Reveal the Unseen:

Retrieving Sense of Place by Public Water Space based on the Former Irrigation System, Ksôkong Tsûn, in Kaohsiung, Taiwan.

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abstract
Industrialization and urbanization undoubtedly have brought many places prosperity. However, the fast-speed urbanization process in Asia results in the loss of local identity and flexibility to adapt to the increasing frequency of extreme climate catastrophes. By looking into the beginning of a city, oftentimes water plays a crucial role to initiate a society. However, the trace of water is usually long gone in many urbanized places. Former water systems are now covered with concrete to meet the increasing demand for space. As a result, the intimacy between people and water is rapidly fading away. Nevertheless, water could be the carrier to keep on telling stories of the place, create a sense of place, and abound with the landscape. Through understanding the former irrigation system, Ksókong Tsùn Irrigation System, in southern Taiwan, this design/research aims to establish landscape architecture design strategies and designs at the local scale to reform people-water relationships to flourish local identity and place attachment. The direction of this project is first to enhance people’s engagement with water by providing good quality public space to initiate an urban, daily, and recreational attachment with water. Therefore, a city’s identity is build up by both the space itself and every individual citizen’s attachment to it. Meanwhile, from designing several locations, a water network is expected to be created to assist the city to become resilient for future challenges.
content
From this point on, through Kôkkong Tsûn irrigation system, river water starts a
different journey on the land of Kaohsiung, intertwined with culture, art, economy and
memory, narrated a tale of the city
The life of people in Kaohsiung was once intimately bonded with water. However, the cityscape changed enormously due to socio-economic change both in the local and global scale. Water swiftly disappeared in people's daily life. The bond between people and water faded away as flood became a threat to people's lives. As extreme weather continues to bring devastation, confront climate change has become an inevitable fate to human. A water system that raised a city in such an extreme climatical condition brings value to the challenges humans are facing nowadays. For nearly two hundreds years, Ksôkong Tsûn Irrigation System has constantly provided water from Tâm-tsui-khe to the innercity of Kaohsiung. However, every challenge in the action adapting climate change also offers unique opportunities for a culture change. The battle against climate change presents opportunities to reveal the unseen value of the traditional water system and a possible living style between people and water.
PART I

Introduction

The beginning chapter tries to understand Kaohsiung from its historical background then looks deeply into the challenge it is facing nowadays. By understanding the development of the traditional water system - Ksióng Tiûn irrigation system- and the secession of the cityscape, the project proposes several research questions to set the foundation for later process.
1.1 A City Raised by Water
1.2 Secession of Cityscape
1.3 Problem Statement
1.4 Research Question
1.5 Project Objective and Action Plan
A City Raised by Water

Kaohsiung’s Geographical and Climatic Context

Located in the southern Taiwan, Kaohsiung is the political and economic centre of southern Taiwan. The growth of Kaohsiung is closely related to its irrigation system development. Ksôkong Tsûn irrigation system is a traditional agriculture purpose water management and irrigation system. It was constructed under the circumstance of steep geography and tropical savanna climate.

The island of Taiwan was formed approximately 4 to 5 million years ago at a complex convergent boundary between the Philippine Sea Plate and the Eurasian Plate. Located on the Circum-Pacific belt, which is a major area in the basin of the Pacific Ocean where many earthquakes and volcanic eruptions occur. Therefore, watershed of rivers are vertically steep. The watershed of Ko-pin-khe river, where Ksôkong Tsûn irrigation system obtains water from, also falls into this criteria above.
Southern Taiwan belongs to Tropical Savanna Climate with Dry-Winter Characteristics (Köppen climate classification), and falls into the frequent typhoon zone. The rain-dry season is clearly apart. High slope and concentrated rain season bring redundant and rapid rainfall in the summer, and lack of water resources during the winter.

Climate zone: Tropical
Sub-climate: Tropical Savanna Climate
with dry-winter characteristics

**Climate & Weather Averages**
- High t°: 32.4°C
- Low t°: 15.7°C
- Mean t°: 25.1°C
- Precipitation: 15.6mm
- Humidity: 75.9%
- Dew point: 20°C
- Wind: 7.56-9.36 km/h
- Pressure: 1012.0 mbar
- Visibility: 8 km
- Hottest Month: July (29.2°C avg)
- Coldest Month: January (19.3°C avg)
- Wettest Month: August (416.7 mm avg)
- Windiest Month: July (12 km/h avg)
- Annual Rainfall: 1884.9 mm per year

**Fig. Rain Distribution in driest and wettest month (monthly average rainfall).** Left: January, Right: August.

**Fig. Regional Scale**
The Ksûkong Tsûn irrigation system located in the most populated area of Kaohsiung.
A City Raised by Water

Development of Ksökong Tsùn Irrigation System

The Ksökong Tsùn irrigation system was the solution for an uneven distribution of water resources in Kaohsiung. Water retention ponds (陂, called Pi in Taiwanese) were dug out to reserve water before a systematic intervention. In 1837, the Ksökong Tsùn irrigation system transferred water from a east side river, Ko-pîn-khe 高屏溪, in order to start weaving a water web in Kaohsiung and the process continued expanding until the last canal was completed in 1931.

Fig. Spatial development order of Ksökong Tsùn irrigation system
1842/
Second branch of Kôkông Kû Tsûn irrigation system:
Kôkông Sin Tsûn (曹公新圳)

1931/
Third branch of Kôkông Kû Tsûn irrigation system:
Tuâ-liâu Tsûn (大寮圳) & Lim-hâg Tsûn (林園圳)

Present/
Many water ways were covered and became a part of city sewage system due to urban development.
The connection between land and people was once profound and unbreakable, especially in the agricultural society before modernization. At the time, people lived closely with the landscape that intertwined by water and fields and constituted a complex living lifestyle consisting of several social and cultural aspects.

From food yield, settlement arrangement, daily leisure and religious beliefs, ways of living evolved intensely around the landscape. Water from river Ko-pin-khe is obtained by a dam, regulated using inlets, directed through ditches, then transported to irrigate rice fields, following natural topography onsite, weaved a aquatic landscape to flourish food production.

Besides the rice fields, Water plants production such as taros and water chestnuts, were located in the water retention. These agriculture production, together with aquaculture, formed a circular system that supported one another. On the landscape, Ksô-kong irrigation system accommodated a variety of human activities. At the time people were close to water, scenes like women doing laundry and socializing by the water, children playing in the field, and men fishing on the edge of waterways were common on daily basis.
I. Introduction

An artificial water retention that is based on the naturally formed pond according to land topography. The retention was used for drinking and irrigational use. Small ones are called "Ti池", larger ones are called "Pi陂".

A linear obstacle built perpendicular to a river to guide and direct water to the river water inlet for irrigation ditch.

A gate element that can control the amount of irrigation water intake. During typhoon season, the gate can be closed to protect crops from flooding.

A open waterway that provides clean fresh water for drinking and irrigational use. Small ones are called “Kau溝”, big ones are called “Tsün圳”.

Water gate that regulates water between irrigation ditch.

An artificial water retention that based on the naturally formed pond according to land topography. The retention was used for drinking and irrigational use. Small ones are called “Ti池”, larger ones are called “Pi陂”.

Fig. Glossary of water works that consist Kiok Kong Tsün Irrigation System
A City Raised by Water

The Ksôkong Tsùn irrigation system consists of four types of elements: dam, inlet, waterway, water retention pond.

**fig. Dam**
Water from river Ko-pin-khe is obtained by a dam made of bamboo and onsite materials, then directed water to the river water inlet for irrigation ditches in the city. (source: National Taiwan University Library)

**fig. Lotus Pond (Renchitan)**
Lotus pond is located by the old walled city, Zuoying, of Kaohsiung. It is an artificial water retention that based on the naturally formed pond according to land topography. (source: 1915 《臺灣寫真帖》第1卷第5期)

**fig. Ksôkong Tsùn-thâu**
The water inlet that worked as a gate made of bricks and wood panels. It controlled the amount of irrigation water intake. (source: 《臺灣回想1895-1945 Taiwan Recollected})
I. Introduction

Fig. Ksôkong Tsùn-thâu
The water inlet that worked as a gate made of bricks and wood panels. It controlled the amount of irrigation water intake. (source: 《臺灣回想》1895-1945)

Fig. Moat by old walled city Zuoying
Segments of the waterway near the old city wall were used as a defense system. (source: Kaohsiung Museum of History)

Fig. 9. farmers used manual powered watermill to obtain water from a water way (source: 1935《農業用揚水機》森周六著)

Fig. Transitional usage of Lāi-ûi Pi
The usage of Lāi-ûi Pi underwent a tremendous transformation. From serving water for agriculture field, it then became a storage for wood industry (shown at bottom right corner on the image above). The location of former Lāi-ûi Pi is now Kaohsiung Museum of Fine Arts. (source: Kaohsiung Museum of History, photo by 董青藍)
A City Raised by Water

The Prosperity Brought by Water and the turning point set by Urban planning

The formation of water networks that consists of canals and ponds contributed to the establishment of agricultural production to 16000 hectares at the time. The agriculture productivity of Kaohsiung was improved from being weather-dependent to a stable two-yield-per-year. Therefore, the establishment of steady agriculture commerce consequently set the foundation for economic growth and accelerated the industrialization process.

The port of Kaohsiung, historically referred to as the Takau Port, was a natural lagoon before eventually developed into a modern harbor over several hundred years since the 16th century. However, not until the beginning of 1900, under Japanese ruling, Takau port was transformed into a modern harbor.

The development of agriculture and the modernization of Kaohsiung Port have both accelerated Kaohsiung’s urban development. Consequently, the growing demand for space caused waterways and ponds covered to meet the need. Therefore water is hardly present in citizens’ daily life.

Fig. Historical images of Kaohsiung
- left: 1898-1904 Taiwan Topographic Map 《臺灣堡圖》 is a topographic map completed in 1904 during the Japanese era. (source: Center for GIS, RCHSS, Taiwan)
- middle: 1936 Grand Kaohsiung Urban Plan 《大高雄都市計畫》 - Since Taiwan’s Japanese era, urban development in Kaohsiung has been attached to its harbor’s development. The city took its harbor as a center, following the railway system to spread to the suburban. (source: Center for GIS, RCHSS, Taiwan)
- right: 1945 TAKAO-SHU, FORMOSA (TAIWAN) 《After fifty years of Japanese ruling, Kaohsiung was transformed from traditional settlement to a modern city. (source: National Archives and Records Administration, NARA, USA)
Fig. Historical images of Kaohsiung (from left to right)

- Formosan Sugar Worker. (source: the Takow Club)
- Businessman and woman in pineapple field. (source: National Taiwan University Library)
- An 1859 illustration of a sugar godown in south Formosa. (source: London News in 1859, Wikimedia Commons)
- A man in sugar cane field. (source: National Taiwan University Library)
- 1910 postcard of pineapple field. (source: National Taiwan University Library)
- 1867 Takao Port. (source: Wikimedia Commons)
Secession of Cityscape

the disappearing waterways and the lost intimacy between people and water

The fast economy boom resulted in the urbanization of Kaohsiung. As households and factories swiftly replaced agricultural fields along the waterway, black water was directly discharged into the canals. Ksôkong Tsûn Irrigation System once was a source of clean water but became a sewage discharge. Moreover, due to the growing demand for spaces, canals and ponds were ultimately covered especially in the city center.

Although the increasing environmental awareness and separation between rainwater and sewage system improved water quality, however, the disappearing of ponds and covered canals result in a decrease area of water runoff and causes the flood-prone area to increase. Kaohsiung is one of the cities in Taiwan that suffer from a high frequency of flooding, thus a landscape architecture intervention could be implanted to alter the situation.

Water profile transition

In the past, people obtained clean water to grow food and lived close to water. After the industrialization, agriculture fields became factories and residential housing, sewage water was discharged into the waterways. Now, the city is even more developed, but the waterways can no longer be seen. Oftentimes, they are underneath the road. Therefore, when the storms come, flooding occurs.

The altering relationship between people with water

Apart from the physical transition, we can also see the change in the relationship between people and water. When the waterways were used to transport fresh river water, people used to be intimate with the water and interacted with the water. But after the water quality decrease, the space near the waterways became the ‘drak area’ that people avoided going. People lost their intimate attachment to water. In the present day, the image of water is often related to flooding. The fear of flood is rooted in citizen’s minds.
I. introduction

Fig. water profile transition and people-water relationship shift from time to time

intimate
distant
fear
**Problem Statement**

Concluded from water profile transition and the swift relationship between people and water, two problem statements can be drawn down:

1. the separation between people and water
2. a banal cityscape and the loss of the city's identity

**The separation between people and water**

The separation between people and water is both physically and mentally. The fear of flooding has been rooted in the citizens’ minds for a long time, therefore it resulted in physical obstacles built to separate people and water. The concrete embankments, gigantic water gate, massive dikes...ect. The lifestyle of citizens has been blocked away from being near to water, after all, water is hardly present in daily life and people are no longer close to water.

