the development of Banze Lake, it might be an area with high commercial value. So how to protect the traditional villages in this area, and develop their commercial value potential, and increase the capacity of narrow river channels are the main design tasks of this area.

FIG5.24 Villages plan propsal

The design proposal is to retain the traditional village buildings by developing the buildings along the water into commercial blocks, increase the commercial value of the village, while expanding the water capacity of the canal. The flow of commercial people could be boost by designing high-quality waterways and walking routes between the two lakes, and formed a green corridor at the same time. The polder grammar will help the villages keep the cultural identity and more adaptive to economic development and enviromental challenges.

5.4.2 LOCAL IMPLEMENTATION

This local implementation will experiment how to apply design principles mainly in building types and public space in the polder grammar, to improve the public space quality of pier, transform the waterfront building to more adaptive buildings and add public space for commercial acticities.

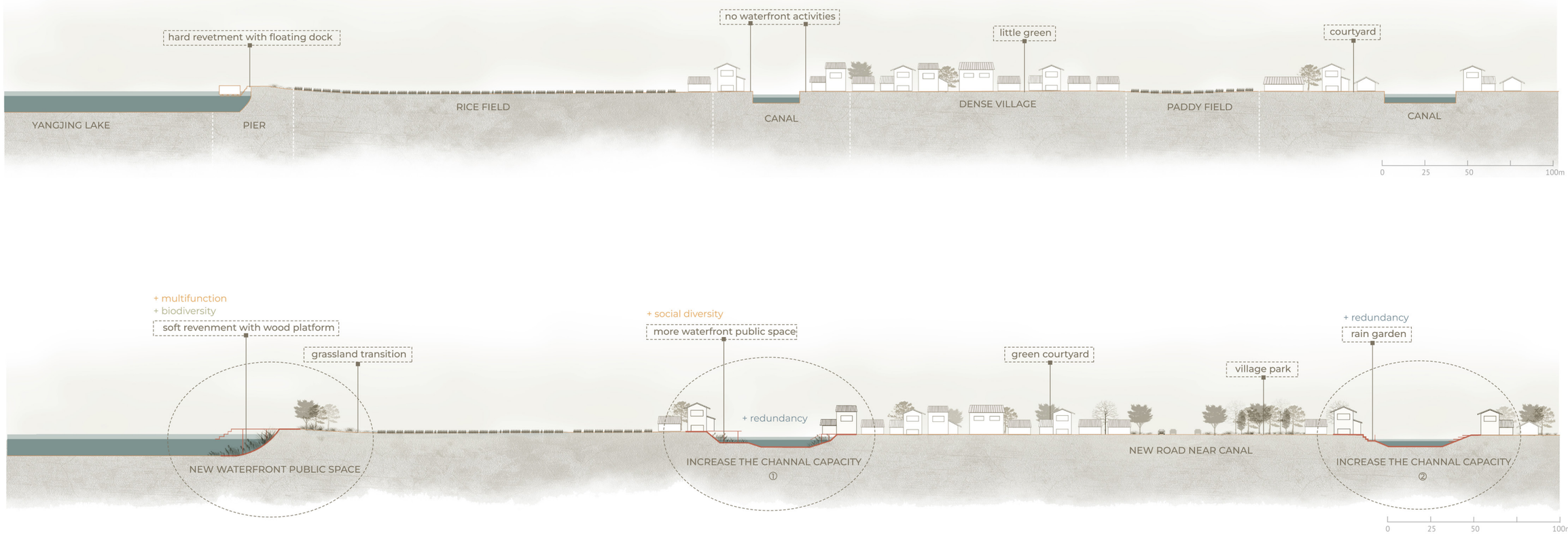


FIG5.25 Section b-b': Villages transormed to commecial district

5.4.3 DESIGN EXPERIMENTS:

APPLYING THE POLDER GRAMMAR IN DESIGNING BOAT STOP SPACE

CURRENT SITUATION

DESIGN EXPERIMENT

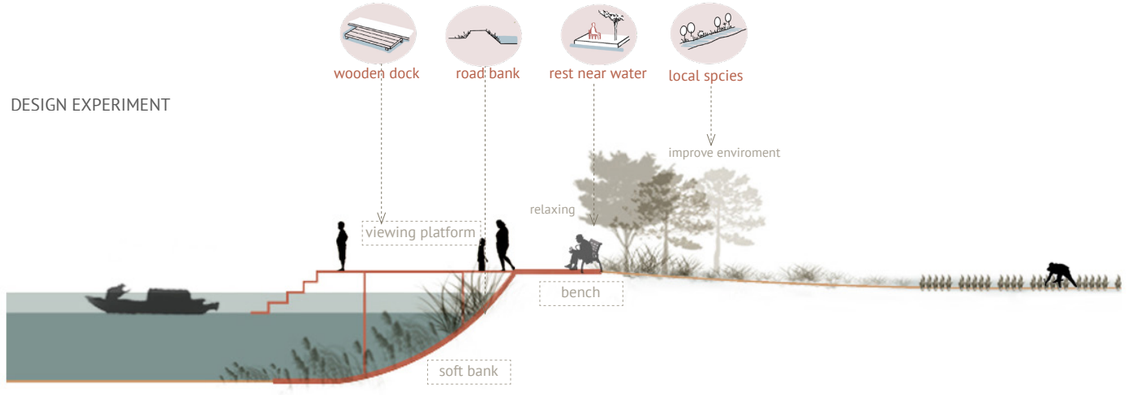
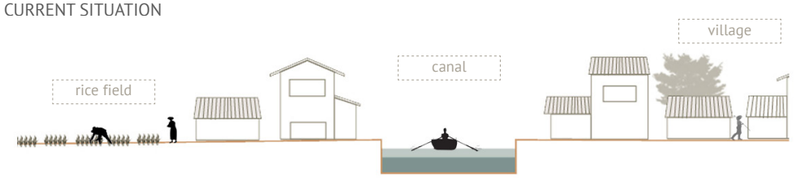


FIG5.26 b-b' section detail 1: pier

The current situation adopts the form of vertical revetment and floating pier, while the proposal experiments the form of traditional road and slope revetment. By planting plants on the sloping bank, the ecological environment of the lake could be optimized, and the extended wooden platform is used to replace the floating pier, which can also be used as a viewing platform when there are no boats. In order to enrich the public space of the pier, people can take a break at the pier by adding seats. And by planting native tree species near the shore, the quality of the rest space is further improved, and makes a division with the agricultural working space.

