

An aerial photograph of a rural landscape in Taoyuan County, Taiwan. The image shows a grid of agricultural fields, some of which are highlighted in a teal color. Several large, irregularly shaped ponds are also highlighted in teal, scattered across the landscape. In the background, a dense urban area is visible, leading to a coastline with a beach and the ocean. The sky is overcast.

Reviving Ponds in the Urban Network

*Towards Resilient Water Landscapes
for Taoyuan County*

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Landscape Architecture MSC
2021

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This thesis has been produced with the
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During my learning experience of Master study in Landscape Architecture track in the Faculty of Architecture and the Built Environment at the Delft University of Technology, the big takeaway is assembling the knowledge pieces and learning to explain them clearly and weave them into a story. This thesis is the reflection of containing knowledge of my master's and bachelor's studies and practical experience while working.

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CONTENTS

PART 1 RESEARCH BASE

01 Introduction.

- 01-1 The beginning
- 01-2 Fascination
- 01-3 Context
- 01-4 Topographic and geological conditions
- 01-5 Landscape transformation

02 Problem Fields.

- 02-1 Vulnerability to climate change
- 02-2 Disappearing ponds
- 02-3 Rapid urban expansion
- 02-4 Traditional living with ponds
- 02-5 Problem statement

03 Methodology.

- 03-1 Project outline
- 03-2 Research question
- 03-3 Theoretical framework
- 03-4 Approaches
- 03-5 Precedent study: Qunli Stormwater Park
- 03-6 Methodological flowchart

04 Site Analysis.

- 04-1 Climate change
- 04-2 Urbanized landscape
- 04-3 Pond types and characteristics

PART 2 DESIGN BASE

05 Conceptual Design.

05-1 Design Concept

05-2 Three design principles cross in multi-scales

06 Design Implementation.

06-1 Principle 1-Robust

06-1-1 Dealing with Drought

06-1-2 Dealing with flood

06-1-3 Green and blue network

06-2 Principle 2-Reflective

06-2-1 Form tests of urban and peri-urban pond

06-2-2 Topography

06-2-3 Hydrology

06-2-4 Vegetation

06-2-5 Recreation

06-3 Plan

07 Design Elaboration.

07-1 Principle 3-Flexible

07-1-1 Urban pond-green infrastructure

07-1-2 Urban pond-blue infrastructure

07-1-3 Peri-urban pond-green infrastructure

07-1-4 Peri-urban pond-blue infrastructure

07-1-5 Adapt to three situations

07-1-6 Urban pond-a bridge in between of two ponds

07-1-7 Peri-urban pond-a bridge across the pond

07-2 Summary

PART 3 CONCLUSION

08 Design evaluation & Refelction.

08-1 Design evaluation

08-2 Refelction

09 Bibliography.

ABSTRACT

Key words:

Landscape architecture, Research for design, Strategy, regional landscape, rural area, urban area, public space, scale continuum, water systems, green structures, ecosystems (flora and fauna), climate adaptation, resilience, ponds, Taoyuan Tableland

The pond is a low-lying ground intended to retain or detain both stormwater. In the past, building ponds was a common way to keep fresh water for livestock and irrigation. Due to the rapid urban development and the emergence of centralized water conservancy facilities, the traditional ponds have largely disappeared. One of the crucial examples of disappearing ponds is in Taoyuan Tableland, in the North of Taiwan. After economic development and the demographic boom, the number of ponds rapidly declined from 4521 in 1904 to 745 in 2020. (Yu, 2017) The phenomenon weakens the resilience of cities in the face of extreme weather conditions. When heavy rain comes, covered ponds lose water storage space, resulting in flooding, and when it has not rained for a long time, they can only rely on reservoirs for water supply. Therefore, this project explores the design interventions with landscape architecture, incorporating with the existing ponds, making the city more climate adaptive and enhancing public space quality.

Under rapid urbanization, the land use in the Taoyuan area is divided into urban and peri-urban areas. The test area includes the emerging urban area and the surrounding peri-urban areas. The applied design principles are robust, reflective, and flexible. The first principle focuses on integrating a robust pond system as a mediator between drought, too little, and flood, too much water. Reflective aims to ponds in the emerging urban area and the peri-urban area as models and transform traditional characteristics of the pond into four guiding design strategies: topography, hydrology, vegetation, and recreation. The ponds can transform into a pleasant public space through these strategies. Lastly, from a large scale, integrated pond water systems to individual ponds can be flexible to the changing circumstances. Sometimes, the ponds can be full of water, dry, and be a wonderland for people.

By reviving the pond system in the urban network, the project's tangible quality is making the city more resilient.

On the other hand, the intangible quality gives withering traditional water systems an important role and re-overlap with people's living spaces.

01 INTRODUCTION

01-1 The beginning

01-2 Fascination

01-3 Context

01-4 Topographic and geological conditions

01-5 Landscape transformation



Figure 01-1 The Taoyuan Plateau was a glittering mass of water paddies and ponds.
Source: Center for Geographic Information Science,2016

01-1 THE BEGINNING

In my hometown: Taoyuan, Tableland Mesa, and Pond has become one of the potential World Heritage Sites in Taiwan, selected in 2009. (Potential World Heritage sites in Taiwan, 2009) Such quantity ponds in the tableland make the county earned the nickname of "county of a thousand ponds."

However, in my own growing experience, there are rare experiences with water. For instance, the image on the right is the one I pass most often, but it often has a foul odor. People usually passed through it quickly. At this point, I was so close and so far away from the water. After growing up, I realized I am living in the pond city, and there are ponds within 500 meters, but none of them appeared in my experience.

Therefore, exploring the past story of the pond will be the beginning of the research. What are the reasons for digging ponds in the area, and how people lived with the pond before? The project attempts to respond to how the new pond, a potential world heritage, can be redefined from the perspective of landscape design.



Figure 01-2 Irrigation works in the community
Source: Taken by author

01-2 FASCINATION

The pond is a product built by both ancestors and nature. From a birds-eye perspective, it is a place where water is stored. But if you look closely at each of the ponds, you can see that their unique shapes fit perfectly with the surroundings.

Over the years, the shape of ponds, like figure 01-3, were long, curved, and divided by roads. Extending to the surrounding environment, pond in the metropolitan area has a more rugged and split boundary. In contrast, the ponds in the farmlands have a thick tree ring as a buffer and a more rounded edge.

The relationship between forms and boundaries in the pond is a physical representation of diversity and reveals people's contemporary social, economic, and living environment.

The pond is a container of water, placed in various environments, and over the years, has a variety of relationships with surroundings.

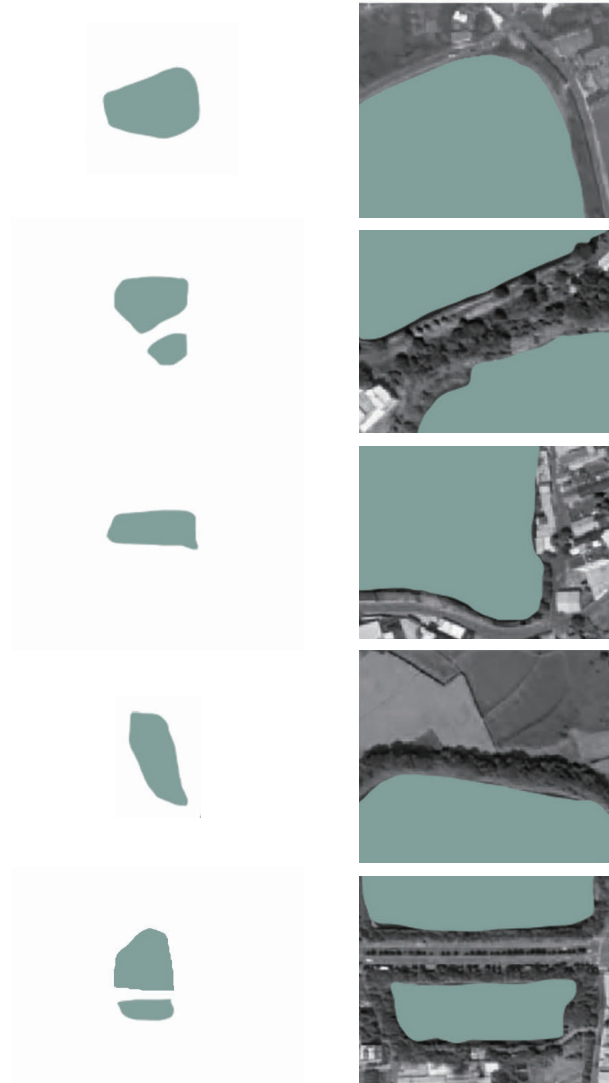


Figure 01-3 Five selected samples of ponds show diverse shapes, edges and surroundings.
Source: Drawn by author

One pond, One story

Due to the expansion of residential demand, build railings, the pond becomes an inaccessible place in the city. There are also pond dyke where rubbish piles up and pollutes the water. Conversely, emerging cities have reinvented the pond as a leisure and tourism destination, integrating the pond as part of an urban park.

However, the pond is a relatively quiet place in the suburbs, a paradise for fauna and flora. The pond also uses as a fish farm.

Each pond has its own story.



Figure 01-4 Set of surroundings images of the Taoyuan ponds
Source: Taken by author



01-3 CONTEXT

“Taiwanese water-oriented productive landscape is representative in Asia’s ‘hydraulic civilization.’” (Wen, 2010)

The productive landscape is significantly interrelated with society. However, one of the representative landscapes is the Farm Pond Irrigation System in Taoyuan tableland.

In terms of national scale, Taiwan is an island in which two-thirds of the area is hilly mountains. The extreme topography and concentrated rainfall mean to cause unsteady water levels.

Concerning county scale, the Taoyuan Alluvial fan has experienced the largest river robbery in Taiwan in terms of topography, which caused all the streams flowing on the alluvial fan to become the beheaded river, resulting in a severe shortage of water. The early settlers dug ponds nearby their house or farmland for reserving rainwater for irrigation. Ultimately, in the figure of local scale, the numerous human-made ponds varied in size and location formed on the Taoyuan tableland.

The pond system played an essential role in water storage and formed a unique water landscape in Taoyuan county.



Figure 01-5 National scale- Taiwan
Source: drawn by author

Figure 01-6 County scale-Taoyuan
Source: drawn by author

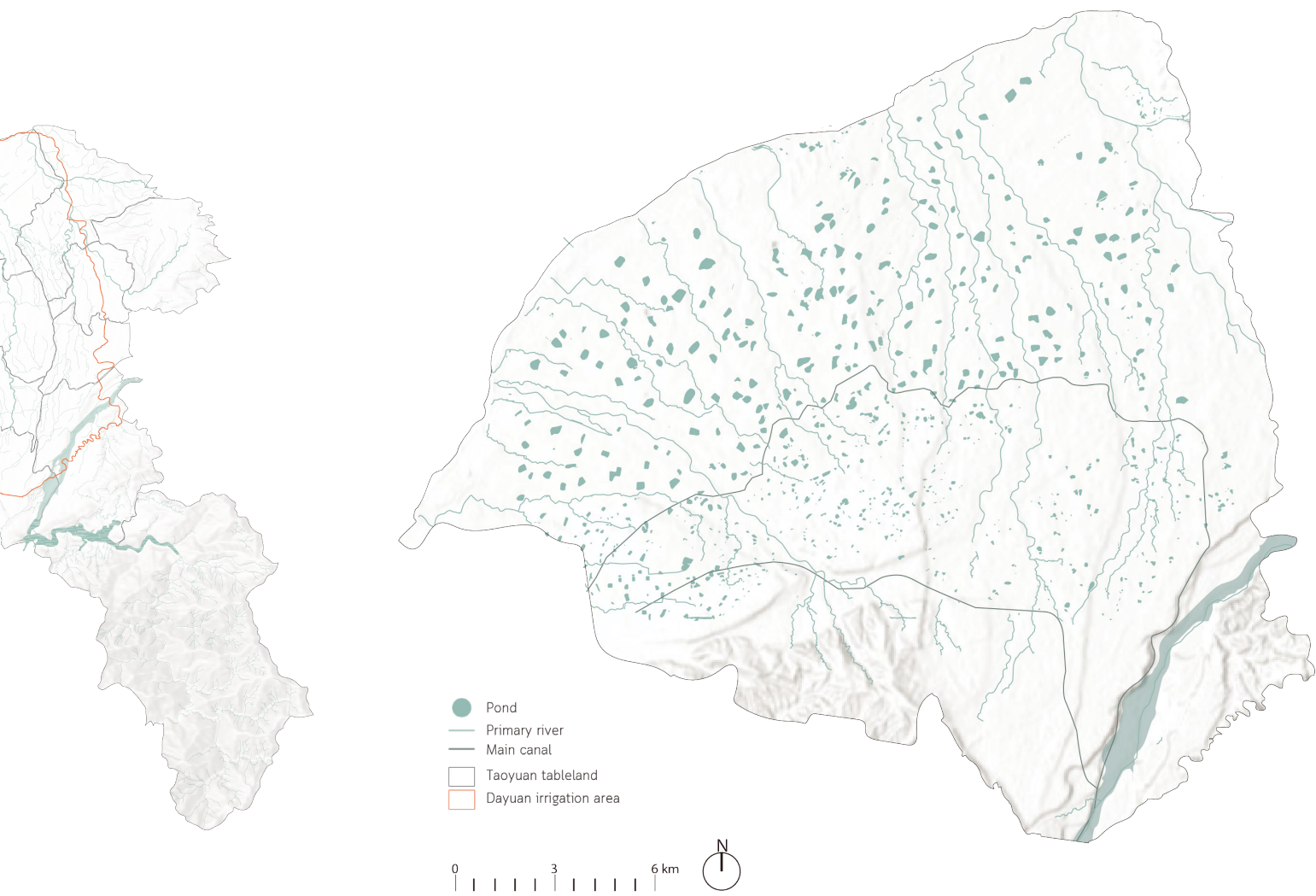


Figure O1-7 Local scale-Tableland
 Source: drawn by author

01-4 TOPOGRAPHIC AND GEOLOGICAL CONDITIONS

One of the reasons for forming pond is the unique topography and geology inherent in geography.

The average slope of the Taoyuan platform gradually decreased from 1/40 to 1/120, and the surface was generally flat except for a few slight undulations. (Chen,1993) This slope naturally makes the surface runoff drainage rapidly. Ancestors took it as an advantage to adapt to the natural topography, dug ponds in the height field to store rainwater.

However, the soil of Taoyuan tableland is mostly barren red soil or red-brown soil, the proportion of which is less than 5%. The permeability of this sticky red soil and red-brown soil is poor. Water leakage of the red soil is less, which is beneficial to developing the excavation pond.

As mentioned above, to supplement the shortage of irrigation water, human-made ponds are based on the local characteristic.

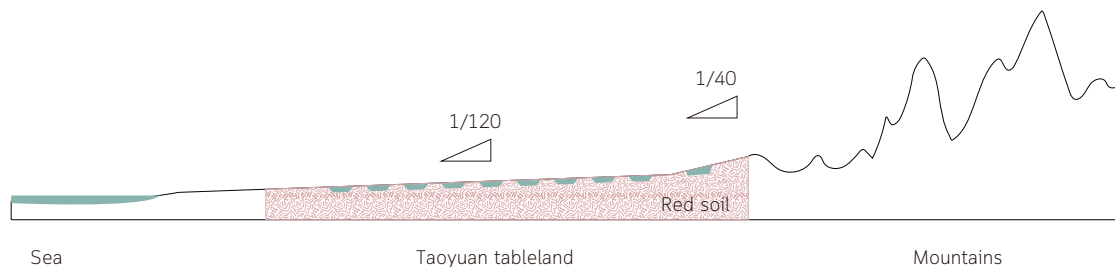


Figure 01-8 Taoyuan tableland conceptual section
Source: drawn by author



Figure O1-9 The terrain and soil maps and soil maps overlap with ponds

Source: 方偉達、林裕彬、鄧東波 (2005)。尺度演繹與復育評估。檢自 <http://www2.thu.edu.tw/~sde/94/www/doc/p1-14.pdf> (April.27, 2003), redrawn by author

01-5 LANDSCAPE TRANSFORMATION

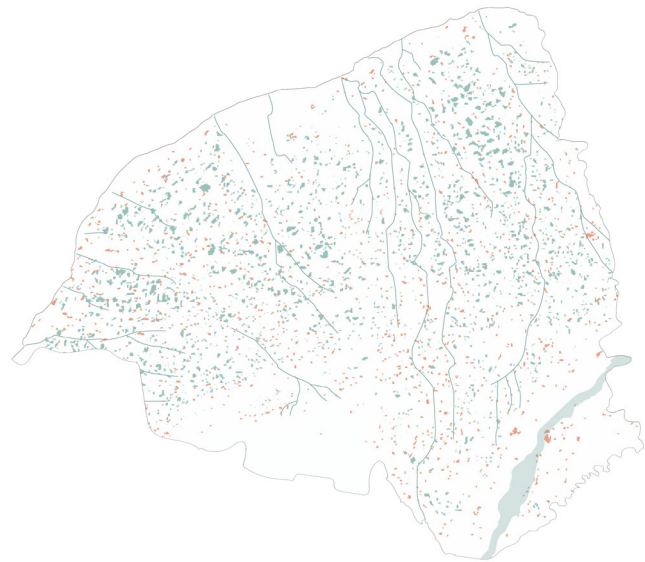
Another reason for forming unique landscapes behind is the riverbed shifts; the rivers in the alluvial fan lost stable water source and became beheaded rivers. Afterwards, the ancients dug thousands of small ponds to collect rainwater for agricultural and living use. The three selected critical periods are 1904, 1930, and 2020 for explaining the farm pond's landscape transformation.

In 1904, the ponds were dug by settlers and located nearby their houses or farmland. The figure shows scattered settlements with small ponds at Taoyuan tableland. Until 1930, there was a great drought. The government constructed the Taoyuan canal for centralized management. All ponds are connected, and thus, an irrigation system created belonging to a public utility. At that time, the small towns start to develop. Then, the Shih-Men canal was constructed in 1963, and the whole irrigation system in the tableland keeps stable water in the pond. However, in 2020, the amount of ponds is rapidly decreased and refilled for buildings during urban and economic development.

Ultimately, there are three trends from 1904 to 2020:

1. The size of ponds becomes larger.
2. The number of ponds becomes less which from 8846 to 744. (Taoyuan Irrigation Association, 2019)
3. The boundary between ponds and building area from blurred to well-defined.

It represents the relation between the water-canal system and society.



1904

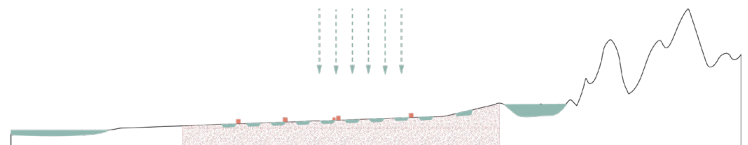
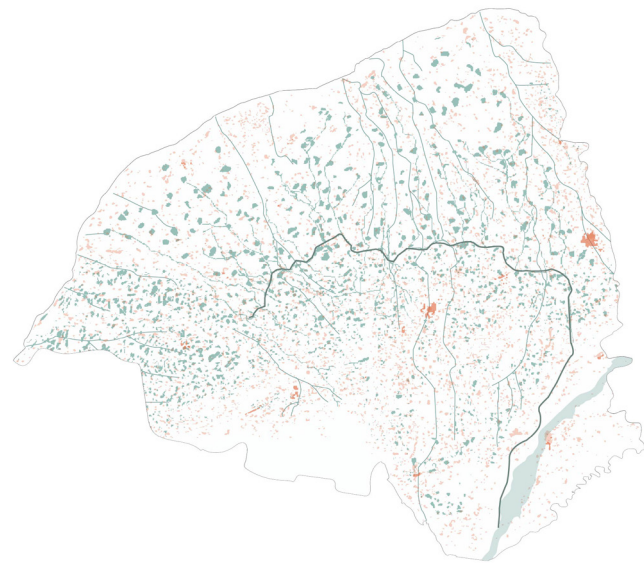
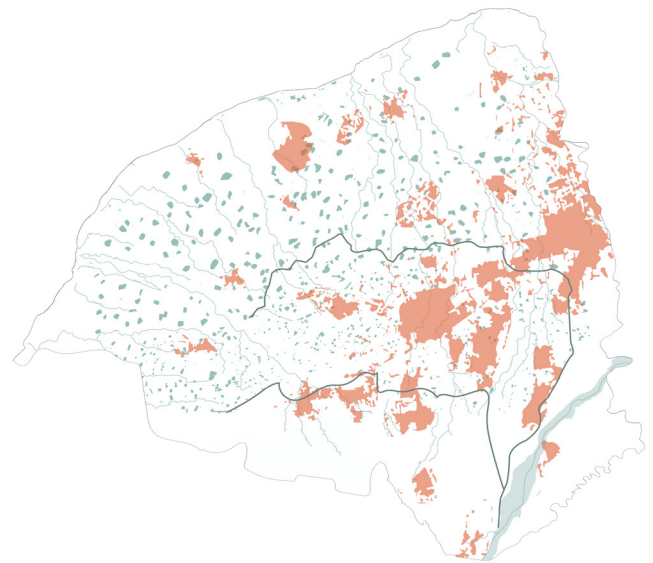


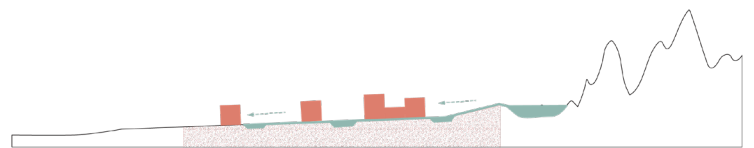
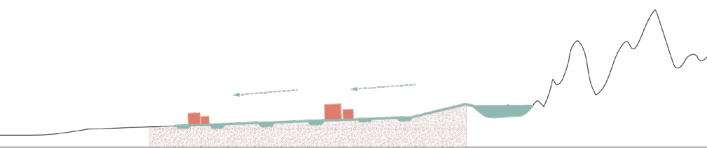
Figure 01-10 Landscape transformation of rivers, ponds and settlement in Taoyuan tableland in 1904, 1960 and 2020. Source: Creative Commons Attribution-NonCommercial-NoDerivatives 4.0 International License, redrawn by author



2010



2020



- Pond
- Building
- Primary river
- Main canal
- Taoyuan tableland

02 PROBLEM FIELDS

- 02-1 Vulnerability to climate change
- 02-2 Disappearing ponds
- 02-3 Rapid urban expansion
- 02-4 Traditional living with ponds
- 02-5 Problem statement



Figure 02-1 The sign shows "Danger: Deep Water"
Source: Taken by author

02-1 VULNERABILITY TO CLIMATE CHANGE

"The distribution of water resources in Taiwan will be more uneven, with a noticeable change in the ratio of wet and dry seasons. Due to these climate change impacts, future water conservation work will be a major challenge for governments." (Huang, W. C., Y. Chiang, R. Y. Wu, J. L. Lee, and S. H. Lin, 2012)

Climate change is changing our living environment, especially water resources.

Taiwan's rainfall with seasonal differences, summer, and autumn due to monsoon and typhoons, bringing abundant rain, known as the wet season, mainly in May to October. On the contrary, winter and spring rainfall is less, especially in the south of Taiwan, defined as the dry season. (see Figs. 02-2) Furthermore, the annual total precipitation map of Taiwan shows that in recent years, the frequency of heavy rain, drought increased, the gap in rainfall increased through time. (see Figs. 02-3)

The research of the TCCIP plan in 2017 produced the estimated map of future rainfall changes in the four regions of Taiwan's north, central, south, and east. RCP was used to present different climate scenarios with varying degrees of warming in the future. There are two different settings with the warming level set by IPCC. The first is RCP 4.5, the moderate warming medium emission scenario representing the temperature increases from 1.1°C to 2.6°C. Secondly, RCP 8.5 means the temperature increases from 3.0°C to 3.6°C. In the scheme of RCP 8.5 happening at the end of the

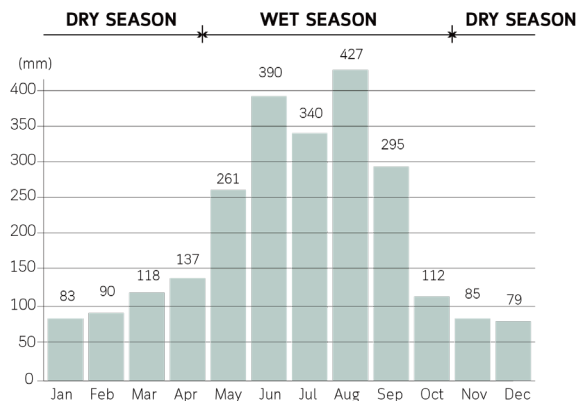


Figure 02-2 Average monthly rainfall in reservoir catchment area
Source: Hydrological Year book from Water Resources Agency, Taiwan, redrawn by author

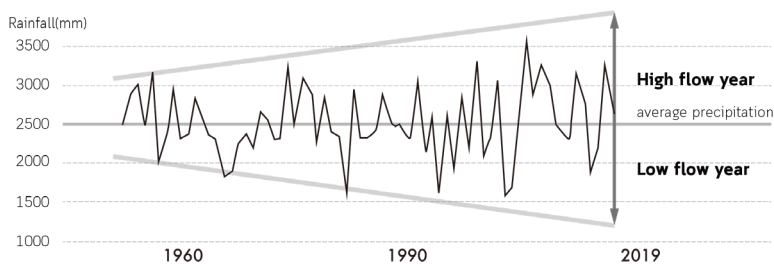


Figure 02-3 The annual total precipitation map in Taiwan from 1960 to 2019
Source: 水利署台灣水文年報, 2017, redrawn by author

century (2081-2100), the rate of change in wet season rainfall will increase by about 14%. Conversely, the rate of change in the dry season will decrease by about 15%. (see Figs. 02-4)

From the above research, the more extreme weather phenomena, the less rainfall in the dry season, and the more rainfall in the wet season are rapidly changing our living environment.

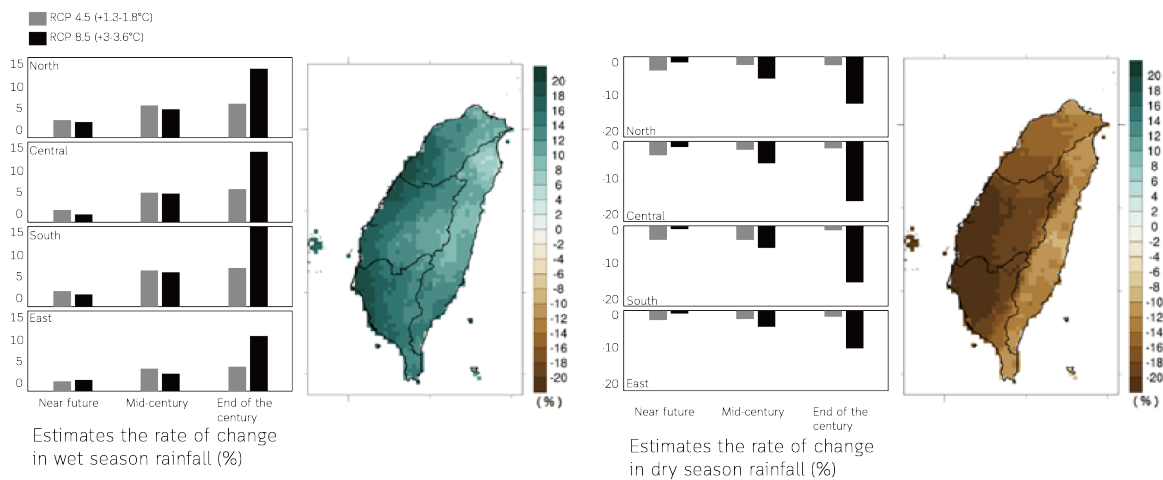


Figure 02-4 Estimated map of future rainfall changes in the four regions of Taiwan's north, central, south and east

Source: 陳宏宇, (2018) 臺灣氣候的過去與未來 《臺灣氣候變遷科學報告 2017—物理現象與機制》 重點摘錄。新北市：國家災害防救科技中心, redrawn by author

02-2 DISAPPEARING PONDS

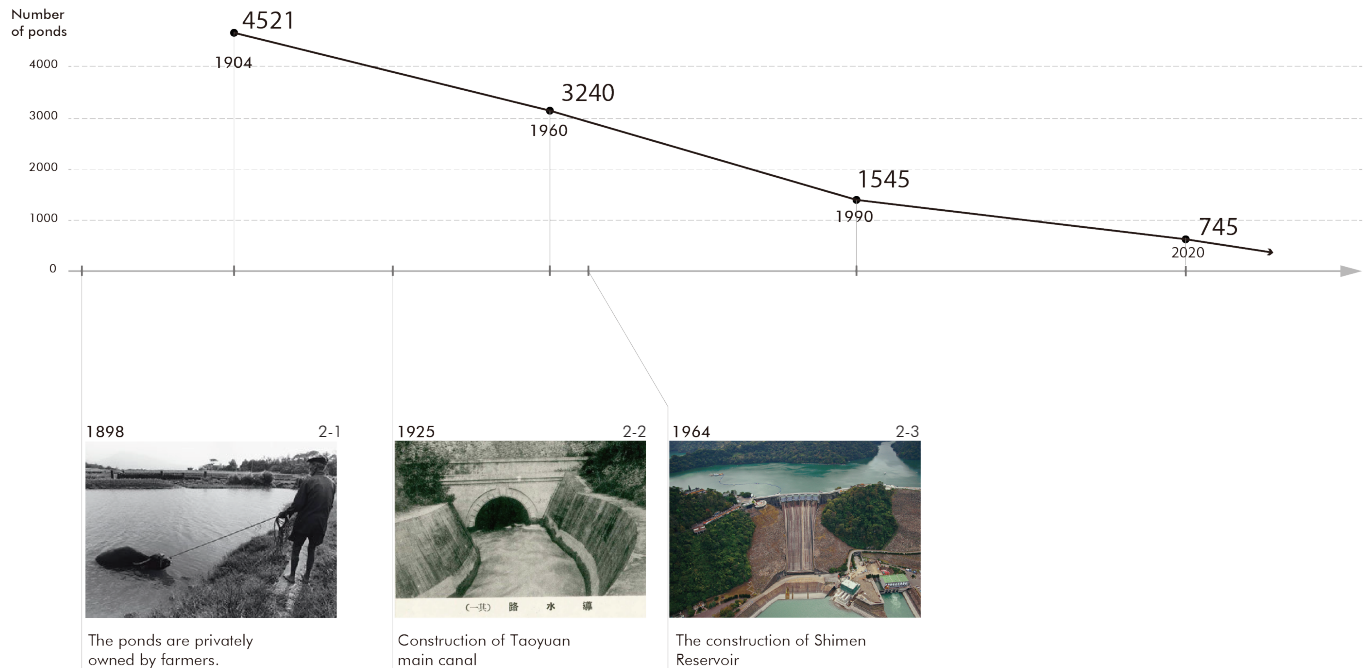
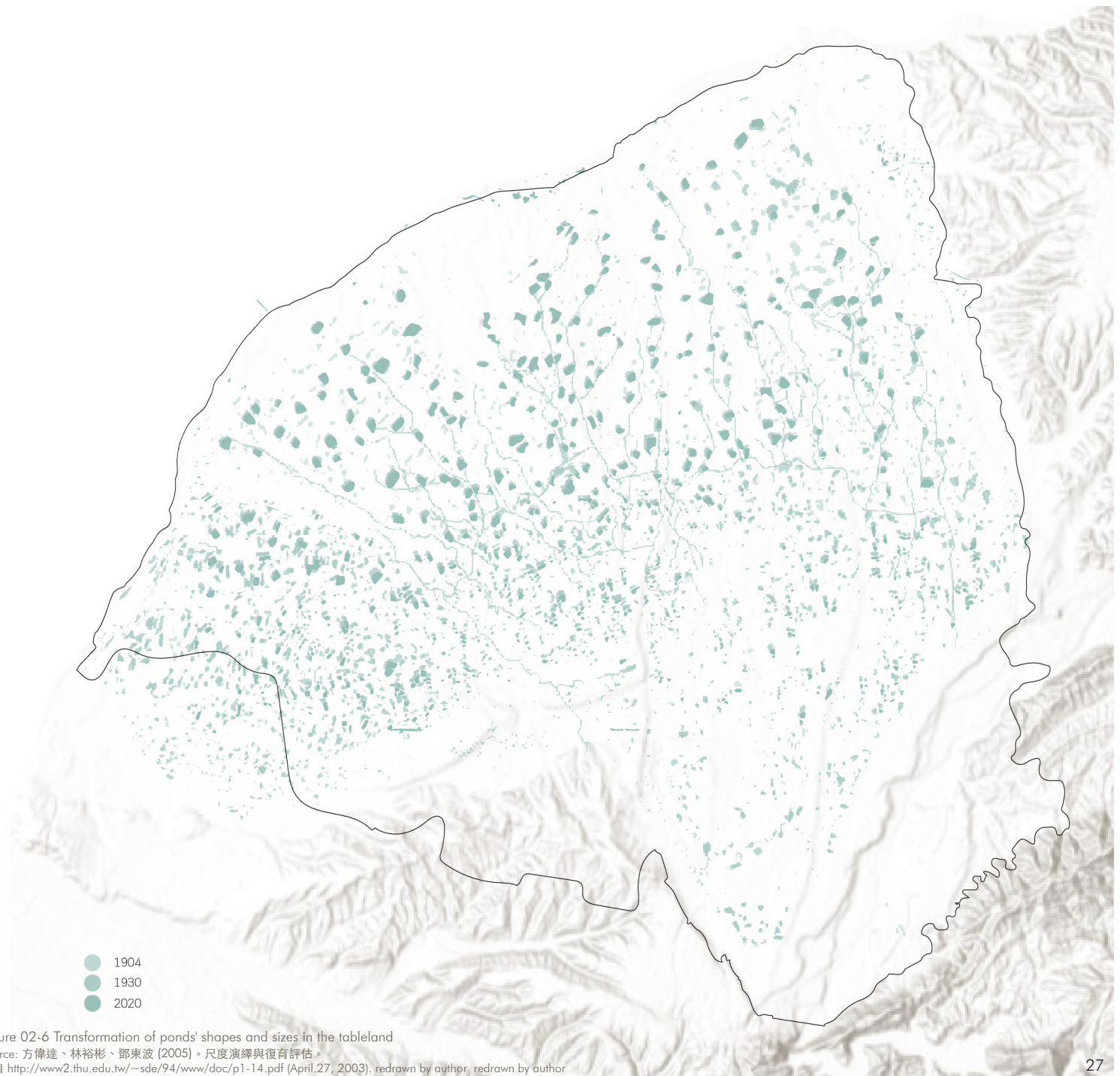


Figure 02-5 The line graph shows the number of ponds through the time
 Source: 方偉達、林裕彬、鄧東波 (2005)。尺度演繹與復育評估。
 檢自 <http://www2.fhu.edu.tw/~sde/94/www/doc/p1-14.pdf> (April.27, 2003). redrawn by author

Image 2-1 by 鍾永和 downloaded from t.ly/epaE
 Image 2-2 downloaded from <https://tia100.azurewebsites.net/build.html>
 Image 2-3 downloaded from <https://www.wranb.gov.tw/3516>

The number of ponds is rapidly decreasing from 4521 in 1904 to 745 in 2020. The number of ponds left 16% now compared to 1904. (see Figs. 02-5) Before 1904, most of the ponds are privately owned and unregulated by the government. From 1904 to 1945, the Japanese government constructed Taoyuan main canal in 1925. Taoyuan main canal connected with ponds improved the irrigation system, which the adequate water storage capacity achieves 41.7 million cubic meters. After constructing the Shimen Reservoir in 1956, the water source of irrigation was abundant, and the number of ponds on the tableland significantly reduced. (Irrigation Agency, Council of Agriculture)
 As mentioned above, the rise and fall of the Pond can be

divided into several aspects. Firstly, with the upgrading of water conservancy construction, the integrated system with canal, reservoir, and ponds has strengthened its water supply area. The second is the transformation from an agricultural society to an industrial and commercial era. The impact of Pond's disappearance has become more pronounced in the rapid development of the past 50 years.



