From the Water

Towards an adaptive landscape framework for sustainable development of agricultural area on the west side of PRD

Yi Lu
MSc Graduation Project

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MSc Graduation Project (P5 report)

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Image: Tian, 2019

Acknowledgement

This graduation project is a precious opportunity for me to learn and interpret my beautiful hometown, the Pearl River Delta, from the perspective of my own profession. I would like to express my heartfelt gratitude to everyone who has assisted me in realizing this opportunity.

First and foremost, I would like to thank Steffen, my first mentor. His great passion for landscape has always inspired me. His extensive theoretical knowledge and expertise have provided me with a strong foundation throughout my research. I am grateful to him for enlightening me about the immense power that landscape possess in improving the world.

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I am thankful for the people and experiences I encountered during my two years of study in the landscape track and the resilient coastal landscapes graduation lab in TUDelft. They have expanded my understanding of landscape and the world, providing me with a clearer vision of the type of landscape I wish to create and the kind of designer I aspire to be.

In conclusion, I believe that these experiences will shape a part of who I am as I embark on my next journey.

Abstract

The Pearl River Delta (PRD) is currently one of the world's fastest-growing city clusters. However, it has been a low-lying area with scarce land resources throughout history due to its dense population and frequent water-related hazards. The traditional agricultural system in the region was a response to these contradictions, serving as a multifunctional system that sustained the land and shaped the local society and culture over centuries.

However, with China's reform and opening up in 1978, a significant amount of agricultural land was converted into urban construction and intensive agriculture, the disappearing traditional agricultural system has led to arising social and environmental issues such as increased flood risks, environmental degradation, landscape homogenization, and the loss of cultural heritage.

This thesis focuses on the development of the remaining agricultural areas on the west side of the PRD. It emphasizes the urgent need for diverse ecosystem services to support the growing population in the face of climate extremes. In this case, an economy-dominated or monofunctional planning approach alone is insufficient to ensure sustainability. Therefore, building upon the region's agriculture-based background, the study adopts an adaptive landscape framework as an adaptation of the traditional agricultural system. By integrating the theories of landscape-based urbanism, social-ecological resilience, and ecosystem service, the landscape framework aims to facilitate sustainable development of this area in terms of production, ecology, water resilience, and living environment.

The study considers agricultural development in the PRD as a long-term process and recognizes the agricultural system as a social-ecological system. Through the learning of the development process, the agricultural area on the west side of the PRD could be divided into two main typologies: dikedfield and sandfield, and further subdivided into four landscape typologies. Together, they compose the landscape structure of the region. By analyzing and evaluating the challenge and potential associated with each typology, an overarching regional vision is proposed. Principles derived of the traditional agricultural system will serve as design guidelines, while the design exploration in Gulao Town, as a typical area representing one of the landscape typologies, will be conducted to showcase part of the regional vision and tangible social and environmental value brought to the local area.

Contents

PART A
Introduction

Source: https://geoshen.com/posts/the-pearl-river-delta-megalopolis

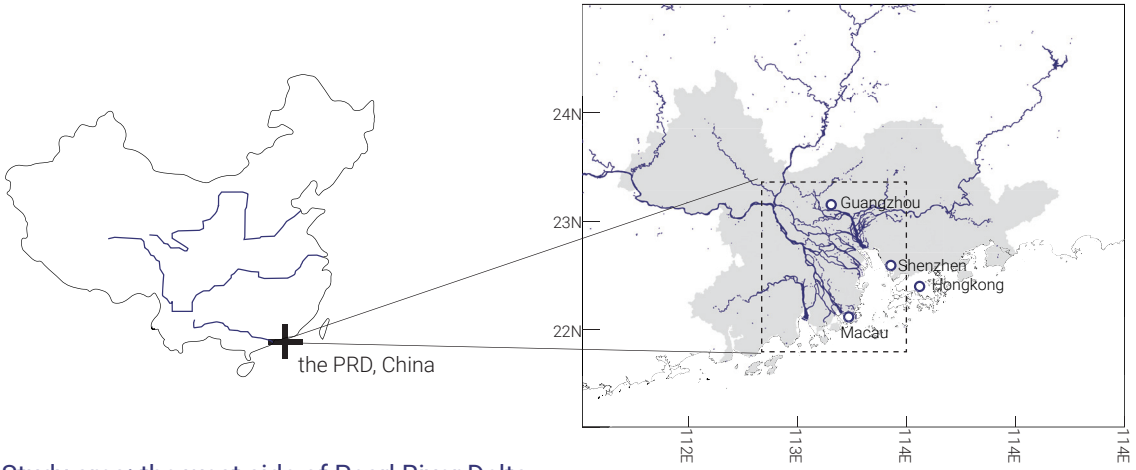
1 Introduction

This chapter will outline the process of selecting the topic, narrowing down the problems, and defining the research objective.

1.1 Fasination: The agriculture-based area

In the book from the soil (1947), the famous Chinese sociologist Fei Xiaotong proposes the idea that 'earthbound society' is the basic and traditional society of China. 'Earthbound' indicates how the ancient Chinese people make a living: land cultivation and agriculture. In other words, agriculture played an important role in the development of Chinese society.

This perspective inspires me to view my hometown, the Pearl River Delta in southern China, through the lens of agriculture. The Pearl River Delta (PRD), also known as the Greater Bay Area), is one of the fastest growing city groups in the world. Today, it's home to 65 million people and its GDP is over $1.2 trillion (Geoshen, 2018). In fact, before 1978, the Pearl River Delta area, like most of China, was primarily rural with a poor economy based on agriculture. But rather than from the 'soil', this is a story about from the 'water'.



Study area: the west side of Pearl River Delta

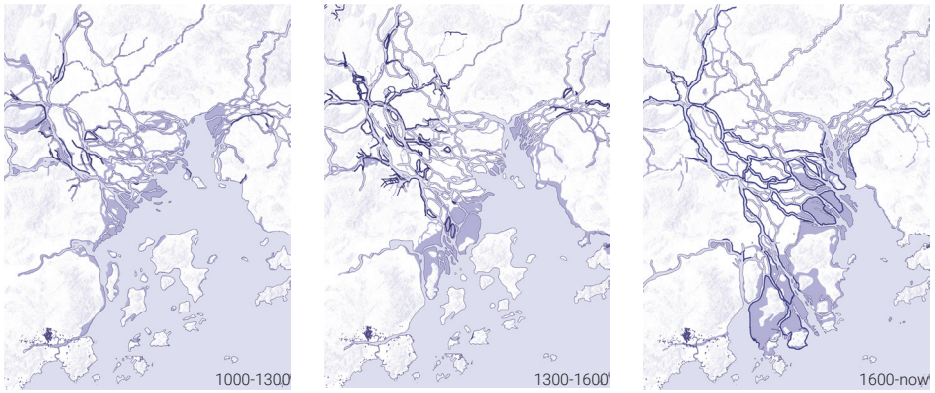
Source: author

A view of Shenzhen: From agricultural region (1964) to megacity (2015)

Source: https://www.theguardian.com/cities/2016/may/10/china-pearl-river-delta-then-and-now-photographs

This megalopolis's central and western parts used to be submerged underwater. Due to the limited sand content in the Pearl River, the estuary could not be adequately filled during the seven millennia of sea incursion. It was not until the Song Dynasty (960AD), with the advanced agricultural techniques and land reclamation methods brought by the migrants from the north, that the land began to emerge from the water.

Over one thousand years, the land was cultivated, and the distinctive clan society came into being. Families joined forces to reclaim the land, protecting it from floods and engaging in agricultural production. As a result, agriculture played a fundamental role in shaping both the land and the cultural identity of the PRD.



The reclamation process throughout one thousand years

Source: adapted from Xiong and Nijhuis, 2019

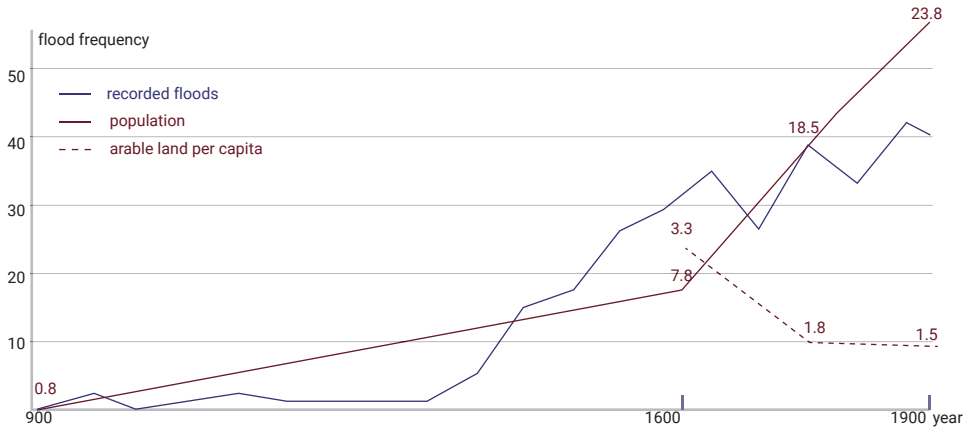
Reclamation in Hengqin in 1980s

Source: Shunde District Archives

In the past, the Pearl River Delta (PRD) has faced significant challenges arising from its dense population and limited land resources due to frequent flooding (Chen Press, 2018). This low-lying region is susceptible to pluvial and tidal hydrology, as well as tropical cyclone events, which severely restrict the availability of arable land. By the time of the Ming dynasty (14th century), the growth of arable land could no longer keep up with the growth of the local population.

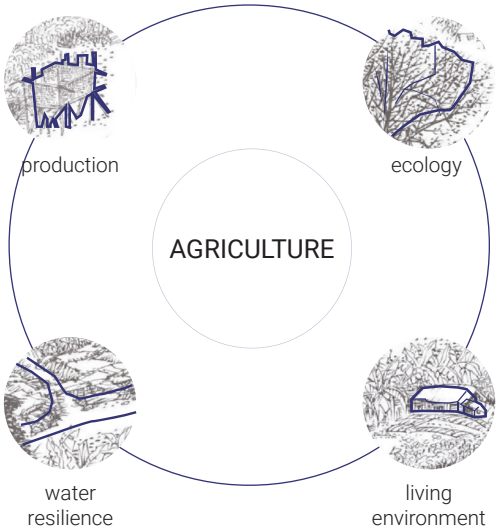
In this case, agriculture serves as a multifunctional system that addresses various needs while striking a balance between social and environmental aspects. Traditional agriculture is intricately connected to diverse aspects such as production, living environments, water resilience, and ecology.

Frequent flood events in PRD's history
Source: google image



Intense land resource due to dense population and threat from water
Data: Chen, 2018

The PRD as a densely populated area
Source: Maryknoll Mission Archives, 1947



Agriculture as a multifunctional system in response to limited land resources

Image: Dikepond Drawing by Faliang Liu

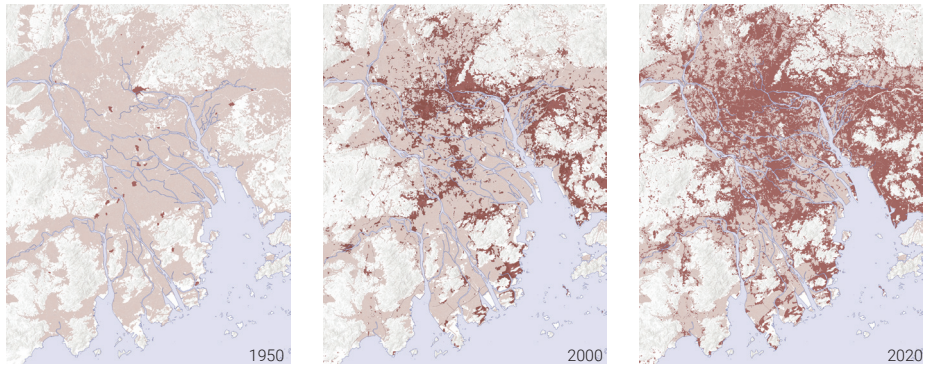
1.2 Problem field

Historically, agriculture has played a pivotal role in the development of the metropolitan region. However, over the past 40 years, with the rapid urbanization rate in the Pearl River Delta soaring from 16% to 87.5%, more than one-third of cultivated land has been sacrificed as cheap land to attract investments and facilitate construction projects.

Traditional agricultural system is disappearing, giving way to emerging problems.

Unlike the ‘earthbound’ agriculture, this kind of economy-oriented development only focused on maximizing the land profits, disregarding the values of water resilience, ecology, and the quality of living environment. The accelerated urbanization and intensified agricultural practices of the past have led to increased risk of flooding, environmental degradation, landscape homogenization, and the loss of cultural heritage.

In 2019, the Chinese central government issued the 'The Outline Development Plan for the Guangdong-Hong Kong-Macao Greater Bay Area’ , which aims to develop the PRD into an international first-class bay area on par with the New York Bay Area and others. The development opportunities will usher in more population and land development, while the urbanization process of the PRD will once again accelerate. However, based on past experience, most of the urban development is concentrated in these lowlying, reclaimed agricultural land, which will



From Agricultural area to urban area

Data: GLOBALMAP30

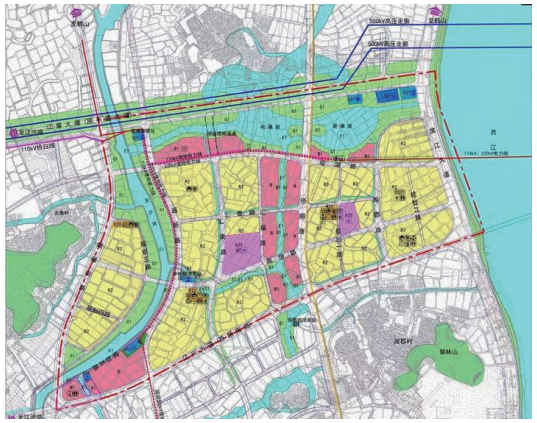
Losing values

Source: http://hdd-group.com/zw/index.php?c=article&id=204

be at greater risk when faced with floodings and rising sea levels from climate change. Thus, the resource conflict between continued population growth and a limited and fragile environment will reoccur in these coastal lowlands of the PRD.

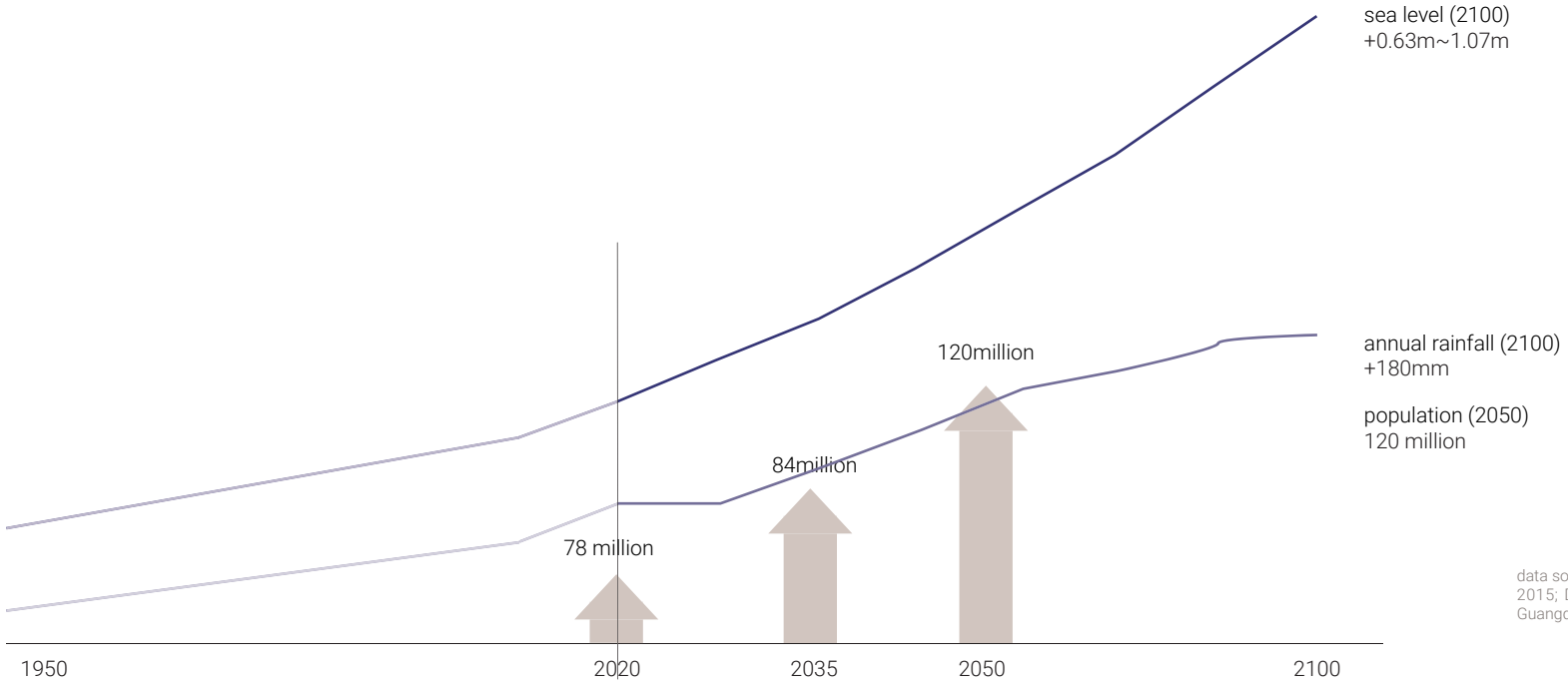
Although many planning and water resource management measures in the Pearl River Delta have started to address these issues at the regional level, there is a lack of coordination between planning, environmental management, and hydraulic engineering (Qu et al., 2014), and the single evaluation method is often used in the current land zoning (Gao, 2019), which might make the area lack resilience and fail to deliver diverse ecosystem services.

In conclusion, the mono-functionalized and economically driven development models have proven inadequate in providing sustainable ecosystem services to support the growing population in the Pearl River Delta (PRD), particularly in the face of climate hazards. Therefore, it is crucial to reflect on the lessons that can be learned from the traditional agricultural model that has historically served as the foundation of the region.



A plan overwriting the previous landscape with monofunctional blocks

Source: Jiangmen City Planning and Design institute, 2020



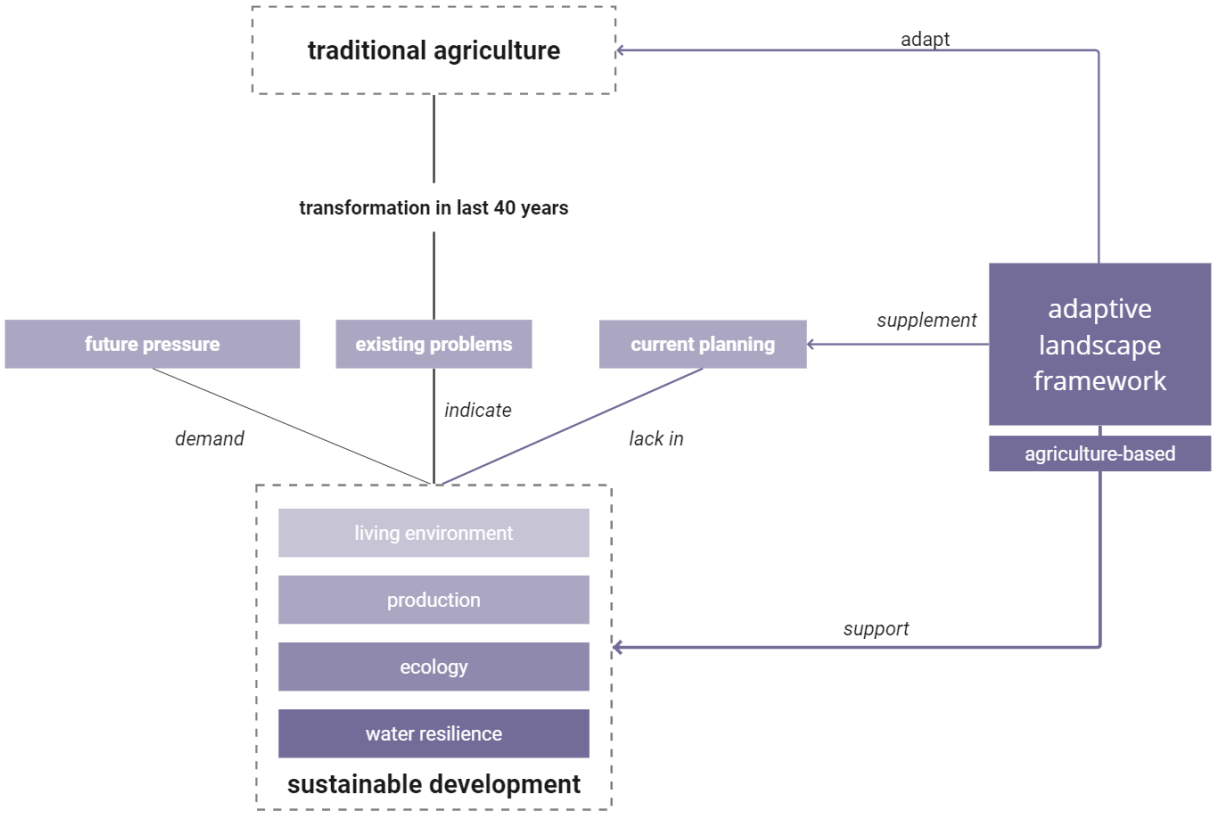
data source: Hong Kong climate change report 2015; Department of Natural Resources of Guangdong Province; Fan Gang

1.3 Research objective

To support the sustainable development of the agricultural area on the west side of PRD by applying an adaptive landscape framework

Through the application of the adaptive landscape framework, the research aims to delve into a more sustainable development model for the PRD. The adaptive landscape framework is grounded in the context of agriculture as the foundation of the Pearl River Delta. It represents an adaptation of traditional agricultural systems within the context of modern development. The framework aims to serve as an integrated and multidisciplinary structure, effectively balancing social and environmental aspects in the face of uncertain future transformations.

The sustainble development model takes into account four dimensions: production, living environment, water resilience, and ecology. These dimensions encompass the various aspects of what ecosystems provide for human well-being. A resilient biosphere is established to support the rapid socio-economic development of the megalopolis while ensuring the provision of adequate ecosystem services for both present and future generations.



In order to achieve the research objective, some research questions were composed as follow. These questions will be answered and reviewed throughout the research and design process.

Understanding	SQ1: How to understand the formative power of agricultural practice on the west side of PRD, and the challenges and potentials of different agricultural typologies?
Principle	SQ2: What principles could be set to form an adaptive landscape framework?
Application	SQ3: How to apply the principles to local-scale design on the west side of PRD and bring social and environmental benefits to the area?
Reflection	SQ4: What experience could be learnt through the project in order to serve the objective better?

1.4 Scope and relevance

The thesis aims to develop an adaptive landscape framework for the agriculture-based area in PRD, and to foster its social and environmental aspect in a sustainable way. The thesis is also referred to the following topics.

Landscape values

In the planning of the Pearl River Delta, top priority has always been given to economic development. However, in this project, my aim is to showcase how landscape-based approaches can offer social and ecological value, leading to a robust, resilient, and vibrant region. This entails creating functional landscapes that not only provide enjoyable spatial experiences for people but also foster a meaningful connection between humans and nature. Additionally, it involves preserving the distinctive character and cultural essence of the local landscape. This will offer alternative possibilities to today's cookie-cutter urban development.

Water sensitive design

The evolution of agriculture in the Pearl River Delta is the result of a long-term learning of local people to live with water, and therefore water resilience has been integrated as an important characteristic of traditional agricultural systems. Therefore, when interpreting traditional agricultural systems and developing principles, these principles respond to a water-sensitive design approach at the levels of natural, agriculture, and settlement. The design exploration in Gulao town exemplifies how to co-exist with water by increasing water capacity and utilizing rainwater.

Rural revitalization

The Chinese government started to promote a strategic plan for rural revitalization in 2018, which aims to revitalize rural industries, culture, and ecology while emphasizing an ecological approach to development. Under such a trend, this project can provide sustainable development ideas for the transformation of the countryside.

Source: google image

Photo: Tianheng Zhang

Source: CCTV News

1.5 Reading itinerary

In the next chapter, also as part of Part A, I will introduce the methodology of the research, which will show what theories I used to support my research and the research methods in the study process.

In Part B, you will learn about the development of the PRD polder region from an agricultural perspective which help the region better look to the future. This includes Chapter 3 on how traditional agriculture (before the 1980s) has shaped the local landscape, the types and characteristics of the landscape and how we can learn from this 1,000-year journey. Chapter 4 then tells how modern development has brought great impact and change to these agricultural areas, and what challenges and opportunities these transformed agriculture will face.

Further recommendations and examples for the future development of agricultural areas are given in Part C. In Chapter 5, the corresponding design principles are provided. Chapter 6 uses Gulao town as an example of one of the agricultural types to show how the design principles can be implemented and their effects.

Part D, chapter 8, will review this study. In this section I will review the extent to which the vision of sustainable development in the PRD agricultural area has been realized and explore possible improvement.

Source: Doumen Today

2 Methodology

In this section, the theoretical framework of the project is elucidated, along with methods and approaches applied to reach the research objective.

2.1 Theory

The adaptive landscape framework is an adaptation to the traditional agriculture system, which is earth-bonded, and has a close relationship with social, economic and environmental change. To further support the landscape framework, I incorporate theories of Landscape-based Urbanism and Social-Ecological Systems (including social-ecological resilience and ecosystem services). These theories closely align with the essence of traditional agriculture and directly contribute to the goal of sustainable development.

Landscape-based urbanism

In landscape-based urbanism, physical landscape structures and associated natural processes are seen as fundamental to creating favorable conditions for future development (Nijhuis, 2022, p258). At the same time, the theory advocates Learning from landscape history and vernacular practice and developing resilient and adaptive spatial frameworks (p259).

Agriculture as landscape in this area should be seen as fundamental to the living environment and society, and therefore can be developed into guidance for spatial transformation.

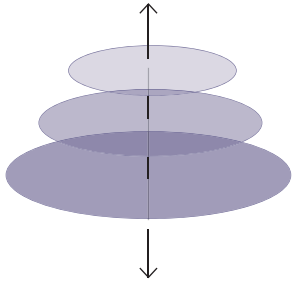
Social-ecological resilience

Socio-ecological resilience refers to the ability of a socio-ecological system to absorb change and disturbance without shifting to a new regime with a different set of processes and structures-i.e., without transforming into a new system state (Walker and Salt, 2006). Compared with engineering resilience and ecological resilience, socio-ecological resilience is able to cope with longer-term changes, and has the ability to adapt and shift with dynamics.

Traditional agriculture in the PRD has undergone continuous development in respond to the changing water environment and evolving human needs. It shows how the society constantly provides feedbacks and interactions toward dynamics. While the social and natural environment is changing rapidly in PRD, the landscape framework should evolves with the environment to enhance social-ecological resilience.

Ecosystem service

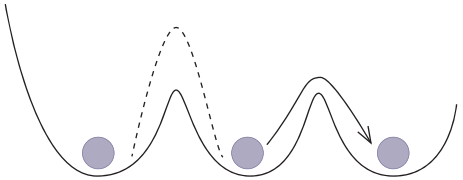
The ecosystem service is identified by TEEB (2010) as "the direct and indirect contributions of ecosystems to human well-being ". The provision of ecosystem services for humans is one of the goals of sustainable development. The Ecosystem services can be divided into Provisioning Services, Regulating Services, Supporting services and Cultural services. Negative (trade-off) and positive (synergistic) interactions between ecosystem services may arise from competing stakeholder interests (Bennett et,al., 2009). Traditional agriculture provides a diverse range of ecosystem services through precise management, while some of them have been lost in recent decades of development in the PRD. Through explicit management interventions, the landscape can enhanced positively correlated services concurrently and achieve a "win-win" situation. (Stosch et al., 2017)



Landscape-based urbanism

Physical landscape structures and associated natural processes are seen as fundamental to creating favourable conditions for future development.

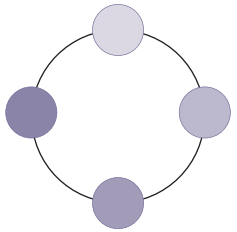
Steffen Nijhuis, 2022



social-ecological resilience

It provides a valuable context for the analysis of social–ecological systems, an area of explorative research under rapid development with policy implications for sustainable development.

Folke et al., 2002



Ecosystem service

the direct and indirect contributions of ecosystems to human well-being

TEEB, 2010

2.1 Methods and steps

The research consists of two domains: Design research, which involves analyzing and developing design principles, and Research by design, which is the process of generating knowledge through the act of designing (de Jong and van der Voordt, 2002). The construction of the adaptive landscape framework serves as a bridge between them.

Design research

Understanding stage

- Literature review: By understanding the concept of the social-ecological system, social-ecological resilience, ecosystem service, adaptive cycle and panarchy, I can better compare and assess the transformation of different agriculture typologies, and understand the system across time and space scales.

-Landscape typology: Four main agriculture typologies are made based on the study of their incremental developing process and their current landform.

-Layer approach: For each typology, I decomposed the physical landscape into three layers, namely the nature and water layer, the agriculture layer and the settlement layer. By understanding the transformation of each layer and the relationship between them, further evaluation of their ecosystem service could be made.

-Parameters and rubrics: The concept of ecosystem service is used to evaluate different typologies from the aspect of supporting, provision, regulating and cultural services.

-Mapping: A structure map will work as a conclusion of the understanding of upcoming challenges and potentials by mapping several essential elements.

Principle setting stage

-Literature review: By going through theories on landscape-based urbanism, social ecological system, resilience and nature-based design, mature ideas and principles can be learnt and adapted.

-Precedent study: Precedent study is complex description through which experience could be gained. On the one hand, I would study the research on traditional agricultural techniques (including water technique and reclamation technique) in PRD to learn how the former people worked with nature. On the other hand, I would learn from existing design cases on flood risk management and agriculture transformation.

-Toolbox: The toolbox will work as an intermediary between principle and design exploration. It will contain several solutions toward different layers (nature and water/ agriculture/ settlement) in adaption to different development conditions.

