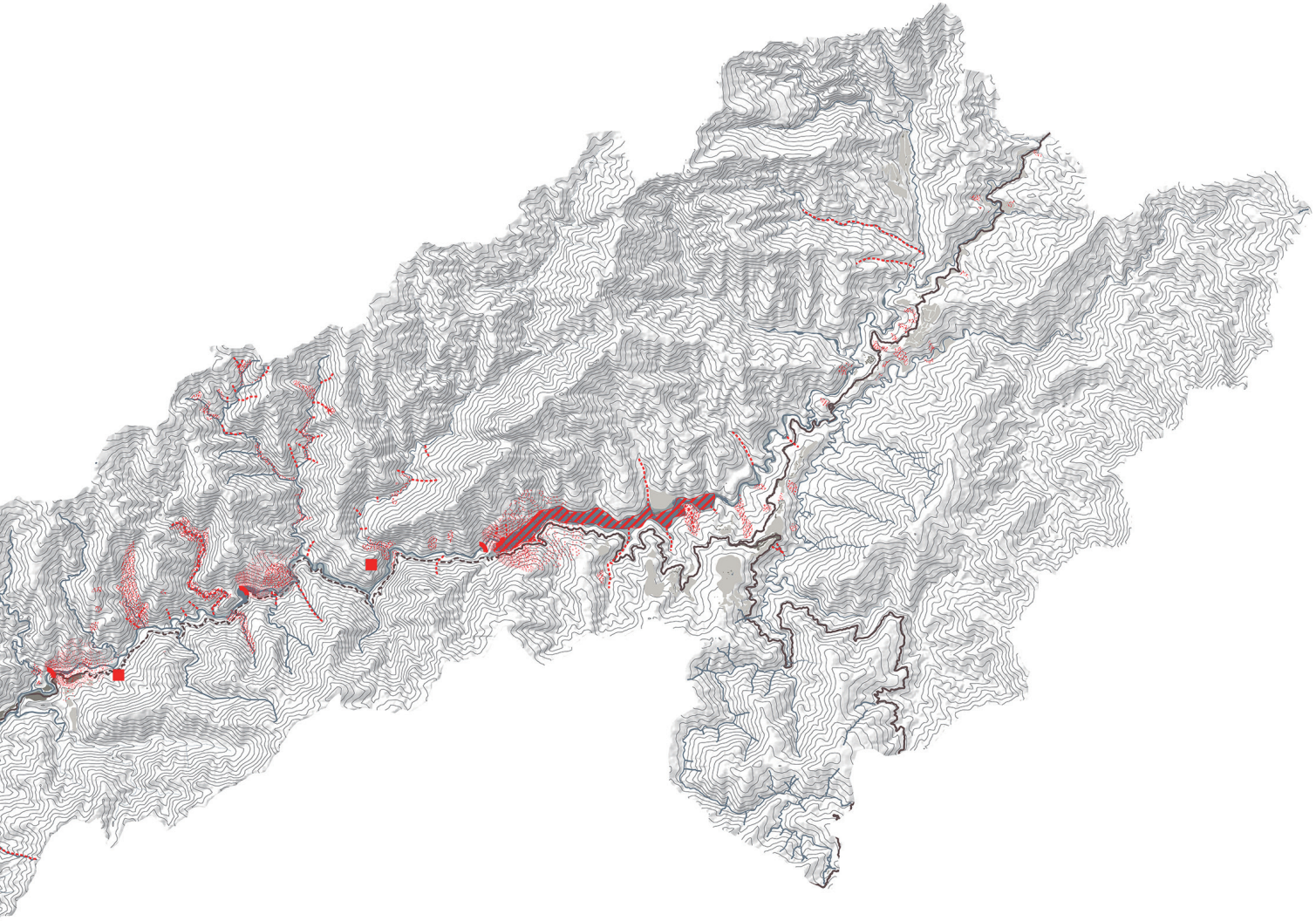

The sensitive river scape, the sinuous territory

Transforming Dajia River Basin as a Water-Sensitive Landscape Infrastructure

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Colophon

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Contents

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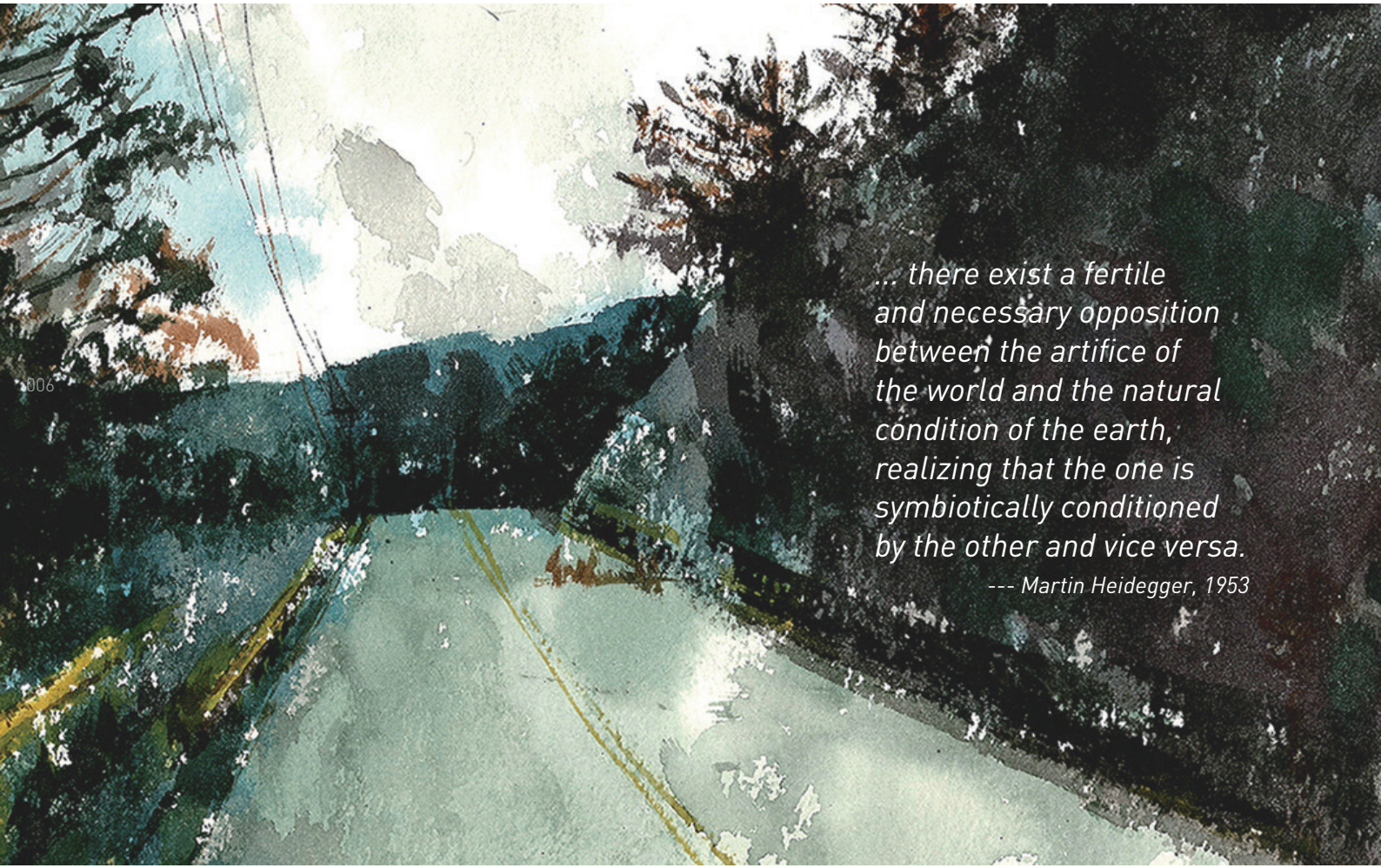


fig. 01 Motor road in the alpine area of Taiwan.
Source: painted by the author (2012)

Abstract

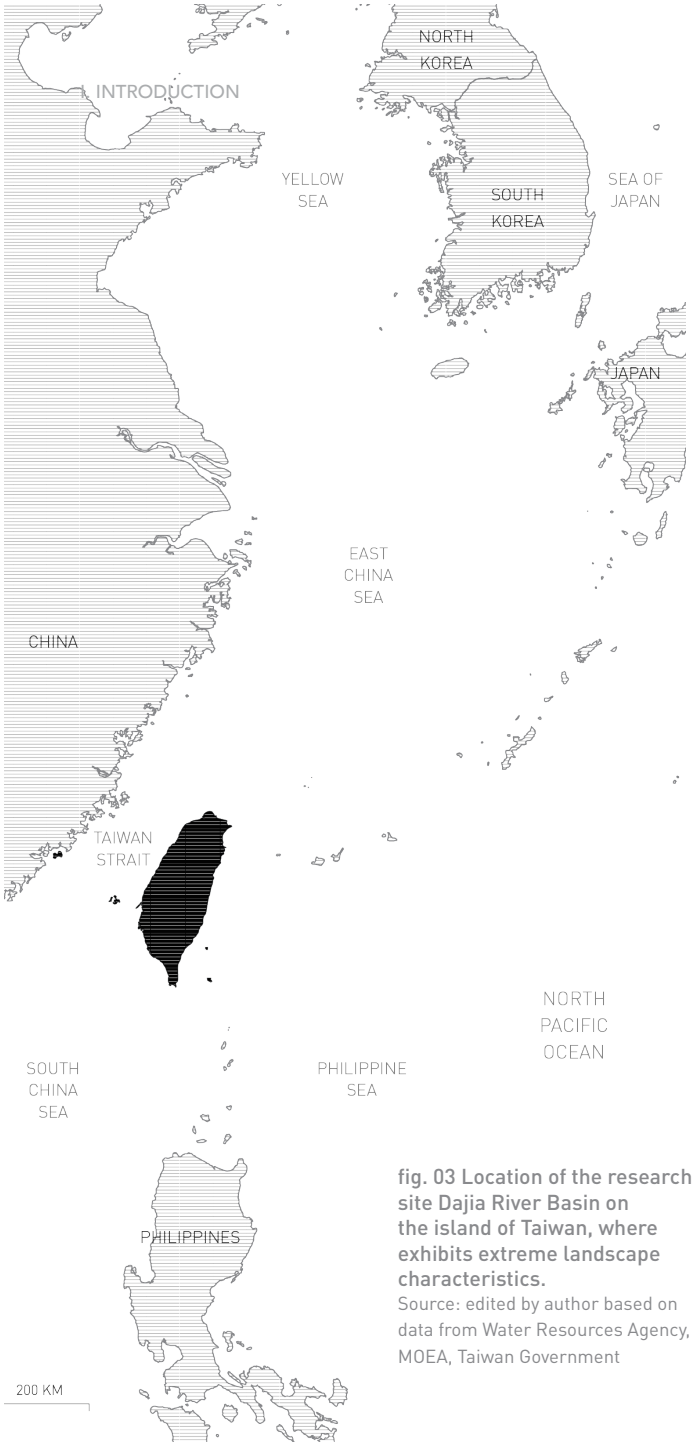
This project explores the landscape potential of Taiwanese river valley in terms of integrating water and river management with urbanism within the context of a dense environment diversity as well as a highly sensitive and dynamic landscape. Taking one of the most illustrative river basin, Dajia River, the steepest river with the most water resource, as the study case, the project intends to test the hypothesis of perceiving mountainous river as opportunities for transforming the river valley as water-sensitive landscape infrastructures.

Based on the theories of landscape urbanism, especially the discourses of landscape infrastructure, the project argues that by enhancing water sensitivity in living environment within river scape, the characteristic of landscape can help building a stronger identity for the territory and its inhabitants. Contextualizing the learnings from theories and practices with context analysis, the research integrates principles, strategic tools and spatial potentials at the regional scale, proposing operative landscape structures as the spatial framework for the future development of the river valley. Based on this spatial framework, strategies for transformation are introduced for upstream, midstream and downstream areas according to their respective situations. Then two zoom-in sites, one at the upstream and the other at the downstream areas, are selected to demonstrate possibilities and potentials through design intervention for integrating water infrastructure with spaces of local habitation and activities. To support the proposals with better feasibility, the project phasing and institutional framework will also be proposed, identifying the priority and potential actors in the process.

With reflections on the contribution to the fields, suggestion to the current planning system, and evaluation of mutual influences between different sites within the river catchment, the thesis expects to provide a showcase with methodology, strategic tools, and spatial possibilities integrating different cases of interaction between human activities and river environment. More importantly, the project exhibits the spatial potential of a mountainous river landscape as an active role in engaging socio-economic with nature, as well as guiding the spatial transformation of the territory for the future.

fig. 02 The landscape of Dajia river upstream area, with alpine agriculture covering the hill-tops beside Deji reservoir.
Source: photo by Min-ming Chen [Online] available at: https://www.flickr.com/photos/83335903@N04/albums/72157631446238646 [accessed 23 Feb. 2016]

I. Introduction



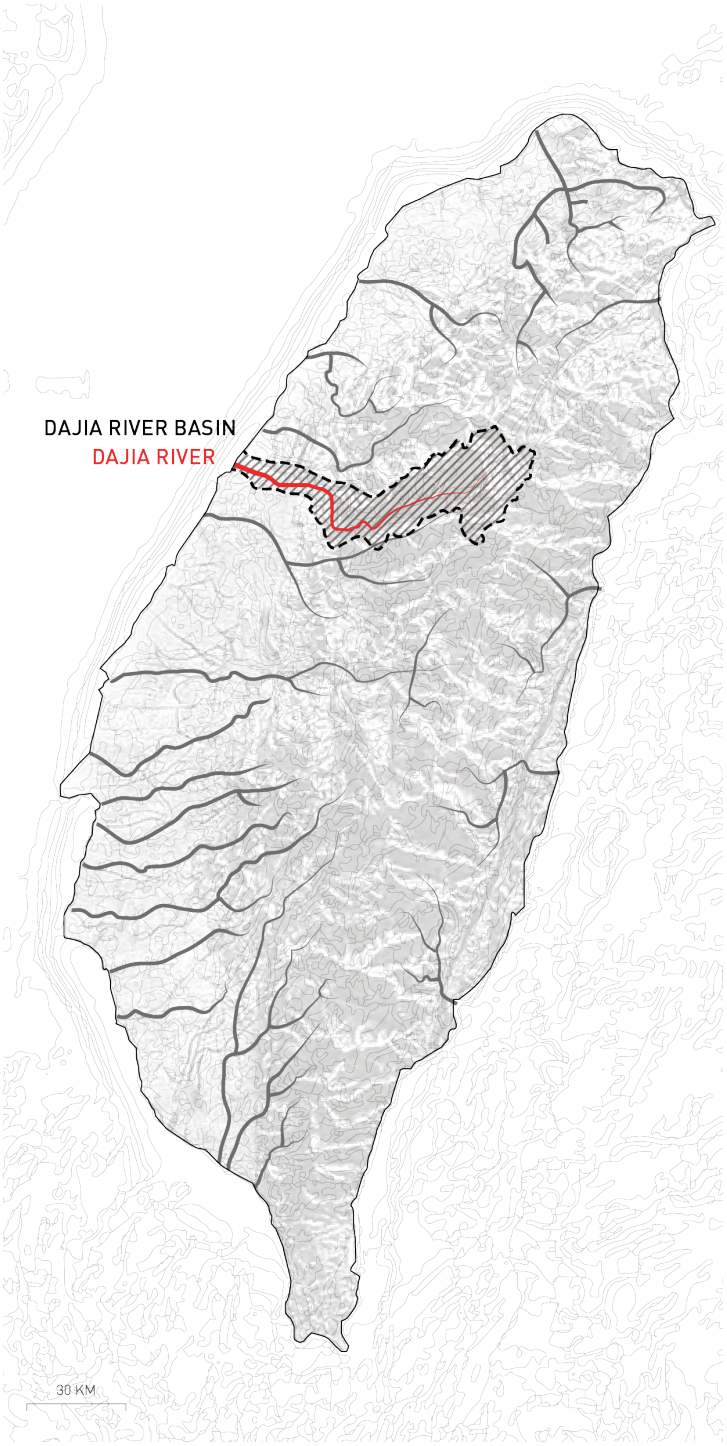


fig. 03 Location of the research site Dajia River Basin on the island of Taiwan, where exhibits extreme landscape characteristics.
Source: edited by author based on data from Water Resources Agency, MOEA, Taiwan Government

I. Introduction

The emphasis in the future must be, not upon speed and immediate practical conquest, but upon exhaustiveness, inter-relationship and integration. (Mumford, 1934) The intricate interwoven of human activities and natural processes has gradually led human societies to ever-increasing complexity and scale of spatial issues. The traditional way of place making which requires weighty apparatus to produce functioning urban effects (Allen, 2001) more and more often fails to prepare a living environment in confronting the forthcoming climate and socio-economic changes. The situation has provoked the emergence of the discourse of landscape urbanism, which explores the potential of landscape in representing and understanding the dynamic systems of the city, and is increasingly perceived as a significant medium for city-making. In many theories and practices, strategies have been developed that attempt to make ecological process operational in design, harnessing natural phenomena such as erosion, succession, or water cycles in the generation of landscapes (Mossop, 2006).

The study area of this thesis situates in Taiwan, where one could find an immense diversity and complexity of natural ecology suffering enormous conflicts with human habitation and activities. The situation shows that the territory is not yet ready for the augmentation of unpredictability and density of extreme hazards. The research scope of this thesis will therefore take the discourses of landscape urbanism as the body of knowledge to emphasize the integration of natural and human processes in planning. Besides, the focused site Dajia River Valley exhibits an urban morphology that is as well largely highlighted in landscape urbanism discussions. It is an urban type that, unlike the traditional core/periphery model, is not focused on a dense middle but instead is a more fragmented matrix of discontinuous land uses (Mossop, 2006).

Furthermore, the the dense and heavy infrastructures which compose a large part of the territory have started to show their limitation with the current model, especially in dealing with water, that needs to be rethought and transformed. The rhetoric of landscape as infrastructure scrutinizes the way in which the landscape of infrastructure has become the most effective means to explore the relationship between natural processes and the city, which is the integral factor in a truly synthetic landscape urbanism (Mossop, 2006). As stated also by Nijhuis and Jauslin (2015), the hybridization of the two concepts, landscape and infrastructure, seeks to redefining infrastructure beyond its strictly utilitarian definition, while allowing design disciplines to gain operative forces in territorial transformation processes. This discourse might shed some light on the transformation and redesigning of the water-sensitive infrastructures in the Dajia River territory.

In this chapter the problem field will be defined to identify the main research scope, and concluded with the statement of issues, the goal of this project and research questions, as well as the social and academic relevance of this thesis. The elaboration on the theoretical and methodological basis will be explained in chapter II, and the further analysis of the identified problems can be found in chapter III. The rest parts of the report present the proposals of overall strategy at regional scale, design interventions at local scale, as well as reflection on technical and institutional evaluations of the project.

I-I. Research Structure

PROBLEM
RIVER + MOUNTAIN = OBSTACLE

HYPOTHESIS
RIVER + MOUNTAIN = OPPORTUNITY

THEORETICAL FRAMEWORK
- Landscape urbanism
- Landscape as infrastructure

DIAGNOSTIC ANALYSIS
- Landscape context
- Historical pattern
- Socio-economic background
- Activities and resources

principles

PROBLEM FIELD
- Sensitive, dynaic, and fragile landscape
- Challenging water resource management

study case

TAIWAN

- mountain / river
- living environment

extreme, unpredictable

EXTERNAL THREATS
- Climate changes
- Socio-economic shifts

TEST & RESEARCH BY DESIGN

RIVER + MOUNTAIN = OPPORTUNITY

RESEARCH QUESTIONS

How does it work?

What can we do?

How do we apply them?