These barrier structures are a common scene in many cities in Taiwan. The figures on the right are street views located in Taipei: (1) It shows a road stays alongside a branch stream but blocked by a 4-meter concrete dike with no sitting or viewing area. (2) In a busy area in the inner city, due to a massive dike, a water gate is constructed to be closed in an emergency of a river flood. It poses a great barrier to the access waterfront. (3) The waterfront with the concrete embankment allows no activities to happen alongside. (4) Dikes by the water create visual obstacles for passersby and damage city images.

For a long time, citizens have to live with an unfavorable condition of public space. In a packed city without a chance to see, to be close to, or to embrace the waterfront, the city becomes even more sophisticated.

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**Fig. barriers of water (top to bottom)**

source: googlemap street view

- a branch stream blocked by a 4-meter concrete dike
- a water gate on a massive dike
- waterfront with concrete embankment
- dikes as visual obstacles
Banal cityscape and the loss of the city’s identity

Secondly, the fast urbanized process violently wiped out the historical pattern. Kaohsiung is no different than other grid-based cityscapes. The time-tested water system provided not only agricultural use but also social public space as a unique heritage pattern. With concrete covered most of the waterways in the city center, a banal cityscape and the loss of the city’s identity can be easily seen.

Fig. Grid cityscape of Kaohsiung
(source: arthur)
Research Questions

Main Question:

How to enhance city’s identity of Kaohsiung, Taiwan by

1. taking water as the main role to provoke site-specificity?
2. strengthening people’s relationship with water through urban water public space?

Sub-questions:

(1) How did the water system work in the past and what did it impact on the change of cityscape?

(2) Through social-economic change, how did the water system shift to the present condition? Due to the change of the water system, how was the relationship between people and water from then to now?

(3) How can water take the role of social connector in a project?

(4) Which pattern of public spaces related to water could work best in nowadays Kaohsiung as means of creating more place attachment and solving water problems?

(5) What is the meaning of water for the citizens of nowadays Kaohsiung?

(6) Where and how could the former irrigation system of Ksökong Tsûn be enhanced and used as a base for a new design for Kaohsiung, Taiwan? Should it be restored (and where)?

(7) Is the memory of it still present and being able to recover the identity of the place in relation to water?
Project Objectives and Action Plan

Water could be the carrier to keep on telling stories of the place, creates a sense of place, forms a bond between people with the landscape. Through using the former irrigation system, Ksôkong Tsûn irrigation system in southern Taiwan as a base, this design/research aims to establish landscape architecture design strategies and designs at a local scale to reform people-water relationships to flourish local identity and place attachment.

The direction of this project is first to enhance people’s engagement with water by providing good quality public space to initiate an urban, daily, and recreational attachment with water. Therefore, a city’s identity is build up by both the space itself and every individual citizen’s attachment. Meanwhile, from designing several locations using the Ksôkong Tsûn irrigation system as a base or inspiration, a water network is expected to be created to assist the city to become resilient for future challenges.

Fig. Action plan - Four phases

<table>
<thead>
<tr>
<th>Traditional water system</th>
<th>New design</th>
<th>New meaning</th>
<th>Shape the identity</th>
</tr>
</thead>
</table>

Initiation Phase

Bonding Phase

Weaving Phase

Final Phase

People’s engagement and environmental awareness trigger other locations to transform. Water web realization

City identity strengthen
After acknowledging the background of Kaohsiung and its close relationship with Ksōkong Tsùn irrigation system, this chapter determines a research methodology to conduct the project. Inspired by Christopher Alexander’s *A Timeless Way of Buildings* and *A Pattern Language*, this project anticipates generating a set of principals for designing water spaces in Kaohsiung based on the knowledge relevant to its traditional water system. The proposed method will establish further design processes and decisions.

**PART II**

**methodology**

*After acknowledging the background of Kaohsiung and its close relationship with Ksōkong Tsùn irrigation system, this chapter determines a research methodology to conduct the project. Inspired by Christopher Alexander’s *A Timeless Way of Buildings* and *A Pattern Language*, this project anticipates generating a set of principals for designing water spaces in Kaohsiung based on the knowledge relevant to its traditional water system. The proposed method will establish further design processes and decisions.*
2.1 Theoretical Framework
2.2 Research Framework
2.3 Pattern Language
2.4 Implication towards design
When defining place as a ‘meaningful location’, Tim Cresswell references from the political authenticity. and to retrieve the well-being of citizens is perhaps by the means of accentuating a city’s conceptualizing a characteristic, meaningful, expressive, and soulful place (Relph, 1976). Many cities in Taiwan fit in the depiction mentioned above, as well as many other cities in the world.

As citizens anchored their home in the cities, their mental reflection towards the city should be well considered apart from the urban physical appearance. In The Image of City, Lynch’s study about the city’s legibility indicates the fact that mobile animals using a variety of sensory cues to identify the environment in order to survive is also applicable to man (Lynch, 1997). Even so, in a conventional cityscape, sensory cues were diminished in a fast pace of development, especially the ones that resonate with the past. Therefore, Living and moving around in a traceless city without way-finding devices: smart phones, maps, street numbers, signs, citizens can easily be lost in the environment. Furthermore, he states, “It is closely related to our sense of balance and wellbeing. The word ‘lost’ in our language means much more than geographical uncertainty; it carries overtone of utter disaster.” (Lynch, 1997). The loss of legibility of a city is beyond geographical disorientation, and brings emotional misery to the life of habitants. Therefore, under the current modernization and globalization, the phenomenon of morphological transition of a city should be seen as a multidimensional issue in order to revive characteristics of cities.

/Being lost in a traceless city/

The process of modernization in Asia resulted in rapid urbanization and brought landscape morphology change in a short period of time. Oftentimes, urban spaces did not have time to adapt to the ever-changing social-economical transition with a well-planned spatial strategy. The expansion demand of space led to a featureless cityscape with grid road system and asphalt pavement. Historical traces are overlooked, covered, even wiped out. Cities have lost their character to development, bit by bit, they look no different from one to another. Moreover, mass communication, increased mobility and a consumer society has reinforced homogenization of the world (Relph, 1976). Many cities in Taiwan fit in the depiction mentioned above, as well as many other cities in the world.

David Harvey takes an example from anthropologist Keith Basso(1984)’s study of the Western Apache to reveal evidence that the bond between people and their habitat could establish values beyond their existences. He writes, “the permanence of places in the landscape, coupled with stories told about those places, provides a means to perpetuate a cultural identity: Apaches view the landscape as the repository of distilled wisdom, a stern but benevolent keeper of tradition, an ever-vigilant ally in the efforts of individuals and who communities to put into practice a set of standards for social living that are uniquely and distinctively their own. In the world that the Western Apache have constituted for themselves, features of the landscape have become symbols of and for this way of living, the symbols of a culture and the enduring moral character of its people.”(Harvey, 2007). The Apache case indicates that a relationship between people and their living environment is strengthened through stories that pass on generation to generation; landscape features are exceeded far beyond its physical setting and become a symbol of representative identity. A means to preserve cultural identity through landscape and narrative has clearly emerged. A way to retrieve a place’s authenticity is seemingly established through “reappearance of a landscape symbol” and “re-narrative the stories of the habitants”.

/Retrieving authenticity/

In modern study, the notion of place is highly associated with the key term “authenticity”, a term that geographers interpret from Heidegger’s thinking, when it comes to conceptualizing a characteristic, meaningful, expressive, and soulful place (Relph 1976, Harvey 2007). In the flow of urbanization, to resist the likeness among featureless cities and to retrieve the well-being of citizens is perhaps by the means of accentuating a city’s authenticity. When defining place as a ‘meaningful location’, Tim Cresswell references from the political geographer John Agnew (1987), he outlined three fundamental aspects: location, locale, and sense of place. Since most of the places have fixed objective coordination on earth surface, unless it is a moving object containing a void like ship or plane. To make a location meaningful, it is determined on the latter two aspects. By ‘locale’, Agnew means the material setting for social relations, the actual shape of place within which people conduct their lives as individuals; By ‘sense of place’, Agnew means the subjective and emotional attachment people have to place (Cresswell, 2004). From these two aspects, it is evident that through interaction and connection, human’s role is an essential entity when it comes to forming a meaningful place, therefore, to examine the relationship between people and the location becomes a crucial key to awake a soulless city.

/Reappearance of landscape/

In the global flows, a landscape with abundant stories is instead covered underneath the asphalt and concrete, becoming a tale that sank into obscurity. With the process of modernization, capital accumulation, and spatial integration, particular territorialized markers of cultural identity were destroyed (Harvy, 2007), the intimacy between people and the environment swiftly faded, at last, authentic places eroded to placelessness (Relph, 1976). Taiwanese writer Haimeng Xie (2017) writes about the waterways’ tragic
under the current modernization and globalization, the phenomenon of morphological transition of a city should be seen as a multidimensional issue in order to revive characteristics of cities.

“...

A way to retrieve a place’s authenticity is seemingly established through “reappearance of a landscape symbol” and “re-narrative the stories of the habitants”.

”
If the landscape elements are gradually buried to ground, what medium should people anchor themselves to regain affection toward the surrounding? "By reviving a sense of place," Heideggerians say, "we may be able to reactivate the care of the environment." (Harvey, 2009). A top-down and bottom-up cooperation project “Wenshan Oasis” was then performed to re-act on the loss caused by urbanization in Taipei. Wenshan Oasis takes advantage of urban regeneration to implement features of historical waterways back to the place, and make reappearance of the former landscape in Taipei. After cleaning the environment, the region successfully draws people's attention and gathers public awareness of their living place. It surely resonated with David Harvey’s (2009) statement: “reawakened sense of beauty of local places may fuel a deeply spiritual concern for the preservation of the environment. It surely resonated with David Harvey’s (2009) statement: “reawakened sense of beauty of local places may fuel a deeply spiritual concern for the preservation of the environment.”

The purpose of spatial intervention is to reveal and enhance the characters potentially present in the given environment (Norberg-Schulz, 1979). Making re-appearance of the landscape could enforce the bond between people with the environment and create experience, memory, and narrative of their own. Yet it does not mean to replicate an identical space but to protect and conserve the genius loci, in fact, to concretize its essence in ever new historical contexts (Norberg-Schulz, 1979).

/Re-narrative towards a prospect future/

From multiple precedent studies, “place” is indisputably a complexity beyond a physical location, and has provoked various abstract values that accentuates the essence of human existence (Cresswell, 2004). People have a dispensable role in defining a place, as human action constantly explores new possibilities and potentialities of a place’s character (Harvey, 2007). With human’s existence, a timeline unfolded, a space becomes a place that accommodates the living of people from past, present to future. The action of retrieving a sense of place builds up a passage from past to future, memory to hope. (Gordon, 1995; Harvey, 2007) Therefore, flowing freely through the passage, the daily routine of an individual’s ‘place-ballet’ (Seamone, 1980) is then choreographed to a narrative of its own.

Being intangible and abstract, narrative requires a concrete entity to be held. A place and the narrative it triggered are codependent to keep on surviving through time as a weave where one strand ties in another (Hayden 1995, 18). As Edward Casey (1987, 186-187) clearly put it in words: “It is the stabilizing persistence of place as a container of experiences that contributes so powerfully to its intrinsic memorability. An alert and an alive memory connects spontaneously with place, finding in it features that favor and parallel its own activities.” Through the production of place, memories can be constituted. There are numerous ways of placing memory, monuments, museums, plaques or preservation of buildings (Cresswell, 2004). However, within a concrete inflexible void, how to vividly narrative a living tradition?

A habitat for memories of past, experience of present, and hopes of future, should be constructed in a flexible and subtle way like an intertidal zone, possessing a gradient of salt and water, that shelters a wide range of co-living creatures. An interactive landscape that accommodates a variety of experiences and narrative, even “provokes those who experience them to be more aware of how their actions affect the environment, and to care enough to make changes in their action.” (Meyer, 2015). An action that will expand a prospect’s dimension of time and intrinsic narrative of place should be the designated approach of production of space.
A way to retrieve a place’s authenticity is seemingly established through “reappearance of a landscape symbol” and “re-narrative the stories of the habitants”.