APPLYING THE POLDER GRAMMAR IN DESIGNING WATERFRONT BUILT-UP AREA

CURRENT SITUATION



DESIGN EXPERIMENT 1

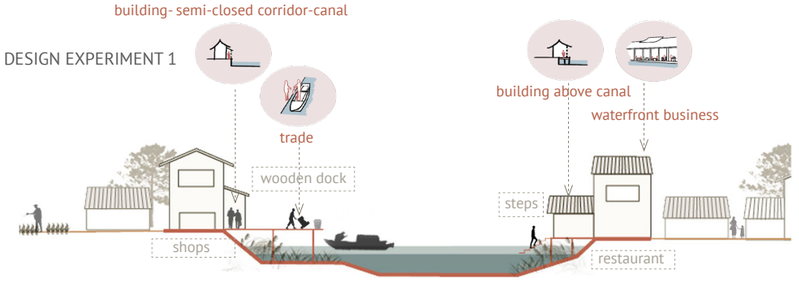
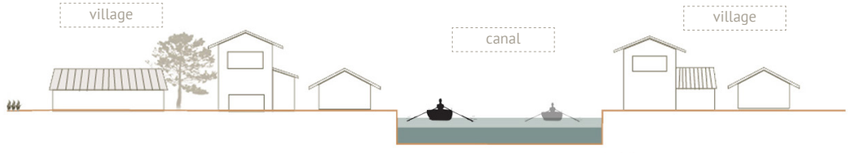


FIG5.27 Section b-b' detail 2: experiment of widening the canal 1

The first experiment adopts two types of waterfront building, and create public space for commercial activities by dock or steps.

CURRENT SITUATION



The second experiment is transforming the waterfront space to a more resilient water storage space, rain garden, which also can decorate canal bank. The waterfront building adopts the canal-street-building type,and the street can provide a public space for waterfront market.

DESIGN EXPERIMENT 2

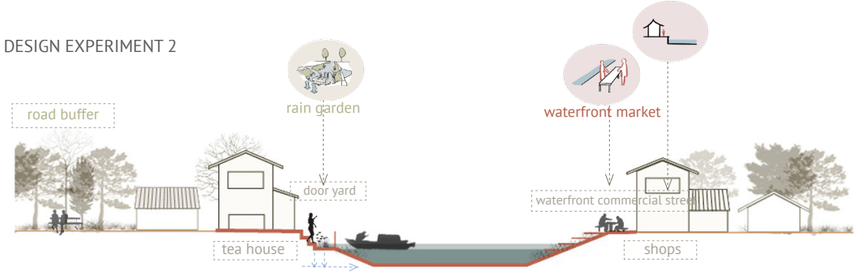


FIG5.28 Section b-b' detail 2: experiment of widening the canal 2

5.4.4 TECHNICAL DETAILS

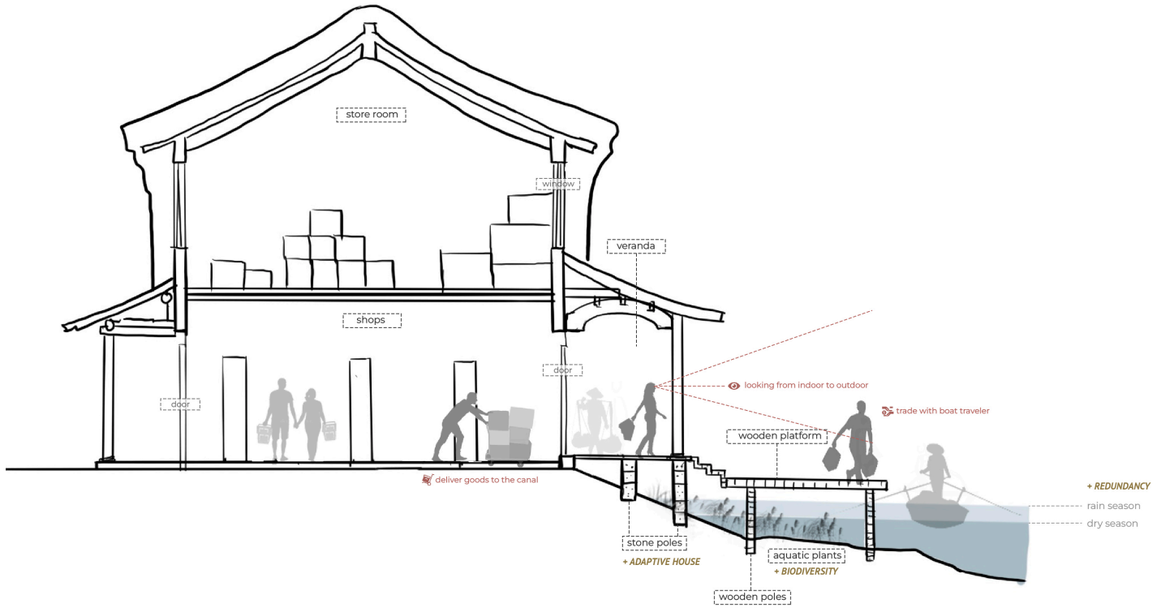


FIG5.29 Technical detail of waterfront building & public space

These are the technical details of waterfront buildings and the design of public spaces for water commercial activities. Widenning the canal increase the its capacity, the waterfront building is more adaptive to the water level flucation, both two point make the villages more resilient to the water safety issues. And the public space above water will facilitate more water-related traditional activities, which could make the commecial acticities more prosperous.