What can we learn from this?

respond

TECHNICAL INQUIRY

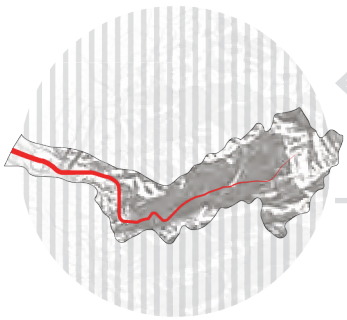
scientific calculation

INSTITUTIONAL INQUIRY

planning system

existing strategies

testing site



DAJIA RIVER BASIN

evaluation

reflection

RESERCH BY DESIGN

test

intervention

DESIGN PROPOSAL

through-scale integration

up-mid-down stream synergy

VISION + STRATEGY

constraints / potentials

I-ii. Problem: River + Mountain as Obstacle

PROBLEM FIELD

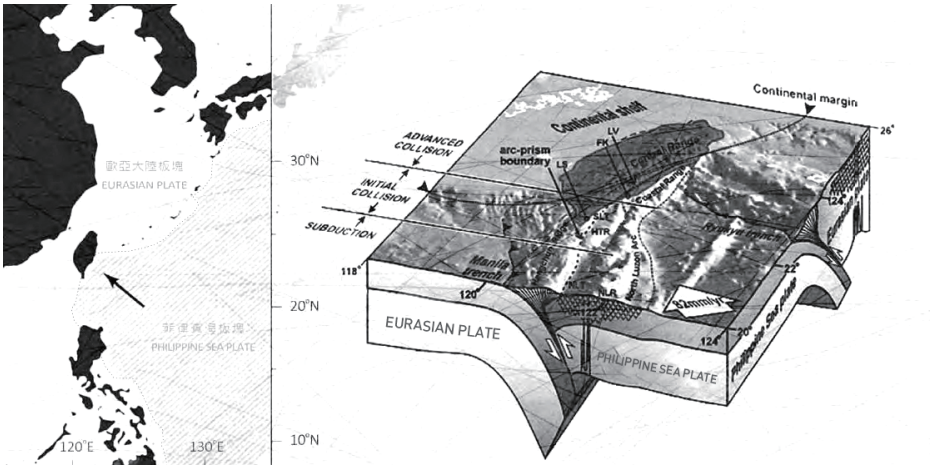


fig.04 The still-ongoing converging process of two Earth's plates, the Eurasian Plate and Philippine Sea Plate, formed the island of Taiwan.
Source: edited by author based on data from NCU Geology GIS database.

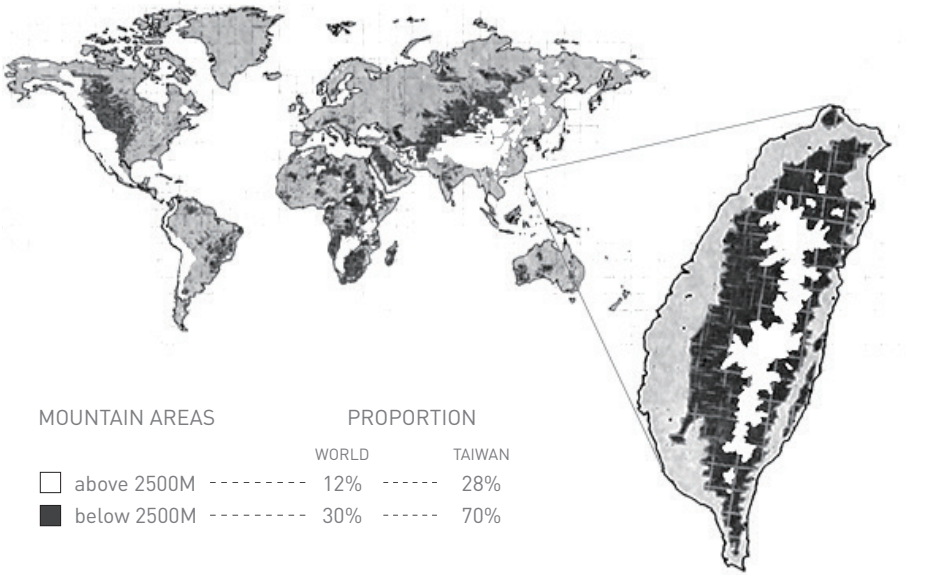


fig.05 Mountain and alpine proportion map of the world and Taiwan.
Source: edited by author based on data from: http://lawr.ucdavis.edu/

1. THE SENSITIVE AND DYNAMIC LANDSCAPE

Landscape is defined as "an area, as perceived by people, whose character is the result of the action and interaction of natural and/or human factors," (Council of Europe, 2000) and is increasingly emerging as a model for urbanism (Allen, 2001). By this definition, the concept of landscape is conceived as an ongoing process of exchange (Corner, 1999) between human activities and the natural condition of the land, with one fundamentally influenced by the other.

Born from orogeny, Taiwan is situated at the converging realm of two Earth's plates, namely the Eurasian Plate and Philippine Sea Plate (fig.04), and this compressing process that elevated the terrain from beneath the sea since six million years ago is still ongoing, forming the extreme geography of the mountainous island. In fact, Taiwan has the highest alpine density among the world, with 70% of the land mountainous, and even 28% over 2500M above the sea (fig.05). The precipitous topography together with the geology composition, abundant rainfall, various natural hazards, as well as the warm and humid climate, contribute to active weathering and erosion of the rocks. **The landscape characteristics of Taiwan is inherently highly dynamic and sensitive**. On the other hand, it also exhibits high biodiversity and geo-diversity due to the lively processes of nature, which have been regarded, both locally and internationally, as precious assets contributing to Earth's environment quality.

Besides, the scale of space and time in Taiwan's landscape is condensed, with drastic topographical, geological, and climate changes within short distances and fast flows. For example, many rivers transported incredibly large amount of sediments within very short distances. If we look at the Yellow River in China, who shifts around 2,650 tonnes/m^2 of silt per year, which is already largely higher than the world's average amount. Nevertheless, there are at least 43 rivers in Taiwan with sediment transportation more abundant than that of the Yellow River. As a matter of fact, there are at least 12 rivers transporting more than 10,000 tonnes/per square-meter of sands ever year.

This dynamic and sensitive character of the landscpae inevitably results in its vulnerability, as all elements are congenitally not at all static and stable. In this context, the mutual influences between ecological process and human activities become extremely acute and intricate. For instance, the abundant volumes of sediment and water clogged to pass through short, steep and narrow trajectories, has severe impact to the performance and the feasibility in maintenance of dams and roads along rivers. These infrastructures in return, if not designed thoughtfully, could also easily weaken the geology structure and thus, more erosion would very likely lead to the producing of more sediment and water flows, making the operation of infrastructure even more difficult.

This thesis starts with the cognition that the sensitive and dynamic landscape fundamentally influences the performance of man-made structures, such as the infrastructures, which is self-constrained in a vicious circle, resulting in a mutual-damaging situation with its current model. In this especially fragile context, it requires a more integral thoughtfulness and more delicate design to allow the interwoven relationships of artifact and nature operating in a synthetic and mutual-supportive way.

2. THE CHALLENGING WATER RESOURCE MANAGEMENT

Mountains, being the sources of the rivers, have always held a privileged relationship with water (Wiegandt, 2008). Observing the landscapes of Taiwan, five mountains stand as the central ridge structure of the island at the north-south axis, which results in all of the rivers in the country relatively short, and most of them flow rapidly and swiftly, running through drastic elevation change in short distances. Figure 3 on page 10 shows how the topography has oriented the main rivers into east-west directions, generating short river courses, with the longest one only 186 kilometers and many even less than 50 km. Compared with many rivers in the world, the rivers in Taiwan are relatively short and steep (fig.06). The study site of this thesis, Dajia River, is among them the steepest.

This phenomenon has caused intense erosion, displayed as fragile and unstable river landscape that has limited the availability and capacity of buffering spaces to keep water. Additionally, though with altitudes as high as over 3000 meters, the climate of Taiwan is too warm for the alpine areas to maintain glacier zone, which has been playing a significant role to store huge volume of water and adjust discharge into a steady process, such as the cases of Alps, Andes, and many other mountains in the world.

The landscape of Taiwan is by nature difficult to keep water. To fulfill the rising demands of agricultural, industrial, and drinking water usage, more than 50 dams and reservoirs have been constructed in the recent 100 years (fig.07), and in support to those, motor roads and hydropower plants also extended onto the arduous slopes. Decades of urbanization and cultivation together with

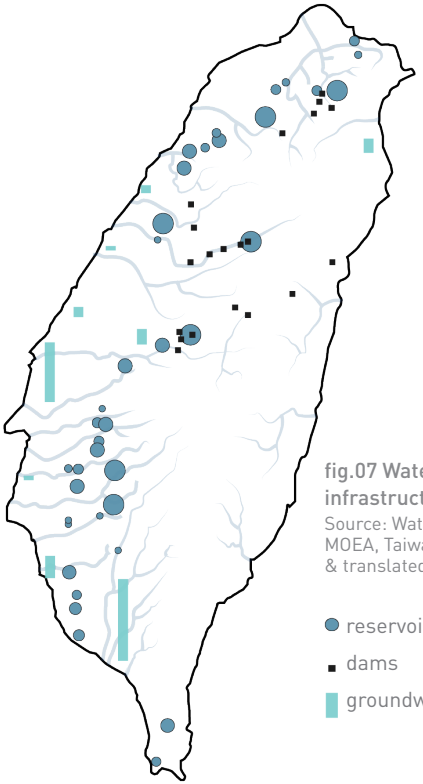


fig.07 Water storage infrastructure in Taiwan. Source: Water Resources Agency, MOEA, Taiwan Government, edited & translated by the author.

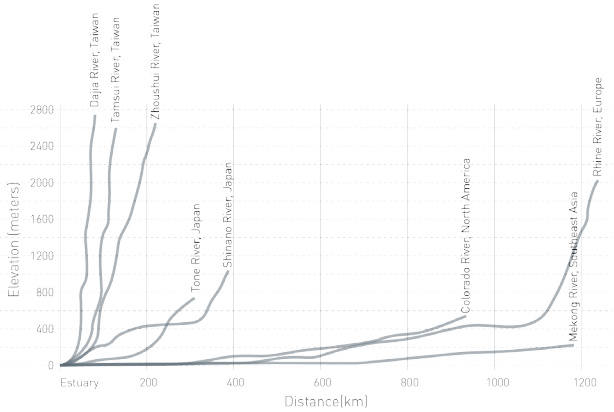


fig.06 Conparsion of rivers elevation and distance in Taiwan and the world. Source: Water Resources Agency, MOEA, Taiwan Government, redrawn and translated by the author.

the gradual infrastructuralization (fig.08) of the natural lands to extract water resources for supporting urban functioning manifested a straightforward, simplified, heavy-engineered approach to control natural forces and overcome geological, geographical and hydrographical limitations. The increasing technical efficiency of engineering achievement had once been the pride of hydrology and geology engineers.

However, These ubiquitous urban environments have been considered and evaluated solely on technical criteria and somehow tempted from having to function socially, aesthetically, or ecologically (Mossop, 2006). Moreover, the inherent fragility of the land limits the possible locations that are suitable to install water infrastructures. Today there is almost no more possible dam site for building a new reservoir. As for the existing ones, there are also severe problems coming from the enormous quantity of sediments which year by year fill into the reservoirs (fig.09), reducing fast their capacity.

As it is almost impossible to dredge and clean the sands and muds out of the reservoirs, due to constraints of both fiscal and spatial availabilities, a future of no more reservoirs to manage water resources is inevitable and approaching. In fact, it is estimated that, due to sediment accumulation, as close as until year 2030, in total 50% of the reservoir capacity in Taiwan will be lost. This means there will be around 4.5 million people suffer from lack of water every day if there is no solution proposed and implemented (Lee, 2014). Even though, today most of the water resources are still captured by reservoirs and dams, with a little part contributed by underground water, which causes other problems such as land subsidence.

Considering also the fact that Taiwan actually has an abundant amount of rainfall, around 3.4 times of world average, yet the available water resource per person is only 18% of world average (fig.10), the current water infrastructure model fails to translate in an appropriate way the natural flows into resources to support the efficacy of the artificial dimension of the world, nor could it in return give a positive feedback to the environment.

fig.08 (below) The heavy-engineered infrastructure landscape of Dajia River valley.
Source: photo from mapio.net

fig.09 Wushe (霧社) Reservoir, now 65% filled with sediment.
Source: Taiwan Academy of Ecology epaper (2013) [Online] http://enews.url.com.tw/ [accessed 20. Feb. 2017]

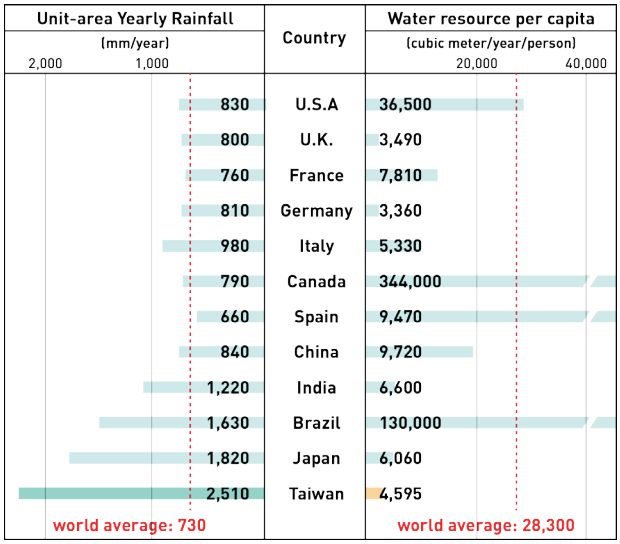


fig.10 Data of yearly rainfall and average water resources. Source: edited by author based on Data from National Taiwan Museum Water Resource exhibition

To maintain the operation of the infrastructures, more investment is needed to restore the frequently breaking-down systems after each natural disaster such as typhoons, earthquakes, rainstorms, etc., causing huge social and economical cost to the society. The gradually infrastructuralized river scape also lead to irreversible ecological damages. For example, at Dajia River, the focused site of this thesis, there once were more than 300 species of fishes, now has reduced to less than 100 as a result of the dense infrastructures along the river.

With the current water infrastructure model facing a bottleneck, the hard-engineered reservoirs and dams could not be the answer to water resources for the future society (or should never have been for the early society). In recent years, in the field of urbanism, landscape, hydrology and ecology, insights into the potentially irreversible harm such single purpose-design has done to natural systems resulted in a growing awareness to strive for more harmonious forms of urban landscape architecture (Nijhuis, 2015). It is essential to rethink the water infrastructure system based on a better understanding of the land on which we live. A new model which takes into consideration the natural flows and the relationship of river and mountain, the geology and soil character, the social and cultural dimensions of landscape is urgently necessary.

3. THE NEGLIGENCE OF LANDSCAPE IDENTITY

According to James Corner (1999), the landscape idea arises as an eidetic filter through which different cultures view their woods, mountains, waters, and fields, and gain a sense of social identity. The mountainous rivers of Taiwan exhibit an unique landscape with diverse geographical and ecological patterns within a compacted time-space frame. However, through decades, the emphasis was more placed on the difficulty it brings to the water resource management, infrastructure construction, as well as urban development. Therefore, for many decades the spatial planning in Taiwan seeks a hard-engineered approach to overcome these obstacles. This reflects in space a divide-and-concur ideology and thus the technical and mono-functional infrastructures that can be regarded as partially responsible for the augmentation of seriousness and frequency of damages caused by natural hazards. In oppose to the increasing devastation to the natural ecology as population continues to grow and resources diminish, another voice aroused, advocating the sentimental nostalgia or conservatism concepts in the recent years. This approach believes landscape concern ought to be directed solely toward the stewardship of the natural world, aiming at the restoration of an essentially cultureless natural world (Corner, 1999).

This situation is evident if one look at the national spatial planning in Taiwan. First of all, the population distribution didn't take into consideration the land capacity and geological character of the land, with almost fifty percent of the population concentrated in northern Taiwan (fig.13), and the trend still continues. The imbalanced population distribution caused the unfair resource distribution among different parts of Taiwan, young-people leaving in many central-west and southern cities, while in the northern Taiwan the growth of metropolitan area led to over congestion, unaffordable housing and social conflict that are further threatened by natural hazard risks such as soil liquidation and intense rainstorms. As a result, in order to increase attraction so as to compete for resources, cities seek to gain attention through big facility constructions with international competitions, or

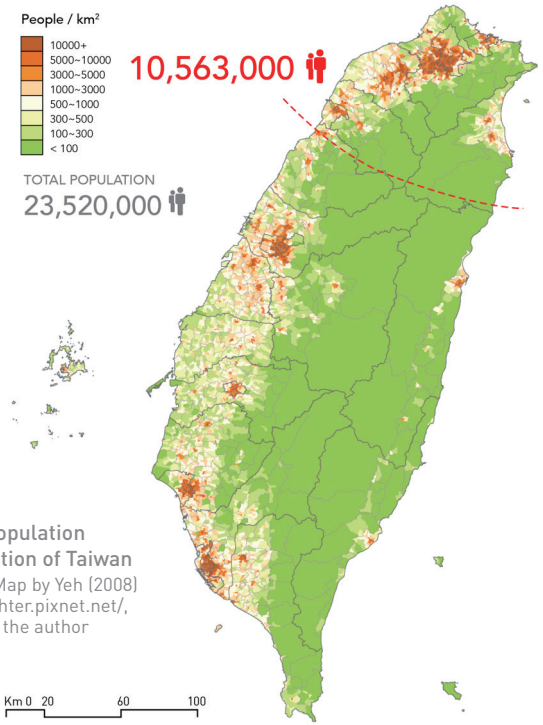
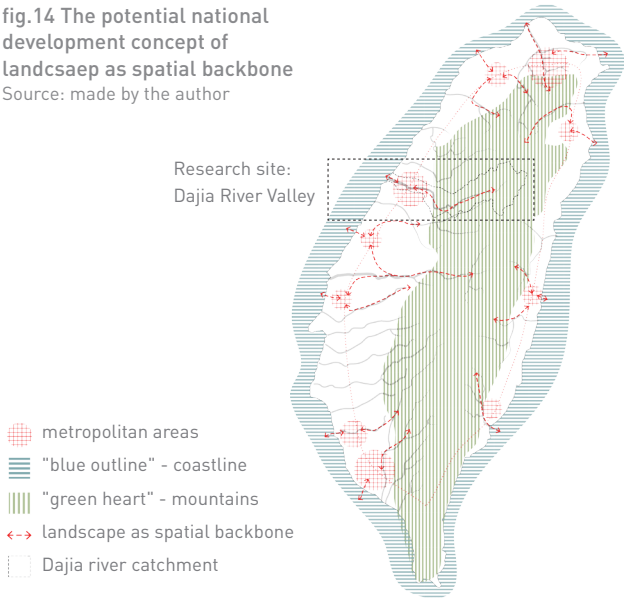


fig.13 Population Distribution of Taiwan
Source: Map by Yeh (2008) http://richter.pixnet.net/, edited by the author

developing new towns which ended up as ghost towns owned by real-estate investors without real residents. The cities have lost their identity and could not position their roles in the national spatial framework. While in fact Taiwan's unique landscape character can be regard as a nature "green heart" with "blue outlines", and the river valleys together with the concerned urban areas can be perceived as territorial corridors of diverse types. The landscape has a potential to play a strategic role in building stronger identity out of the the landscape quality, with the cities as important nodes contributing to the collective life in each shared river territory (fig.14).

In other words, the landscape potential in terms of culturally innovation and social engagement is virtually neglected or not explored at all. In the metropolitan area of Taichung, whose water usage relies largely on water resources from Dajia River, the official urban plan does regard the environmental elements as an important structure for future spatial framework (fig.15). However, from some investigation of land use regulations and industry policies we can found that landscape is only passively recognized as a picturesque background that needed to be conserved as a distant scenic painting. The active role of landscape's engagement into daily-life places and helping a territory to establish collective identity and meaning (Corner, 1999) is yet to be explored.

fig.14 The potential national development concept of landcsaep as spatial backbone
Source: made by the author



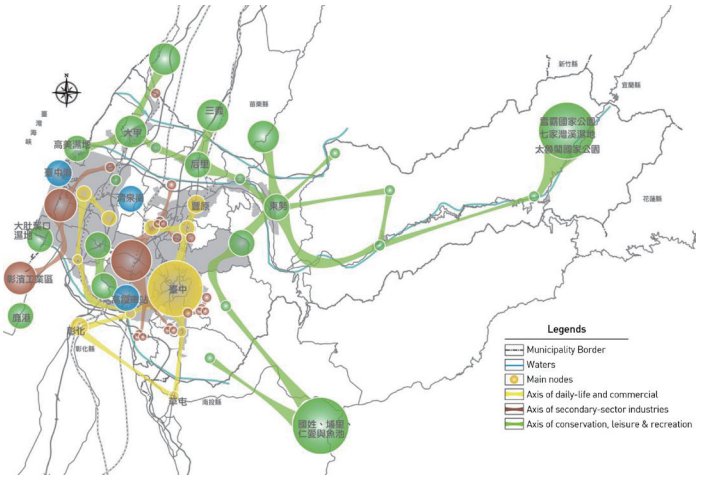


fig.15 The Municipal urban planning concept of Taichung Metropolitan area.
Source: Urban Development Bureau, Taichung City Government; translated by the author.