“

It is the stabilizing persistence of place as a container of experiences that contributes so powerfully to its intrinsic memorability. An alert and alive memory connects spontaneously with place, finding in it features that favor and parallel its own activities. — Edward Casey.
In the time of contemporary decay of aura (Benjamin, 2010), the loss of authenticity results in placelessness around the global. Yet, place is a fundamental matrix of history, culture, and everything that makes a profound living surrounding. This literature review on the notion of place set a fundamental and comprehensive base for design intervention to develop on. A question of space can only be answered through spatial means. To retrieve the unseen essence of a place and “respect the genius loci is” says Norberg-Schulz, “to determine the identity of the place and to interpret it in ever new ways by relating it to a set of locally founded parameters. Only then may we talk about a living tradition which makes change meaningful” (Norberg-Schulz, 1979). Through reconstructing three fundamental aspects: place, people, and narrative, a ballet in space and time is therefore choreographed to “reveal the unseen”.
Reference


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Research framework

To respect the genius loci "means to determine the identity of the place and to interpret it in ever new ways. Only then may we talk about a living tradition which makes change meaningful by relating it to a set of locally founded parameters." (Norberg-Schulz, 1979)

Inspired by the books conducted by Christopher Alexander, <The Timeless Way of Building> and <A Pattern Language>, this project tries to use patterns as a tool to gain a database of quality elements that construct a good public space. The research attempts to construct an initiative <Pattern language for water public space in Kaohsiung>. Through the collected patterns and the newly generated patterns, the project abstract the onsite observation and case study to seize the essential elements of authenticity, then localize into the design and program in the project. This swift between "design by research" and "research by design" weaves a complex project altogether.

/ Design by research:
Using literature review, on-site visit, mapping, precedent study, case study, and pattern language to direct design decisions. The research framework is constructed by three branches of methods: inspiration from the traditional water system, identifying local context and problem field, and, forming a typology database of case studies. First, to understand how the irrigation system works and what was the relationship between people and water by precedent study and site visits. Then, through mapping the transition of the irrigation system, to understand how the social-economic change affected the morphology of KsÔkong Tsün Irrigation System. Zooming into the irrigation system itself, to clarify the current condition of the water that runs through KsÔkong Tsün Irrigation System is a crucial step for determining different water spaces to be implanted along different segments to enhance social interactions.

/ Research by design:
Concerning complex environmental challenges, oftentimes the practitioner is confronted with changing conditions and shifting programs. A design approach can be adaptive to this uncertainty and complex condition. It makes creative jumps in thinking and solving possible. Through research by design, this project will explore the gradients of interaction between water and urban landscape, the possibilities of using water to create place attachment, and mitigation of flood.
II. Methodology

Constructing Object Methodology and Time Frame

Understanding Situation in the Past

Traditional Water System Study
Cao-Gong Irrigation System

Cao-Gong Irrigation System ↔ People

Mapping: Transition Timeline and Pattern
Precedent Study
On-site Visit

Understanding Present Site Condition and Local Users

Identify Problem Field

Site Kashiing ↔ People

Mapping: Urban Tissue
Precedent Study
On-site Visit

Interview Questionnaire
Community Map

Selecting of Initiated Design Sites

Application of Initiated Design

Reflection of Initiated Design

Intervention Strategies Principal

Explore Possible Solution

Criteria Setting

Case Study

Mapping Literature Review
Precedent Study
On-site Visit

Patterns

Eurasia: Rotterdam, The Netherlands, Amsterdam, the Netherlands, Berlin, Germany
Asia: Korea, Japan, Shanghai, Shanghai, China

What are the motives to learn from elsewhere that:
1. How good water/place qualities in an urbanised area.
2. Are under the same condition of exist former irrigation system due to fast urbanization.

To form a structural database for later design use?
Pattern Language

<pattern language for water public space in Kaohsiung>

The research of constructing an initiative <pattern language for water public space in Kaohsiung> consists of four sources of patterns, each of those can fit in a scaled category ranging from 0.6m (a length of a person’s shoulder, object scale) to 6000m (town scale) and relate to the goals of the project:

1. <strong>onsite observation</strong>: by visiting the current Ksôkong Tsûn Irrigation System, both the renovated segment and the remain uncovered segments, several notable patterns can be taken into account. (a space that either self-built by locals, or by the previous renovation design team but has been well used by locals)

2. <strong>literature review</strong>: the well studied and tested patterns from <A Timeless way of Building>, <A Pattern Language> by Alexander Christopher

3. <strong>case study and visit</strong>: first understanding five cities, both Asia and Europe, and their water system, then visit the city to obtain patterns by onsite observation.

4. <strong>Research by design</strong>: By refining and applying the patterns provided above onto the later landscape architecture design, it becomes a set of digestive patterns tested by design process. When constructing <pattern language for water public space in Kaohsiung>, within each pattern, it has to meet with at least one of the goal of the project’s objective, which was set up through the process of project problem statement and site analysis, the details will be explained in the next chapter:

- **security**/
a space that adapt flooding water, provide safety feeling while being close to water

- **symbolism**/
enhance water image in urban environment or enhance historical related image by water space

- **amenity**/
enhance experience with water public space by improve water quality, enhance local ecology, and other means

- **livability**/
provide daily function to the locals which makes the space sustainable in usage

- **connectivity**/
connect other existing public space or public transportation hub
II. Methodology

1. Onsite Observation: Local Patterns
2. Literature Review: Pattern Language
3. Case Study

Research by Design

Object 0.6m x 0.6m
Element 6m x 6m
Place 60m x 60m
Neighborhood 600m x 600m
Town 6000m x 6000m

Amenity, improve water quality
Symbolism, enhance sense of place
Security, defensible space
Connectivity, accessible walks
Livability, provide daily function

Many groups
Group of groups
Group of groups of groups
Object of groups

II. methodology // 39
Patterns from the untouched segment:
Most of the untouched and uncovered segments of the Ksôkong Tsûn Irrigation System are located in the suburb area, close to the source of its obtained water, Kaoping River. Some of these segments are still in use for agriculture irrigation, some become a sewage discharge. Even those parts of the Ksôkong Tsûn Irrigation System had changed from time to time, some space by the waterfront has adapted the new way of usage and transformed by the locals. These spatial qualities provide important insight and value of bottom-up waterfront spaces.

Pattern #L-1 | ●
A balcony hover over water

A balcony hover over water with sitting benches on the edge. Provide a close overlooking area for users to view water. It is located at an intersection of two waterways which provide a scenic view of a vanishing point with the action of water running.

A bridge and well-grown vegetation gives it an intimate feeling of the space. The area is around 10x5m, it provides a good location for both individual staying and small community gatherings.
When walking between two waterways, the feeling of yourself surrounded by water gives you a floating perception with water, a drifting action. A smaller scale of this situation also occurs at the border between two fields.

The water level difference created by two different waterways caused a sudden fall of water through a regulation watergate. The sudden fall of water creates a natural sound of rapid water and gives an atmosphere of wild surroundings. Therefore, walking along the path, the sound of water makes it a unique experience.
Pattern language:
onsite observation - local patterns (L)

Patterns from the renovated segment:
The renovated segment of the Ksôkong Tsùn Irrigation System is located in the historical part of Kaohsiung city. It was transformed in 2008. At the time, the construction was aimed to complete the sewage collection system to avoid polluted water directed discharge into the waterways and to provide a pleasant waterfront for the locals. After a decade, some part of the waterfront is more popular than the others, and some part of it is transformed into something else by the locals. Therefore, an onsite observation helps to identify the essence of a good water public space quality through a lens of Pattern Language.

Pattern #L-4 | ●
Materials of embankment which help micro ecososystem to form

Several types of waterway embankment can be found on site. Mainly using different stone arrangement to create a variety of waterfront. By a vertical pile of stones, an earth ramp with horizontal scattered stones or even using an iconic local material, coral stone, all these methods above create some gaps in between that allow fauna to grow.

Pattern #L-5 | ●
Space to stay by the water
the renovated segments of Ksôkong Tsùn Irrigation System provide several types of space to stay near the water. One is to extend a plane alongside the waterway and provide a wider view for the users. the other one is simply providing stairs for users to approach to water, in this way, the view is restricted but offers a closure feeling.

A surprising self-built community garden sits right next to a waterway. It shows the interest of locals participating in gardening. It gives the waterfront a touch of the local spirit.

The form of linear waterway transformed at the end to a round surface, a pond, with water lilies dotting on top. Along the round surface edge, steps are created to invite people to approach and creates a square surrounding the water. There is a kiosk by the side, which offers a place for people to gather or simply viewing water. The view gives a picturesque perspective.
Pattern language:

case study - images of cities

There are places around the world that share the same destiny of losing people’s bond with water. People’s attitude towards water varies from place to place, therefore, it results in distinctive cohabitation pattern and specific narration with water in different societies. By means of case studies in both Europe and Asia, this project intended to formulate case study database of irrigation system transformation. Cases are selected to focus on the places that either has good water space quality in both urbanized and rural area or undertakes the same condition of losing former irrigation system in both Asian and European background.

/Asia
By the fact that Taiwan shares cultural similarity with Japan due to fifty-year Japanese colonization at the beginning of the twentieth century, some of Japan’s successful experience with water is insightful to learn from. For example, the canals in Yanagawa city was restored in the 90s and reinforced the losing connection between people and water through community participation and tourism. Biwako Sosui Canal runs through the historical Kyoto and becomes a part of citizens’ daily scenery as well as international tourist.

/Europe
In Europe, the concept of living with nature is taking the main trend in many water-related disciplines. Undoubtedly, in the Netherlands, people have constantly been handling water and contributed the practice and wisdom to water-related fields. In Rotterdam, public space along the Singels is now leisure space for citizens’ daily activity. In Apeldorn, water features are considered on the road profile as a symbol of the Grift. In Zürich, Bachkonzept brought back numerous stream to dayling, now the city streams run through the city and acts as a vivid character through different interact methods with the locals.

By looking closely through these case study cities, some of the patterns could be considered for Kaohsiung when developing a good water public space.
### Pattern language

**case study - images of cities**

<table>
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<tr>
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<tr>
<td>nowadays usage/ tourism, ecology, city image</td>
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II. methodology

/Singel/Rotterdam, the Netherlands.

- 1800s
  ▼ 1829
  ● 2007-2020

/Bitwako Sosui Canal/ Kyoto, Japan.

- 1885-
  ▼ 1951
  ● 1970-1996
  ▲ 2018

/Biturin/ Zürich, Switzerland.

- 1850s-
  ▼ 1900-1950s
  ● 1988-

Background: to solve water quality and hygienic problems due to growing populations during city expansion. Original purpose of usage: separation between surface water and sewage water, provide leisure public space. Nowadays usage: provide leisure public space.

Background: to boost city economy and development. Original usage: hydroelectricity, industry, transportation, gardening, drinking water, fireproof. Nowadays usage: hydroelectricity, garden, drinking water, fireproof, tourism.

Background: natural stream flowed directly down from the slopes of Uetliberg, Käferberg, Zürichberg and Adlisberg into Lake Zürich and into the rivers Limmat, Sihl and Glatt. Original usage: natural stream. Nowadays usage: flood protection, water cleaning, provide leisure public space.
Rotterdam

/ from city canal to the singels

The Water project is a project from the 19th century to provide the city of Rotterdam with clean surface water. The first plan was designed in 1841 by Rotterdam city architect Willem Nicolaas Rose in collaboration with Jan Arent Scholten of the Schieland Water Board. The Water Project dates from the time when the water in the canals and canals of Rotterdam had three functions: drainage of rainwater and household waste water, landfill of waste, source of drinking water.

The singles were decorated by landscape architects Jan David Zocher and Louis Paul Zocher, and formed an attractive living environment for the upper layers of the Rotterdam population.

The design of 1841 was considered too expensive by the Rotterdam city council, so it was decided to implement only the western part. When cholera continued to break out in the following years, it was decided in 1854 to implement a revised plan for the entire area. Around the city, a waterway was realised, and the space in between was filled with housing. This waterway ‘Singel’ used the difference in ground water level. Clean, fresh water from the river Maas was directed into the Singel. Two steam-driven pumping-stations where used to pump the unclean water out, to the Maas. This Singel was not only used for water management, but it was also a green recreational route.

The name Rotterdam was first mentioned in 1283, when a small tract of reclaimed land was created by draining the mouth of the Rotte River (another distributary in the Rhine River delta). Rotterdam developed as a fishing village and was chartered in 1328. In 1340 the town received permission to dig a canal to the Schie (another tributary of the New Meuse River), and it became the major port of the province.