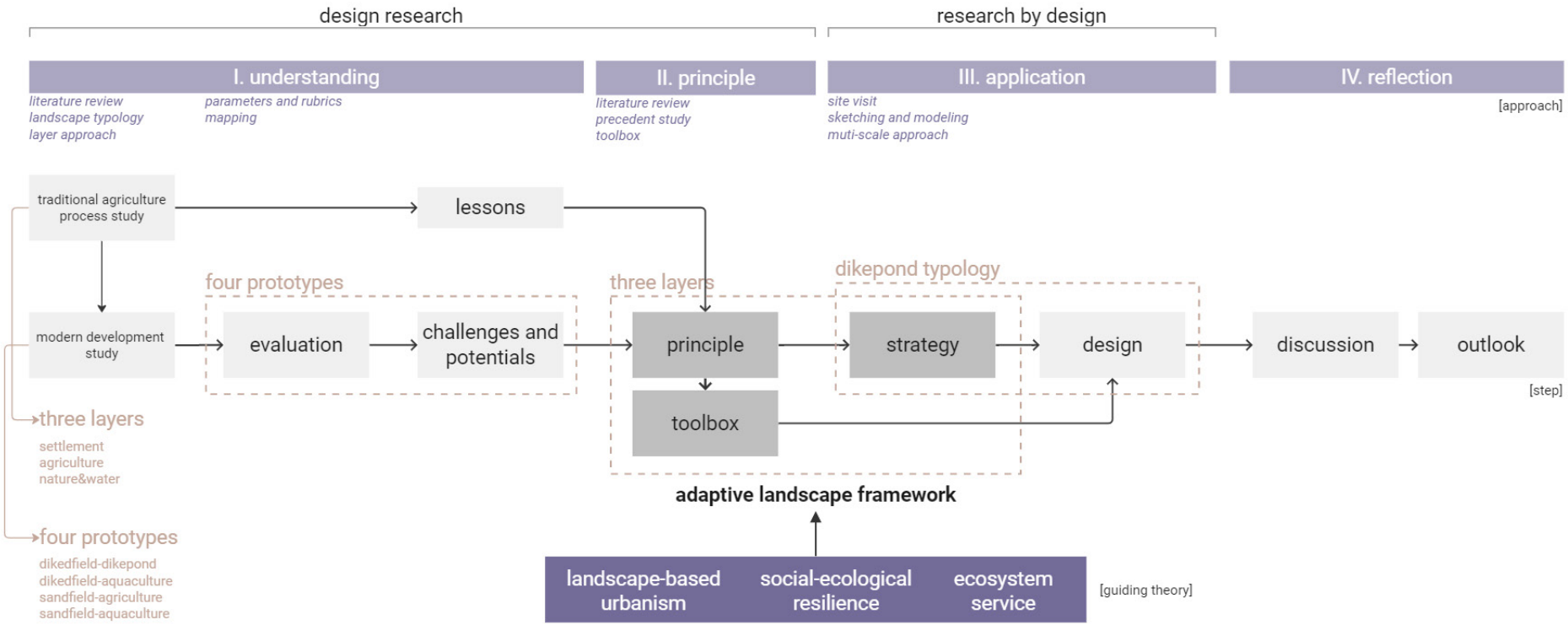
Research through design

Design exploration stage

-Site visit: The site information will be collected online, including information from google maps, google earth, google images, and official websites (https://www.octgulou.com/).

-Sketching and modelling: during the design process, sketches and digital models will be made to help me visualise and iterate my ideas.

-Multi-scaler approach: the design principles and exploration will be conducted through different scales: Meso scale (regional vision), micro scale (landscape structure) and nano scale (spatial experience).



The relationship between theory, method and step

Source: author

PART B
Understanding through Process

Source: http://hdd-group.com/zw/index.php?c=article&id=204

3 Traditional agriculture

"In the Pearl River Delta, you can strongly perceive the spatial difference through these two routes.

The first route crosses the plains between the rolling low hills and the rivers, with fishponds in patches, dense villages with big banyan trees, temples and ancestral halls.

In the second route, among the vast rice fields or sugarcane fields, small, humble houses are built along a dike fence, beneath which channels gush.

——Liu, 2003

3.1 The land formation

The overall evolution of the PRD can be understood as a series of “filling up” processes. Initially, several sub-deltaic plains were formed through the deposition of river sediments, which were generated by medium-scale, consistently dynamic systems. When the reclamation started along with the agricultural practice, the broad water body was gradually funneled into the channel frame of the PRD network (Wu, 2014).

The polder type on the west side of the PRD can therefore be divided into two main categories depending on the method and the time of reclamation: namely dikedfield and sandfield.

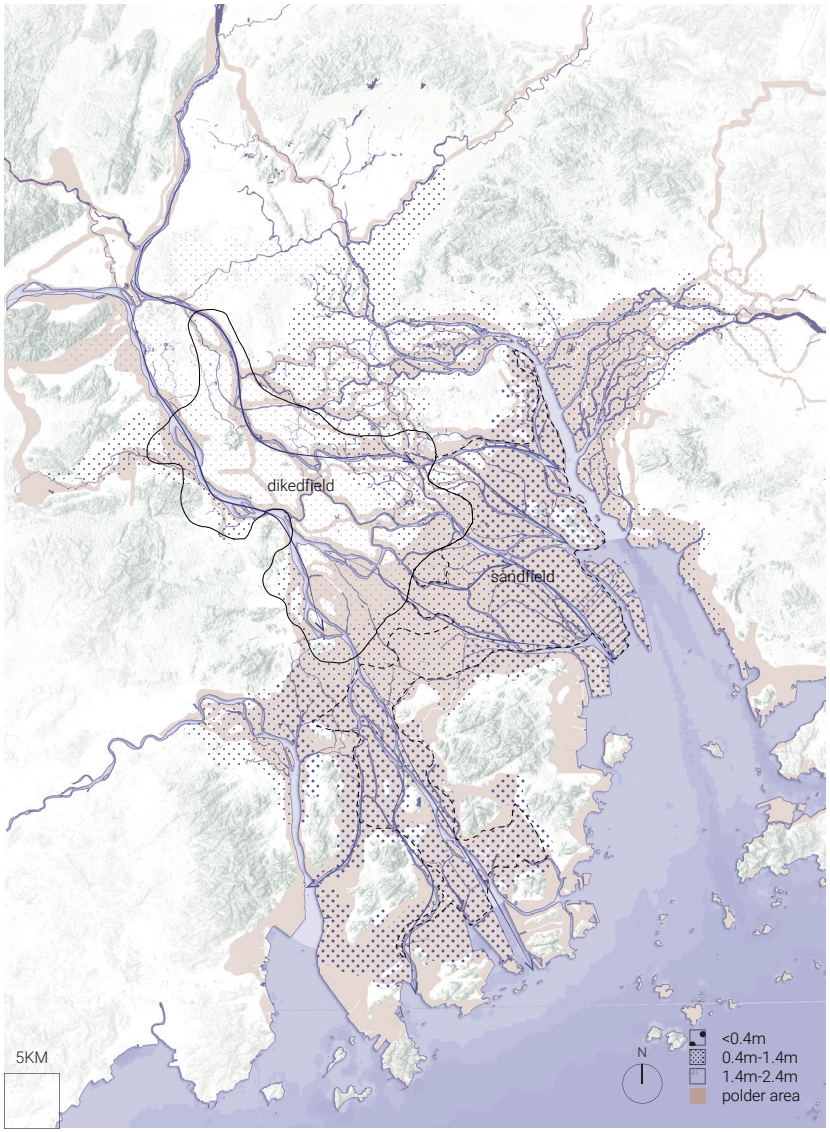
Dikedfield was the first area that people earned from water, starting from the Song Dynasty (960AD). It is located on the northwest side of the delta with a relatively higher elevation and separated mountainous terrain. Here, people reclaimed the land by building a dike in the tidal area of the estuary. The land is composed with silty clay.

The Sandfield was formed much later, beginning in the Ming Dynasty (14th century). At that time, people had more advanced reclamation techniques, and they gained land by throwing stones and planting grasses in the water to accumulate sediment. The sandfield is low and has sandy loam. River network is more dense in this area. With the reclamation of sandfield, the land in the Pearl River Delta began to expand rapidly in the direction of bay.

(dikedfield and sandfield are the translation of the Chinese terms ‘weitian’ and ‘shatian’)

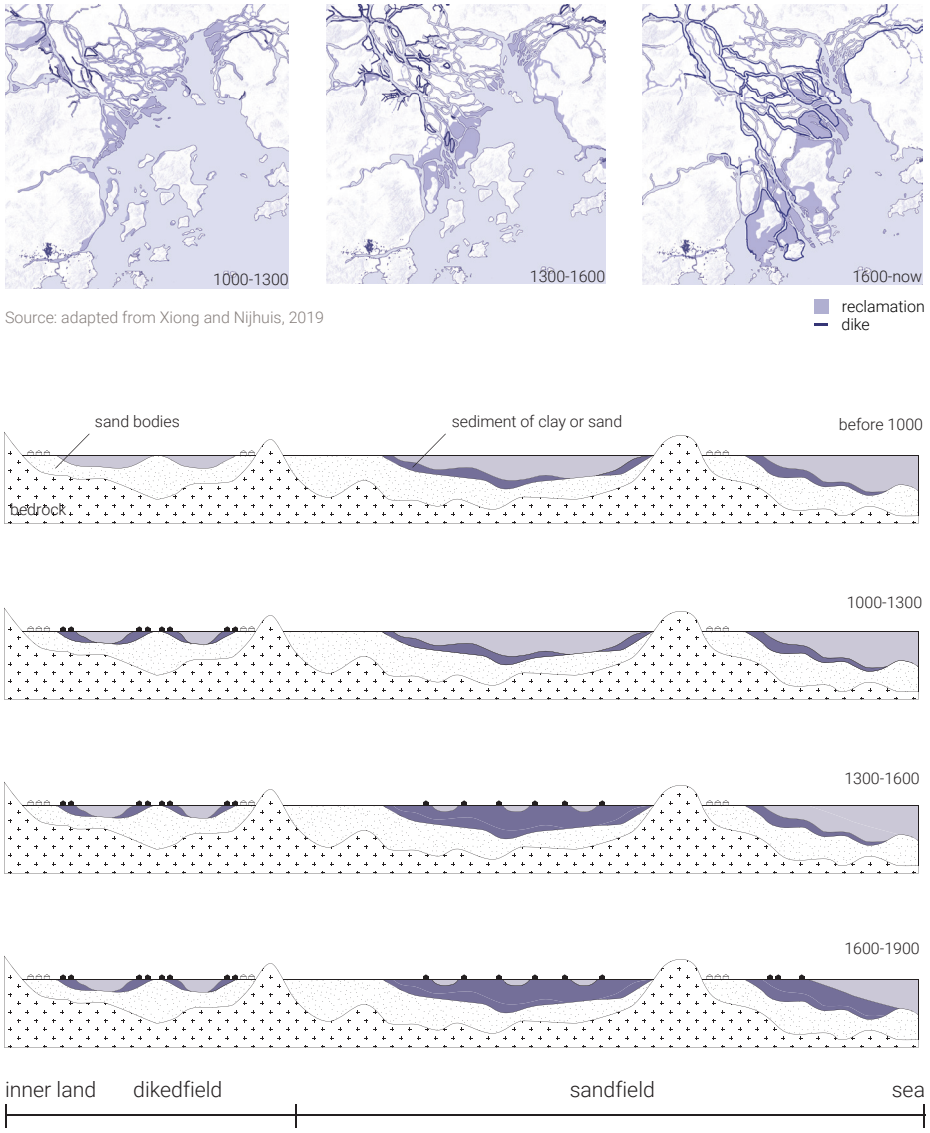
The natural deposite and deltaic evolution processes before 2000BP

Source: adapted from Wu, 2014



Geographical condition of dikedfield and sandfield

Source: based on Zong et al., 2004



The land formation process

Source: based on Wu et al., 2021

3.2 The incremental process

In this process, the natural environment is not only transformed by human activities, and in turn contributes to the transformation of economic activities and social life in the PRD. The agricultural system of the PRD then shows a incremental development process under the social and ecological interactions.

Initially, dikes were built to convert marshland to cropland, that is, the dikedfield. At that time, dike was an open system, and people used tidal water to irrigate single cropping rice. By the Ming Dynasty, dikes and silted tributaries changed the hydrology of the main rivers. The falling tide level made it difficult for people to use the tide water, while the river bed raised by silt deposits made the flood level rise. People had to raise the dykes and close them with sluice gates for flood protection. The enclosed system makes it difficult for stormwater to drain from land, making these lowlands highly prone to flooding. For this reason, people excavated lowlands to form fishponds, and transformed the agricultural model into rice-fish rotation or planting vegetables and fruits on dikes around fishponds. The large number of water conservancy projects have greatly promoted the birth of clan society that cooperates with the family unit.

By the late Ming Dynasty, the increased population stimulated the development of commodity economy in the dikedfield. The most typical example is the mulberry fishponds that relied on the international silk trade in the 17th century. At the same time, some villages dominated by large clans started to reclaim land at the estuary, that is, the sandfield, in order to obtain arable land for grain.

Reclamation in sandfield was often done by clan-employed fishermen. After losing the fishing waters, these fishermen also turned to crop farming in the Sandfield. However, the process of reclamation was often disorganized. Facilitated by the government, the development of sandfield became a competition for land grabbing by various clans. The reclaimed land increased the length of the river out to sea, which further increase in the river's flood level. The embankments in the dikedfield often burst, so in the Ming and Qing dynasties, embankments were built within embankments. Today the dike system is still the way of coping with floods in the Pearl River Delta.

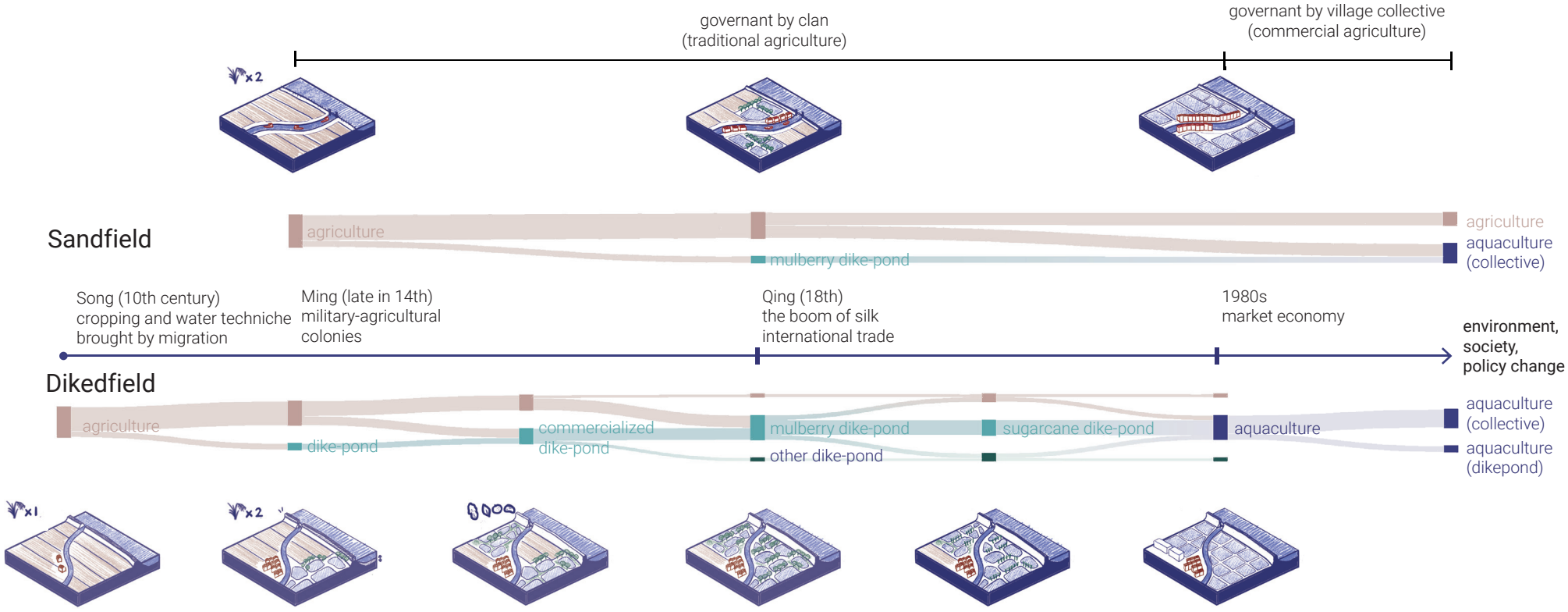
The sandfield district has always been dominated by grain production. A small portion of farmland was converted to mulberry-based fishponds when the mulberry silk trade became popular. It was not until 1990s, after the market was opened, intensive farming with great economic benefits became popular in dikedfield and sandfield. This transition will be detailed in Chapter Four.

Ancestor hall in dikedfield, the symbol of clan

Figure: http://www.laozhaopian5.com/

Fishermen transporting in the sandfield

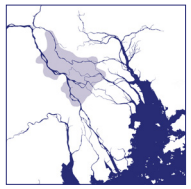
Figure: https://m.thepaper.cn/newsDetail_forward_8807118

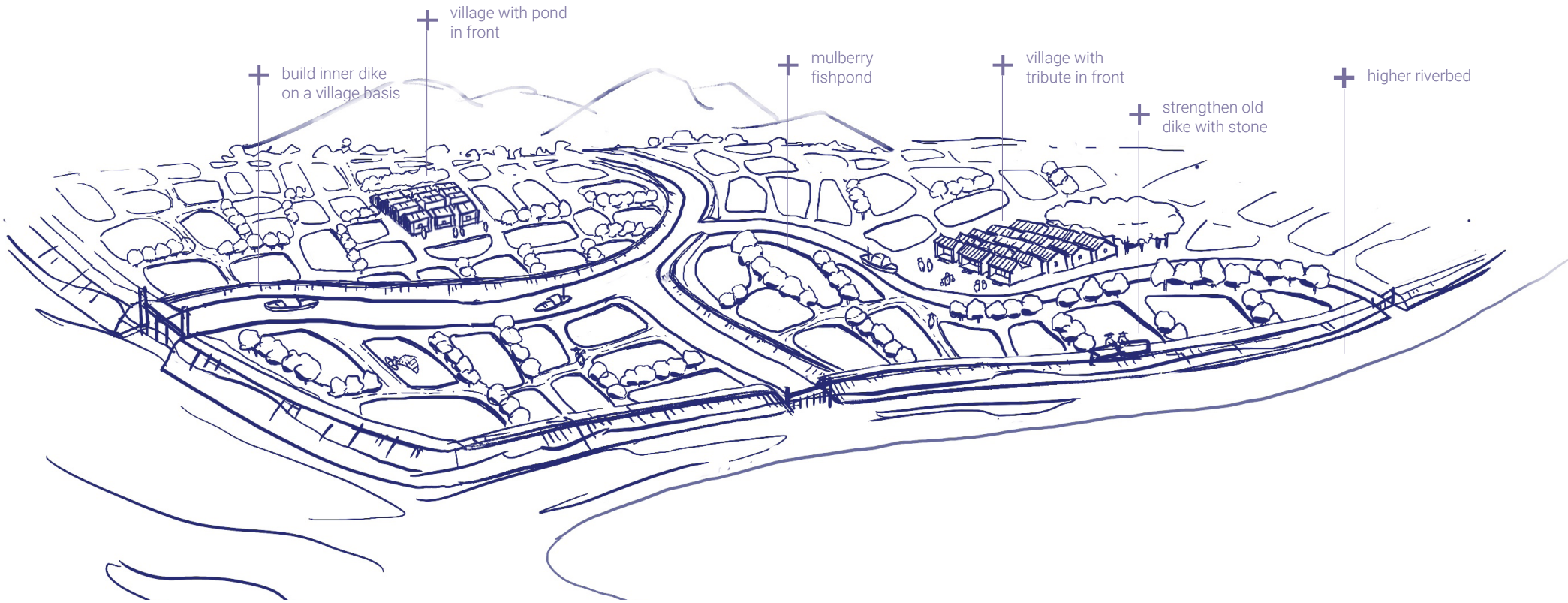


The development process of traditional agriculture

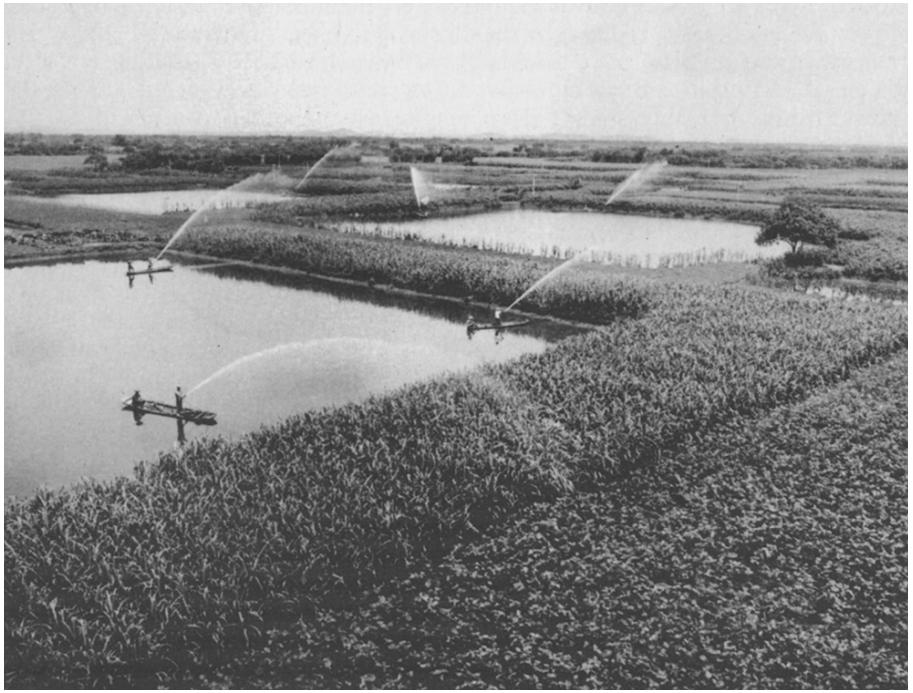
Source: author

Dikedfield





An overview of dikedfield
Source: author



The outer rivers of dikedfield tended to have much higher flood levels than inland. People responded to increasing floods by continuously strengthening dikes. Both agriculture and settlement obtained water through terminal water systems, such as channels with controlled water levels through sluices and the ditches connected to channels. To address waterlogging issues, people had dug ponds in low-lying areas. The dredged silt from these ponds was then used to create mounds around them, where fruit trees and crops were planted. The cluster-like villages emerged under the influence of clan dominance.

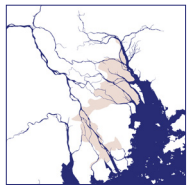
Irrigating sugarcane and mulberry with pond water (left)

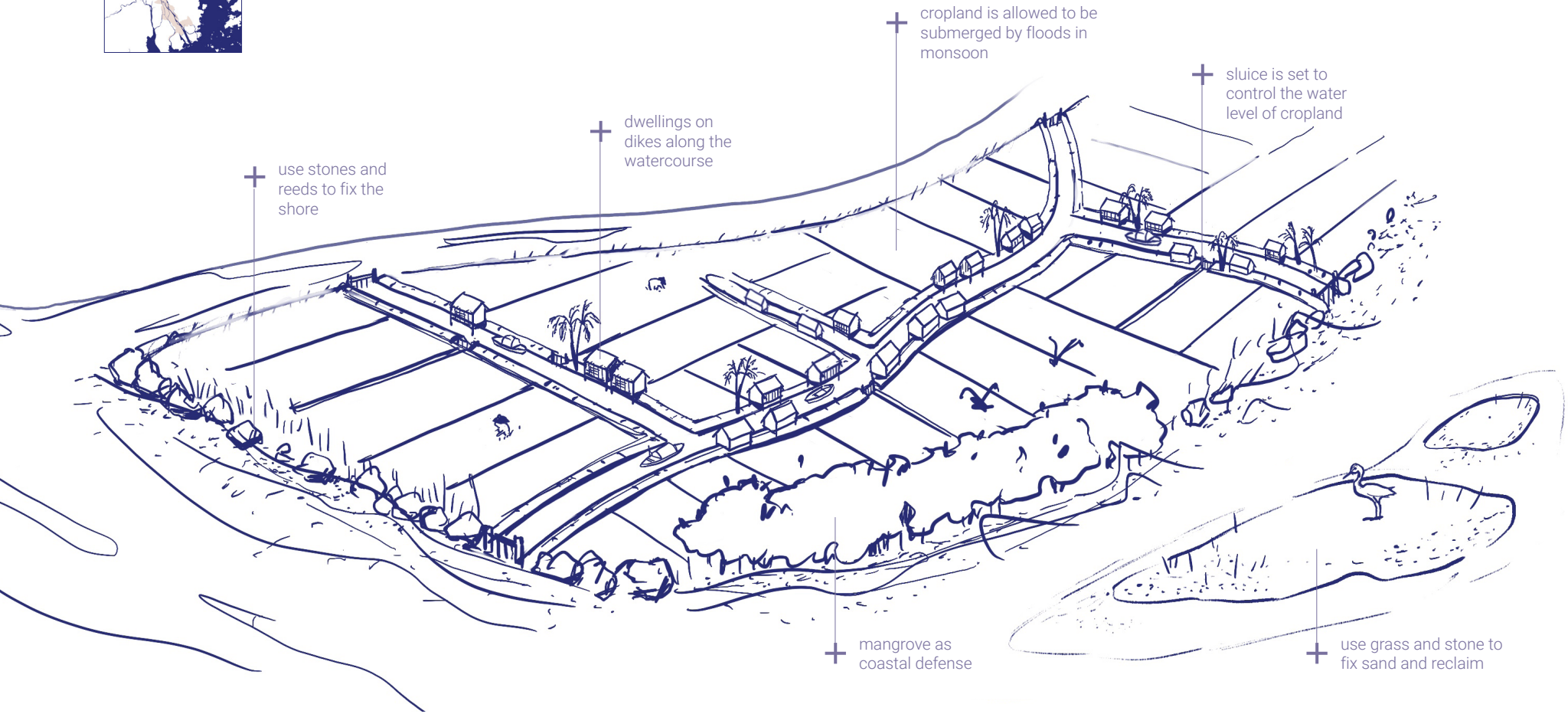
Figure: Zhong et al., (1983)

The village cluster (right)

Figure: Guangdong New Express

Sandfield





An overview of sandfield

Source: author

The Sandfield was typically created through the gradual accumulation of sand over a span of more than ten years, aided by the deposition of grass and stones. To protect against typhoons and storm surges, mangroves were employed as a natural defense, while the shore was protected using soft edges created by stones and reeds. In terms of agriculture, salt- and flood-tolerant rice varieties were utilized for crop rotation. During the monsoon season, floods were channeled through ditches to supply freshwater and nutrients to the cropland, facilitating a beneficial exchange. The managers of the sandfield, the fishermen, who traditionally lived on boats parked along the banks and were restricted from accessing the land until the 17th century, developed settlements with a distinctive linear structure along the dikes of the channels.

Crop harvesting in 1970s (left)

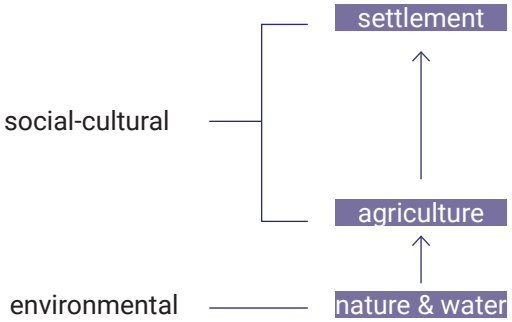
Figure: Nansha Library Archives

Settlement in 1960s-1970s (right)

Figure:Nansha Library Archives

3.3 lessons

Based on the characteristics of diked fields and sand fields, as well as insights from Chen's research in "Rural Landscape Planning and Theoretical Tradition" (2010), the agricultural system in the Pearl River Delta can be viewed as a social-ecological system consisting of three interconnected layers: nature and water, agriculture, and settlements. Lessons can be derived from each of these three aspects.



Nature and Water

Multiscale network & connectivity

The traditional agricultural water system is divided into three levels: external water, channel and ditch. People seperate different levels of water by dike and connect them with sluice. In this way, the flow and renewal of water body can be ensured while preventing flooding.

Space for water

When people realize that water is not able to be blocked or discharged, they find way to live with them by giving more room for water. Moreover, they generate technique to make use it, for example, raising fish , restore freshwater etc.

Agriculture

Multifunctional

By making best use of the water, the agricultural land develops funcitons besides production, such as providing freshwater, fixing inundation etc.

Regenerative and efficient

In order to make best use of the limited land and gain the most profit, people combine different farming types (such as fruit farming, crop farming and aquaculture) in the same space in an intensive way or in different period of a year.

Work with nature

People are good at using natural material (such as sludge, mangrove, reed and stone) and natural process to build up their environment.

Settlement

Make use of terrain & land efficiency

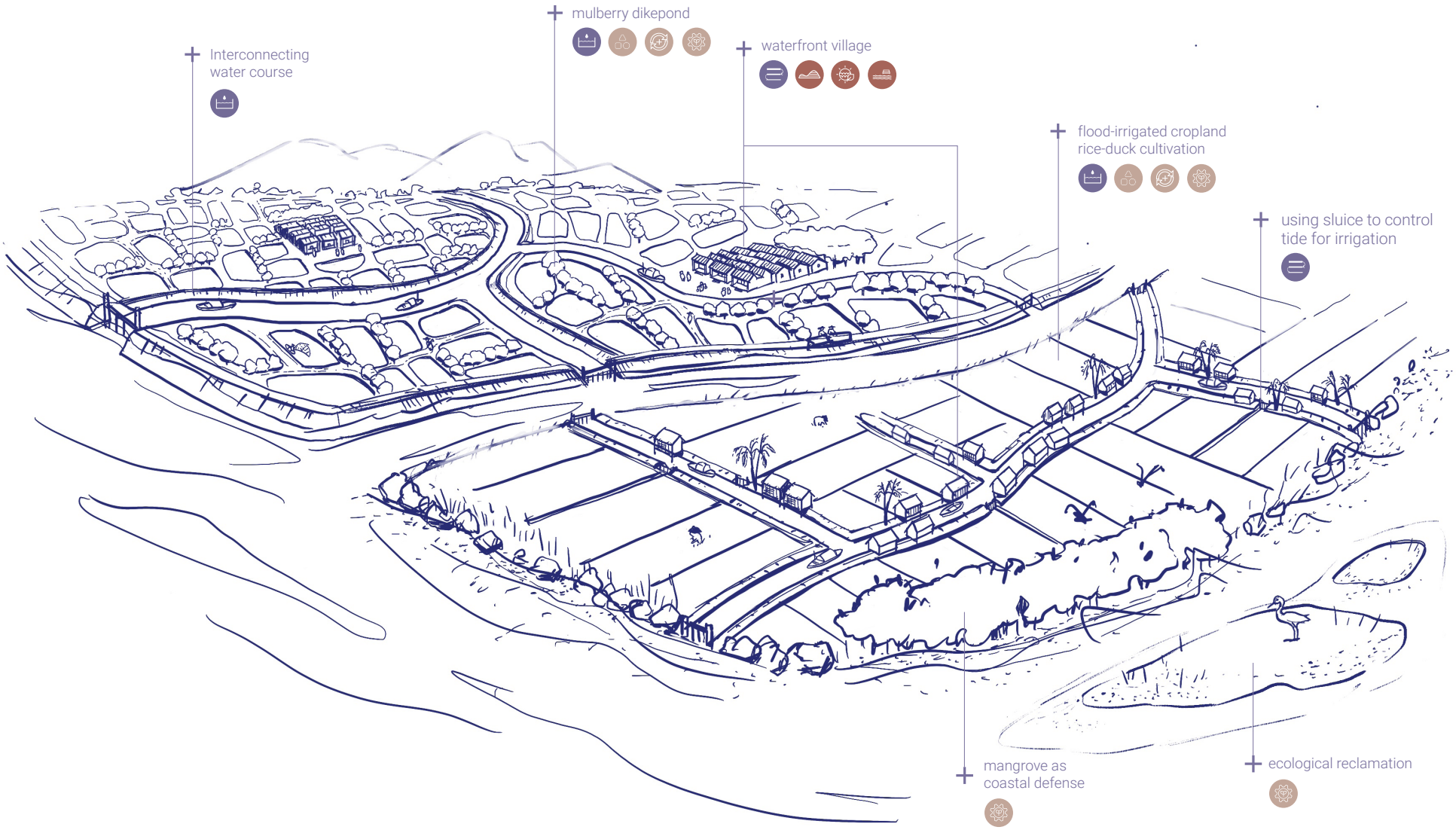
In order to avoid floods, settlements are located on high ground or dikes. Since the land that meets these conditions is limited, the layout of buildings is often condensed.