4. THE EXTERNAL THREAT: THE CHANGING CLIMATE

The difficulty of managing water is explicitly intensified by the augmentation unpredictability and frequency of extreme weather brought by climate changes, albeit the island is already highly exposed to natural hazards (fig.16) such as typhoons, rainstorms, and earthquakes, all of these could further weaken the soil and geological structure. Research has also show that there is a tendency the overall situation of weather is getting even more extreme. In recent years, the supposedly rare situation of intense rainfall of 200-year return has happened almost every two year (Lee, 2014). The statistic figure also shows that both the amount and the frequency of extreme rainfall and drought periods are increasing significantly (fig.17).

In recent years, more often do we see floods in some cities whenever there comes an intense rainfall, while the insufficient of water supply threatens the activity of many industries (especially agriculture) during droughts (fig.19). This is taking place with increasing frequency, almost happening every year. The current mountainous river landscape is not ready for the forthcoming climate threats, and the subsequent socio-economic changes.

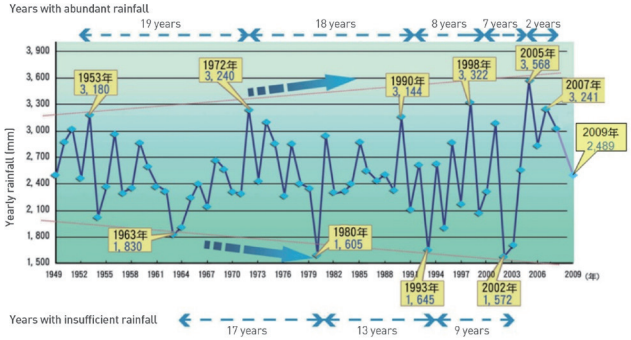
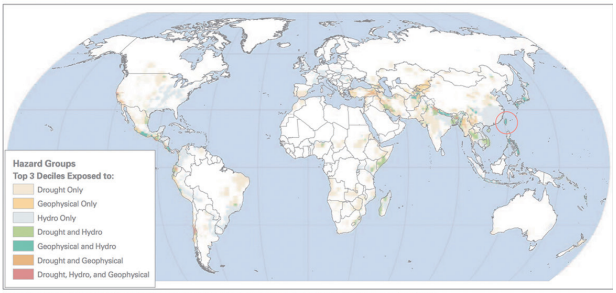


fig.17 (left) Statistics showing the extreme rainfall events in the recent 60 years.
Source: Speech slide of Lee, H.Y. (2014) [online] available at: https://www.slideshare.net/ [accessed 10 Apr, 2017]; translated by the author



Countries Most Exposed to Multiple Hazards

a) Three or more hazards (top 15 based on land area)

Country	Percent of Total Area Exposed	Percent of Population Exposed	Max. Number of Hazards	Country	Percent of Total Area Exposed	Percent of Population Exposed	Max. Number of Hazards
Taiwan	73.1	73.1	4	Vietnam	8.2	5.1	3
Costa Rica	36.8	41.1	4	Solomon Islands	7.0	4.9	3
Vanuatu	28.8	20.5	3	Nepal	5.3	2.6	3
Philippines	22.3	36.4	5	El Salvador	5.1	5.2	3
Guatemala	21.3	40.8	5	Tajikistan	5.0	1.0	3
Ecuador	13.9	23.9	5	Panama	4.4	2.9	3
Chile	12.9	54.0	4	Nicaragua	3.0	22.2	3
Japan	10.5	15.3	4				

b) Two or more hazards (top 60 based on land area)

Country	Percent of Total Area Exposed	Percent of Population Exposed	Max. Number of Hazards	Country	Percent of Total Area Exposed	Percent of Population Exposed	Max. Number of Hazards
St. Kitts and Nevis	100.0	100.0	2	Mexico	16.5	9.6	4
Macao, China	100.0	100.0	2	Korea, Dem. People's Rep. of	16.4	13.5	3
Antigua and Barbuda	100.0	100.0	2	Lao People's Dem. Rep. of	15.2	12.6	3
Hong Kong, China	100.0	100.0	2	Turkey	15.1	11.3	3
Taiwan	99.1	98.9	4	Panama	15.0	12.6	3
Vanuatu	80.8	75.6	3	Swaziland	14.3	14.2	2
Costa Rica	80.4	69.2	4	Nicaragua	12.4	49.8	3
Philippines	62.2	73.8	5				
Nepal	60.5	51.6	3				

fig.16 (above) Taiwan is one of the countries mostly exposed to natural hazards.
Source: The World Bank (2005) Natural Disaster Hotspots: A Global Risk Analysis

PROBLEM STATEMENT

EXCESSIVE WATER

fig.18 The Daji Reservoir at the upstream of Dajia river, which contains abundant water resources.
Source: photo from video clip by Y.S. Wu.

As the population grows and resources diminish, water management becomes crucial with issues and needs for flooding protection, maintaining ecosystem integrity, and restoration as well as protection of water resources, particular where human impacts were severe. (E. Herricks & L. Osbonrne, 1985). The landscape of Taiwan is highly dynamic, sensitive, and fragile, providing enormous challenges when urban development attempts to control natural flows, such as water, soil, and geology, with hard-engineered infrastructures. Especially in the case of water system, decades of infrastructuralization of the riverscape has taken its toll on the society in terms of irreversible ecology, human life, and property devastation.

In fact, though unevenly distributed both temporally and spatially, the yearly rainfall amount in Taiwan brings a large quantity of water. However, most of the water flows rapidly into the sea, which not only barely contribute to the supply of resources but even result in strong erosion which further worsen the damage of natural hazards. The unstable and dynamic pattern of the natural flows were not taken into consideration when the existing water infrastructure were designed, thus there is this paradox of abundant rain fall with frequent drought (fig.18 & 19), disclose the incongruity of the current water management system.

fig.19 Farm fields forced to fallow due to frequent drought and the policy of prioritizing industrial platforms with water usage.
Source: photo from LTN News

Moreover, as the importance of the unique and lively natural process of Taiwan's landscape has long been neglected, in compensation this has led to the growing ideology of pure-conservation and sentimental nostalgia for the environment. Both approaches together limit the potential of landscape in a dualism thinking, reduce the possibility of landscape to embrace difference and complexity, to establish relationship between socio-cultural and natural aspects, and to allow flexibility of spaces to be adaptable for future changes. Neither direction is feasible and probable in solving the conflict between artifice and nature, leading to the recognition that a better integration of water landscape and urban environment is essential for both ecosystem maintenance and social, economical and cultural reasons.

As the capacity of many water infrastructures continue to decrease and the weather getting increasingly extreme and unpredictable, the existing water infrastructure system not only fails to fulfill the current need, nor could it prepare the territory ready for the forthcoming future change. Besides, it has also become one of the main factors of many water-related disasters. A rethinking of the water infrastructure model is urgently necessary.

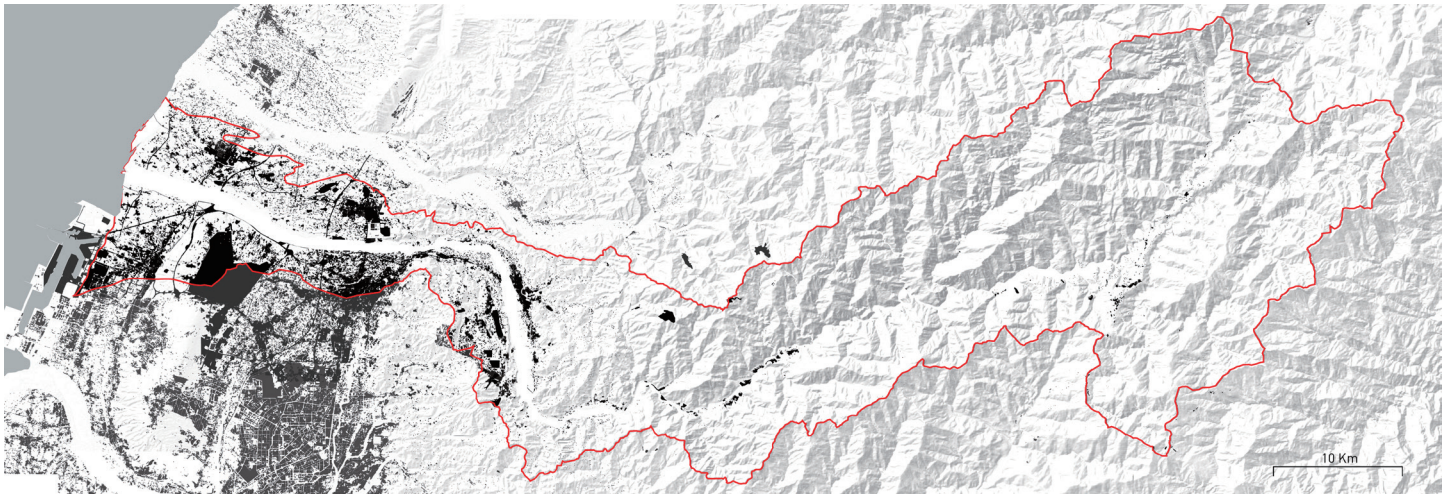


fig.22 Current urban occupation in the area dependent in water resources of Dajia river catchment.
Source: map made by the author based on data from National Land Surveying and Mapping Center, MOI.

fig.20 The upstream landscape of Dajia River, constructed with Daji Reservoir and cultivated with alpine agriculture.
Source: photo from YANNLIN PHOHO (www.yannlin.com.tw/)

fig.21 The mid-stream landscape of Dajia River and Shigang dam to manage water resources for Taichung area.
Source: photo from YANNLIN PHOHO (www.yannlin.com.tw/)

DAJIA RIVER BASIN: AN EXTREME CASE

In this research the study focuses on Dajia River Basin for it is an extreme case. Being the steepest river, it represents the typical mountainous river landscape in Taiwan. Possessing the most abundant amount of water resource, the spatial arrangement of the river is closely related to water infrastructures (fig.20 & 21), yet the water supply for the area is frequently insufficient. Along the river, various land use patterns present diverse landscapes, a variety of spatial issues and urban morphologies (fig.22), presenting the problems and potentials of the integration of human habitation and nature.

Dajia River situates at central-western Taiwan. Originated from the Central Ridge Mountains (中央山脈) and Xue Mountains (雪山山脈), the river is 124.2 km long, with slopes ranging from 1/16 to 1/100, being the steepest river in Taiwan (fig. 23 & 26), and is a typical riverscape which flows rapidly and swiftly with strong erosion and abundant sediment transportation. The average rainfall of Dajia River catchment is 2,155 mm per year, while 77.5% of the rain concentrates between April to September (fig.24), with as large as around 2,500 mm difference between mountainous and plain areas (fig.25), showing a very uneven distribution of precipitation in the territory.

The catchment contains the largest amount of water resources, providing drinking water, agricultural irrigation, industrial water usage, and hydropower electricity generation for the Taichung Metropolitan area in Taiwan (fig.27). Dajia River is one of the river with the highest amount of water resources. The annual runoff is about 2.6 billion cubic meters, with around 38% of the river runoff is utilized as water resources. The peak discharge

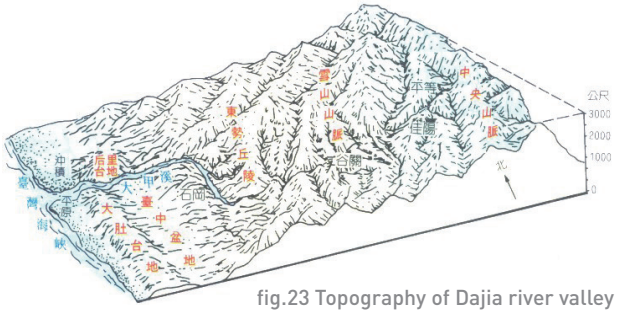


fig.23 Topography of Dajia river valley
Source: http://www.tlsh.tp.edu.tw/

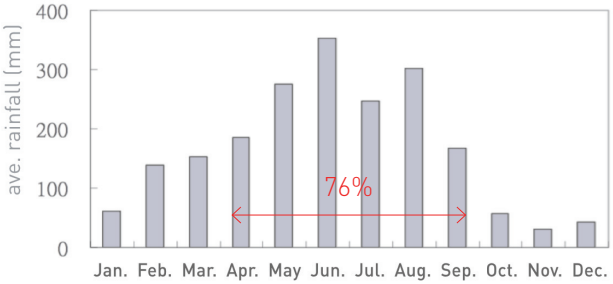


fig.24 Monthly average rainfall in Dajia catchment
Source: Water Resources Agency, MOEA, Taiwan Government

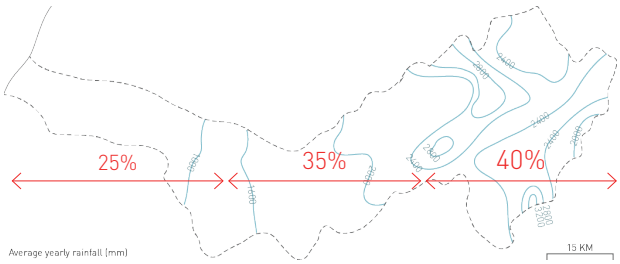


fig.25 Average yearly rainfall map of Dajia catchment.
Source: made by author based on data from CWB, TW Gov.

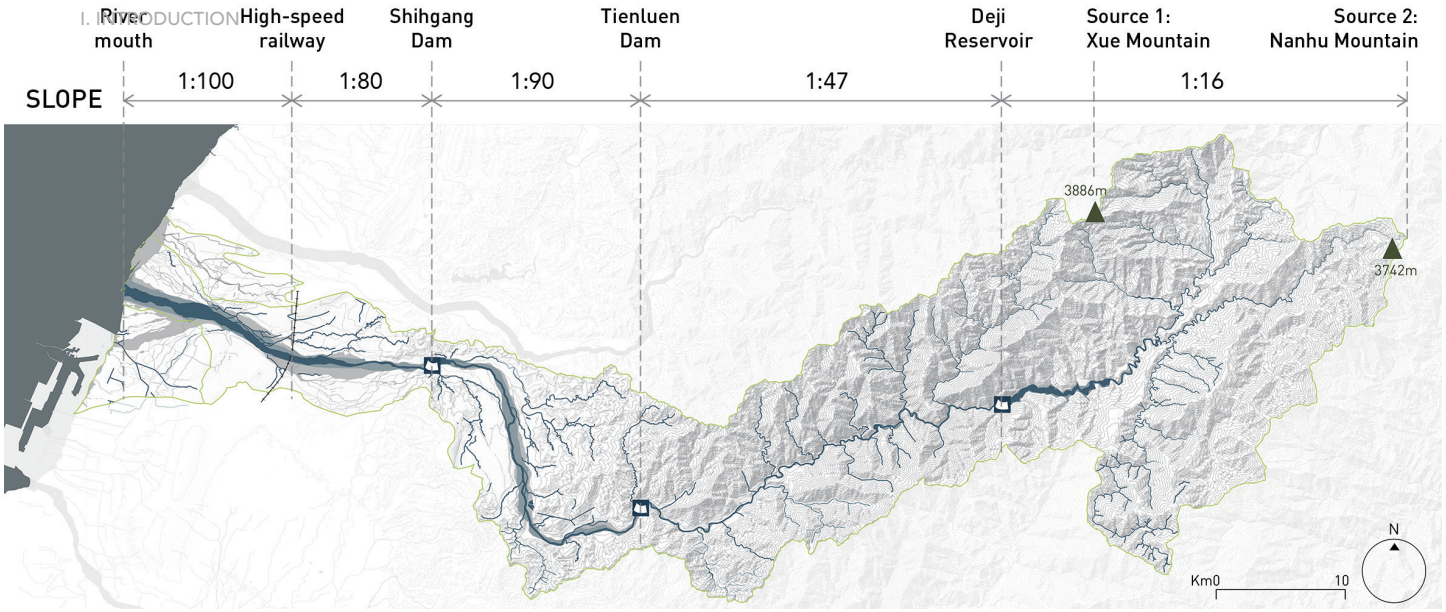


fig.26 Slopes and main infrastructure along different sections of Dajia river
Source: made by author based on data from GIS & Water Resources Agency, MOEA, Taiwan Government

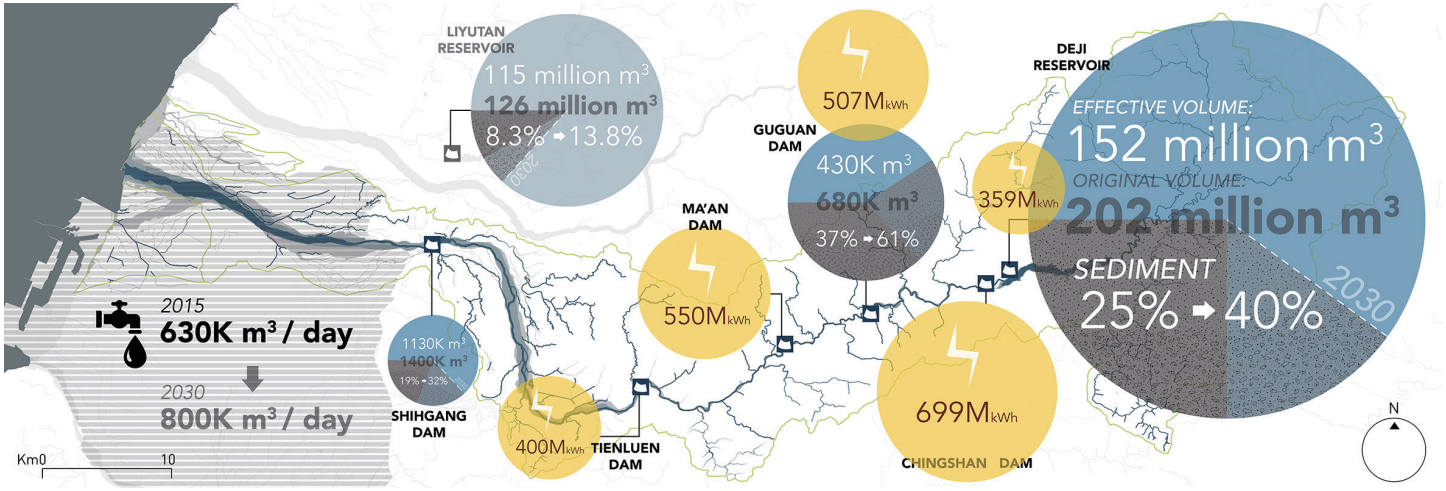


fig.27 The expected future water demand and sediment accumulation in the reservoirs in 2030; the current hydropower generation of each dams.
Source: made by author based on data from Water Resources Agency, MOEA, Taiwan Government

Dajia river
Flooding plain
Historical river courses

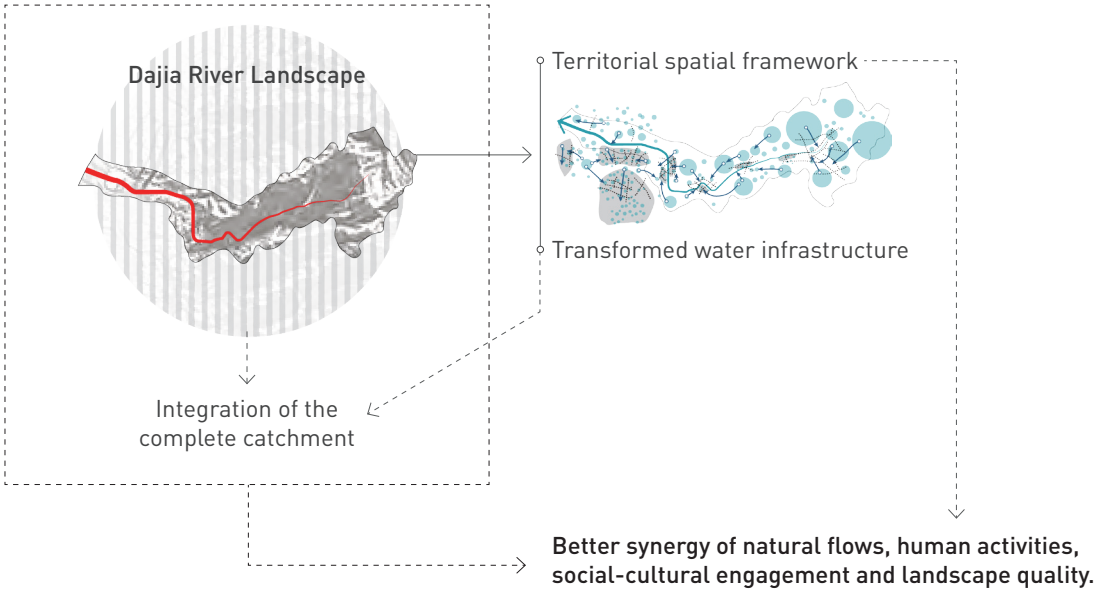
at the river mouth is 10,300 in 100-year return period (the criteria currently used as discharge management standard).