Rotterdam grew considerably in the 19th century. It went so well economically that this caused major problems. The waste disposal system was also overloaded. Most houses and industries increasingly dumped their waste and droppings directly into the city canals and ditches. The stench of the dirty stagnant water could be smelled for miles outside the city and the use of this polluted water as drinking water caused the cholera disease to regularly break out in Rotterdam.

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The Water Project significantly improved the quality of the surface water in Rotterdam and also reduced the odor. However, the cholera outbreak problem was not fully resolved. That is why the Municipal Drinking Water Pipeline Rotterdam was established in 1870 and in 1883 the construction of municipal sewers was started.
fig. Water project (1854)
Pattern language

case study - images of cities

Apeldoorn
/rethinking the Grift

The Grift is a watercourse on the Veluwe in the Dutch province of Gelderland, running from Ugchelen through the center of Apeldoorn, to the IJssel near Hattem. The Grift is the main stream on the eastern flank of the Veluwe, presumably founded in the 14th century and was and is being fed by the other streams and spits, such as the Eendrachtsprengen and the Koningsbeek.

source | Municipality of Apeldoorn

It was built in the Middle Ages, probably in the 14th century. The Grift was originally used for dewatering land between the IJssel and places such as Apeldoorn, Vassen, Emst and Epe, so that they became suitable for agriculture and animal husbandry.

Originally, the Grift fed a number of water mills in Apeldoorn. The Grift was later used for the oil and copper mill industry and the many laundries.

Finally, in 1829, parallel to the Grift (in some places even barely a dozen meters next to it) a new dug navigable canal was completed, the Apeldoorns Kanaal. The Grift has since ended in Heerde. In the built-up area of Apeldoorn. With the disappearance of oil and copper mill industries, the Grift also largely disappeared underground. After the demolition of the water mills, large parts of the stream disappeared in tubes under the road surface. Overall, the Grift between the railway line and the Anklaarseweg had disappeared. The main sewer of the city has been laid underground on those parts of the route.

Parts were opened again at the beginning of the twenty-first century, such as in the city center and along Vlijtseweg. On September 15, 2008, the renewed Grift flowing through large parts of the city was officially opened by State Secretary Tineke Huizinga (Transport, Public Works and Water Management). However, about 3.5 kilometers still had to be brought above the ground. In March 2012, the section along Beurtvaartstraat was officially delivered.

In April 2009 the municipality of Apeldoorn announced that the brook prick (a rare jaw-less fish) had been spotted in the Grift, which would indicate a healthy aquatic environment. In 2012, the pike was again spotted in the center of Apeldoorn.

Water makes the city cooler, provides more nature, more water collection in heavy rain and makes the city more attractive.

\[ 50 // Reveal the Unseen \]
fig. cadastral map of Apeldoorn (1842) (source: CODA Museum)
Biwako Sosui Canal
/a waterway plan toward the revival of Kyoto in Meiji era

"Lake Biwa Canal," one of the greatest industrial heritage sites in Kyoto, is a facility that is still actively in use. It consists of three major canals. "The First Canal" extends from Kannon-ji, Otsu City to Horizome-cho, Fushimi-ku, Kyoto City and it is approximately 20 km long. "The Second Canal" is approximately 7.4 km long and it runs in a complete tunnel along the north side of "The First Canal". The third canal is called "Canal Branch", which is 3.3 km long and it is divided from Keage area, Sakyo-ku and reaches to Kita-Shirakawa.

source | Biwako Sosui Museum

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▲ formation

After the Meiji Restoration, Kyoto was declining due to a decreasing population with the capital having been transferred to Tokyo. Then, the construction of "Lake Biwa Canal" is planned as a reconstruction measure aiming for industrial development using the power of water irrigated from Lake Biwa. Hydraulic power generation and waterwheel power utilizing Lake Biwa Canal led to significant development in the industry, and ship transportation brought more people and materials coming and going, providing new vitality to Kyoto.

▼ decline

By the time Japan entered the Showa Era, the cargo volume of boat transportation had further decreased, and the Keage Incline was closed in 1948 (Showa 23rd year). As of September, 1951 (Showa 26th year), canal ship transportation was brought to a stop for a long period of time.

● restoration

Since around the 40s of the Showa Era, the historical value of Lake Biwa Canal, which is actively in use, gained attention. In the above background, maintenance along the canal branch, such as with "Philosophers' Path" was completed, the Keage Incline was restored, and the Higashiyama Ryokuchi Park (Yamashina-ku) was maintained. Afterwards, the Nanzenji Suirokaku and Keage Incline were designated as Kyoto City Historical Sites in 1983 (Showa 58), and furthermore, the 12 Lake related facilities to Biwa Canal including the above two sites were designated as National Historic Sites in 1996 (Heisei 8).

■ revival

In March, 2018 (Heisei 30), Lake Biwa boat transportation, brought to a stop in 1951 (Showa 26), began again for the first time in 67 years.

Lake Biwa Canal continues preserving and supporting the water supply of Kyoto for over 120 years, although it has adapted its use with the times to create new values of its use.
fig. Biwa Sosui Canal
Pattern language
case study - images of cities

Yanagawa Canal
/a system that overcame the challenge of modernization and became an eco-tourism attraction

Yanagawa is located in the southern part of the Chikugo Plain in the southern part of Fukuoka Prefecture. It is known primarily for its hundreds of kilometers of canals, and this is what pulls in the tourists. Yanagawa was originally a farming village, and the canals were built hundreds of years ago for irrigation. They have since been restored and today are plied by donkobune-low flat boats powered by a man with a pole that take tourists on short cruises known as kawakudari (going down the river) around the town.

\[\text{formation}\]
About 2,000 years ago, people start to live in the land of the tidal flat. The land is almost like a wetland. Houses and fields were created by digging low places, draining, and raising the excavated soil. Yanagawa is famous as a water town where the waterways pass through in all directions, but the prototype of the waterways was thus created 2000 years ago. Yanagawa was originally constructed in the mid-16th century by the Kamachi clan. Before then, it had been a traditional farming village, with the canals used for irrigation; Tanaka Yoshimasa (Japanese: 田中義政; 1548 - 1609) ordered the canals to be maintained and built a castle in Yanagawa, which is still maintained today.

\[\text{modern}\]
Modern water supply was completed around 1955, therefore the canal ended its role as a water supply. The spread of electric washing machines, adoption of oily Western-style foods, and the use of synthetic detergents, chemical fertilizers, ended the role of the waterways in daily life.

\[\text{decline}\]
When the garbage was eventually thrown into the water, fish no longer appear, and no children play in the water. Sightseeing river descent began in 1961, and trash was quickly accumulated in the waterways. In the 1975s, there was a growing demand for landfilling waterways.

\[\text{restoration}\]
After the decline of the canals, the local government soon realized that if the canals were buried, the groundwater recharge function would be lost, the entire city of Yanagawa would sink, and the floods could occur anywhere in the city each time it rained. Therefore the government started communicating with the community by reminding them of the memories of when the waterways were beautiful and when they enjoyed daily life by the water. Through this way, between 1978 and 1978, the 36 km waterway in the city was revived.

\[\text{revival}\]
As no garbage can be found in the waterways, fish swimming, children playing, fireflies flying, the desire of citizens is to resurrect the clear water flowing other than landfill the waterway. Now Yanagawa is not only a pleasant place to live in, but also a touristic attraction hotspot for domestic and aborad travel.

source | Fuji Clean Industry Co., Ltd. and Mizkan Holdings Co., Ltd. (ミツカン水の文化センター事務局)

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fig. The Story of Yanagawa’s Canals, Studio Ghibli (1987)
fig. Yaragawa Canal (source: Journal "Water Culture" No. 32
Flood Control Family - 机関誌『水の文化』32 号 治水家の統 (すべ))
Pattern language

case study - images of cities

Stadtbäche
/ streams that runs through the city of Zürich

The natural water streams were brought back after underwent a well planned daylighting process by the city of Zürich. For around 20 years, the rivers and streams in the city of Zürich have become fixed parameters in spatial planning and urban development. The green and open spaces along the large rivers Limmat and Sihl offer a lot of recreational value and contribute significantly to the high quality of life in the city of Zürich. But the streams also form valuable natural spaces in the quarters. The example of the city of Zürich shows that urbanity and nature are not mutually exclusive.

In the past, numerous watercourses flowed directly down from the slopes of Uetliberg, Käferberg, Zürichberg and Adlisberg into Lake Zürich and into the rivers Limmat, Sihl and Glatt.

Due to the heavy building activity in Zurich from the end of the 19th to the middle of the 20th century, however, almost all of the streams in their middle and lower courses had to give way to overbuilding and traffic routes. They were overturned and flowed into the canals on the edge of the settlement. They had largely disappeared from the cityscape.

The City of Zurich incorporated key elements of future-oriented urban drainage with its brook concept in 1988. This envisaged promoting the natural water cycle in urban areas as much as possible. The concept approved by the city council as a planning instrument also took into account the Water Protection Act that has been in force since 1991 when it was implemented.

Bach concept of the city of Zurich (Bachkonzept der Stadt Zürich) has brought 18 kilometers of creeks hidden in tubes back to the daylight and renatured around 3 kilometers of existing streams over the past 25 years.

Thanks to these measures, the living environment of the neighborhoods was upgraded and the habitats for plants and animals could be preserved or newly created.
II. methodology

fig. Situation in 2007 (source: ABW_Broschuere_Baeche)
Pattern language
case study - images of cities

The patterns were collected from the personal visits of the case study sites. All the following patterns are labeled with five different themes, which resonate with the project’s goal and current issues. The five themes are:

- **security** /
  - a space that adapt flooding water, provide safety feeling while being close to water

- **symbolism** /
  - enhance water image in urban environment or enhance historical related image by water space

- **amenity** /
  - enhance experience with water public space by improve water quality, enhance local ecology, and other means

- **livability** /
  - provide daily function to the locals which makes the space sustainable in usage

- **connectivity** /
  - connect other existing public space or public transportation hub

### Pattern #C-1

**Soft embankment that provides a flood-buffered gradients and sets a distance between people and water**

The embankment is a gentle slope, along the singels of Rotterdam. Together with slow water speed, it creates a very calm feeling while walking or staying by the side without being too close to water. The gentle slope also provide a buffer zone to adapt flooding water to adapt to sudden storms.

**#C-1 profile:**
- relation to project objectives: security
- pattern scale: place (60m x 60m)
- location: Spoorzinsel (Rotterdam)
- water width/depth: vary from 3-5m/ vary from 0-2m
- embankment material: soft
- surrounding context: city center

### Pattern #C-2

**Multifunctional water retention**

A multi-functional water square sits on the edge of Apeldoorn. Underground, it is a parking space to provide the locals or visitors to park before going into the city center. On the ground floor, besides a playground, a skatepark, and a park, the water ponds also serve as flood retention for exceed water coming from the city and discharge to the existing surrounding water system. The space is suitable for both for locals and visitor.

**#C-2 profile:**
- relation to project objectives: security, livibility
- pattern scale: place (60m x 60m)
- location: the Grift - Amaliapark (Apeldoorn)
- water width/depth: vary from 1.4m/ vary from 0.1m
- embankment material: semi-hard
- surrounding context: city center
The waterways in the space highly demanding center Kyoto takes advantage of the plantation to set a buffer line between pedestrian and water to provide a safe walkway.

#C-3 profile:
relation to project objectives/ security
pattern scale/ element (6m x 6m)
location/ Takey river (Kyoto)
water width / depth/ vary from 0.1m
embankment material/ hard
surrounding context/ city center

A small high difference between the walkway and car lane provides pedestrian safety while walking along the side of the water. It also creates a closure feeling to be embraced with the water while sitting by on the side.

#C-4 profile:
relation to project objectives/ security, livability
pattern scale/ place (60m x 60m)
location/ Philosophy path (Kyoto)
water width / depth/ vary from 1-3m/ vary from 0.5-1m
embankment material/ semi-hard
surrounding context/ city outskirt

In the city center of Aelpdoorn, a small stream is presented along the street to remind people of the Grift, a creek that once ran through the city. Combine with bus stop and resting area, it also enhance the view of city’s streets.

#C-5 profile:
relation to project objectives/ symbolism, livability
pattern scale/ place (60m x 60m)
location/ the Grift - Hofstraat (Apeldoorn)
water width / depth/ vary from 0-2m/ vary from 0-2m
embankment material/ semi-hard
surrounding context/ city center
Pattern language

case study - images of cities

Pattern #C-6 | ●
Historical element display on the water-outdoor museum

In the city center of Kyoto, a display of historical elements sits on waterways with a board of information explanation. The display serves as an outdoor museum to remind pedestrians of the usage of waterways in the past.