Sufficient resource supply

Settlements often choose places with enough arable land and close to water sources to achieve self-sufficiency

Water-related public space

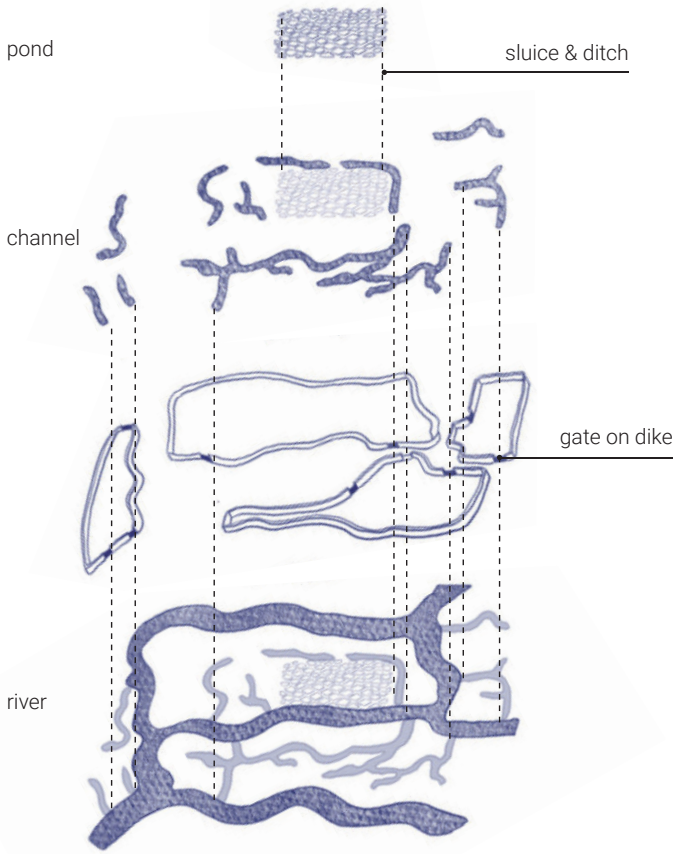
As most activities are happened along the waterside, places like the square in front of ancestral hall, pier, and water market has naturally become the social space for people.



Summary of lessons from traditional agriculture

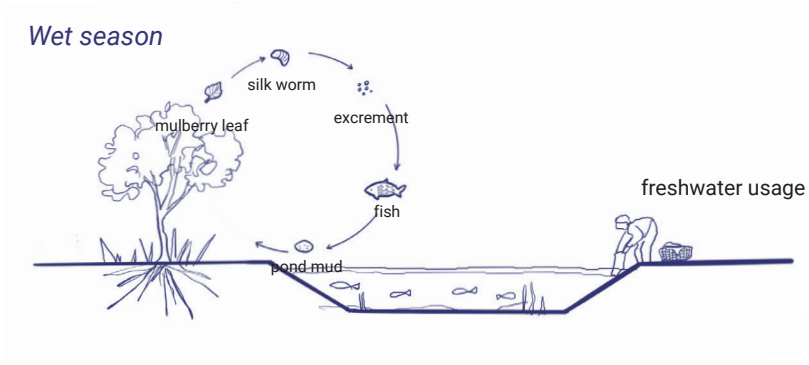
Source: by author

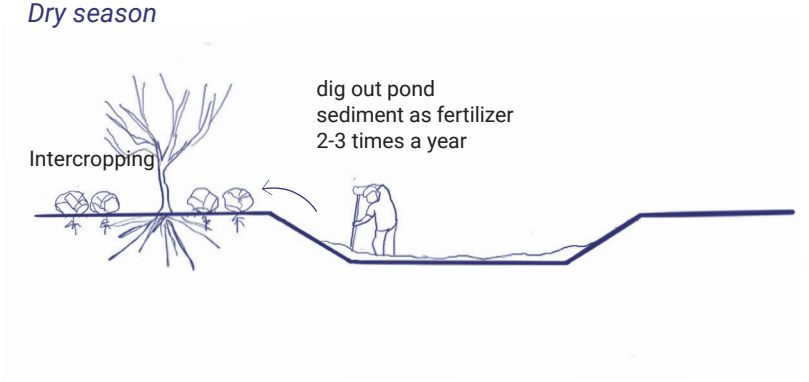
Case 1: Water structure in dikedfield



The infrastructure works together with the natural water system to form the traditional water structure. The outer river, dike, and gate form the peripheral system. The channel, ditch, sluice and pond form the stable and controllable inner system (Liu, 2016).

Case 2: Mulberry dikepond

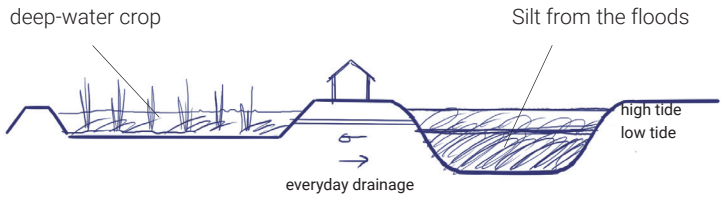




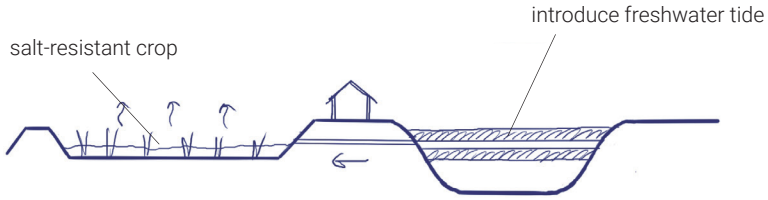
The production of mulberry, silkworms, and fish is an interconnected and cyclical process. Mulberry leaves are used to feed silkworms, and the silkworm waste, known as silkworm sand, can be used as food for fish. Additionally, mulberry can be planted in the nutrient-rich pond mud, further enhancing the overall production cycle.

Case 3: Floodable cropland

Flooding season



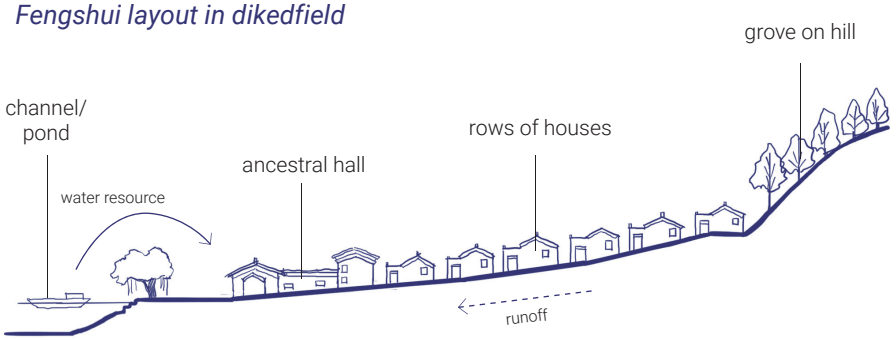
Dry season (salt tide invasion)



During the flood period, the freshwater tide allows people to carry out drainage and irrigation everyday. Floods bring a lot of silt, increasing nutrients in rice fields (GDAAS, 1962). During the salt tide invasion period, freshwater tide can be introduced in specific tide level (Working Group of Guangzhou Soil Research Institute, 1960). Also, deep-water crop and salt-resistant crop are intercropped to fix inundation and saline environment.

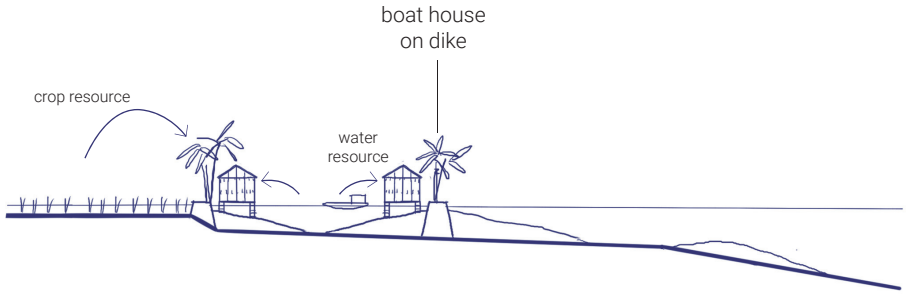
Case 4: Waterfront village

Fengshui layout in dikedfield



Distributed along tributaries or ponds, the village is led by the ancestral hall. The terrain at the back of the village is higher than the front to facilitate drainage. The waterfront area of the ancestral hall is the place for people to gather and socialize (Chen, 2018).

Boat houses in sandfield



The residential buildings are built along the embankments of the channels for convenient water intake and irrigation (Zhang et al., 2019).

Although sustainable development experiences could be learned in traditional agriculture, we can still observe some vicious trends throughout the development process.

First of all, the construction of dikes and reclamation influence the hydrology and intensify the floods. The result, in turn, will promote the construction of dams, forming a vicious circle. Secondly, with the strengthening of human activities and the improvement of productivity, it is inevitable to destroy the ecology. With the improvement of productivity, crops are increasingly dependent on manual fine-grained management, resulting in higher costs and lower risk resistance.

Unfortunately, this trend has been rapidly intensified in the past forty years, and the people of the Pearl River Delta have thus placed themselves in a fragile environment.

Waterlogging caused by the joint-dike construction in early 1950s

Source: Chinese Video History


Source: http://hdd-group.com/zw/index.php?c=article&id=204

4 Modern development

"During the process, it is hard for the local citizen to realize their change in their farmland can lead to a totally change of urban pattern in the delta scale. It is an urban pattern that heavily dependent on the delta-scaled dike system, instead of the long tradition of landscape dependent in the Pearl River Delta.

——Xiong & Nijhuis, 2018

4.1 The rapid transformation

Background

After the implementation of economic reforms and the opening up of China in 1978, the Pearl River Delta region experienced rapid industrialization and urbanization. The government's push for the development of secondary and tertiary industries led to the conversion of vast farmlands into industrial and residential areas. The dikedfield, characterized by its developed economy and flat terrain suitable for construction, became the focal point for urban expansion, and traditional villages were surrounded by rapidly growing townships.

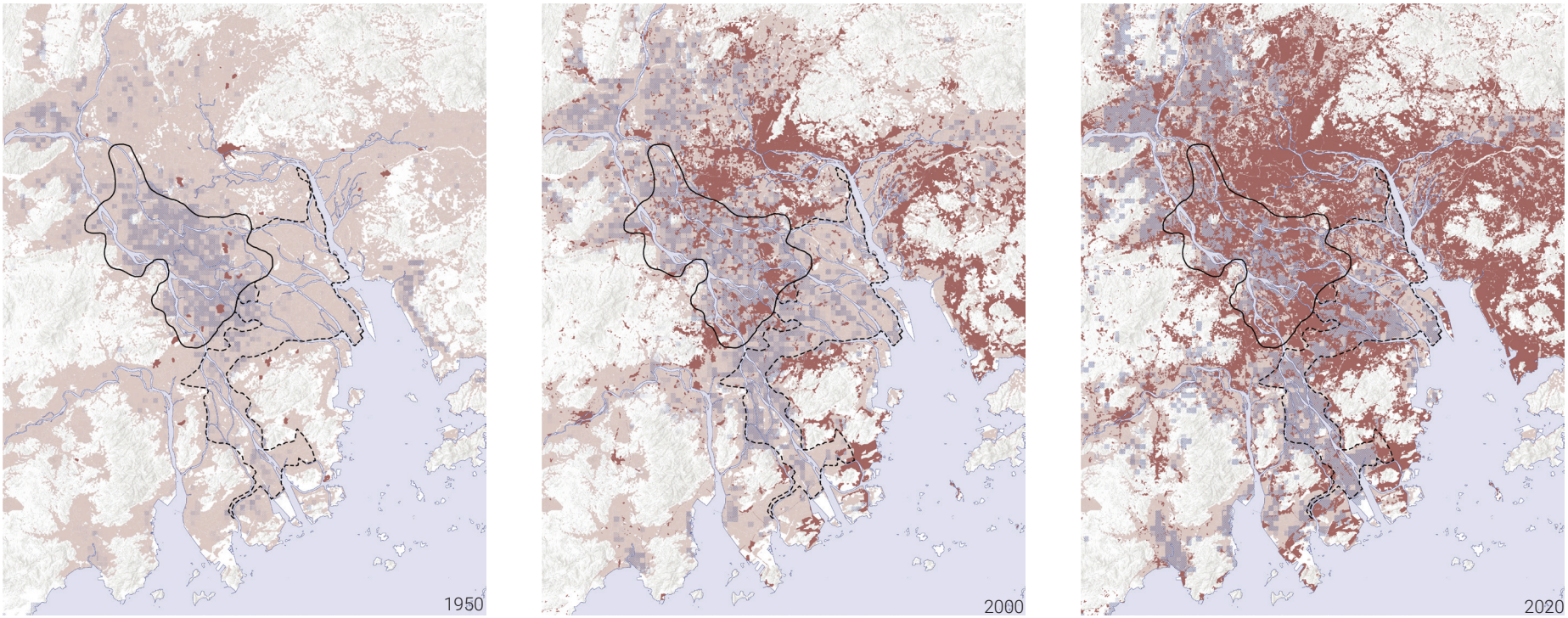
Simultaneously, farmers were granted the freedom to choose their crops and sell them in the market. Motivated by profit, agricultural practices in the Pearl River Delta shifted from subsistence farming to commercial agriculture. Specialization, mechanization, and large-scale farming became prevalent trends in the region (eduhk, 2021). Additionally, in 1990s, modern aquaculture systems offering profitable opportunities were introduced and adopted by local farmers (Guo, 2015).

The farmland around the village were turned into construction area

Source: Yang, 2011

Aquaculture standardlization

Source: http://www.gxxjzy.com/nd.jsp?id=536



Urbanization & Aquaculture expansion

Data: GLOBALMAP30; Zhang, W. et al., 2021

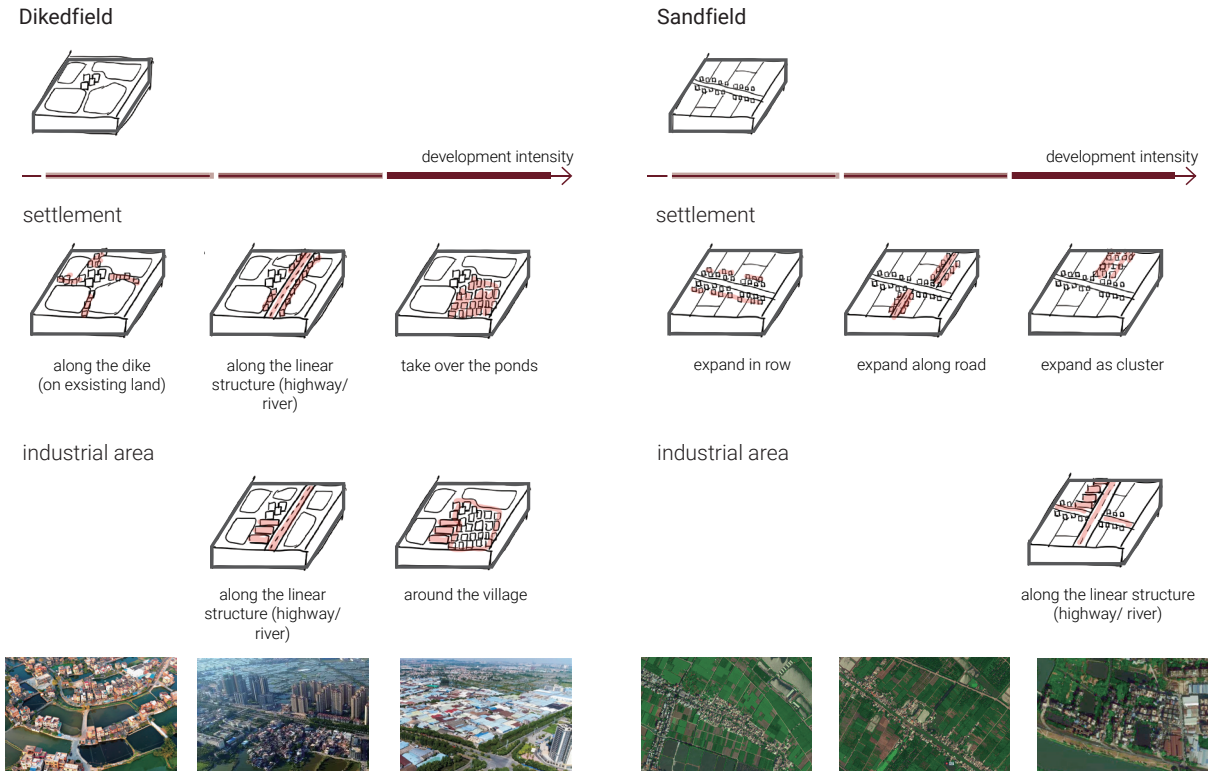
Development mode study

To gain a comprehensive understanding of the spatial significance of these transformations, a study of the development mechanism at the meso scale was conducted.

Urbanization mode

Overall, the urbanization intensity of dikedfield is higher than that of sandfield. For the dikedfield, the settlement patches firstly grows into the continuous “edges” around the ponds. With the construction of new infrustructure, settlement as well as factories develop along highways or canals (Tian, 2019). Finally, the large mosaic of residential area and industrial plot take over the pond and expand along the villages, which will be connected to the adjacent villages and combined as a large cluster of 2~6 times the original scale (Yang et al., 2022).

For the sandfield, the expansion of urbanization is not obvious. According to Zhang's research (2022), traditional linear settlements still account for 79.5% of the settlements in sandfield. When the space cannot meet the demand, the residents expand parallel to the linear structure in an array. Then it extends along the road, which forms a herringbone or cross shape. The last is the demolition of old sites and construction of new fisherman's villages, but this type only accounts for a minority (2.5%).



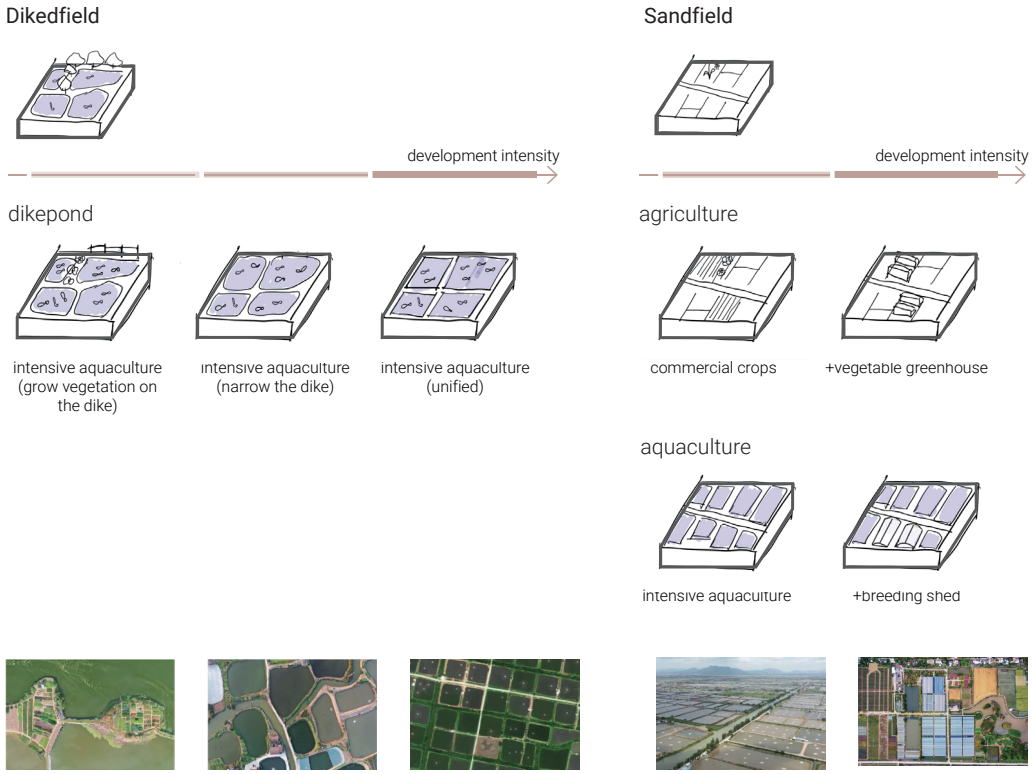
Urbanization mode

Source: author

Agriculture intensification mode

The popularity of aquaculture had a direct impact on the land-water proportion. On a small scale, the dikes were gradually narrowed, leading to a shift from traditional fruit tree and mulberry tree planting to extensive cultivation of self-produced and self-marketed vegetables and fruits (Tian, 2019). This transition eventually resulted in the implementation of standardized grids for more efficient land management. On a larger scale, the farmland in the sandfield was transformed into unified ponds to accommodate aquaculture activities.

Large-scale and specialized farming method has also led farmers to choose to plant high-yield varieties driven by market profits, which has greatly reduced the types of crops to be planted. (eduhk, 2021). This transition has been accompanied by the widespread use of chemical fertilizers, pesticides, auxins, and nylon film seedlings (Zhang, 2022)

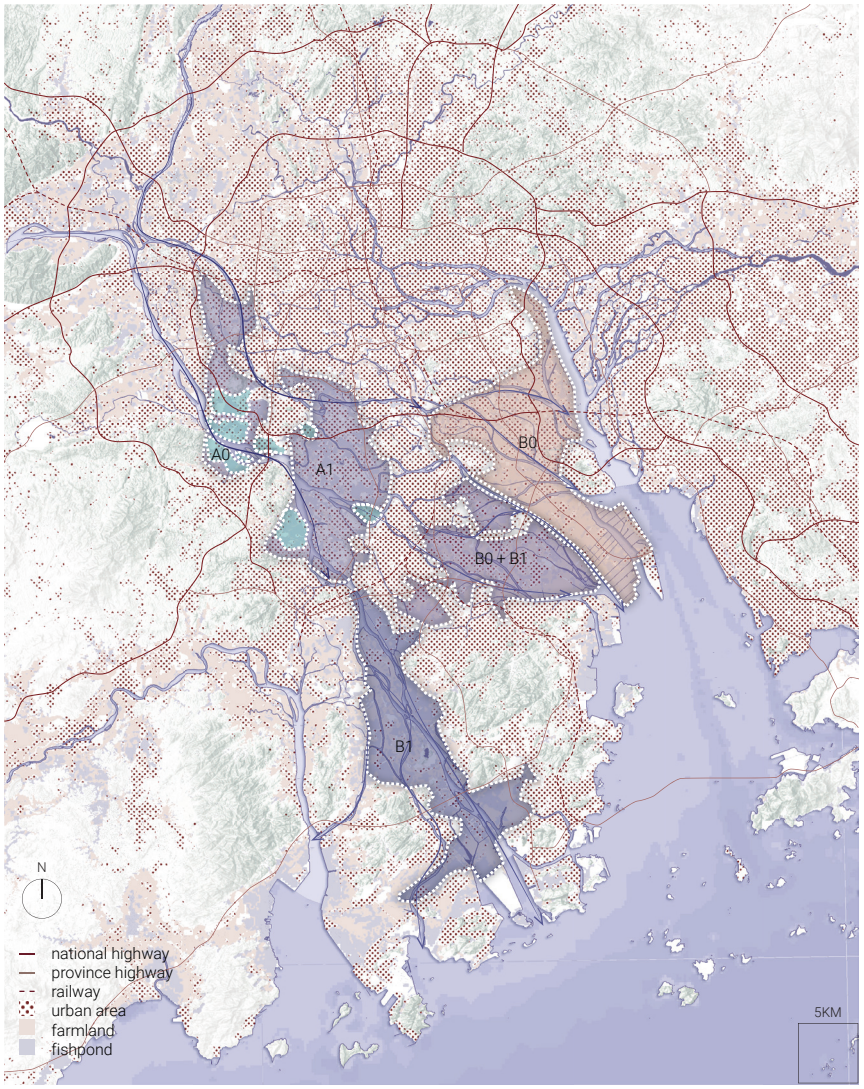


Agriculture intensification mode

Source: author

Landscape typologies

According to different intensity of urbanization and agricultural intensification ,dikedfield and sandfield can be further divided into four polder typologies, respectively a0-dikedfield dikepond, a1-dikedfield aquaculture, b0-sandfield agriculture and b1-sandfield aquaculture. Among them, a1 and b1 can be regarded as the result of further development of a0 and b0. Most of the dikedfield has been transformed into a1, and part of a0 is distributed along the banks of the Xijiang River and its tributaries. Sandfield transitions from b0 to b1 from northeast to southwest.

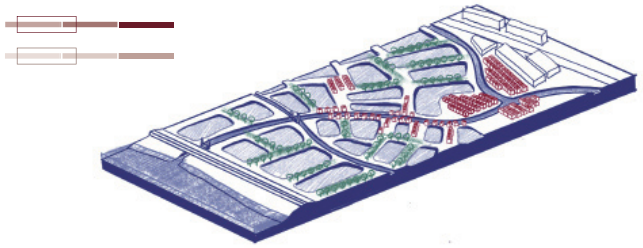


Landscape structure map (left)
Source: based on Zhang et al.,(2018), Liu (2016) and the landuse map from globemap 30

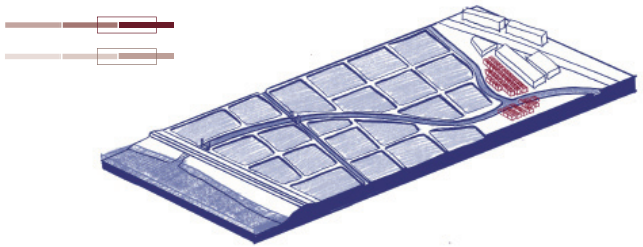
Landscape typologies (right)
Source: author

Dikedfield

A0-dikedfield-dikepond

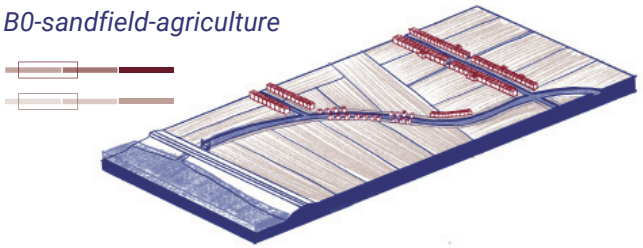


A1-dikedfield-aquaculture

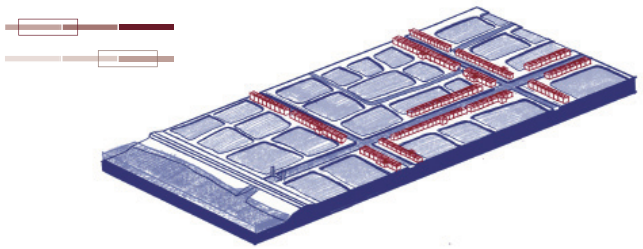


Sandfield

B0-sandfield-agriculture



B1-sandfield-aquaculture

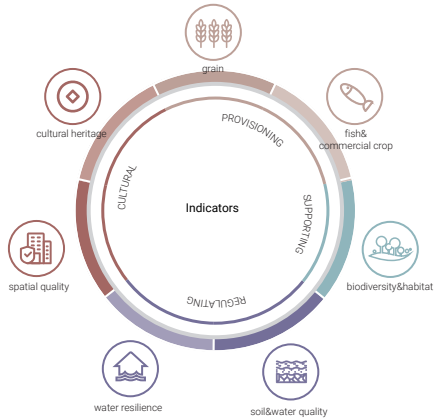


4.2 Evaluation

Indicator

To further understand the characteristics of these four typologies, ecosystem services on provisioning, regulating, supproting and cultural are referred as indicators to evaluate each typology. These indicators also align with the sustainable development goals related to production, ecology, water resilience, and living environment.