There are currently 6 reservoir/dams and 5 power plants along Dajia river, the density of water infrastructures is also the highest among the whole country. From figure 27 we can see there is an predicted growth of water demand in the Taichung metropolitan area, where the water supply relies mainly on Dajia river, and partially supported by Liyutan (鯉魚潭) Reservoir which belongs to Da'an river catchment in the neighboring municipality. Besides the increasing demand for water, there are a serious sediment accumulation problems in almost all of the reservoirs.

The water infrastructures also provide hydro-electricity generation, which demonstrates sustainable energy symbols. However, the six power plants all together produces however less than 1% of the total electricity consumption in Taiwan. Considering their frequent collapse during typhoon and heavy rains, these hydro power plants have been taking more economical and social costs than the benefit they could generate (Chang, 2013).

In short, the water infrastructure along Dajia River could not act as an operative interface to engage the natural processes with human activities, nor could it establish a responsive mechanism for the society to give positive cultural input and integral factor in the generation of a truly synthetic landscape. Therefore, in this thesis the author takes the territory of Dajia River Basin as the study case, to explore the landscape potential of a mountainous river landscape in integrating human habitation and natural environment. The design of landscape as infrastructure will be the main approach to test the hypothesis of mountainous river landscape as an opportunity for the territorial transformation. The project will propose principles and strategies for the region to adapt to the changing ecological, social and economic context, and to move on towards an era with the role of reservoirs to regulate water flows replaced by the landscape-based structures.

I-III. Hypothesis: River + Mountain as Opportunitie



This thesis explore the potential of the landscape of Dajia River Basin. Based on the current situation that the existing infrastructure approach being problematic and a transformation is needed, the research tests the hypothesis that designed landscape as infrastructure can be allowed to develop over time (Mossop, 2006), engage social and imaginative dimensions as much as engineering (Shannon & Smets, 2010), and perform the task of shaping urban landscapes (Nijhuis & Jauslin, 2015).

A sequence of hypotheses will be guiding the analyses towards proposals. Firstly, the diagnosis of the natural context will be employed to understand the most permanent and enduring elements that are believed to dominantly underly the spatial framework for the area. Secondly, as we observe the territory, a large part of the river valley is infrastructuralized with supportive functions for the neighboring metropolitan area, such as dams and reservoirs for water supply, agricultural fields for food production, and motorways for transporting the resources between logistic points. The territory has generally become a set of mono-functional realm of infrastructure that is presumed to require a rescue from the limbo of urban devastation to recognize its role as a part of the formal inhabited city (Mossop, 2006). Thus the study of historical patterns and current land uses will also be conducted, so as to integrate the various potentials in the territory, rethink an interwoven matrix as the future spatial model which, as stated by Mossop (2006), will recognize that all types of space are valuable, not just the privileged spaces of more traditional parks and squares, and they must therefore be inhabitable in a meaningful way.

Lastly, the political potential of this project will also be discussed as the whole catchment is mostly within the administrative border of Taichung Municipality. This might reduce the complexity of management since the international competition for use among different sectors (Wiegandt, 2008) in many river basins around the world. However, the compartmentalized planning system of Taiwan and the lack of an cross-nation binding forces, such as the role of the River Basin Management Plans of the European Union, might add another layer of difficulty to the project.

I-iv. Research Objective and Questions

The aim of this project is to develop a landscape-based strategic plan for transforming Dajia River landscape into a water-sensitive and integrated territorial infrastructure.

The intention is to construct a spatial framework for which the mountainous river with its highly dynamic, sensitive and vulnerable landscape characteristic, as well as the complexity of its cultural and historical patterns of human activities will be taken into consideration in the generation of a more sustainable future landscape. It is assumed that in this way a reciprocal model of human habitation and nature can be achieved not only ecologically, but also in the aspects of economic and social integration.

The project takes the basin of Dajia river as the study area, for it is one of the most illustrative river scape in Taiwan, flowing through drastic elevation changes with diverse kinds of human activities, patterns of developments, and habitation contexts along the river. More importantly, the water management problem and the subsequent spatial issues in the territory are in urgent need of a solution.

Lastly, the project reflects on the current planning and river management system of Taiwan, and compare it with other river-basin management cases in the world. Critics of the inappropriate approaches and reasons that frustrates the efficacy of some policy and mechanism will be identified. Suggestions will be given to support feasible transformation towards a more sustainable spatial framework, as well as to emphasize the importance of local inclusion and integration in the construction a culturally and ecologically resilient future landscape as infrastructure.

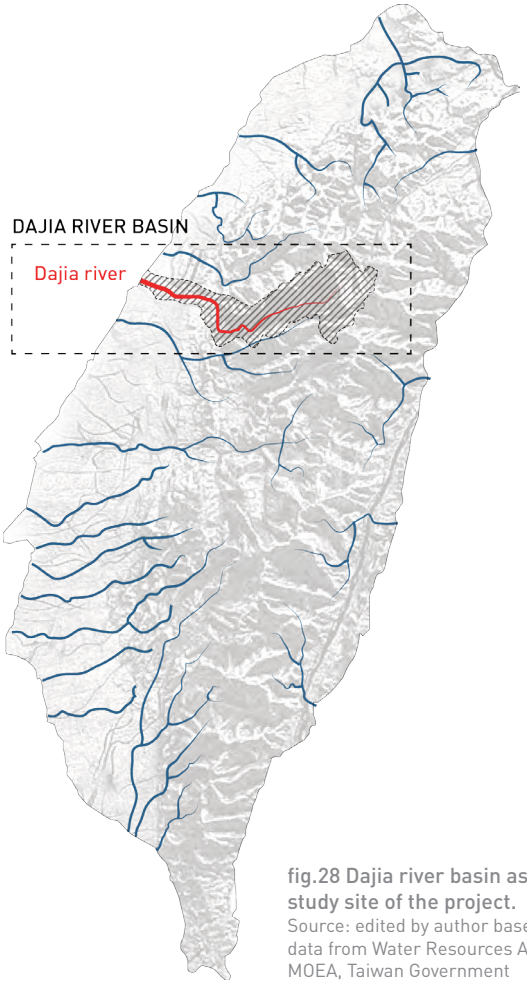
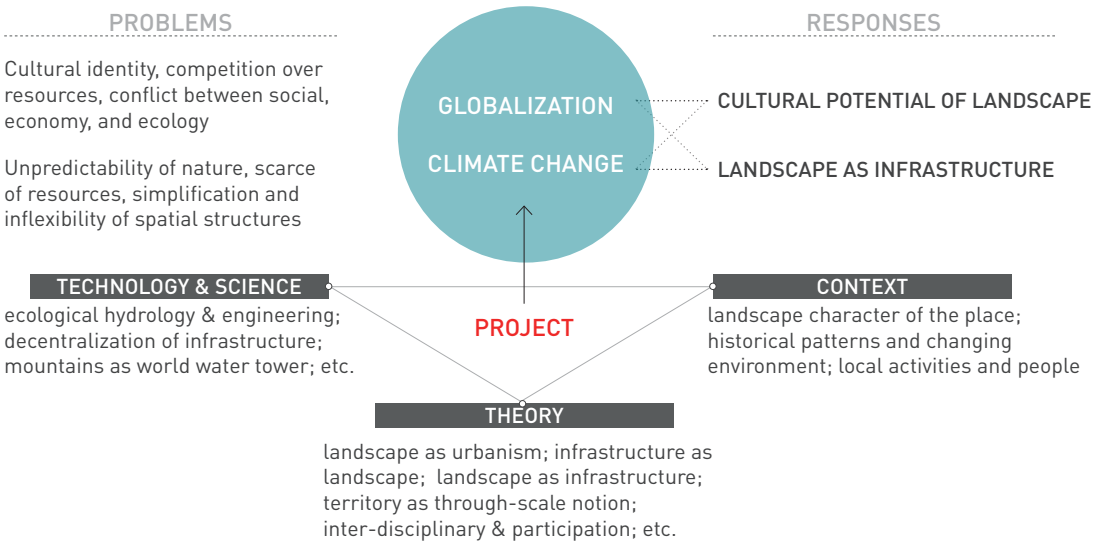


fig.28 Dajia river basin as the study site of the project.
Source: edited by author based on data from Water Resources Agency, MOEA, Taiwan Government

At a higher level, the project is expected to respond to the common challenges faced by almost all cities around the world: globalization and climate change, bringing up issues of building local identity and sustainability. This thesis explores the landscape-based approach in the form of transformation of infrastructure, seeking contextualized opportunities and correspondences for constructing a more coherent and adaptable relationship between human-modified world and natural biophysics. The result of the project with its process to derive specificity of the theories, developing of methodologies, and exploration of possibilities through research by design with intervention principals, will be able to contribute to the knowledge field regarding landscape urbanism in mountainous river scape for transformation of a territory.

In the design aspect, the project can act as a showcase providing examples in the form of strategies, toolkits, and spatial interventions for other river valley territories, especially those with a mountainous geography. The project will also argue that a good integration between artifact and nature will help the inhabitant build a stronger territorial identity through establishing the relationship between city and landscape quality.



RESEARCH QUESTIONS

How to rethink the river landscape as opportunities instead of obstacles, so as to achieve a more sustainable integration between artifact and nature? Further on, how to build a stronger identity for the living environment through the process of redesigning a mountainous landscape as water-sensitive infrastructure?

1. HOW DOES IT WORK?

- How has the river landscape been influencing human activities and vice versa?
- What lessens can we learn from the changing patterns of the interaction between natural landscape and artificial spaces? (what wisdoms can be inherited and what mistakes should be avoided?)
- What urgent problems have been accumulated from natural disasters and inappropriate use of land can we found in the river valley?
- What ecological, social, economical and cultural potentials can we found in the area?

2. WHAT CAN WE DO?

- How to develop a strategy that establishes a better connection between living space, human activities and water for the human habitation in the territory?
- How to develop a incremental mechanism to transform the landscape of Dajia River to manage water resources in a more sustainable way and allow local participation in the process?
- What relationship can we identify to integrate the diverse resources and potentials in the region?
- Who can be the actors to initiate and join the transformation process? How to encourage the collaboration between them?

3. HOW DO WE APPLY THEM?

- What spatial methods can arouse awareness and incentivize local inclusion in achieving a shared common good?
- How can the theory of landscape urbanism and the discourse of landscape as infrastructure help in developing principles, strategies, and methodologies in this study?
- How can the local industries transform from being sources of environmental damage to becoming bottom-up activities that enhance social, economic and ecological integration?
- How can the left-behind people who used to specialized in local industries be the main actors in the transformation?
- How to synthesize the single-purposed concepts such as ecology corridor, alpine conservation axis, eco-tourism, water supply, river management, etc., so as to develop a through-scale strategy that establishes operative structures and facilitates local interventions for the landscape of the river valley?

04. WHAT CAN WE LEARN FROM THAT?

- What can we benefit from integrating technical engineering with social-cultural aspects in landscape urbanism thinking?
- What difference/similarities can we identify when we compare the approaches of water urbanism in alluvial plains and mountainous areas?
- What difference/similarity in the strategies and methods can we propose when different landscape and cultural contexts are taken into consideration?
- Considering the current planning system of Taiwan, what would be the limitation and obstacle to the proposal of the project? What suggestions and reasonings can we contribute to the existing institutional framework of spatial planning?

I-v. Social Relevance

According to the research by the Water Resources Agency of Taiwan government for the Metropolitan area of Taichung, the water-related risks is estimated for each district (fig.30 to 35). It can be observed that many of the districts within the range of the Dajia river catchment suffer higher risks of life and property in the events of rainstorms. As the metropolitan area actually rely on the heavy infrastructuralization (fig.27) of the catchment area for water supply, it can be assumed that the current and future system could not respond to an fair distribution of resources spatially. In other words, the living environment in the catchment area is a mono-functional realm of infrastructure that need a rescue from the limbo of urban devastation to recognize its role as a part of the formal inhabited city (Mossop, 2006).

In recent decades, the intensity of rain and drought has increased exponentially, and the problems of this unfair water distribution system began to show. For example, the conflicts between different stakeholders in competition of water and investment in facilities are already taking place in many events, such as the conflict between agriculture and industrial areas regarding priority of water supply during droughts (fig.29), leading to a growing distrust between people and government, making integration of resources in achieving a synergy of natural processes and human activities even more difficult.

Thus, it requires a transformation of the infrastructural landscape, which involves the recognition that all types of space are valuable, not just the privileged spaces of more traditional parks and squares, and they must therefore be inhabitable in a meaningful way (Mossop, 2006).

This thesis provides an theoretical and implemental exploration to rethink the water infrastructure system, proposing a transformed model to reduce the reliance or water on hard-engineered reservoirs, and to merge infrastructure and landscape as vessels of collective life, and must function and be acceptable in order to enhance the quality of the landscape (Shannon & Smets, 2010), so as to prepare the territory ready for the coming threats and risks, as well as adapt the spatial framework towards more sustainable and resilient future.

fig.29 Photo of farmers protesting water supply prioritizing industrial platform and science park during drought events.
Source: photo from Appledaily news [online] available at http://www.appledaily.com.tw/ [accessed 9 Mar. 2017]

LIFE RISKS WITH 200-YEAR-RETURN, 24-HOUR RAINSTORM IN 2035

Dajia river catchment

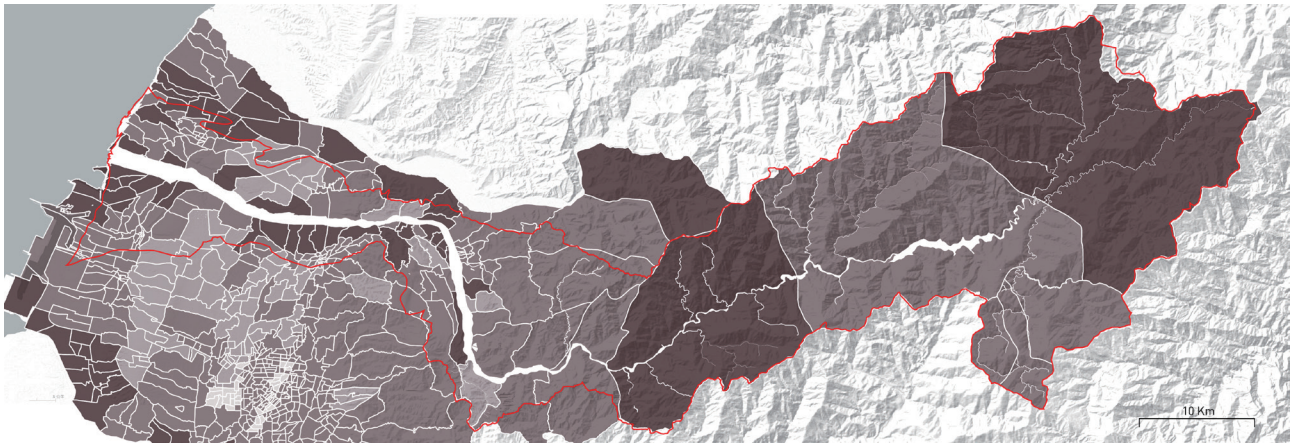


fig.30 Map of life risks estimation of Taichung Metropolitan area in 2035.
Source: map redrawn by the author based on data from National Science and Technology Center for Disaster Reduction, Taiwan Government.

PROPERTY RISKS WITH 200-YEAR-RETURN, 24-HOUR RAINSTORM IN 2035

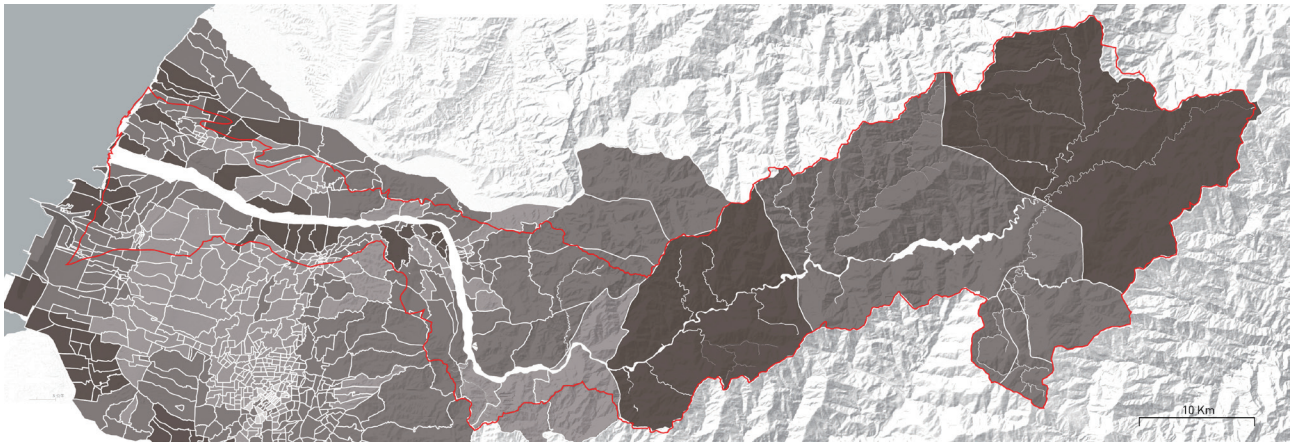


fig.31 Map of property risks estimation of Taichung Metropolitan area in 2035.
Source: map redrawn by the author based on data from National Science and Technology Center for Disaster Reduction, Taiwan Government.

FLOOD AREAS AFTER 24 HOURS OF RAINSTORM

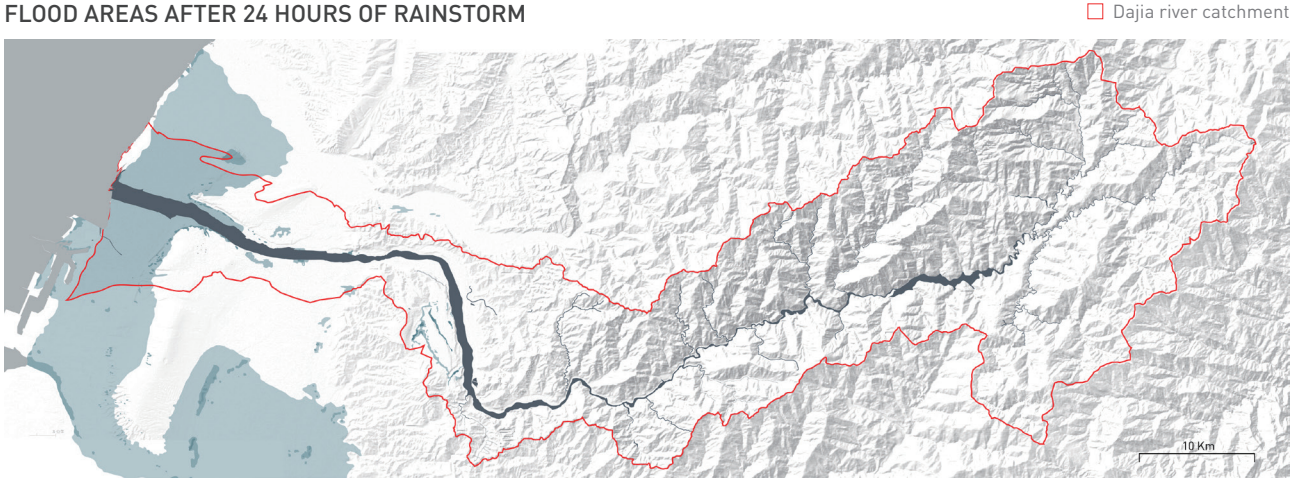


fig.32 Map of flood simulation in situation of 24-hour rainstorm with daily rainfall 500mm. Source: map redrawn by the author based on data from National Science and Technology Center for Disaster Reduction, NCDR, Taiwan Government.