- 1904
- 1930
- 2020

Figure 02-6 Transformation of ponds' shapes and sizes in the tableland

Source: 方偉達、林裕彬、鄧東波 (2005)。尺度演繹與復育評估。

檢自 <http://www2.thu.edu.tw/~sde/94/www/doc/p1-14.pdf> (April.27, 2003). redrawn by author, redrawn by author

02-3 RAPID URBAN EXPANSION

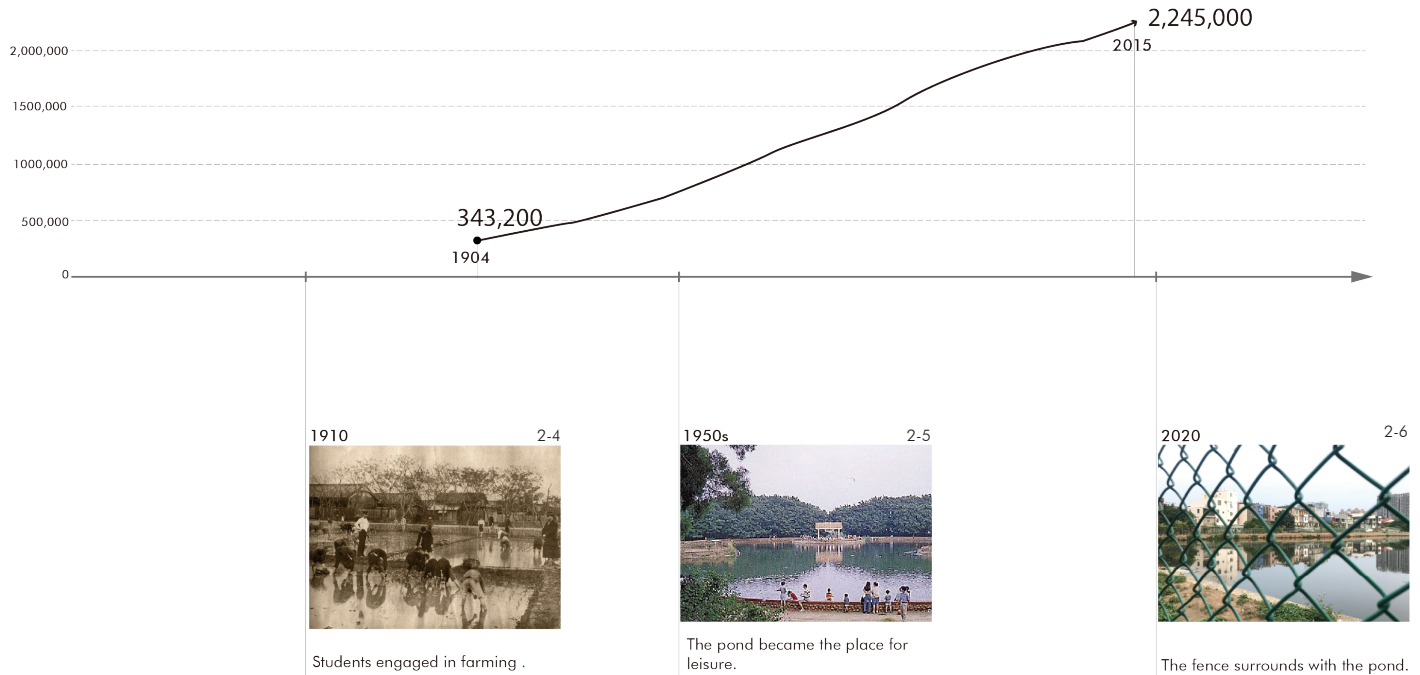


Figure 02-7 The line graph shows the number of population through the time
Source: Construction and Planning Agency, Ministry of the Interior, 2019. redrawn by author

Image 2-4 downloaded from <https://www.twmemory.org/?p=8167>
Image 2-5 downloaded from <https://blog.xuite.net/edave77/twblog/136154494>
Image 2-6 was taken by author

One of the reasons for the decrease in ponds was the rapid expansion of the city. Urban patterns gradually transformed from diffusion to centralized and then to development. (see Figs. 02-5) The population in Taoyuan county increases to almost 6.5 times of population compared to 1904.

Before 1904, the settlement mostly took the small unit as the benchmark and took agriculture as the primary lifestyle. As the population rose, the ponds gradually transformed into a space for viewing and resting, and currently, some ponds have become unsafe spaces in the city in the 1950s. In terms of the transformation of the socio-economic situation, industry focus has

long changed from agriculture to industry and commerce at the second and third levels, and rice cultivation is no longer the most economically efficient way of land use.

As a final point, as urban development increases the demand for land, much of the pond will also be reclaimed. The amount of arable land on the Taoyuan Tableland decreases.

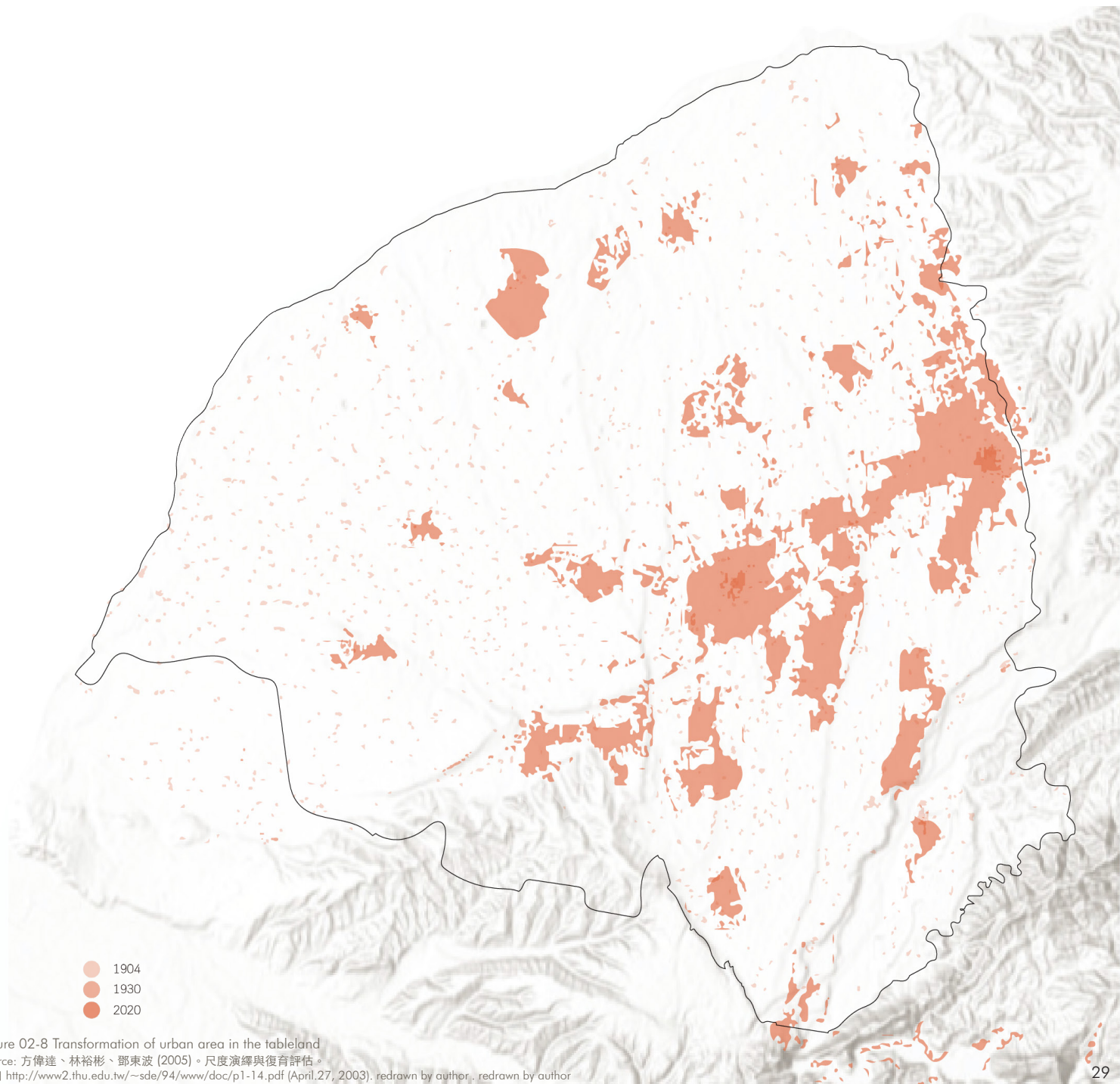


Figure 02-8 Transformation of urban area in the tableland

Source: 方偉達、林裕彬、鄧東波 (2005)。尺度演繹與復育評估。

檢自 <http://www2.thu.edu.tw/~sde/94/www/doc/p1-14.pdf> (April.27, 2003). redrawn by author. redrawn by author

02-4 TRADITIONAL LIVING WITH PONDS



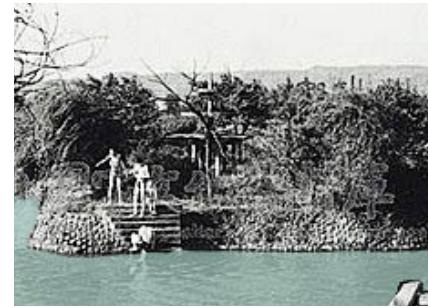
2-7

1 PRODUCTION



2-8

2 LIFE



2-9

3 RITUAL

Figure 02-9 The types of pond space in the past. Source: redrawn by author

Image 2-7 from Taoyuan City Government

Image 2-8 by 李梅樹, 1981

Image 2-9 by 陳長祿 downloaded from http://doi.org/10.6681/NTURCDH.DB_NRCH/Collection

Now the function of ponds in Taoyuan tableland is divided into seven items: agricultural production, regulation, storage and purification, cultural landscape, ecological conservation, recreation, flood prevention, and other specific purposes. (Taiwan Institute of landscape architecture, 2005) However, in the past, the irrigation system was not yet fully developed. The pond was the most important place for local people to live. It shaped the unique cultural landscape. People had a diverse way of living with ponds in the past.

This study defined how to coexist with ponds by understanding past life patterns. This study breaks down the pond space of the

past into production, life, ritual. It's all includes intangible and tangible values. The water space in the pond has many roles, such as irrigating farmland, raising fish, laundry, and even setting up temples. People have developed more behavior in this space, fishing activities, women's laundry side social conversation, children diving activities, dragon boat festival activities, etc.

The abundant ways of living with ponds show the ponds' enormous potential as an essential element in future planning in the region.

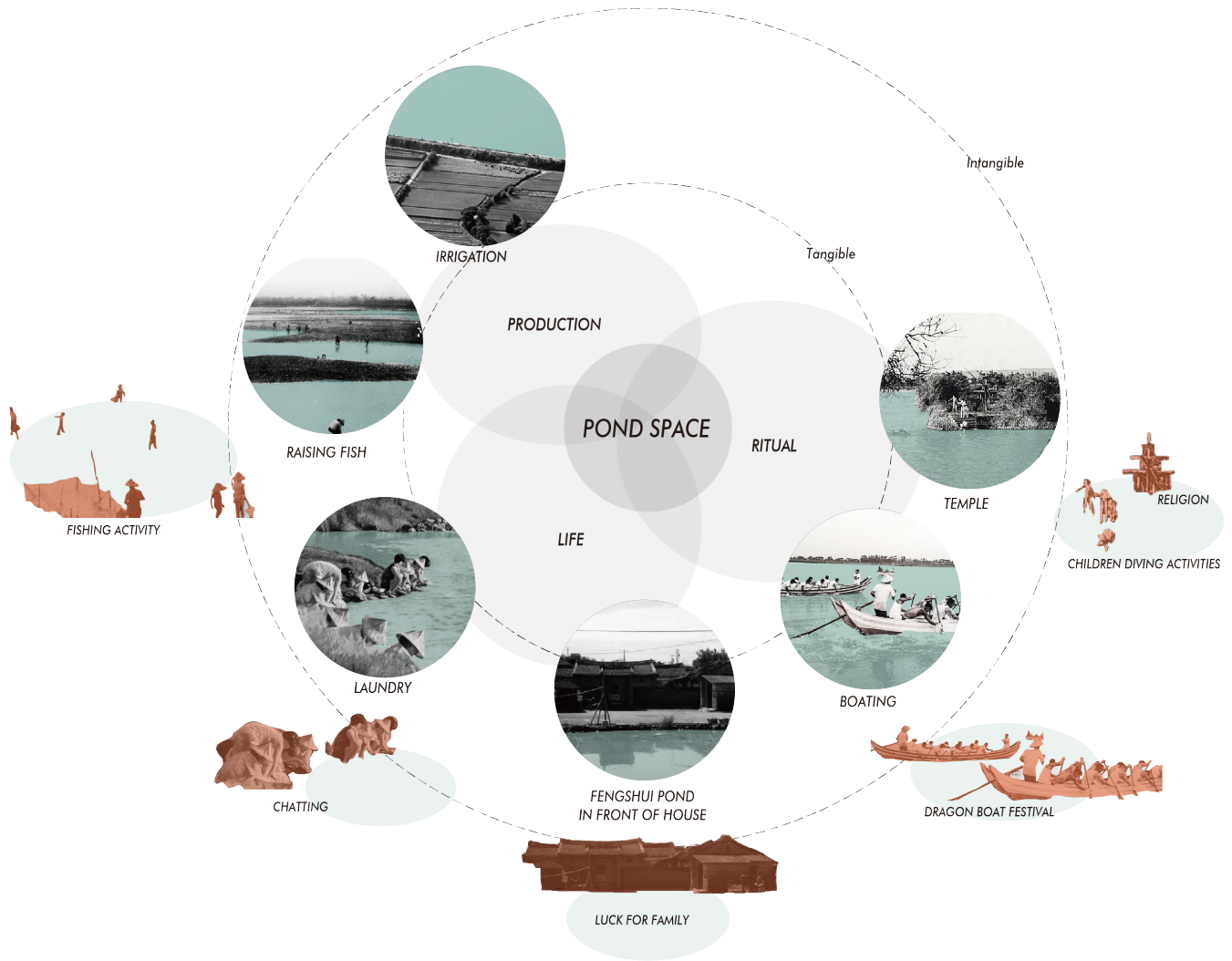


Figure 02-10 The diagram of tangible and intangible elements forming from the pond scape
 Source: drawn by author

02-5 PROBLEM STATEMENT

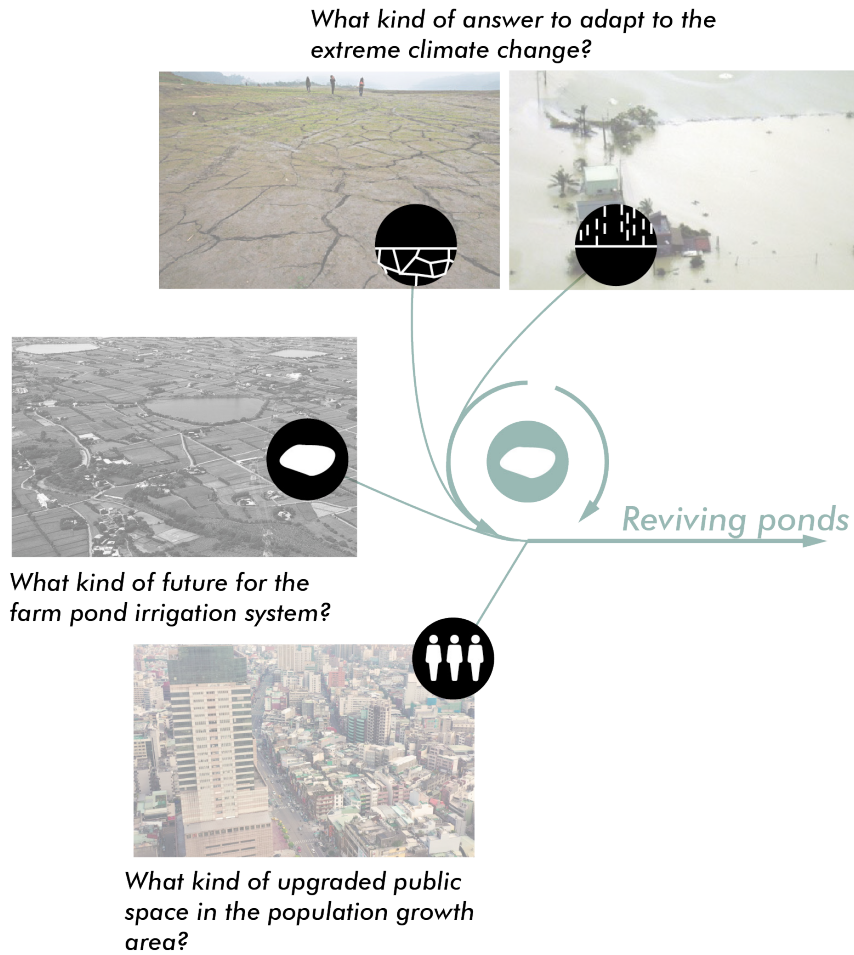


Figure 02-11 The diagram for description of problem statement
Source: drawn by author

As mentioned before, in recent years, the weather changes in Taiwan have increased dramatically, with excessive water for a short time and too little water for a long time, resulting in frequent flooding and drought. Cities must find strategies that can resist or respond to extreme situations.

In retrospect, when ancestors faced water problems, they dug up Pond to store water. By 1925 ponds were integrated, linking the Main Taoyuan canal to irrigate farmland effectively. However, with the construction of reservoirs and the development of cities, ponds are no longer the primary source of water resources. (Irrigation Agency, Council of Agriculture) Many ponds filled, and some of the ponds have even polluted from the factory from time to time. The filled ponds have disappeared, but the remaining ponds are left in the corner of the city. The Taoyuan tableland is losing its unique landscape: farm ponds landscape.

This project aims to propose another perspective to the ponds in Taoyuan county. By looking from the existing water system with ponds regards as a design platform. The rest of the Pond and canals can be a regulator of urban water in the face of extreme weather. As facing future climate challenges, now is the time to re-examine traditional water systems' values and upgrade them.

It led to the problem statement of this thesis as follow:

"Ponds used to be the center of People's lives, but now it's left in the corner or even disappear. As facing future challenges, it is needed to take ponds back. Through reviving ponds, the city can be more robust."

03 Methodology

- 03-1 Project outline
- 03-2 Research questions
- 03-3 Theoretical framework
- 03-4 Approaches
- 03-5 Precedent study: Qunli Stormwater Park
- 03-6 Methodological flowchart

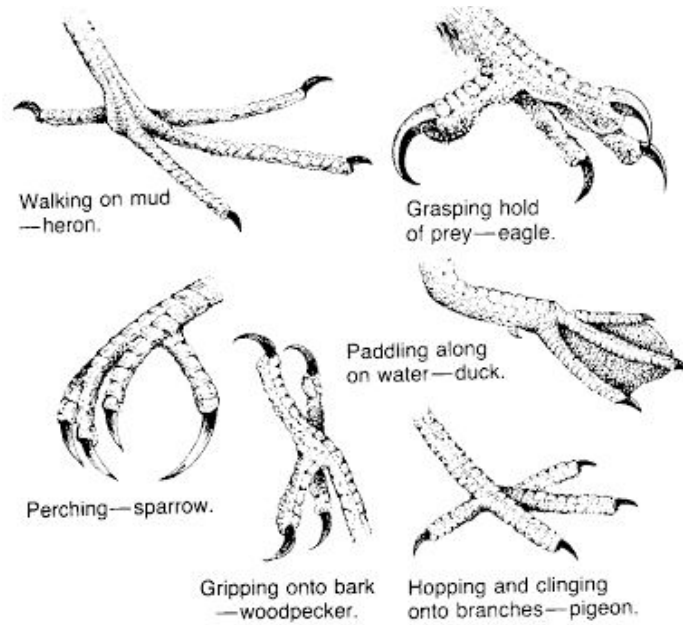


Figure 03-1 Bird claw adaptations.
Source: downloaded from lansingwbu.blogspot.com

03-1 PROJECT OUTLINE

03-1-1 Problem focus

According to the problem statement, the research field focuses on increasing extreme weather conditions of drought and flood, negative environmental impacts from urban growth, and neglected culture value of ponds. The research background will be a brief overview of current national and county government policies on the ponds and put forward the research aim.

03-1-2 Research background

In 2017, the plan of "Taoyuan's Reservoir and Canal Important Wetland" has been designated pond in Taoyuan tableland as a nationally important wetland. A project for constructing a multi-function flood detention facility has launched in response to climate change. (Ministry of the Interior, 2017). There is also a change with the urban planning in the county scale. In the early urban planning, ponds were designated as public facilities such as schools and parks. As a result of those mentioned above national and local policies, ponds have gradually been paid more attention.

However, when extreme weather occurs, the current pond system can not help in time. For example, when a drought happened, pond water can not supply immediately. When flooding occurred, the ponds disconnecting from the drainage system were the disaster area of flooding. Whether transforming ponds will keep up with the pace of climate change is unknown.

Farm Pond network is regarded as a means of living with extreme. The transformation of pond space and water is no longer an action after extreme climate but an opportunity to adjust the city's constitution from the base, making the city more resilient.

03-1-3 Research aim

The primary aim of this thesis is through redefining and reviving ponds to make city more resilient. Therefore, the project is to research how the existing farm pond network can apply the climate change adaptation strategy by integrating ecological infrastructure in waterfront public space, in order to improve the resilience in Taoyuan county, especially in the urban and peri-urban areas.

To achieve the research aim, the project will propose a set of planning principles, design strategies and key design interventions including three main domains.

- (1) Climate adaptation strategy
- (2) Ecological infrastructure
- (3) Integrating pond into public space

03-2 RESEARCH QUESTIONS

" How to incorporate the existing ponds of Taoyuan County to make the area more climate adaptive and enhance the public space? "

SUB QUESTIONS

1. Can the existing ponds linked in a network play a levelling role in times of extreme weather conditions, long periods of drought and heavy rainfall?

2. Can the ponds network be related to a green network to enhance the ecological values of the area?

3. Can the ponds play a role in creating public space, where people meet in the urban and peri-urban areas?

4. How can the redesign of the ponds bring back memories?

OBJECTIVES

Understand the existing water system under extreme climate change

Reintegrate the existing blue-green system with ponds

Explore the position of ponds in the urban and peri-urban areas

Experiment several techniques in the detailed design

SCALES

Multi-scales

L: Irrigation farm ponds and the canal network

M: Selected ponds in Urban and peri-urban area

S: Objects in the pond

03-3 THEORETICAL FRAMEWORK

Landscape architecture could be about adjusting the relationship between humans and the environment to be "just right." Intervening in the excessively artificial space by design can restore to be the balance with nature. Design intervention is not a short-term adjustment that can produce efficient results. A flexible plan is necessary.

In the current state, the unbalanced condition becomes more complicated due to **climate change**. In the twentieth century, humans pursued to resist unstable situations within the scope of the short-term. However, climate change is changing faster than before and has become extreme.

The water landscapes are the center of the fundamental elements that include the hydrological system with the natural and human-made creations. It is also a space that has more extraordinary biodiversity and more vulnerable. Further study could get more specific problems and arise in other parts of issues.

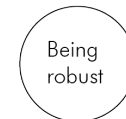
The main research themes in this project are interconnected with the theoretical framework. The first perfectly matches the idea of learning how to adapt the extreme condition is **Resilience**. Then, the second topic is **Water Urbanisms East** focusing on the water space, which engaged with the specific objects of "the city" in Asia.

03-3-1 Characteristics of Resilience

"The origin of the word is Latin, where *resilio* represents the act of bouncing jumping back, going back to the original position." (Cavaliere, 2010) The word of resilience has described that once the system is disturbed and it will have the ability to return to the original state. Therefore, building strength has become a significant component of climate adaptation, environmental management, regional economic development, and strategic planning. (Davoudi et al. 2013)

"Resilience is more than a metaphor but less than a theory. At best it is a conceptual framework."(Swanstrom ,2008)The four-dimensional framework for resilience building was mentioned in Evolutionary Resilience and Strategies for Climate Adaptation in 2013. The conceptual framework can help us to think the climate adaptation in a new way with more dynamic. The four are persistence, preparedness, transformability, and adaptability. (Davoudi et al. 2013)Persistence, adaptability, and transformability are regarded as the domains with multiple scales in the ecological system towards resilience. (Holling et al. 2002). In addition to the environmental aspect, the social context includes the human action that reflects the intentionality of human activity and intervention. The fourth component added is preparedness.

Four-dimensional framework
for resilience building
2013



Persistence



Preparedness



Transformability



Adaptability

Figure 03-2 Four-dimensional framework for resilience building.
Source: Simin Davoudi , Elizabeth Brooks and Abid Mehmood, 2013

Moreover, the approach from the 100 Resilient Cities initiative attempts to stimulate the awareness of urban vulnerabilities and the adoption of measures to overcome the consequence of a crisis. (100RC, 2018). Below are seven characteristics that City Resilience Framework identified the city-systems need.

Seven characteristics

1 Reflective

using past experience to inform future decisions

2 Resourceful

recognizing alternative ways to use resources

3 Inclusive

prioritize broad consultation to create a sense of shared ownership in decision making

4 Integrated

bring together a range of distinct systems and institutions

5 Robust

well-conceived, constructed, and managed systems

6 Redundant

spare capacity purposely created to accommodate disruption

7 Flexible

willingness, ability to adopt alternative strategies in response to changing circumstances

In this project, the approach taken towards resiliency will be integrate with the design.

7 Characteristics of resilient system 2018



Robust



Reflective



Resourceful



Redundant



Inclusive



Integrated



Flexible

Figure 03-3 The pond in the city enclosure with fence
Source: <https://www.100resilientcities.org/resources/>

03-3-2 Water Urbanisms East -Ecological infrastructure

Water urbanism was coined as a notion five years ago (Shannon, De Meulder, Gosseye & d'Auria,2008). Water can be seen as a resource but also a potential threat. Water urbanism concentrates on the water as a "common" and a public domain.(Bruno De Meulder & Kelly Shannon,2013). Water urbanism is taking the city as a base and dealing with the water issues in a natural and integrated social way.

Furthermore, the east means the site selected in the Asia context. The vast Asian world and its rich cultural heritage hold great lessons for the revered role water once held in its ancient cartography, history, mythology, festivals, cities, and everyday life (Shannon & Chen,2013). Compared to the past, industrialization, and technology developed over time. The connection of waterways and the culture of living with water has been disappeared. For instance, most canals and rivers were in concrete linings or become unseen waterway in the underground. Instead of recalling the past beauty, the new water urbanism connects to the traditional system is needed and urgent to face the current condition and future uncertainty.

An integrative strategy is coined to solve the water crisis and landscape architect's angle, reconstructing adaptive water landscapes for both flood and drought. "Ecological infrastructure" (EI) is the key to building on the base of water processes across scales.(Shannon, De

Meulder, Gosseye & d'Auria,2008)There are three landscape categories on which EI focuses.

Three landscape categories

1Abiotic processes are mainly dealing with water management.

2Biotic processes conserve native species/biodiversity.

3Cultural and landscape 'security patterns' (SP) protect and re-creation heritage as a powerful tool for open public space.

03-3-3 Multiple scales

According to the study from Burns and Kahn in 2005, the site is a dynamic relational construct and a trans scalar. Three areas constitute a site in design. To begin with, the area of influence with no specific scale mainly focuses on historical development and processes. Then, the size of the effect with the scale ranges from 1:10000 to 1:1000, named intermediate scale. In this scale, the focus is on understanding the system and deciding actions. Finally, the area of control with the scale range from 1:1000 to 1:200 has made the spatial boundaries that the area of the design actions implement and the level of dealing with materialization. (Burns C. and Kahn A.,2005)

Having defined what is meant by different scales, I will now discuss the project's specific scope. In this project, the large scale is irrigation farm ponds and the canal network related to the intermediate scale. Then, the area of control in this project is divided into two scales: the medium of two selected ponds and the small scale of the objects in the pond.

03-3-4 Applying Design Principles, Landscape categories for design

In this project, climate adaptation, ecological infrastructure and integrating pond into public space are three main domains. Design will be guided by the following Principles, as seen in the 100RC resilient characteristics: Flexible, Robust and Reflective. Framing the focusing landscape categories with abiotic, biotic processes, and cultural

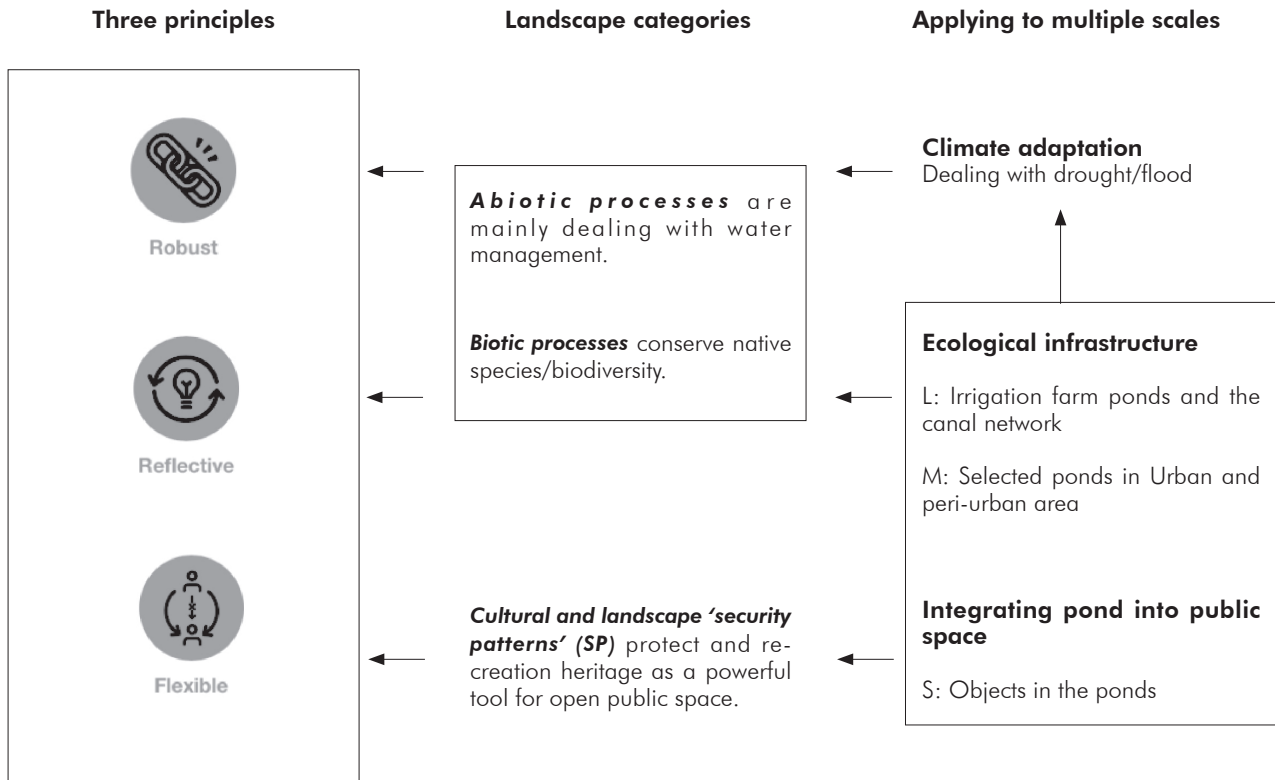


Figure 03-4 Applying Design Principles, Landscape categories for design
Source: drawn by author

03-4 APPROACHES

Several approaches were used in the project for understanding, analysis, and experiment with different perspectives. The text below explained more about the purpose and the focus scale.

03-4-1 Literature study

To learn more about the background knowledge of climate change adaptation, ecological infrastructure, and integrating pond into public space, most of the literature study is done primarily in theoretical parts, and background information on ponds in Taoyuan county is also gained from many local articles.

03-4-2 Analysis: Traditional water system

The analysis on Traditional Water Systems is using the illustrative method developed by I. Bobbink and M. Ryu in 2017. By mapping traditional water system and collecting the past story on different scales can understand the mechanism of the water system. Through the analysis, the clear knowledge offers insight on redesign and match with the local characteristics.

03-4-3 Case study- Qunli Stormwater Park: A Green Sponge For A Water-Resilient City.

“Floods are not enemies. We can make friends with water”(Yu,2019). The case shows the landscape design of sustainability. One of the design methods is the cut-and-fill areas, making more space for recreational areas and water for purification. The method can experiment in the project, which has the same issue of more space for people and water.

03-4-4 Interview

To understand the experience and existing pond's management, interview the locals is the most efficient way. The interviewees target the residents who have the experience of living beside a pond before and the pond's managers. The collection of oral literature can

help the project to gain information on how people living with ponds in the past and the dilemmas of the current condition.

03-4-5 Model experimentation

In the small scale of spatial design, the fundamental landscape design tasks in the project are topographic modeling, cut-and-fill analysis, and water flow modeling. Therefore, the clay model can be a tool to think with hands, which can be more virtual and quickly understand.

03-5 PRECEDENT STUDY:QUNLI STORMWATER PARK

The ponds in Taoyuan county faced the challenges of climatic change, rapid rainfall, and long-term drought. Therefore, the water purification and storage of the pond became a major issue. The case of Qunli Stormwater Park shows how to provide multi-ecosystem services through the urban stormwater park to collect, purify and store rainwater to replenish groundwater aquifers.

The project is located in the eastern New Town of the northern Chinese city of Harbin, the park covers an area of about 30 hectares and was originally mostly flat and covered in concrete. The design is faced with two major issues, the first is the summer rainfall concentration, easy to cause flooding; the second is the original wetland facing year-by-year reduction, ecological degradation, wetland landscape facing the loss. Therefore, several design strategies and elements were employed in the following.

1. Protect the existing :

The existing wetland is allowed the natural habitats to continually evolve.

2. Earthwork balance:

The Cut-and-fill strategy is to create an outer ring of mounds and ponds.

3. Walking experience:

Firstly, a network of paths links the ring

of ponds and mounds grant visitors to have a walking-through-forest experience. Secondly, a skywalk links the scattered mounds allowing residents to have an above-the-wetland and in-the-canopy experience. (see Figs. 03-4)

For the construction of the pond, a cut and fill strategy was used to balance the earthwork in the buffer zone and an artificial wetland was set up. In addition to the formation of a good wetland landscape and rich habitat and plant resources, but also create a different sense of space between people traveling in the wetland. This strategy can be seen as the hinge of people and nature. (see Figs. 03-5)

Ultimately, the several aspects gained from the park. In terms of ecological benefit, the maximum storage capacity of the wetland park is 137674.64 m³. However, for society, the wetland park has become the best place for residents to exercise and an educational site for students to visit.

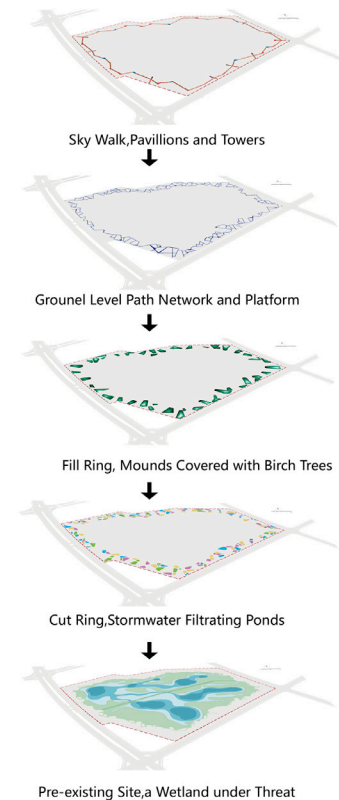


Figure 03-4 The image of the design concept and site plan
Source: <https://www.asla.org/2012awards/026.html>

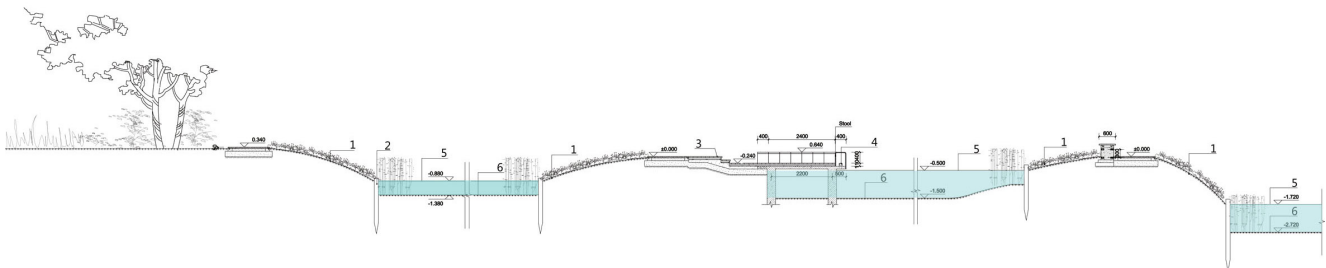


Figure 03-5 The section of the pond-and-mound ring with path system and tower view
Source: http://www.arquitectes.cat/itframes/paisatge/fotos_proj/8a_BIENNAL/P8020/P8020F4.jpg

03-6 METHODOLOGICAL FLOWCHART

In this methodological flowchart, the structure of this thesis is explained with research questions and a sequence of research and design.