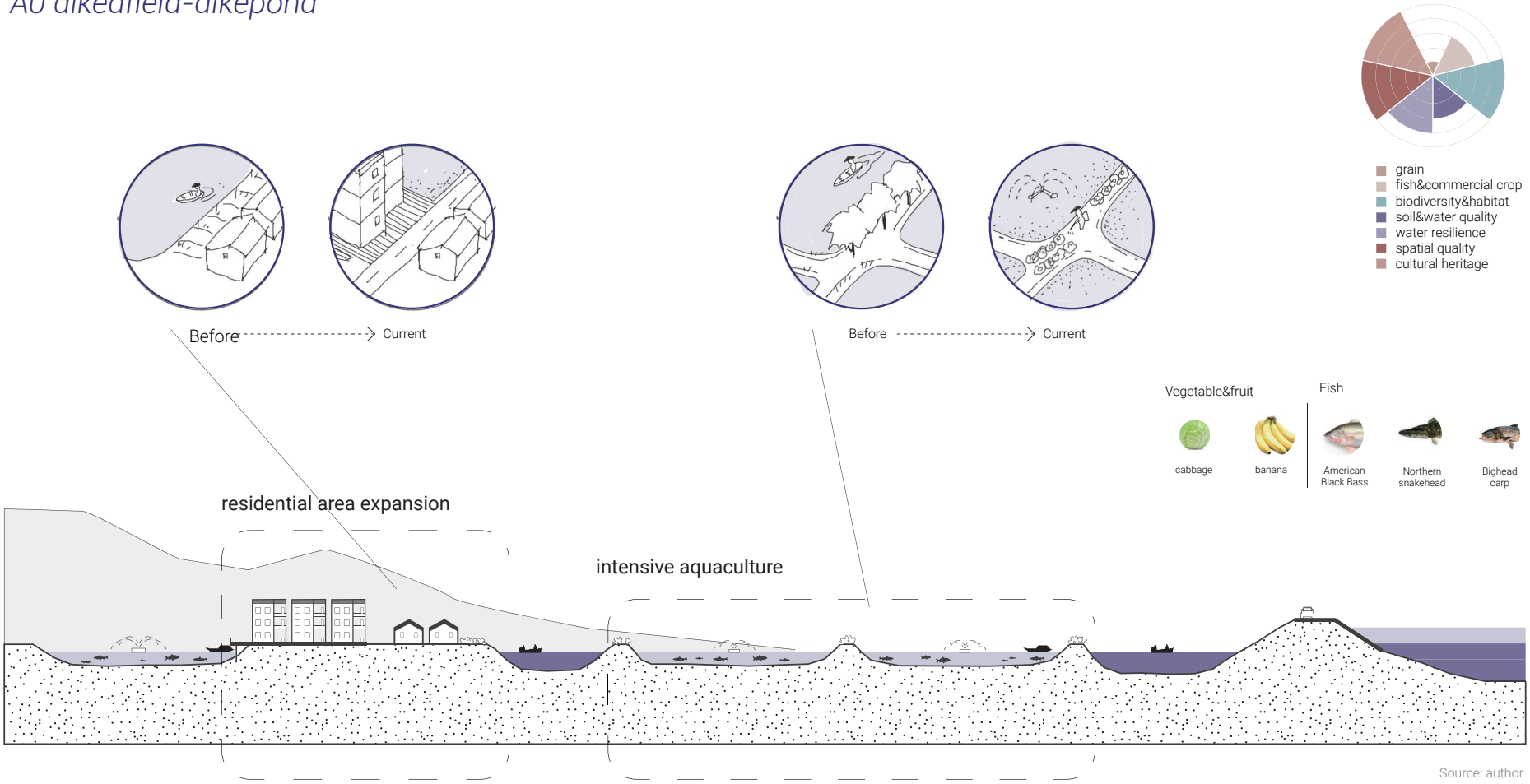
The evaluation adopts a qualitative method, and the evaluation criteria and basis are as follows.



ecosystem service	provisioning		regulating			cultural	
sustainable goal	production		ecology		water resilience	living environment	
indicator	grain	commercial	habitat quality	soil/water quality	flood buffering	spatial quality	cultural heritage
standard	-the productivity of grain crop	-the productivity of commercial product like fish, fruit and vegetables	-landuse habitat suitability -threat factor (residential area, industrial area, high way) (standard reference: Wu et al., 2021)	-the level of soil pollution by pesticides and water eutrophication according to the intensity of agriculture	-natural and man-made capacity to infiltrate and reduce surface run-offs (indices of soil type and run-off coefficient) -water connectivity (standard reference: Jian et al., 2021)	-accessibility of open green/ water space -disturbance of infrastructure (highway, factories)	-perservation of tradional agricultural landscape pattern and water structure (standard reference: Liu, 2016)
high(5)	high productivity	high productivity	suitable and less threat	less soil pollution and water eutrophication	good capacity, good connectivity	enough green space with little disturbance	well preserved
low(1)	no production	no production	unsuitable, many threats	high soil pollution and water eutrophication	bad capacity, bad connectivity	little green space with heavy disturbance	heavily destructed

Indicator and criteria
Source: author

A0 dikedfield-dikepond



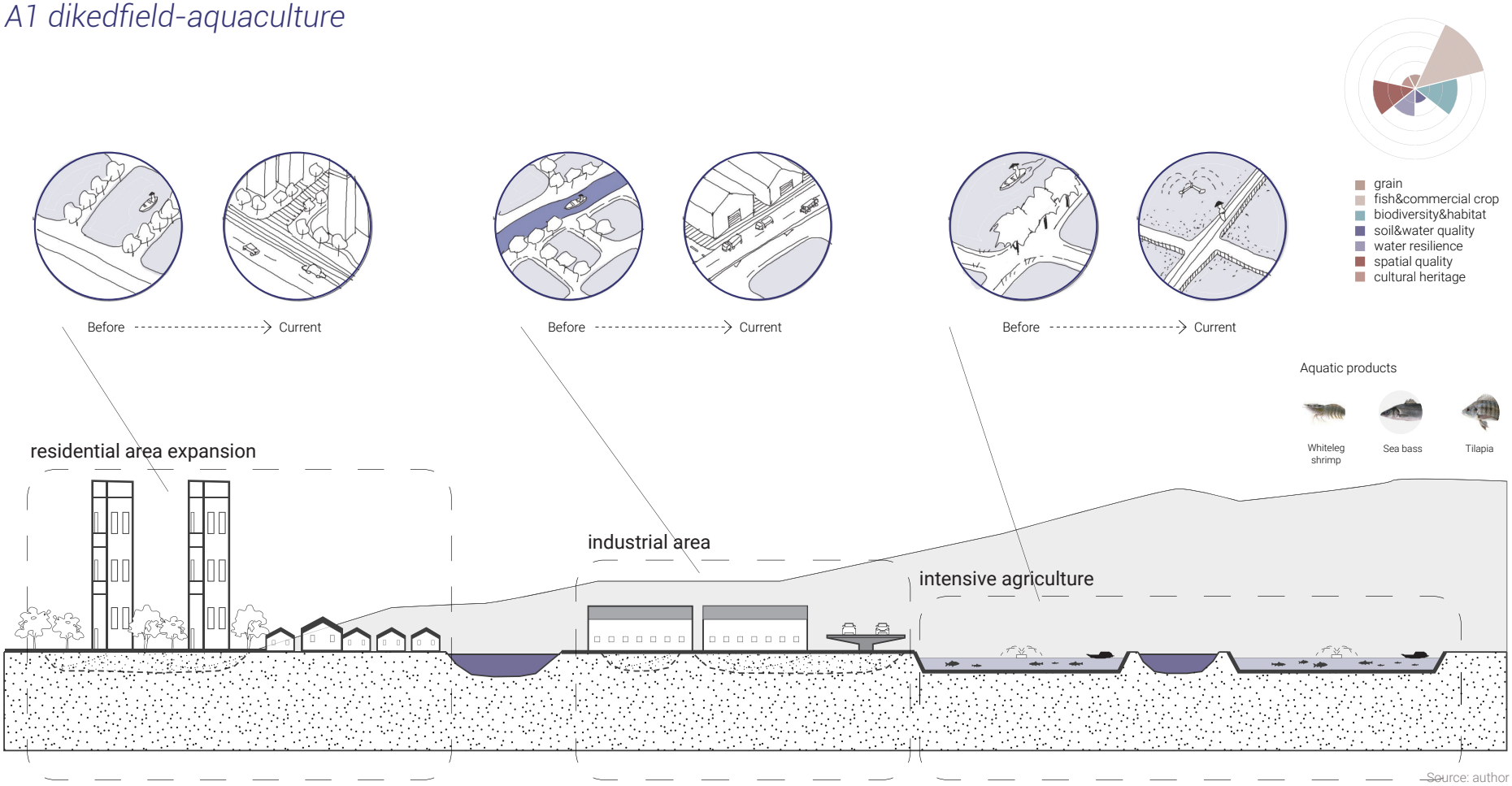
Source: author

For the dikepond, its development has often lagged behind in terms of construction and management. The dikes primarily serve for the cultivation of vegetables and fruits, and although some fishponds have been converted into intensive aquaculture, they have not reached a large scale. As a result, the yield of commercial crops in dikepond is low. Furthermore, the disrupted material circulation between water and land reduces its self-purification capacity, leading to water eutrophication.

However, the presence of large, undisturbed fishponds still offers habitats, stormwater buffering space, and cultural landscape significance. The waterfront areas and natural dikes also contribute to the spatial quality of the area.

Source: https://www.sgss8.net/tpdq/13056603/

A1 dikedfield-aquaculture

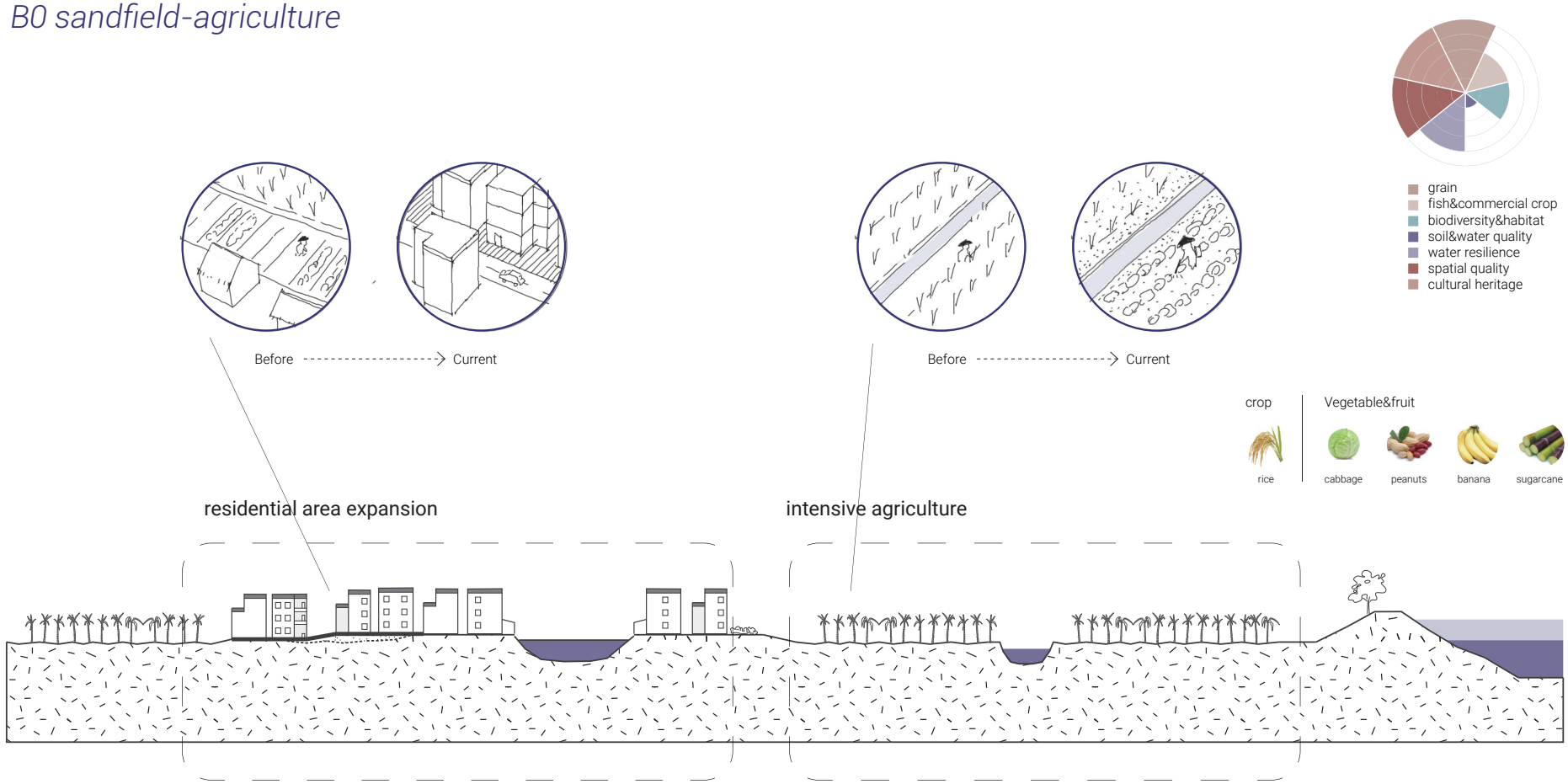


Source: author

Compared to the previous type, this landscape type involves more industry and infrastructure, and the fishponds are modified into a grid network to facilitate external contracting, resulting in a higher commercial output value. However, the solidification of the pond foundations and construction areas, as well as the encroachment of construction land onto river courses and fishponds, have significantly reduced the storage capacity. The intrusion of heterogeneous landscapes such as industrial facilities and highways (Yang et al., 2022) has also led to the degradation of the area's habitat value, spatial quality, and cultural landscape significance.

Source: google image

B0 sandfield-agriculture

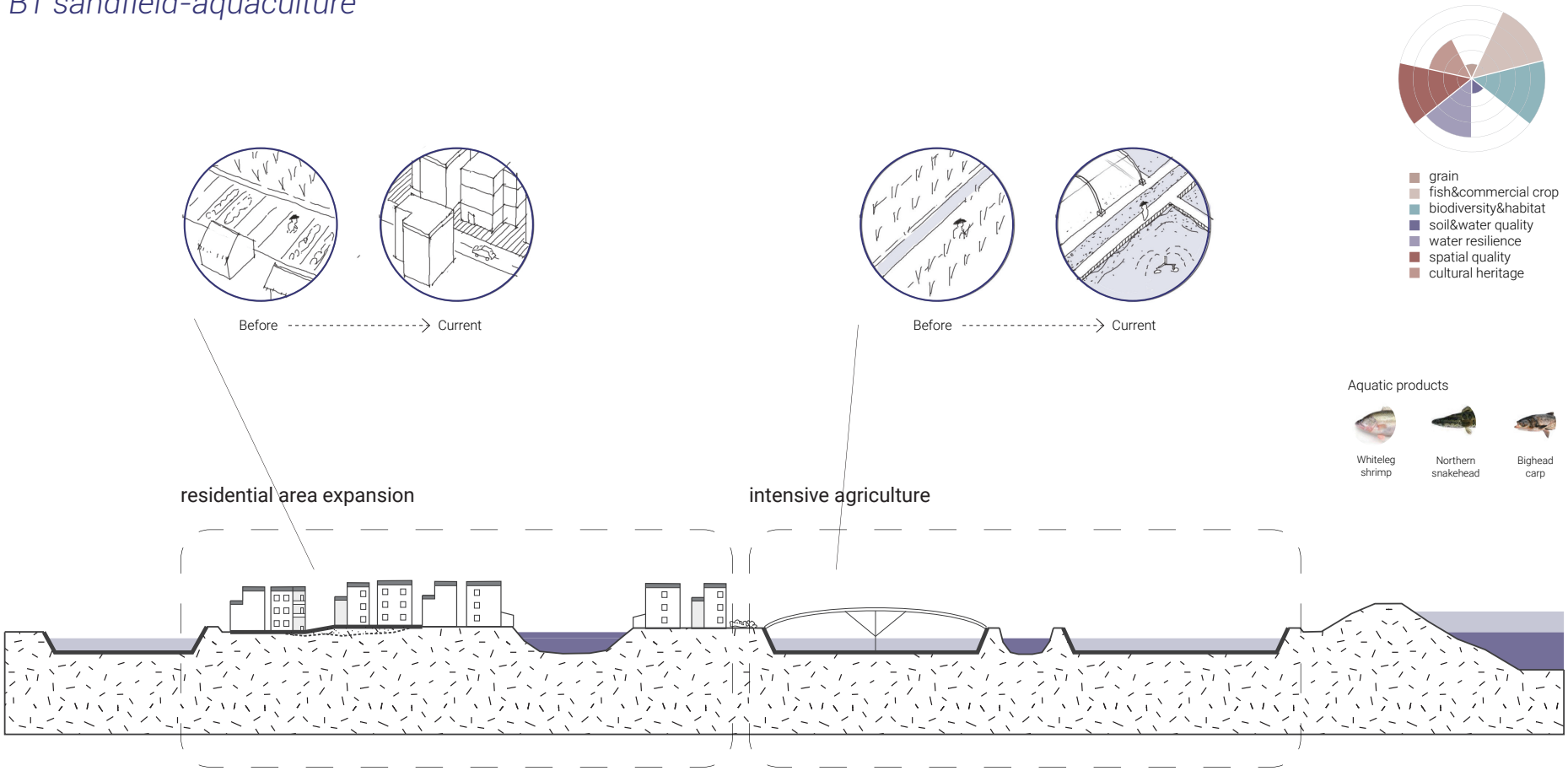


Source: author

This landscape type is relatively less affected by urbanization and industrialization, and its transformation is primarily seen in the modernization of agriculture. Instead of traditional single rice cultivation, it now offers a wider variety of commodity crops, including fruits, vegetables, and sugar cane. The sandy loam soil in the sandfield allows for good permeability, and the low density of road networks and the presence of parallel rivers contribute to the unique landscape pattern. The scenery of rivers dividing vast hectares of fertile land remains preserved, serving as a valuable landscape resource and cultural feature. It also provides a farmland habitat with minimal human intervention.

Source: google image

B1 sandfield-aquaculture



Source: author

Compared to b0, the agricultural pattern of this type has undergone significant transformations. The majority of farmland has been converted into gridded fishponds for high-density aquaculture, which has resulted in issues related to wastewater pollution. The extensive fishponds serve as habitats for wetland species and provide storage space,. However, the changes in the traditional agricultural landscape pattern have led to a reduction in its cultural value.

source: http://hdd-group.com/zw/index.php?c=article&id=204

4.3 Challenge and potential

Future threat

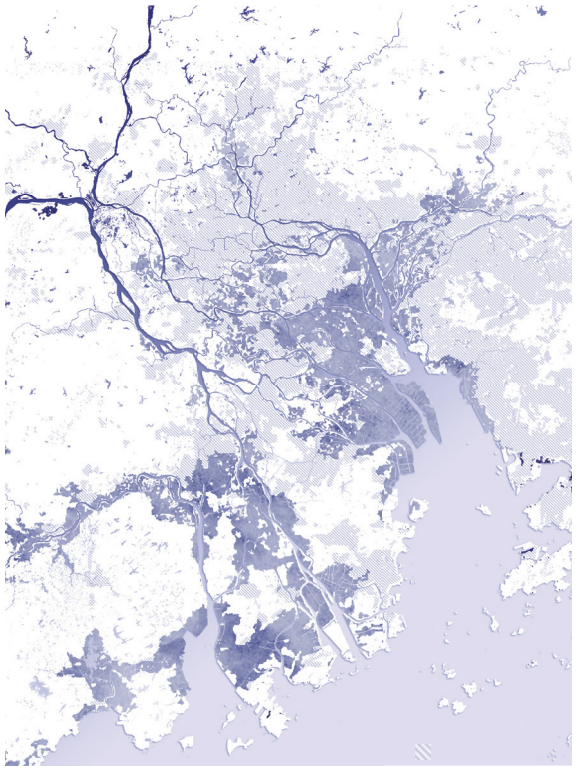
These agricultural areas are facing two major challenges of the Pearl River Delta, which have always been the main contradictions in the region: increasing population and flooding caused by climate change.

The current construction land and population distribution are mainly concentrated in dikedfield. According to the land and space planning of Guangdong Province, the Pearl River Delta will add 20 million people in 2035. The future urban expansion in the Pearl River Delta is likely mainly concentrated in the Dikedfield along the Xijiang River and its tributaries in Foshan (Wu, Liu et al, 2020). A growing population means more food and good living environment needs to be provided.

The area's water threat comes from riverine flooding from the major river network, pluvial flooding by intense precipitation and coastal flooding along the coastline. Although flood control measures taken along river banks and coastlines can protect cities from major river or coastal flood events, heavy rainfall can easily cause excessive surface water in the built-up area (Jian et al., 2021).

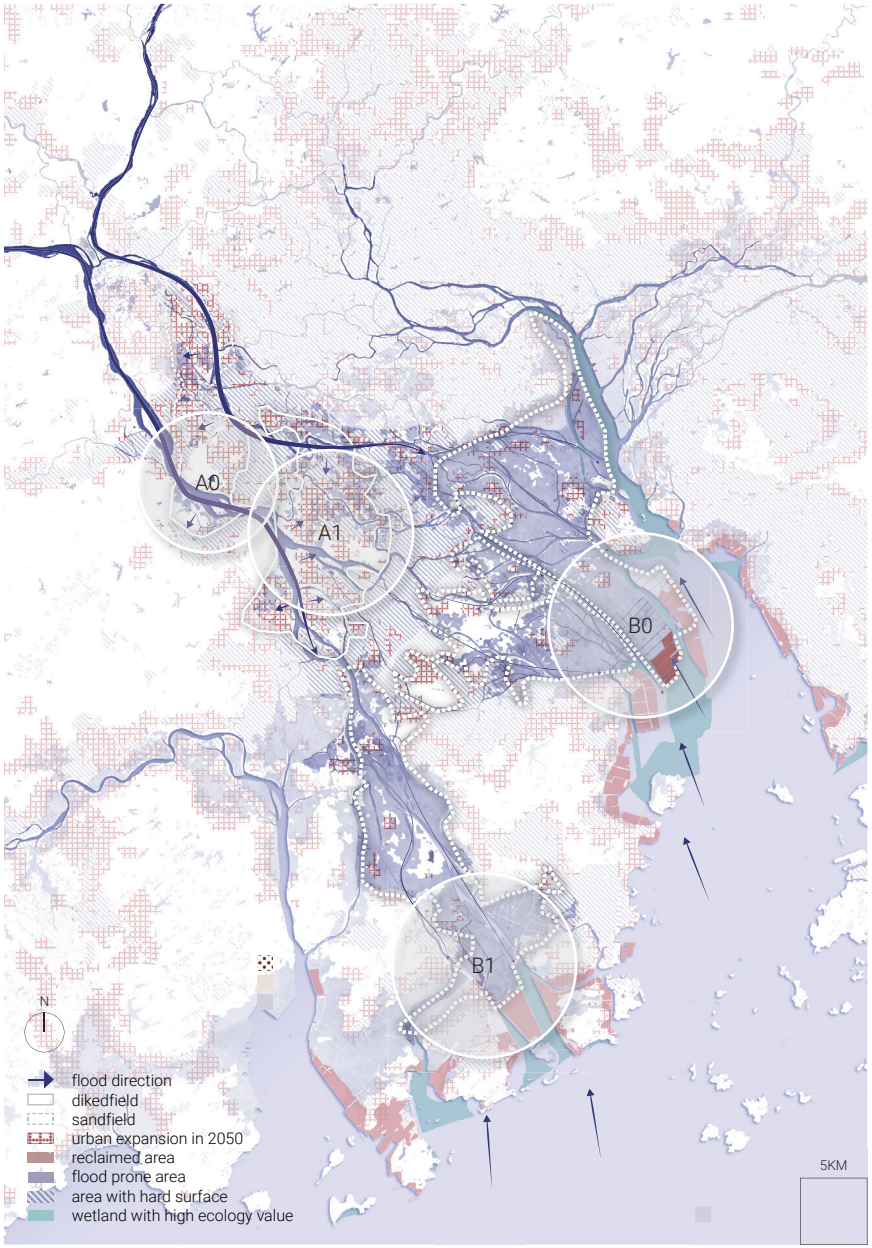
The responses of various typologies to future threats can be regarded as challenges and potentials for future development.

Urban expansion area in 2050
Source: based on Wu, Liu et al.



Flood threat
Source: based on https://coastal.climatecentral.org/

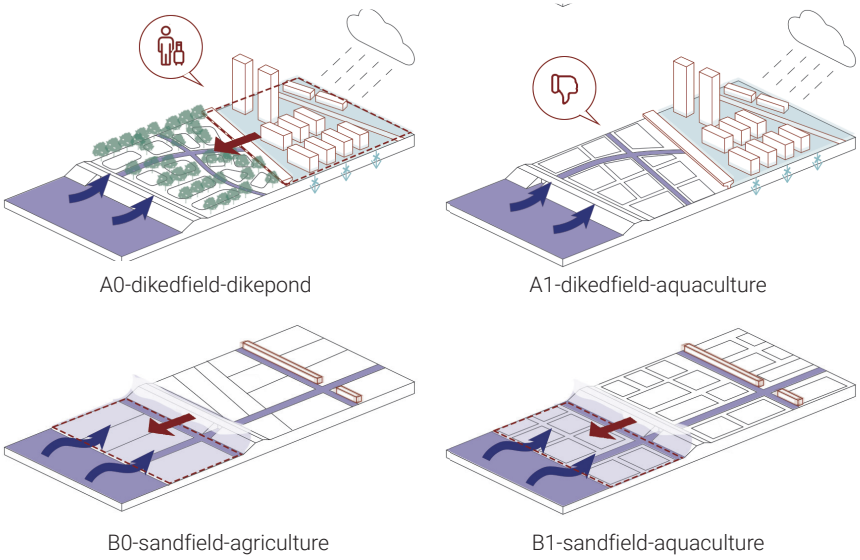
Challenges



The dikedfield-dikepond requires careful consideration to provide construction land while preserving the wetland habitat and landscape pattern of the dikepond. It also needs to address the risk of waterlogging resulting from the hardening of built-up areas and the reduction of water bodies.

In the case of dikedfield-aquaculture, the focus is on renovating existing built-up areas to accommodate the increasing population and improve the overall spatial quality. It is crucial to create a favorable living environment for migrants and enhance water resilience to withstand the impact of intensified storm-flooding events.

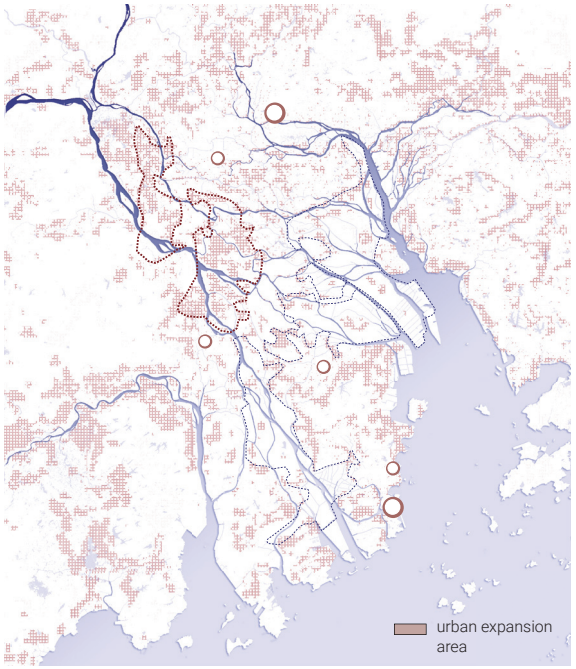
For the sandfield typologies, the primary challenge is to address the ecological and hydrological damage caused by reclamation activities along the coast of the Pearl River Delta. The threats posed by storm surges and rising sea levels to the low-lying terrain will have implications for both food production in sandfield-agriculture and aquacultural activities in sandfield-aquaculture.



Challenge map (left) and diagram (right)

Source: author

Potentials

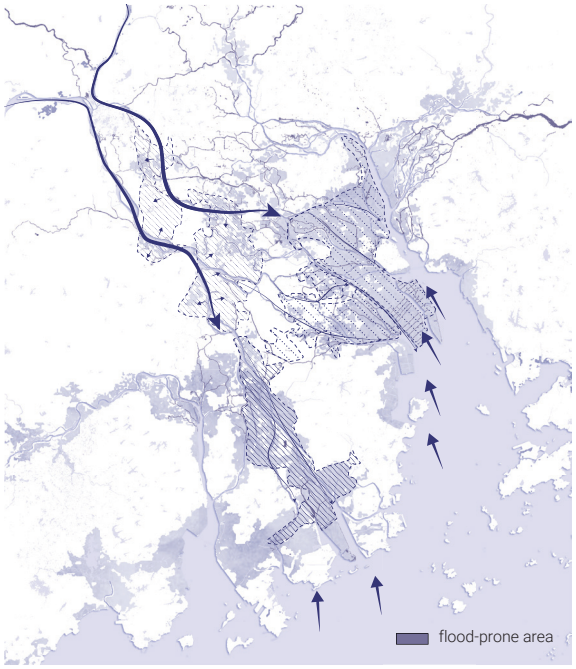


Food source supply

The agriculture in dikedfield area can be developed into urban farming, such as modern agricultural industrial parks and community agricultural parks, to provide local residents with healthy and safe food products.

Improving quality of living environment

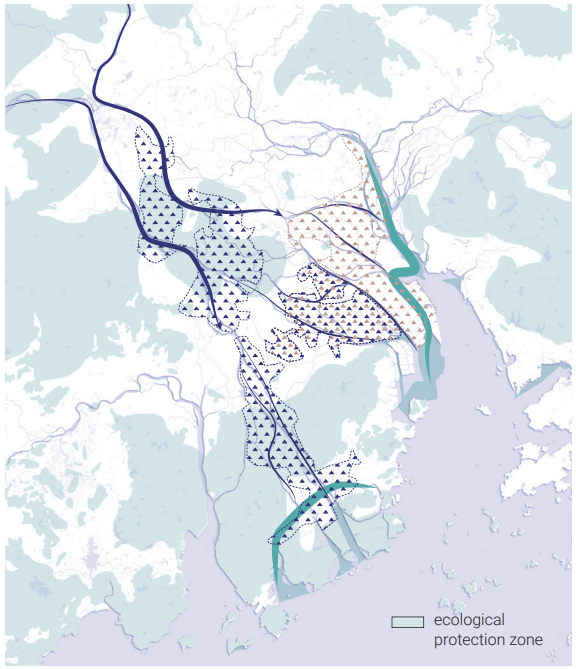
The agricultural area can serve as an open space for urban residents, offering greenery and waterfront spaces that enhance the landscape quality. Traditional landscape patterns, such as dikeponds and croplands in sandfields, embody the cultural value of the district and contribute to its agriculture-based identity.



Flood mitigation

Pluvial flood & riverine flood: Fishponds, farmland in sandfield, together with the multiple watercourse along them have high water capacity or infiltrattion ability to reduce surface run-offs. The reduction of runoff helps reduce The amount of rainwater discharged into the river, slowing down the flooding of the river during the rainy season.

Coastal flood: Part of the sandfield can be used as a buffer zone and floodplain as the traditional agriculture did to reduce flood damage toward inland as well as release the pluvial flood from the upstream .

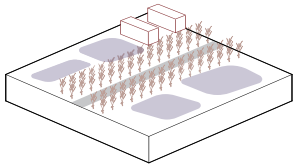


Habitat

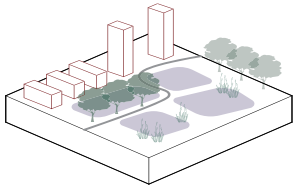
The polder area consists of several habitats. The adjoining fishponds can form a consistent wetland zone along the west river, while the farmland provide orchard and cropland habitats. Some can be transformed into river shore and tidal brakish marsh to provide linear habitats along the river and the coast. These water-friendly habitats help attract migrate or resident birds and are beneficial to a variety of amphibians, reptiles, mammals and insects .

Potential maps (above)
Source: author.