#C-6 profile:
relation to project objectives/ symbolism
pattern scale/ object (0.6m x 0.6m)
location/ Takase river (Kyoto)
water width / depth/ 4m/ 0.1m
embankment material/ hard
surrounding context/ city center

Pattern #C-7 | ●
Representation of city image with historical water system elements

In Yanagawa-shi, historical elements are still visible on site. While taking a water boat sailing through the historical city, many of historic bridges and watergates can be seen. They enhance the atmosphere of the city and remind the spirit of the past.

#C-7 profile:
relation to project objectives/ symbolism
pattern scale/ object (0.6m x 0.6m)
location/ Yanagawa canal (Yanagawa-shi)
water width / depth/ 4-5m/ 1-1.5m
embankment material/ hard
surrounding context/ historical city center

Pattern #C-8 | ●
Water pattern creates by different material at waterway’s bottom

Waterways in the center of Kyoto is very shallow during dry season. In this period of time, with less than 10cm depth of water, it showcase the bottom of water bed, which creates poetic patterns by using bricks or tiles.

#C-8 profile:
relation to project objectives/ amenity
pattern scale/ object (0.6m x 0.6m)
location/ Takase river (Kyoto)
water width / depth/ 4m/ 0.1m
embankment material/ hard
surrounding context/ city center
The embankment on the side of bigger canals in Yanagawa sometimes uses soft materials with plantation. Either passing by with boat or walking along the side, it creates a good atmosphere. With layers of plantations, it also brings biodiversity to the place.

#C-9 profile:
relation to project objectives/ amenity
pattern scale/ place (60m x 60m)
location/ Yanagawa canal (Yanagawa-shi)
water width / depth/ 4-5m / 1-1.5m
embankment material/ soft
surrounding context/ historical city center

Pattern #C-9 | ●
Gradient embankment plantation creates biodiversity and visual variety

The waterways in the city center Apeldoorn allows some plantation to grow at the bottom and the side of it. It creates a microecology to street life and makes the narrow waterway even more vivid than itself.

#C-10 profile:
relation to project objectives/ amenity
pattern scale/ object (0.6m x 0.6m)
location/ the Grift - Hofstraat (Apeldoorn)
water width / depth/ vary from 0.2m / vary from 0-2m
embankment material/ semi-hard
surrounding context/ city center

Pattern #C-10 | ●
Microecology on the street

Using pile of stones and bricks instead of concrete allows flora to grow and make that waterway ecology friendly at the same time increase aesthetic value.

#C-11 profile:
relation to project objectives/ amenity
pattern scale/ object (0.6m x 0.6m)
location/ Philosophy path (Kyoto)
water width / depth/ vary from 1-3m / vary from 0.5-1m
embankment material/ semi-hard
surrounding context/ city outskirt

Pattern #C-11 | ●
brick embankment material allows plants to grow
In Kyoto, the smoking area and nonsmoking area are clearly divided in public spaces. A kiosk right behind a metro station exit is created next to the water to allow smokers a place to stay. It is like a hideout not only for smokers but also for some pedestrians to rest while being on the street.

#C-12 profile:
relation to project objectives/ livibility, connectivity
pattern scale/ element (6m x 6m)
location/ smoking area at Kawaramachi metro station 1A exit (Kyoto)
water width / depth/ 4m / 0.1m
embankment material/ hard
surrounding context/ city center

At an exit of Kyoto metro station, a small area is created with wide stairs to give people to sit and rest or even to meet up with friends.

#C-14 profile:
relation to project objectives/ livibility, connectivity
pattern scale/ element (6m x 6m)
location/ Kawaramachi metro station 1B exit (Kyoto)
water width / depth/ 4m / 0.1m
embankment material/ hard
surrounding context/ city center
Implication towards design
and an INDEX

The previous patterns generated from the onsite visit (pattern #L) and case studies (pattern #C) will be used to apply in the design process. As the design proceeds, new patterns are assumed to be developed according to the local context (pattern #RD).

The purpose of using pattern language as a tool is to obtain the essential elements that construct a valuable public space with water. In this way, locally found quality water space could keep on inspiring future design interventions. Besides the patterns found through remaining waterways, some patterns are derived from the renovated segments. These patterns provide time-tested spatial elements and reveal the local’s acceptance of the water space.

After the process of abstraction, locally found water public space essentials can be applied to other relevant locations when it comes to water public space design. Therefore, gathering onsite observation (#L), case study (#C), and research by design (#RD), this project goes through a journey of “a timeless way of building” a set of <pattern language for water public space in Kaohsiung>.

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chart. Index of all patterns in <pattern language for water public space in Kaohsiung>

chart. Index of all patterns in <pattern language for water public space in Kaohsiung>

- security / a space that adapt flooding water, provide safety feeling while being close to water
- amenity / enhance experience with water public space by improve water quality, enhance local ecology, and other means
- symbolism / enhance water image in urban environment or enhance historical related image by water space
- livability / provide daily function to the locals which makes the space sustainable in usage
- connectivity / connect other existing public space or public transportation hub

#L - patterns from local onsite observation
#C - patterns from case study
This part of the project tries to understand the local context and to get an insight into the challenges and opportunities. Through mapping, a radius gradient is presented from the city center to the suburban. Kaohsiung is a city with radial patterns in various layers, including urbanization, agricultural land, existing waterways, public open space, flooding-prone area, and industrial land use.
3.1 Reading the landscape
3.2 Mapping the present condition
3.3 Conclusion from analysis
Reading the Landscape

Landscape morphology transition

If we follow the water system from its source towards the city center, and take a few sections of city Kaohsiung from the east toward the west, the transition of landscape morphology is clearly shown. The surrounding is shifted from agricultural land to industrial factories, then to a residential area. Sections from the suburb to the city center reflects different landscape pattern and land use. In the east, there are pineapple and rice fields. Then gradually small villages appear. Finally, a well-structured grid pattern, which is the nowadays city center.

The horizon gradually changed from a board view of pineapple field and rice field to factories, 4-floor housing, apartments, and finally high-rise buildings. A timeline of land transition is drawn following the former irrigation system. As for the waterways, they are visible and approachable from the beginning, then due to the built density increase, they become invisible and buried underneath the road.

fig. sections of landscape morphology
III. site condition // 67
Following the direction of water flow, going toward the city center, several things can be notice in landscape patterns:

/ The overall patterns shift from irregular to geometric. The size of patches tends to shrink, and reflects different usage.

/ For the waterways, in the suburb they are still visible and affect the road’s geometry. Going downstream, gradually, the waterways are put underground and disappear in the grid pattern of the city. One the 4th section counting from the top, the trace of a former waterway is still visible through the shape of the road.
The area of agriculture is mainly close to the source of water and decreases towards the city center. As the agricultural land decreases, waterways were put underneath the pavement.

Industrial land use can be found before entering the city.

Residential areas gradually increase along the waterway and get the most intense in the city center. Floor heights also increase from 5-floor residential to 50-floor highrise.
Mapping the present condition

As the irrigation system was built on agricultural purposes, by layering information of the agriculture field and both existing and disappeared waterways, the graphic shows the location where the function of the water system still serves as its original purpose.

The green patches show the agriculture area in Kaohsiung is located in the suburb east part. As for the waterways, the disappeared ones are mostly located close to the city center, while the remaining ones are located close to its water source, which is the proximately the location where agricultural land is.

After confirming with an onsite visit, therefore, it can be concluded that the existing open waterways are still in use to irrigate the agricultural fields in Kaohsiung.

The remaining open waterways are the study locations for understanding the relationship between people, water, and the surrounding environment. For instance, the mechanism of the traditional water system, the way people interact with water, the symbol of water, and the role of water in people’s daily life can be learned to inspire and to deepen the project.

>>> Existing open waterways are still in use to irrigate the agriculture field. These open waterways are crucial for understanding the relationship between the traditional irrigation system and the people.
Mapping the present condition

*industrial land use x water quality*

The current condition of the water system varies from segment to segment. The Ksôkong Tsûn Irrigation System transports water from Tamshui Khe through Kaohsiung city, then discharge to Kaohsiung port. The water discharge of Kaohsiung City is divided into five zones and the former Ksôkong Tsûn Irrigation System nowadays plays a role of water discharge system that runs through three zones: FongShan, Ksôkong Tsûn Irrigation System, and Inner city zone. The water quality of the Ksôkong Tsûn Irrigation System depends on two factors: land use and the sewage system.

Within the inner-city zone, the sewage system and rainwater system are separated and well constructed (99.25%), however, most of the channels in the inner-city zone are covered with concrete due to the high density of city development (residential, commercial district). Those waterways now exist underneath city roads.

However, in the Fongshan discharge zone, land usage has a higher percentage of industrial use, with the complete rate of the sewage system of 48.48%. In this zone, untreated water is more likely to discharge into the Ksôkong Tsûn Irrigation System. The demand for space is less than the city center, therefore, the channels in this area mainly remain open. Furthermore, the main channel of Ksôkong Tsûn Irrigation System runs from the Fongshan zone to the inner-city zone. Therefore, inevitably, the rainwater system in the inner city zone is more or less contaminated by the water that runs through the Fongshane zone.

The present condition of Ksôkong Tsûn Irrigation System brings up a challenge to create a public water space using the former Ksôkong Tsûn Irrigation System: the west segments of the waterways are relatively clean but covered, and the east segments waterways are polluted but remain open.

>>> Upper stream’s sewage water pollutes the lower stream:
Incomplete separation of sewage and rainwater, some waterways are still in used for sewage discharge, plus industrial factories occur mostly in the lower completion zone, it affects the water quality to decrease. Aiming to improve the water quality in downstream provides an opportunity for a multi-functional filter system.
Mapping the present condition

To understand the most effected area relate to citizens’ security, residential area and flooding prone area are layered together to identify the areas that are most urgent to deal with and those areas can be the possible design site location.

Using 150mm rainfall per 6 hours, which is the summer average high rainfall, the graphic showed flooding occurs mostly in the densely built residential area.

The flooding prone area indicated by National Taiwan University in 2014 considered the present condition of the sewage system.*

>>> Flooding mostly happens in the densely built area where most of the residents live. These areas are most at risk therefore a design intervention here would make an influential impact on the area.

*National Taiwan University was commissioned by The Water Resources Agency of the Ministry of Economic Affairs of Taiwan to conduct the mapping of flooding prone areas in 2014. The flooding prone area data used the Dutch SOBEK flooding model and Horner rainfall under the condition of the normal operation of the water sewage system.
Mapping the present condition

safety x covered waterways

To understand the relationship between disappeared waterways and the most affected flooding area, the condition of waterways and flooding prone areas are layered together to identify the areas that are most urgent to deal with and those areas can be the possible design site location.

Using 150mm rainfall per 6 hours, which is the summer average high rainfall, the graphic shows flooding is most likely happen in the city center where former waterways are covered underneath concrete due to the reduced water runoff area.

The flooding prone area indicated by National Taiwan University in 2014 considered the present condition of the sewage system.*

>>> Flooding mostly happens in the densely built area where most of the waterways are covered. A design intervention here would create an adapting flood public space to minimize the flood risk and at the same time reveal the traditional water’s symbol.

*National Taiwan University was commissioned by The Water Resources Agency of the Ministry of Economic Affairs of Taiwan to conduct the mapping of flooding prone areas in 2014. The flooding prone area data used the Dutch SOBEK flooding model and Horner rainfall under the condition of the normal operation of the water sewage system.
**Mapping the present condition**

**public land x flooding**

In general, to do design intervention by taking public land is relatively easier to proceed than privately own land, especially for a larger scale plan. Public land is less fragmented and easier to get access. Besides, using public land as design interventions can reach more people to influence the general public’s feelings and relationships towards the water.

Therefore, using the same parameter of flooding condition (150mm rainfall per 6 hours) together with public land use (including green open space and school) are layered with each other to see if the flooding location matches with public land.

It is indicated that there are several rather large flooding areas overlaps with public land, therefore, there is a possibility to solve flooding issues by using public land and at the same time provide quality water public space to the citizens.

>>> Green open space and schools show the possibility to adapt flooding water. By using public land, the design intervention would be more influential to the public.
**Conclusion from analysis**

*a radius gradient from inner city toward the suburb*

The direction of this project is first to enhance people’s engagement with water by providing good quality public space to initiate an urban, daily, and recreational attachment with water. Therefore, a city’s identity is build up by both the space itself and every individual citizen’s attachment to it. As local condition varies, the previous analysis shows a gradient from the suburb to the city center. The figure on the right shows: remained open waterways, agricultural areas, flooding prone area, industrial area, residential area, open space (public green and school). Therefore, at different locations, there are different context and different characters of local neighborhood.