This project takes pond as a key element to enhance the city's resilience. It needs to make the process of guiding principles, planning green-blue networks with ponds network and the public space design with ponds on the smaller scale.

The flowchart shows all decisions with specific issues and scope.

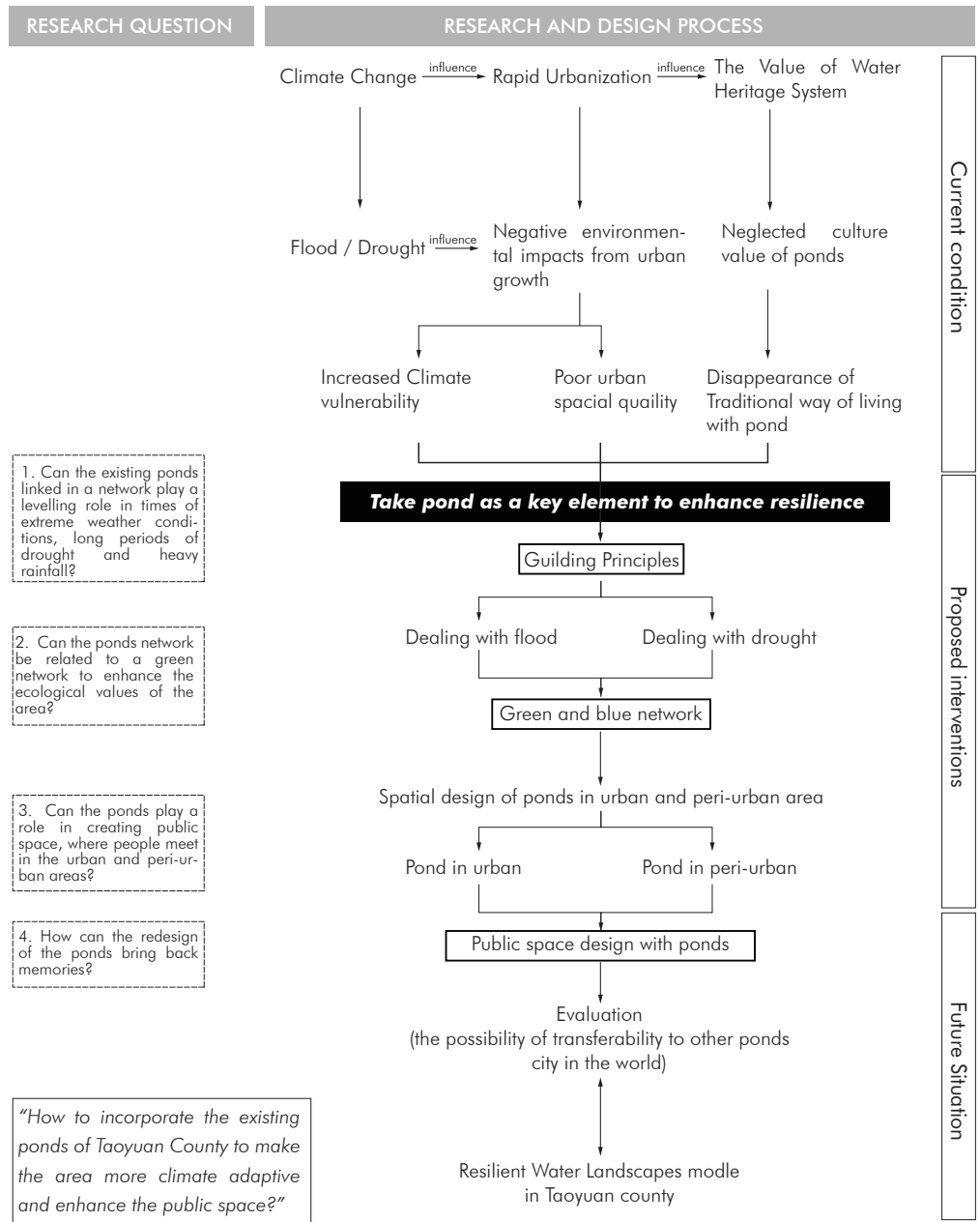


Figure 03-6 Methodological flowchart
Source: drawn by author

04 Site Analysis

04-1 Climate condition

04-2 Urbanized landscape

04-3 Pond types and characteristics



Figure 04-1 Drought condition in 1994 and flood condition in 2009
Source: <https://www.cw.com.tw/article/5065821>

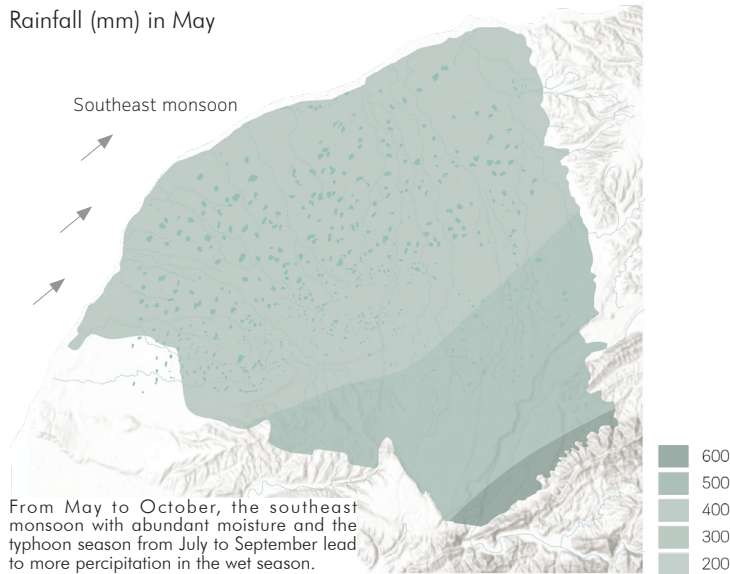
04-1

Climate condition

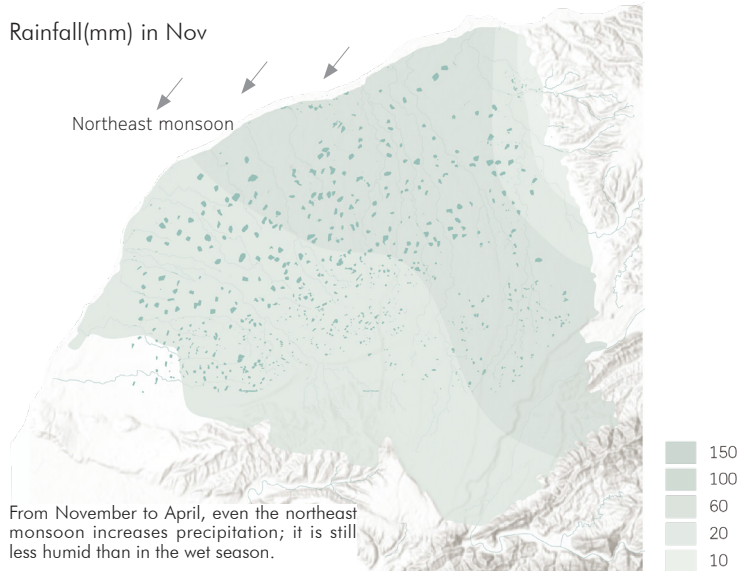
- 04-1-1 Climate condition in Taoyuan
- 04-1-2 The role of ponds in the water flow
- 04-1-3 The role of ponds during drought
- 04-1-4 The role of ponds during flood
- 04-1-5 Three situations

04-1-1 CLIMATE CONDITION IN TAOYUAN

Rainfall (mm) in May



Rainfall(mm) in Nov



Climate zone: Subtropical climate
 Climate & Weather Averages
 High t: 38.4°C
 Low to: 6.4°C
 Mean to: 23°C
 Precipitation: 125.7mm
 Humidity: 75.5%
 Dew point: 13 °C
 Wind: 2.3 km/h
 Pressure: 1022 mbar
 Hottest Months: Jan (16.8°C)
 Coldest Month: July (30.7°C)
 Wettest Months: Sep (152.5mm avg)
 Windiest Months: November (4.6 km/h avg)
 Annual Rainfall: 1509 mm

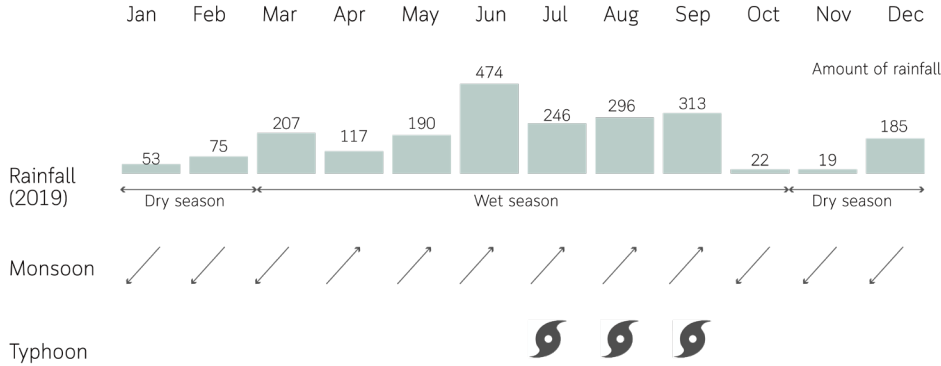
The climate in Taoyuan is mainly affected by the monsoon and divide into wet and dry periods. The northeast monsoon started in late October and ended in March with strong winds and low temperatures which are defined as the dry season. Then, during the wet season, the southwest monsoon starts in May and September with light winds and sunny weather. There are many thundery showers in the afternoon, especially typhoons in July and September.

Due to the rapid summer rain in the wet periods, the high rainfall intensity and higher evapotranspiration can easily lead to a shortage of irrigation water. It is one of the reasons for establishing a farm pond irrigation system.

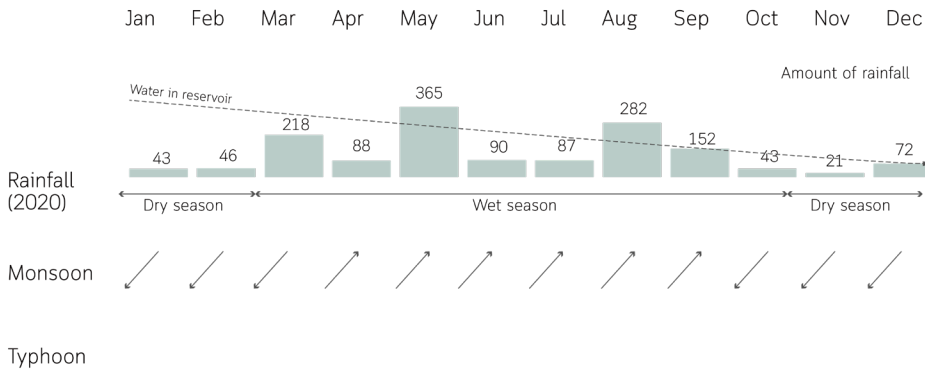
Figure 04-2 Rainfall (mm) in May and Nov

Source: https://watch.ncdr.nat.gov.tw/watch_history_rainmap

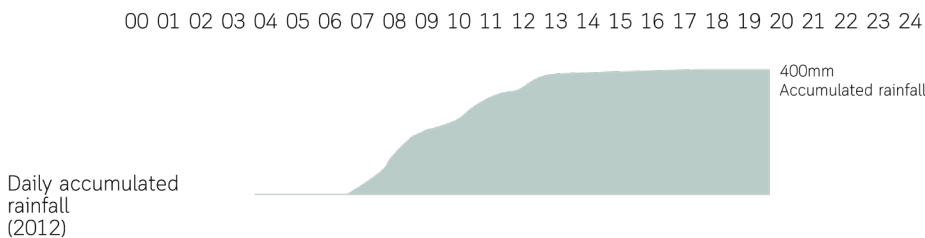
Normal Annual Rainfall



Low Annual Rainfall



Short-Duration Intense Rainfall



Floods and droughts are occurring with increasing frequency due to global warming and climate change. Therefore, this study will be divided into three types of climate comparison: normal annual rainfall, low annual rainfall, and short-duration intense rainfall.

The typical year is taken from 2019, and during the rainy season, rainfall from typhoons contributes to vital water supplies, which are stored in reservoirs and do not cause droughts. But based on a drought year in 2020, Taiwan will not be affected by a typhoon until November, and the Shimen Reservoir in Taoyuan, in particular, has a small capacity and needs to be replenished many times, without the rainy season, the arid climate will be the norm to cause the extreme drought condition. (Zhang Daiping, Lin Shufan, 2020)

Moreover, flooding usually occurs under the climatic characteristics of short-duration intense rainfall. The National Science and Technology Center for Disaster Reduction (NCDR) defined the characteristic happened with measuring at 50 mm per hour; 130 mm in three hours, and 200 mm in six hours. The daily accumulated rainfall figure takes Taoyuan Puxin weather station in 2012, for example, reached 400 mm in 24 hours (NCDR, 2012) It caused the extreme flooding situation in the city.

Figure 04-3 Normal, low annual rainfall and short-duration intense rainfall chart
Source: Central Weather Bureau (CWB), 2012, 2019, 2020

04-1-2 THE ROLE OF PONDS IN THE WATER FLOW

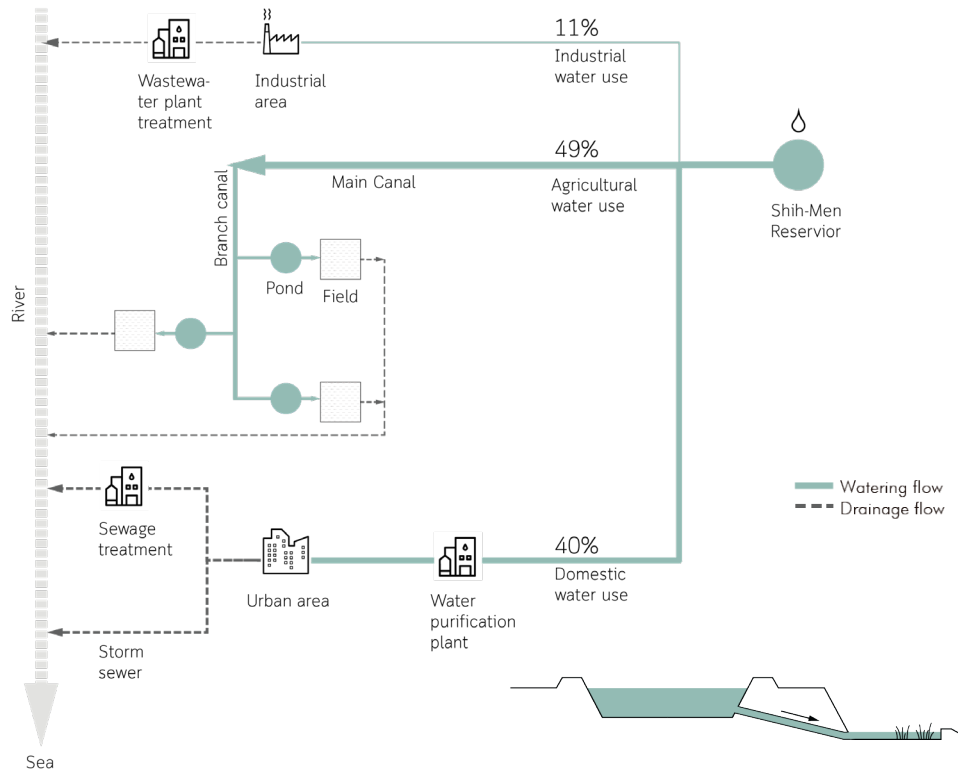


Figure 04-4 Existing water flow in the Taoyuan county
 Source: 行政院農業委員會 (2015)。2015 農業灌溉白皮書。
 Redrawn by author

The Taoyuan area's main water supply is from reservoirs, with 49% of agricultural water is the most, followed by domestic use, and finally 11% of industrial use. (Water Resources Agency, Ministry of Economic Affairs, 2004 to 2013) The main function of the pond under the whole water system is to store water and irrigate the farmland.

Moreover, the ponds are connected with the canal and reservoir. (see Figs. 04-6) To prevent the influence of the climate, the two irrigation systems create to solve the issue of unstable water supply during the dry season. The one is Taoyuan main canal system includes 284 ponds and another is the Shih-Men main canal

system with 460 ponds. Besides, the Shih-Men Reservoir serves as the water source for two systems that extended the irrigated area. This water conservation system distributed water to different service areas by turns, not incessantly, and thus provided each unit of farmland just enough amount of water needed. (Taoyuan irrigation association, 2019)

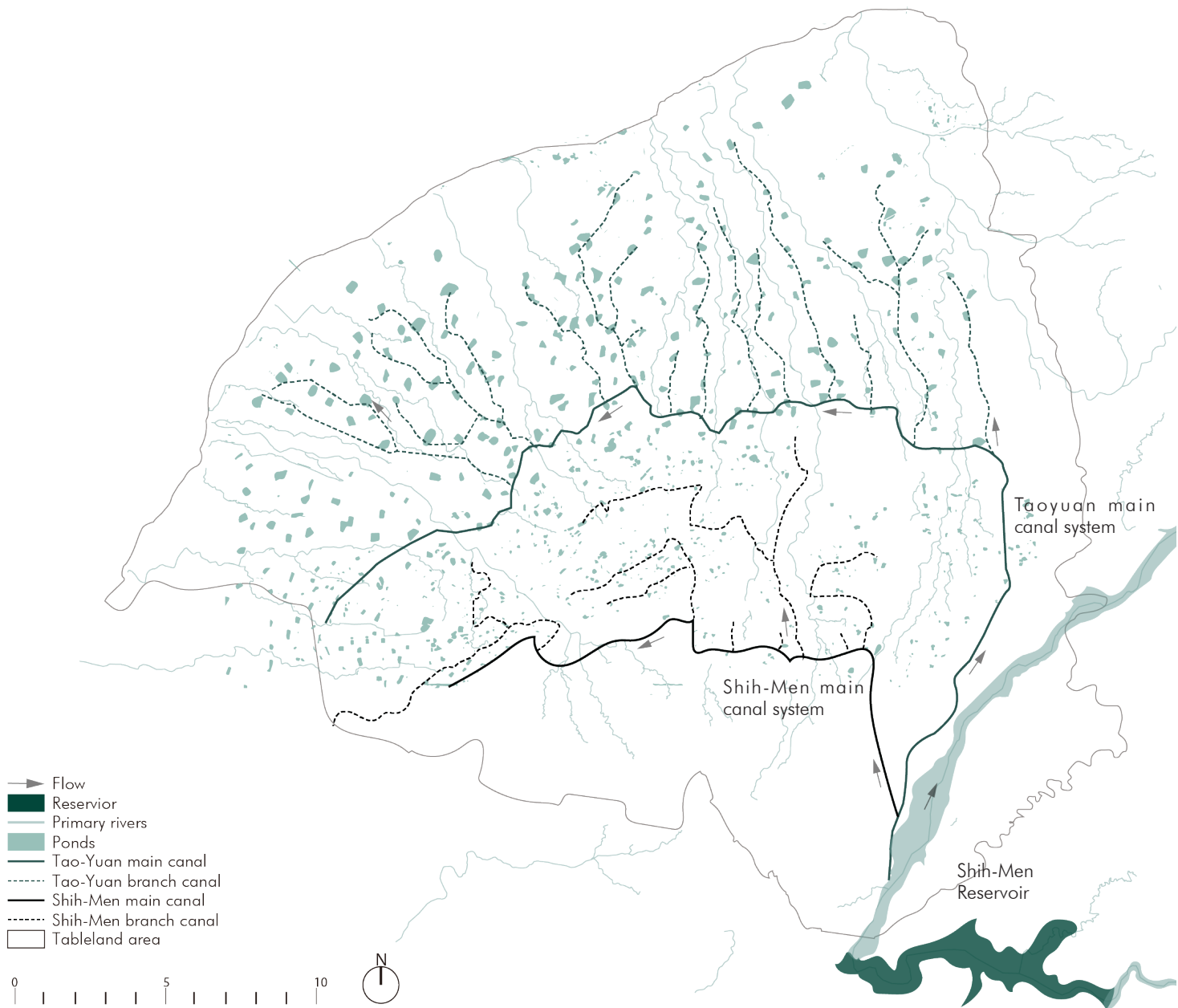


Figure 04-5 Irrigation water system in Taoyuan tableland

Source: 桃園市政府 (2010)。埤圳保存推動計畫成果報告書。Redrawn by the author

04-1-3 THE ROLE OF PONDS DURING DROUGHT

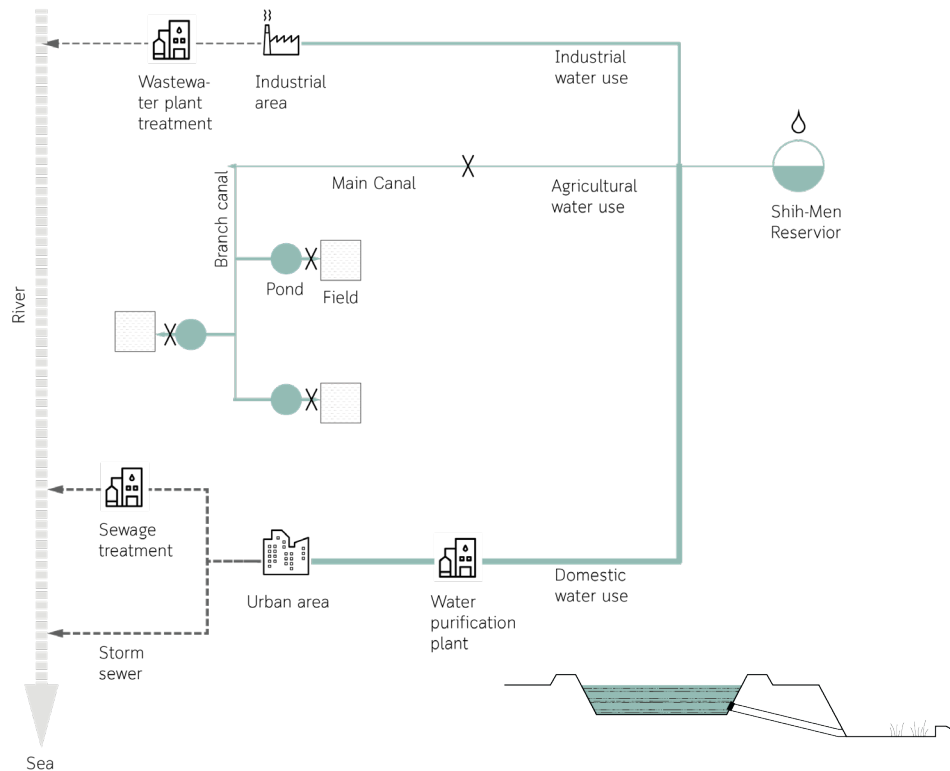


Figure 04-6 Existing water flow in the Taoyuan county
 Source: 行政院農業委員會 (2015) 。2015 農業灌溉白皮書。
 Redrawn by the author

According to the report from the National Science & Technology Center for Disaster Reduction, drought is defined as precipitation of less than 0.5 mm for more than 20 consecutive days and cumulative annual precipitation of less than 60% of the latest quasi average.

2021 had the fewest rainfall in Taiwan in 52 years, causing water shortages in several reservoirs, causing severe drought. (The Ministry of Economic Affairs of Taiwan,2020) To conserve water resources, the pond was stopped to irrigate the fields, and water was kept in the pond. However, most of the water in the ponds can not supply the people's living water because of the distance from

the water purification plant and the lack of a clean water source.

As a result of the cessation of irrigation, 27,000 hectares of farmland in the Taoyuan Irrigation area, i.e. the Taoyuan, Kwun Yam, Dayuan, and Shek Mun irrigation areas, have to be stopped. (Council of Agriculture, Executive Yua,2021) To preserve the water resources of the pond and supply the water for People's life and industry, the water for agriculture irrigation was sacrificed. This section has explained the two reasons why the pond couldn't mitigate the water shortage. The first is too far from the water purification plant and the poor water quality.

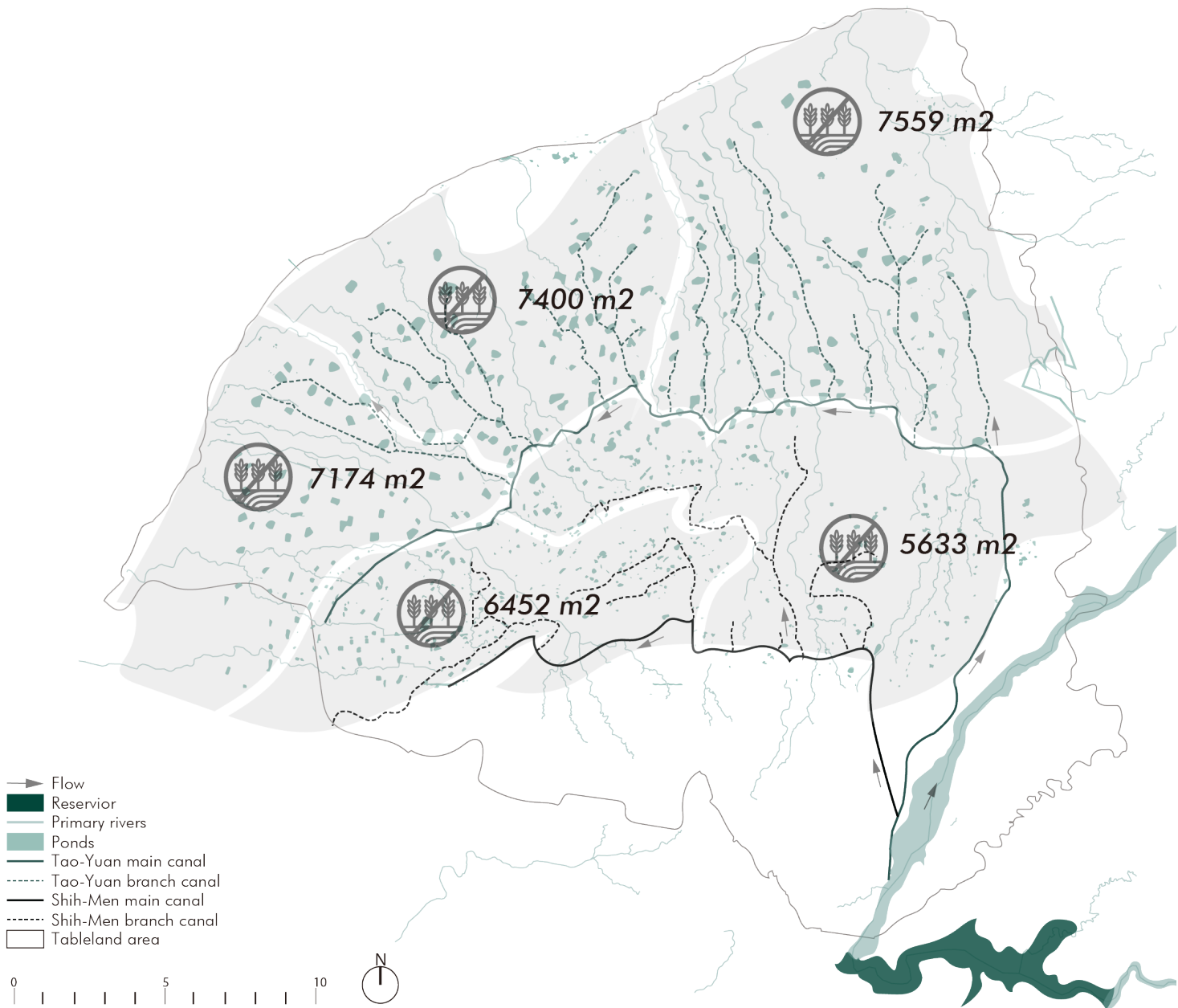


Figure 04-7 Irrigation water system in Taoyuan tableland

Source: Council of Agriculture, Executive Yuan, 2021. Redrawn by the author

04-2-4 THE ROLE OF PONDS DURING FLOOD

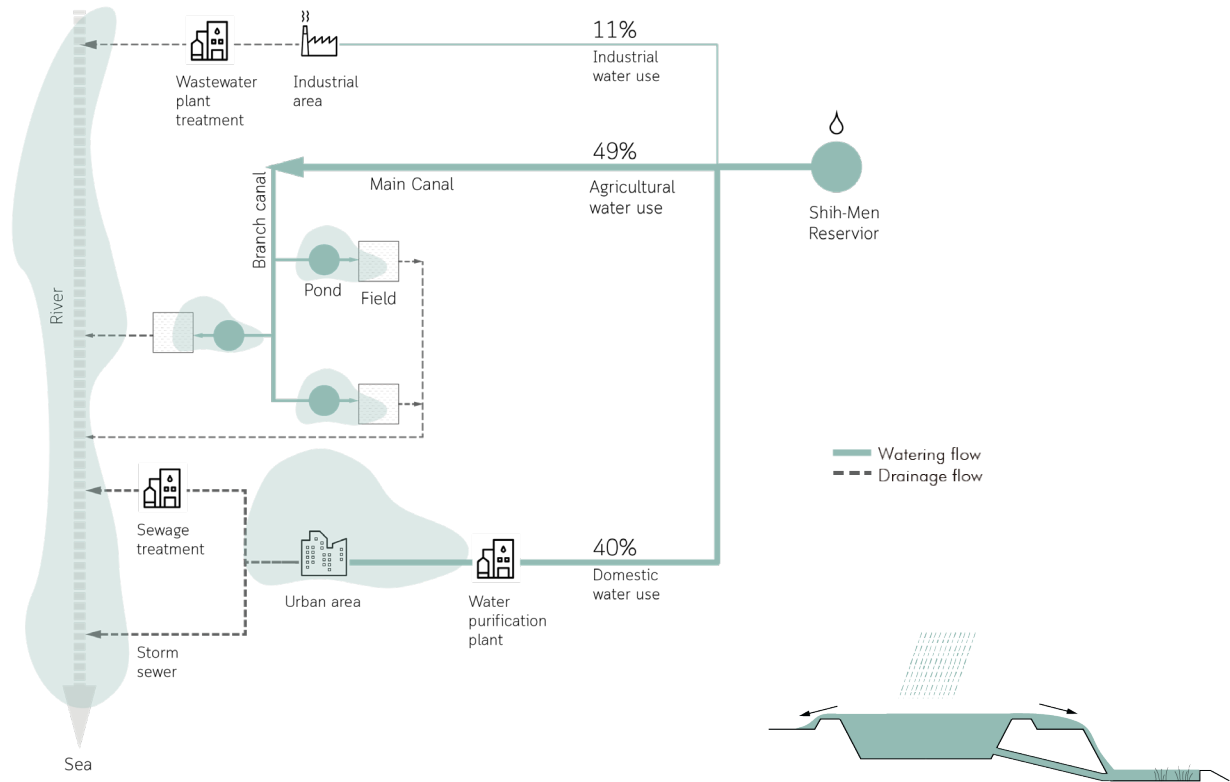


Figure 04-8 Existing water flow in the Taoyuan county
 Source: 行政院農業委員會 (2015)。2015 農業灌溉白皮書。
 Redrawn by the author

For example, the 24-hour accumulated rainfall of 500 mm is rated as the Cloudburst (CWB) in Taiwan. As you can see on the figure 04-10, most of the flooded areas are along the river banks, and urban drainage systems are unable to absorb stormwater and cause disasters.

However, the pond normally maintains a full water supply. It is difficult for the inflow and outflow channels to carry out flood detention operations. In heavy rain, ponds can not play the role of flood mitigation. Instead, they overflow and cause disasters. The drainage and irrigation roads of the adjacent ponds were not in good shape. The pond system is supposed to be a natural

flood control system on the surface of the Earth, but it has lost its regulating function because of the lack of a good water management system.

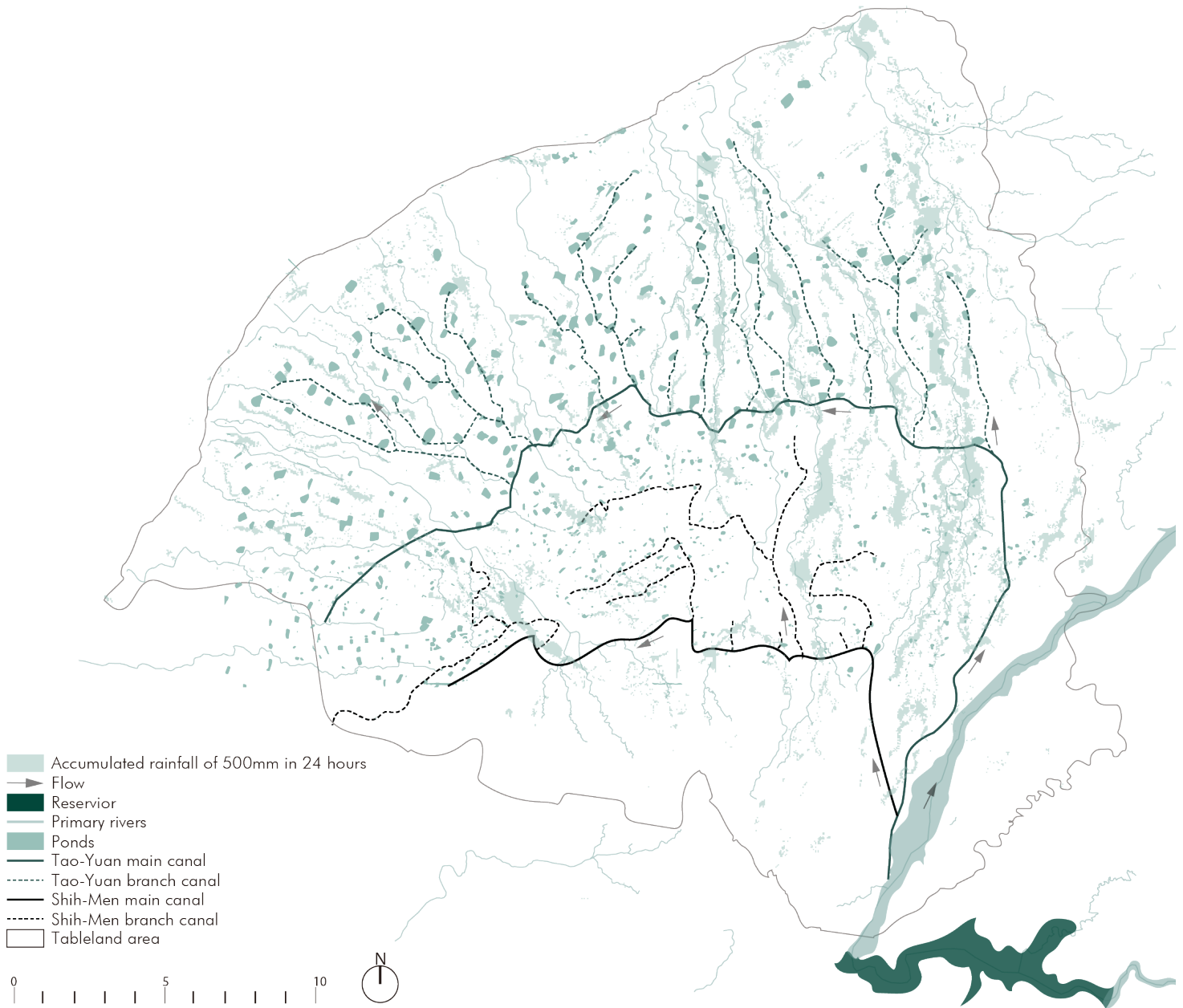


Figure 04-9 Irrigation water system in Taoyuan tableland

Source: 國家災害防救科技中心 (2016), Redrawn by the author

04-1-5 THREE SITUATIONS

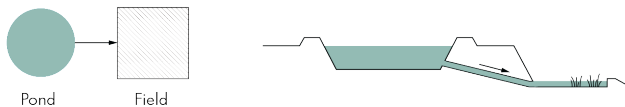
To sum up, the pond under three types of climate conditions have different roles. During normal conditions, the pond used to store water for irrigation. However, during drought, the water quality in the pond is not good enough. Therefore, most of the water couldn't be supplied for domestic use. Moreover, during the rainy season, the water level usually keeps the pond. Instead of discharging stormwater, it becomes a flood-prone area.