DRINKING WATER RISK IN 2035

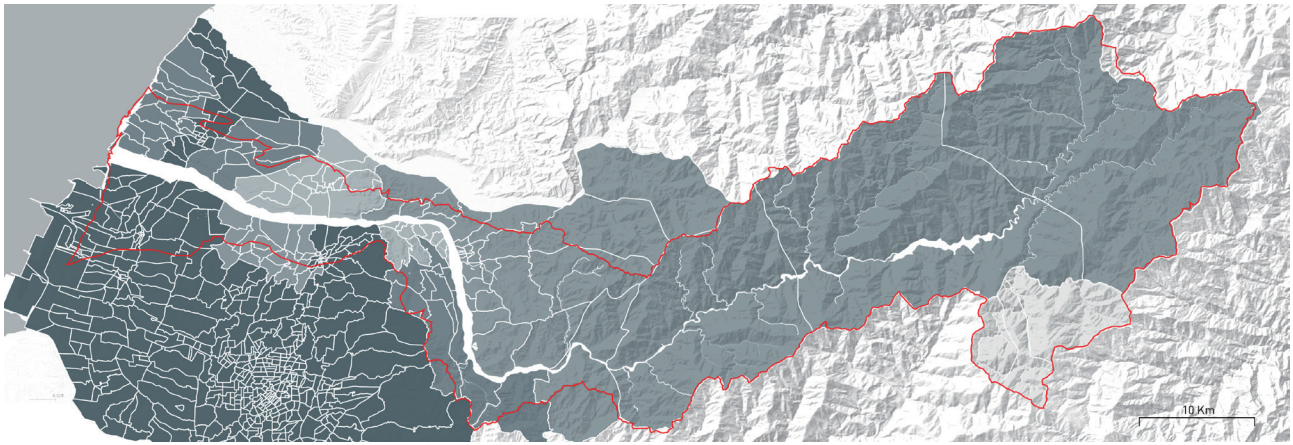


fig.33 Map of drinking water risks estimation in 2035.
Source: map redrawn by the author based on data from Water Resources Agency, MOEA, Taiwan Government.

AGRICULTURAL WATER RISKS IN 2035

Dajia river catchment

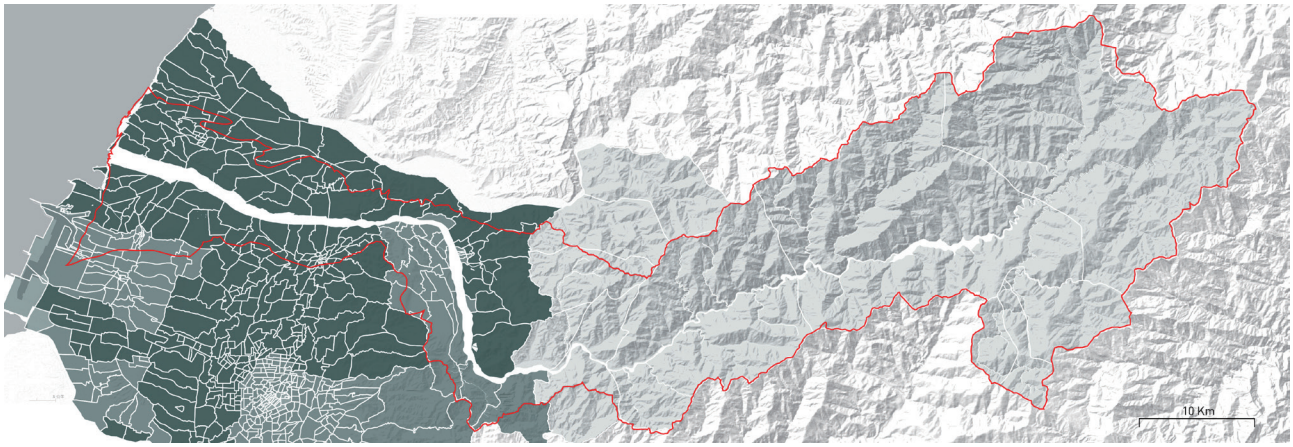


fig.34 Map of agriculture water risks estimation in 2035.
Source: map redrawn by the author based on data from Water Resources Agency, MOEA, Taiwan Government.

Agriculture water risk
very high
high
medium
low
very low

INDUSTRIAL-USE WATER RISKS IN 2035

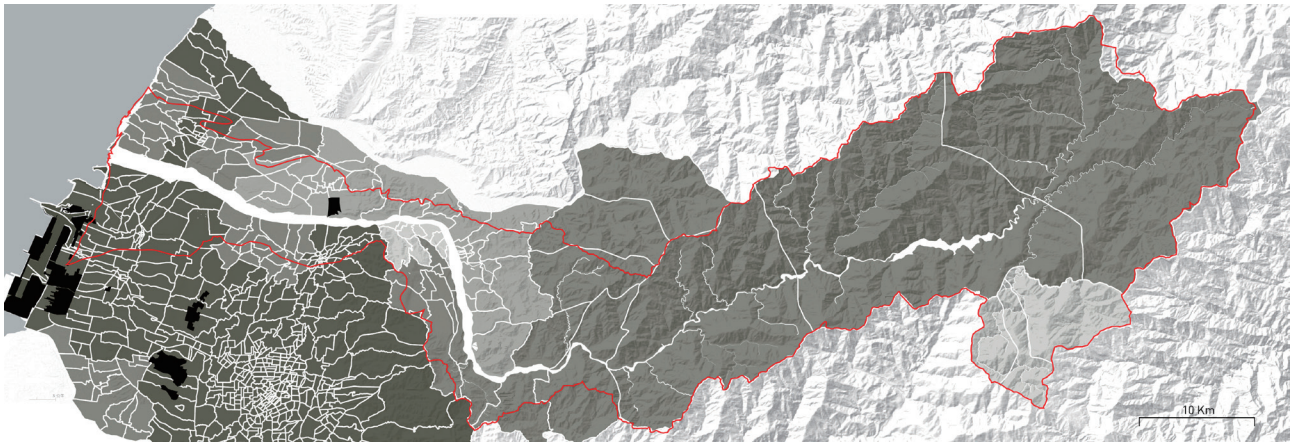


fig.35 Map of industrial-use water risks estimation in 2035.
Source: map redrawn by the author based on data from Water Resources Agency, MOEA, Taiwan Government.

Main industrial clusters

Industry water risk
very high
high
medium
low
very low

I-VI. ACADEMIC RELEVANCE

1. THE PARADIGM SHIFT OF WATER MANAGEMENT

Water was the origin of all things, as the Greek philosopher Thales asserted. Early human settlements were mostly seen developed following rivers, such as the famous Mesopotamia culture was established surrounding the two rivers, Euphrates and Tigris. To support everyday life and protect themselves from flooding threats, our ancestors have been maintaining delicate and intelligent relationships with water through thousands of years.

However, as the growth of population led to the expansion of living spaces, as well as therefore the increased demand for resources, the competition for land between human and water resulted in the construction of infrastructure. Infrastructure such as reservoirs, dikes, dams, power plants, and the reclamation of lands from alluvial plains or coastal tidal areas, have gradually modified the original river scape. Moreover, during process, water and nature have been more and more perceived as technical functions and resources, gradually getting distant from the habitual activities of everyday-life.

The accumulated consumption of resources has resulted in deterioration of natural environment, and increased the occurrence of natural disasters. Water management becomes crucial with issues and needs for flooding protection, maintaining ecosystem integrity, and restoration as well as protection of water resources, particular where human impacts were severe. (E. Herricks & L. Osbonrne, 1985). Water-related problems have caused the degradation of living environment or the huge costs for problem solving. Debates were seen between development and nature conservation of river scape, the former emphasized on economic necessities with pure engineering approaches to combat nature, while the latter focused on ecological and environmental concerns. However, neither direction is feasible and probable in solving the conflict between artifice and nature, leading to the recognition that

a better integration of water landscape and urban environment is essential for both ecosystem maintenance and social, economical and cultural reasons.

Hence, regarding water management, dealing with one of the most important elements of living, and its highly dynamic and forceful character, the new concept of landscape urbanism and the perception of uncertainty have endowed the water-scape a new relation with human habitats in many places around the world. Especially in many port cities and flood-prone areas, plans and projects were initiated and accomplished, aiming at bringing an more coherent integration and providing good ecosystem services for the living spaces of people.

2. WATER MANAGEMENT IN THE MOUNTAINOUS AREAS

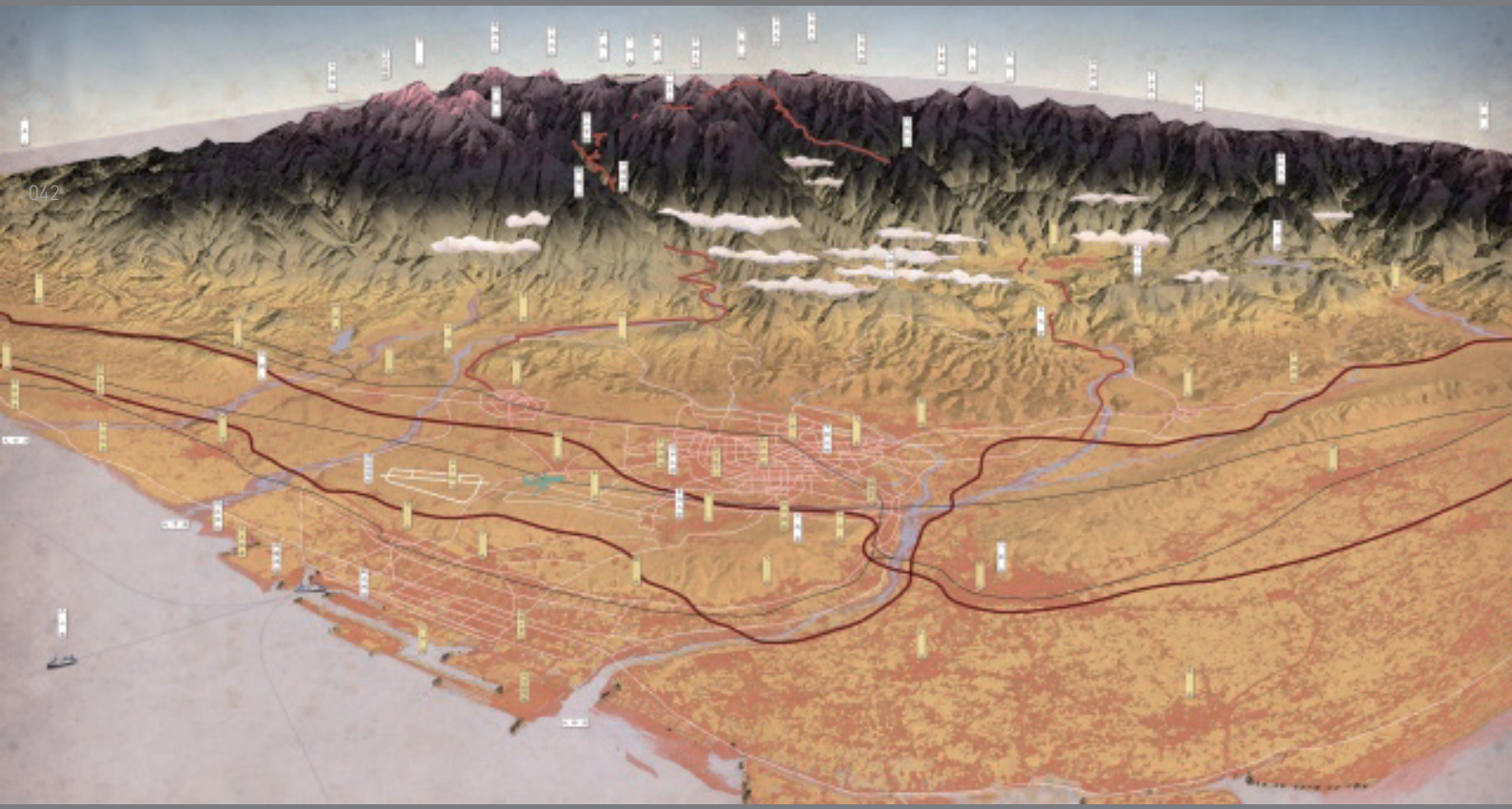
Mountains, on the other hands, have always held a privileged relationship with water as the sources of the world's greatest rivers (E. Wiegandt, 2008). Searching through the academic and practice database, there are, however, still a lack of theoretical knowledge and methodological toolkits for water management in the mountainous areas. Several cases talking river scape and mountainous cities were found in Switzerlands, however still more from the aspect of hydrology, engineering, and natural protection. Forums about mountainous water management can be found among latin american countries, but the focus are still more on technological and ecological considerations.

The mountainous landscape, in fact, is essential for water and needs especially delicate design. The mostly seen situation is the exploitation of mountainous resources causes erosion, and therefore results in irreversible devastation of lands, which is the reason of many river-related problems such as sediment accumulation, subsidence, landslide, land collapse, etc. Examples of once fertile lands now suffering desertification due to over exploitation of resources are not unfamiliar, the "promised land" of Palestine and ancient remnants of Phoenicia shows that the battle with natural was a losing one (W. C. Lowdermilk, 1940 citing R. L. Thoumin, 1936). Nevertheless, an astonishing example of agriculture on steep and sloping lands lasting over several thousand years proved that a good balance of resource use and human cultivation is possible.

The mountainous part of the river is not only important for groundwater infiltration, sediment balance, environment ecology, and moreover, the identity construction of a territory.

As Wiegandt (2008: p.3-13) states: 'Floods, landslides, and avalanches are disasters that do not affect mountain populations uniquely, but these water-related disasters nevertheless take an especially heavy toll on mountain communities.' Therefore, the project intends to focus the discuss on integrating the human activities with water in the mountainous river scape, taking the river landscape of Taiwan as a compact case for the focused area of study.

fig.36 Bird-eye view drawing of Taichung Metropolitan area.
Source: AA Visiting school Taiwan project [online] available at: http://www.aaschool.ac.uk/STUDY/VISITING/taiwan [accessed 19 March 2017]



II. Theoretical Framework

II. Theoretical Framework

In the mid-16th Century, when the Portuguese fleets passed by Taiwan, the impressive landscapes made the sailors exclaimed "Ilha Formosa", meaning literally the "beautiful island," and it has remained as the name of the island for a long while (fig.37). This term today, however, suggest more often a sentimental nostalgia in the vague descriptions of historical books, as a concept for environment protectionists to criticize all kinds of construction, or as a sublime scenic veil that can only be appreciated distantly. Landscape has gradually become detached from daily life for most of the population in the society. Its significance is still recognized, but more from the perspective as an conflictual opposition to artifact, as challenges and difficulties that need to "overcome", or as the ameliorative beautification that needs to be done to the impact of development.

This chapters present an theoretical and methodological exploration of the potential of recovering landscape's active role (Corner, 1999) as a dominant element in the living environment. The theory of landscape urbanism and the affiliated concept of landscape as infrastructure are to be explored, together with reference case studies as sources of knowledge. Then analytical framework will be developed to generalize and contextualize these discourses according to the situation of the research area, the Dajia River Basin of Taiwan, so as to conclude with principles for testing the hypothesis in the next step of spatial intervention.

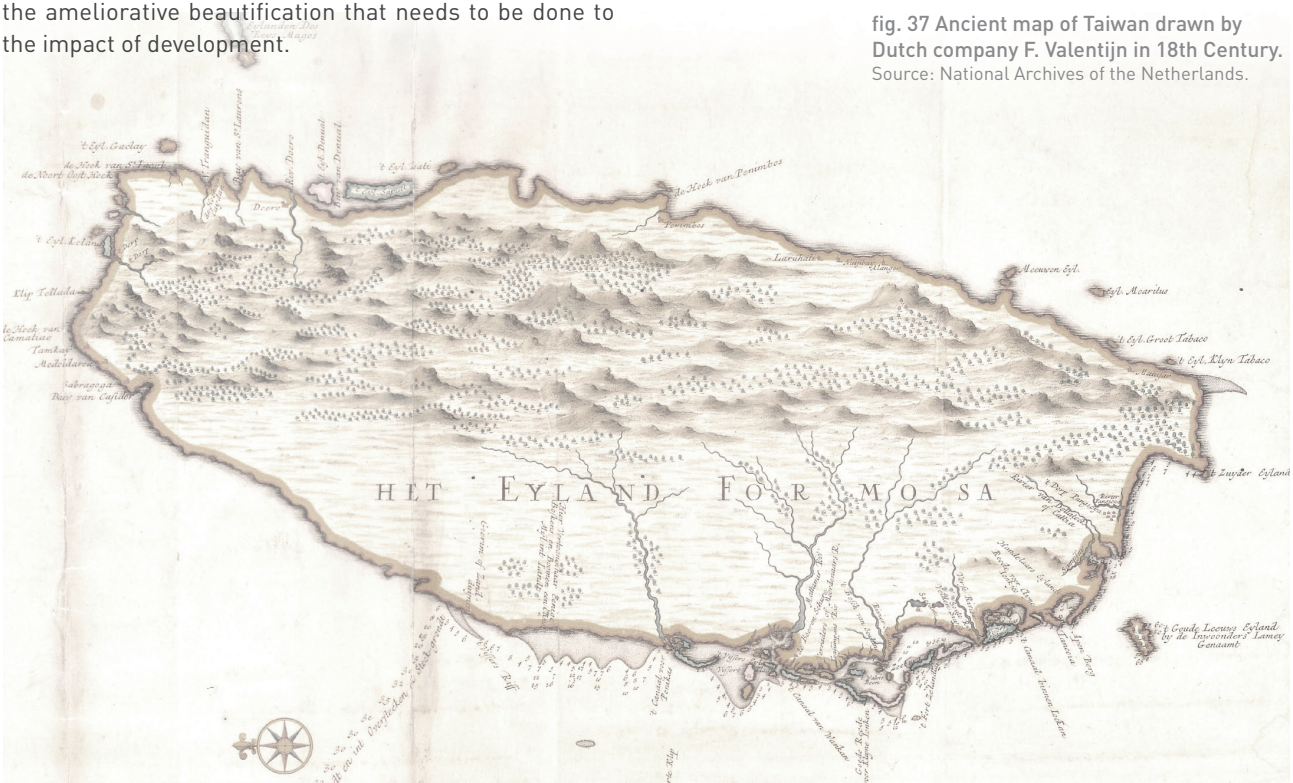


fig. 37 Ancient map of Taiwan drawn by Dutch company F. Valentijn in 18th Century.
Source: National Archives of the Netherlands.

II-1. Landscape Urbanism as Theoretical Foundation

"Increasingly, landscape is emerging as a model for urbanism. Landscape has traditionally been defined as the art of organizing horizontal surfaces.... By paying close attention to these surface conditions— not only configuration, but also materiality and performance— designers can activate space and produce urban effects without the weighty apparatus of traditional space making." (Stan Allen, 2001).

In the recent 30 years, the burgeoning theories and practices of landscape urbanism began to regard landscape much more than parks or gardens, but as a model for contemporary urbanism that enables the engagement of the radically decentralized urbanization in the context of complex natural processes.

The natural condition of the earth that has been guiding the development of human habitation in every civilization around the world had gradually be replaced with its importance by the increasing capability of technology and engineering. This link had again been re-established in 1950s by scholars such as Patrick Geddes, Scottish biologist and sociologist, who first brought the ecological arguments into the field of regional planning in his work of Cities in Evolution (1949), pioneered the discussion of evolution and adaptation in urbanism discourses (fig.38). Influenced by Geddes, Lewis Mumford also explicitly linked ecology and planning in his description of the city as composed from human processes intricately interwoven with natural processes (Mossop, 2006 referencing Mumford, 1956). This had led to the ideas proposed by Ian McHarg with his book Design with Nature (1969) which consolidated the significant role of planning in applying the knowledge of ecological processes to human settlements. The contention of ecological/ environmental in planning, however, has been pushed too far to equated landscape as purely scientific, objective ecology, which polarized the profession by placing nature and social and cultural development at two ends of the balance.

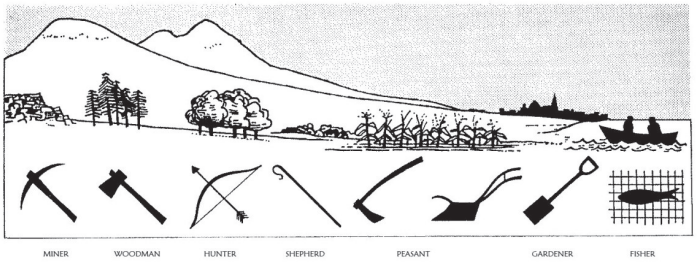


fig. 38 Geddes' Valley Section to explain the evolution concept as continuous health and survival of cities.
Source: Geddes, P. (1915) *Cities in Evolution*.