A gradient through different situation where more or less presence of water and the presence of elements related to water creates a sequence of space that could adapt local issue. In addition to water spaces, related historical elements that are once overlooked need to be seen by enhancing its surrounding environment. By doing so, this project could possibly contribute in mitigate flood occurrences.

The aim of the project is to use the presence of water to represent the history, culture and identity of a place. Along the segments that are still open, it is rather possible to create public space along. In contrast, the segments that were already covered and became city rain water sewage system, could have possibility to be uncovered or use an alternative way to represent the former Ksôkong Tsùn Irrigation System. Therefore, the aim of this project is to contain three different type of water space: the original irrigation system of Ksôkong Tsùn, the uncovered water channel, and the newly-add water space.

Meanwhile, from designing several locations using the Ksôkong Tsùn Irrigation System as a base, a water network is expected to be created to assist the city to become resilient for future challenges.

Water could be the carrier to keep on telling stories of the place and create a sense of place, a bound with the landscape. Take the current situation into account, through using the former Ksôkong Tsùn Irrigation System in southern Taiwan, as a base, this design/research aims to establish landscape architecture design strategies and designs at the local scale to reform people-water relationships to flourish local identity and place attachment.

fig. Gradient in each analysis. From up-left to up-right there are: remained open waterways, agricultural area, flooding prone area. From bottom-left to bottom right there are: industrial area, residential area, green open space and school.
Leaped from the discovery of the previous chapter, the intervention concept defines an ax from the source of Kso Kong Ts’un irrigation system to its discharge point at the Kaohsiung port. Following the ax, several nodes are identified to become possible sites of research by design.
4.1 Intervention Concept
4.2 Possible Intervention Locations
4.3 Intervention Location Ideas
Intervention Concept

forming an ax from suburb towards the inner city

By layering all the gradient from analysis, open water, agricultural land, flooding area, industrial land, residential area, public area, and take a section from one side to another, along the section there are a gradient of space to be discover. Following the origin of the water system that still exist, toward the lower stream, draw a section crossing the city.

The concept of design intervention is to identify an axe using the main channel of the Ksôkong Tsûn Irrigation System, to draw a clear gesture pointing from the river toward the harbor. It is from the starting point of Ksôkong Tsûn Irrigation System’s origin to its end point. This axe will become an axe of identity, an ax of city image, and an ax for social interaction.

In different segments of former Ksôkong Tsûn Irrigation System, different possible interventions are introduced.
Possible Intervention Locations

An ax is formed with several nodes attached. The nodes consist of public facilities such as open space and schools. The concept is to present a variety of water public space that relate to one another but at the same time contribute something to the local neighborhood. Due to the different surrounding context, according to site analysis, in each node, there are different goals to achieve:

- **security / a space that adapt flooding water, provide safety feeling while being close to water**
  Residential area in the densified area is exposed to the flooding risk, therefore the main actions to take in the urbanized area is to provide security by adapting flood-water.

- **symbolism / enhance water image in urban environment or enhance historical related image by water space**
  Close to the source of Ksôkong Tsûn Irrigation System, few historical elements can still be found, hence to reveal the historical image of Ksôkong Tsûn Irrigation System has much potential.

- **amenity / enhance experience with water public space by improve water quality, enhance local ecology, and other means**
  In the suburban, water quality is less pleasant due to industrial land use and sewage system completion. These factors keep people away from being close to water. Thus, to provide amenity by purifying water and bring better ecology to the site is rather crucial.

- **livability / provide daily function to the locals which makes the space sustainable in usage**
  A public facility with function supporting people’s daily activity will sustain the longterm relationship between water and people.

- **connectivity / connect other existing public space or public transportation hub**
  A space that connects to existing public space and transportation will benefit its surrounding area and lift the use rate of the place.
**Intervention Location: Four Ideas**

*node 1 - historical site ⚫ symbolism ⚫ livability ⚫ connectivity*

The first node is the water resource origin of the Ksökong Tsùn Irrigation System. The main element here is a municipality level historical heritage - a water gate from the 1800.

Though situated in the suburban, it is a hot spot for weekend outing. There are a wetland park, several historical land marks, pineapple fields, and open land in the surrounding.

The gate can be found by following the water way to a sunken square. The current situation of the gate is that it has been overlooked for a long time however it could be a meaningful initiate space to tell the story of Ksökong Tsùn Irrigation System.

**potential patterns:**

- Representation of city image with historical water system elements

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**Location character/**

Urbanization level: Suburb
Status: municipality level historical heritage
Surrounding context: wetland park, historical landmark, pineapple field
Water status: open, river water
IV. intervention strategy

Historical landmark - Tile Kiln

Historical landmark - steel rail bridge

Historical landmark - pineapple factory

Pineapple field

Silvergrass field
Intervention Location: Four Ideas

node II - water lane  ● symbolism  ● livability  ● amenity

Going toward west, the waterway here is open but polluted by the direct sewage discharge. The factories and households are closely next to the water. Oftentimes there is no path on one side of the waterway. Here we can see that a railway cut through the area in half and affected the difference of development on each side. The lower part has more residential and the upper part has more fields and factories.

There are waterways on both side. The water quality in the upper part is affected by those factories. Therefore, the first thing to do is to improve the water’s quality, and then creates a circular path for the near by neighborhood to visit. In this way, the north side could possibly be a low density development area for the extension of the south and the expanding area for the city.

potential patterns:

#C-3 Plantation provides soft buffer for pedestrian by water
#C-4 Walkway by the water draw a clear division between pedestrian and car lane
#C-13 Spaces that forms dialogue with water

Location character:

Urbanization level: transition zone toward suburb
Status: sewage waterway
Surrounding context: industrial, residential
Water status: open, polluted
Intervention Location: Four Ideas

Toward the inner city, this node, located in a densely built residential and commercial area. The waterways can no longer be seen here and flooding is a big issue. There are three school that sit side by side here so the intention is to proposed a share campus idea with flood adaptation functions.

The blue patches show the flooding prone area during average high amount of rain fall in the summer. The neighborhood surround the schools are mostly flooded. However the waterways here are covered and no longer in use, so the concept is to retain the flood water within the campus for a period of time before it can be discharge through a newly create waterway.

potential patterns:
- Multifunctional water retention

Location character/

Urbanization level: Densely built area
Status: schools front, pedestrian
Surrounding context: residential and commercial
Water status: flooding
The retention ponds within the schools need to be multifunctional for the students and even for the neighborhood. Because in Taiwan, most public schools are consider public spaces that locals enters the school after school hours to jog or to take a walk or to talk to the neighbors like they are in a park.

So the reference for this node is a sport field in a city called Yilan in Taiwan, which the running path is a floated structure on top of a water retention pond. And also the renown example in Rotterdam, the basketball field combining with the water retention.

As for the discharge waterway, a reference in Apeldoorn in the Netherlands show a smaller scale of water, which is a possible way to design in a condense urban space. It transports water and also make a representation of water image in the city.
Intervention Location: Four Ideas

node IV - water plaza
- security
- symbolism
- connectivity

The last node in the end of the axe is right next to the harbor. The area is very densely built and it is the egg-yolk part of the city. It is surrounded by some major city hot spots and tourist attractions. The design intervention place here is a green space between two parallel roads which covers the former irrigation waterways.

The former irrigation waterway underneath this linear green space is believe to be the rainwater discharge of the city in nowadays. Therefore the design intention here is to uncover the water before it discharge to the port. On top of it, the green space here could be a retention area to adapt the flooding issue in surrounding neighborhood. The goal is to turn this linear park to a water public space.

potential patterns:
#C.9 Gradient embankment plantation creates biodiversity and visual variety
#L.2 A feeling surrounded with water
#L.5 Space to stay by the water

Location character/

Urbanization level: Densely built area
Status: Park on traffic island)
Surrounding context: Attractions, City hotspot
Water status: covered, rainwater
Taking the example of City Apeldoorn, the waterway collects the water from inner city and store in it the park then discharge to the existing water system. Underneath the park, it is a parking space that at the same time release the pressure of parking in the inner city.

The Takase river in Kyoto center provides a nice public space nearby water. It is a smoking area with resting places for the people nearby.
In this chapter, a flooding adaptation system in the city-scale is first drawn down to be the general guild of the indicated design sites. Selected from the nodes on the ax, two sites are chosen to develop a further design. One is located in the hustle and bustle city center, where locals and tourists both present on site. The other is situated in a neighborhood that accompanies residents in daily life. The two sites are different in characters but both provoke a lifestyle of living with water.
5.1 Intervention Locations - Focus Site Selection
5.2 Cloud Burst - Kaohsiung
5.3 Site #1: URBAN FIELD
5.4 Inter-site: Connection Road Profile
5.5 Site #2: AQUA-GRID COMMUNITY
Intervention locations - focus site selection

The site analysis and intervention strategies determine the selection of potential design sites. Three main points are listed below:

1. Most flooding affected area:
The most vulnerable area is the more urgent area to take the intervention. It could result in unfriendly flooding treatment if the amount of flood-water continues to increase by extreme weather.

2. The most urbanized area:
The area close to the Kaohsiung port is where the city is mostly transformed into a grid system and lack of locality patterns.

3. Intensive people’s activity zone:
To maximize the impact of a newly added public space, the efficient approach is to locate the sites in the area with maximum people's activity.

All the points concluded above resulted in the two design site selection on the ax, shown in the diagram on the right page.
Fig. Two intervention location
Cloud Burst - Kaohsiung

Flooding adaptation in city scale

The flooding hazard threatens people's safety, results in numerous unpleasant public flood-prevent facilities, and most badly it destroys the relationship between people and water. Therefore to adapt flooding issues is crucial to rebuilding the relationship between people and water.

Learning from SLA's Cloud Burst project in Copenhagen, this project takes the principal and made some refinements according to the Kaohsiung context. The method is by using current public space such as road systems, open spaces, and schools to provide space for flooding buffer and assist the sewage system overflow during storms. A flooding adaptation is drawn down to minimize flooding areas and at the same time provide citizens a pleasant public space.

The Kaohsiung Cloud Burst plan considered the pattern of the city road system and the topography. Kaohsiung sits on a slope that generally descends from north-east towards the south-west, therefore, four types of elements are used to consist of the flood adapting system. The four types of elements are the following: detention area, detention road, divert road and absorb road. After identifying the elements, the elements in the same flooding area work together as clusters. Between clusters, water flows from one to another.

![Diagram](image)

**Fig. bottom** - terrain of Kaohsiung

**Fig. right** - Kaohsiung Cloud Burst Plan
Cloud Burst - Kaohsiung

Four types of elements

1. Detention Area

The method is to overlay public area with flooding prone area to find suitable locations for large temporary flood retention. The Detention area collects most of the runoff water from the surrounding neighborhood, retain for some time before discharge.

2. Detention Road

Using major roads (referencing urban pattern, vertical to terrain slope) and general terrain slope (descend from north-east to south-west) to identify several larger roads to collect runoff water from surrounding neighborhood, retain for some time before discharge.
3. **Divert Road**

Using major roads (follow the urban pattern, parallel roads to terrain slope) to collect part of the runoff water on the street, discharge water when the situation allowed.

4. **Absorb Road**

In addition to other typology, absorb water directly on site and provide short distance discharge.
Cloud Burst - Kaohsiung

overlay elements with former Ksôkong Tsùn Irrigation System

Former water system as a base/a prototype for transformation. Since most of the Ksôkong Tsùn Irrigation System waterways in the city area were abolished or covered under roads as part of the sewage system, some locations of the Cloud Burst elements overlay with the former waterways that are still present underneath the road. These locations have great potential to be transformed into a visible waterway or green open space (type I). For those already disappeared, a reformation is also possible to bring good amenity to the surrounding and represent the historical landscape.

Type I

Former waterway became rainwater discharge underneath road, possibly be retransformed into permeable road (as most of the time dry green strip) or open waterway (always have water).

Type II

former waterway completely disappear in urban fabric, restore/rebuild water way to provide amenity environment and help adapt climate challenges.
On the left, a framed area shows one end of a waterway at the estuary. Here, a portion of the water from Ksôkong Tsûn irrigation system was discharged into a lagoon, which later became an international trading harbor. In 1904, just a bit more than a century ago, the estuary was not yet paved and embanked with concrete. The tidal seawater fluctuated with river-water and nurtured the living flora and fauna.