NORMALCY



Figure 04-10 Pond for irrigation in normal condition

Source: Image by 林湘玲 downloaded from <https://www.iatyu.nat.gov.tw/irrig.asp?offset=0>, redrawn by the author

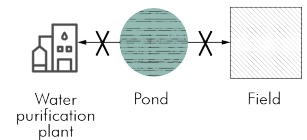


DROUGHT



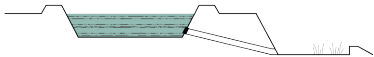
Figure 04-11 Pond during drought condition

Source: Image downloaded from <https://www.agriharvest>





tw/archives/46718, redrawn by the author



FLOOD



Figure 04-12 Pond during flood condition

Source: Image downloaded from <https://ourisland.pts.org.tw/content/356>, redrawn by author

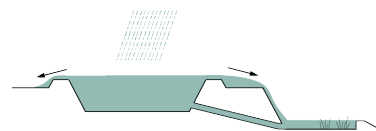
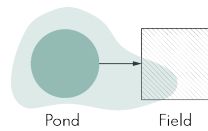




Figure 04-13 Urbanized landscape in Taoyuan county
Source: Image downloaded from http://sky.tycg.gov.tw/Home/Overlook?scenic_id=43

04-2

Urbanized Landscape

04-2-1 The rapid urban expansion

04-2-2 Potential inundation map

04-2-3 Disturbance Hydrology

04-2-4 Fragmentation of urban green space

04-2-1 THE RAPID URBAN EXPANSION

2040

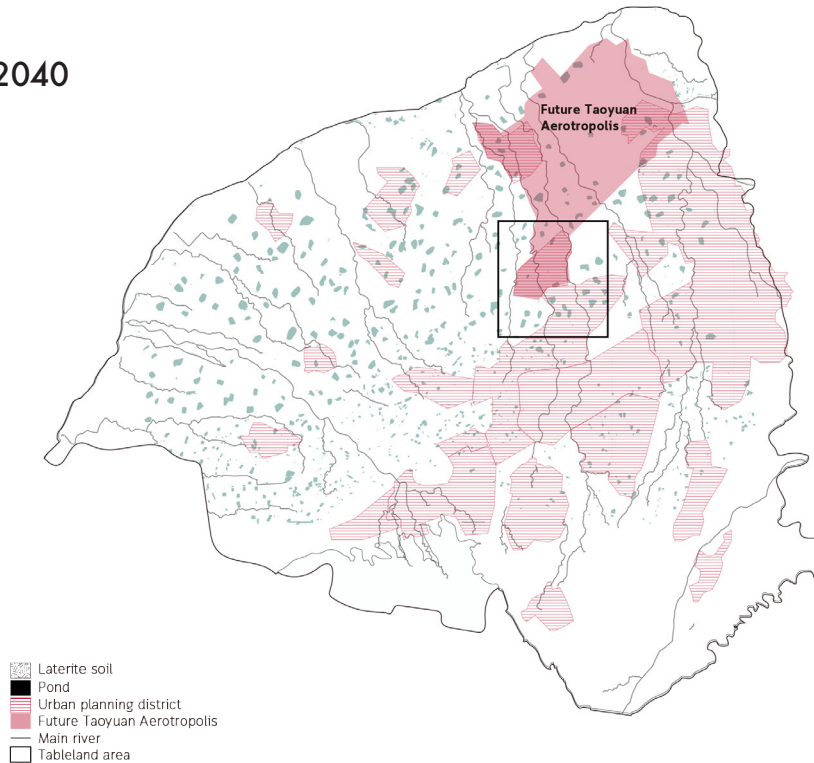


Figure 04-14 The land use planning in 2040
Source: Taoyuan City Government, 2019. redrawn by the author

In 2008, an airport-based metropolitan region plan is developing, a so-called Aerotropolis. The plan is not only to enhance the competitiveness of Taoyuan International Airport, but also promotes the overall development of Taoyuan, and advocates the transformation and internationalization of Taiwan's industry.

The future scope of Taoyuan Aerotropolis includes the high-speed rail Taoyuan station district which is the emerged urban area. The area is the inter-between Aerotropolis and the existing Jungli urban district. The projected population of this emerging urban area will reach 60,000 by 2036. (Taoyuan City Government, 2019)

However, in this area, there are still four ponds which are zoned as parkland, with an area of 4.51 ha, 1.65 ha, 0.99 ha, and 1.28 ha respectively, the future will be planned as a cultural activity, education area. In addition, the existing pond should be used as a function of regulating the environment for flood detention.

In this study, the pond resources are regarded as the basal network of the city with a larger scale, which should be integrated into the water resources network with the suburban ponds, except that the pond resources were designated as parkland.

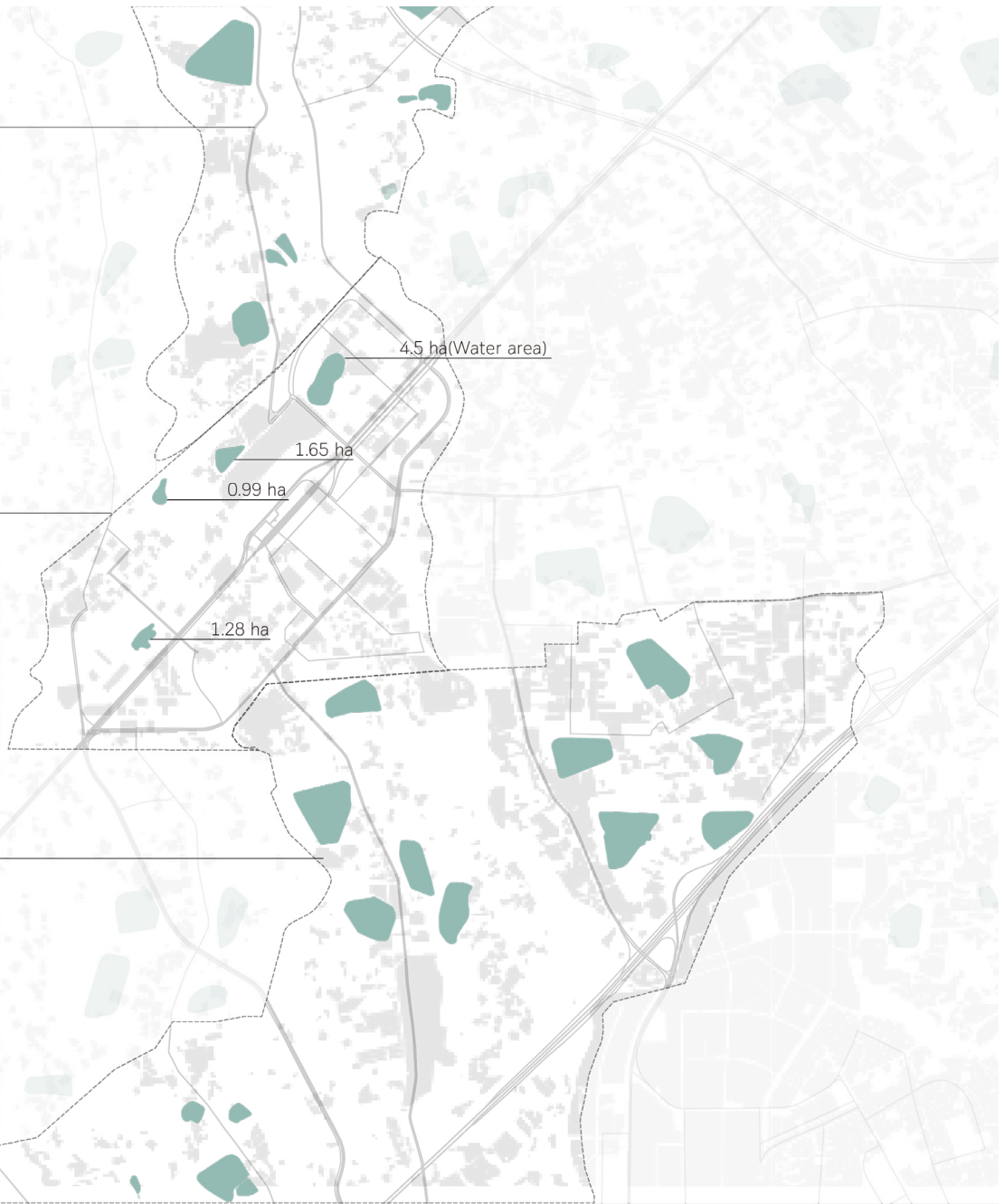
2040
Taoyuan Aerotropolis
Value-added agriculture



2020
High speed rail
Taoyuan station district



The highway Zhongli and
interchange Special district plan



- Built area
- Pond
- Urban planning district

Figure 04-15 The map of urban planning district with ponds
Source: drawn by author

04-2-2 POTENTIAL INUNDATION MAP

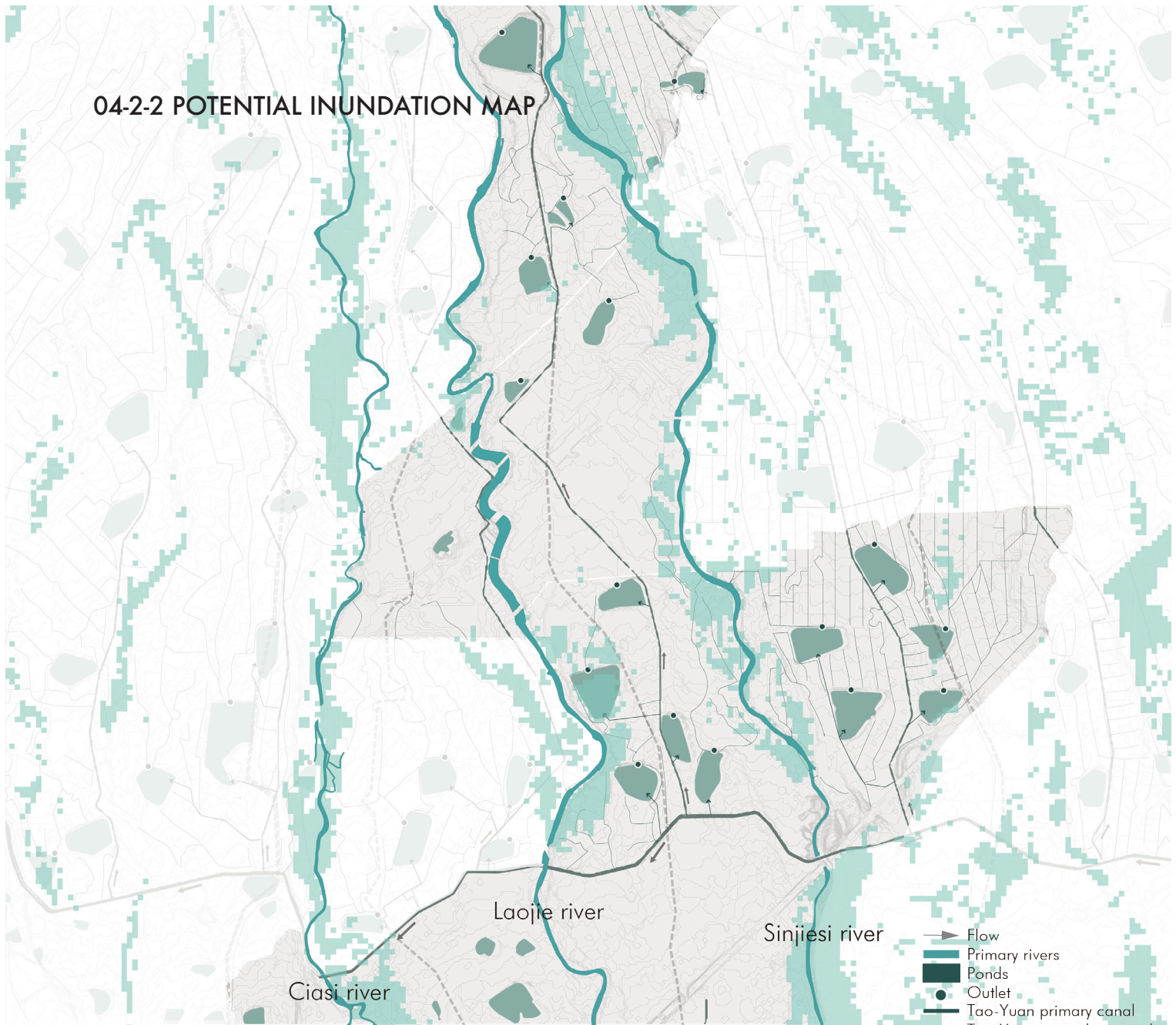
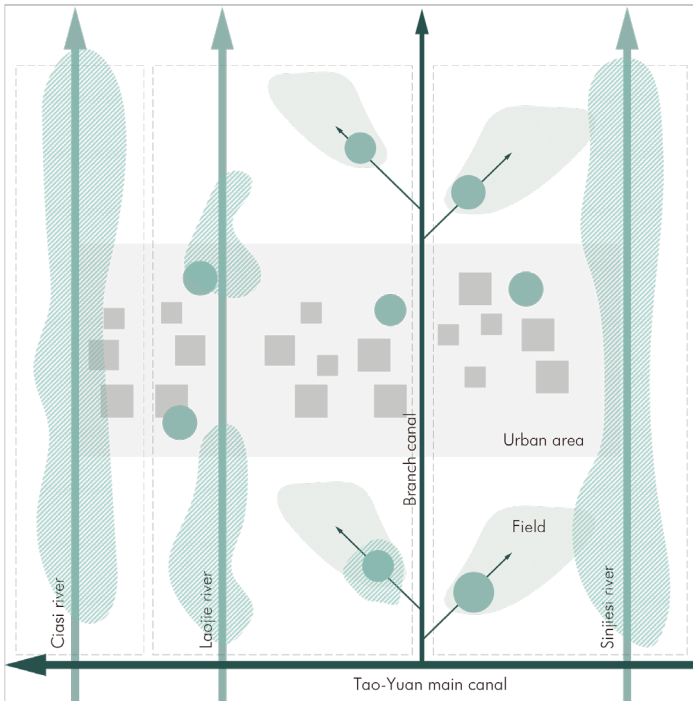


Figure 04-16 The water pattern in normal and in flooding risk of 24hr 500mm

Source: 國家災害防救科技中心 (2016), redrawn by author

- Flow
- Primary rivers
- Ponds
- Outlet
- Tao-Yuan primary canal
- Tao-Yuan secondary canal
- Tao-Yuan tertiary canal
- Ditches
- Drainage catchment area
- Fields
- Project focused area
- 24hr, 500mm



According to the analysis of the flood potential map, when the accumulated rainfall is 500 mm, the Xinjiang, Laojiexi, and Qixi in this area are flooded, and the flood depth is about 0.5 ~ 2 meters, the reason for flooding is that the amount of rainfall exceeds the capacity of the urban side ditches and drainage systems. In addition to urban drainage lines, the current caltrop is also a flooded area.

In urban areas, the lack of Storm drain is often due to pipeline migration, traffic maintenance, lack of planned urban roads, resulting in incomplete construction of drainage systems and runoff that can not be collected, transported, and eliminated, causing flooding in the metropolitan area. (Construction and Planning Agency, Ministry of the Interior)

Moreover, in Taiwan, the annual rainfall decreases, and the instantaneous rainfall increases. Due to the over-exploitation of some areas, the surface water permeability decreases, and the runoff can not penetrate the ground to replenish the groundwater

Currently, all four ponds in the High-Speed Rail Taoyuan District have flood retention functions, but they are not enough to slow the flooding.

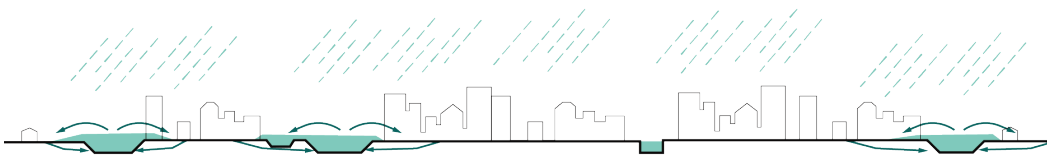


Figure 04-17 Diagram and section during flood
Source: drawn by author

04-2-3 DISTURBANCE HYDROLOGY

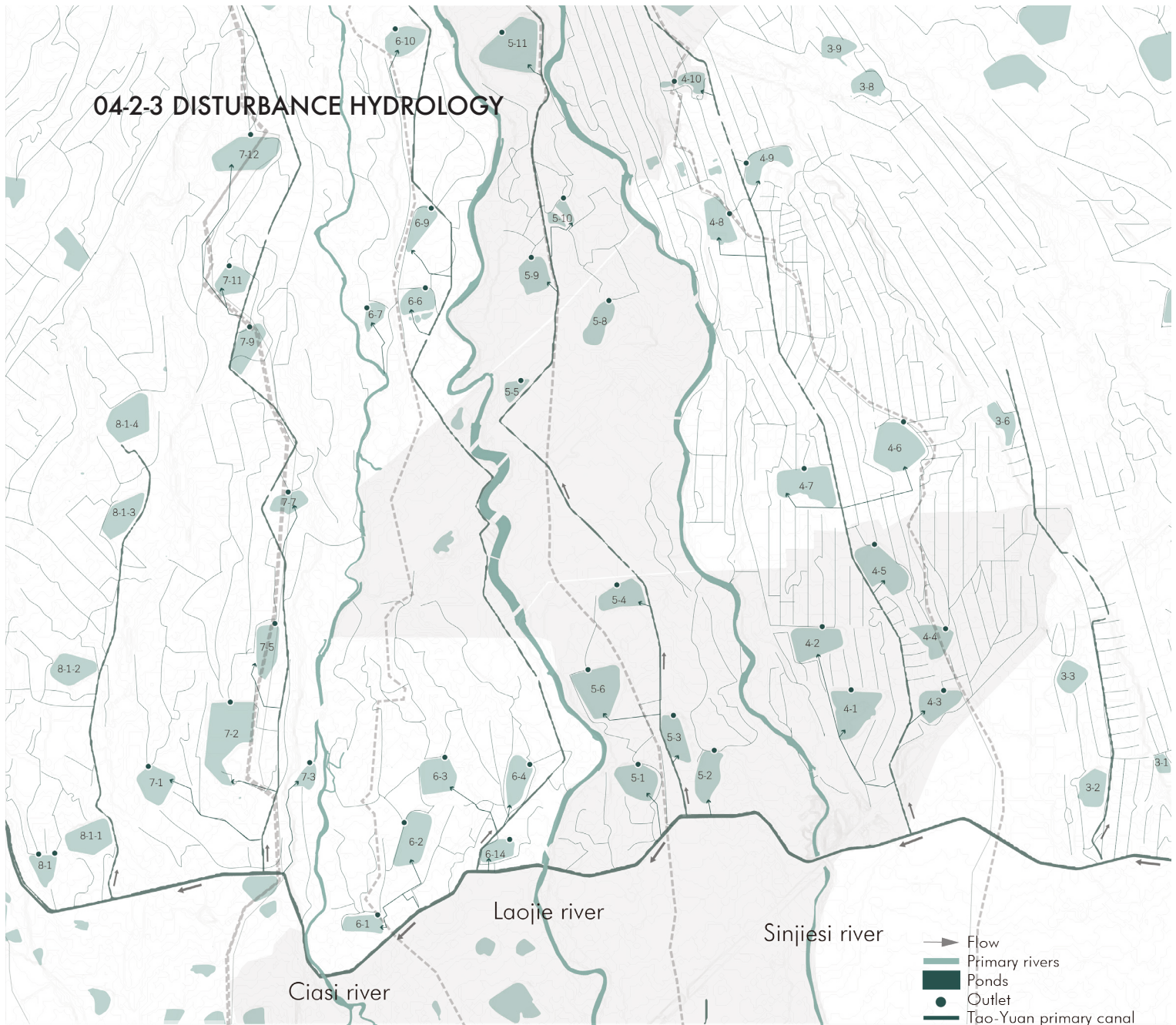


Figure 04-18 The existing water system
 Source: Taoyuan irrigation association. (2009). Retrieved from <https://www.iatyu.nat.gov.tw/relic/areamap.asp>, Redrawn by author

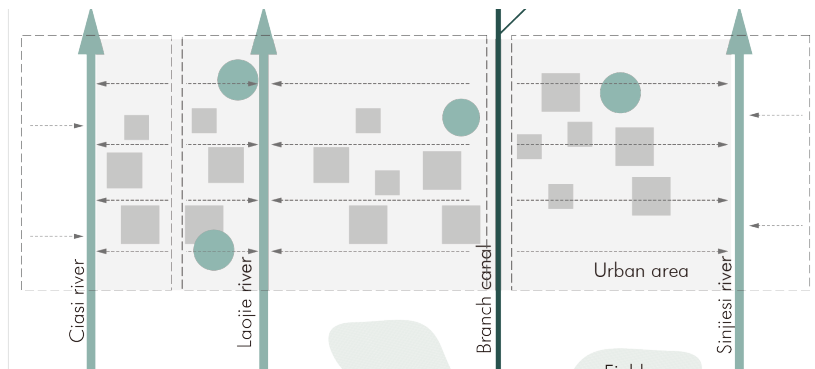
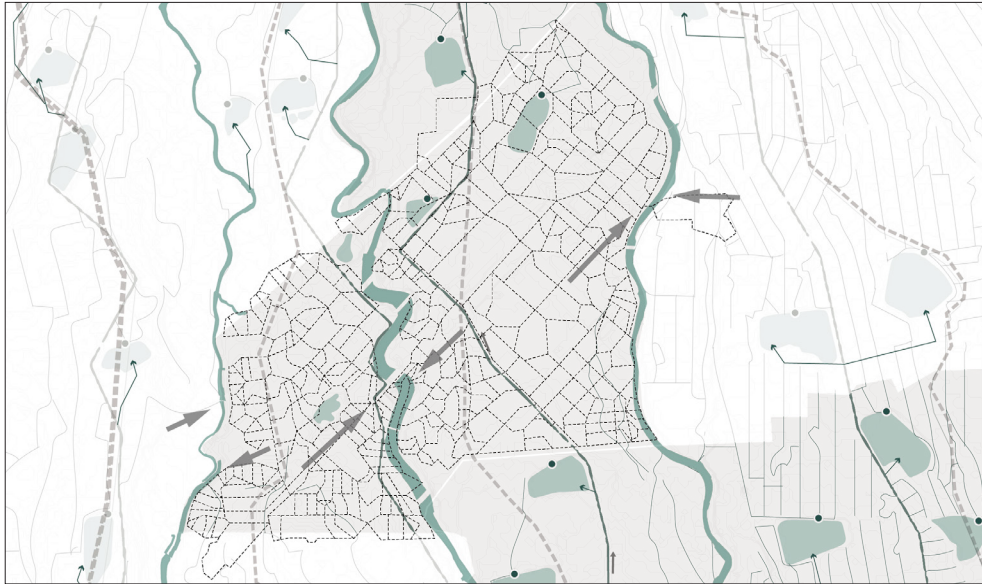


Figure 04-19 Existing underground drainage system in the high speed rail Taoyuan station district
Source: National Development Council. Retrieved from <https://rdi-123.wrap.gov.tw/>, Redrawn by author

Before urbanization, a system of ponds was spread over the terrace of Taoyuan. As can be seen in this area, the ponds were still connected with tributaries in the suburbs and continuously irrigated the farmland. The topography is high in the South and low in the North. The amount of secondary canals belonging to TMC is fourteen. The map shows 4,5,6,7 secondary canals with ponds as an example. Water sources from the Shih-Men reservoir through the Taoyuan main canal distribute to each secondary canal. Afterward, water through tertiary canal input to each pond and irrigate to the fields. By using the canal and pond network, the field can gain a stable water source instead of rainwater. The water network is the artery of agricultural society. Sending water with natural gravity to various irrigation districts without the pumping station makes Taoyuan county becomes a rice warehouse for the area.

However, in the cities, Pond lost its irrigation function and disconnected from the original irrigation tributaries. The High-Speed Rail Taoyuan Station District district is located on the east and west sides of the new street stream, the new street stream, and the old street stream. The drainage area is centered on three rivers. The storm drain is currently being built in this area as a result of the emerging cities.

From this analysis, it can be found that the existing irrigation pond and drainage system in urban areas were disconnected, farmland was reduced due to urban expansion, and the original function of water storage and irrigation in the pond was gradually deprived, finally only the function of water storage.

04-2-4 FRAGMENTATION OF URBAN GREEN SPACE

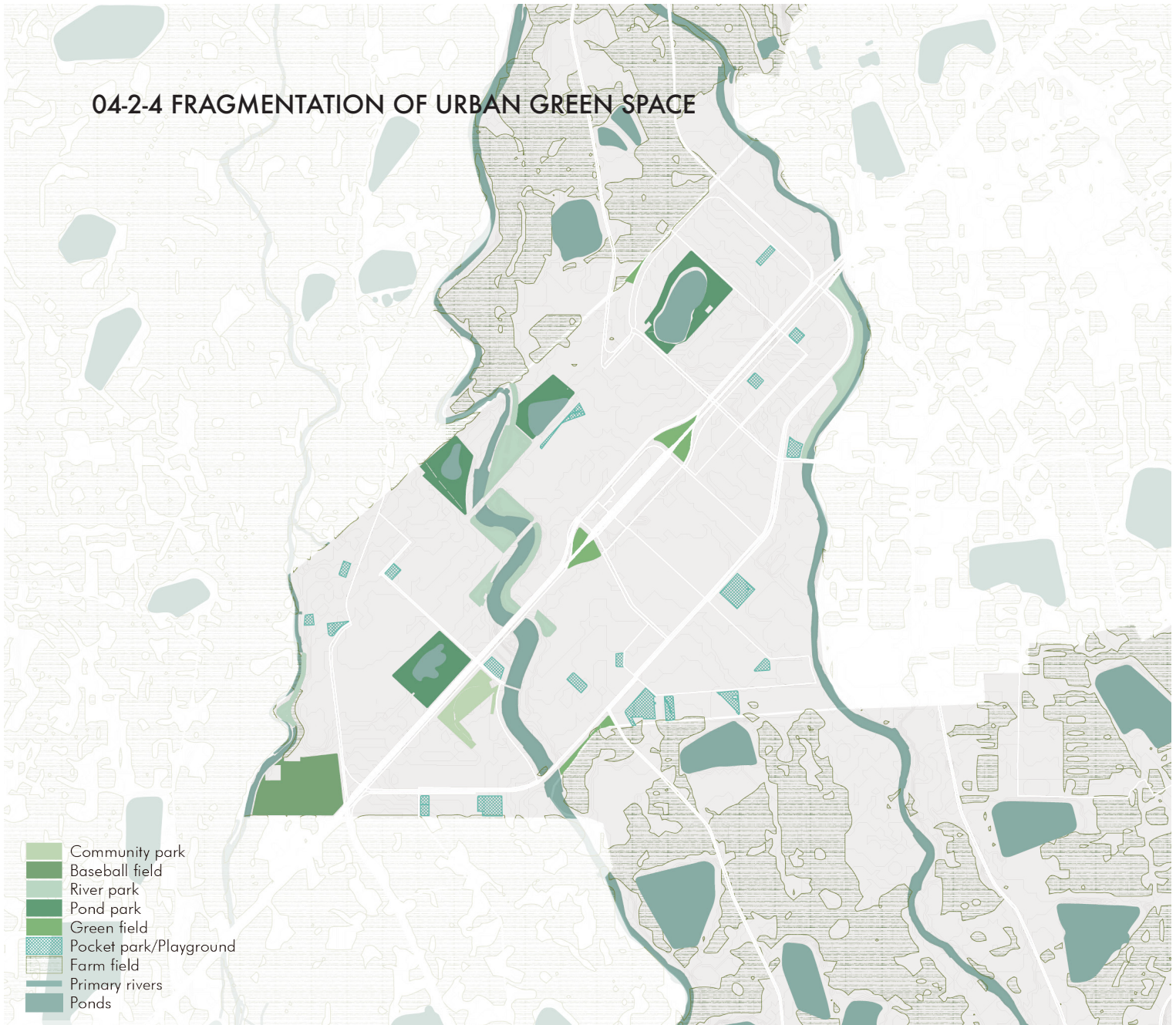
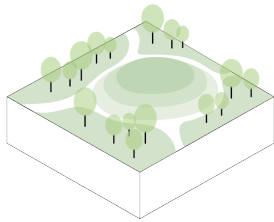
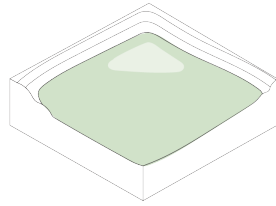


Figure 04-20 Existing green patches
Source: Taoyuan City Government, 2019, redrawn by author

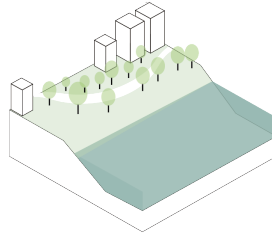
Inside the area of the high-speed Rail Taoyuan Station District, the park and green space is 8.79 percent of the total planned area, which is about 43 hectares. (Taoyuan City Government, 2019) by this project analysis, classified into six park green land types, were community park, baseball field, River Park, Greenfield, playground, and pond park.



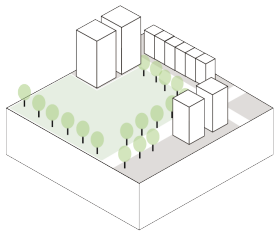
● Community park



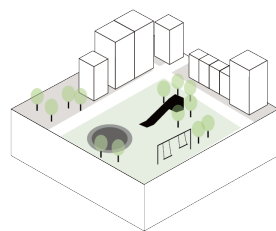
● Baseball field



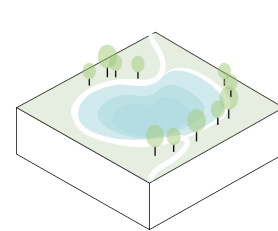
● River park



● Green field



● Pocket park/Playground



● Pond park

Six park typologies

1. Community park

For a larger area of the park green, to provide urban wide grassland, while planting trees, providing a comfortable walking space, the park is also set up art installations.

2. Baseball field

To the southwest of the area, there is a 4.8-hectare baseball stadium, which is an important sports ground in Taoyuan. Games are held during holidays and weekdays to attract spectators.

3. River park

At present, there is no overall planning of the riverside park, only with simple green and planting trees as green open space.

4. Greenfield

In the urban street profile of the zero green space, usually surrounded by high-rise buildings, space is more crowded, not open green space is a simple wall to prevent residents from entering.

5. Pocket park/Playground

Pocket Park is small in urban areas and usually has a children's play area.

6. Pond park

Ponds have been incorporated into urban areas, as well as urban park green areas, with walkways designed along water boundaries and to reduce the urban heat island effect.

Even if the new urban planning area, park green space has been painted, but from an ecological point of view, urban park green space can be more than just a function of rest. The current plan is much smaller and more fragmented than the farmland type.

Figure 04-21 Existing green patches
Source: drawn by author



Figure 04-22 Ponds in urban and peri-urban area
Source: Taken by author

04-3

Pond types and characteristics

04-3-1 Selected ponds

04-3-2 A comparative study

04-3-3 Water system circular diagram

04-3-4 Local experience

04-3-1 SELECTED PONDS

There were 19 ponds on the fifth branch canal in total. These ponds were established by the ancestors in the 1800s. Due to the urban development of the high-speed rail Taoyuan station district, only 12 ponds were left on the fifth branch canal in 2003. (Council for Hakka Affairs, Executive Yuan, 2003) Therefore, three ponds are selected in this area for studying the characteristics and relationship with the urban surrounding.