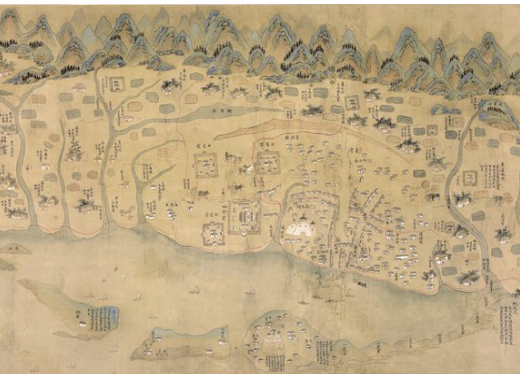
Looking at the urbanism and landscape concepts in Taiwan, as well as in the studied area of this thesis, Dajia River Valley, a similar pattern in spatial development can be observed. In traditional Oriental philosophy of space making — from the construction of city, the configuration of building mass to the arrangement of household interior — the concept "feng-shui" (風水), which literally means wind and water, specified that the design of spaces should accord to the essence of nature, assuming that there are spirit, god or goddess existing in all elements in the environment. The symbolic meaning of this concept also emphasized space-making in responding to local religion, rituals and the working cycle of agriculture activities, as pointed out by Stanislaus Fung (1999), that there is an

important aspect of mutuality and inclusion to Oriental ideas of landscape as distinct from the binary dualism characteristic of Western conceptions. The role of this concept can still be seen in the spatial arrangement of many traditional houses and villages in Taiwan. Especially in the early cultivating settlements and aboriginal tribes, developed delicate wisdoms in configuring settlement communities along contour lines in the alpine forest, or designing pole-column architecture types for living on the alluvial plain and make use of the recurrent flooding for agriculture. Landscape once was the determinant backbone of inhabited spaces (fig.39) and sustained a resilient and sustainable model of habitation on the island.

In the recent 100 years, the war resource supply, the post-war population growth and the subsequent urban development justified the over-extraction of resources (woods, rocks, water) and over-cultivation of hills and mountains. Civil-engineering construction had been leading the urban development and resource management, manifested as the "economic miracle" (fig.40) by the post-war society of Taiwan. The advanced technical engineering also imbued planners' minds with the believe that constructed system could control the flows of nature. The reckless decision of the location of Taichung Science Park is an evident example, which is located at the eastern side of Dadu Hill that is by nature a dryer land than the surrounding, while the technical research industries in the science park consumes a huge amount of water, and a short while of insufficiency could result in enormous economic loss. Realizing that the aggrandization of economy and efficiency had taken its cumulative toll in terms of pollution, deterioration of ecology, and the increased vulnerability to natural hazards, the environmentalist movements in the 1980s

fig. 39 The Kangshi Taiwan Map (partial) in around 1699-1704. Source: Bureau of Cultural Heritage, Taiwan Government.

fig. 40 The 1962 photo of the bridge construction connecting the Kuguan Dam hydro power station, one of the dam infrastructure along Dajia River.
Source: photo from http://taipics.com/



aroused the awareness of ecological importance, and had impelled the setting up of the environmental bureaus in different levels of governmental organization, and influenced the process of the urban planning system. However, today, the relationship between conservation and development seem to have fallen into controversial debate between nature and artifact. For more than 15 years the conflict between ecology conservation and human life (fig.41) couldn't find a way to coexist, let along to develop a mechanism to integrate the two aspects of society into a mutual-supportive operation. This appears in the spatial-work fields, resulted in the gap between the works of urbanists and architects, and the missing scale between planning and design. Landscape specialists, in many cases of design practices, have been devalued as merely garden designers or environmental impact evaluators for architecture projects. This schism in the discipline, as criticized by Mossop (2006) and the territoriality it perpetuated, has led directly to landscape (architecture)'s failure to engage with urbanism and with the bringing together of ecology and design.

Looking back at the urbanism theories in the Western World, the intellectual and cultural renewal in the landscape discipline (C. Waldheim, 2006) in the recent years have brought about the transformed concept of landscape, as is defined by European Landscape Convention (ELC) in 2000, the term "landscape" not only refers to the natural beings as an opposition to the artifact, but also refers to the the human-modified world, which "has an important public interest role in the cultural, ecological, environmental and social fields, and constitutes a resource favourable to economic activity...; contributes to the formation of local cultures". According to ELC, landscape, or the living environment, is "an important part of the quality of life for people everywhere: in urban areas and in the countryside, in degraded areas as well as in areas of high quality, in areas recognized as being of outstanding beauty as well as everyday areas." Landscape potentials has thus gradually been "recovered" (Corner, 1999) and asserted as a medium (Corner, 1999; Allen, 2001; Waldheim, 2006) uniquely capable of critically engage the meta-physical and political programs that operate in a given society. Scholars and practitioners advocating this concepts began to explore and testify landscape's active and strategic roles in contemporary issues, contending that its full efficacy is extended to that of a synthetic and strategic art form, one that aligns diverse and competing forces (social constituencies, political desires, ecological processes, program demands, etc.) into newly liberating and interactive alliances (Corner, 1999). They also criticized the passive perspective to regard the sentimental preservation of worshiping only the past scenery while surprising the experimental and innovative potential of landscape.

In the latest decade, more people in different disciplines started to recognize the potential and importance of this synergy of cross-disciplinary, through-scale and social-inclusive integration in the works of regional planning due to the ever-increasing complexity and scale of the spatial issues (Lee, 2014). Nevertheless, the attention on multi-disciplinary collaboration, due to the lack of operative platforms or effective methods and the problem-solving mindset, as well as the combination of nostalgia and consumerism led to the compartmentalization of the planning discipline. As in many other countries around the world, stated by Bélanger (2012), the twentieth-

century planning has been, for the most part, relegated to a generation of lawyers and economists reliant on an overarching legal or economic world view. Not unlike engineers, planners too have failed to see the greater synergies made possible by a more ecological, more integrative lens that couples and synthesizes different spatial, biophysical conditions with social and economic concerns.

Today, the limitation and deterioration of the existing engineering structures and the high fiscal and societal costs of coping with the aftermath of recurrent disasters, has pushed forward the urgency of rethinking the spatial management work in Taiwan, especially in the regional planning issues. The recovering and establish of landscape as a active tactic in guiding the spatial development of territories and enhance better integration between human habitation and nature is pressingly essential. This thesis develops an experimental process to explore the landscape potential of Dajia River Valley through applying the theory of landscape urbanism. To inquire deeper into the theoretical and methodological possibilities in the developing of more specific principles, strategies and spatial interventions, the discourses of designing landscape as infrastructure will also be discussed in the next paragraph.

fig. 41 News paper describing the conflict between living and ecology, the roads to the alpine agricultural villages has broken down for 16 years.
Source: photo from http://www.taiwanhot.net/

II-II. Landscape Infrastructure as an Approach

This thesis test the argument that landscape, while designed as guiding structure for the development or transformation of living environment, has the potential to enhance the integration between nature process and human activities, entail through-scale and cross-region synergy, as well as preparing a territory with robustness and adaptiveness to persist under conditions of future uncertainty and drastic changes. In the last paragraph the theories of landscape urbanism has been generalized as an appropriate concept and contextualized as an appropriate approach to rethink the landscape of Taiwan.

Looking closer to the landscape of the focused site of this thesis, Dajia River Basin, the abundant rainfall, steep slopes, the soil and temperature character of the lands conditioned the activities of water resources supplying, hydropower generation, and agriculture. Consequently, a complex set of energy production, logistic, and water storage infrastructures were constructed along the river. These infrastructures have been in service of the conquest of nature, whereby the environment has been denied its natural dynamism in favor of colonization that relies on more controlled and static systems (Nijhuis & Jauslin, 2015). Natural landscape have thus been transformed into urban, logistic, industrial, and waste landscapes (Meyer & Nijhuis, 2014; Waldheim & Berger, 2008; Prossek et al., 2009; Berger, 2006) (fig.42) that eliminates the inherent ability of landscape to accommodate diversity and pluralism, and enables differences to play themselves out (Corner, 1999). Though once perceived as an economic and engineering miracle (fig.43), the tendency of a divide-and-concur approach and thus a single-purpose approach often resulted in disrupted landscapes, defaced retrofitted constructions and buildings, and erasure of cultural and natural values (Strang, 1996).

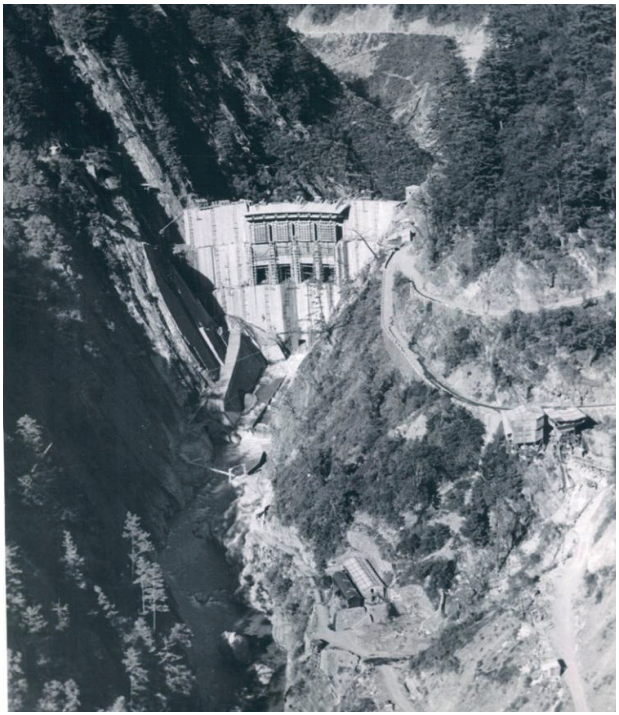


fig. 42 Photo in 1959 showing the transforming of the natural landscapes of Dajia Valley.
Source: photo from http://taipics.com/

This situation could also been observed in many areas in the world, and infrastructure has been for a long time dominate the progress of urbanization, and the

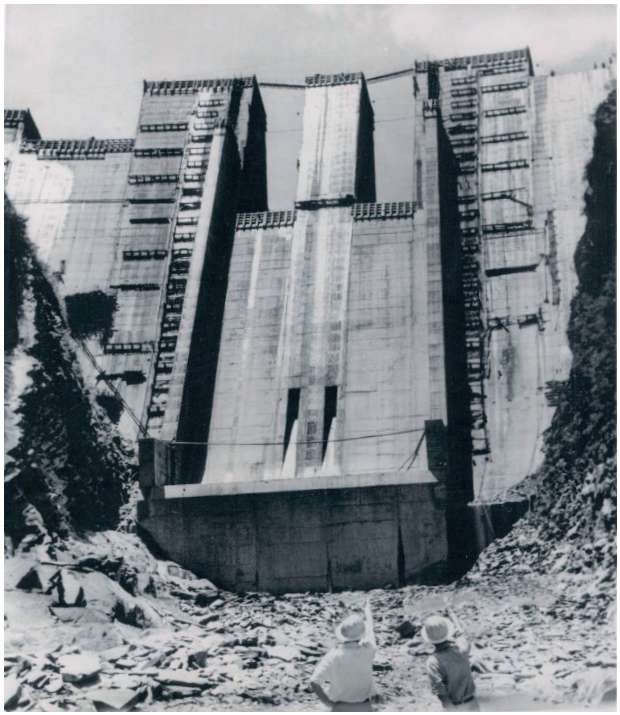


fig. 43 Photo in 1958 showing that "dam goes up in Formosa" and expecting to boost more development.
Source: photo from http://taipics.com/

construction of them has dominant the resources and investments of the public and private attentions in many countries. The largeness and complexity of these infrastructural projects led to the distributed and decentralized responsibility and decision, this might increase the efficiency and the feasibility of the engineered structure in the short term, however, in a long-term perspective, the compartmental working model resulted in the negligence of intricate connections between multifaceted factors in the system, and therefore generating deviations that finally accumulating as the limitation of its operation. As a matter of fact, the notion of landscape as infrastructure is proposed in the recent two decades to consider designing urban landscape infrastructure as armatures for the development of urban systems and which facilitate social and ecological interactions, contending that infrastructural design can be redefined as interdisciplinary design effort to establish a local identity that has tangible relationships to the region (Nijhuis & Jauslin, 2015).

Considering the dense water infrastructures in Dajia River Valley and their increasing fragility in the recent 20 years, the limitation of these engineered structures in the forthcoming could be expected and needed to be diagnosed first with their causes. Then, the potential of appropriating the concept of designing landscape as infrastructure in the region is to be evaluated, as well as studies of water management in mountainous areas will be reviews. Finally, as a conclusion, the discussion provides the project with contingent principles and methods for strategic spatial transformation.

1. THE INABILITY TO DEAL WITH FUTURE CHALLENGES

The way of contemporary infrastructure engineering has encountered a bottleneck, which can be seen prompted by the two common challenges many cities around the world are facing: globalization and climate change. The former has impelled the horizontality of the urbanized areas -- the centrally-controlled of infrastructural systems that shipped the resources from afar, broadcasted ideology, as well as the transferred methodology and technology that gradually homogenized places disregard of the contextual criteria of the land. The continuous decontextualization of city scape and urban infrastructure has provoked the re-cognition of local identity, and as stated by Pierre Bélanger (2012) in his proclamation of landscape infrastructure states, "from this flattening of urban administration and engineered hierarchy, a set of new regionalized identities are emerging that privilege diversity and differentiation, most evident in a more visible landscape of resources, cultures, territories, and innovations."

The latter, the extreme and unpredictable weathers brought about by climate change, on the other hand, has confronted the traditional ways of infrastructure construction. In the region of Dajia Basin, recent events such as the recurrent breakdown of Central Cross-Island Highway from 1999 onwards (fig.44) or the collapse of dams and hydropower station along the river in 2005 (fig.45) have, as many other natural disaster around the world, demonstrated the limits of engineered controls, and the shortcomings of rational efficiency. Its over-exertion has now made apparent the impermanence and limited lifespan of infrastructure (Bélanger, 2012). Some

fig.44 The recurrent collapse and restoration of the Guguan section of Central Cross-island Highway.
Source: Lee, H.Y. (2014) "How Can Goverments Be Smart" speech slides [Online] available at: https://www.slideshare.net/codefortomorrow/[accessed 19 March 2017]

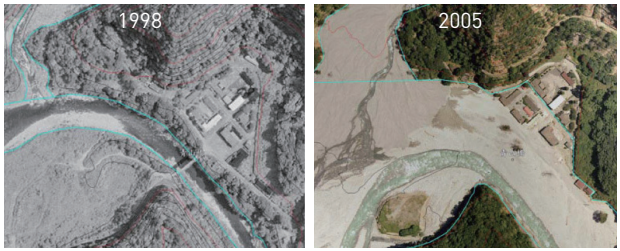


fig.45 Photos showing the damage caused by Typhoon in 2005, the power plant office and the dam was destroyed.
Source: Cheng, C.T. (2011) Disaster Management e-paper [Online] available at: http://www.dmst.org.tw/e-paper/04/001.html [accessed 20 March 2017]

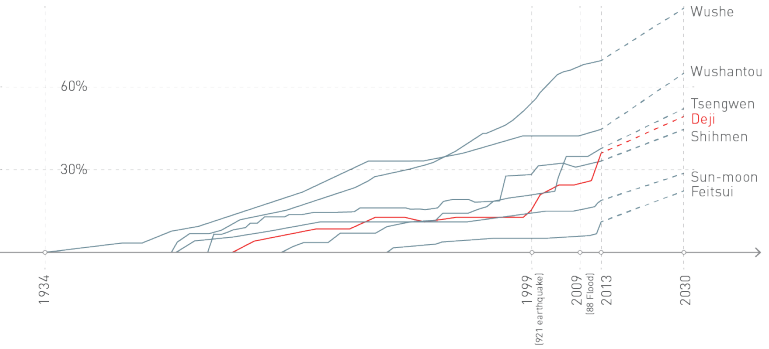


fig.46 Sediment accumulation situation and estimation of Taiwan's main reservoirs.
Source: made by the author based on data from Water Resource Agency, MOEA, Taiwan Government.

economical and ecological experts even argued that the fiscal and social costs of restoring the power station and roads has largely exceeds the benefit these infrastructure can bring to the society. Moreover, many problems, such as sediment accumulation in the reservoirs (fig.46), which will bring an early end to the lifespan of these infrastructures couldn't yet find a feasible solution. Meanwhile, as the capacity of the Taiwan's land provides very little possibility of expansion or new construction of water-storage dams and reservoirs, a rethinking and transformation of the water infrastructure for the river valleys of Taiwan is urgently necessary.

2. SIMPLIFICATION LEADS TO FRAGILITY

Infrastructure is the interface by which we interact with the biological and technological world (Bélanger, 2012). Infrastructure translates the natural elements and forces into resources to support everyday-life, as well as transports people across boundaries and limits of distance and time beyond individual ability. Yet the responsibility for designing this machinery into the landscape is diffused, falling piecemeal to many disciplines -- engineering, architecture, landscape architecture, agriculture, planning and biology. (Strang, 1996) The fragmentation of instead of integration of infrastructure design results in simplification of focusing its relation to the environment from one aspect and mono-function construction. Selecting a function while excluding another reduces the complexity of a given space to remove any ambiguity from its configuration, neutralizing the intention of the subjects (Cavalletti, 2005). From an ecological point of view, this means reducing the resilience of an ecosystem, its ability to adapt and/or react to disturbances (Pickett et al., 1999). The increasing fragility of the mono-functional system thus requires more artificial components to 'fix' the disrupted relations that had been seeking to self-reconnect because those mutual-related flows and forces was the original state of the complex landscape. This suggest that the mono-functional model in a long-term perspective, is a continuous consuming process of the natural resources, that could not give positive if not negative feedback to the ecosystem. As a result, simplification and fragility can be perceived as characters composing the vicious circle that incrementally devastate the system.

In the case of Dajia River, the construction of the Central Cross-island highway, designed with the single function of mobility, disrupts the flows of branch streams and the geological continuity along the slopes. Years of the natural forces of these elements regaining their flows has shown that a full restoration of the road is almost impossible. However, the new flows created via this infrastructure for shipping agriculture products and supply daily-life necessities, on the other hands, has also been obstructed by the break-down of the motorway. The social vulnerability and ecology fragility present the deadlock of the current system caused by the mono-functional design of the infrastructure.

3. THE IMPORTANCE OF VISIBILITY & LOCAL INCLUSION

Despite this reliance on the constructed landscape, our culture's response to the disruptions of infrastructure has largely been one of denial, rather than reverence. Designers have most often been charged with hiding, screening and cosmetically mitigating infrastructure, in order to maintain the image of the untouched natural surroundings of an earlier era. (Strang, 1996) However, infrastructure systems, by virtue of their scale, ubiquity and inability to be hidden, are an essential visual component of urban settlements (Strang, 1996). The hiding of infrastructure only result in the invisibility of flows that supports the operation of city and region, causing ignorance of landscape value and quality and even social conflicts over control, distribution, and supervision of natural resources. The de-cognition of the relation between industry or activity with resources can even very possibly lead to indifference of their scarcity, hence over-exploitation continues even though most of the people knows there is a coming threat called climate change. The potential of infrastructure systems has for shaping architectural and urban form is largely unrealized. They have an inherent spatial and functional order that can serve as the raw material of architectural design or establish a local identity that has a tangible relationship to the region. They can be designed with a formal clarity that expresses their importance to society, at the same time creating new layers of urban landmarks, spaces and connections (Strang, 1996).

According to some review of the water management examples and issues in the mountainous communities also suggest the importance of visibility of infrastructure, and its active role as organizing the social system and constructing local identity. A comparative cross-cultural study, done by Paul Trawick in 2003-2005, of several successful and long-lasting, local-operated irrigation system in the Andes and Mediterranean areas suggest that the visibility, and the passive vigilance provided by neighboring landowners, helps the community to maintain a sustainable and resilient water system. Especially considering the small-scale, alpine communities that compose most of the urban morphologies (fig.47) at the upstream area of Dajia Basin, the principle suggested by Ostrom (1987) can also be taken as a reference. He states that small scale, and the kind of intensive face-to-face interaction among water-users that this makes possible, seems to be a common denominator that can contribute significantly to local success.
The institutional system of water management in Taiwan today, both the public sector and academic fields started to recognize the importance of integrated management

of river basin, and some administrative organization of river-basin planning has been suggested and outlined. However, the compartmentalized institution planning system and land-use oriented model fail to formulate adaptation strategies to future changes, and many top-down imposed project proposals do not take into consideration the complexity of communication, resulted in useless conflicts between centralized, detached decision makers, local administrative executors, as well as the real concerns of the local residents. The proposed transformation presented in this thesis, studies also the possibility of local inclusion, and as stated by Nijhuis & Jauslin (2015), that infrastructure design should be redefined as an territorial spatial tool of interdisciplinary design that establish a local identity through tangible relationships to a place or region (Nijhuis & Jauslin, 2015).

fig.47 Mountainous communities at upstream of Dajia River Valley. Source: screenshot from video clip by Shen [online] available at https://www.youtube.com/watch?v=MISj8s-6SSw.