A hundred years later, this tidal wetland has transformed into the city center of Kaohsiung, a hustle and bustle district mingled with locals and tourists, alike the seawater and river water. A waterscape-featured city park will resonate with the symbolic landscape of the traditional water system, enhance the sense of place, and nurture local ecology, but most importantly, reconnect the relationship between water and the citizens.

fig. 1898~1904 Taiwan Topographic Map 《臺灣堡圖》 is a topographic map completed in 1904 during the Japanese era.
Approaching the site

reflecting the intervention strategy

0. Goals from the axe concept

- security
- symbolism
- connectivity

1. Positional aspect:

The proposed design location are highlighted yellow in Fram 1 presented with City Library within. Located by the port Kaohsiung, the area (marked as grey) that used to be a former industrial site has now been transformed into an art and cultural center within the recent decade. The area’s popularity has been increased and become a weekend hot spots for citizens and travelers. The site sits right behind the water front along with city icons such as Pier 2 Art district, Kaohsiung Music Center, Kaohsiung Port Terminal, Kaohsiung exhibition center. Therefore the site is expected to reach certain amount of visitors. At the same time, it connects these cultural facilities towards the city to the locals. In both things mentioning above, this location shows a great potential to bring a purpose of new living style with water.

2. Functional aspect:

The site’s role regarding to flooding resistance measurement is within the framework at a scale above. It poses a role as a detention area and a divert road to coop with other spaces as a complete network. Site #1 has to detain flood water during severe weather condition and divert the water out to Kaohsiung port afterwards. A detention road is crossing between two divert road, therefore working as a join network, the junction where different types of flood adapting space intersect should be carefully carried out.

As situated in lower stream, site #1 takes the water from the upper stream system, which is where site 2 located. Thus, the water quality of site #2 is crucial to have further usage when it enters site #1.
3. Connection aspect:

Transportation/
site #1 is situated between one of the main MRT line, that travels across Kaohsiung from north to south, and a light rail that goes along the port. This condition gives it good accessibility for citizens and tourists to reach.

Surrounding blocks/
The surrounding blocks have both residential and business areas. Shown in two colors of flowing lines, the yellow ones are the assumption route of residents that coming from their dwelling to reach the site. The blue ones show outsiders’ route from business locations or tourist attraction.

Flow/
The flow reveals some issues based on the current surrounding situation. At some crossing location, people have to cross a wide road, 6 to 8 lanes, to reach the other side. Besides, the site should be able to connect the surrounding pedestrian to perform a continuous extension of the site.

Active time/
In Kaohsiung, people’s active period in public space has three peaks: in the early morning, late afternoon, and evening. Each season slightly varies.
site #1 - URBAN FIELDS and its surrounding

The design location is situated by Kaohsiung Port, presented with both brackish water and freshwater, which create a possible bio-rich habitat for a variety of indigenous plants and animals. The design location is located in the city center surrounding a city library and a cultural center. Together with the library, local organization, foundations, community, plenty of activities, and education programs could be created at a highly accessible location for the public.
A field of local ecology/nature as a playground

In the past, many children’s games were highly related to the surrounding environment. Water channel and ridges in the ricefield, naturally formed ponds, and wild groves were children’s ultimate playground. Their connection with nature was rooted through interaction with plants, animals, water, and earth land. During the day, they were catching fish in the ditches, capturing frogs and snakes in the rice fields, picking up snails and scarabs in the bushes, climbing trees to get cicada or its shell, throwing clay to each other; in the night, they wait for the fireflies to appear, and listen to the sound of crickets. They use local plants to create toys, the seed of bishop wood were marbles, spinning tops made from guava trees, using rice as glue to make a kite, use bamboos to create handy toys. Children, therefore, develop a keen sense of nature and seasons through playing in the fields. As the bond between nature and kids was established, though gaming, plants, and animals to them are more than objects, they are life and beings.
A field of cultural social event / from knowledge exchange to social interaction

In the old days, while working in the fields, people would rest on the ridges. Between the fields, there was sometimes a small patch of land with some trees where people could have lunch and tea or take a nap or offering tea to the people passing by; after harvest, they would use the clay soil to build an earth kiln for cooking and sharing food. At night, entertainment activities such as outdoor cinema, hand puppet show, Taiwanese opera took place from time to time during the cultural festival. Activities were related to local materials. While the library preserving records of life, the surrounding public space could provide a field for onsite cultural and social activities. Cooperating with the library, numerous events could happen and continue connecting the locals.
Adaptive field of flooding risk

The grid of Rice Field was originally created for efficient water transportation. In recent year, flooding causes the fields to flood leave roads and buildings as islands floating on the surface. This landscape phenomenon shows how fields contain water within a certain area. Therefore by using this landscape morphology, the quantity of field patches could be manipulated to flood according to the condition of storm. At the same time create water space for people to approach.
site #1 - URBAN FIELDS
program, activity and #Pattern used

A. crossing bridge
B. pier #L-2
C. mangrove walkway #L-4
D. stair plaza #L-5
E. eco islands #C-9
F. pocketpark
G. aqua balcony #L-1
H. water plaza
I. explore field
J. billy playground
K. stream plaza
As the site located by Kaohsiung Port, to create a mixture of fresh water and brackish water is therefore a plausible strategy to increase the site’s biodiversity and enhance people’s experience with water.

Considering water sources, there are: 1. rain water from the upstream which remains in the former irrigation channel, 2. water from site#2, and 3. the brackish water brought by daily tidal change.

With a clear division of dry and wet season, the site needs to adapt a huge amount of water during the rain season.
V. design intervention // 121

Water gate control

Water flow direction

- Port
- Site 1
- Site 2
- River

- Rain water from upstream (factor: rain amount)
- Recycle water from site 2
- Brackish ocean water (factor: tidal change)

- Fresh water
- Brackish water
Several conjunctions in the site regulate brackish water and fresh water. Between the site and the port, a connection is served as two function, a brackish inlet and a fresh water outlet. The inlet determine the intake of brackish water during high tide, therefore taking the lowest level of monthly average high tide, in this case February (0.474m), and round up to 0.5m to be the height of inlet. During low tide, exceeded fresh water will outflow to the port. For fresh water discharge, a bridge in the site separate two type of water but is also installed with open pipes to allow water overflow to the other side. (*The instrument reference level of each tide station is calibrated to a tide gauge benchmark beside the station. The elevation at a tide gauge benchmark is based on the first order leveling network of the Ministry of Interior leveling survey, on which the mean sea level of Keelung Peil is treated as the zero datum level for the Taiwan area (Taiwan Vertical Datum 2001, TWVD2001). Therefore, the tide records of each tide station should be interpreted as the height above TWVD2001.)

A. brackish/fresh water exchange
B. Fresh water overflow to the other side when it reaches its capacity

C. Fresh and brackish water moves freely under bridge

D. Fresh water control by water gate and discharge to the pond during low tide
site #1 - URBAN FIELDS

water system - water level fluctuation /

Summer with more rain
+ High tide

Summer with less rain
+ Low tide

Summer high tide
Summer low tide
From dry to flood, the amount of field patches are regulated through height difference. By a small amount of 10 cm, it creates a variety of a field landscape.
-0.6m field patch
-0.7m field patch
-0.7m plaza

Flood

water gate open to discharge when low tide

water distribution
water collection
water collection with pump

fresh water exchange with port water by tide
site #1 - URBAN FIELDS
planting plan: Species choice

according to season (color pallet, solar term) first priority: native plants with local stories or with obvious flowering seasons, butterfly-attracted, endanger native plants
second: not native but have been imported and planted for decades and show no threat to local species
this illustration exaggerated the height in elevation to show space quality in section
site #1 - URBAN FIELDS
planting plan: sections

- Miscanthus floridulus (Labill) W arb. ex Schum. & Laut.
- Taxodium distichum
- Kandelia candel (L.) Druce
- Barringtonia racemosa
- Calophyllum inophyllum L.
- Ormosia formosana Kanehira
- Cassia fistula
- Phragmites communis (L.) Trin.
Oryza sativa ssp. japonica

sowing season: early spring, late summer

harvest season: early summer, late autumn

fallow season: winter

Cosmos bipinnatus
Brassica campestris L. var. amplexicaulis Makino

Tabebuia rosea

Cassia fistula

Tabebuia chrysantha (Jacq.) Nichols.
Inter-site: Connection Road Profile

pocket parks

10m street

#C-3  #C-4  #C-5  #C-10

before

after
Inter-site: Connection Road Profile

Type A. resting bench

Type B. walkway with parking
Type C. walkway only

Type D. Bus stop
Before
By reading the aero photo taken in 1945, rice fields and water elements composed the organic shapes of the landscape. At the time, the ripple of urban planning had rapidly reached every corner of Kaohsiung. Grid systems were introduced for urban development. With in the grid, a waterway was put underground. Now seventy-five years later, the grids are not only filled with houses, public facilities, business buildings, but also with the fate of development.

As the city grows, the population density in the area has reached over 20000 inhabitants within one square-kilometer. The grid system has proved its value by providing efficiency to habitat millions of citizens. What can this efficiency contribute to adapt to the climate challenge and propose a new pattern of lifestyle?

fig. Aero photo by US Army, 1945. (source: National Archives and Records Administration, NARA, USA)
1. Positional aspect:

The proposed design location is highlighted in yellow. The site is in an important spot that sits right next to a east-west direction road that connects east part of the city and the west part and situated by a highway that define the edge of the egg-yolk city center. It is surrounded by a vivid residential area with schools, small business and municipal public facilities.

By reading the urban pattern, a green corridor winding right by the side of the chosen site is a water way of the former irrigation system. Though a gird system is clearly seen, however the area’s urban pattern sorts of follows the line of this waterway. Through time, this water way has transformed into a rainwater collection pipe underneath the green corridor.
2. Functional aspect:

Considering the topography, the site is between two rows of small mounds, with one row’s height of 5m and the other of 10m. The water flows northeast towards southwest, according to the general topography of the city, but it gets conjugated at the 5m row. Therefore this results to a risk of flooding.

The site’s role regarding to flooding resistance measurement is within the framework at a higher scale. The site is appointed to have several detention area with a divert road and a detention road.

Site #2 takes the water from the upper stream system, and discharge water to site #1. Therefore, the water quality of site #2 is crucial to have further usage when it enters site #1.
3. Connection aspect:

Transportation/
The site is highly accessible by tram line and MRT line.

Surrounding blocks/
The site is situated in a residential area. Users here can be describe in two groups. One is the residents in the surrounding neighborhood. The other is the students that go to the schools within the site.

Active time/
Due to Kaohsiung's warm weather, the local residents’ active time in public space falls in two major time period, in the morning right after sun rise, and around sunset until around 10pm.

4. Design Intention

The main goal of this project is to enhance people-water relationship according to different location in the city. Concluded from previous site analysis, flooding issues is a major challenge here at site #2. Therefore, to reform people-water relationship, it is important to first increase the safety threat that posed by flooding. In a highly density area, that habitats 20000 residents within a square kilometer, a multipurpose space usage thus becomes crucial. Two design intension of site #2 is clearly stated:

- Adapt flooding: solve water catastrophe
- Optimize space usage and Increase variety of activities by water
5. The free water entity: Opposition to the regular city urban pattern

By looking into the historical morphology, the organic pattern of crop fields underneath the grid can be clearly seen. Within one box of the grid, there is more than one genre of crops attaching to one another like mosaic, showing a dynamic pattern of usage in a fix area. Besides crop fields, there were water ponds in the fields to obtain water. These ponds were used to store exceeded water for rice agriculture during the rain season and provide water during dry season. Taking the inspiration from former landscape, to obtain its free form to oppose to the regular lines of the surrounding, and bring a time tested solution to the current situation. In addition to that, referring this design concept to historical usage is at the same time to provide symbolic meaning to the site.

6. Design decision/

- Adaptive water grid
  The grid road systems is used as water collecting and water drainage to divert water into the selected intervention areas. These intervention sites are scattering in the area, each site plays a role as a rain bucket to adapt serve rainfall jointly. The “buckets” are at the same time collecting water in the few raining day to provide water usage in dry season.