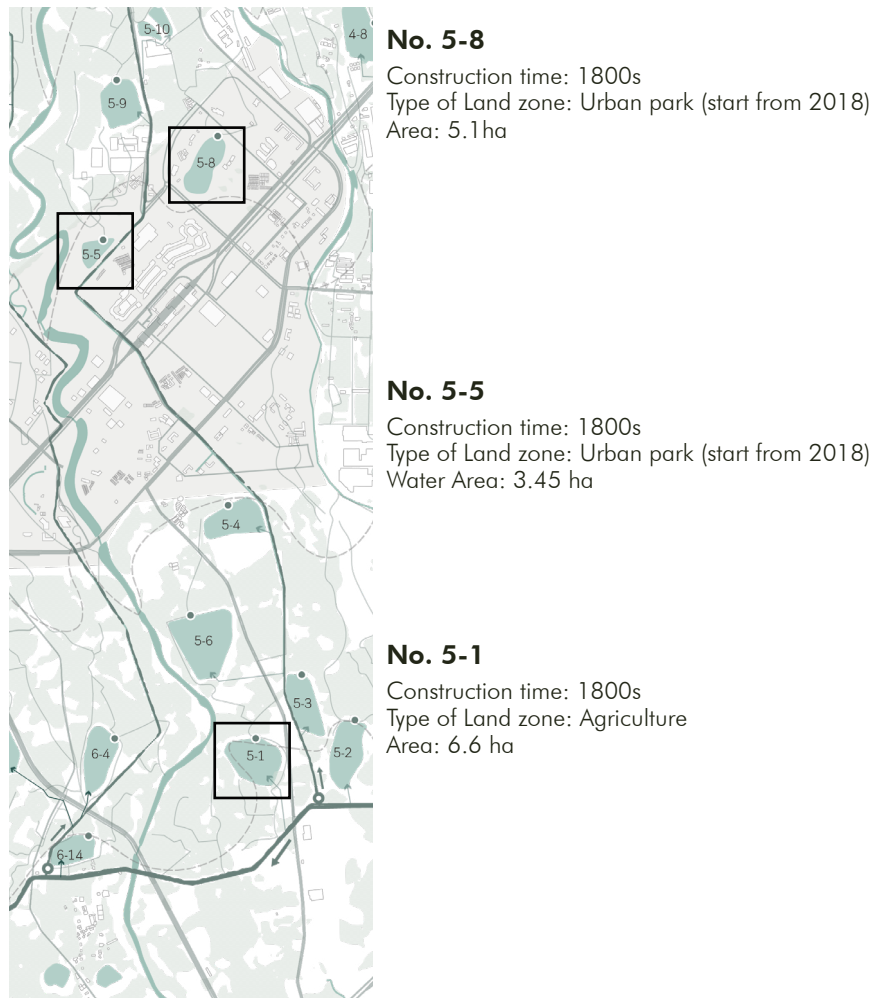
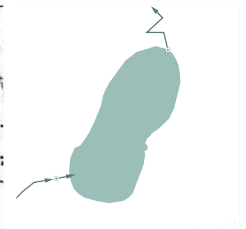
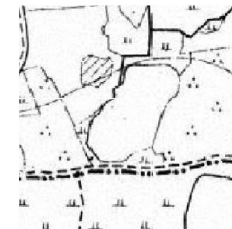


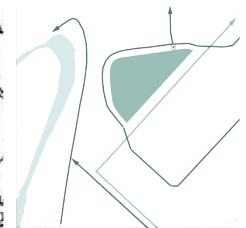
Figure 04-23 Location of selected ponds
Source: 陳其澎 (2003)。桃園大圳及光復圳系統埤塘調查研究計畫。行政院 客家建設委員會。

1904

Water system



Connect with rainwater drainage



Connect with rainwater drainage



Connect with Taoyuan branch canal

Figure 04-24 Comparison table

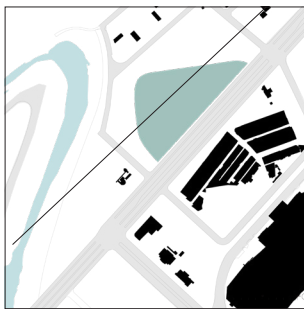
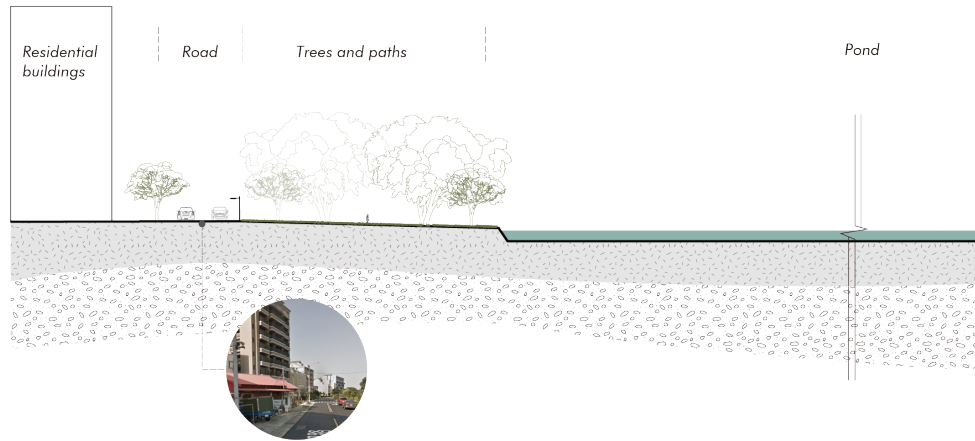
Source: map of 1904, retrieved from <http://gissrv4.sinica.edu.tw/gis/twhgjs/>, t

Building Facing Direction	Surrounding	Edge	Activity	Water quality	
					<p>The water area of no.5.8 was larger than in 1904, but it is no longer irrigated. In 2018, the pond was converted into a park use and combined with the rainwater drain to form a retention pond.</p>
					<p>The water area of no.5.5 has been significantly reduced, partly filled by the construction of residential buildings and roads. It is now designated as parkland and is no longer irrigated. However, the water edge is not friendly as no.5-1.</p>
					<p>The water area of no. 5-1 pond is larger than that of 1904, and it is still irrigated. In the pond, there is also the use of aquaculture.</p>

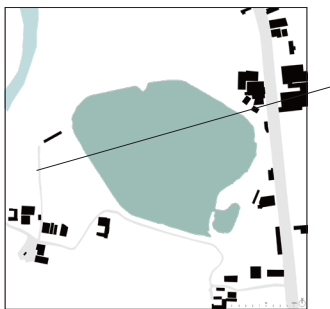
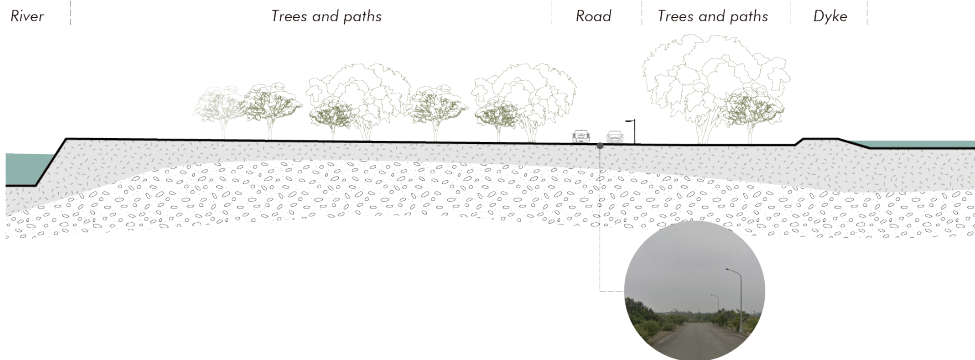
04-3-2 THREE TYPES OF PONDS



No. 5-8



No. 5-5



No. 5-1

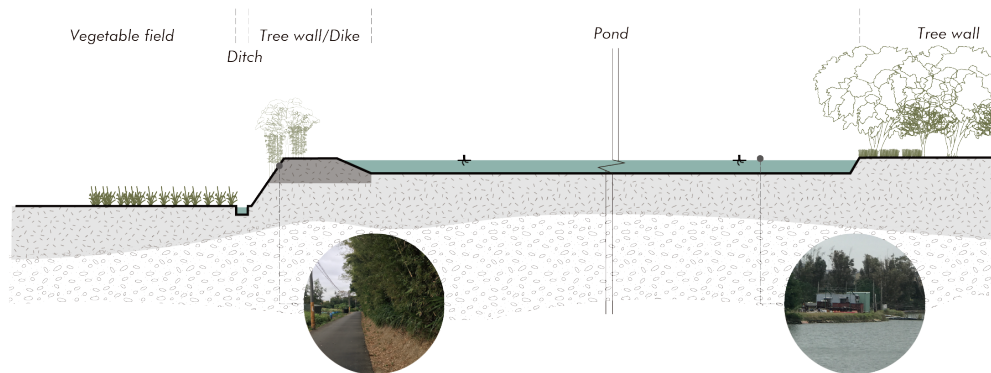
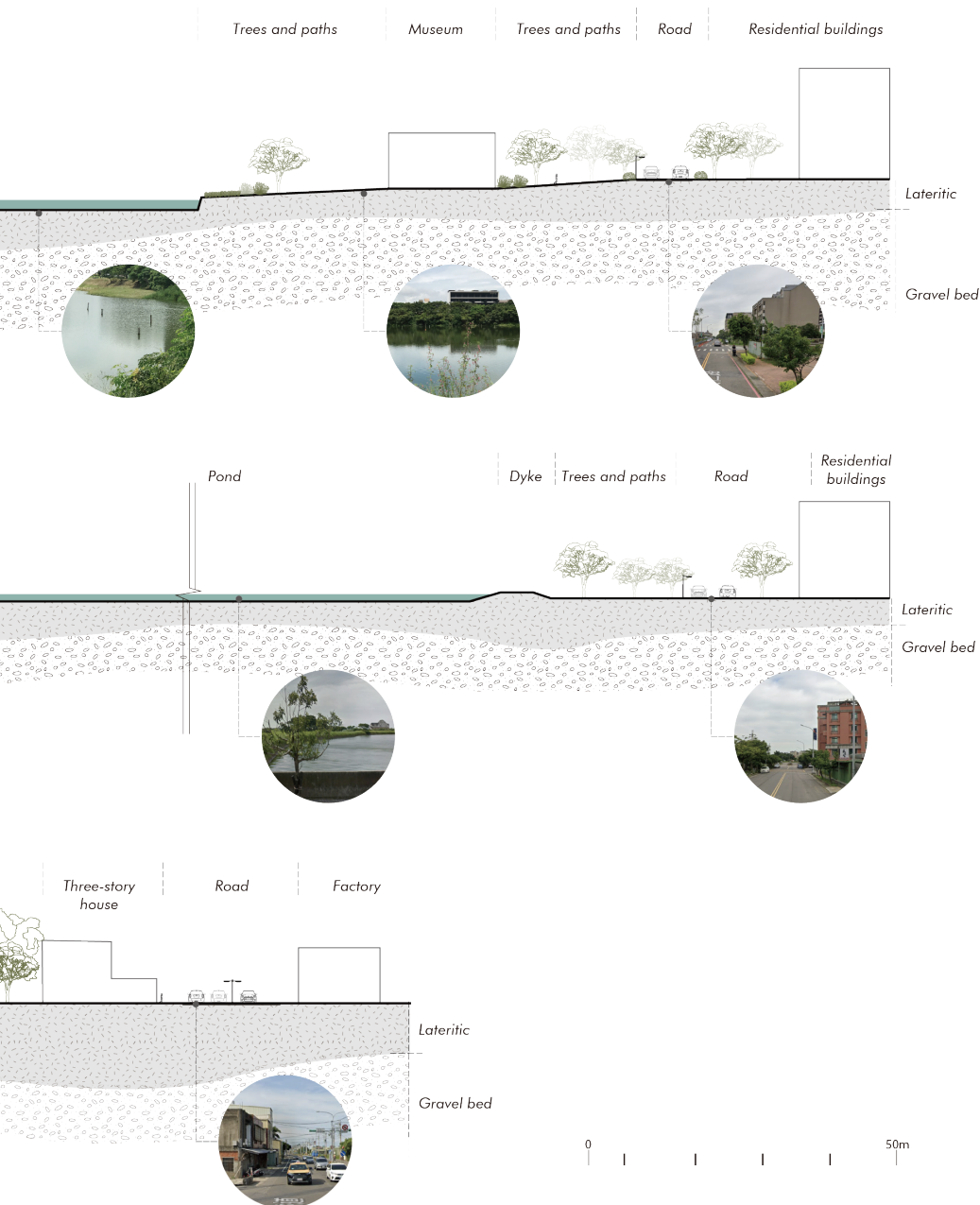


Figure 04-25 A comparison of ponds section
Source: drawn by author



Three typologies of the pond in the urban fabric



No. 5-8 pond park

The pond space has been integrated with the park green area, which includes playground and museum facilities. However, around the park is a residential area, facing the park, the caltrop pond character also increases the living quality.



No. 5-5 pond park

The pond space has been integrated with the park green space, and the park contains a playground. But the pond was unmodified and connected with simple green beautification.



No. 5-1 pond

Pond maintains the functions of agriculture, irrigates the farmland, and is now mainly used by fish farmers. Surrounded by factories and houses, with a pond on the back.

In terms of urbanization, no.5-8 has been transformed into an urban park and storing urban stormwater, transforming from an agricultural irrigation system in the pond. However, no.5-5 has no irrigation function and is not integrated well with the surrounding space. Finally, the no. 5-1 pond retained the irrigation function and space was enclosure surrounded by bamboo groves.

04-3-3 WATER SYSTEM CIRCULAR DIAGRAM

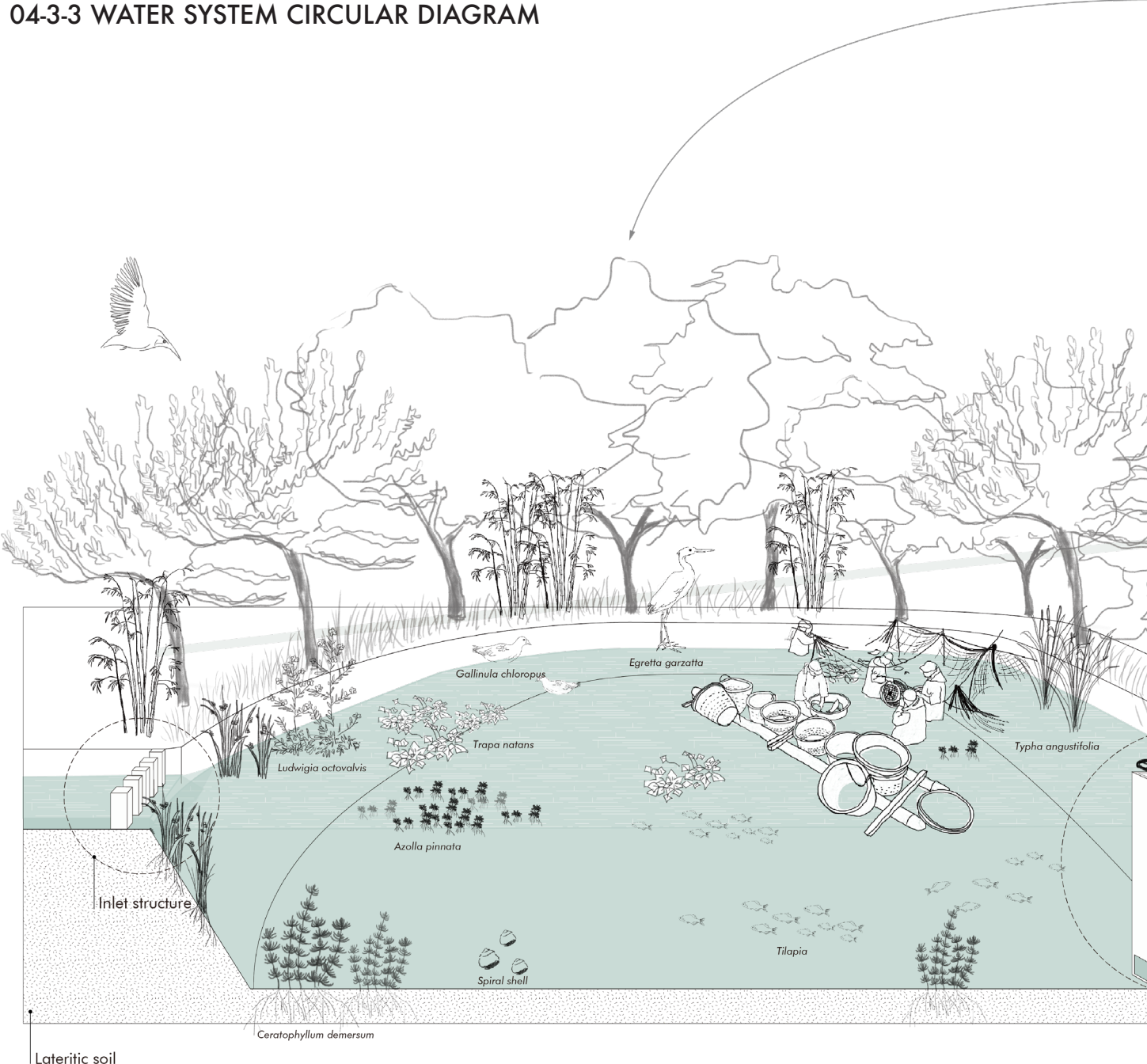
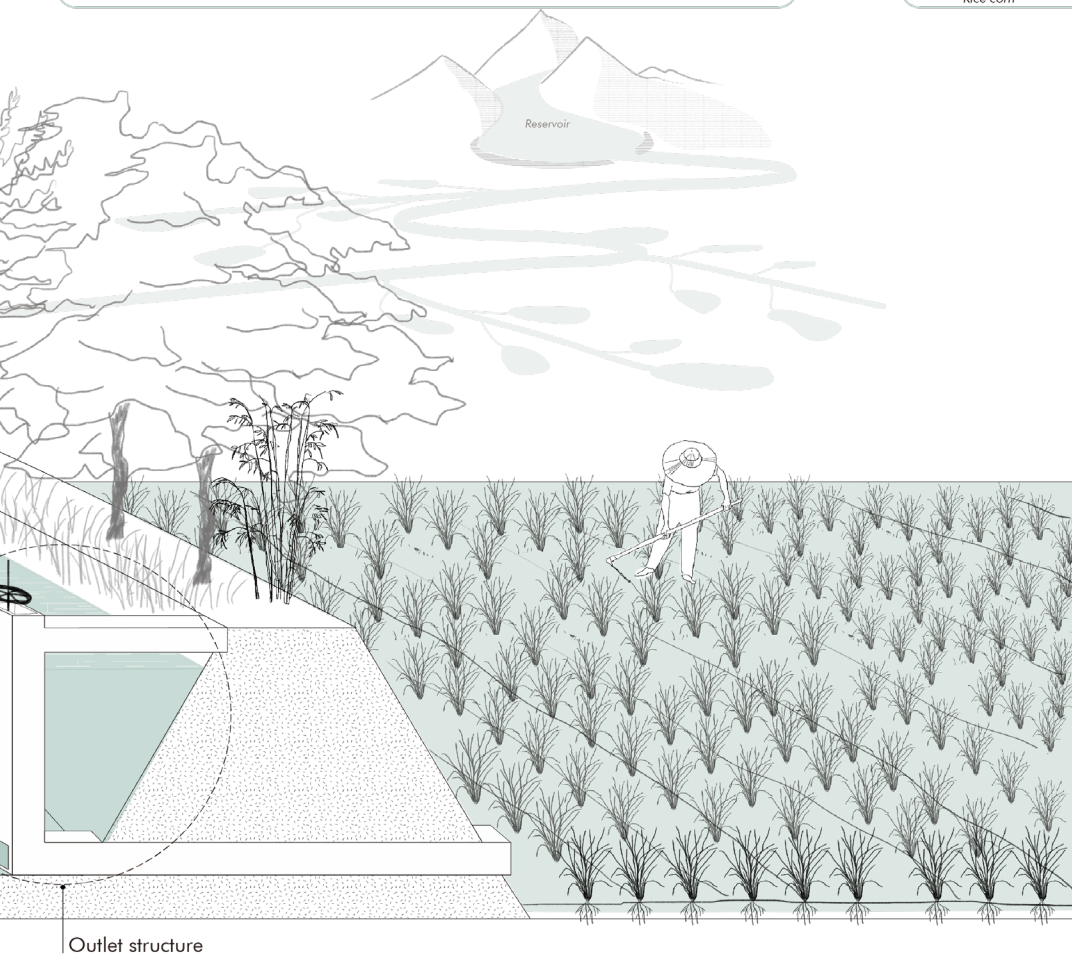
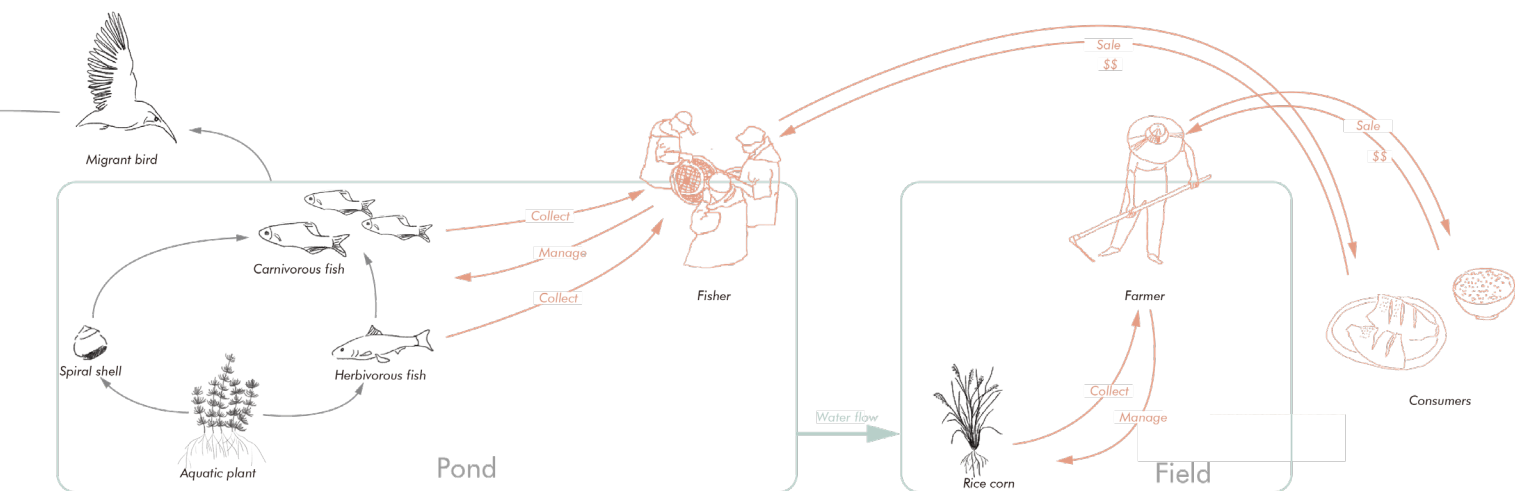


Figure 04-26 Water System Circular diagram

Source: drawn by author



The diagram shows the farm pond's water circular system which starts from the highest point of reservoir and through the canal input to the pond. Then, irrigate water to the field and ultimately drainage to the fields. The farm pond system serves as small reservoir to the fields on the tableland. The farm pond provides great habitats for wildlife which forms the pond ecosystem. Not a single pond wildlife can be omitted. Moreover, ponds are regarded as the stepping stones for migrant birds. In addition to the pond ecosystem, the pond offers food production for people such as fishes and crops. Under the well management, water in the pond can raise fish and irrigate the fields. Water system gives birth to the pond ecosystem, aquaculture and agriculture system. The circular economy and ecosystem formed with the farm pond system.

04-3-4 LOCAL EXPERIENCE

Interviews with the members in the Tao-yuan Irrigation Association and the local people provide valuable insights into the project.



1 HUANG, SING-LONG (70-Year-Old)

Committee member, Tao-yuan Irrigation Association

Past: When I was young, adults took cows to graze by the pond and went swimming as an aside.

Past-Now: Agriculture used to be the main industry. However, the government provides water for industrial use as a priority now.

The pond has been multi-functional, such as a park, flood detention, and so on. For example, besides my house, the pond has transformed into a park that walks for **a round of 1km.**

Then: Ponds have a recreational function is a good transition. More and more people need a place for doing exercise and relax.



2 HU, JIN-SHU (60-Year-Old)

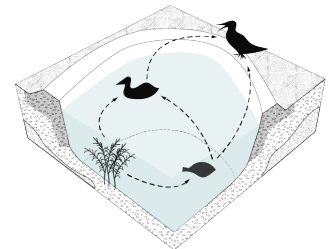
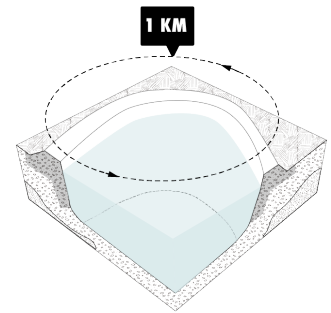
Group leader of pond (7-13/7-14), Tao-yuan Irrigation Association/ Owner of fishing pond

Past-Now

I cultivated the clams in the past, but in recent years, pesticides caused the water quality polluted, which I couldn't operate. Farming fisheries also must rely on the climate for food. As the saying goes, "Taiwan does not have a good situation for three years." The more polluted water and more extreme climate make the farmer survive in tough times.

Then

If we want to have a successful farming system, **the balance of the pond's food chain must be important.**



KEY TAKEAWAY



3 JHANG, SU-JHEN (50-Year-Old)

Local people used to live beside the ponds.

Past

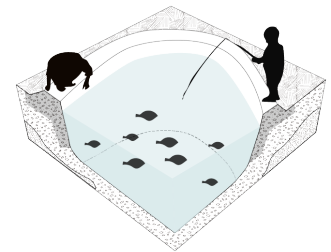
After school, I liked to catch fishes and calms from the pond, which can sell to the vendor. Especially after the typhoon, many fishes and crabs surfaced, which was the big meal.

Past-Now

After moving to the city, it is a pity that there is no chance to see the pond's landscape.

Then

I miss the space where I can **play in the water and the pollution-free water quality.**



4 KAO, XING-HUANG (50-Year-Old)

Local people used to live beside the ponds.

Past

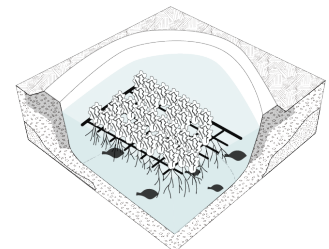
In my childhood, the water level in the pond decreased during the lunar new year. It was the best time to catch fish and rich our meal.

Past-Now

From the agricultural society to industrial society, there is no ponds' scene in the living environment anymore.

Then

Aquaponics might be a new opportunity for reviving ponds.



KEY TAKEAWAY

05 Conceptual Design.

05-1 Design Concept

05-2 Three design principles cross in multi-scales

05-1 DESIGN CONCEPT

In retrospect, in the face of drought, the ancestors created ten thousand ponds to store rainwater and irrigate their fields. However, in the face of rapid urban development, the decline of agriculture, ponds were filled for the construction. Now, the vulnerability to climate change is turning to be an opportunity to reveal and revive existing pond network.

The design will be elaborate the concept of

“ Reviving disappearing pond network ”

to make the area more climate adaptive.



Figure 05-1 Pond transformation
Source: drawn by author

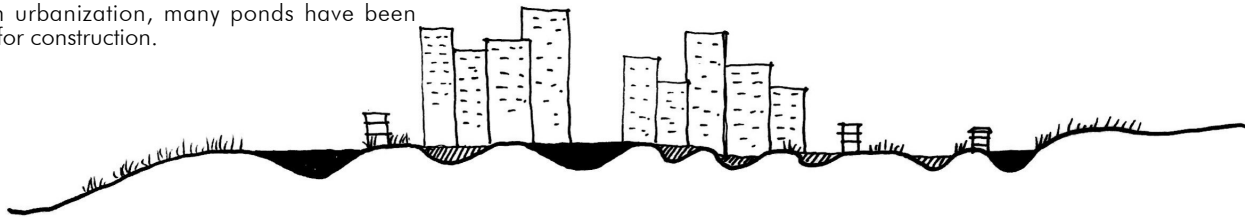
PAST-1904

Numerous ponds surrounded by the dispersed settlement in the agriculture age.



NOW-2020

Through urbanization, many ponds have been filled in for construction.



PROPOSED

Explore more space for water in the urban area help the city be more resilient during extreme condition.

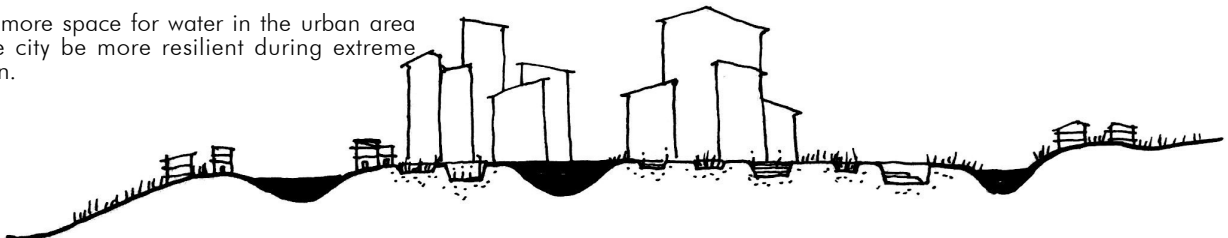


Figure 05-2 Design concept diagram
Source: drawn by author

05-2 THREE DESIGN PRINCIPLES CROSS IN MULTI-SCALES

To revive the disappearing pond network, the project selected three important design principles chosen from the 100 Resilient Cities.

Robust focuses on integrating the existing pond system as a mediator between drought, too little, and flood, too much water. It is aimed to construct a well-conceived pond and urban green and blue network.

Reflective selects two ponds in the emerging urban area and the peri-urban area as a model and transforms traditional characteristics into design decisions.

Flexible, the range cover from large, medium to small scale, integrated pond water systems to individual ponds can be flexible to adapt to changing circumstances. The ponds can be full of water, can be dry, and also can be a leisure place for people.

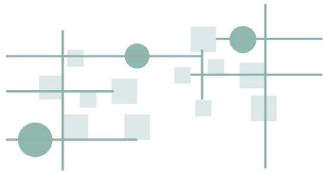
TARGET

SCALE L
Irrigation farm ponds and the canal network

SCALE M
Ponds in urban and peri-urban areas

SCALE S
Design objects in the pond

Figure 05-3 Table of three design principles
Source: drawn by author



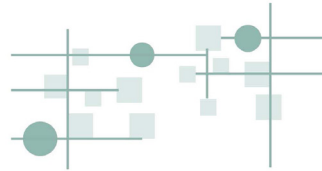
Robust

Construction of the well-conceived pond and urban green and blue network

Create a green and blue network

Add biological stormwater treatment facilities

Integrate facilities into the site



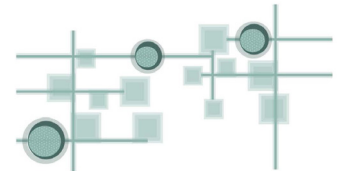
Reflective

Transform the past pond culture into new design decision

Incorporate the existing farm ponds network

Transform the existing ponds into new public space (site specific interventions)

Reveal the existing water works and dyke characteristics



Flexible

Ability to adapt to changing circumstances

Become an adaptive water system

Enlarge the water capacity
Improve water quality

Design a bridge for creating a various walking experience during different climate conditions

Primary test scale
 Benefit for other scale

06 Design Implementation.

06-1 Principle 1-Robust

06-1-1 Dealing with Drought

06-1-2 Dealing with flood

06-1-3 Green and blue network

06-2 Principle 2-Reflective

06-2-1 Form tests of urban and peri-urban pond

06-2-2 Topography

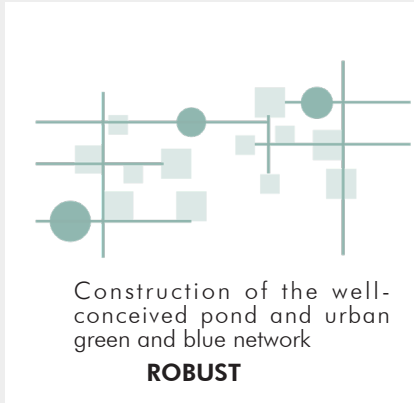
06-2-3 Hydrology

06-2-4 Vegetation

06-2-5 Recreation

06-3 Plan

06-1 PRINCIPLE 1-ROBUST

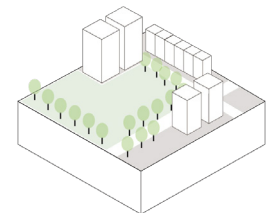


ROBUST WATER SYSTEM AND MODEL

To make the pond network a robust system, the strategy is to enhance existing urban infrastructure to ecological infrastructure beyond utility functions.

The project selects five key space categories and executes low-impact development. Greenfield, Pond Park, road, farm pond, and canal. Construction of the vegetation treatment in the pond parks in the urban area and farm ponds in the peri-urban area. Vegetation treatments are built at linear roadside drainage and canals. Then select the urban undeveloped or leftover greenfield to establish rain gardens.

By applying the low impact development, water drainages and channels are simultaneously purified as they carry water, but before entering the pond, the water is again purified and stored. The urban greenfields build with native planting and having the role to capture and infiltrate stormwater.



Green field

+

Rain garden

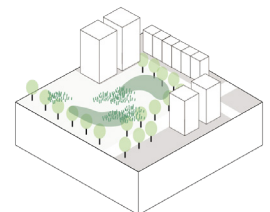


Figure 06-3 Five key space categories with biological structure
Source: drawn by author

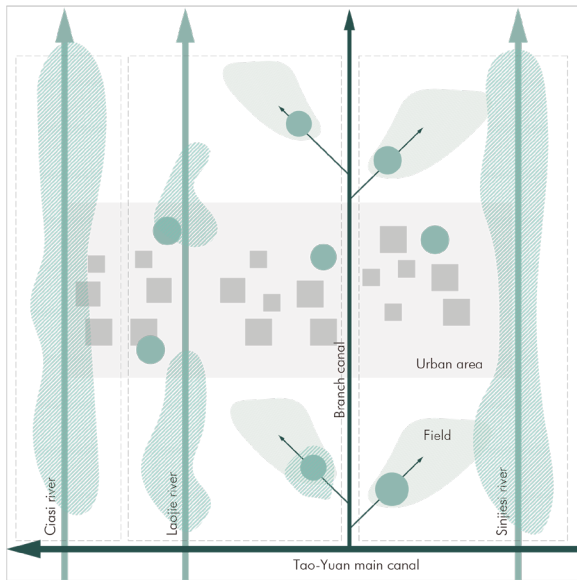


Figure 06-1 Existing water system condition during floods
Source: drawn by author

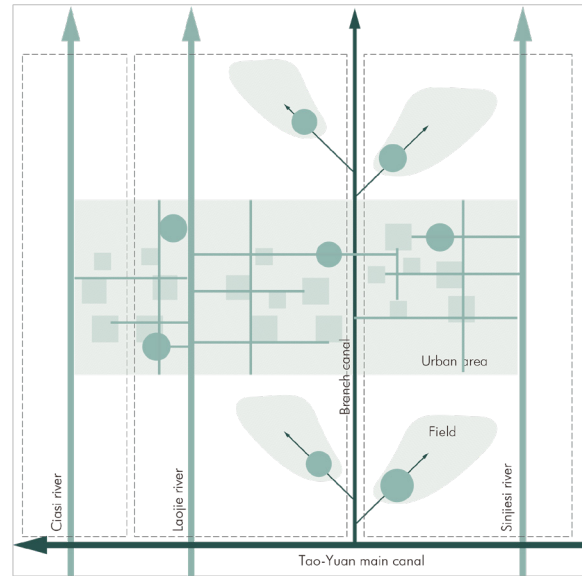
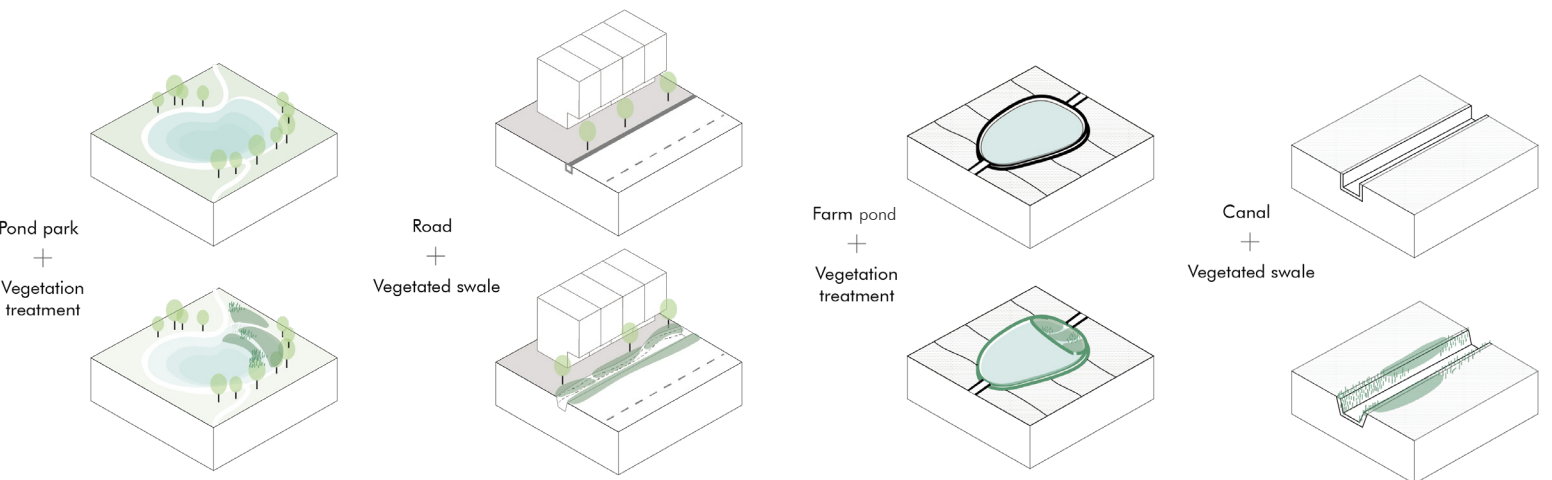
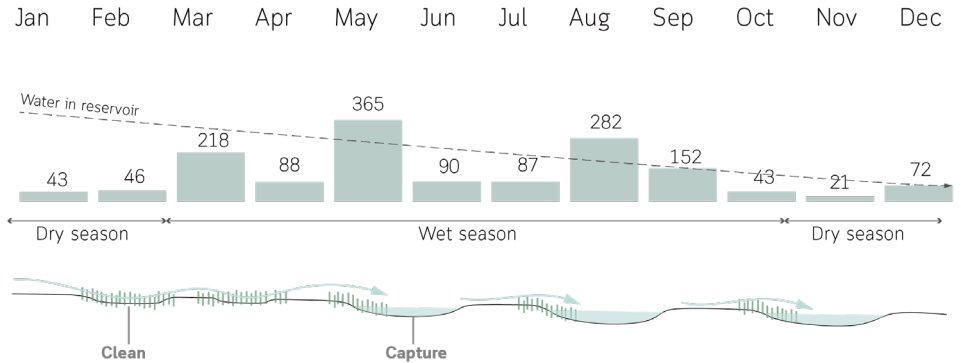


Figure 06-2 New pond network
Source: drawn by author



06-1 PRINCIPLE 1-ROBUST

06-1-1 DEALING WITH DROUGHT



CLEAN AND CAPTURE SYSTEM

Drought condition is relatively long-term for one year or even more, the project proposes a clean and capture system which consists of the green street, green canal for cleaning the surface water. Then, through the urban park with a rain garden to clean and capture little water to supplement groundwater. As a water store in the pond park and farm pond. It can be supplied to alleviate the water shortage.