Food and open space provision for the expanded urban area

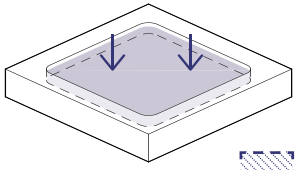


urban farming

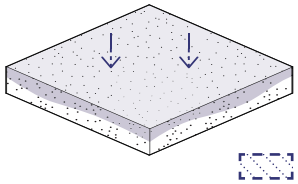


waterfront space

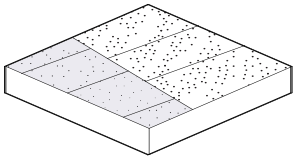
Coping with pluvial and coastal floods



pond

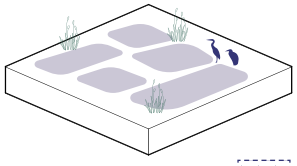


salty loam

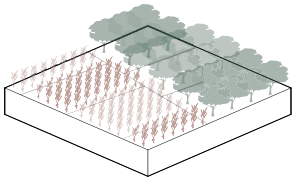


floodplain in sandfield

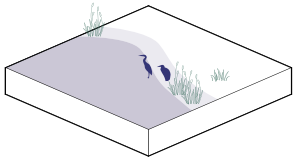
Diverse habitat



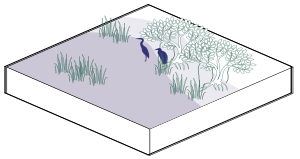
wetland



orchard &
cropland



river shore



tidal brakish marsh

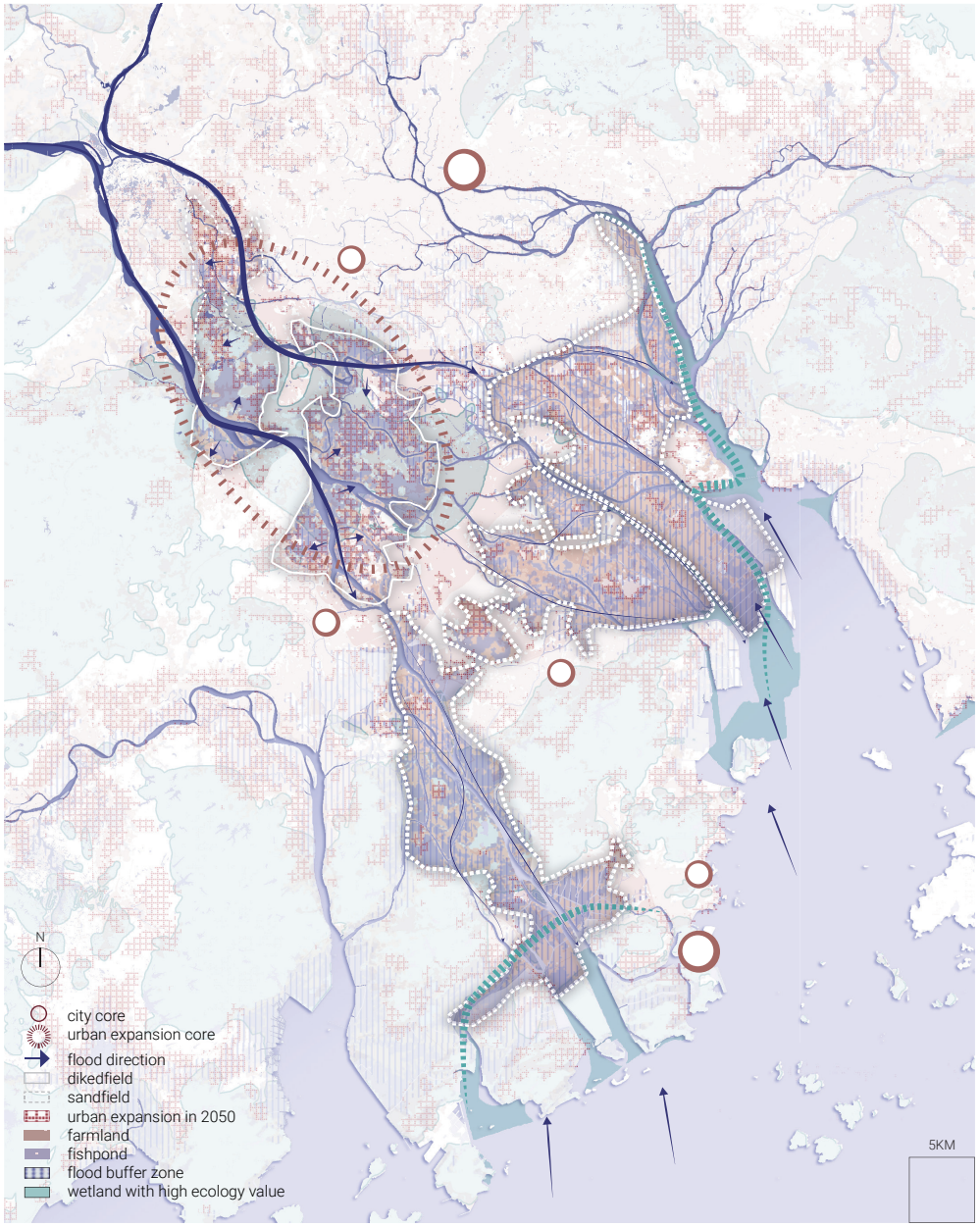
Potential diagram

Source: author.

4.4 Proposal

Based on the challenge and potential analysis of the agricultural area in the PRD, I propose a landscape structure for the region. In this structure, the agricultural areas serve as water buffers, restoring and releasing floodwaters along the riverside and coast. Additionally, ecological patches are created along the water network, forming an ecological buffer zone for the city. The dikedfield can be developed as eco-friendly productive communities, addressing urban waterlogging issues, while the sandfield can be developed as crop-producing areas that support coastal habitats and mitigate storm surges.

While areas with the same landscape typologies are likely to share the silimar characteristic, the overall vision of the region can be achieved by providing development model to each typology. In this case, typical area of each typology could be selected as pilot project. In the next part, I will demonstrate how a design at a local scale can be implemented as part of a larger vision with the guidance of landscape framework.



PART C
Towards An Adaptive Landscape Framework

Source: Gulou waterfront

5 Design principles

Design principles are proposed in this chapter as a guidance to achieve the sustainable goals.

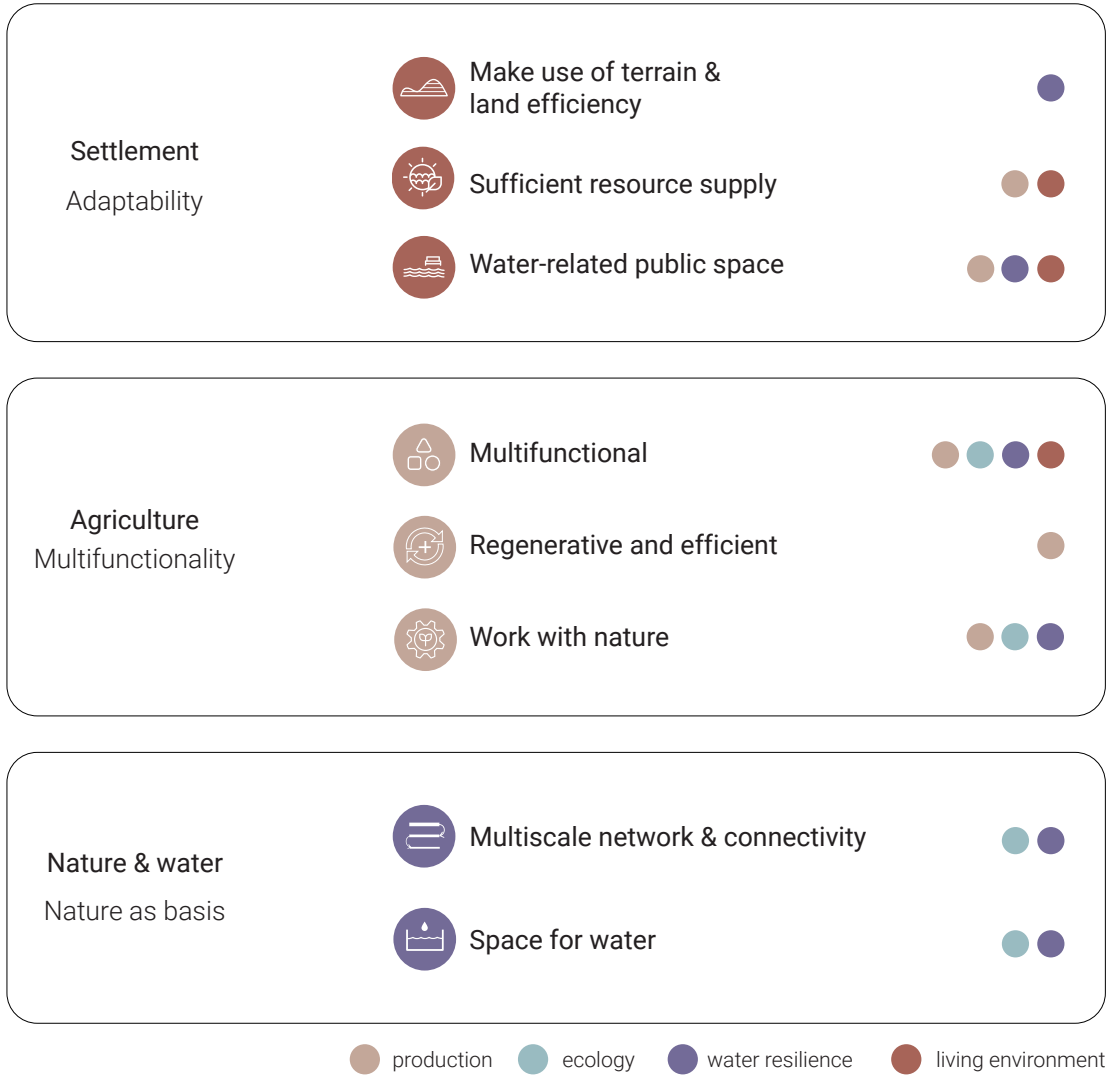
5.1 Design principles

Design principles are drawn upon according to the lessons (chapter 3.3). These principles are closely aligned with the sustainable goal.

Nature and water should be considered as the basis for the other layers within the landscape framework. The design should be determined by the physical and biological factors of the site, rather than solely relying on human intervention and technological prowess (Ruff, 1982). This is evident in how people adapt agricultural models to fit natural conditions, select suitable habitats, and utilize natural processes efficiently in construction and production.

The key principle of agriculture is its multifunctionality, which can be accomplished through the integration, stacking, or time-shifting of functions (Ahern, 2011). To achieve the coexistence of multiple functions, it is crucial to efficiently utilize limited energy and materials within the system.

Finally, when it comes to settlement, it should be an adaptive choice based on the aforementioned principles. It is essential to provide people with a safe and comfortable living environment. Therefore, settlements should be selectively established in stable areas with minimal natural interference, where the surrounding environment is suitable to fulfill both material and spiritual needs through human intervention.

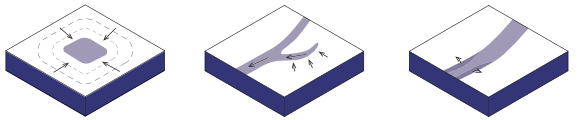


5.2 Toolbox

The toolbox is translated from the traditional experience with the combination of modern practice. Some of the implementation of these tools will be shown in the next chapter, in the design exploration of Gulao Town.

nature & water

multiscale network & connectivity



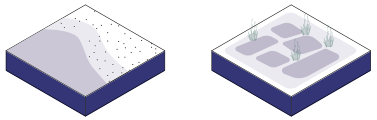
add waterbody

add tributes

widening&dredging

*room for the river project

space for water



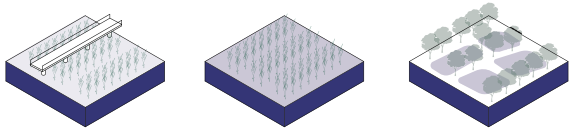
create flood plain

create wetland

*room for the river project

agriculture

multifunctional



add recreation

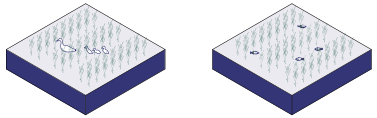
*Luming park

water resilient ricefield

*Hong Kong fishpond conservation scheme

dikepond

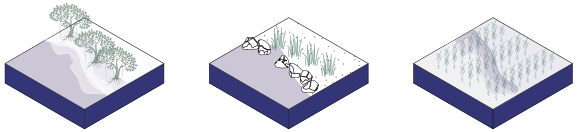
regenerative and efficient



raise duck in ricefield

rice-fish rotation

work with nature



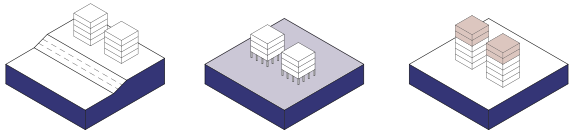
mangrove as coastal defence

ecological reclamation

use fresh tide for irrigation

settlement

make use of terrain & land efficiency

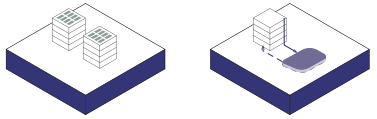


highland

stilt building

increase plot ratio

sufficient resource supply

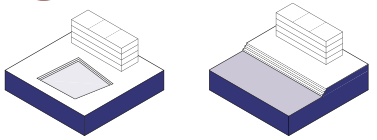


roof garden/ farming

*green alley project

rainwater circulation

water-related public space



water plaza

*Watersquare Benthemplein

waterfront space


Source: https://m.thepaper.cn/newsDetail_forward_8149557

6 Design exploration in Gulao

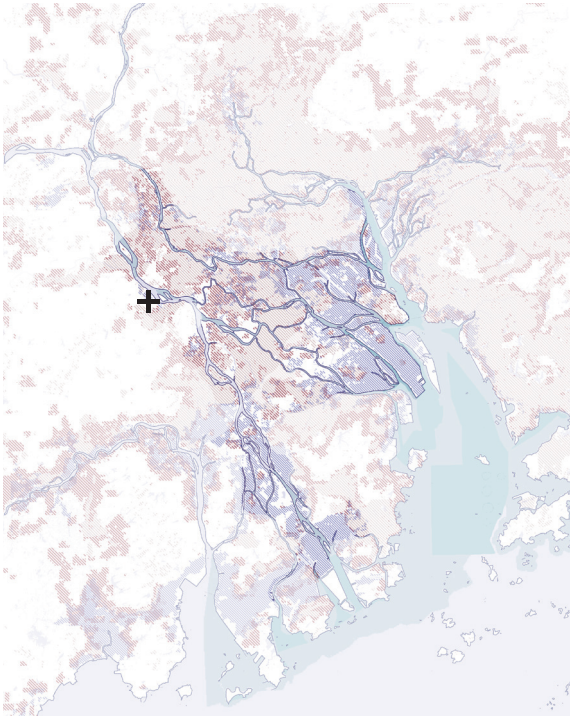
"The flowing water gives birth to our thriving water town.

——Quanheng Li, 2018

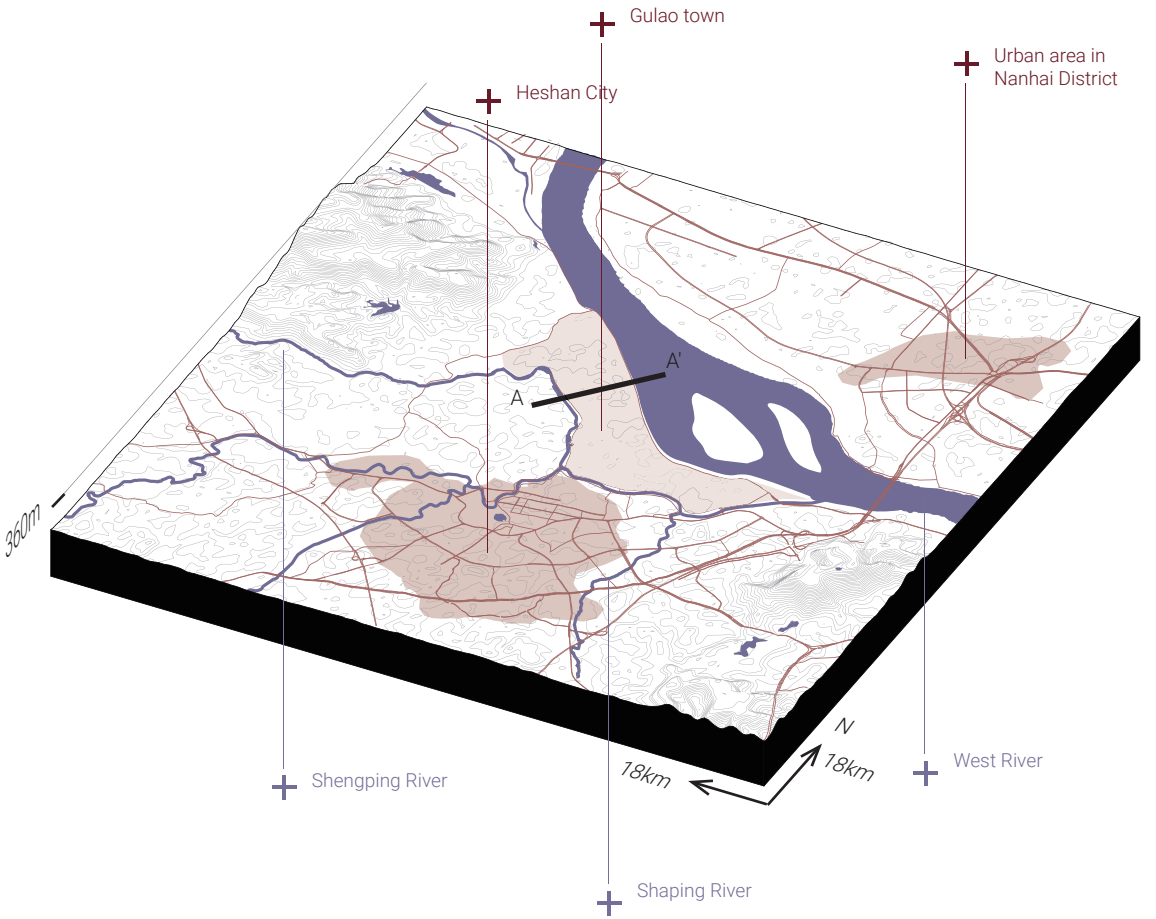
6.1 Background

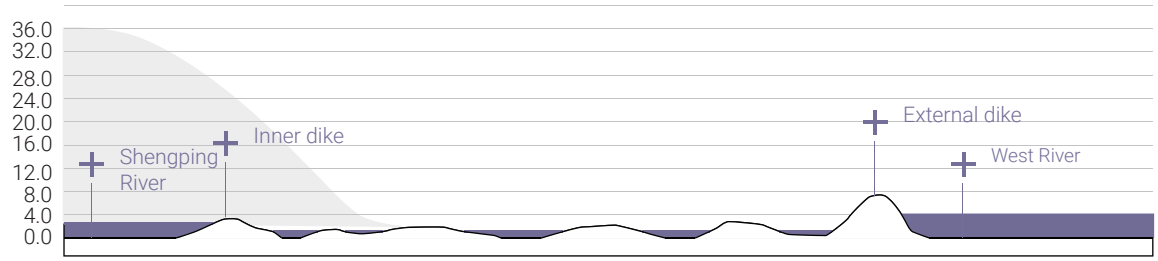
Location

Gulao Town is located on a lowland with an altitude of 1-2.5m (pan, 2022) and surrounded by several rivers. On the south side of Gulao lies Heshan City, Jiangmen, which is connected to Foshan City on the north side of the Xijiang River by an expressway.



Location of Gulao Town
Source: author





Section AA'
Source: adapted from Pan, 2022

The dilemma

Gulao Town stands as one of the earliest regions where dikeponds were formed. Owing to its low-lying terrain, it was only during the Ming Dynasty that the construction of the Gulao Dike enabled residents to harness the potential of the lowlands for dikepond agriculture. However, water has posed a persistent challenge for centuries, with regular floods occurring until the construction of the concrete external dike.

Today, Gulao Town remains predominantly focused on agricultural production. However, due to the slow development of the local area, the majority of farmers are elderly, while younger generations seek employment opportunities elsewhere. As a result, some villages and fishponds have gradually become abandoned. In 2020, in an effort to boost the local economy and enhance infrastructure, the local government allocated 10 square kilometers of land on the west side to real estate developers for the construction of residential and tourist facilities. By 2022, the tourist area received a total of one million visitors. This project, named "Gulao Waterfront," has transformed a portion of the traditional water town into a Disneyland-like destination for urban residents, while the villages located outside the scenic area remain like "ghost towns."

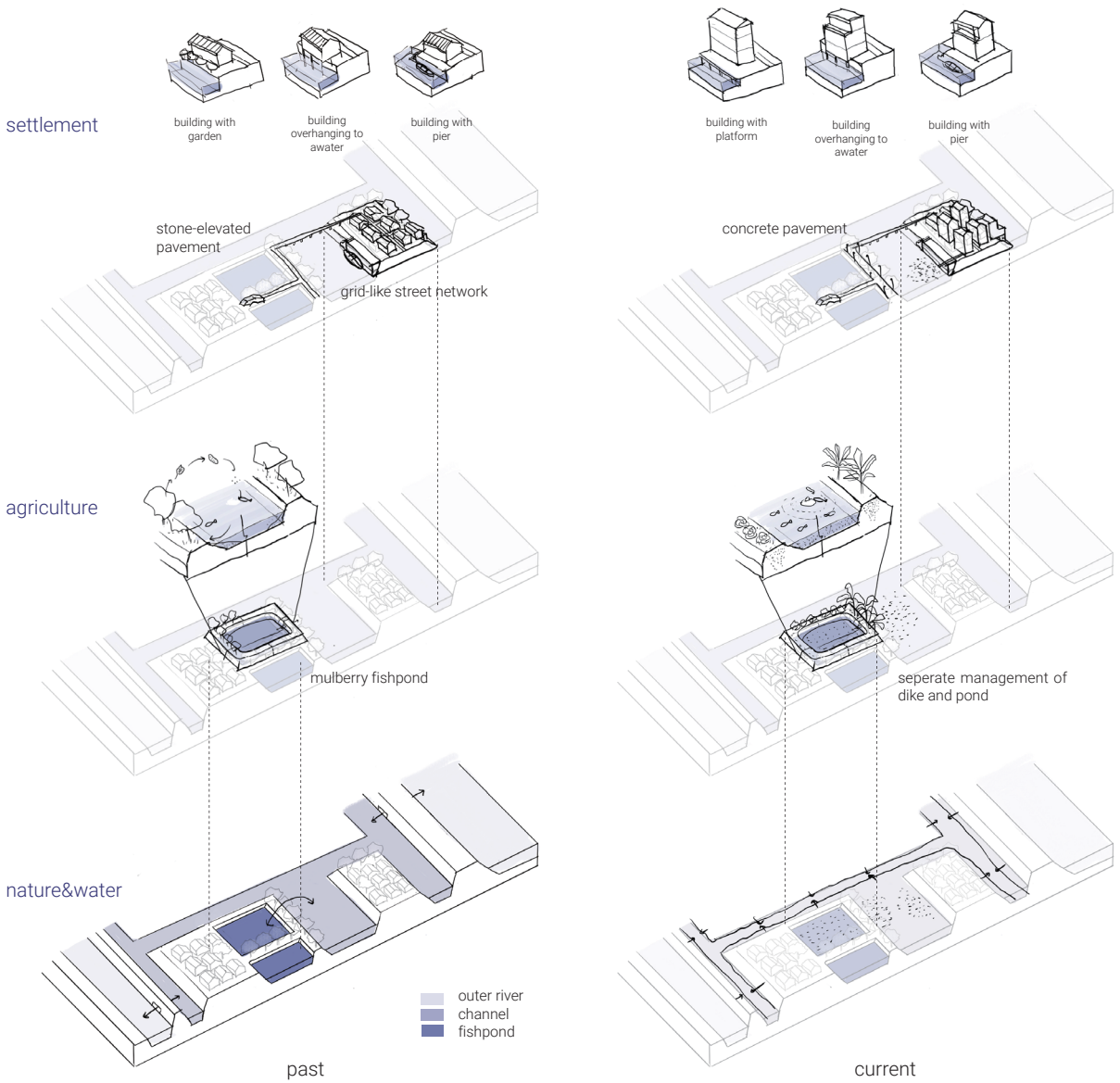
Here comes the question, can the future of Gulao Town only be one of the scenarios?

The traditional dikepond village
Source: https://m.thepaper.cn/newsDetail_forward_8149557

The Gulao Waterfront tourism development project
Source: Gulou Waterfront

6.2 Understanding

In order to explore new possibilities, Gulao Town is interpreted through the lens of the landscape framework, considering three key aspects: nature and water, agriculture, and settlement. By examining these dimensions, we can gain a comprehensive understanding of the town's potential and identify opportunities for its sustainable development.



Understanding through layers

Source: author

Water

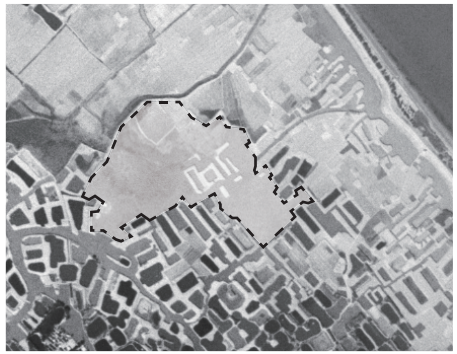
The water structure of Gulao Town can be considered into three levels: The outer water, the inner water network and the fishponds. Sluices and drainage holes are set to connect different levels and control the water levels.

As the local saying goes: The reservoir is the stomach that stores the water, the lake is the liver that regulates the water, and the channel is the heart that circulates the water. This multi-scale and interconnected structure helps maintaining the water functions.

The problems today, however, come from three aspects. Firstly, the water quality is compromised due to the improper discharge of household sewage and aquaculture wastewater. Secondly, the water body becomes so contaminated that rainwater can only be discharged instead of being reused efficiently. Finally, while some water areas are buried or narrowed down, the destination of stormwater remains a question when the water body is covered by built-up area.

The channel

Source: Nanfang Daily



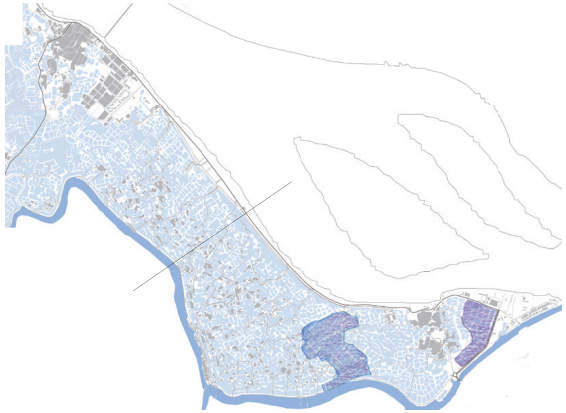
The disappearing water area (1970 & 2020)

Source: USGS, Google map

Agriculture

Dikepond used to as the traditional agricultural model in Gulao Town. The villagers sustained their livelihood through a combination of aquaculture, silkworm cultivation, and the cultivation of fruit trees. The system operated efficiently due to a rational energy cycle. And therefore the water quality was remained pristine that even recreational activities such as swimming could happen.

In today's agricultural model, the management of dike and pond is separated: the dikes are allocated by the village collective, and the crops on dikes turn into banana trees and vegetables. Some of the ponds are rent to the enterprise and transformed into high-density farming (Wei et al., 2021), while some fishponds are abandoned due to low productivity, silted up or flooded with aquatic plants. The material and energy flows in the ponds carefully maintained by human beings are out of balance. On the contrary, the dependence on feed and chemical fertilizers has brought about serious water and soil pollution.



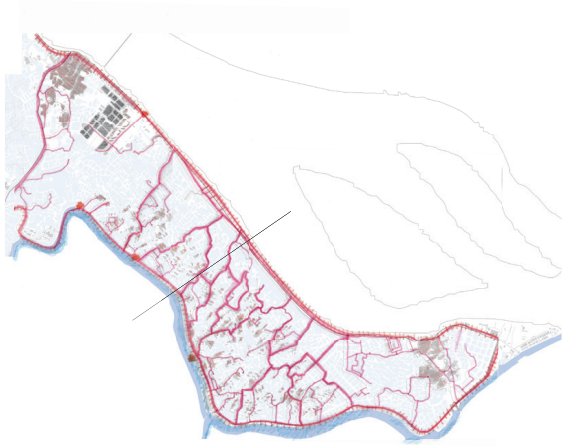
Various crops on the dike

Source: Wenxiu Chi

Settlement

The scattered villages are constructed on elevated highlands that have been formed from dikes, giving them the appearance of small islands nestled among the fishponds. The streets and alleys of these villages are regularly laid out in a checkerboard shape, so that all the streets and alleys are connected to dikepond and channels (Wei et al., 2021). The traditional residential buildings are closely arranged, consisting of three rooms and two corridor houses. Waterfront buildings are close to the water's edge, or have planted gardens and docks (for barges, washes) along ponds.

Today, traditional houses and docks are greatly abandoned. The new residence is a three- to four-story self-built house built on the original site of the traditional dwelling, some of which are protruded from the fish pond or occupy the cultivated dike.



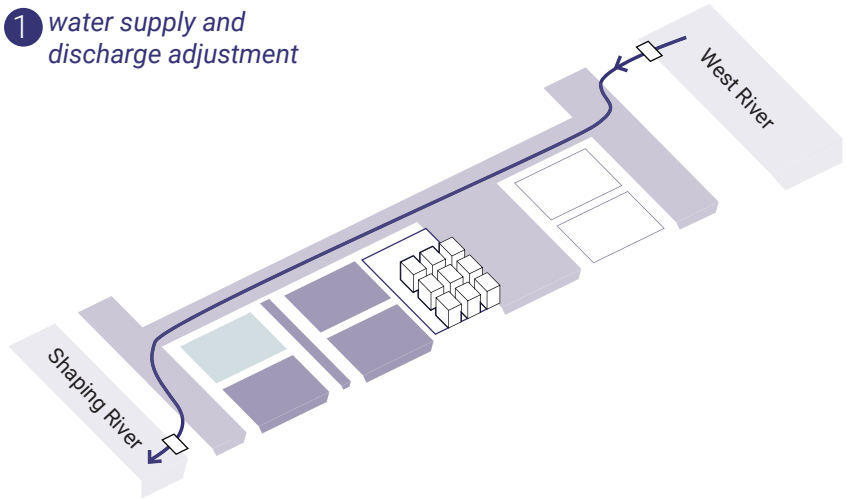
Preserved buildings
Source: Nanfang Daily

Self-built houses
Source: bilibili

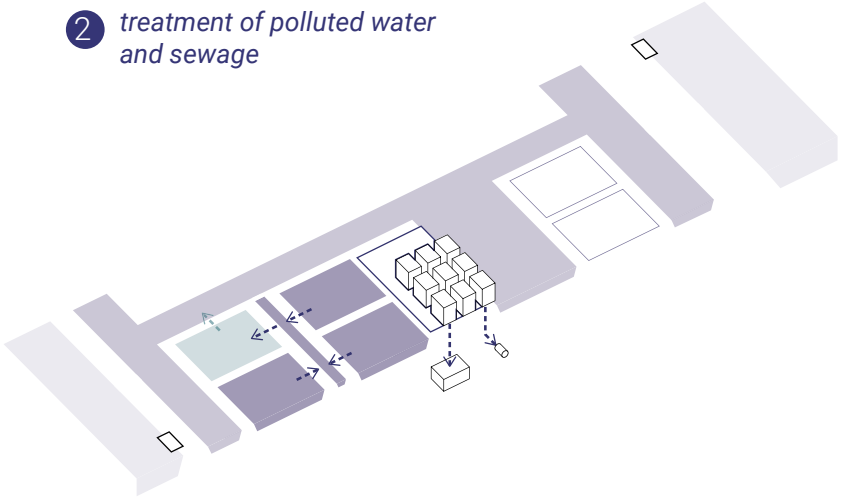
6.4 Strategy

Strategy on water

1 *water supply and discharge adjustment*



2 *treatment of polluted water and sewage*



The water and nature layer defines the fundamental landscape structure, which subsequently guides the development of agriculture and settlement programs. Four strategies on water are proposed.