4.4.5 VISUALIZATION OF THE DESIGN

WATERFRONT COMMERCIAL VILLAGE

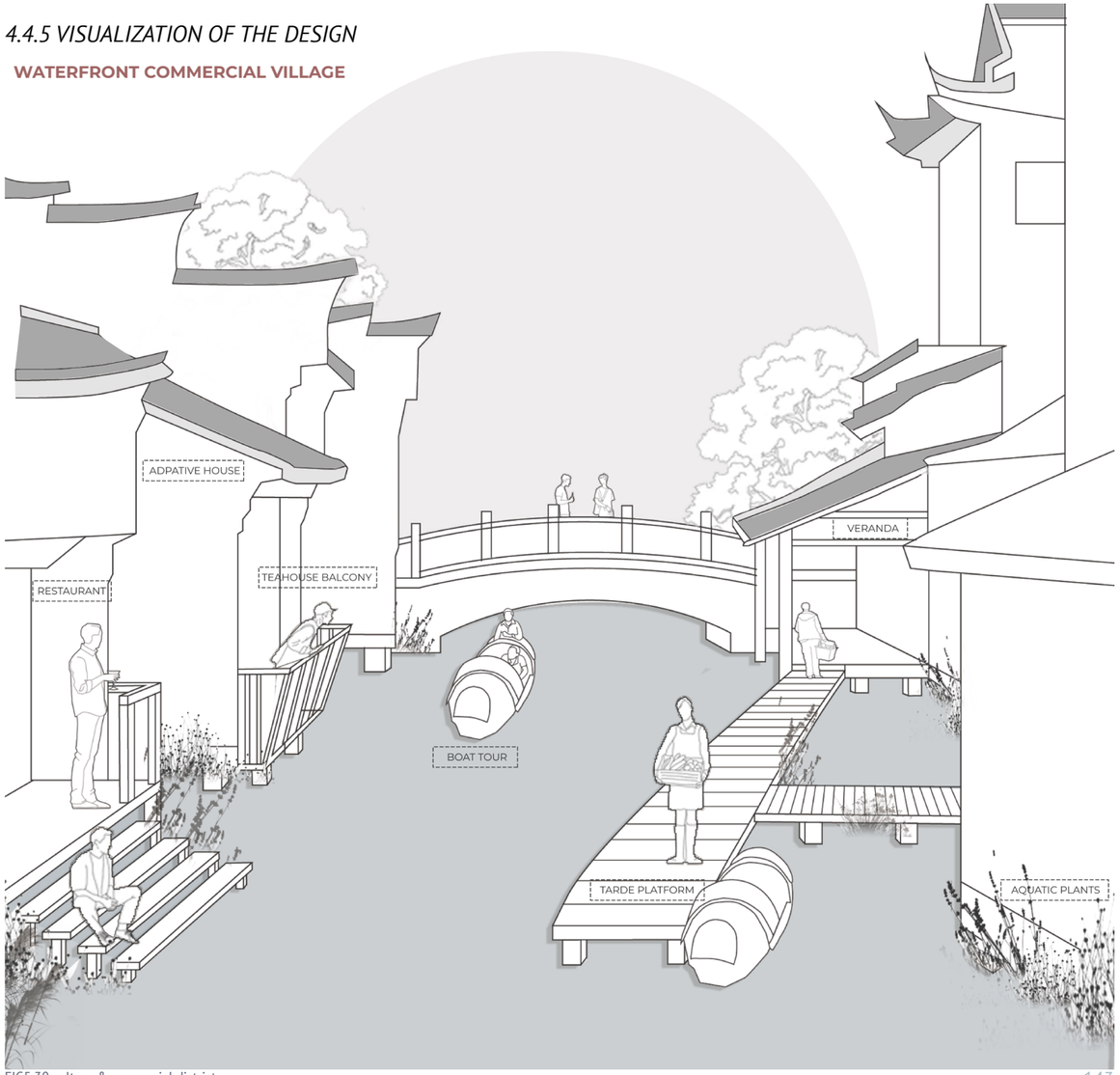


FIG5.30 culture & commecial district

5.5 EXAMPLE OF CITY DEVELOPMENT

5.5.1 DESIGN ASSIGNMENTS

FIG5.31 Current situation of the city area

For the city area, the city main road cut the watercourse, and the community are too dense with low quality public space far away from water. So the design task is mainly to redesign the road, to recover the continuous blue-green network, and add waterfront public space for the community with a livable density.

FIG5.32 City area plan proposal

The design proposal is to reopen the water hidden by road, redesign the road beside and along with the watercourse,which is the transportation strategies in the polder grammar. In this way, the blue-green corridor could be continuous in the city, and the waterbank could also be a new pubilc space for the city. The introduced water follows the polder grammar with a irregular shape, work as a bioswale in the community, and also provides waterfront public space, plus green roof and permeable pavement could promotes rainwater infiltration in urban area. The polder grammar help those new resilient strategies adaptive to the local conditions and cultural history.

5.5.2 LOCAL IMPLEMENTATION

This local implementation mainly experiment how to apply the principles regrading to water managemet, transportation, and public space in the polder grammar, to decrease the negative effect of city road, form a high-quality waterway and walking routes along water, and create a resilient way of rainwater management and high-quality public space for the communi-

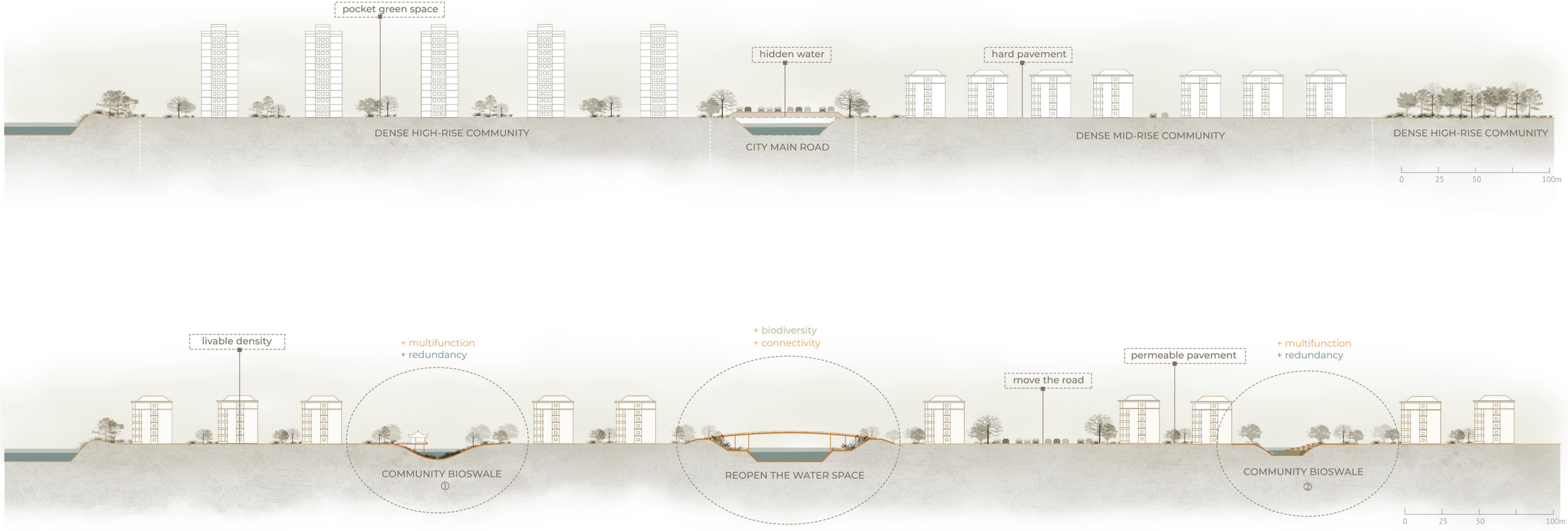
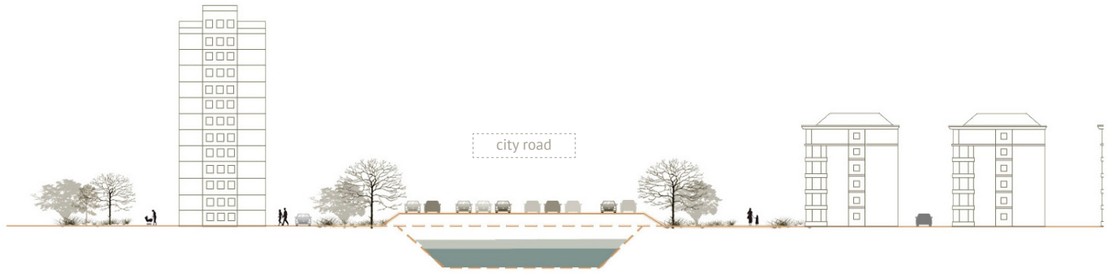