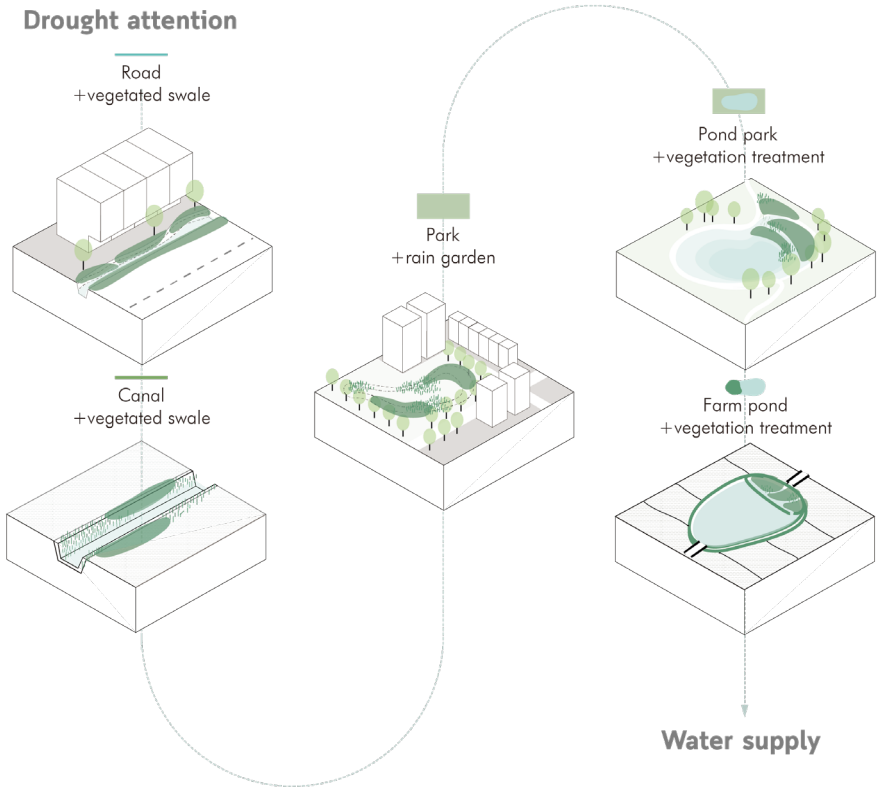
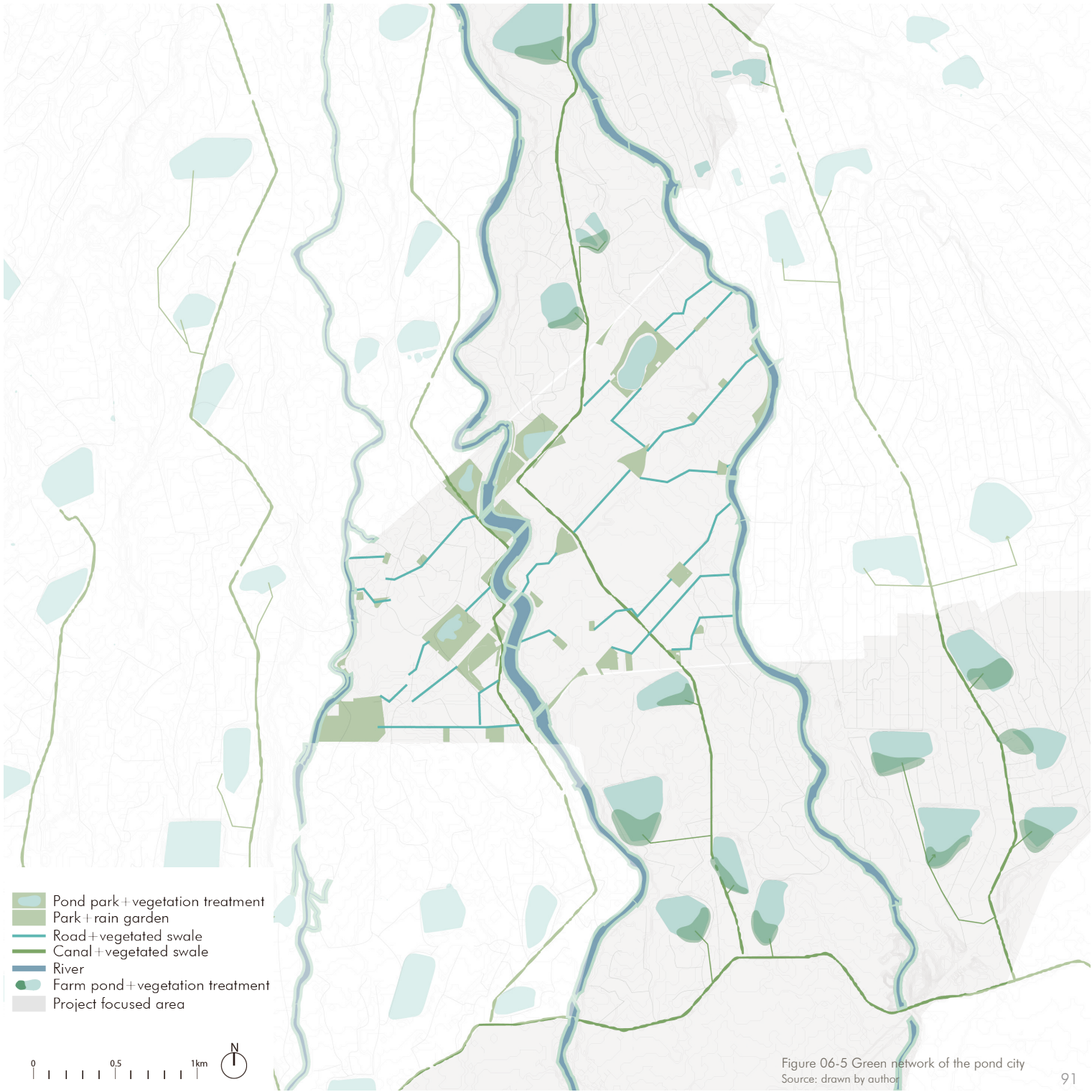


Figure 06-4 Clean and capture system diagram
Source: drawn by author



- Pond park + vegetation treatment
- Park + rain garden
- Road + vegetated swale
- Canal + vegetated swale
- River
- Farm pond + vegetation treatment
- Project focused area

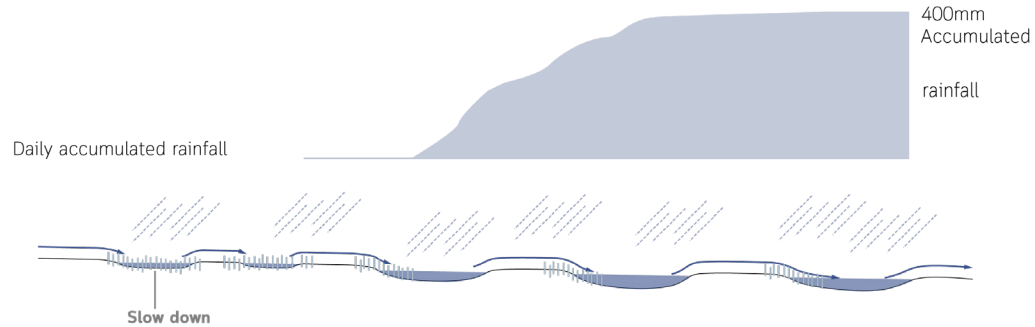


Figure 06-5 Green network of the pond city
Source: drawn by author

06-1 PRINCIPLE 1-ROBUST

06-1-2 DEALING WITH FLOOD

00 01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24



SLOW DOWN SYSTEM

On the contrary, the flood condition usually happened in the short term which can be within a half-day, and accumulated rainfall for 400mm. The robust models can work together for slowing down the speed of stormwater especially in the pond park and farm pond which have more space to let water stay temporary.

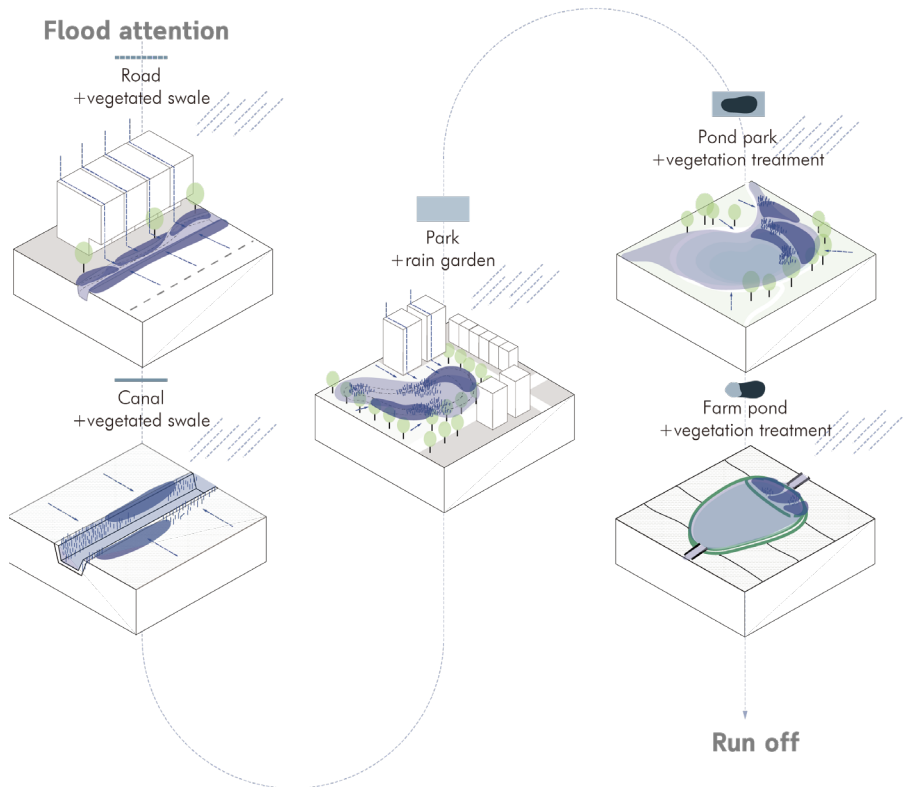
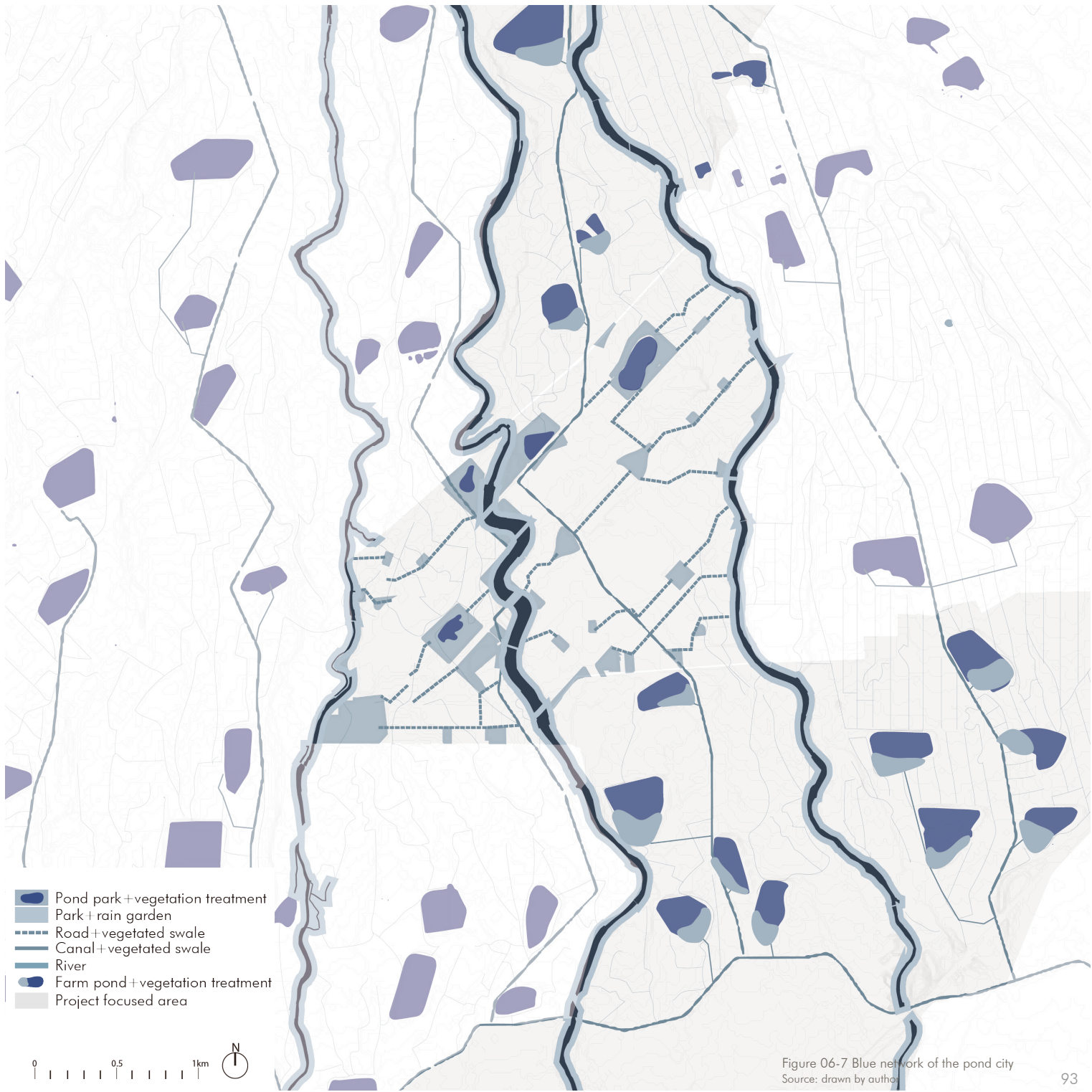


Figure 06-6 Slow down system diagram
Source: drawn by author



- Pond park + vegetation treatment
- Park + rain garden
- Road + vegetated swale
- Canal + vegetated swale
- River
- Farm pond + vegetation treatment
- Project focused area



Figure 06-7 Blue network of the pond city
Source: drawn by author

06-1 PRINCIPLE 1-ROBUST
06-1-3 GREEN AND BLUE NETWORK



Figure 06-8 Green and blue network of the pond city

Source: drawn by author



- 1 Taoyuan main canal
- 2 Sinjiesi river
- 3 Laojie river
- 4 Ciasi river
- 5 Vegetated farm pond
- 6 Pond walking trail
- 7 Rain garden park
- 8 Green street
- 9 Vegetated urban pond park
- 10 Riverfront green space

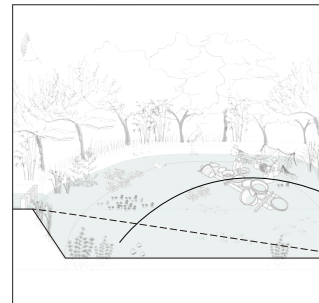
06-2 PRINCIPLE 2-REFLECTIVE



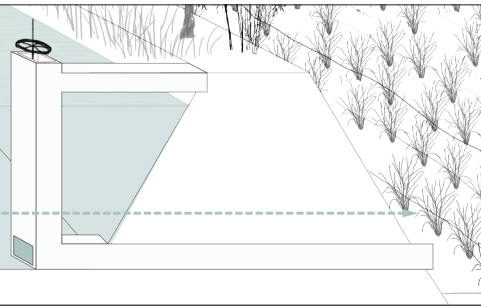
FOUR GUIDING STRATEGIES

There are four essential features of pond culture. The first is construction in which The ponds are built with The earth work balance. Then, with the sluice, water in the pond can be controlled. Naturally, the native plant grew up in the dyke formed the typical pond scape. Last, the pond offers the food production for people such as fishes. Several rituals also occur in ponds, as in the dragon boat festival.

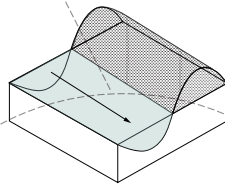
In response to the new challenges of extreme climate and urbanization, and towards the goal of reflective, the project transforms four features into four design strategies for the transformation of pond. Four guiding strategies are topography, hydrology, vegetation, and recreation, which will be described in more detail in later chapters.



Construction

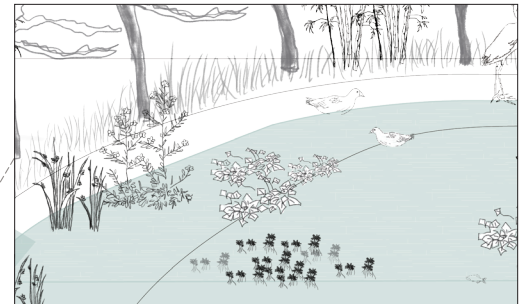


controlling

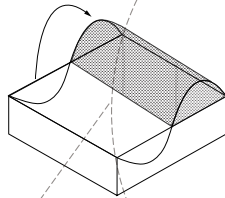


2 Hydrology

Intervention: Install water works
Aim: Controlling water volume in the pond during different conditions

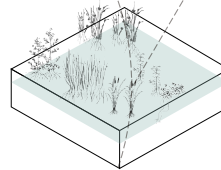


Native plant



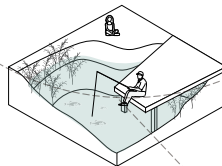
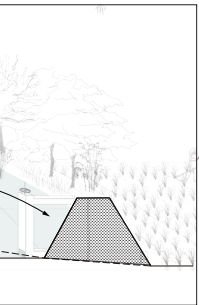
1 Topography

Intervention: Cut and fill balance
Aim: Increase space for the water capacity



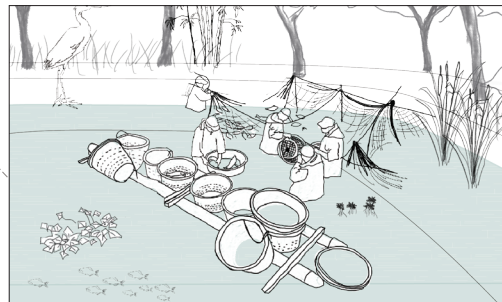
3 Vegetation

Intervention: Vegetation treatment
Aim: Eliminate pollutants



4 Recreation

Intervention: Leisure facilities
Aim: re-creation heritage as a powerful tool for open public space



Production / Ritual

06-2 PRINCIPLE 2-REFLECTIVE

06-2-1 FORM TESTS OF URBAN AND PERI-URBAN POND

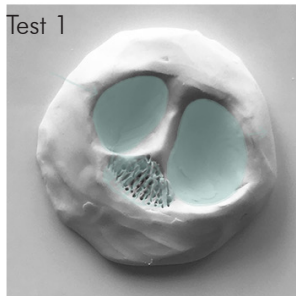
Through the test of the model, the project tries to design the urban pond, which combines purified water space and maximizes water storage. Therefore, the existing pond will be combined with the surrounding green through micro-topography, experiments in different forms, how to maximize water storage while purifying rainwater.



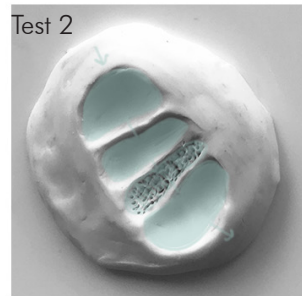
The initial idea for an urban pond is to create a new pond to replace the adjacent green space and build a treatment wetland.

By using three different test models of water passing through different ponds and the vegetation wetland. The final form chose the first test, which is suitable for the size of the site and has enough space for water purification.

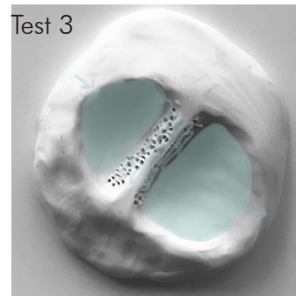
Figure 06-10 Existing water system in the urban pond
Source: drawn by author



Test 1
Two ponds with one treatment wetland



Test 2
Three ponds with one treatment wetland



Test 3
Two ponds with one treatment wetland in the embankment

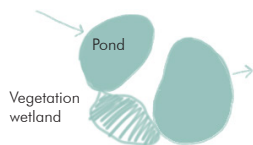


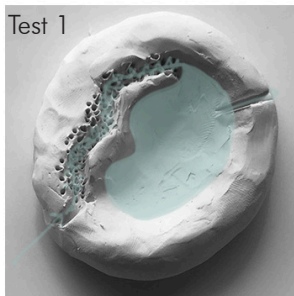
Figure 06-11 Form tests of urban pond
Source: drawn by author



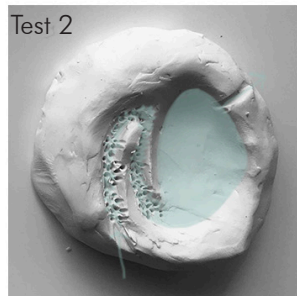
The initial idea for the farm pond is to purify the water before it enters the pond and to increase water storage space.

Three kind forms of vegetation wetland into the pond with testing models. However, the third test was selected because the existing southeast bank is easy to mold and also close to the water inlet.

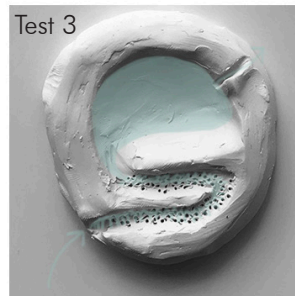
Figure 06-12 Existing water system in the peri-urban pond
Source: drawn by author



Test 1

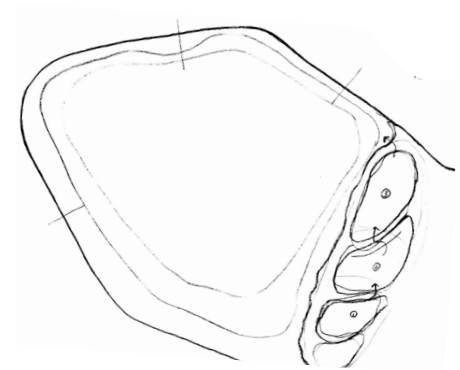


Test 2



Test 3

Sketch of final decision



Straight form of vegetation wetland in the west of pond

Sinuous form of vegetation wetland in the west of pond

Sinuous form of vegetation wetland in the south of pond

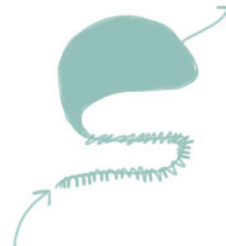
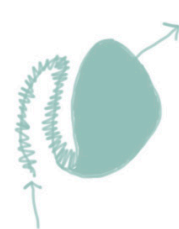
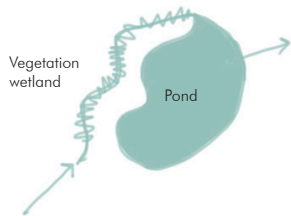
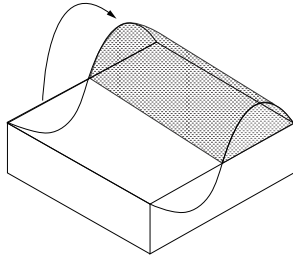


Figure 06-13 Form tests of peri-urban pond
Source: drawn by author

06-2 PRINCIPLE 2-REFLECTIVE

06-2-2 TOPOGRAPHY



1 Topography

Intervention: Cut and fill balance
Aim: Increase space for the water capacity

By learning from the traditional earthwork, the cut and fill balance in the site is implemented.

The idea for the urban pond is to make the existing pond deeper and fill new pond's dyke.

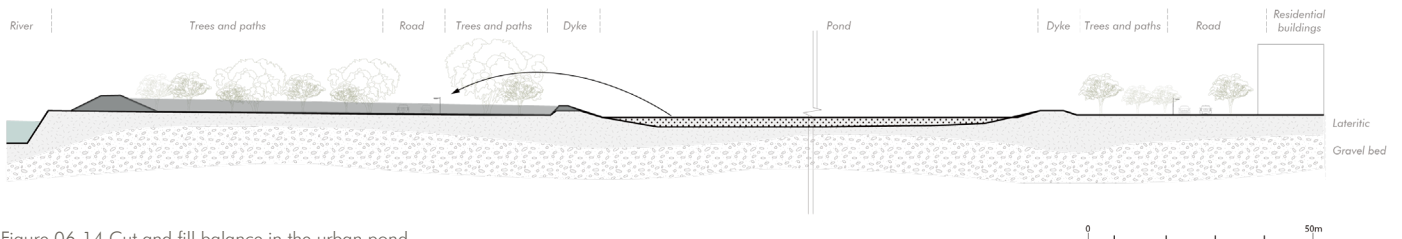
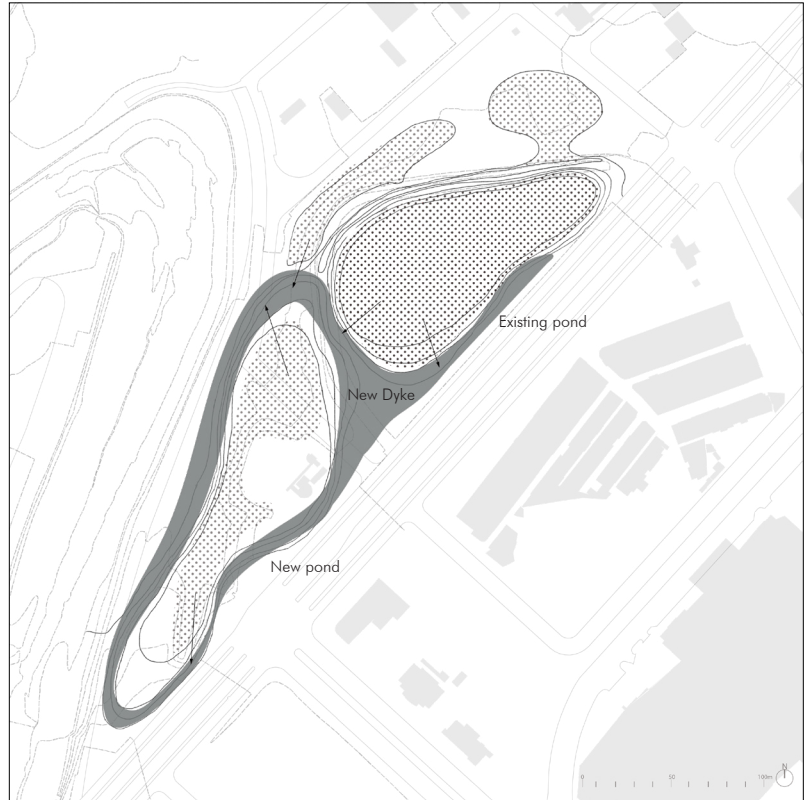


Figure 06-14 Cut and fill balance in the urban pond
 Source: drawn by author

Similarly, the pond in peri-urban makes the existing pond deeper. By using cut soil to fill the form of new vegetation wetland and also fills in one side of the dyke to gentle the slope.

●●●● Cut
■ Fill

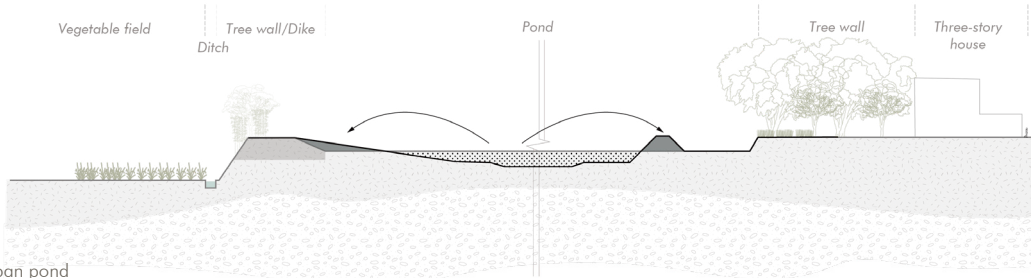
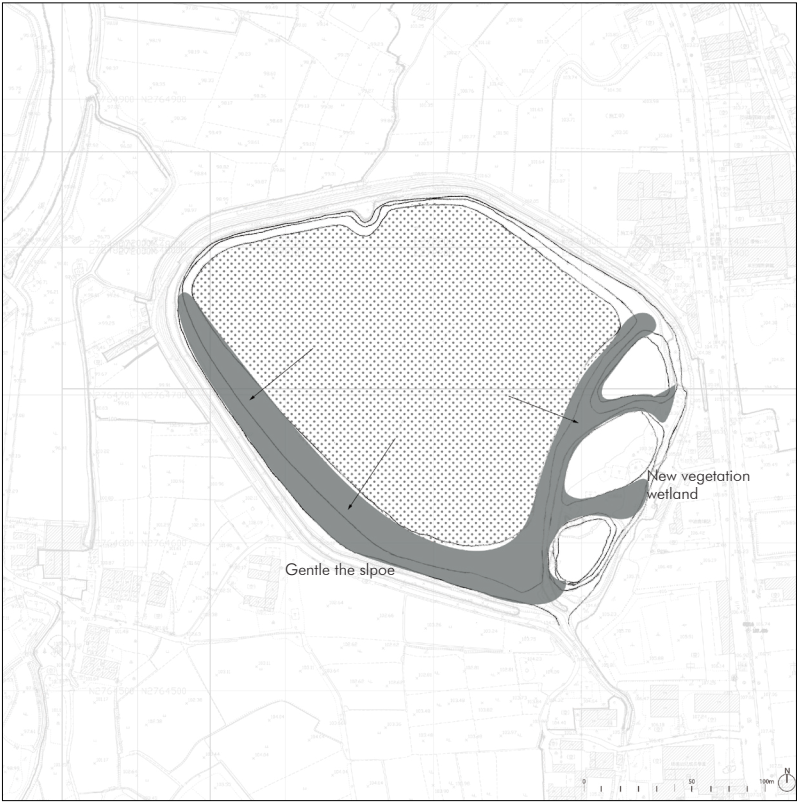
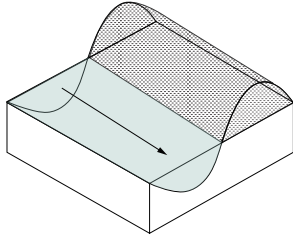


Figure 06-15 Cut and fill balance in the peri-urban pond
Source: drawn by author

06-2 PRINCIPLE 2-REFLECTIVE

06-2-3 HYDROLOGY



2 Hydrology

Intervention: Install water works
Aim: Controlling water volume in the pond during different conditions

The pond in the urban area connects with the rainwater drainage system. Therefore, to manage the water level in different conditions, there are five control points for the inlet and outlet. Neighborhood rainwater will be collected and flow to point 1, fed to pond 1, then through point 2, fed into the vegetation treatment plant, and the purified water can through point 4, fed to pond 2, and finally fed to water playground via point 5. However, when there is too much water, it will overflow from point 3 into the river.

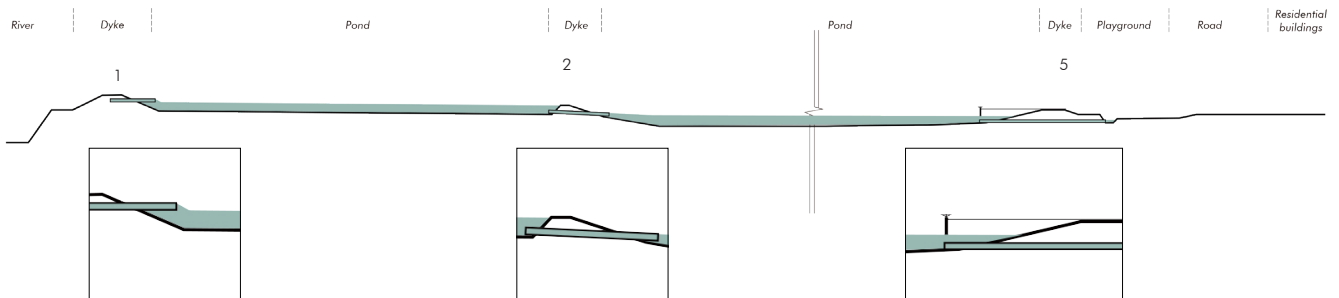
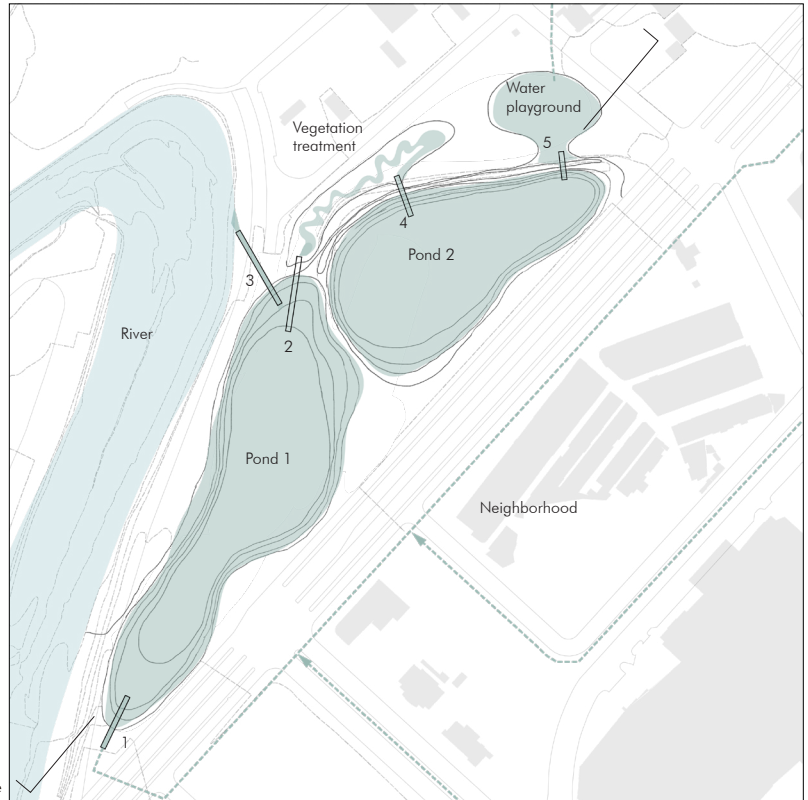
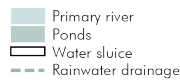


Figure 06-16 Water control in the urban pond
 Source: drawn by author

The water flow in the peri-urban pond remains the existing way and directions. However, the water does not enter the pond directly, a new intake will be installed for the vegetation treatment, the water will be purified and stored at the pond, and the irrigation flow will be controlled through point 2.

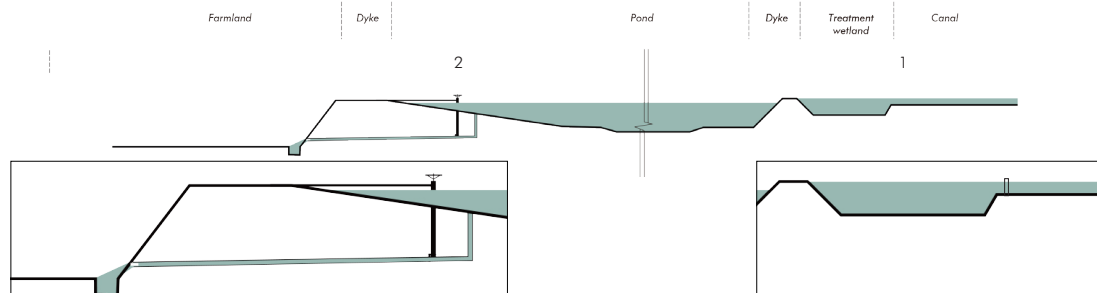
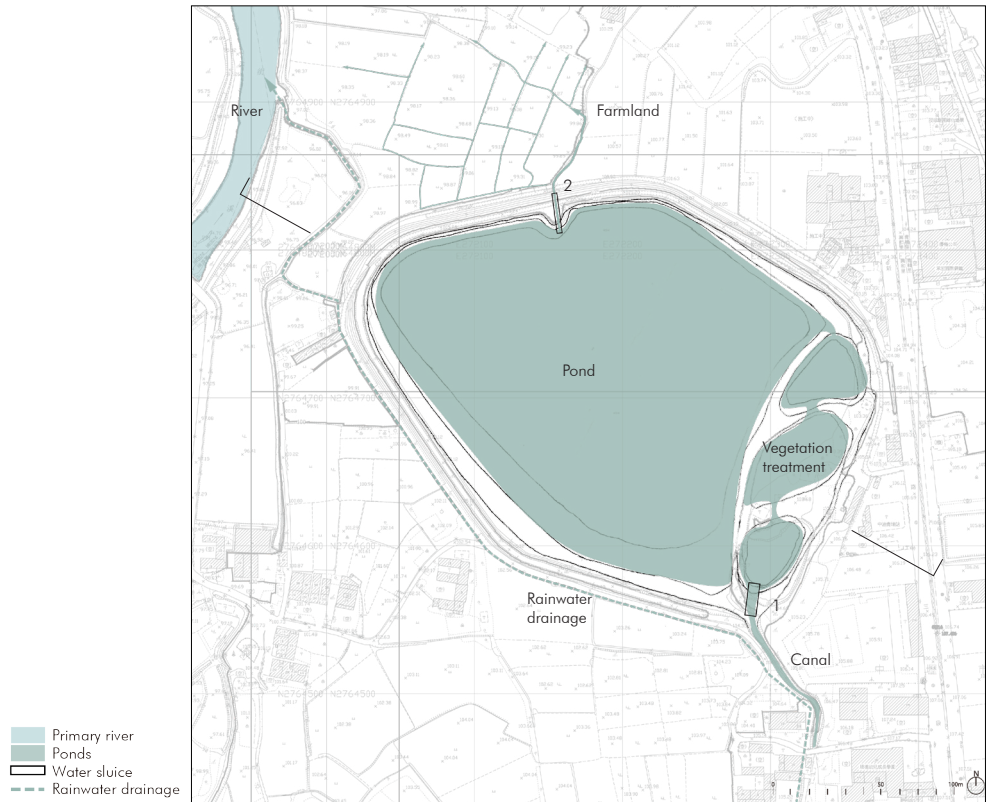
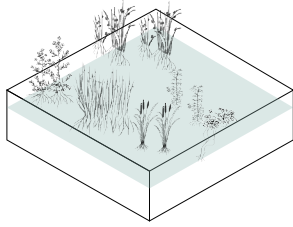


Figure 06-17 Water control in the peri-urban pond
Source: drawn by author

06-2 PRINCIPLE 2-REFLECTIVE

06-2-4 VEGETATION



3 Vegetation

Intervention: Vegetation Treatment
Aim: Eliminate pollutants

The shallow wetland combined in the urban pond can help to clean the rainwater and store from pond 1 to pond 2. Through the long and winding channels, the water is purified in one depth and one shallow depth, and aquatic plants are planted on the ground to protect the plants on the ground while removing pollutants.