1.water supply and discharge adjustment

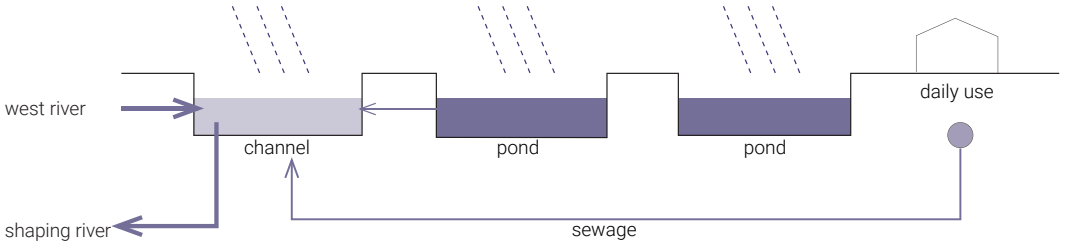
The water source within the dike is adjusted. Water supply priority is given to collected and retained clean rainwater. Water is replenish from the West River only when the water level of the inner water network is lower than the minimum water level in the dry season. Secondly, through the adjustment of the position of the sluices, the Gulao water system always receives water from the West River, and flows out to the Shaping River, preventing the conflict between clean water and sewage flow.

2.treatment of sewage and waste water

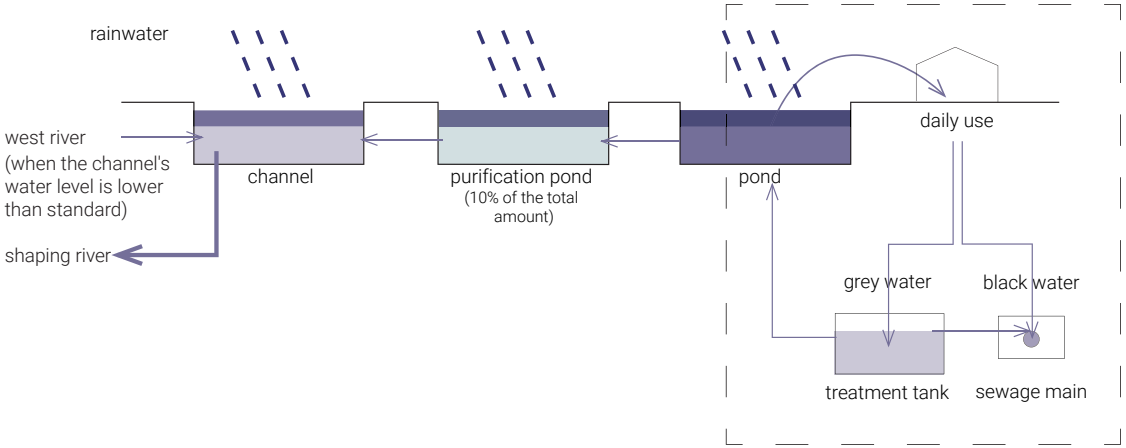
For the black water in domestic sewage, sewage pipes need to be laid for discharge. Gray water, on the other hand, can be purified for reuse. The aquaculture wastewater is guaranteed to meet the quality standards before discharged into the inner water network level through self-purification and wetland purification.

Strategy on water (above)
Source: author

current



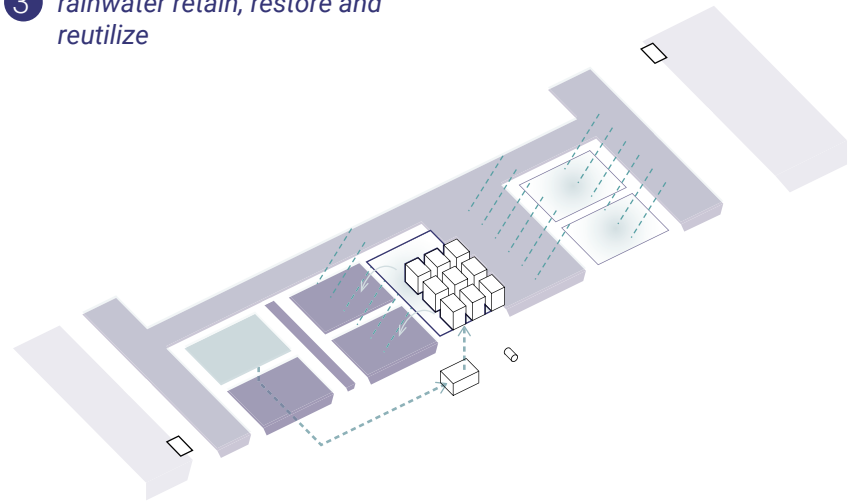
proposed



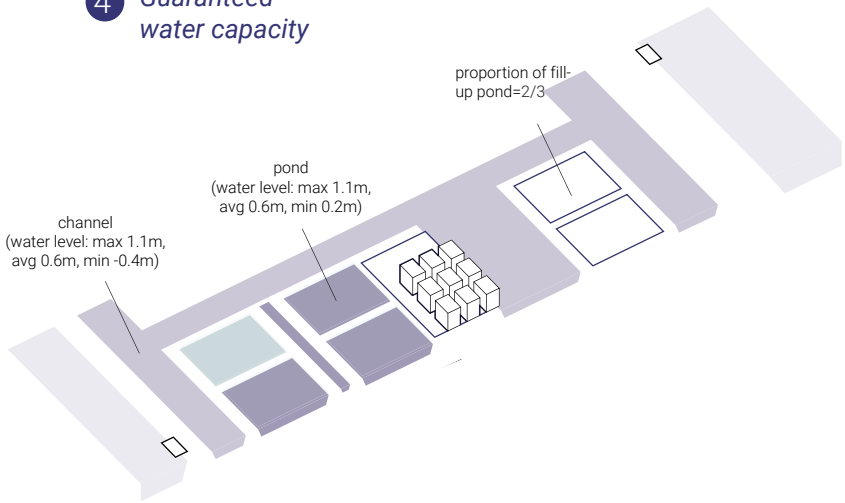
Water flow before & after

Source: author

3 *rainwater retain, restore and reutilize*



4 *Guaranteed water capacity*



3.Rainwater retain, restore and reutilization

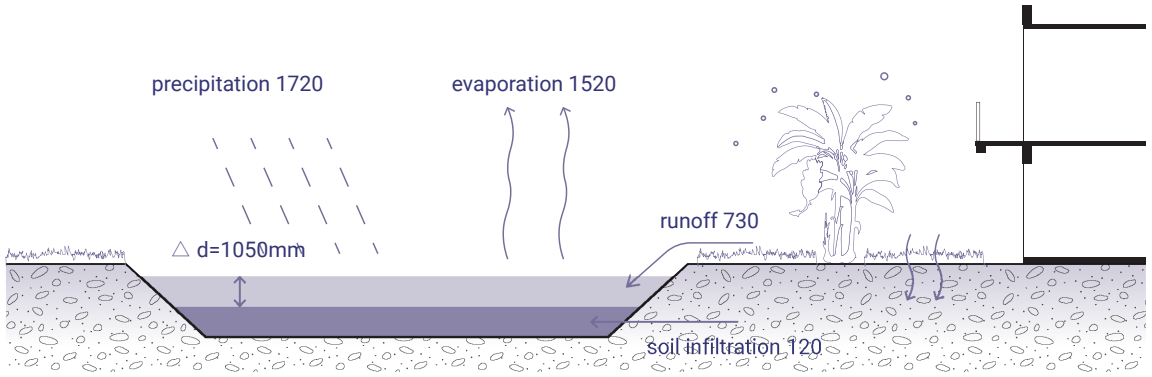
Rainwater can be orderly discharged through the organized drainage of built-up areas and the control of surface runoff. Part of the ponds can be converted into cisterns to store rainwater and recycle it.

According to the research data of Zhong and the annual rainfall and evaporation statistics of Jiangmen, under natural conditions, the water income of ponds is much higher than the water expense, so most of the rainwater still needs to be discharged. At the beginning of the rain season, 400mm of water could be stored (the height difference between the lowest water level and the normal water level). 500mm of water could be stored (the height difference between the base surface and the normal water level) in the short term in extreme events, thereby reducing the pressure of the channels and rivers, and extending the response times of emergency.

4.Guaranteed water capacity

In order to ensure a safe local water environment, it is necessary to have a assessment of the local water capacity. The calculation is demonstrated in the next page.

Strategy on water (above)
Source: author

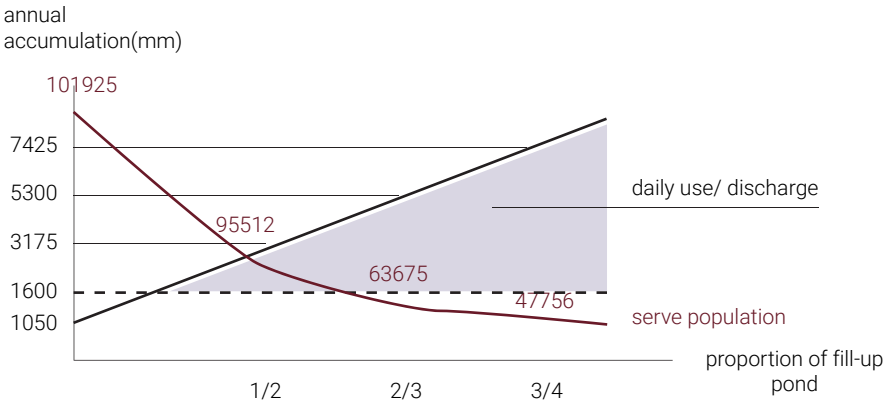


Taking Jiangmen's annual average rainfall of 1800mm as a benchmark, and calculating the water income of the water area based on the research data of Zhong, it is estimated that the water level will rise by 1050mm a year without water level regulation, which can be regarded as fluctuation of the Inner water network.

Furthermore, with the area of the pond filled increases, the pond's water storage capacity also decreases, which means that more precipitation needs to be drained out of the system. It is assumed here that the pond in the built-up area can accommodate a water level change of up to 1200mm, and the minimum capacity for extreme weather is calculated with 300mm as the extreme Maximum Process Rainfall and a surface runoff coefficient of 0.6. Then the proportion of the landfill pond should not be higher than 2/3.

The balance of water income and expenses of dikepond

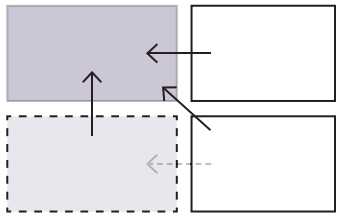
Source: based on Zhong, 1986



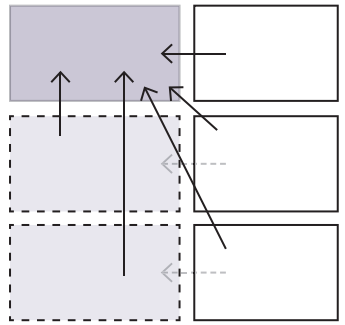
Less water can be used with more fill-up ponds

Source: author

With Flexibility Of Pond Water Level 1.2m,
Maximum Process Rainfall 300mm



surface runoff coefficient= 0.85
proportion of fill-up pond=1/2

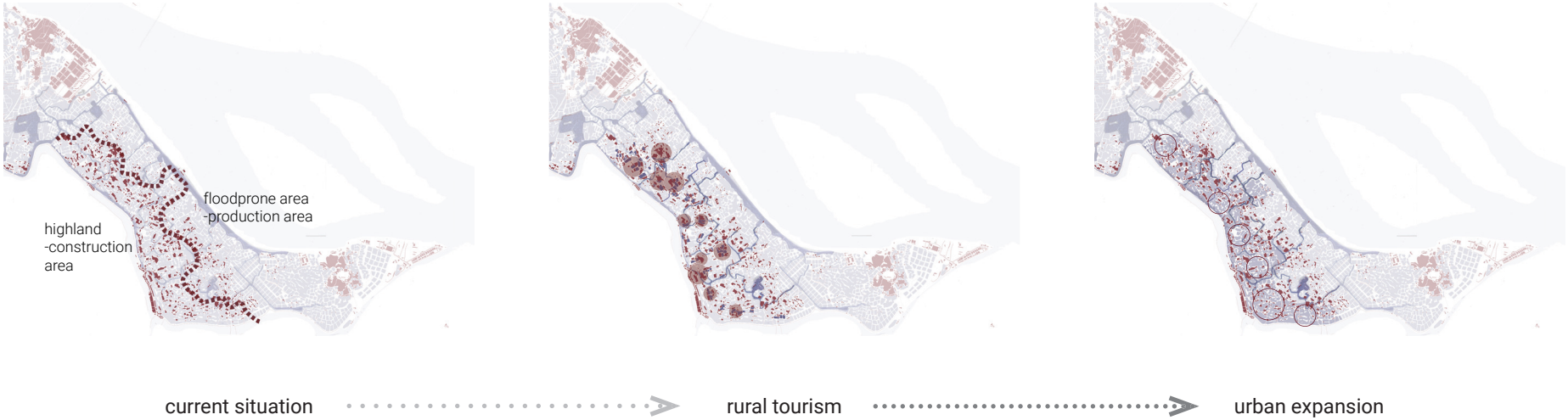


surface runoff coefficient= 0.6
proportion of fill-up pond=2/3

Relationship between runoff coefficient and pond amount

Source: author

Strategy on agriculture and settlement



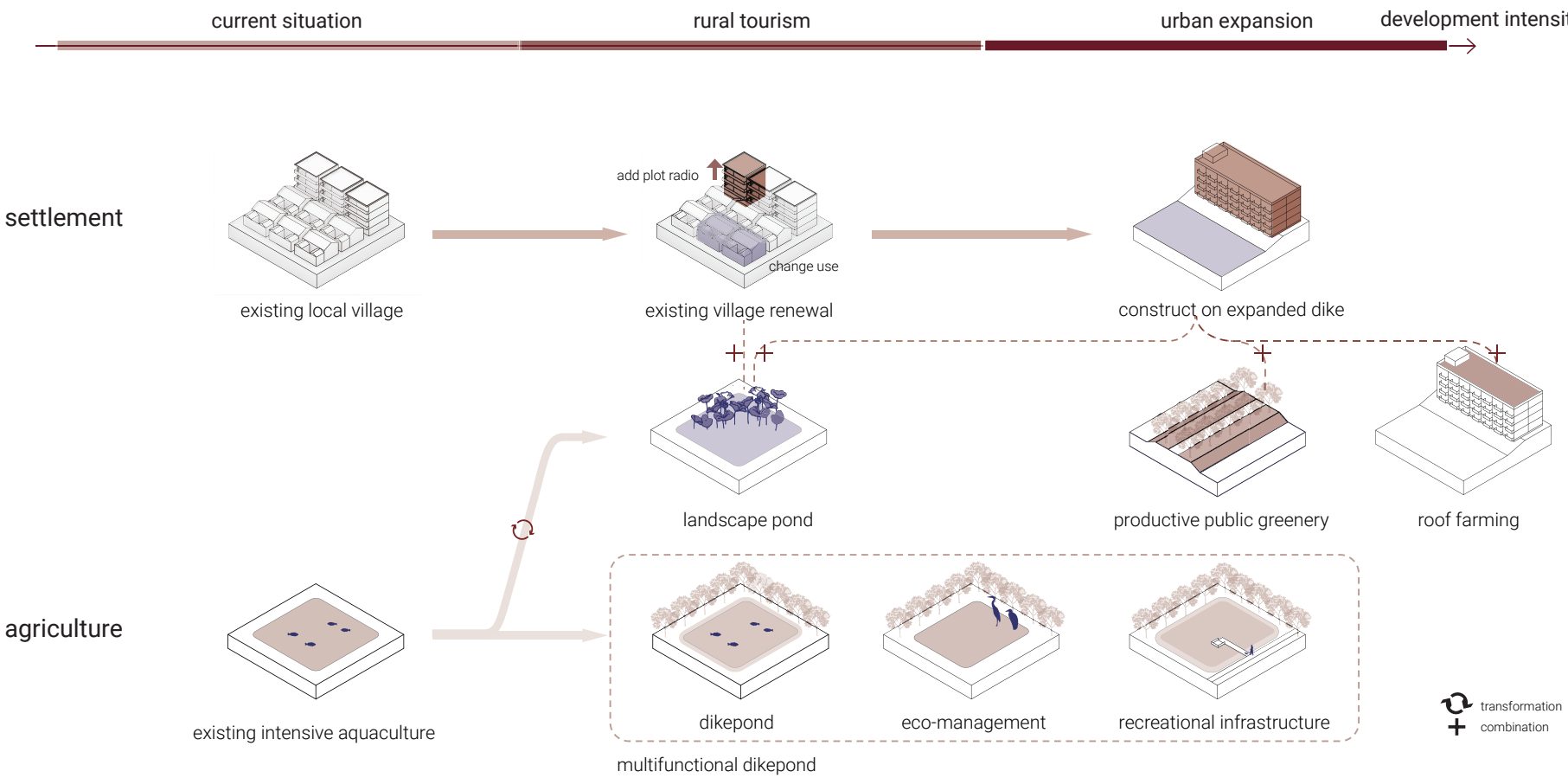
Agriculture

In terms of agriculture, the first step is to upgrade the existing aquaculture areas, including the rational use of abandoned fishponds. The aims are: 1) Develop circular agriculture and reduce external pollution by strengthening energy recycling within the system. 2) Integrate tourism projects to allow urban residents to experience productive landscapes and generate income for the local area. 3) Create a productive wetland and integrate it into the riverfront ecosystem.

For aquaculture fishponds located near settlements, the focus is more on their daily use. These fishponds are designed to combine with community renewal, tourism, and residential area expansion by enhancing their recreational function and providing better open public spaces. Productivity of the ponds can still be ensured through extensive aquaculture. Finally, productive landscape will be introduced in public greenery, roof gardens, and community parks.

Settlement

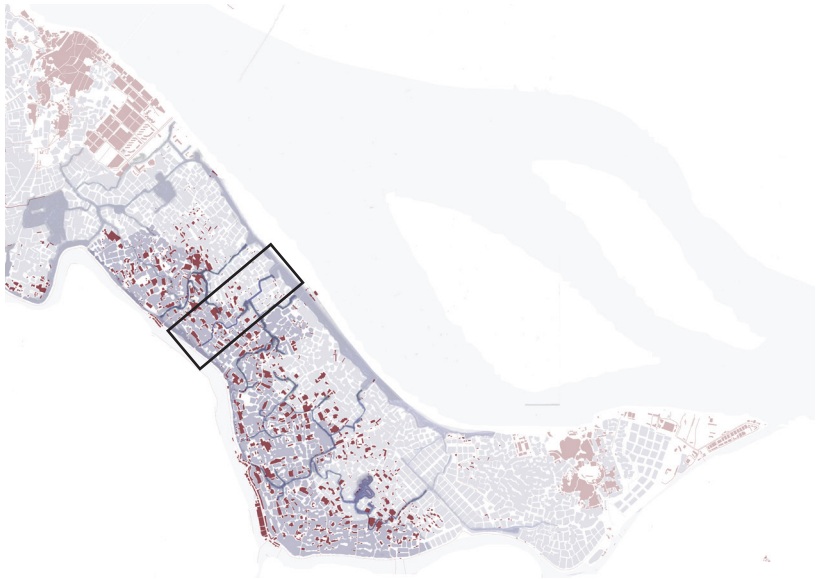
For the settlement, the strategy first focuses on the regeneration of existing buildings, including converting some of the residential functions into commercial ones. The quality of public space and sewage treatment will be improved for the community. Secondly, for further residential construction, the new settlement should be concentrated in the highland area. In order to preserve the water area and landscape structure as much as possible, the buildings should be built along the dike , and the landfill area should not exceed 2/3 of the pond area.



Strategy on agriculture and settlement

Source: author

The plan



1 agricultural produciton area

production+

2 residential area

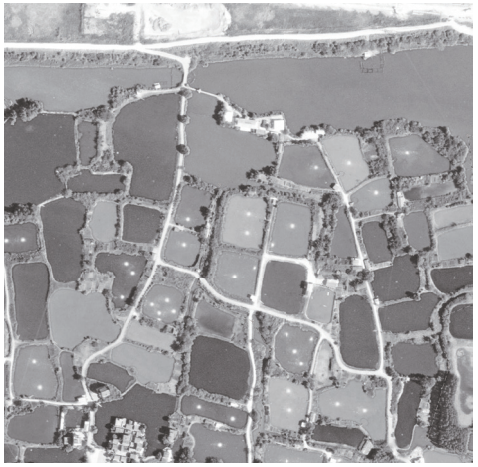
living environment+

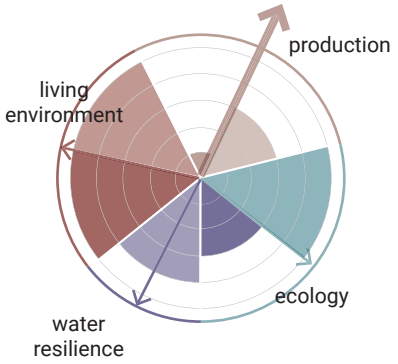
1. main channel
2. main road
3. monoculture fishpond
4. polyculture fishpond
5. visitor center
6. public building
7. preserved village
8. flat
9. terrace house
10. landscape pond
11. landscape axis

N

In this section, a typical strip that represents the landscape structure of Gulao Town will examplify the spatial design. The design of this strip has two main focuses, aiming to demonstrate the influence of the strategy on the area: enhancing the value of agricultural production areas other than production and the value of residential areas other than living environment.

6.5 Agricultural production area: production+





Goal on sustainability

Source: author

An agricultural production area providing

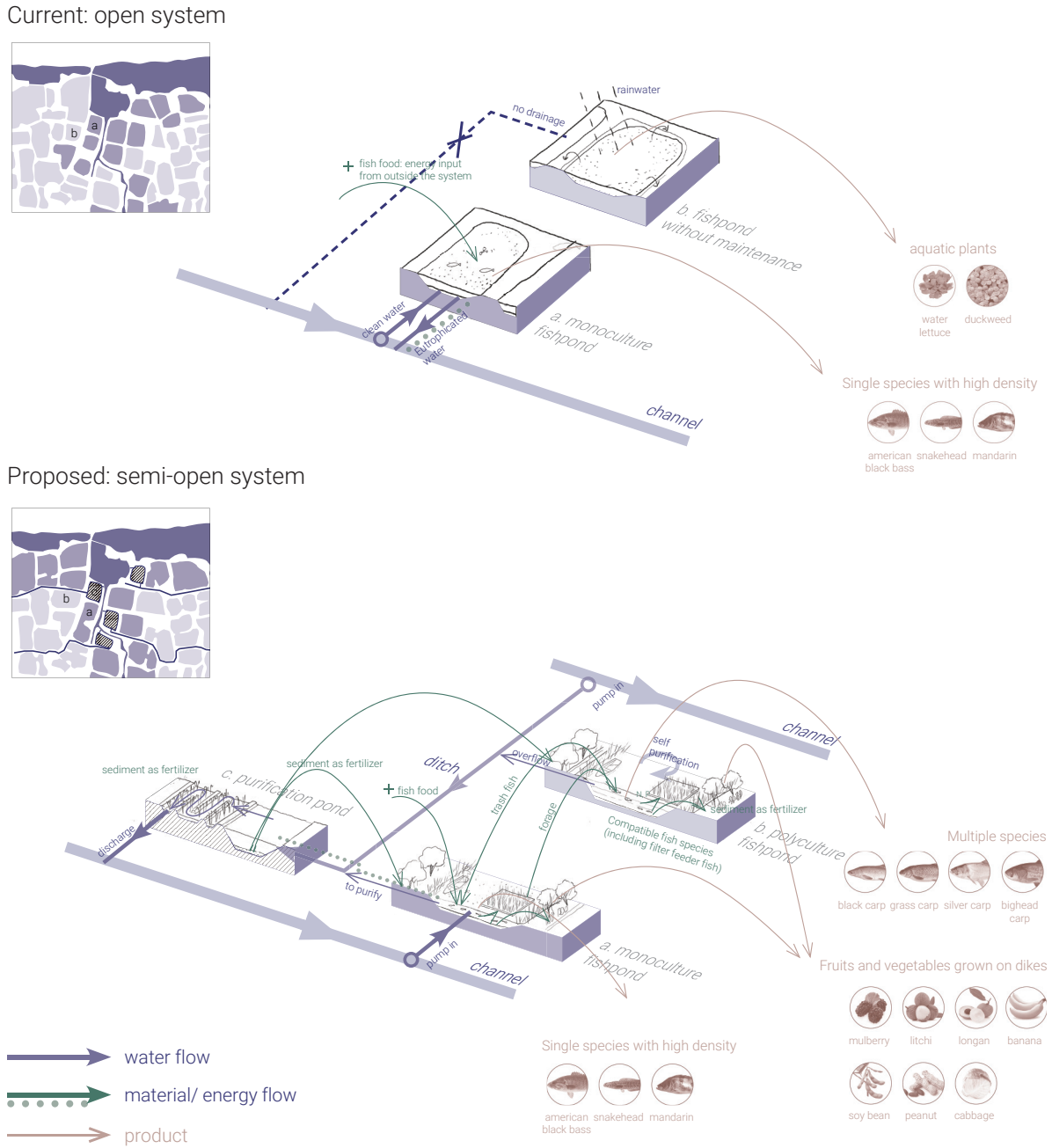
+agricultural experience,
+ecological conservation,
+nature education

Regenerative system

The major transformation of the agricultural area will start with the upgrade of agricultural model. This starting step can ensure the water quality and ecosystem stability of the fishpond, and furthermore bring virtuous circle with more diverse product, less cost of feed and fertilizer, and higher productivity.

The new agricultural model requires better water connection and material reutilization. The former is achieved by adding ditches that connect the inner ponds (which used to have no change of water) with channels. Water levels of these ponds are better controlled, as the water can be discharged in time during the flooding season and supplied during dry season, and the productivity is therefore promoted.

By planting trees on dikes, raising filter feeder fish, growing forage on floating board and reeds in purification pond, the excessive nutrient in the pond can be further utilized, and more product can be provided. Also, by doing this, the pond will generate less entrophicated water and even achieve self purification, which decreases the polluting effect on the environment.



Agricultural model comparison
Source: author

Ecology and recreation

The production area can also turn into attraction to wildlife and human.

Ecological value

The dikepond itself has a high ecological value in addition to agriculture and aquaculture use. A number of adjacent fishponds and reedland can form suitable wetland habitat for waterfowl, while the dikes with rich vegetation provide resting place for amphibians, reptiles, mammals and insects. The main channel, with its water quality improved, also becomes ideal home for aquatic creatures.

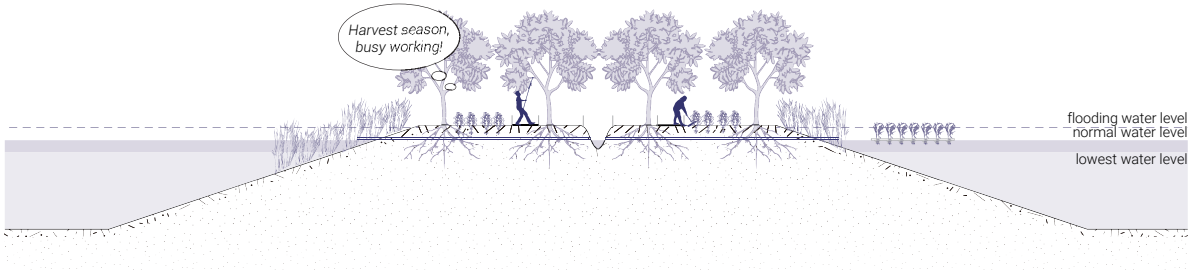
Recreational value

The dikes will serve not only as a daily farming area for farmers, but also as an agrotourism destination for sightseeing, agricultural experiences, and nature education.

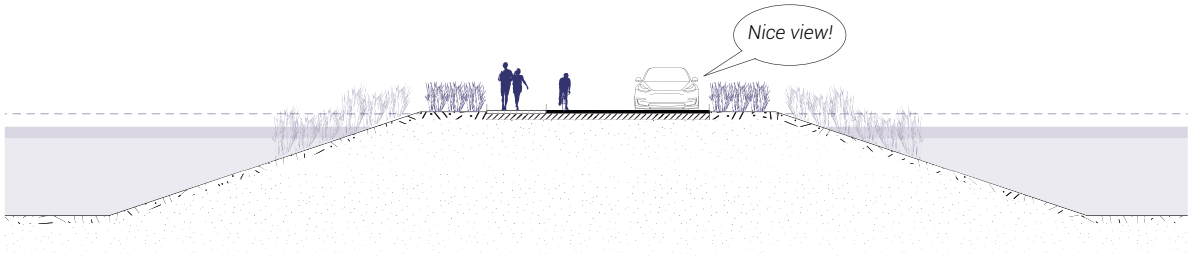
In this context, a demonstration area showcasing circular agriculture and fishpond wetlands with diverse species provides extra value to the local tourism industry.

Urban residents and the younger generation will have the opportunity to learn about dikepond culture, agri-aquaculture techniques, various organic products, and observe wildlife.