FIG5.33 Section c-c': dense community development in city area

5.5.3 DESIGN EXPERIMENTS:

APPLYING THE POLDER GRAMMAR TO REDESIGN THE ROAD

CURRENT SITUATION



DESIGN EXPERIMENT

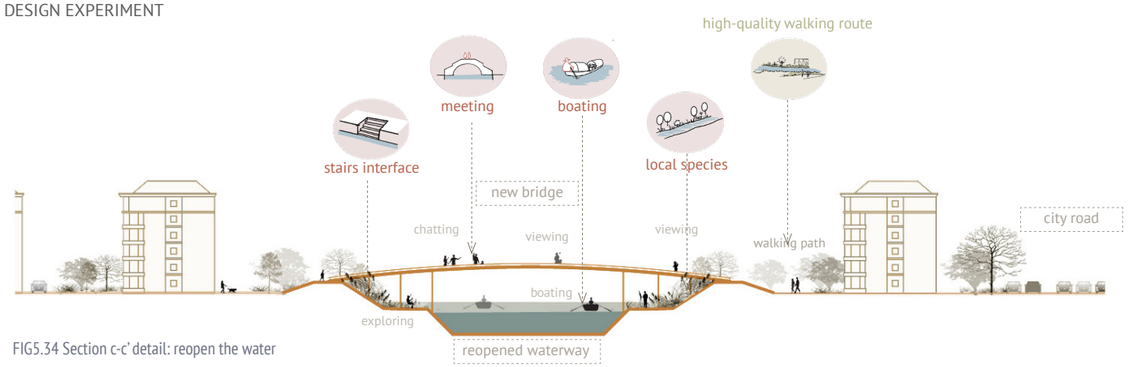
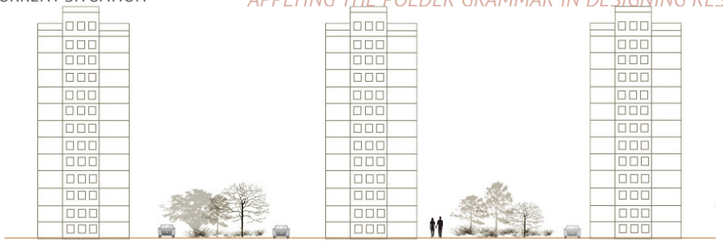


FIG5.34 Section c-c' detail: reopen the water

Moving the city road beside the water, and add bridges on the open water to create a meeting and viewing space on the water, and add local species to the watercourse bank to improve the ecological quality along waterway and walking roads beside, the stairs interface allows people to go downside to explore the environment further.

CURRENT SITUATION



DESIGN EXPERIMENT 1

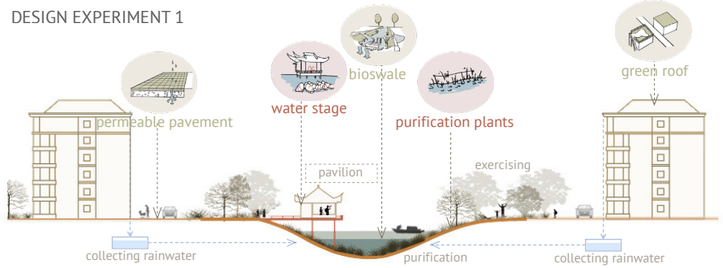
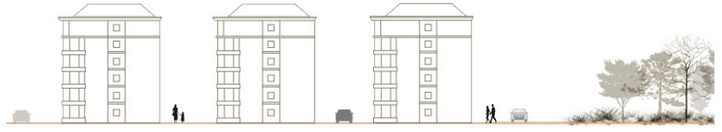


FIG5.35 Section c-c' detai: experiment of adding bioswale 1

The first experiment is to add pavilion above water and plant purification plants for the bioswale, adding aquatic plants in the bioswale to fulfill the purification function, the public space environment are more natural.

CURRENT SITUATION



DESIGN EXPERIMENT 2

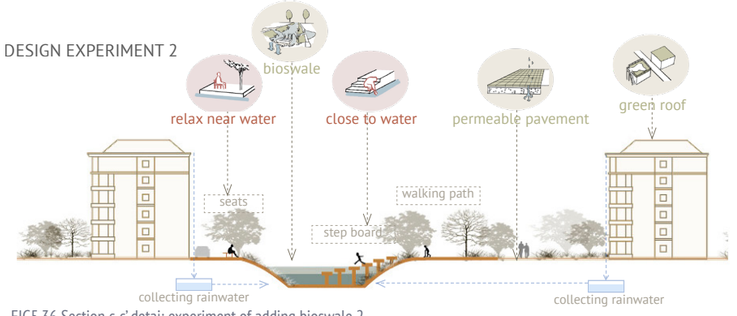


FIG5.36 Section c-c' detai: experiment of adding bioswale 2

The second experiment is to add seats near the water to provide a relax space, and add some stepping stone in bioswale to create opportunities geting closed to water, the purification plants concentrated on the end, this kind of public space provide people with more opportunities to interact with water.