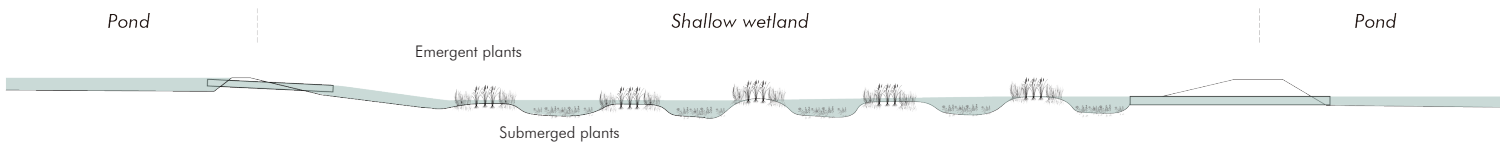
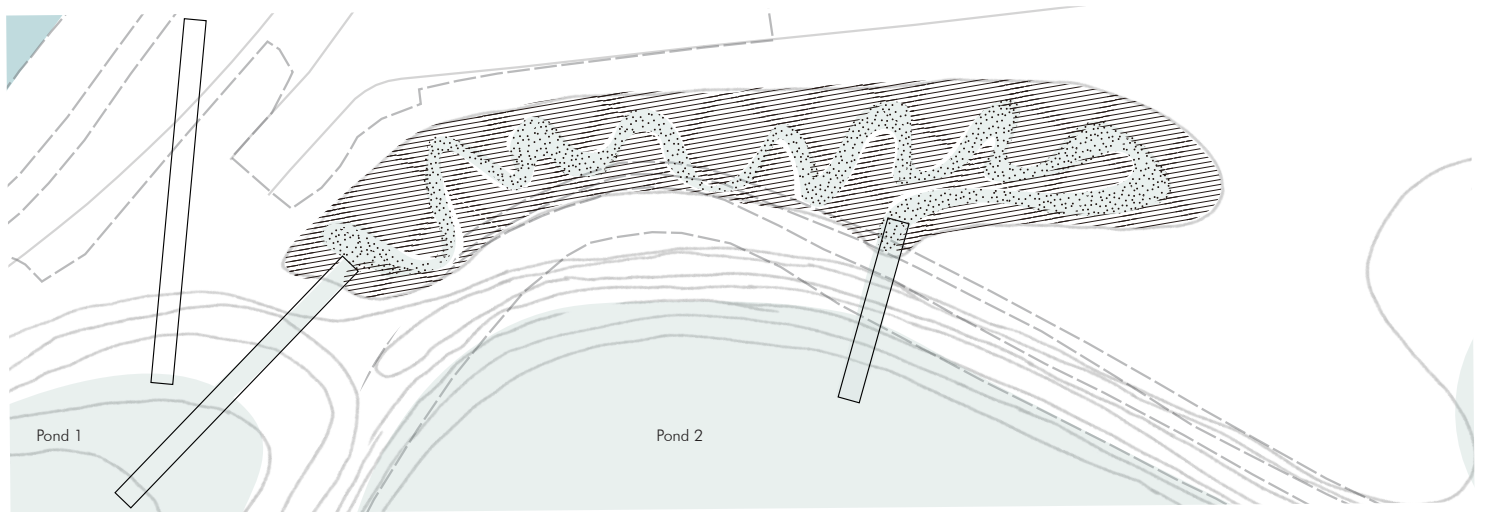
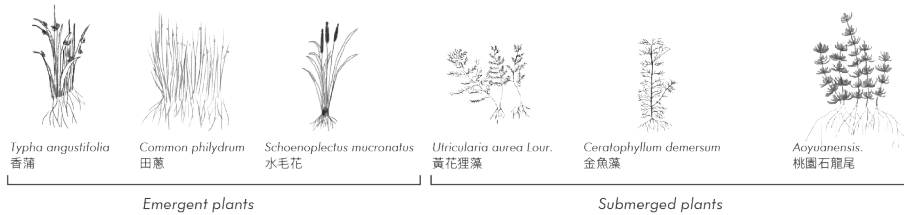


Figure 06-18 Vegetation treatment in the urban pond
Source: drawn by author



The free water surface wetland was designed just after the inlet structure which cleans the irrigated water and stores it in the farm pond. There are three main zones in the wetland. The first is a sedimented basin for dissolving pollutants. Then, the second part of the macrophyte zone allows the biological and chemical removal of nutrients and some pesticides. Finally, a deep pool is to regulate outflow and the water level in the treatment wetland.

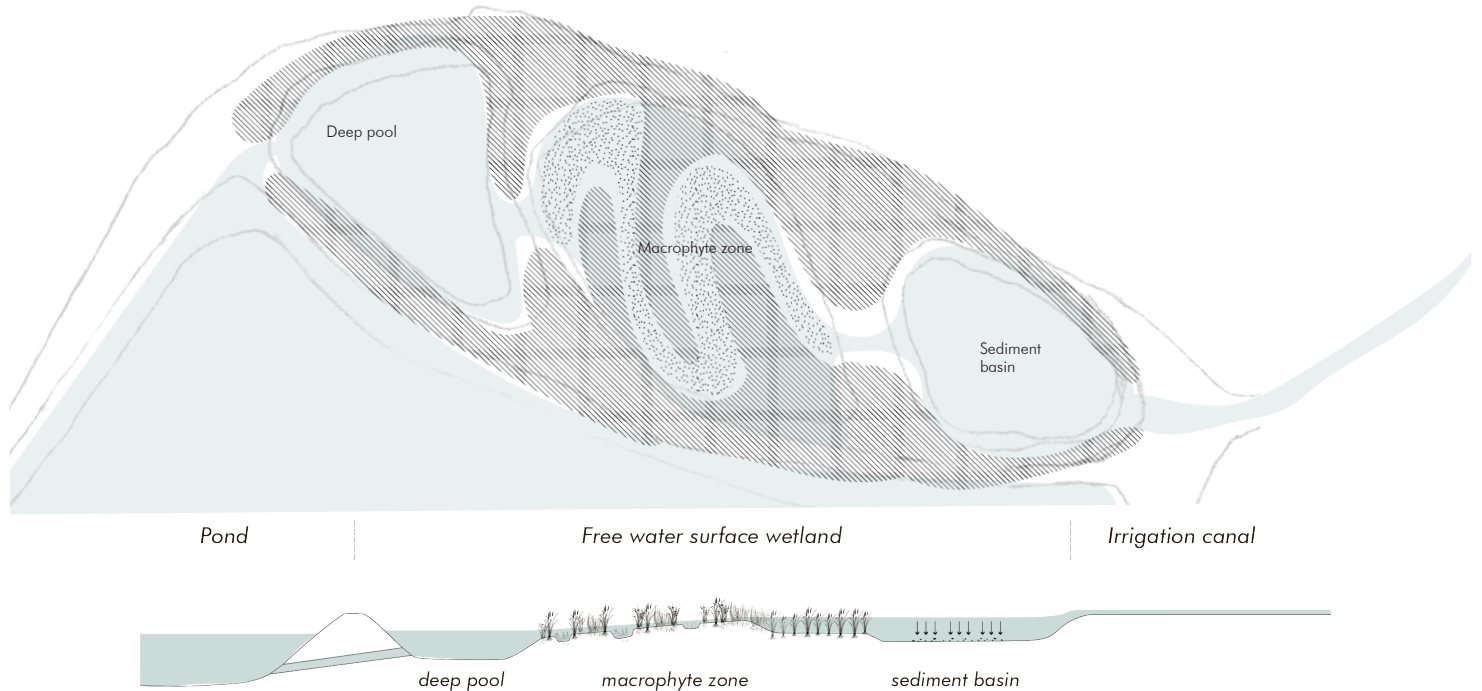
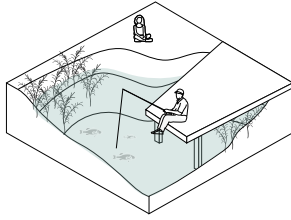


Figure 06-19 Vegetation treatment in the peri-urban pond
Source: drawn by author

06-2 PRINCIPLE 2-REFLECTIVE

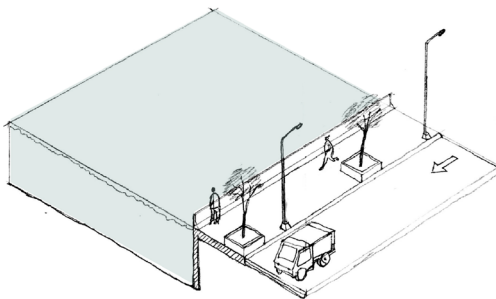
06-2-5 RECREATION



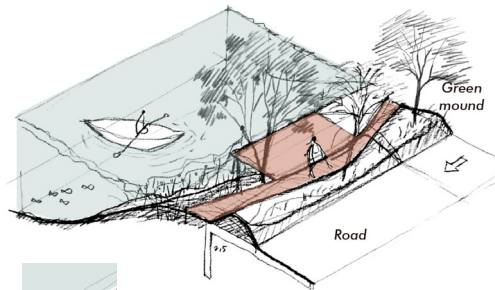
4 Recreation

Intervention: Leisure facilities
Aim: re-creation heritage as a powerful tool for open public space

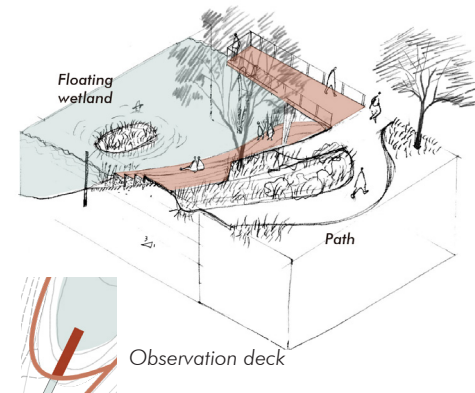
The existing edge of pond with pedestrian divided with a long railing. In order to make the pond more accessible, the round path and staying deck beside the pond are designed to make visitors can feel walking path beside pond is part of city route. Through the intervention, pond can integrate into urban space.



Existing edge



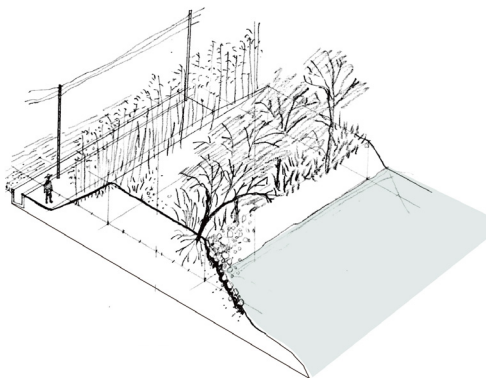
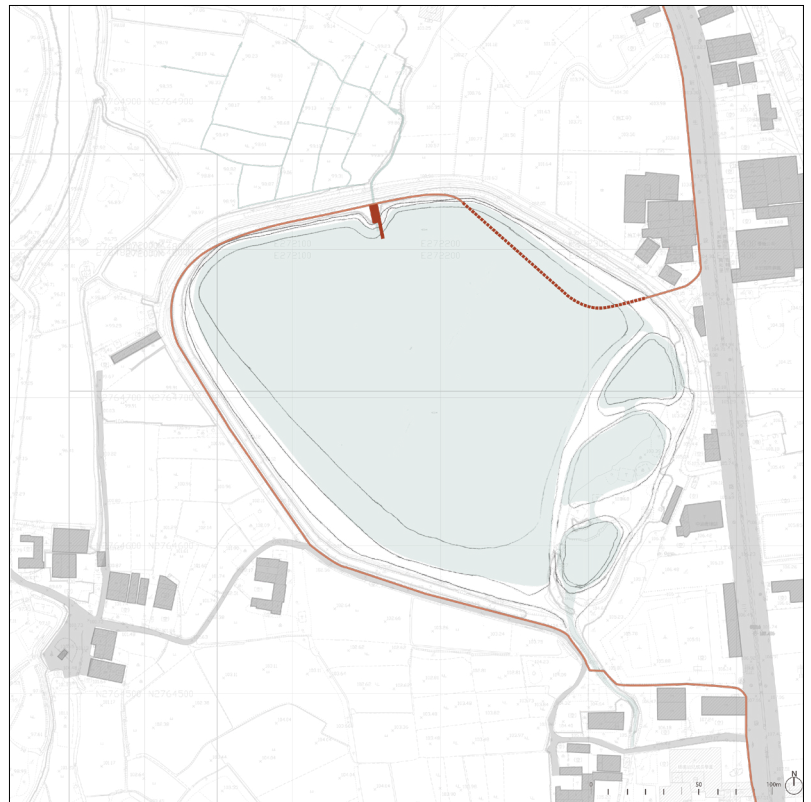
Wooden deck



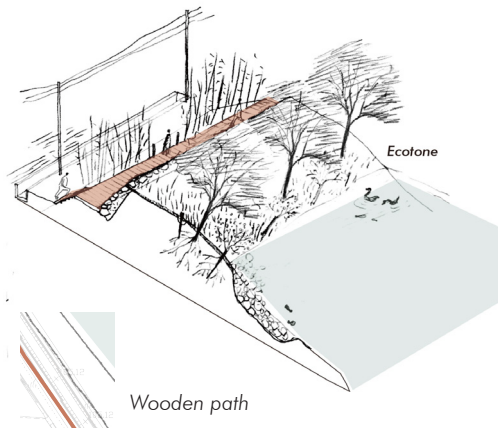
Observation deck

Figure 06-20 Leisure facilities in the urban pond
 Source: drawn by author

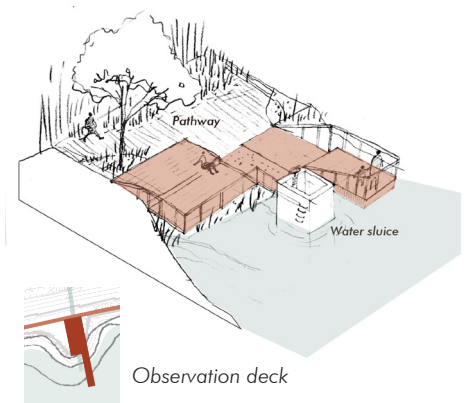
The design intervention in the peri-urban pond is less obvious but still has a round path which visitors can walk through. There are two models that show a diverse way of walking with paths, stay on the wooden deck in the highest point.



Existing edge



Wooden path



Observation deck

Figure 06-21 Leisure facilities in the peri-urban pond
Source: drawn by author

06-3 PLAN



Figure 06-22 Urban pond plan
Source: drawn by author



Figure 06-23 Peri-urban pond plan
Source: drawn by author

07 Design Elaboration.

07-1 Principle 3-Flexible

07-1-1 Urban pond-green infrastructure

07-1-2 Urban pond-blue infrastructure

07-1-3 Peri-urban pond-green infrastructure

07-1-4 Peri-urban pond-blue infrastructure

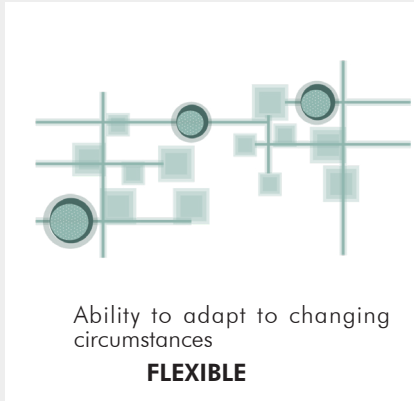
07-1-5 Adapt to three situations

07-1-6 Urban pond-a bridge between two ponds

07-1-7 Peri-urban pond-a bridge across the pond

07-2 Summary

07-1 PRINCIPLE 3-FLEXIBLE



MAKE DRY / WET INTO DAILY SCENE

The chapter explains how the pond network is able to be flexible, how the robust models proposed by the large scale blue-green system are materialized on a small scale, and demonstrates how the ecological infrastructure is used in daily life in urban and peri-urban areas, to minimize the effects of extreme weather.

In addition to the upgraded infrastructure, two scenes in the urban and peri-urban areas were chosen as a demonstration of the everyday life of urbanites, with urban pond providing a bridge to enhance the perception of the water level of the pond, in a single pond can be seen from the micro-landscape. At farm pond, however, in addition to the fish farm, it can be a place for people to run and relax. By combining the water sluice with the new design, the old facility is superimposed and transformed into something more than a single function.

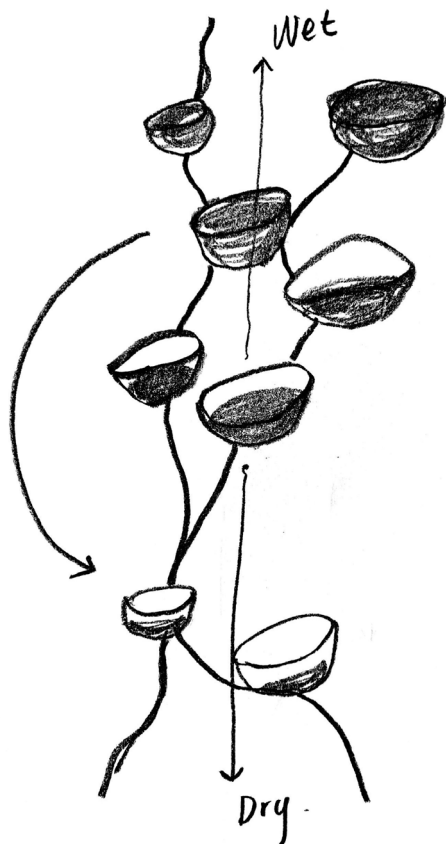
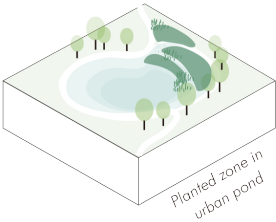


Figure 07-1 Abstract drawing of pond adapting to wet and dry
Source: drawn by author

07-1 PRINCIPLE 3- FLEXIBLE
 07-1-1 URBAN POND-GREEN INFRASTRUCTURE



The section shows how the urban pond applied robust models on a small scale.

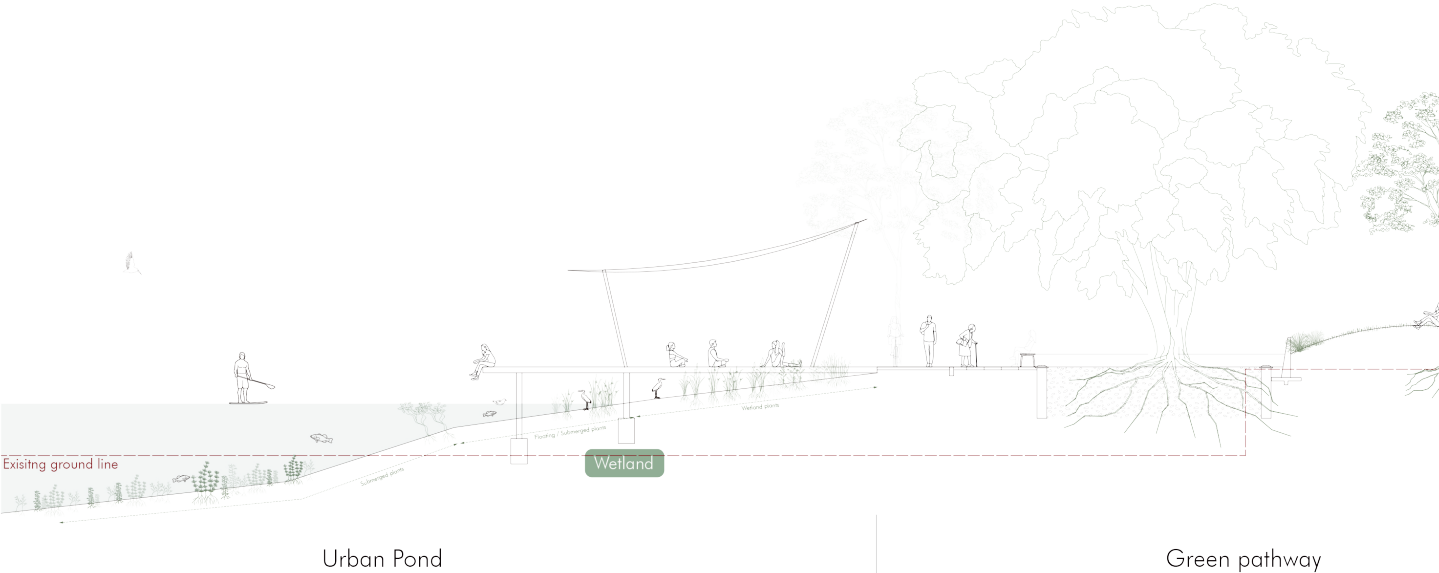
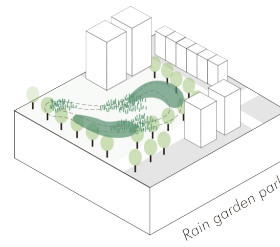
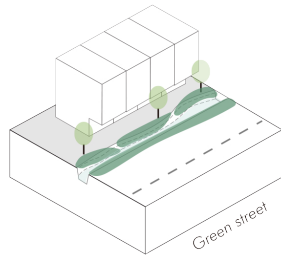
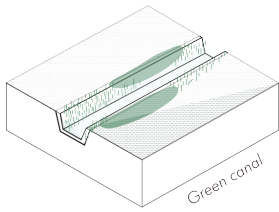


Figure 07-2 Section of urban pond with green infrastructure
 Source: drawn by author



07-1 PRINCIPLE 3- FLEXIBLE
07-1-2 URBAN POND-BLUE INFRASTRUCTURE

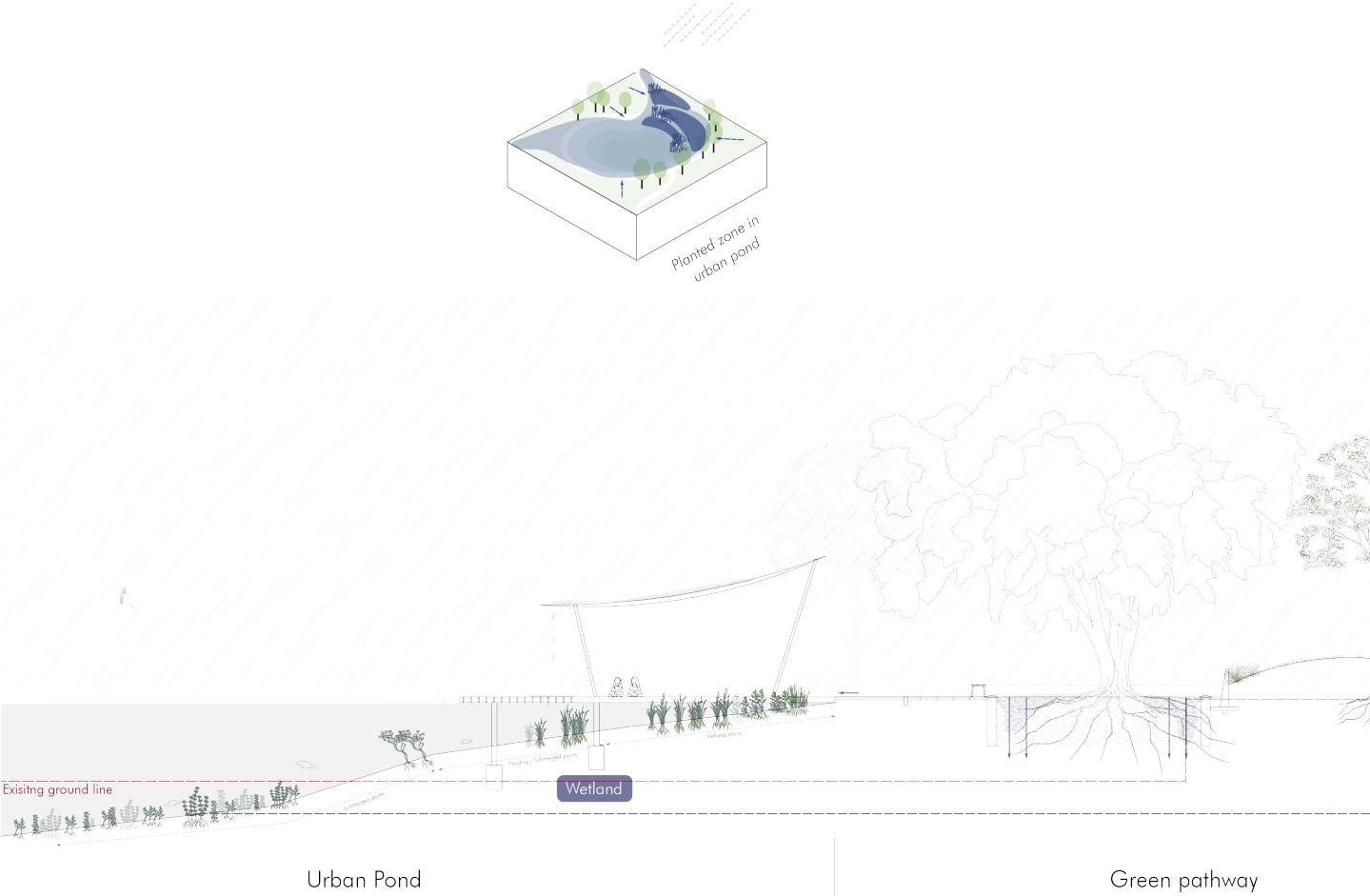
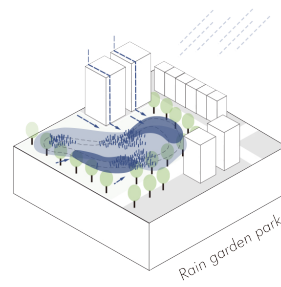
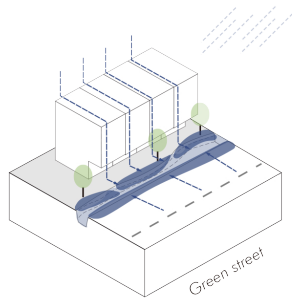
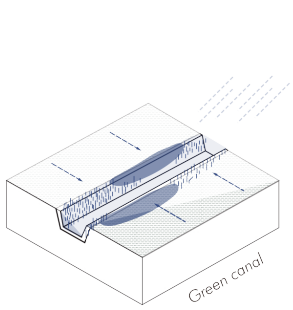
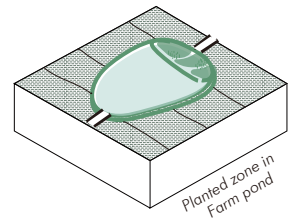
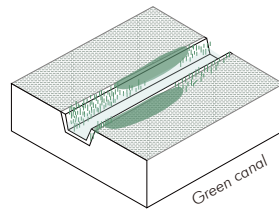
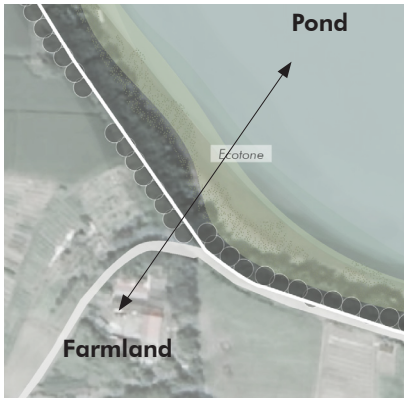


Figure 07-3 Section of urban pond with blue infrastructure
Source: drawn by author



07-1 PRINCIPLE 3- FLEXIBLE

07-1-3 PERI-URBAN POND-GREEN INFRASTRUCTURE



The section shows how the peri-urban pond applied robust models on a small scale.

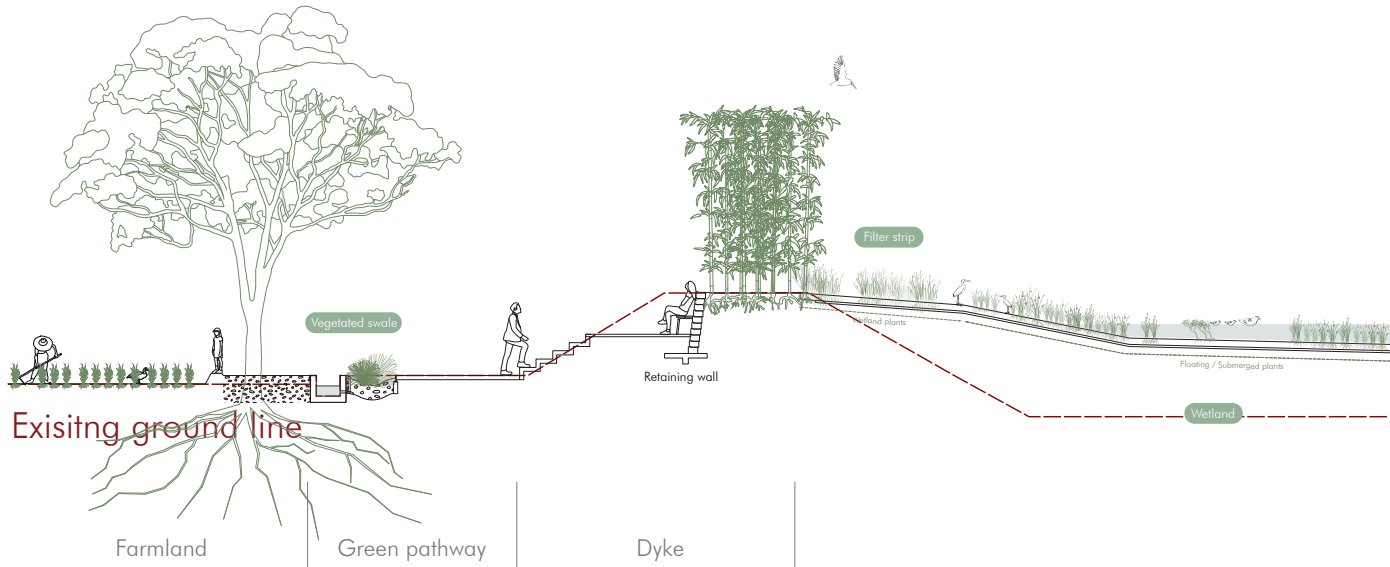
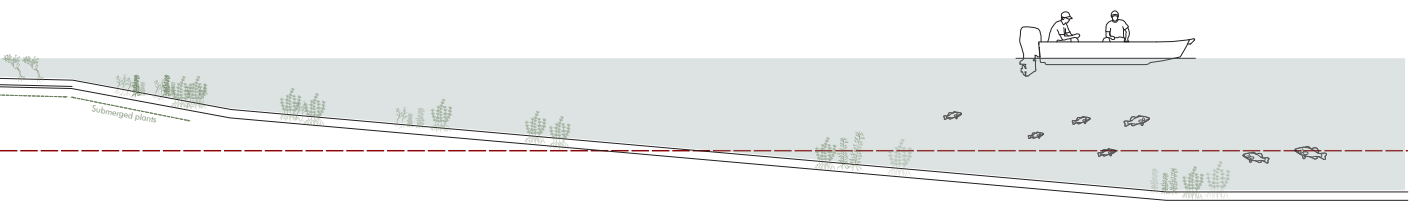


Figure 07-4 Section of peri-urban pond with green infrastructure
Source: drawn by author



Pond

0 | | | | 5M

07-1 PRINCIPLE 3- FLEXIBLE
 07-1-4 PERI-URBAN POND-BLUE INFRASTRUCTURE

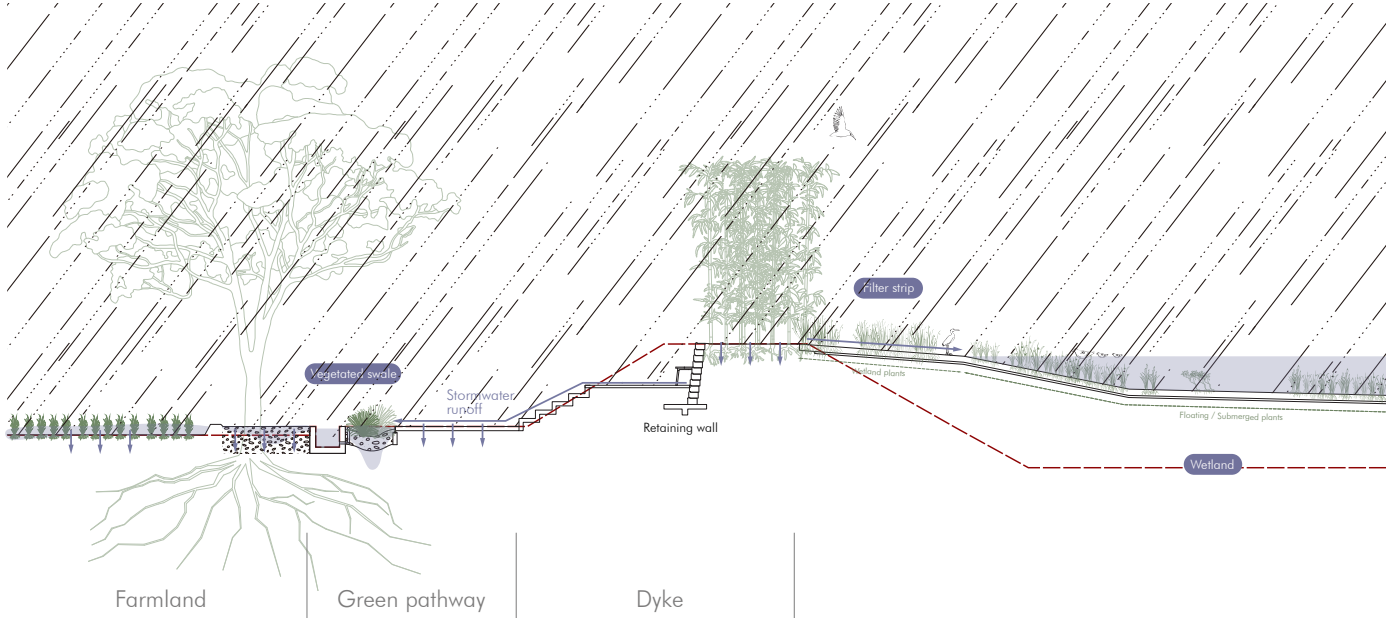
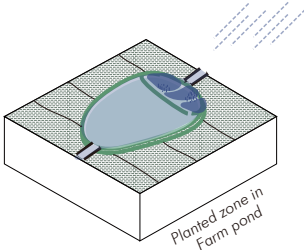
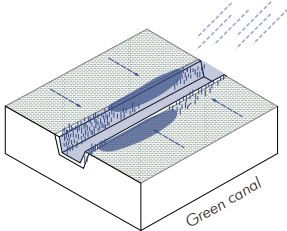
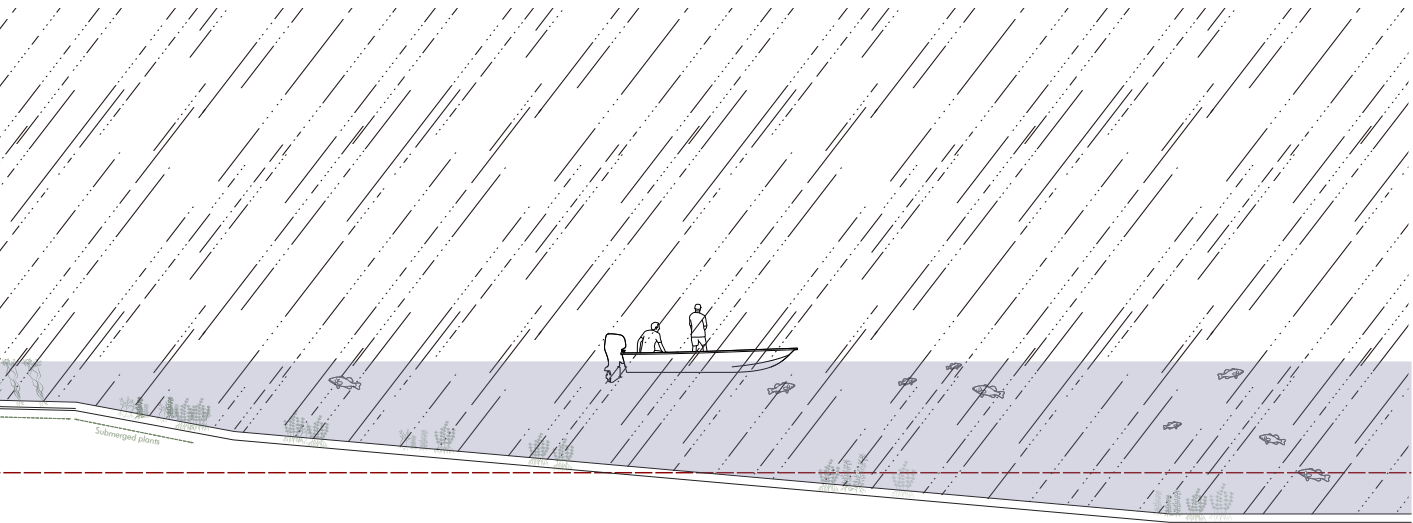