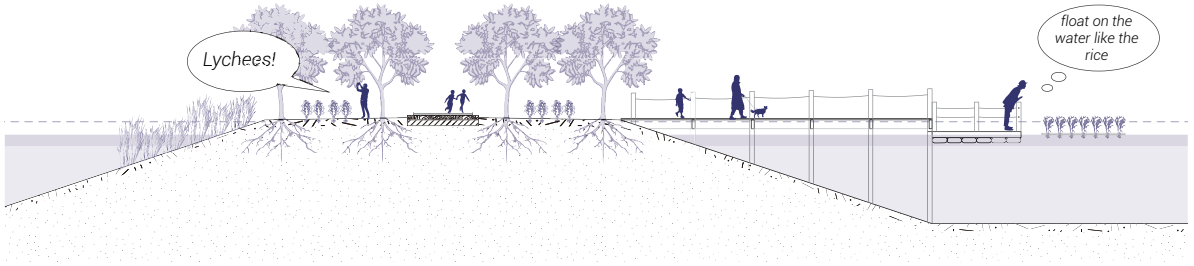
1. farming dike with ditch (8m)



2. motorway (10m)



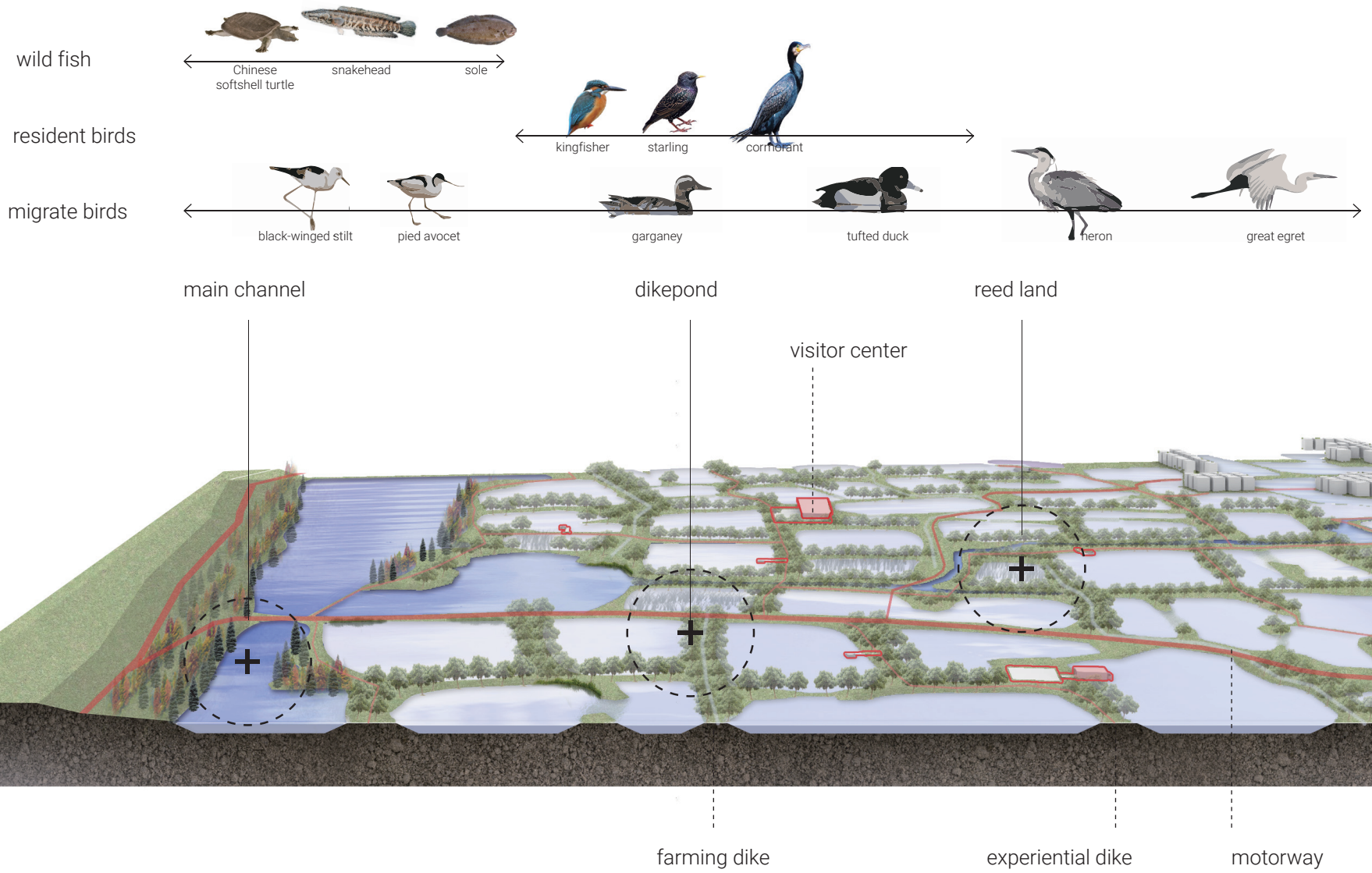
3.experiential dike (12m)



0 1 5 m

Diverse dikes

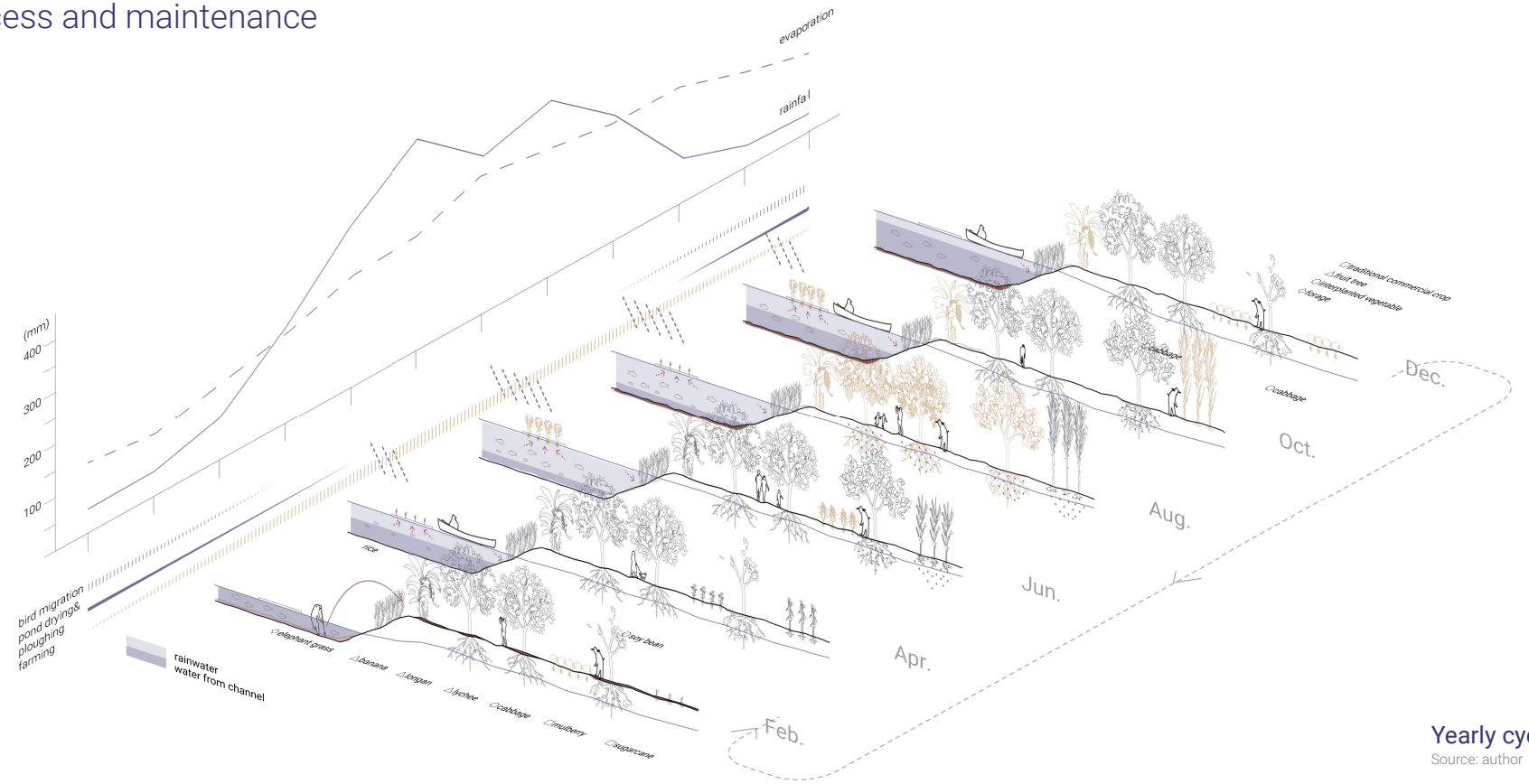
Source: author



Attraction to human and wildlife

Source: author

Process and maintenance

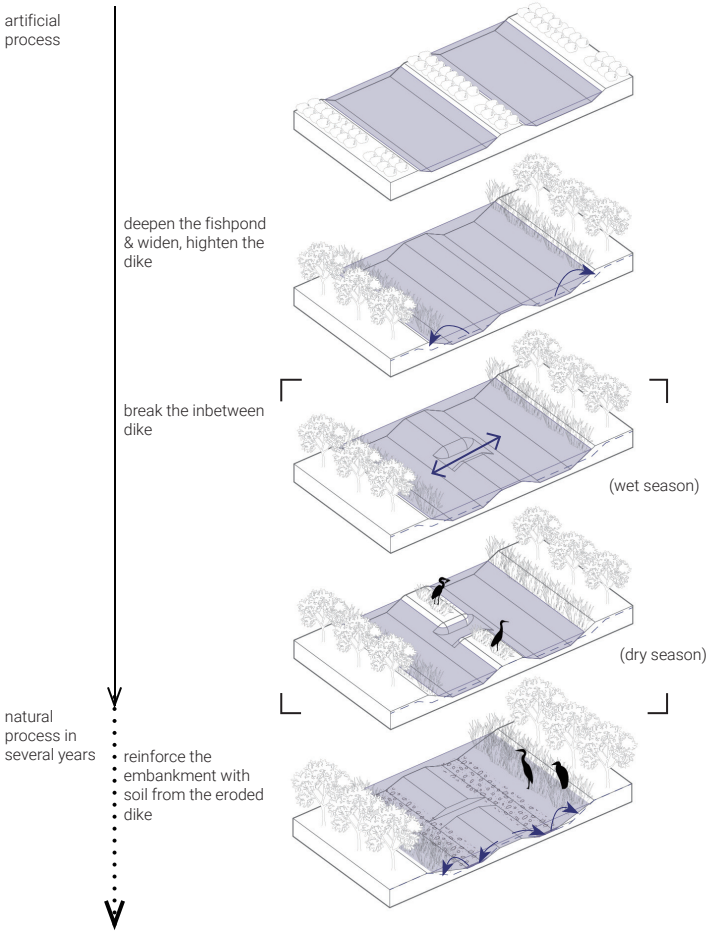


Yearly cycle
Source: author

Under systematic management and natural processes, agricultural areas can achieve multifunctionality in water level control, crop production, visitor experience, and habitat preservation.

Firstly, farmers are able control water levels by managing the inflow and outflow of rainwater and channel water based on hydrological conditions throughout the year. Tourists can observe and experience the fluctuations between the dry and rainy seasons. Notably, there is a distinct period when farmers purposely lower the water level in the ponds for fishing. This coincides with the period of least rainfall, allowing farmers to catch fish and deposit nutrient-rich silt on the dikes for fertilization, maintaining a balanced water and soil ecosystem. The lower water levels during this time also create suitable habitats for migratory birds, as the trash fish could be provided to the waterbirds.

In addition, according to different crop characteristics, the area can realize the rotation of crops, fruits and vegetables throughout the year. This seasonal variation in crops provides tourists with an authentic and immersive natural experience.



Fishpond connecting and dike widening process

Source: author

To improve management efficiency and income stability, small fishponds are merged into larger ones (4000-6000m²). Rather than removing the ridges between ponds, they are broken to establish a connected water system. The natural erosion reduces labor and provides winter habitats for waterfowl.

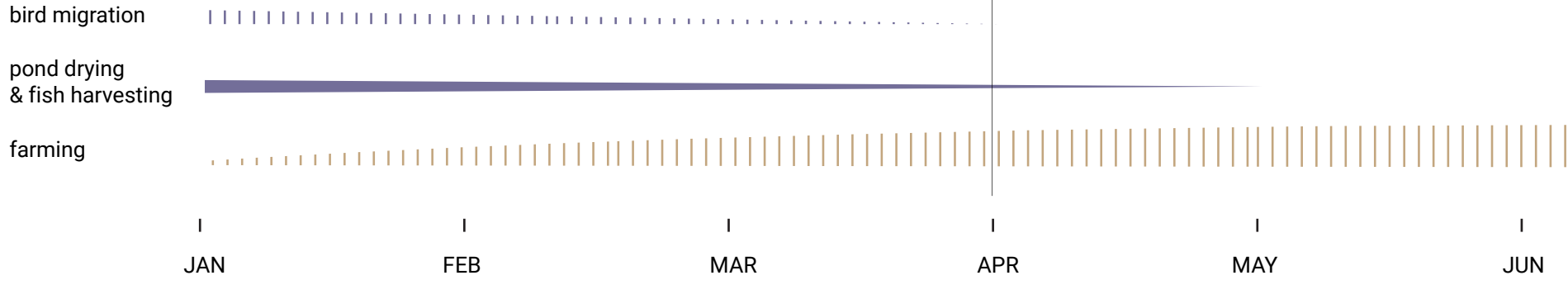
Image: Wenxiu Chi

The tranformation of dikepond through process

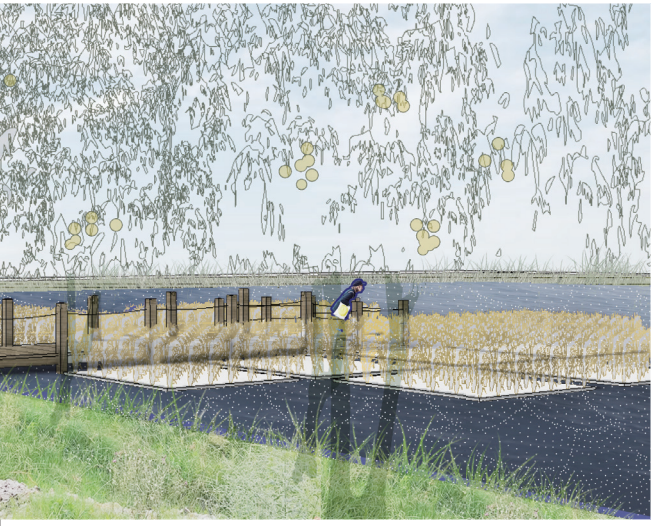
Source: author

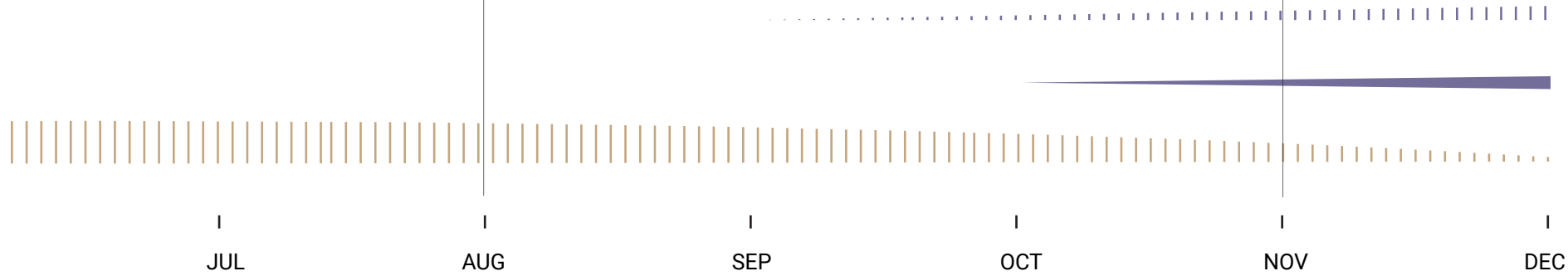
Low water level in spring

High water level in crop harvesting season



The fish harvesting season

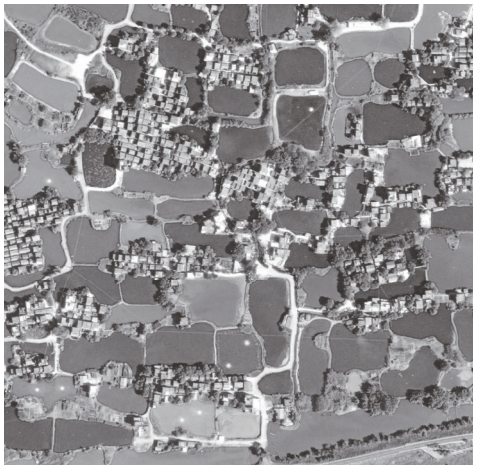


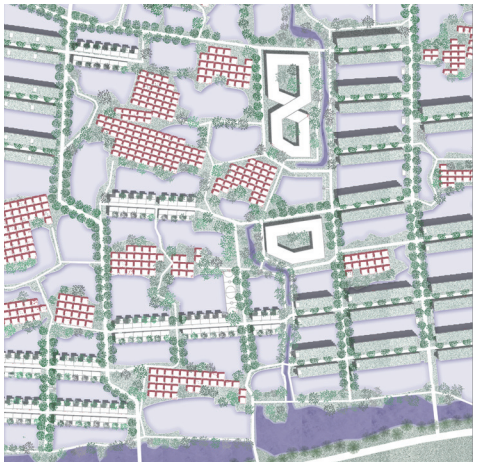


Yearly scenarios

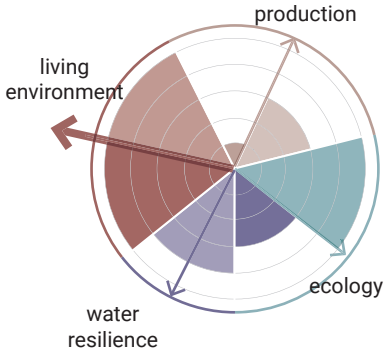
Source: author

6.6 Residential area: living environment+





Plan: before and after
Source: left-google earth; right-author



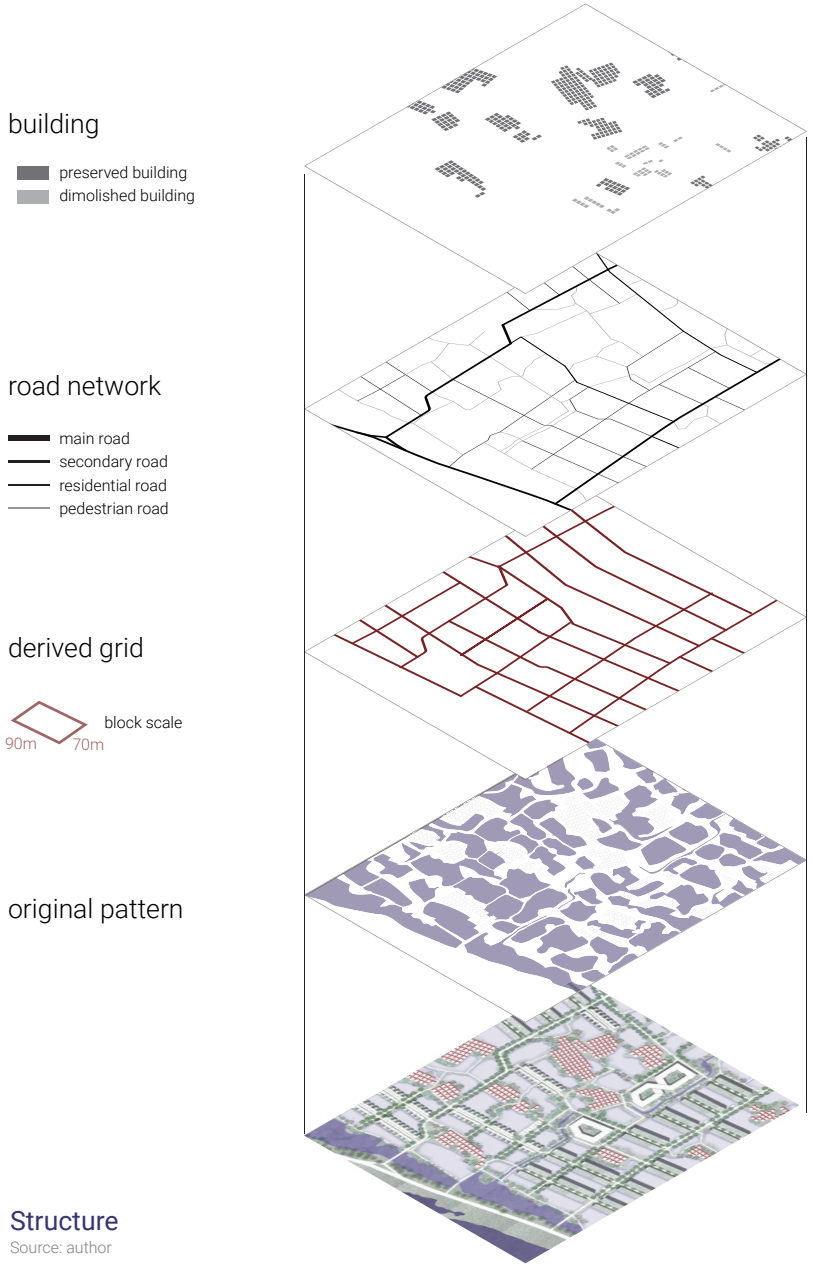
Goal on sustainability
Source: author

A dikepond neighbourhood promoting

+water resilience
+urban farming
+waterfront social life

The new neighbourhood pattern

To preserve the landscape pattern and provide adequate space for flood mitigation, the construction area will adopt a grid layout inspired by the original dikepond pattern. The blocks will have an average scale of 90m x 70m. With a dense network, the residential roads will prioritize slow traffic and serve as spaces for socializing and relaxation. Historic villages of cultural significance will be preserved and connected by pathways, while new buildings will be aligned along the roads, placing water areas at the center of the blocks.

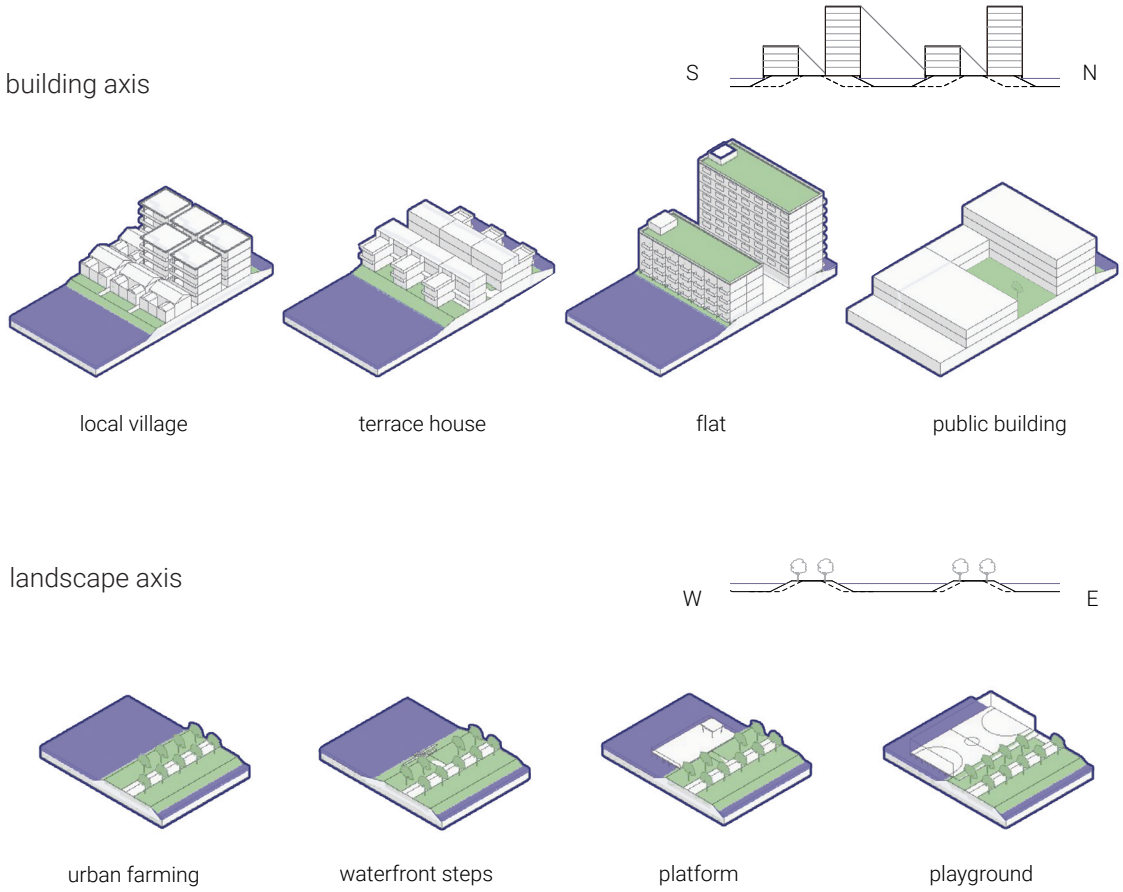


Structure
Source: author

According to the function diversity, the grid is further divided into two axes, the building axis and the landscape axis. Both these two axes can be regarded as expansion construction on the existing narrow dikes.

Axis in west-east direction will be the building axis, which means the buildings are mainly arranged along this axis. The planning follows the traditional village layout, which can also be observed in Gulao town, that the buildings are always facing south in order to get better lighting and ventilation.

Axis in north-south will be the landscape axis, which contains the main functions of greenery, production and outdoor public space. The north-south direction provide the axis with more average light through a day. It is composed with community gardens and fruit trees along the road, and with waterfront structures for extra outdoor activities.



Building and landscape axis

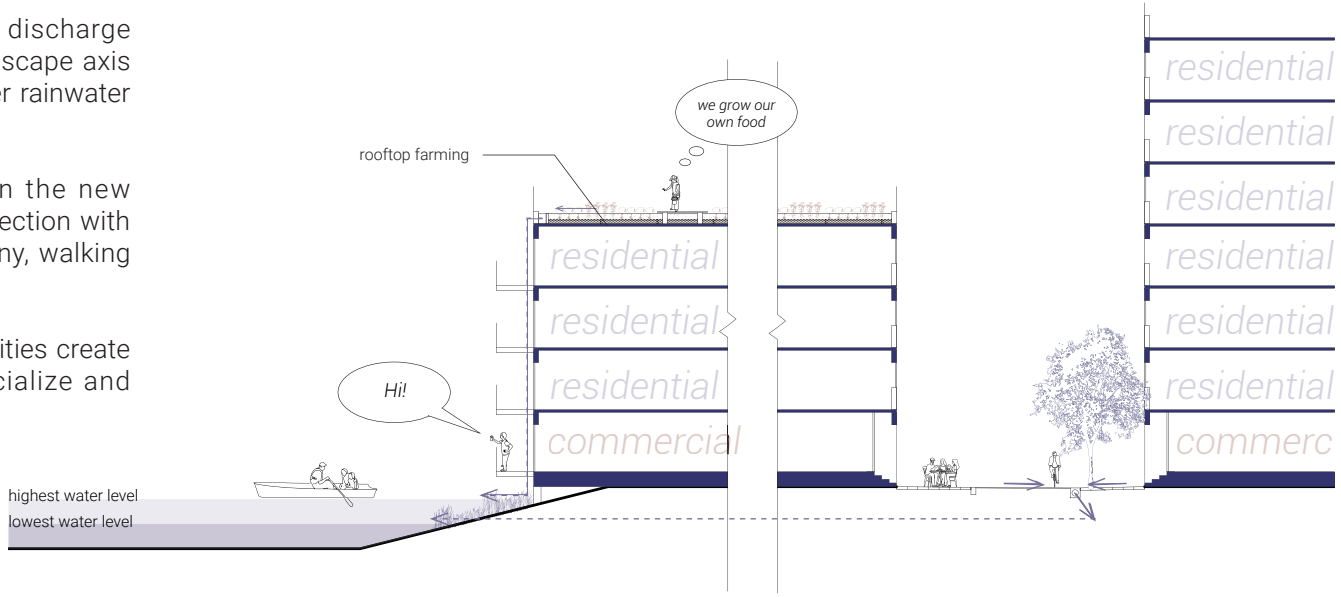
Source: author

Production and water management

The large water area helps storage and discharge water. Both the building axis and the landscape axis are designed to quickly collect and transfer rainwater to the adjacent ponds.

Therefore, what remains unchanged in the new neighborhood is the residents' close connection with water. Whether it's lounging on the balcony, walking around the house, or rowing in the pond.

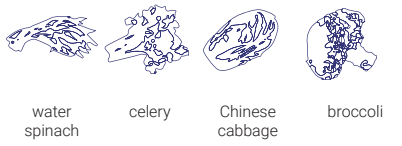
Water-friendly initiatives and farming activities create opportunities for local residents to socialize and participate in community management.



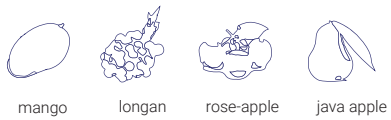
water front residence

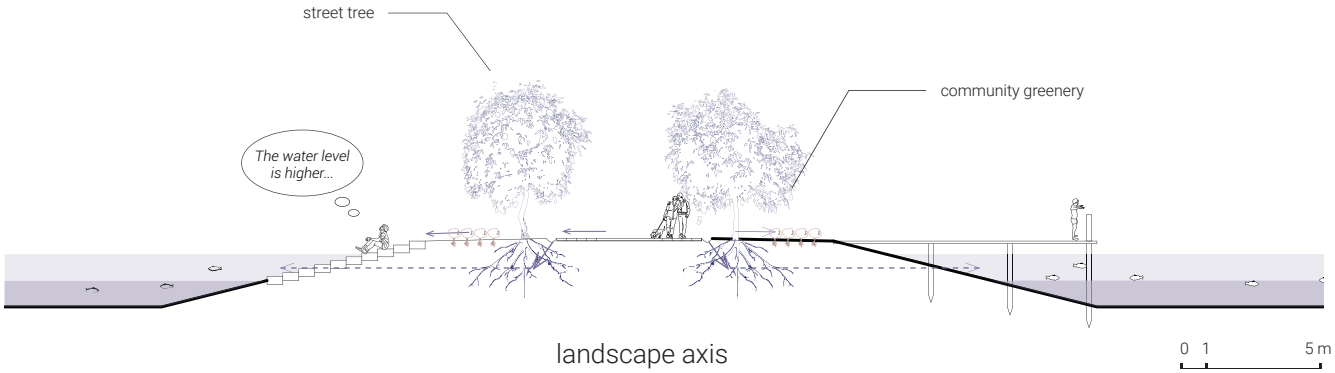
water convey street

plants for rooftop farming and community garden



species for street trees





landscape axis

Sections of two types of axis

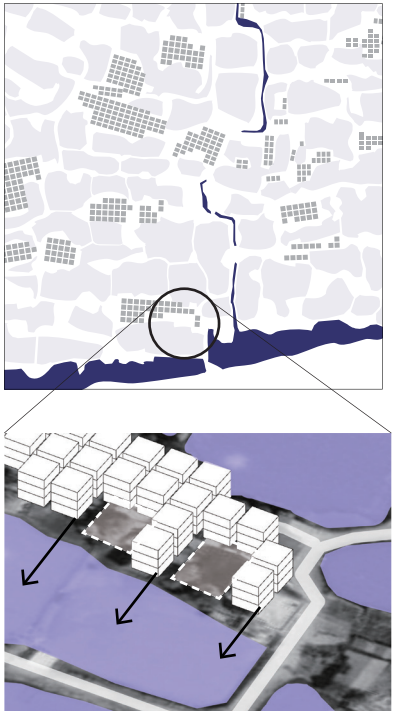
Source: author

Process

The construction of the residential area can be divided into several phases. The plan of proposing a grid-like neighbourhood is at the final phase.