5.5.4 WATER MANAGEMENT

This show how the rainwater are collected in the community, and how the bioswale worked to purified the rainwater.

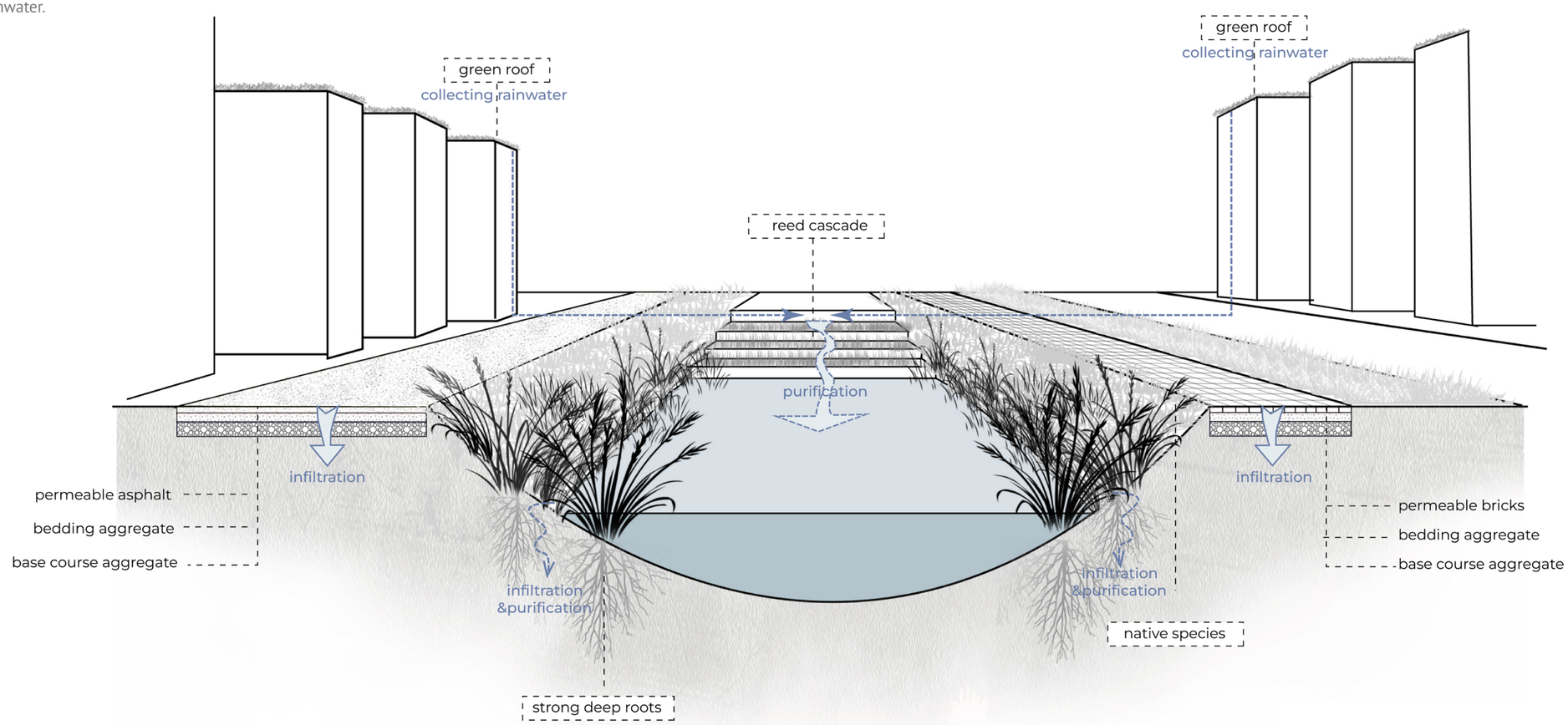


FIG5.37 water management of the community

5.5.5 VISUALIZATION OF THE DESIGN

BIOSWALE IN THE COMMUNITY

FIG5.38 Visualization of the bioswale

FIG6.1 Highly urbanized Shaoxing city
Source: https://stringfixer.com/files/119457357.jpg

06

DISCUSSION & CONCLUSION

In this chapter, I will first discuss the possible strategy application process in the whole Shaoxing strip and Ningshao Plain, and the adding value of the polder grammar approach. And then I will conclude the lessons I leanred from the graduation project, reflection after exploration, and outlook for the fucture.

6.1 APPLYING POLDER GRAMMAR IN SHAOXING STRIP

The design experiment part in the last chapter could be an example of applying polder grammar for the Shaoxing strip, here is the vision for the process of applying polder grammar in the whole Shaoxing strip area.

FIG6.2 Highly urbanized Shaoxing city

This design selects the characteristic elements of the Shaoxing area, the lagoon area. In the second stage, other important elements of the landscape structure of the Shaoxing belt area, the mountain reservoir area, the Grand Canal, and the old seawall area along the river can also be used as a reference to build some pilot projects. In the third stage, the pilot project can play its leading role and develop into a complete landscape framework based on the polder structure in this area. The area developed under the framework not only retains the characteristics and culture of the polder landscape in Shaoxing, but also provides development space, tour routes and a system for addressing the challenges of climate change for Shaoxing city.