4. TAIWANESE LANDSCAPE AS INFRASTRUCTURE

The highly dynamic and sensitive landscape characteristic of Taiwan demonstrate the immense complexity of natural flows where one flow mutual-relates to many others. Therefore the effort of amending the disrupted connections between ecology and social economy caused by mono-functional engineered infrastructures is beyond feasibility, and will inevitably succumb to eruptions of natural hazards. Therefore, based on the principals derived from the theories of rethinking infrastructure as landscape and landscape as infrastructure, the transformation of territorial landscape infrastructure should emphasis on the potential to stimulate inter-visibility of activity and flows, the connection of human activity to their lands, as well as the capability to facilitate complexity and ambiguity of the natural flows and forces, thus able to accommodate and adapt to disturbances of the changing environment in the future.

II-III. Learning from Other Projects

Even though the appearance of landscape urbanism and landscape as infrastructure discourses are relatively recent, and there has been not much discussion regarding the mountainous areas, the interaction between water and mountain communities has existed for a long time in the human history. In some places like the Honghe Hani Rice Terraces in Yun-nan, China, the Subak irrigation system in Bali, Indonesia, or the Qanat water system in Xinjiang area and Iranian Plateau, the mountainous habitation have even lasted for more than thousands of years. Other examples, such as the autonomous governing system in Huaynacotas community in Peruvian Andes, developed and operated by local villagers, has maintained full control of water supply in conditions of acute scarcity of water, and has been able to distribute the supply equitably, efficiently, transparently and minimized conflict. In most cases, unique geography, particular experience, and often special institutions characterize the distinctive interactions between mountains and water. Their multifaceted relationship comprises several aspects that also relate to wider environmental issues (Wiegandt, 2008).

Besides the mountainous area, still other examples can be seen from the designed infrastructure that make use of the underflow water, or compose a characteristic landscape interwoven with agricultural settlements, such are the irrigation infrastructures in Pingdong and Taoyuan, Taiwan. Looking at some more contemporary references, the planning project in Medellin in Aburra River Basin, Columbia, exhibits how to systematically develop operative structures that guides local-inclusive regeneration of slope area currently occupied by informal settlements, and to provide betterment in both ecological and socio-economical aspects. In terms of regional integration, the River Basin Management Plans of the European Union display the institutional framework and how the large-scale landscape analyses determine guiding structures for river valley development.

The selection of these cases intend to give a comprehensive study regarding river basin spatial planning, covering various scales and aspects including indigenous wisdoms, landscape operative structures, as well as institutional system and regional integration. Tracing sources of knowledge thus tells us about more than the technique itself; it also allows for reflection about how ways of life have been shaped by particular understandings of nature (Wiegandt, 2008).

TRADITIONAL WISDOMS

CASE 01

The Subak Rice-growing System
- Bali, Indonesia.

CASE 02

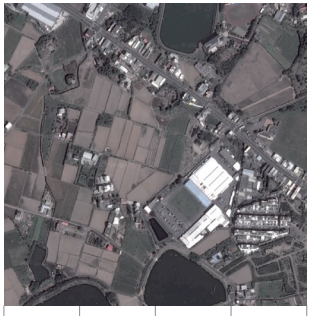
Honghe Hani Rice Terraces
- Yun-nan, China

CASE 03

Er-feng Hyporheic Trench
- Pingtung, Taiwan

CASE 04

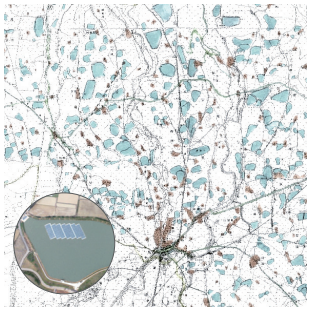
A Thousand Irrigation Ponds
- Taoyuan, Taiwan



LANDSCAPE AS INFRASTRUCTURE

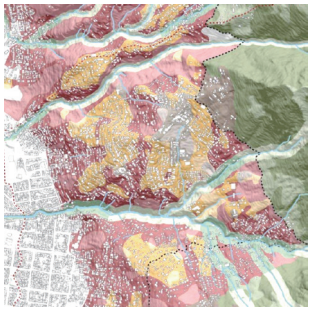
CASE 04

A Thousand Energetic Ponds
- Taoyuan, Taiwan



CASE 05

Rehabilitar la Montana
- Aburra River Basin, Columbia



REGIONAL INTEGRATION / PLANNING SYSTEM

CASE 06

EU River Basin Management Plan
- River Basin in European

CASE 01 THE SUBAK RICE-GROWING SYSTEM

Scale: unit watersheds with various sizes of villages (from around 60 to 500 households.)

History: 9th century to now

Morphology: rugged volcanic terrain turned into terraced topography

Features: interaction of realms of spirit, human world and nature; democratic and egalitarian farming; prolific production; metabolic system and agro-activity timetable synchronized with cycles of natural flow.

Challenge: growing population, impact of ecological damage due to use of chemical pesticide and fertilizer; impact of tourism due to being listed as world heritage.

fig.48 Rice terraces adopting Subak system in Bali, Indonesia.
Source: de Meulder, B. & Shannon, K. (2013) *Water Urbanisms : East*.

Recently listed as UNESCO World Heritage Cultural Landscape, the Subak agriculture system has been adopted by the traditional agrarian settlements in Bali, Indonesia, maintaining high biodiversity and productivity (fig.48). The Balinese indigenous religion, cultural and ceremonial life is close combined in the system, with sub-catchment of the rivers as autonomous unit, and habitation, primitive forest, and cultivated area maintaining a sustainable proportion (fig.49, 50). The 180-day rice growing cycle (fig.53) has been developed, presented as a calendar making use of nature's flows (fig.51) such as seasonal flooding, rainwater trajectories, gravity, and the intricate network of nutrient exchange between herd, fowl, insects, microorganism as well as wildlife creatures, which requires completely no pesticide or fertilizers, and has been operated over millennia .

fig.49 The geomorphology of agrarian settlements, paddy fields, and primitive greens proportioned in river catchments.
Source: edited by the author based on Google Satellite photo.

fig.50 Rice terraces of Subak Kumba Bawa. Source: World Heritage Convention, UNESCO [online] http://whc.unesco.org/en/list/1194 [accessed 2.Jun.2017]

fig.51 (below) The Subak Nutrient Cycle.
Source: de Meulder, B. & Shannon, K. (2013) Water urbanisms : East. Zürich, Park Books.

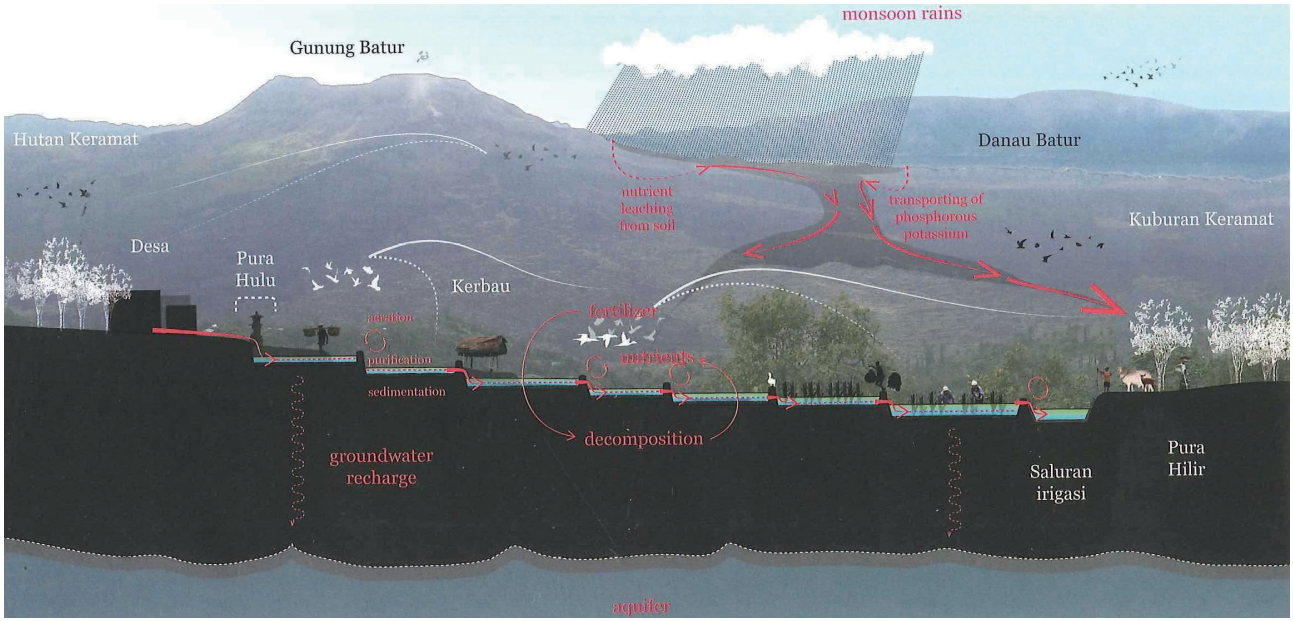


fig.52 Subak Meeting in Pakerisan.
Source: World Heritage Convention, UNESCO [online] http://whc.unesco.org/en/list/1194 [accessed 2.Jun.2017]

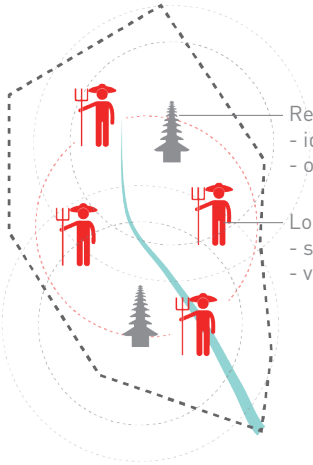
fig.53 (below) The 180-day rice growing cycle arrange agricultural activities according to the season characteristic of natural flows.
Source: de Meulder, B. & Shannon, K. (2013) Water urbanisms : East. Zürich, Park Books.

SYSTEM & STRATEGIES

TOOLS

Water resource managmenet

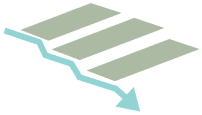
Watershed as autonomous unit



Religious temple
- identify water resource
- organize local activity

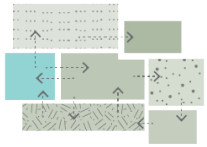
Local operator
- self-organized mechanism
- visibility and passive vigilance

Gravity as water distributor



Make use of nature forces

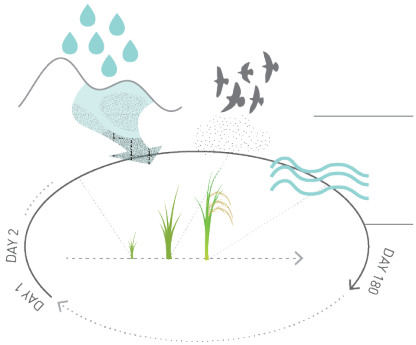
Hybridization of agro-activity



Establish connection between activities

Sustainability maintenance

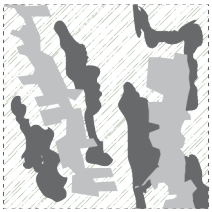
Synchronized activity cycle and natural flows



Seasonal natural phenomena and the materials

Agriculture activity timetable

Maintain balanced proportion among different land use



Harmonize give/take to/from the land

Allow exchange among natural and artificial elements

forest | habitation | agriculture fields

CASE 02 HONGHE HANI RICE TERRACES

Scale: villages of population around 650 people and terrace fields around 60-140 ha as autonomous units.

History: 7th century to now

Morphology: high mountains + deep valleys crisscrossed by gullies and ravines;villages situated between mountaintop forests and the terraces; rice-terraces altitude ranging from 603 m - 1996 m.

Features: four-element system (forest, water system, village and terraces); democratic social and religious system in management of water and land uses;

Challenge: impact of tourism due to being listed as world heritage; pressure of population growth

fig.54 Rice terraces and Hani villages in Ailao Mountains.
Source: photo by Li Kun © Hani Terraces Administration of Honghe Prefecture [online] available at: http://whc.unesco.org/en/list/1111/

In the Ailao mountains in Yun-nan, China, the Hani Ethnic groups has lived a sustainable agrarian society for more 1300 years. The rice terraces and the traditional villages (fig.54), with their management system of forest, water and society has been listed as World Heritage by UNESCO. The spatial structure maintains a four-element system (forest, water system, village and terraces) that has formed scientific and ecological material cycle and energy flow (fig.57). A area proportion of forest land and rice terraces, as well as the village size (fig.55) has always been carefully maintained in a dynamic balance. Besides, a complex ditch system is designed with minimal manual interference. Delicate devices such as woodcut (fig.56) are used to manage a fair distribution, and maintained by the social system of the society in a form of democratic and collective works.

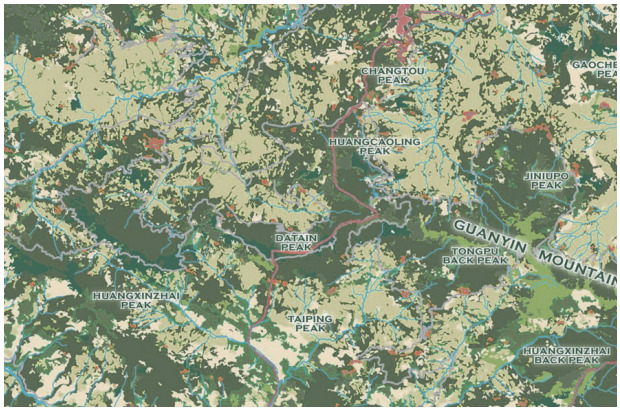


fig.55 In the Honghe Hani cultural landscape, 51% of the land is forest, and 28% rice terraces.
Source: Map from the UNESCO World heritage nomination file [online] available at: http://whc.unesco.org/en/list/1111/ [accessed 2.Jun.2017]

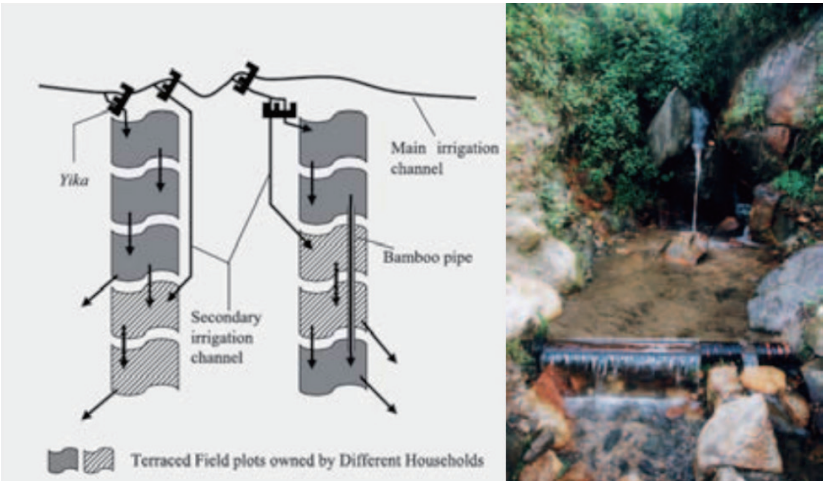


fig.56 Schematic diagram of water distribution by woodcut system.
Source: data from UNESCO World heritage nomination file [online] available at: http://whc.unesco.org/en/list/1111/ [accessed 2.Jun.2017]

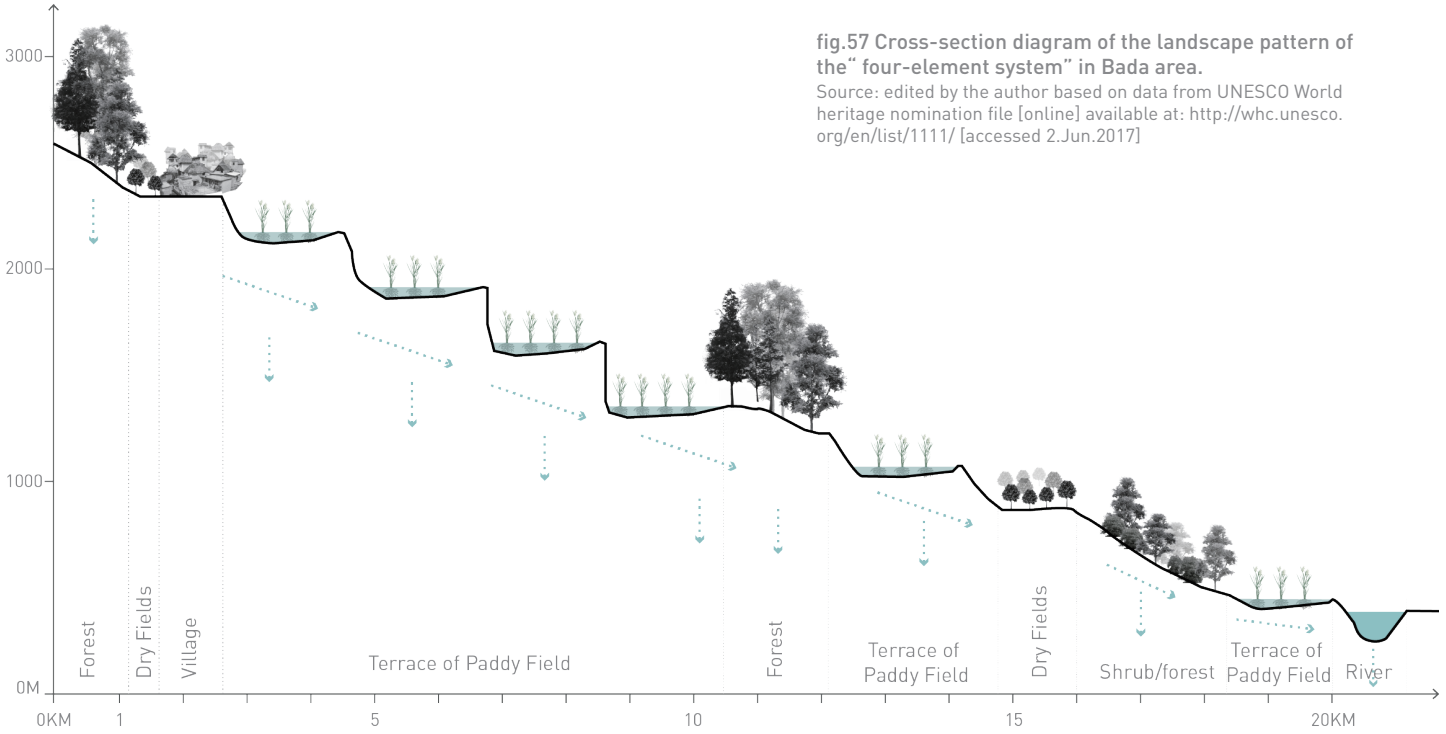


fig.57 Cross-section diagram of the landscape pattern of the“ four-element system” in Bada area.
Source: edited by the author based on data from UNESCO World heritage nomination file [online] available at: http://whc.unesco.org/en/list/1111/ [accessed 2.Jun.2017]

To maintain a scale suitable for autonomous democratic management, the village size is carefully maintained at a population of around 650 people per community, with people taking turns organizing collective works such as ditch keeping, forest keeping.

The construction of the terrace fields, on the other hand, is a digging method that requires more collective maintenance of the structure, but easier to built than the piling method (fig.59) and allows more flexibility to change the use of the plots. This construction method also fits together with the dynamic village morphology that whenever a village grows bigger than the sustainable, they split into new villages and a new unit of the four-element system is formed.