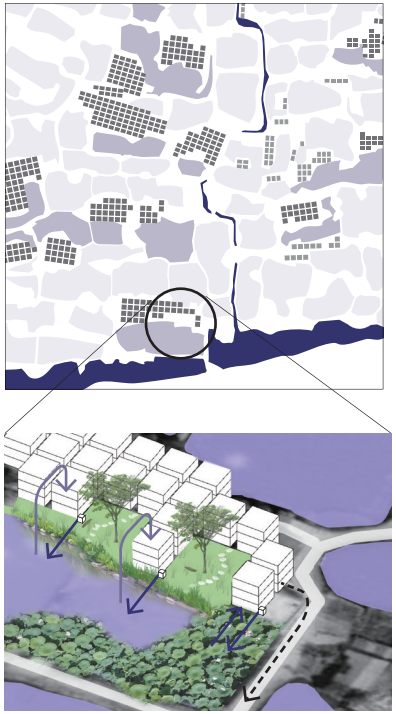
In the rural tourism phase, the abandoned backyards of the villages can be turned into new public gardens. The original fishpond will be transformed into landscape pond that stores treated grey water and rainwater and reutilize it. For the new residential area, the preparation stage will first be modularization by turning the dike into landcape axis and annual crop farming dikes. When construction starts, the latter can be used for building construction.

current situation



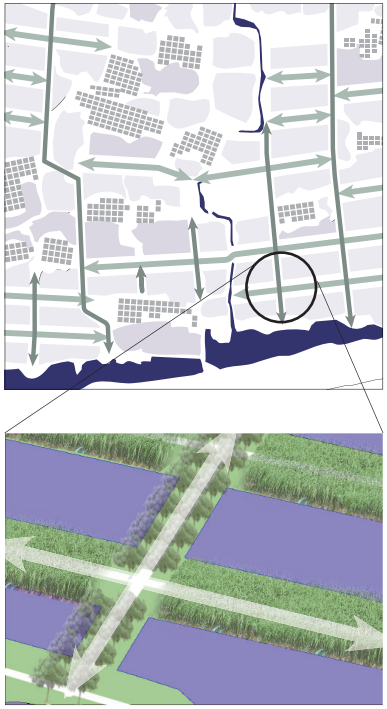
-abandoned backyard
-sewage pollution

1. village renewal



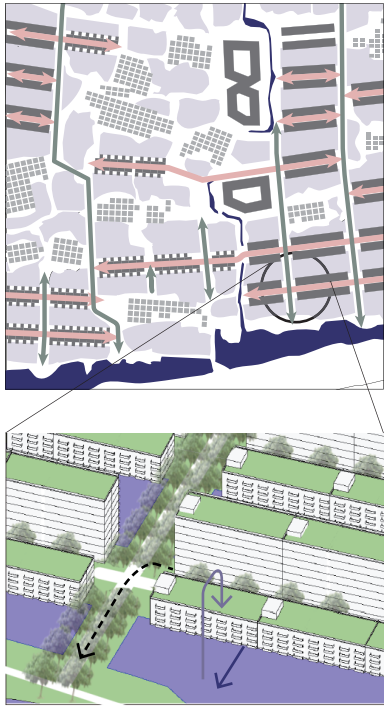
-public garden
-water infrustructure
-landscape pond

2. preparation: Modularization



-north-south: landscape axis
-west-east: cultivation with annual crop

3. new neighbourhood



-north-south: landscape axis
-west-east: buildings

Development process
Source: author

Water connects the community together
Source: author

Enjoy a peaceful night along the main channel

Source: author

An afternoon walk to the traditional village

Source: author

6.7 Implementation and evaluation

Relatively speaking, the public sector holds greater prospects and influence in local development. The government and village committees play a crucial role in formulating rural plans at the macro level, coordinating resources, and providing financial support. On the other hand, the civil sector, despite being landowners, often lacks a platform to voice their opinions and their individual power is often insignificant. Therefore, it is important to establish channels that promote their participation, allowing them to become active contributors and beneficiaries in the development process.

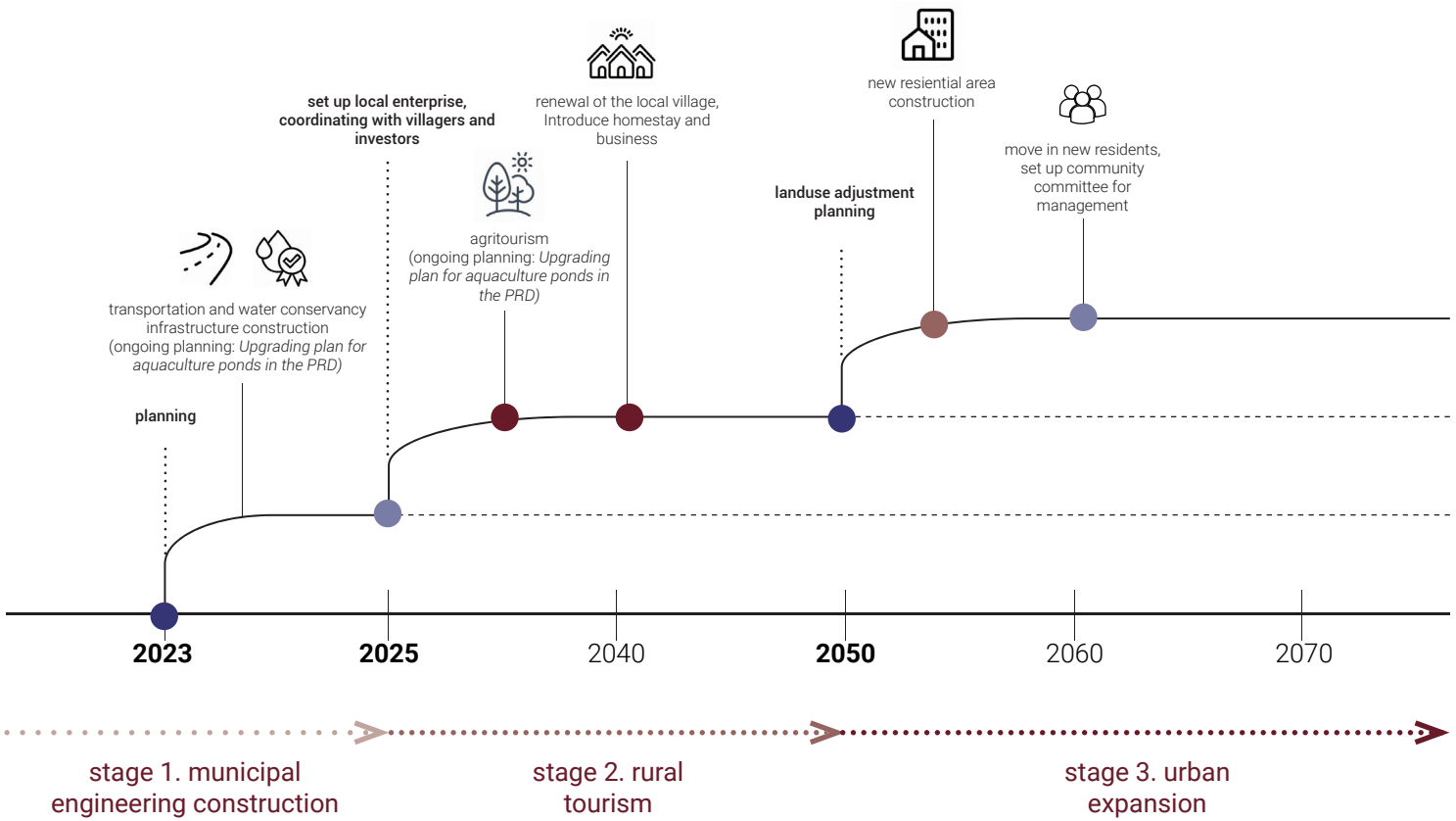
First and foremost, it is essential for the government and local sectors (including the Agriculture, Environmental and Water Resources Bureau), to establish comprehensive development plans for Gulao Town and its surrounding areas. These plans should encompass large-scale projects such as transportation and water conservancy infrastructure, which require significant financial support from the government and are crucial in creating favorable conditions for local development.

In the second stage, the village committee brings together villagers and investors to establish a company, which is a method of combining top-down planning and bottom-up needs. Through this approach, investors provide funds, villagers contribute land or funds and gain employment, and the village committee effectively manages the land. Local companies then drive the spontaneous development of rural tourism project. At the same time, the government should provide policy support, and various departments and agencies should provide professional consultation to ensure the sustainability of the project.

In the third stage, the planning department transforms rural land into urban construction land. Close communication between the developer and the planning department is necessary to ensure the preservation of ecological and social value. The newly established community committee takes charge of managing the new community under the guidance of relevant departments

Stakeholder analysis

Source: author



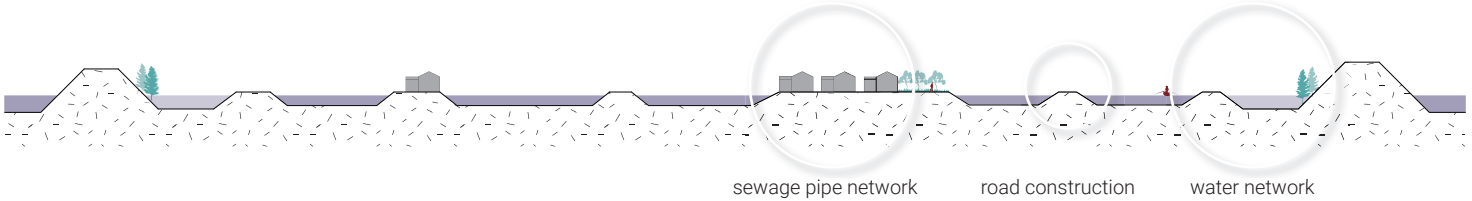
social	☑ set up condition for introducing new industry	☑ promote first and third industry ☑ increase local people's income and attract villagers back	☑ more accomodation ☑ provide new job opportunity for villagers ☑ community involvement
environmental	☑ water connection and quality improvement	☑ rainwater utilization ☑ water quality qualified ☑ better environment for people and creatures	☑ sustainable community

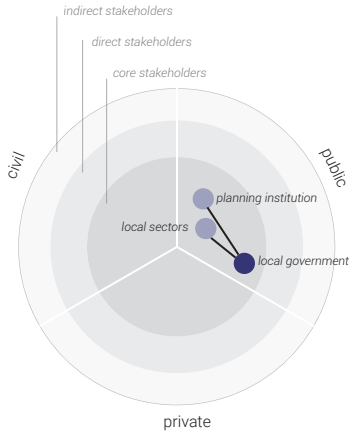
Projects and goals

Source: author

Implementation process

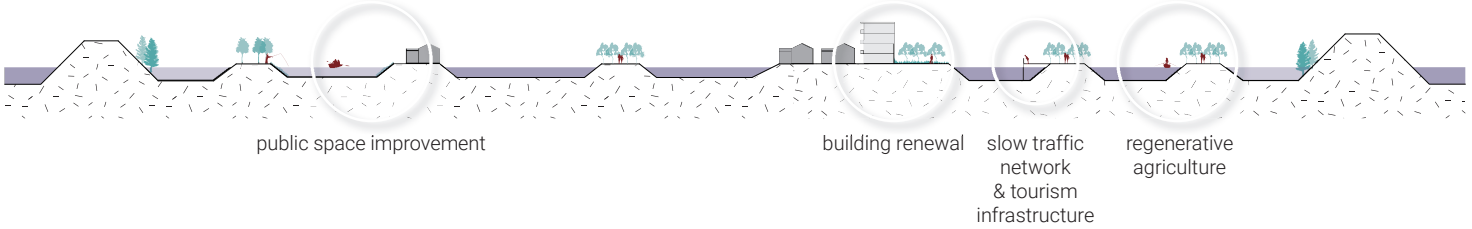
Stage I: 2023-2025
[planning, construction]

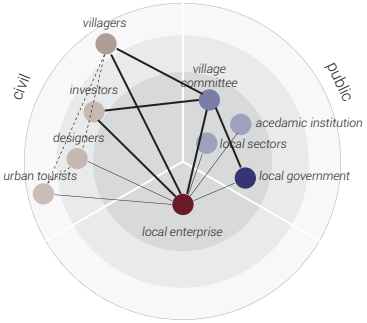




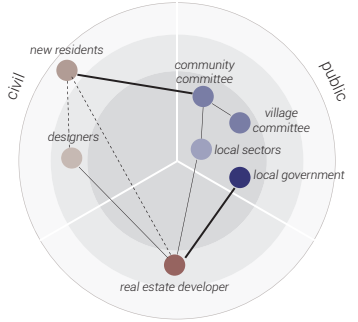
Stage II: 2025-2050
[construction, management]

construction, management





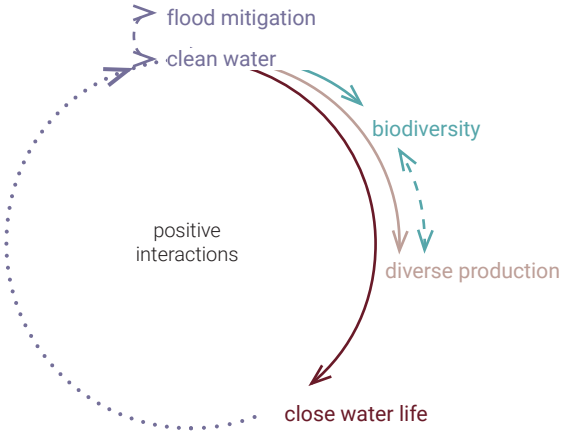
Stage III: after 2050
[planning, construction, management]

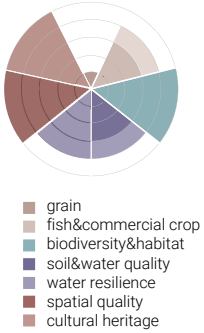


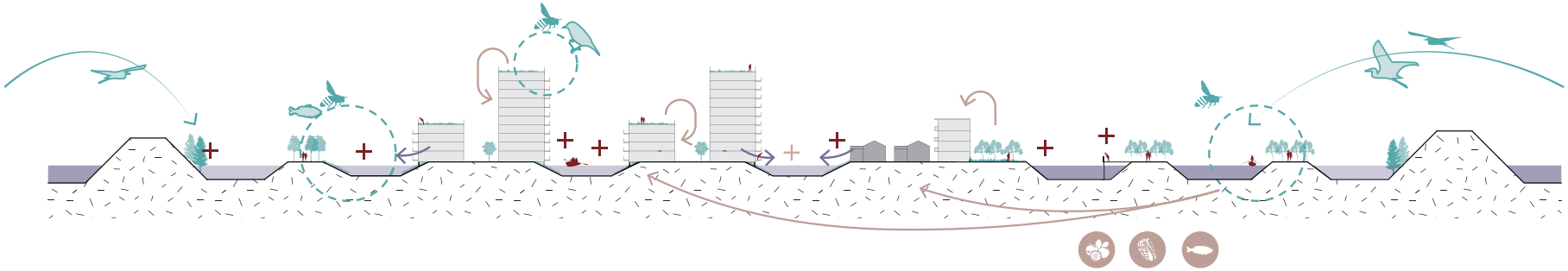
Development process

Source: author

Evaluation





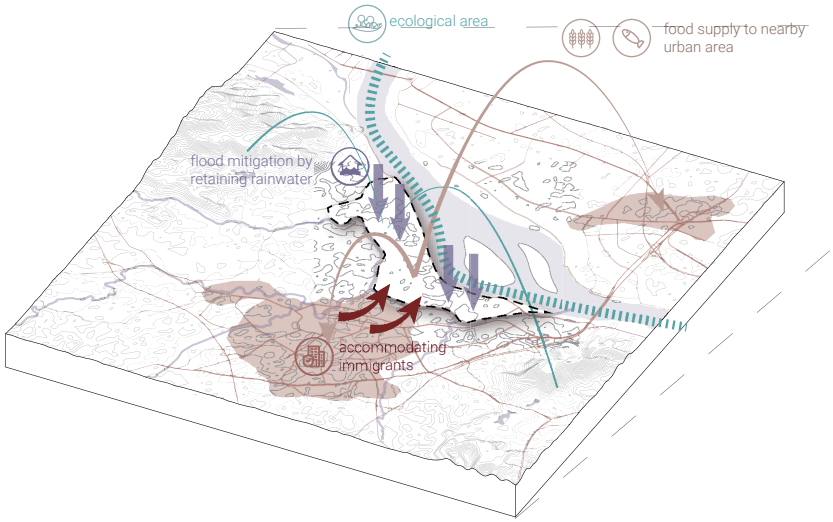


In conclusion, Gulao Town can evolve into a self-sufficient food system where a greater variety of products are produced within the existing agricultural area, and farming becomes integrated into the daily lives of the residents. The ecology is enhanced by improving water quality and ensuring the continuous habitats in both the dikepond wetland area and built-up areas. Most importantly, the preservation and proper utilization of ponds contribute to the invaluable water resilience of the region, passing on this notion to future generations.

In this process, there is a mutually beneficial relationship between different values and functions. It is important that this positive cycle is created, ensuring that stakeholders benefit from it and actively maintain it. This allows the Gulao Town to truly become an area constantly enriched with diverse values.

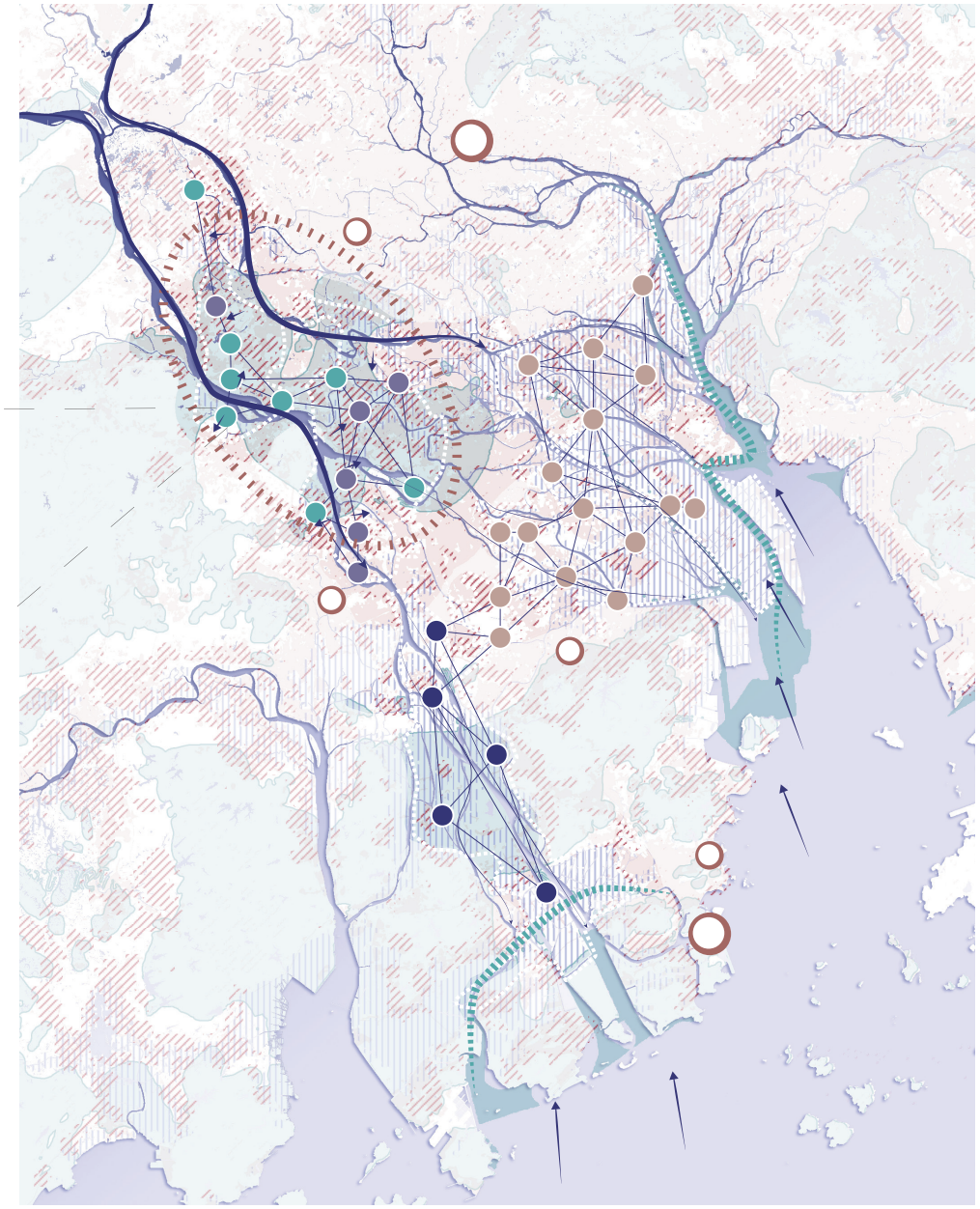
Evaluation (above)
Source: author

The project of Gulao Town exemplifies how the aforementioned principles can be implemented to achieve a vision of sustainable local development. Furthermore, this project not only benefits the immediate area but also serves as an inspiration for the surrounding region. Similarly, by undertaking various projects with different focal points as outlined within the region, the overall vision for the Pearl River Delta can be realized and advanced.



Values to the surrounding region

Source: author



As part of the regional vision

Source: author

PART D Conclusion

Image: Tian, 2019

7 Synthesis and outlook

The story 'From the Water' should be continued.

7.1 Discussion

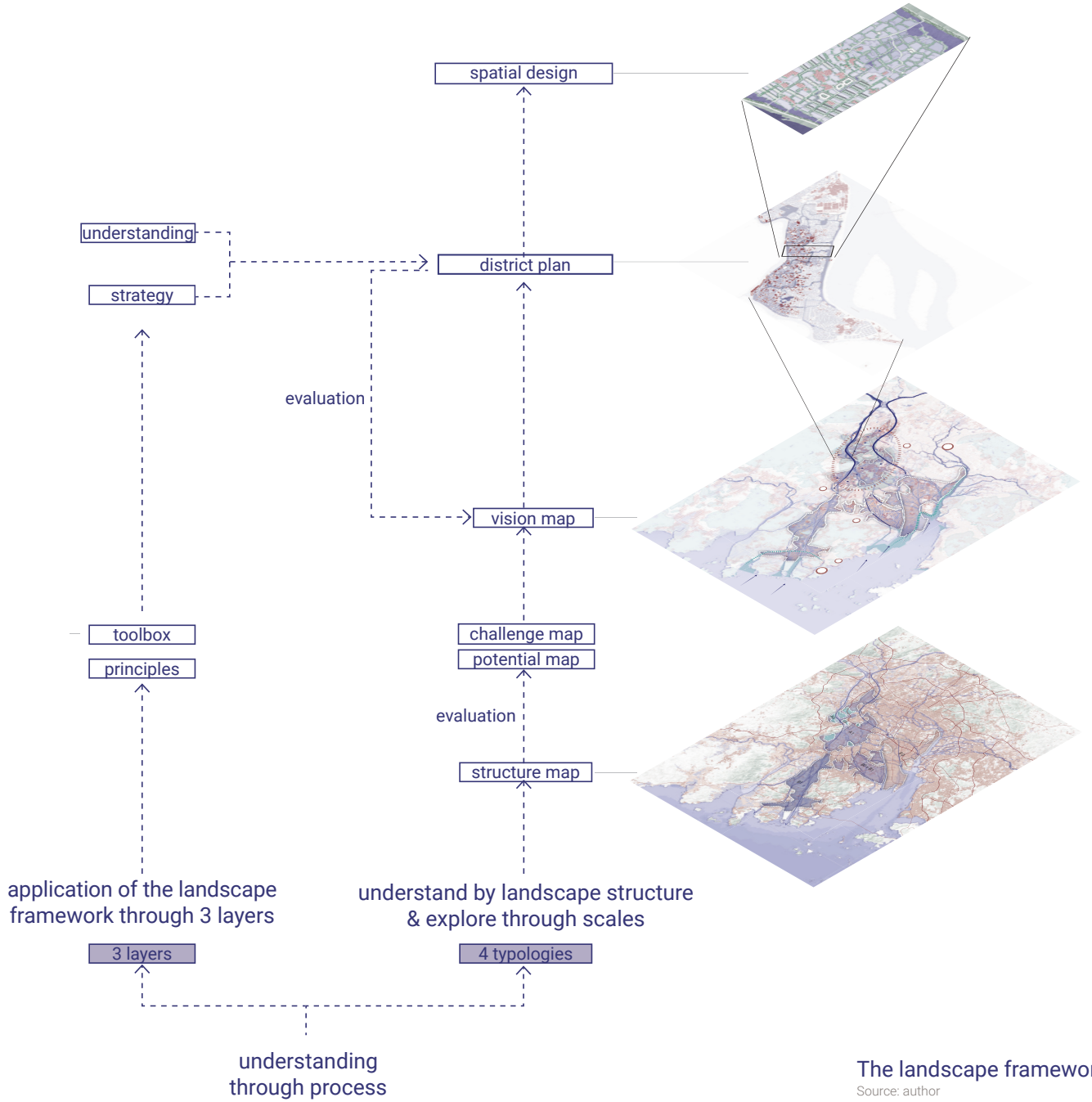
The landscape framework methodology

In order to reach the objective of sustainable development, the landscape framework methodology is built up based on the steps of understanding, principle and application. In this process, the consistency of methodology is guaranteed by three main notions, namely understanding landscape as process, working through scales and understanding landscape by layers.

Firstly, by studying the traditional and modern transformation process of the agriculture in the Pearl River Delta, four polder typologies are classified to clarify the landscape structure of the study region. Area with the same typology shares the same features in natural and social aspect. Therefore, they are likely to share the same general challenges and potentials, and even the same vision. Challenge and potential maps are then composed by the evaluation result of the four typologies. Moreover, the overall vision of the region can be achieved by providing development model to each typology. In this case, typical area of each typology could be selected as pilot projects. The projects are then unfold through strategic plan and spatial exploration in multiple scales.

By understanding the traditional agriculture system, three layers (water and nature, agriculture and settlement) are used for interpretation. Principles and toolbox are generated through these three layers, and are further transformed into the local strategy based on the understanding of local area in the design exploration stage. The strategy helps setting the basic landscape structure of this area, while there is flexibility remained as it allows adaptation and development of the landscape with the social process.

Finally, the sustainable development goal goes through the whole process of my research and design. For the understanding part, the evaluation indicators of the four polder typologies reflect the value of the sustainability goal, which therefore exposed the challenges and potentials that are highly related to achieving these goals. Secondly, the correspondence between principles and sustainability is identified, so that the goal could be achieved through applying the principles. Finally, the final design outcome will be evaluated again to see its feasibility before it's reflected back as a component of the PRD regional vision.



The landscape framework methodology

Source: author

Academic and societal value

-What is the relation between your graduation (project) topic, the studio topic (if applicable), your master track (A,U,BT,LA,MBE), and your master programme (MSc AUBS)?

The flowscape studio (design studio in Msc3&Msc4 of landscape architecture) aims to develop innovative spatial armatures that guide urban and rural development through landscape architectural design. In my project, I use landscape framework to foster the future sustainable development of agricultural areas in the Pearl River Delta. In this way, landscape helps to offer a new perspective and entry point from conventional economy-oriented planning. Moreover, the perspectives of landscape on palimpsest, spatial-visual structure, scale-continuum, and process are regarded as essential support for my methodology.

The resilient coastal landscape lab focuses on the coastal area, which is regarded as a vulnerable area facing the threat of natural and human forces, and takes landscape-based design approach as solution. In this case, it shares a similar context with my research fascination in the west side PRD, where people have responded the floods and population growth issues through agricultural practice for 1000 years. My project shows the potential of transforming the traditional experience into modern landscape design approach.

-What is the relevance of your graduation work in the larger social, professional and scientific framework?

In the planning of the Pearl River Delta, top priority has always been given to economic development, which goes against the logic of traditional agricultural model. My project aims to take the perspective of landscape architecture as complementary to the current planning perspectives and provide an integrated framework for multiple ecosystem services. This project presents a compelling picture of using the landscape as a starting point to demonstrate that the biosphere can serve as the basis for a well-functioning socio-economic (Folke et,al., 2016) . So as to promote more sustainable development in the region.

Meanwhile, through the literature review, I found many Chinese scholars, including landscape architects and ecologists, have their research on traditional agricultural landscapes in the PRD, which have shown a considerable reserve of experience in these traditions at the academic level. However, the practical objects of these researches are mostly focused on the protection of heritage landscapes, while their potential of evolving into strategies for the modern development of agricultural areas is neglected. Therefore, while collating and learning from the traditional agricultural experience in the study area, my project aims to transform these experiences into principles and applies them to village-scale design, which is another step closer to practical application. In the context of rural revitalization in China, the landscape framework methodology could be learned for the development of many other polder areas in the PRD.

7.2 Lessons

Like the title of the thesis "From the Water," this project serves as a reminder for people to perceive the Pearl River Delta as an agricultural-based region, where the local population relies on the landscape they have created from water. Therefore, the objective of this project is to interpret the traditional agricultural system from a landscape perspective and provide guidance for the future development of the agricultural area. The insights and findings of this project have been categorized into two main aspects. Firstly, it is a great opportunity to gain and apply locally specific knowledge and experience. Secondly, the insights gained from the construction and development of the agricultural system can effectively complement the landscape framework methodology. Here is the summary of the latter.

The water

In this project, I use three layers to interpret the polder system in the Pearl River Delta. When talking about rural development today, people often pay more attention to in the regard of agriculture and settlement, for example, common projects about industrial upgrading and spatial transformation. In fact, when we use water as an entry point, as the ancestors there once did, it can connect these projects and even provide more possibilities. In the project, I take water as the basis of the three layers. Water-based principles can make agriculture more regenerative, thereby reducing pollution and improving the ecological environment; while buildings provide more room for water and nature has a closer relationship with them, thus creating a more pleasant living environment.

The dynamic

From the perspective of historical evolution, the development of the agricultural landscape has always been a dynamic process, reflecting people's continuous adaptation to natural and social changes. Therefore, in this project, it is most important to understand and design the landscape structure and provide corresponding principles and strategies that ensure the ecological services of the system will not be lost with the construction, while the landscape form and function of the area are allowed continuous adjustment in line with the natural and social process. For example, after the water capacity standard is determined in Gulao Town, the water carrier can be either a fish pond or a landscape pond in the community that has evolved over the years; the production landscape can occur either at the dike of the fish pond or in future residences building roof. This can be also regarded as a response to social-ecological resilience.

The landscape value

The development of a region may differ based on different value judgments, just like the great changes that have taken place in most agricultural areas driven by economic interests in the past three decades. There are also value trade-offs in my design process. For example, the farming model of the ecological cycle in Gulao Town requires more maintenance costs, and the preservation of water bodies will reduce the construction area of the land, etc., which are possible obstacles to its implementation. But as landscape architects, more sustainable and healthy development models and possibilities from the perspective of the landscape should always be proposed. Design exploration should demonstrate how landscape-based design can deliver tangible and diverse local benefits, and works as an attractive and predictable vision to promote the joint participation of the government, developers, and local residents.

7.3 Outlook

The Pearl River Delta metropolis, as a complex system, faces the long-term and intricate challenge of achieving a balance between human activities and the natural environment. From the perspective of landscape framework, this project proposes a vision for the agricultural area in the Pearl River Delta. Further in-depth research should include the following:

Firstly, the formulation and implementation of principles and strategies within the landscape framework require interdisciplinary collaboration. Professional advice is needed at the three levels of water and nature, agriculture, and settlements. While landscape designers emphasize the interconnectedness of these aspects, their feasibility needs to be guided by professionals in specialized fields. For instance, water and nature require the input of hydraulic engineers and ecologists, agriculture requires consultation with farmers and agricultural experts, and settlement planning necessitates input from urban designers and architects. Given the adaptability of the landscape framework, their involvement should be integrated throughout the various stages of project development and implementation.

Secondly, the vision based on the landscape framework stems from the sustainable services provided by the ecosystem. It needs to be further integrated and improved in alignment with visions that prioritize social and economic development, such as The Outline Development Plan for the Guangdong-Hong Kong-Macao Greater Bay Area' and local overall planning. By regarding the former as a strong complement to and support for the latter, it will facilitate the refinement and implementation of landscape strategies and assists in constructing a more comprehensive and sustainable development system for the region.

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From the Water

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