6.2 TOWARDS A LANDSCAPE FRAMEWORK FOR THE NINGSHAO PLAIN

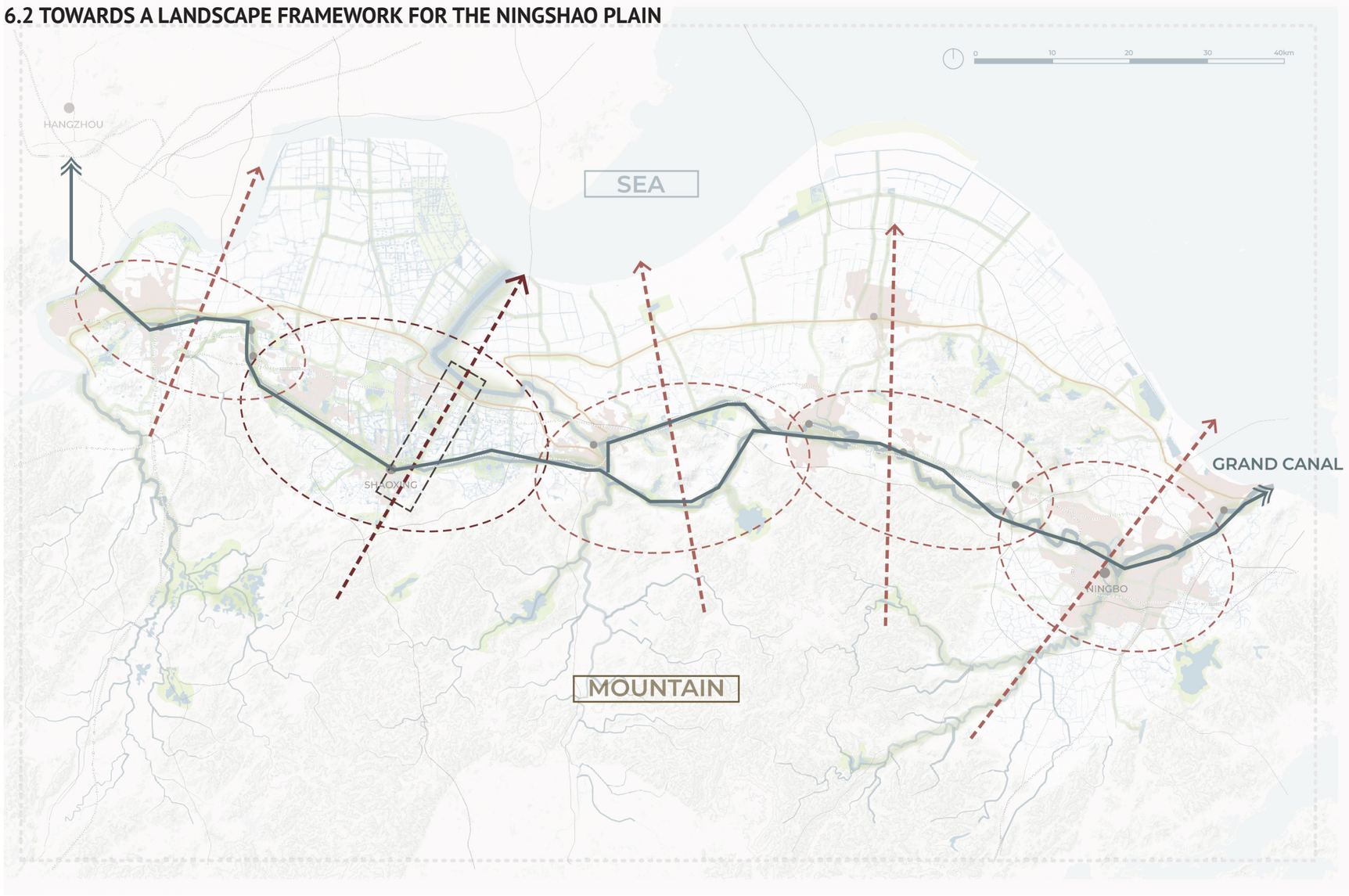
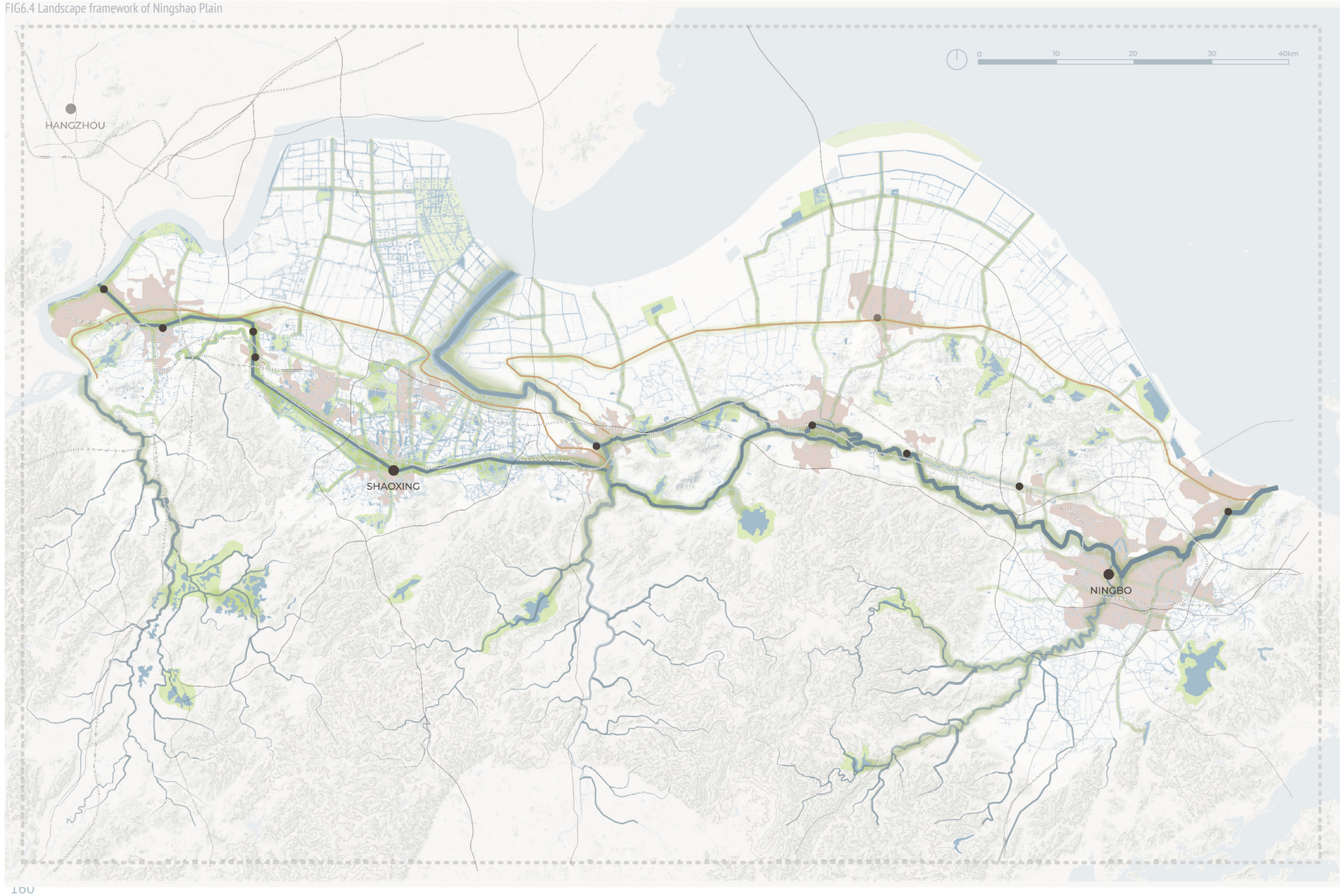