Figure 07-5 Section of peri-urban pond with blue infrastructure
 Source: drawn by author



Pond

0 | | | | 5M

07-1 PRINCIPLE 3- FLEXIBLE

07-1-5 ADAPT TO THREE SITUATIONS

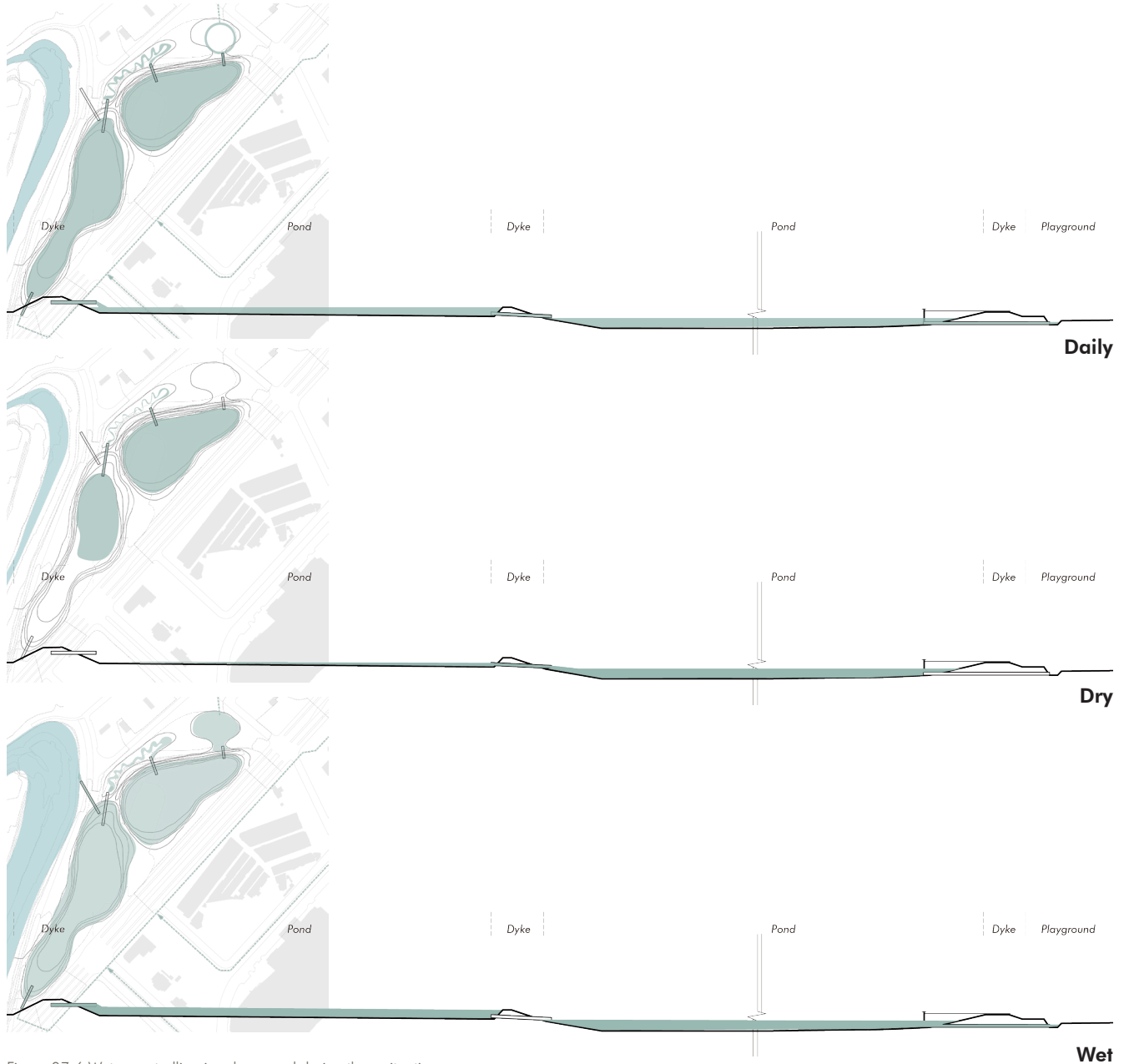


Figure 07-6 Water controlling in urban pond during three situations
Source: drawn by author

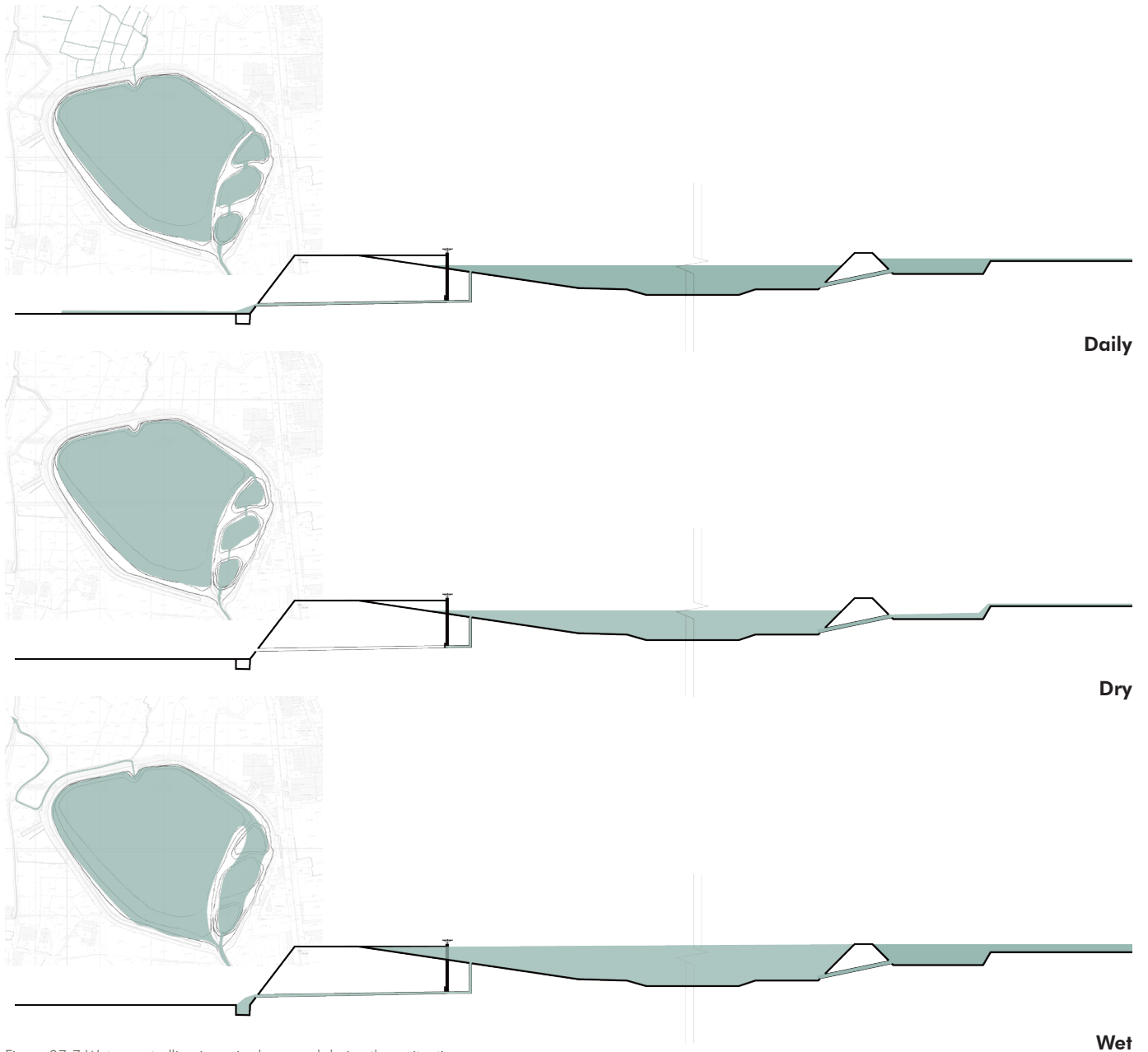


Figure 07-7 Water controlling in peri-urban pond during three situations

Source: drawn by author

07-1 PRINCIPLE 3- FLEXIBLE
07-1-6 URBAN POND-BRIDGE IN BETWEEN OF TWO PONDS



DAILY SCENE



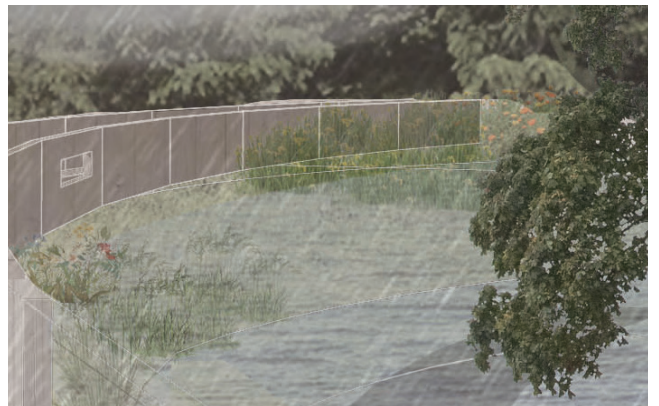
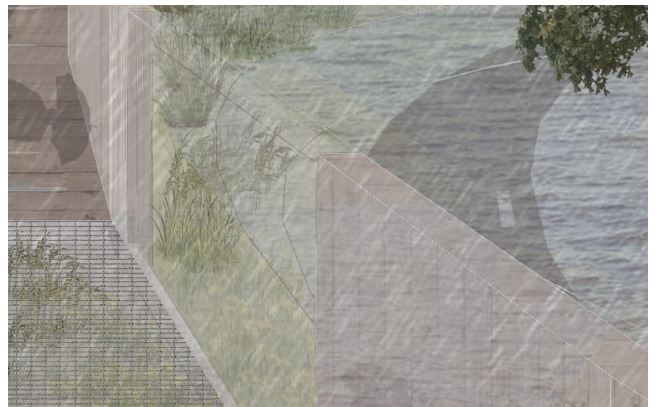


DRY SCENE





WET SCENE

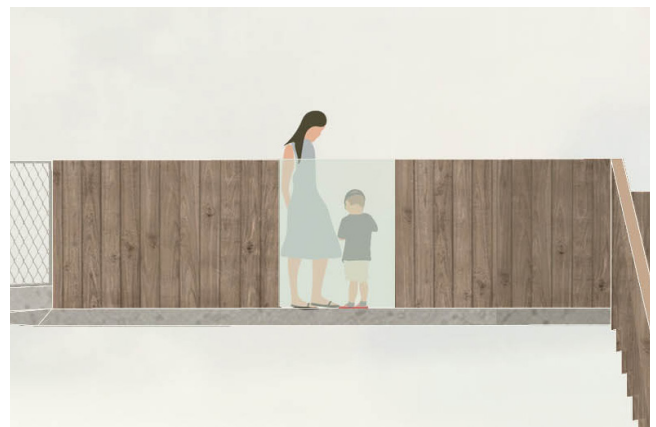


07-1 PRINCIPLE 3- FLEXIBLE

07-1-7 PERI-URBAN POND-A BRIDGE ACROSS THE POND

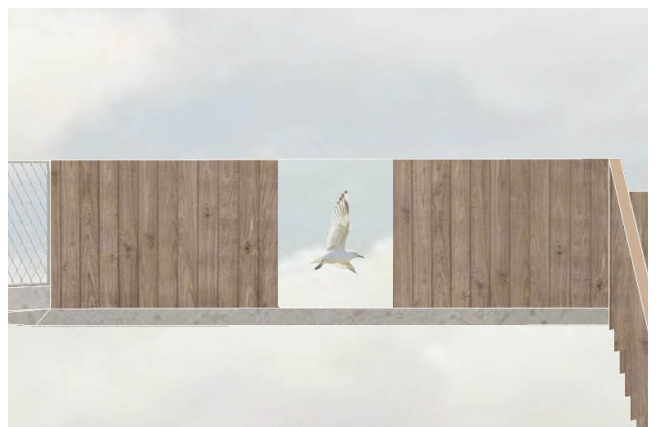


DAILY SCENE



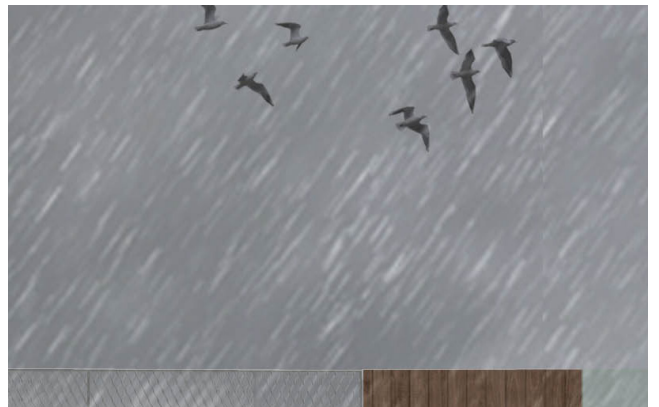
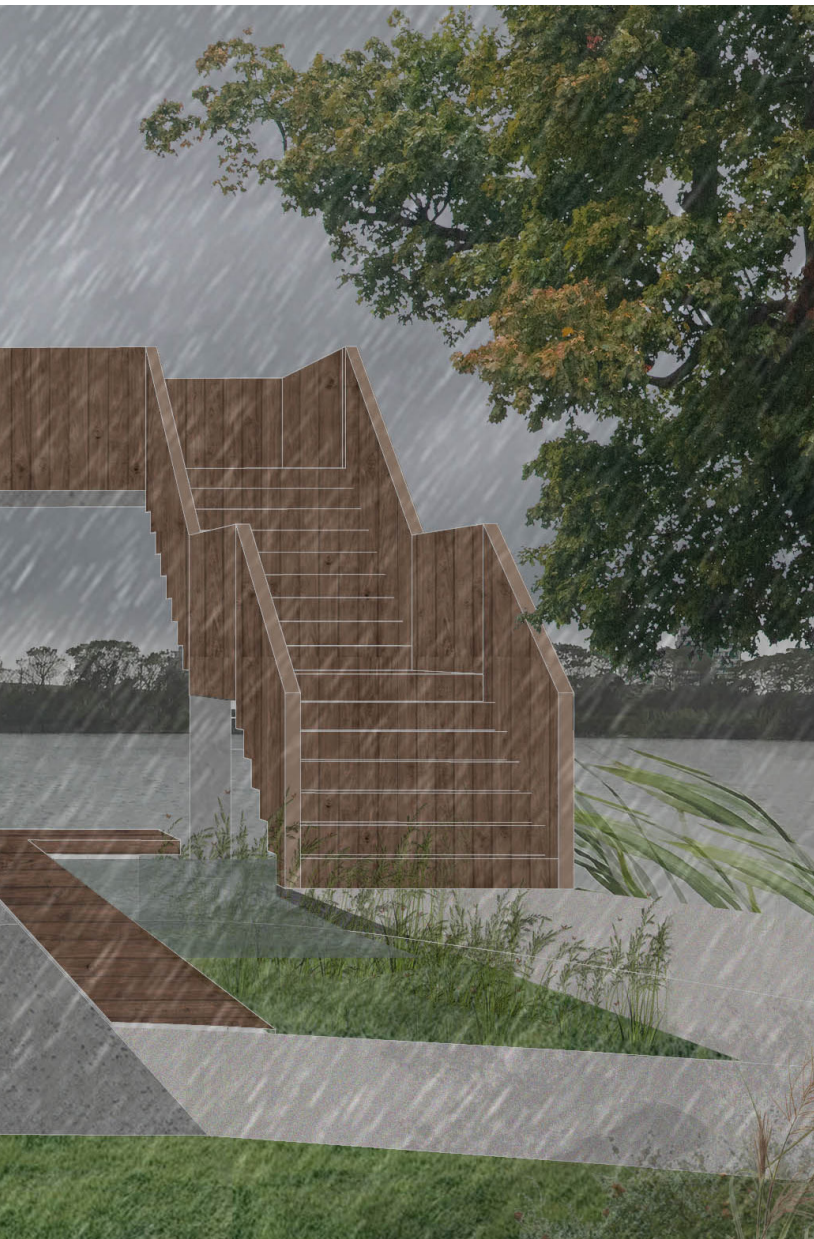


DRY SCENE





WET SCENE



07-2 CONCLUSION

07-2-1 RELATION BETWEEN CLIMATE ADAPTATION AND PUBLIC SPACE

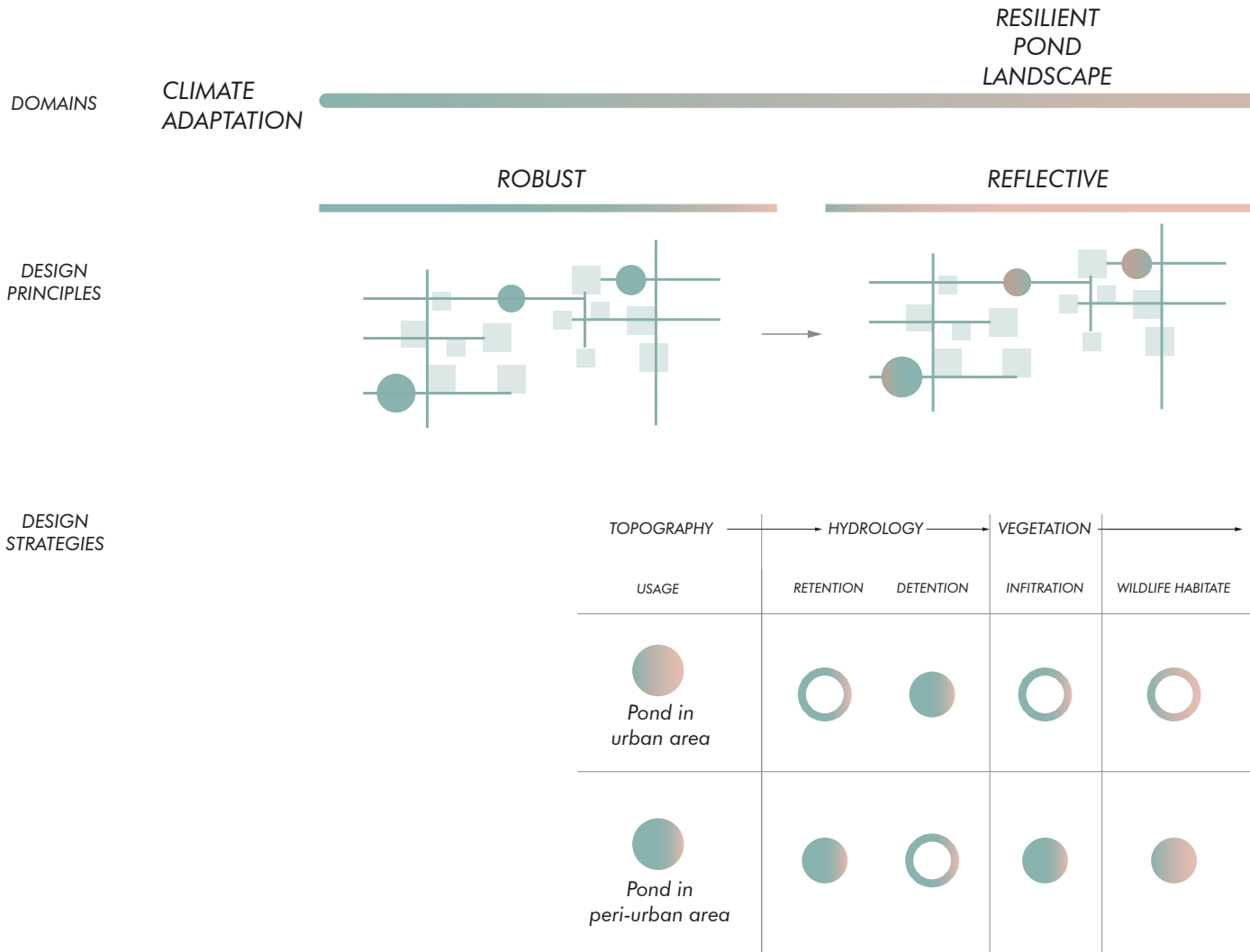
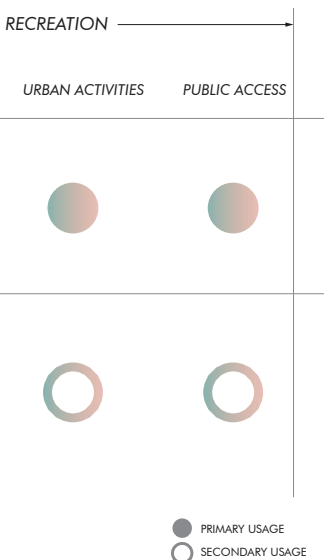
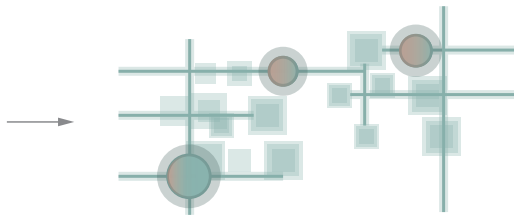


Figure 07-8 Diagram of relation between climate adaptation and public space
Source: drawn by author

PUBLIC SPACE

FLEXIBLE



The main two topics covered in this study : one is climate adaptation and the other is public space.

The three design principles applied from robust, reflective to flexible, from primarily addressing the climate issue to finding a space to coexist with public space.

However, in design strategies, two urban and peri-ponds are selected as examples to illustrate the primary functions and secondary functions respectively. To conclude, the urban pond takes the primary role of detention especially during flood, offering space for urban activities, and public access. Differently, the peri-urban pond takes the primary role of retention especially during drought and also infiltration of water for the canal. In the recreation aspect, the peri-urban pond create more space for wildlife habitat.

Therefore, the different role of two ponds can cooperate to become a powerful mediator.

07-2 CONCLUSION

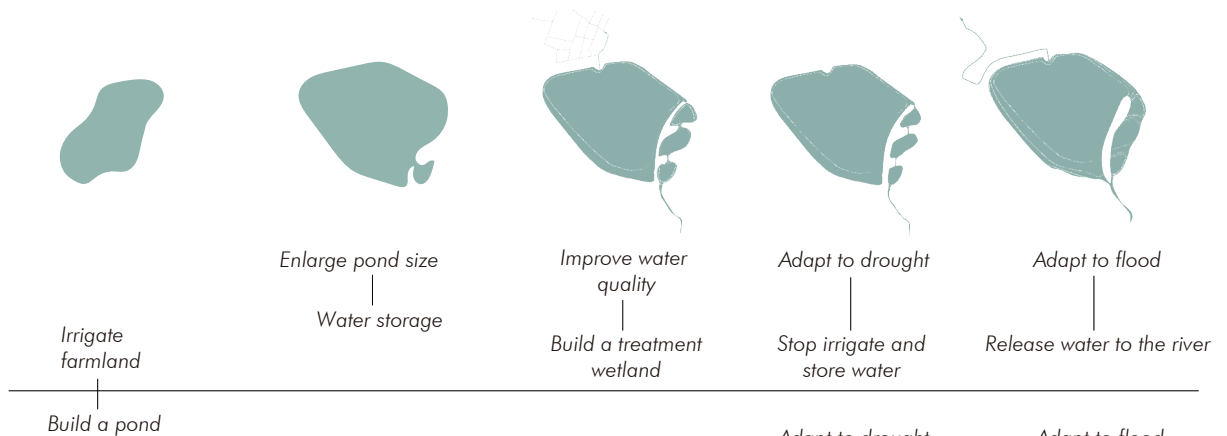
07-2-3 POND ADAPTATION



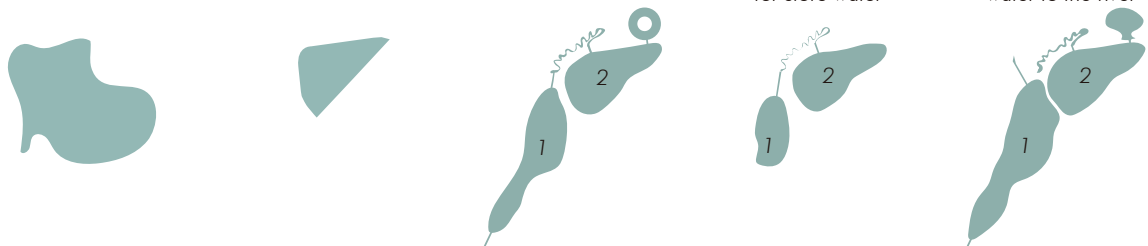
Bird claw adaptations.

Source: downloaded from lansingwbu.blogspot.com

Pond No.5-1



Pond No.5-5



Pond adaptations.

Figure 07-9 Pond adaptation
Source: drawn by author

Biological adaptations inspire the pond adaptation. As shown on the left, the bird claw adapts to different forms for the needs of different environments and survival.

Similarly, ponds started to store water and have a steady supply of water to irrigate farmland. But today, the demand is no longer just for water storage and irrigation. In the face of extreme climate change, ponds can transform when there is too much water, and too little become an essential coordinator of the water system.

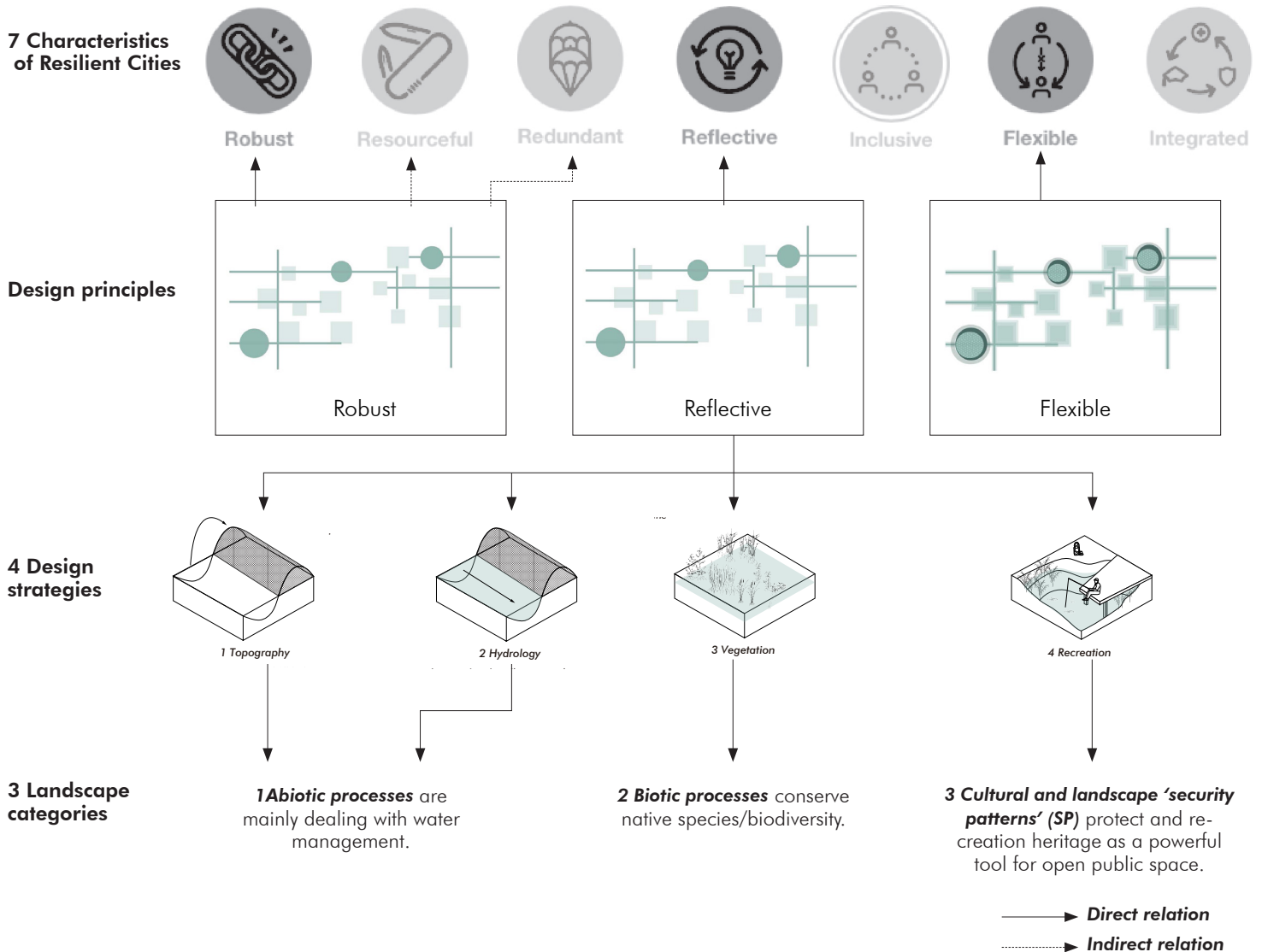
The pond adaptation will continue over time. The present peri-urban pond may one day incorporate into the new urban area. The ponds of the emerging cities will become the old urban areas, and the pond will change over time, preserving, deconstructing, reorganizing, and improving a solid foundation for future generations.

08 Design evaluation & reflection

08-1 Design evaluation

08-2 Reflection

08-1 DESIGN EVALUATION



This thesis is an example of treating the declining traditional water system as an opportunity for urban transformation, to mitigate the effects of flooding and drought, and to test it through two ponds under the scope of landscape architecture design, re-creation ponds as a valuable space for the public. Therefore, the seven characteristics from the 100resilient Cities and three landscape categories on which ecological infrastructure (EI) focuses. Mentioned in chapter 3 will be used as design evaluation criteria.

In the chapter on conceptual design, selecting three guiding characteristics: robust, reflective, and flexible and translating them into principles applicable to pond design, the following describes the evaluation.

Principle 1: Robust

In addition to establishing the pond network as a well-conceived system and a managed green and blue network. Robust includes recognizing alternative ways to use resources as well as water resources during droughts and floods which benefits Resourceful. To resolve too much water and too little water, the test models execute low-impact development. This is one of the strategies for moving toward Redundant features.

Principle 2: Reflective

Using experience to inform future decisions is a very important design idea in this thesis. Therefore, the test site is two ponds, corresponding to the three landscape categories of (EI) focuses, four design strategies are produced, namely topography, hydrology, vegetation, and recreation. In the process of transforming the pond from site preparation, dealing with water management and the use of local cultivation of water purification, and finally the preservation of the pond heritage into public space.

Principle 3: Flexible

The final design principle is arguably the ultimate goal of the thesis, producing alternative strategies in response to changing circumstances.

However, the interview part of this project, which attempts

to bring the ideas from the local pond managers, can be oriented towards Integrated features, Inclusive awareness of research for design, narrow down the focus of the issue, and implementation of tests after materializing the design principles and design strategies.

Taoyuan Pond City changes the structure to improve its chances of survival or of successfully raising the next generation.

08-2 REFLECTION

1 Reflecting through the process

1-1 The relationship between research and design

The project aims to propose a resilient model for the farm pond system in Taoyuan county. The two essential states play an important role in the project which are research and analysis.

In the research state, it is easily falling in the abundant database. On the other hand, working in the design stage helps to frame the specific scope and turn back to the research state for distilling the guidelines or adding analysis. The process of back and forth between research and design is consistent. None of these two can be excluded from the graduation project.

1-2 The limitation of the project

The design proposal is to enhance the farm pond system for mitigating the impact of climate change. The topic touches on the profession of water management such as the feasibility of flood prevention, water storage, and water purification. As a consequence, the practical case study helps to narrow the limitation with the profession of water management.

1-3 The Ethical Issues and Dilemmas encountered in doing the project

During the drought, the resource of water becomes sacred. The water ethical issues involved the distribution for industrial use, agricultural use, and domestic use. Once the water shortage happens, the current strategy is to stop irrigating and keep the water in the pond or reservoir for domestic use and industrial use. However, in terms of the ecological aspect, it will affect the ecological system in the farmland.

Moreover, the existing dilemmas between keeping good water quality and operating fish farming in the ponds. The approach of the future pond in the peri-urban area is a

model of the circular economy. Furthermore, the design also considered a synergy way of cooperating with fishers, farmers, and managers of ponds.

2 The relationship between project with studio CWS and landscape architecture

The studio of CWS offered various approaches in the landscape architecture of mainly working with water. Especially, the research of traditional water systems focuses on the context, landscape transformation, water system, circular diagram, and glossary which take water as the main element and learn the experience through the research. The water heritage includes tangible and intangible meaning. Due to the topography and hydrological environment's limitations, ancients dig the pond to store rainwater. Afterward, the system turns the individual ponds into more than ten thousand ponds connected with the canal system, all over the tableland; the high-density level is rare in the world. The farm pond system's value represents local characteristics and plays an essential role in regulating the ecological climate.

As a result, the graduation project distilled many traditional techniques to the design outcomes. It shows the link between the past, now, and future through landscape architecture interventions for solving the challenges and revealing the values. The traditional water research basically applied in the design principle of reflection.

In addition to traditional water systems research, the Lab conducted seminars on water related issues, such as watershape, which I was responsible for, after reading how to read the landscape and urbanism east, also included in my thesis for the design of pond pattern, to provide design methods and explore the relationship between water patterns and space.

3 Dealing with stress during the COVID-19 pandemic

Less chance to meet classmates causes the loss of motivation during working with the thesis. There are still many disadvantages to only meeting each other via zoom. When discussing the design with mentors, it is impossible to draw on the paper in scale which makes the discussion inefficient. Consequently, to keep high efficient rhythm at thesis work, one of the methods is trying to work in a different environment and keep taking a break in between.

In a severe environment, trying to find the best way to work, compared to the evolution of the pond, in severe dry and rainy weather, change patterns to adapt, I think people are also in this severe epidemic, life-changing ways continue to exist.

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