- Multipurpose space: Open school, shared space.
  As many schools closely situated by another in a high densify area, the proposed idea is to break the boarder of each school to form a share campus with one another and with the neighborhood. In this way, it could benefit the surrounding neighborhood to increase public space usage quality and brings an opportunity for the students to learn with the community.
Taking a neighborhood by a previous water channel to experiment an alternative way to engage one’s life with water. A gradient of closeness to water with people’s activity and different group of users (age).
A. wetland playground / eco education
B. water passage
C. community garden
D. playground

E. platform
F. water education filter system
G. floating basketball court
H. courtyard

I. water atrium
J. community outdoor lounge
K. sunken garden

V. design intervention // 147
During the dry season, the water on site is supplied by the former traditional system winding right next to the site, it is covered underneath a green corridor. The connection between the former canal and the site is important to allow some water on the site to have the symbol of water.
In the rain season: flood water will be collected from the flood overflow of surrounding neighborhood.
The goal is to provide a multifunctional public space that invites locals to do activities inside, ranging from kids to the elderly. And at the same time provide security by adapting flood water during summer time storm days.
Programs are introduced here to create a new attachment to place and water. Therefore, programs here are closely related to people’s daily activities both of the neighbors and the students.
site#2 - AQUA-GRID COMMUNITY
water system - general flow

open water
rain run off
sluse
pump
water connection underground
Form/
Elementary schools: school boarders are defined and secured by water as a moat.
Higher education institutes: water as medium to invite people to enter campus

Function/
Storm water temporary storage, Filter storm water for reuse
Dry season: river water supply from traditional water system
Rain season: flood water collect form neighborhood sewage overflow water

During the dry season, only river water is presence in the site, therefore the connection between the former canal and the site is important to allow some water on the site to have the symbol of water.
site#2 - AQUA-GRID COMMUNITY
water system - water purification system

The flood catchment area collects the storm water, then filter, and reuse. The water purification system contains three parts of water body, including inlet zone, ephemeral zone, and wetland zone, that each plays certain function to improve the quality of urban storm water before discharge into the river. (Source: Melbourne Water 2005)
I. Emergent Plant
1. Thalia geniculata 水竹芋
2. Pennisetum alopecuroides 紅繼尾草
3. Hedychium coronarium 野薑花
4. Cyperus alternifolius 輪傘草
5. Myriophyllum aquaticum (Vell.) Verdc. 粉綠狐尾草
6. Cyperus haspan 畦畔莎草
7. Acorus gramineus Soland. 斑葉石菖蒲
8. Typha angustifolia L. 水蠟燭
9. Rhynchospora colorata 白鷺莞

II. Floating-leaved Plant
1. Nuphar shimadae Hayata 台灣萍蓬草
2. Trapa taiwanensis Nakai 台灣菱
3. Nymphaea lotus L. var. lotus 齒葉睡蓮

III. Free-floating Plant
1. Pistia stratiotes L. 水芙蓉
2. Salvinia cucullata Roxb. 台灣原生槐葉蘋

IV. Submerged Plant
1. Limnophila sessiliflora 石龍尾
2. Ottelia alismoides 水車前草
3. Isoetes taiwanensis 台灣水韭
/ wet days /

Inlet zone for energy dissipation and sediment removal prevents clogging of wetland and silting of vegetation.

Vegetation bands across wetland maximise contact of vegetation with flows, slow flows and promote sedimentation.

Biofilms on plants aid removal of nutrients and pollutants. Plants also oxygenate their root zones, improving aerobic conditions.
B.

/wet days/

/dry days/
site#2 - AQUA-GRID COMMUNITY

future water plan for buildings: minimizing pressure on sewage system

The concept of a sustainable water flow within the newly densify area is:
1. Creating rain water collecting system and simple purify system.
2. Separating drinking water cleaning system with other usage of water, since only drinking water needs more purification treatment.
3. Recycling and reusing grey water as much as possible.
The last chapter assembles all the patterns collected throughout the research process, including the patterns abstracted from research by design, and gives an overview of <Pattern Language for Water Public Space in Kaohsiung> - a Design Principal. In the end, a reflection gives an insight into the after-thought of the project.
6.1 Design Principal for Kaohsiung Water Public Space
6.2 Reflection
Design Principal for Kaohsiung Water Public Space

Pattern #RD-1 | Taking an ax in a city to experiment with different water quality space and generate general principle for other similar location

Pattern #RD-2 | Cloud Burst: Using the city road system as a flooding adaptation base for temporal storage and drainage

Kaohsiung is a city with radial context of the city. In several analysis criteria, Kaohsiung city shows a radial distribution. Therefore the concept was to grasp one line from the city center to the suburban and indicate several nodes along the line to conduct further research. The research method is through the design process to experiment suitable water space according to the location’s surrounding context. Thus, several sets of principals will be created after design, these principals could be used for other locations along other lines within the same city.

#RD-1 profile:
relation to project objectives/ amenity, symbolism, livibility
pattern scale/ town (6000m x 6000m)
location/ Kaohsiung
surrounding context/ varies

#RD-2 profile:
relation to project objectives/ security
pattern scale/ town (6000m x 6000m)
location/ Kaohsiung
surrounding context/ varies

Learning from SLA’s Cloud Burst project in Copenhagen, this project takes the principal and made some refinements according to the Kaohsiung context. By using current public space such as road systems, open spaces, and schools to provide space for flooding buffer and assist the sewage system overflow during storms. Four types of elements are used to consist of the flood adapting system: detention area, detention road, divert road, and absorb road. The elements in the same flooding area work together as clusters, forming a system to adapt flood water coordinately. Between clusters, water flows from one to another.
The grid road system is used as water collecting and water drainage to divert water into the selected intervention areas. With several intervention sites presenting in the area, each site plays a role as a rain bucket to adapt serve rainfall jointly. These “buckets” are at the same time collecting water in the wet season to provide water usage in the dry season.

#RD-3 profile:
relation to project objectives/ security, livibility
pattern scale/ neighborhood (600m x 600m)
location/ Kaohsiung
surrounding context/ city center

Pattern #RD-3 |  ⬤  ⬤  
Adapting grid: using public land to form a flood-protective zone for the surrounding neighborhood

The grid of Rice Field was created for efficient water transportation. In recent years, flooding causes the fields to flood leave roads and buildings as islands floating on the surface. This landscape phenomenon shows how fields contain water within a certain area. Therefore by using traditional water management such as waterways and water gates, we could manipulate the number of field patches to adapt flooding water according to the condition of a storm. At the same time, according to different seasons, the patches allow a variety of plantations to enhance the urban landscape. The symbol of the historical water system is seized by the creation of water open space.

#RD-4 profile:
relation to project objectives/ security, amenity, symbolism
pattern scale/ place (60m x 60m)
location/ Kaohsiung
surrounding context/ city center

Pattern #RD-4 |  ⬤  ⬤  ⬤  
Miniature ricefield uses traditional water management method to create an urban landscape that adapts floodwater and symbolizes the historical landscape
Situated by the coast, the site presents two sources of water, which are fresh river water and brackish tidal water. The site connects the water with the port, therefore a part of the site's water level is affecting by natural tidal change. Together with the freshwater coming from upstream of Ksökong Tsûn Irrigation System, the condition creates various habitats for diverse species. By taking a stroll through the crossing bridge, one will experience changing flora and fauna from one end to another.

**#RD-5 profile:**
- relation to project objectives: connectivity, livibility
- pattern scale: element (6m x 6m)
- location: Kaohsiung
- surrounding context: city center

In the traditional water system of Ksökong Tsûn, segments of waterways near the city wall were used as a defense system, called moats. In Taiwan, primary schools tend to require a higher level of security. Inspired by the old technic, this project takes waterway to substitute fences with water to secure primary schools. At the same time, it provides water space for water playground and water education.

**#RD-7 profile:**
- relation to project objectives: security
- pattern scale: place (60m x 60m)
- location: Kaohsiung
- surrounding context: city center
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<th>amenity</th>
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<td>#C-6 #C-7</td>
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<td>#L-2</td>
<td>#RD-6</td>
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<td>#RD-1</td>
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</tr>
</tbody>
</table>
Reflection

The relationship between people

The relationship between people and the environment has constantly changed from time to time. The earliest cradles of civilization are settled along the water by instinct. Water was the source of life as well as the seed of culture. Through the process of modernization, the attachment between people and water swiftly changed.

Growing up in Kaohsiung, my parents were born in the 1960s, during the time, water was their playground, a place their childhood memories attached to. In the 1970s, Taiwan underwent a dramatic socio-economic change. Development was prior to the environment. By the time in the 70s, they were no longer kids. They were told not to go near the water because the water and its surroundings are always chaotic and polluted. Only until recent years, with the global rise of environmental awareness, a part of Ksōkong Tsùn Irrigation System was regenerated into a water public space. The generation that experienced the loss relationship with water was able to reconnect with it. Through frequent family walks along the regenerated waterways, I learned to know the traditional irrigation system that raised the city I lived in.

The meaning behind the water itself is revealed through personal spatial experience. Daily experience deepens the influence of a place on people’s perception with water. This experience testifies that through spatial intervention, stories of the place can be told on. I didn’t grow up with water present in my childhood. Only if we would, the experiences we have missed will be pieced together bit by bit in the urban space.

The possibility to create a new attachment to place and water

To create a new attachment to place and water, I believe it is crucial to intervene through connecting daily public spaces and public service points. Daily public spaces such as schools, public libraries, neighborhood parks, and public transportation play important rules in citizens’ life. Introducing a water public space within people’s daily realm will aid rebuild and strengthen people’s bond with water.

It was difficult to imagine the life with water in the past at the beginning of the project, as the experience with water wasn’t present through the time I grow up. Therefore, to comprehend the relation between people and water, I interviewed the elders, did literature review, and went through historical photos and historical maps as much as possible. Besides secondary data, I also went on-site visit to the location where some segments of the irrigation system are still present and in use. Using the method of pattern language, the essential elements of a quality water space is abstracted to use for later design decisions. In addition, through case studies in both Asia and Europe, my visits recorded some features of quality water spaces by using pattern language that helps to define and to sculpture a water public space design in Kaohsiung.

Reflection on Flowscape studio: ‘infrastructure as landscape’ and ‘landscape as infrastructure’

Over the last centuries, humans took infrastructures as a tool to conquer nature. The natural dynamic was controlled to maintain a static system. However, this approach has been proven less sustainable and brought irreversible harm to the natural system. Over the years, many learned from experiences that living with nature by allowing natural dynamics is a longer-term solution.

Recalling one of the main problem statements from this project: Kaohsiung’s citizens are separated from water by physical obstacles, thus, this project has to alter the current method of flood-dealing to enhance people’s relationship with water. Taking a landscape approach to face the city’s water challenge, the design intervention brought a multifunctional water space to the city by creating water public spaces that provide citizens recreational use and at the same time adapt flooding water.

The approach of this research project resonates with the theme value that the flowscape studio is provoking of. The growing awareness to create more harmonious forms of urban landscape architecture is a shared value among spatial design disciplines.

The abstraction of research results

By reading the cityscape of Kaohsiung, a radial gradient from the city center to the suburb is observed and analyzed in the research. Therefore on the same radius, locations are similar to another. By taking one radius, this research took two locations to test water public space in different location contexts, one by the coast, the other in a local neighborhood. The outcome of each location was extracted to generate design principles for other similar locations on the radius.

The method to extract design principals in this project took inspiration from Christopher Alexander’s A Pattern Language. The main purpose of A Pattern Language is to easily apply the distilled patterns to any locations to form quality spaces. Therefore, in this project, learning from the remaining segments of the traditional water system in the suburban area and a recently renovated segment in the historical city center is valuable to create patterns to test in other design locations. In addition to that, referring the design concept to historical usage is at the same time to provide symbolic meaning to the site.

The difficulty of using Pattern Language is that there is
no certain way to form a pattern as well as a correct way to use a pattern. Through the process, trying out forming patterns took some trial and error to finally conclude the final set of patterns. The team of A Pattern Language took eight years to formulate a set of patterns for spatial professionals to apply in their discipline. Within less than a year during the graduation project, time is limited to generate a profound and well-thought-through set of patterns. However, the main idea is to deliver the intention to use a locally found parameter to generate a sense of place and take the experience of forming patterns as an experiment.

**Societal relevance**

As daylightening* movement getting on-trend around the world, the capital of Taiwan also started a series of movements to provoke uncovering historical waterways. The project Taipei Wenshan Oasis focused on preserving historical waterways for forming a climate-resilient city by participation design onsite workshops. With personal participation in Wenshan Oasis for two years, I have acknowledged the will of local citizens to invite water public space to be a part of their daily life again. In Kaohsiung, a segment of the traditional water system was also renovated in recent years and it is used by the locals in their daily life. During site visits, it shows the sign of locals willing to be close to the water and the rising awareness of their living environment in the urban context. These observations were taken into account for later design decisions. The project’s intention to provide water public spaces is shown to be supported by social communal will.

*Daylighting refers to “the practice of removing streams from buried conditions and exposing them to the Earth’s surface in order to directly or indirectly enhance the ecological, economic and/or socio-cultural well-being of a region and its inhabitants”. (Khirfan L., Mohrat N., Peck M. A systematic literature review and content analysis combination to “shed some light” on stream daylighting (Deculverting) Water Security, Volume 10, 2020)