FIG6.3 Structure of Ningshao plain's framework

Returning to the scale of the entire Ningshao Plain, the five types of polders on the Ningshao Plain have their own 'polder grammar' respectively, which can be the basis to build landscape frameworks under different morphological characteristics. However, the five polders share the common ground, that all the structures of them are connecting mountains and sea from south to north, the Grand canal and sea defense system are the key west-east element linking the five diverse landscape frameworks. Therefore, the final landcape framework of the Ningshao Plain will be composed of five parts, and the Grand Canal connecting them. The Grand Canal is both a cultural corridor and an ecological corridor.

FIG6.4 Landscape framework of Ningshao Plain



+ ECOLOGICAL VALUE

INCREASE BIODIVERSITY

IMPROVE MICROCLIMATE

ADAPTIVE TO SEA LEVEL RISE

+ SOCIAL/ECONOMIC VALUE

LIVABLE HOUSING

BOOST TOURISM

RECREATION NETWORK

As the basis for urban development, this framework not only retains the characteristics and cultural identity of the Ningshao polder landscape, but also provides space and a high-quality ecological environment for the needs of urban land use, and can respond adaptive to challenges such as environmental problems and climate change. From a long-term perspective, it is more cost-effective and sustainable planning, and the prosperity of the culture and the improvement of the recreation system can also bring more tourism economy to the region, which is worth-while planning that the government and planners can consider.

6.3 LESSONS LEARNED & REFLECTION

6.3.1 Research by design

Research by design is a new way of thinking and reasoning for me because design often has no standard answer, and even the same design assignments will have a lot of alternatives, how to evaluate these alternative designs is the question that I have always been thinking about in the previous studying. In the whole research process, taking the design as a research object, the research goal is equivalent to giving the design a certain range of context, making the design more pertinent, rather than endlessly pursuing everything. I think this process is more conducive to the accumulation of knowledge and experience through design, rather than just output creative ideas. Because the design is regarded as a research experiment, the research objective can always be used as an evaluation criterion to test which one of the methods learned from the theory, case studies or experiments is more able to answer the research question, the next time I encounter problems in the same field, I will have some experience. I think this way of thinking is a very good way to learn and summarize new knowledge for design.

Answering the research questions

1. What is the landscaape structure of the hydrological heritage landscape of Ningshao plain?

The landscape of the Ningshao Plain is basically based on the structure of the hydrological system, from south to north, it is basically a mountain-reservoir lake-Grand Canal-lagoon-sea dense system-tidal flat structure. The entire structure is connected by dense watercourse network at all levels, and each part of the this structure breeds different ecological conditions and environments, resulting in various settlement forms and cultures.

2. What are the key factors influence the change of the polder landscape of Ningshao Plain? How they influence landscape through time?

In the early days, due to frequent transgression, changes in the coastline were the main factors affecting people's activities. The sea defense system was an important structure for the stability of the coastline. Later, the development of agriculture and water conservancy technology promoted the transformation of the wet land by local residents. The water network that can discharge water quickly, reservoirs and lagoons that can store water for agriculture become important elements to maintain water security and sufficient water supply in the area. With the growth of population and the needs of economic development, the Grand Canal become an essential element that promotes east-west transportation and economic prosperity in history. In the modern society, the transportation function of Grand Canal was replaced by new infrastructure, and urbanization demand became the main factor leading the landscape change

3. What are design principles based on polder landscape? What strategies and principles are more resilient for the development of Ningshao plain?

We can summarize the main form and spatial characteristics of the polder landscape as design principles, and learn the local methods of dealing with the relationship between people and land from the process of polder formation. It can also be used as design principles. Following these design principles allows for design interventions that do not disrupt the basic structure of the polder landscape as much as possible.

Strategies and principles that enable Ningshao Plain to have flexible space to deal with challenges such as dry seasons, extreme weather, and urbanization pressure are more conducive to the sustainable development of Ningshao Plain.

4. How to apply the principles in a more adaptive to the local way?

It is important to understand deeply how local people and natural factors transform the landscape, and the underlying logic that constitutes the local landscape, these more local transformation ways and spatial forms can be chosen even when applying new design strategies, making the design more locally sensitive or historically sensitive.

5. Does the design provide new practices for the protection of cultural landscapes? Is there any other relevance value for society or other professional field?

This project provides new clues to the protection of the polder landscape. First of all, I strongly agree with the idea of protection with planning. The design that takes development into consideration is more resilient and strong. During my design, I firmly grasp this point, researching the development and challenges faced by the site, and at the same time adopting principles learned from the site itself. I hope to follow the logic of the original landscape while facing challenges. So I think my design provides some methods for interpreting polder and other hydrological heritage landscapes from the perspective of landscape architecture and is a practice to test this kind of landscape-based design method.

For society, government planners, or real estate developers, my project is new possible planning that is landscape-based but does not ignore the urban development or economic development needs. Because it shows the large potential value of the polder landscape related to environmental issues, culture, tourism, social aspect, etc. If a landscape-based design can be taken into account by them, is of great significance to the protection of the polder landscape and urban sustainable development.

6.3.2 Method & Approach

The method of layers mapping disassembles the complex landscape system very well, so as to better understand the logic of landscape and find the key elements in the landscape structure, which are the key steps in constructing the landscape framework.

Polder grammar theory provides the most important method for design research, starting from the site itself, looking for experience from the development process of the landscape. If those fidings are adaptive for the development, we can keep it as design principle, if not, we can learn the experience why it is failed. This method makes the design more site-specific, especially suitable for the protection and intervention of cultural landscape, enhances the cultural identity and facilitate to sustainable development.

6.3.3 The relationship between the graduation project topic, Resilient Coastal Landscape lab, the Flowscape studio, and Landscape Architecture Track.

The Hydrological Heritage Landscape project is guided by Resilient Coastal Landscapes Lab under Flowscape studio, Landscape Architecture track. The perspective of Flowscape studio is regarding landscape as infrastructure, exploring the ecological, social, aesthetic, and other functional value of the landscape, which gives my project a direction to explore the potential of hydrological heritage landscape as the backbone structure to facilitate the sustainable development of cities. Resilient Coastal landscape lab focuses more on the water issues that landscape can undertake, and resilient strategies for design. The knowledge of water management, ecological succession, and landscape transformation of coastal areas also offered me the toolbox to design hydrological landscapes. During the two years of my postgraduate program, I learned a lot about the Dutch polder, which is one of the reasons why I chose the Chinese polder project. I think the polders in China and the Netherlands are essentially the result of human intervention in the hydrological landscape, but have different water systems and cultural identities under different cultural backgrounds and natural conditions. Therefore, in the research phase and design strategy, some methodologies can be generalized, but at the local and more detailed scale, design choices more suitable for local specific conditions need to be made.

6.3.4 Limitation

The biggest problem in my research is the limited sources of research materials. Most of the research on polder types in China is concentrated in the Pearl River Delta region, and there is very little information about the Ningshao Plain. Due to the Covid-19 restrictions, I have no way to go to the site to investigate by myself, so the research on the human scale is relatively lacking. In addition, I think it is more beneficial to talk with local residents to understand the local cultural customs and the impact of the landscape on their lives because they are the most important stakeholders of the landscape, and the design is easier to be accepted and continued by satisfying stakeholders' living needs and visions. When I return to China, I hope to go to the site for further investigation and research. Maybe I will have a new reflection on the design and research, and I hope to participate in related cultural landscape protection projects in the future, so that I can have the opportunity to practice the knowledge.

6.4 CONCLUSION

Landscape structure

This project demonstrates a method of analyzing the structure of a polder landscape, that is, first regard the landscape as a system, disassemble it into several sub-systems, and analyze and extract the key elements in each layer. Then analyze the relationship between each layer and between each and the whole, finally, the essential structures that form the landscape can be derived.

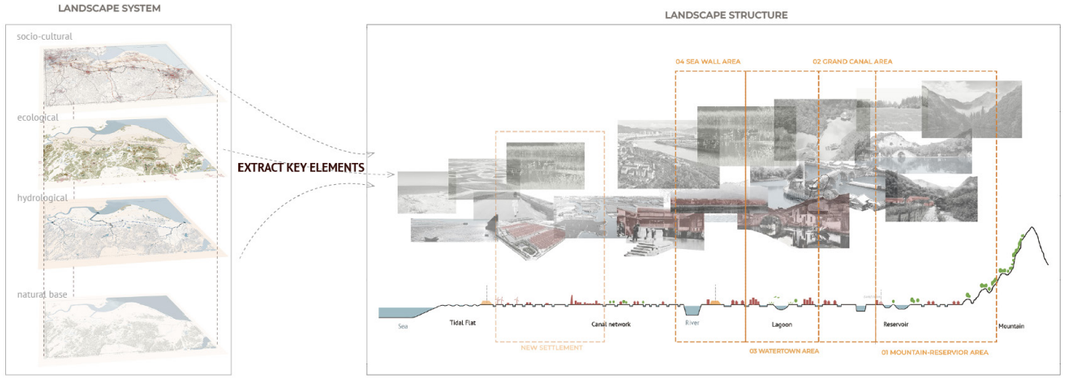


FIG6.5 Process of analyzing the landscape structure

Resilient Landscape framework

The project shows that the landscape-based approach is a good way to meet the needs of urban development on the premise of protecting the original landscape structure. As a kind of landscape-based approach, polder grammar is good way to understand the landscape structure and history and help to build the framework. Although there are also some resilient principles in the polder grammar, it couldn't cope with all the challenges, considering the resilience theory as supplement is necessary for building resilient landscape framework. And the results of site diagnosis is also crucial to help to build a framework for development.

Polder Grammar as design principles

The design experiments in the project verify the design principles obtained by 'polder grammar' method can make the design more adaptable to local conditions, in line with the historical and cultural background, and make the design more locally and historically sensitive while meeting the design assignments.

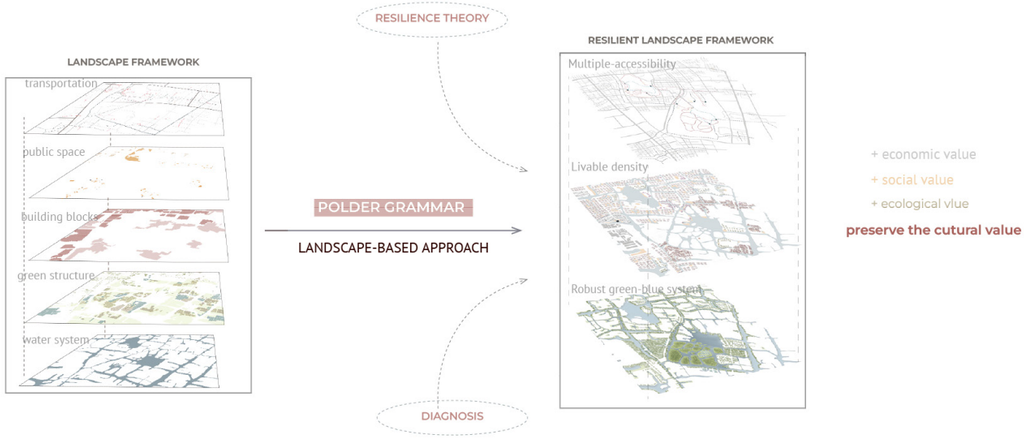


FIG6.6 Polder grammar as one of the landscape-based approach to build resilient landscape framework

6.5 OUTLOOK

There are a lot of polder landscapes in the Yangtze River Delta and Pearl River Delta in China, and they all face some similar problems as this project. This project provides readers with ideas for the analysis and protection of these hydrological heritage landscapes, and how to create a spatial framework based on the cultural landscape and adapt to the development of modern cities, a reference case is provided. However, this project focuses on the analysis of the structural framework and the research on water-related issues. More can be considered in terms of implementation details, and further in-depth research can be done in terms of ecology such as soil and plants in the future.

protect polder by planning it ....

June 2022

Delft, Netherlands