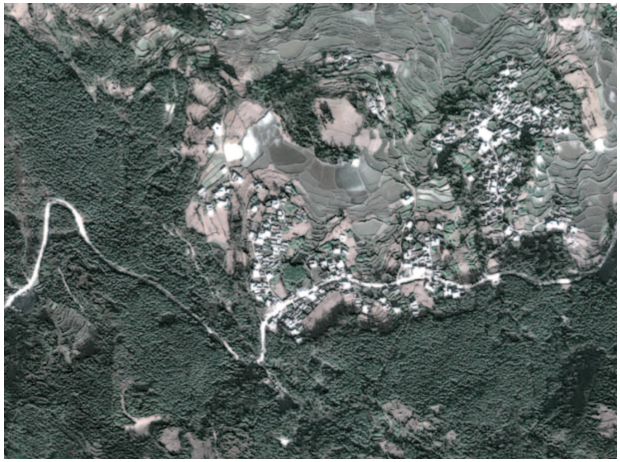
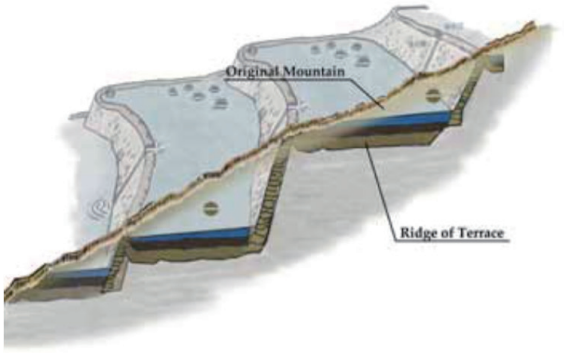
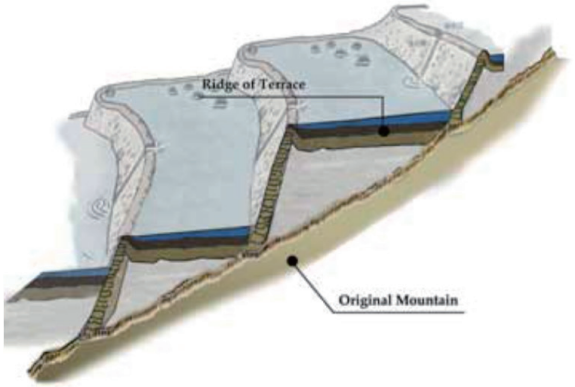


fig.58 Nominated village – Niuluopu Village. Source: photo from UNESCO World heritage nomination file [online] available at: http://whc.unesco.org/en/list/1111/ [accessed 2.Jun.2017]

fig.59 Comparison between the digging and piling methods of rice terraces. Source: UNESCO World heritage nomination file [online] available at: http://whc.unesco.org/en/list/1111/ [accessed 2.Jun.2017]



Construction methods of Honghe Hani Rice Terraces: digging



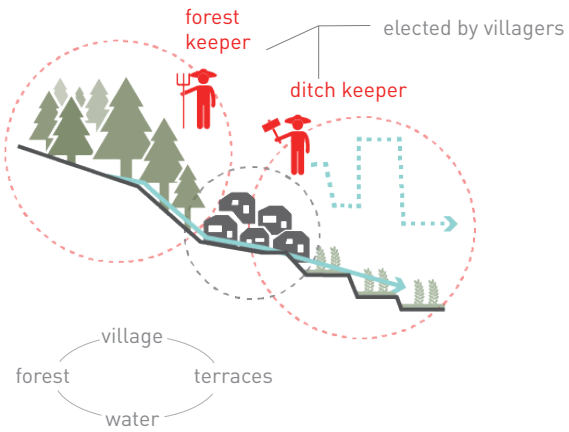
Construction methods of Rice Terraces of the Philippine Cordilleras: piling

SYSTEM & STRATEGIES

TOOLS

Water resource managmenet

Four-element system as the autonomous unit

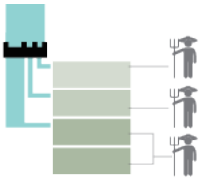


Gravity as water distributor

Use of nature forces

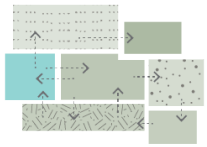
Minimal manual interference

Local-material made devices to distribute water



Maintain fairness in different situations of rainfall amount

Hybridization of agro-activity



Establish connection between activities

Sustainability maintenance

Dynamic multiplication of sustainable-scale units

Maintain balanced proportion among different land use

Harmonize give/take to/from the land

Allow exchange among natural and artificial elements

forest | habitation | agriculture fields

CASE 03 ER-FENG HYPORHEIC TRENCH

Scale: village of population around 1000 people.

History: 1920s to now.

Morphology: riverside agricultural village.

Features: make use of hyporheic water; make use of micro topography; reuse of reservoir sediment.

Challenge: riverbed erosion due to decrease of sediment flow has damaged the infrastructure structure.

In order to solve the frequent drought and flood problems, Japanese hydrologist Nobuhei Torii observed the micro-topography and river flows in the vicinity of Lai-yi village, and then constructed Er-feng trench (fig.60) in 1921. The water infrastructure collects the underflow water (fig.61) from Linbien River through an embedded channel beneath the river bed. The structure is simple and cause almost no ecological damage before and after construction. The water collected is naturally filtered by the gravel layer underground. When the trench flows into the village, it also becomes part of daily-life spaces for the people (fig.62). For almost 20 years, the trench steadily supplies the village with around 20 tonnes of water everyday, never been affected by drought.

Besides Er-feng trench, hydrologist Kang, chun-er also applied the principle of hyporheic water to the project of coastal protection. With an installation of a simple water-retaining wall made of reservoir sediment (fig.63), the fresh water could be maintained in the barren coastal lands and the windbreak forest were successfully planted.

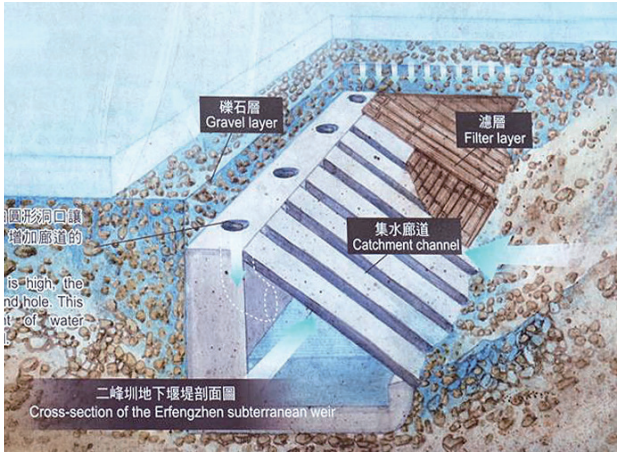


fig.60 The subterranean weir structure of Er-feng Trench.
Source: https://www.newsmarket.com.tw

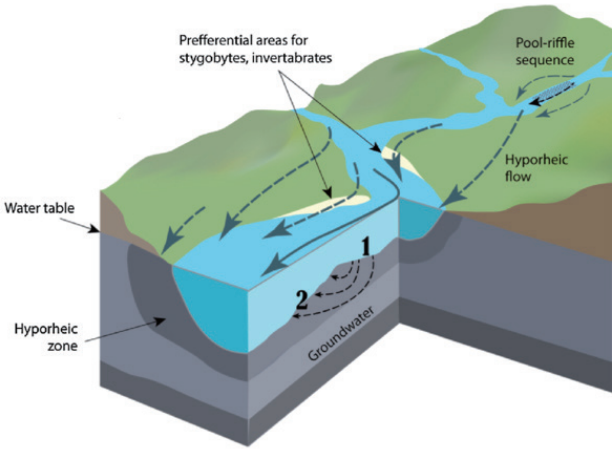


fig.61 Diagram of hyporheic zone of a river system.
Source: G. Bertrand, D. Siergieiev, P. Ala-Aho, & P. M. Rossi (2013).

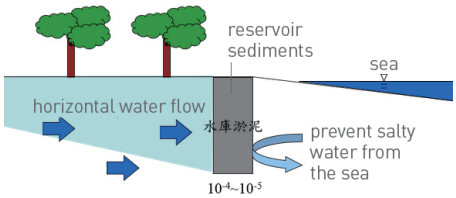


fig.62 Diagram of coastal forestation project.
Source: Kang, chun-er; translated by the author.

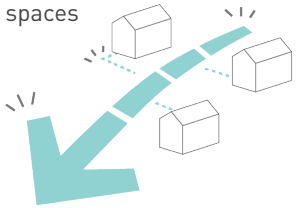
fig.63 (right) Photo of local people having fun in Er-feng trench.
Source: Screenshot from video clip by ckmizunoo [online] available at: https://www.youtube.com/watch?v=xMzpcSNFzkQ. [accessed 14 Jun 2017]

SYSTEM & STRATEGIES

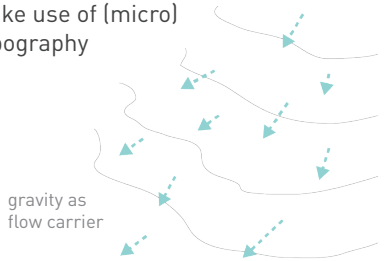
TOOLS

Water resource managmenet

Water infrastructure as visible public spaces

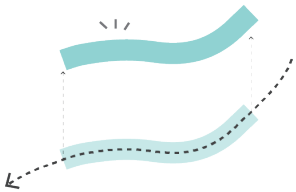


Make use of (micro) topography

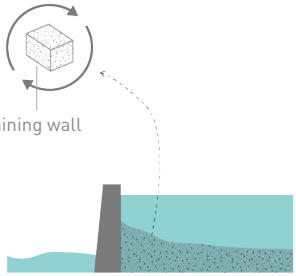


Sustainability maintenance

Ricover the hidden flows



Sediment recycle



CASE 04 A THOUSAND IRRIGATION PONDS -> A THOUSAND ENERGETIC PONDS

Scale: agricultural rural settlements.

History: 1800s to now

Morphology: slightly sloped topography; poor-permeable soil types (red soil, yellow soil, and clay).

Features: self-sufficient irrigation units; reuse of irrigation water of the overflow from the upper field.

Challenge: urbanization

The hilly lands and the short and small rivers had led to the construction of irrigation ponds by the Taoyuan people for agricultural activities. Before the construction of Shimen Reservoir which now replaced most of the functions of the ponds, there were over 10,000 ponds in the Taoyuan county (fig.64), most of them are mutual connected and organized the paddy fields as a self-sufficient system. The slope gradient and soil type of Taoyuan allows little vertical infiltration of water, therefore with simple digging, the pond can be maintained to store water. Today, there are around 2,500 irrigation ponds remain, many of them have turned into leisure and recreational uses (fig.xx).

In the event of 2017 Agriculture Exposition, a project of "A thousand energetic ponds" was proposed to install floating solar-panel power facilities on all the irrigation ponds in Taoyuan (fig.xx), with around 0.48 ha water surfaces, it is possible to generate enough electricity for 170 households. The project aims to achieve 660MW electricity generation in 3 years, turning the water infrastructure into sustainable energy landscape.

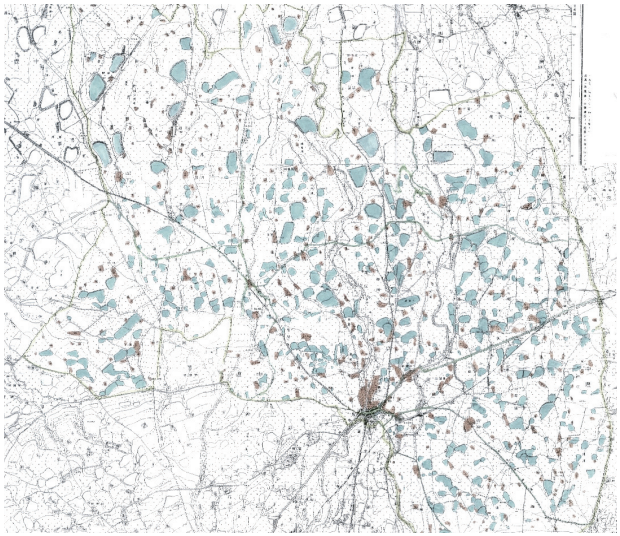


fig.64 Map of irrigation ponds in Taoyuan in 1904.
Source: Taoyuan Irrigation Association

fig.65 Aerial view of Taoyuan irrigation ponds landscape.
Source: http://pclhvs.cl.edu.tw/

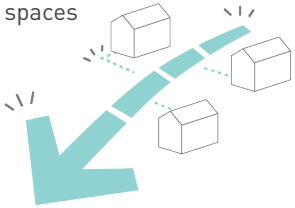
fig.67 (above) The Energetic Pond proposal.
Source: Taoyuan County government.

fig.66 (left) Bade Pond Ecological Park.
Source: photo by S.X. Lu.

SYSTEM & STRATEGIES

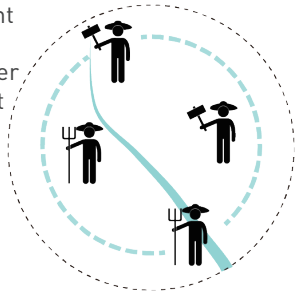
Water resource managmenet

Water infrastructure as visible public spaces



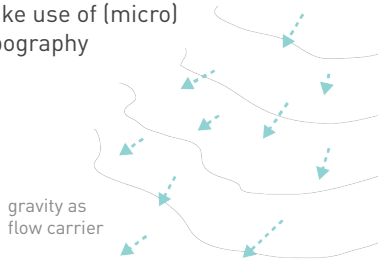
Sustainability maintenance

Self-sufficient autonomous units for water management



TOOLS

Make use of (micro) topography



CASE 05 REHABILITAR LA MONTANA

Scale: informal occupation of around 2,700 households.

Date: 2013

Morphology: long and thin river valley; hillside with altitude around 1,650m; informal settlements on hillside while formal city in the valley; high rainfall;

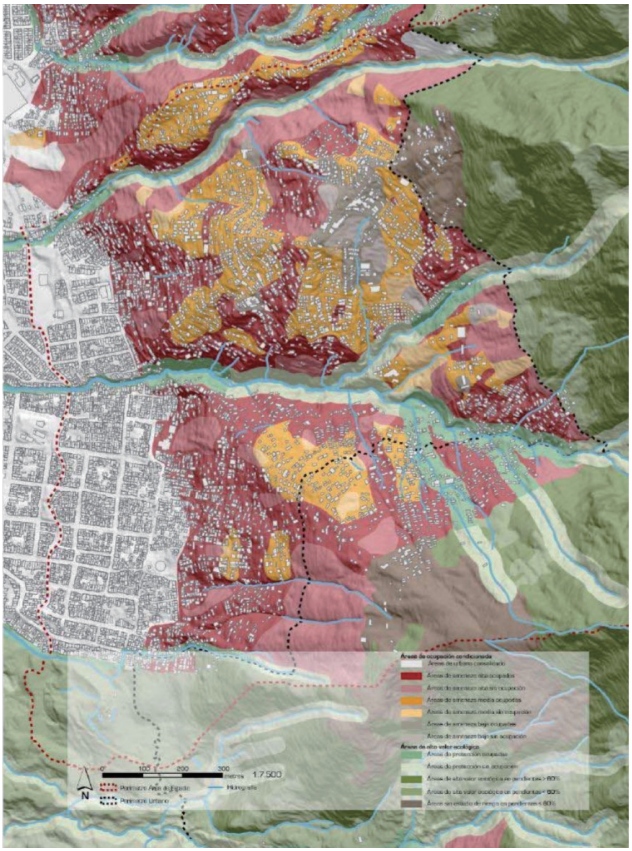
informal settlements on the hillside of river valley, where situated the city center.

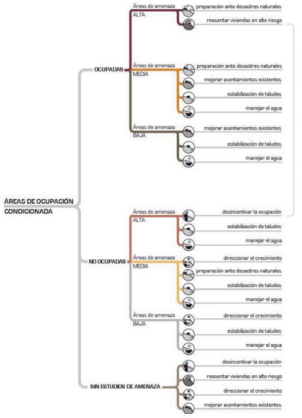
Features: landscape operative structure; slope stabilization as new landscape; participation mechanism; water management as collective work.

Challenge: limited budget; drastic weather; participation willingness of informal settlement inhabitants; population growth; hazard mitigation.

The geographical situation as a long and thin river valley, Medellin is a city mainly affected by two types of natural hazards: landslides and floods. This situation becomes more critical with the informal urbanization concentrated intensely on the slopes of the valley, presenting a continuous conflict between the natural environment and the growing urbanization (fig.68). Led by the municipality of Medellin in collaboration with academic fields, the project "Rehabilitar la Montana" in 2013 proposed a plan to define landscape-based structures (fig.69) as the future spatial framework of transforming the area, also designed mechanism and intervention projects to include informal inhabitants' participation in the process. Several tasks such as slope stabilization and water system installation have also been designed with construction method making use of local, inexpensive materials and simple techniques (fig.70-72).

fig.68 Informal settlements living in high risk of natural hazards; the extensive informal urbanization also worsened the situation. Source: Report of "Rehabilitar la Montana", municipality of Medellin.





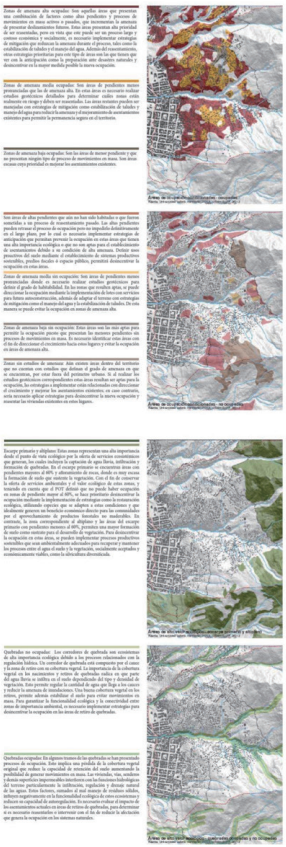


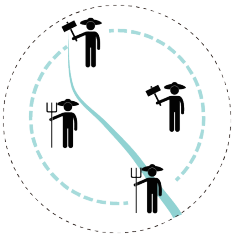
fig.69 Strategic plan proposed in the project, defining landscape operative structures as future spatial framework.
Source: Report of "Rehabilitar la Montana", municipality of Medellin.

fig.70 Local inhabitants joining water system construction.
Source: Report of "Rehabilitar la Montana", municipality of Medellin.

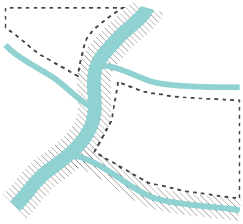
fig.71 Simple construction stabilize the slope.
Source: Report of "Rehabilitar la Montana", municipality of Medellin.

SYSTEM & STRATEGIES

Water management as collective work; inclusion of local inhabitants



Landscape operative structures as future spatial framework



TOOLS

Slope stabilization with simple technique and materials.

fig.72 Constructiion technique of slope stabilization. Source: Report of "Rehabilitar la Montana", municipality of Medellin.

CASE 06 EU RIVER BASIN MANAGEMENT PLAN

Scale: River catchments in European Union.

Date: 2000 - today

Features: cross-boundary collaboration.

Challenge: international conflicts between water management and related activities.

Starting from 2000, the EU Water Framework Directive has initiated the River Basin Management Plan to conduct cross-national integration regarding water systems and river environment. Current the plans have been developed for each river catchment with analytical data (fig.73) and general guiding principles (fig.74). The implementation, on the other hand, still relies on the collaboration of different countries and adaption and amendment of the plan would be ongoing processes according to different situations from regional to local scales.

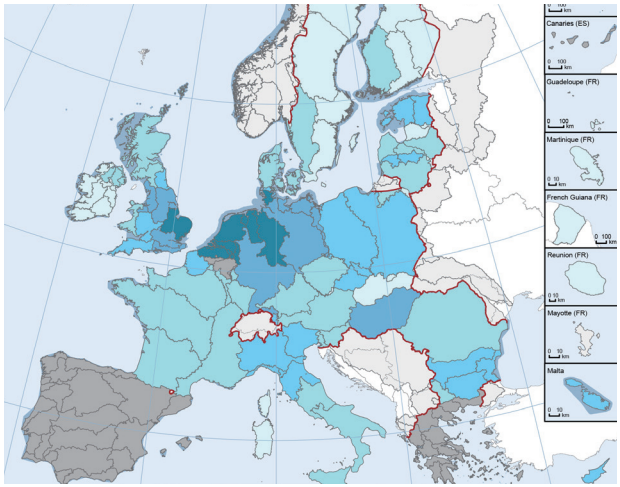
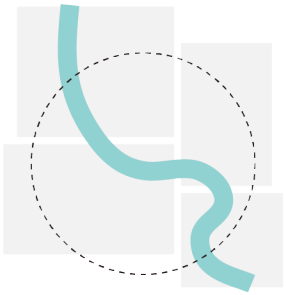


fig.73 Map (partial) of percentage of heavily modified water bodies and artificial water bodies in River Basin Districts.
Source: Water Framework Directive, EU Commission.

fig.74 Map of expected improments of river morphology for Danube River Basin.
Source: Water Framework Directive, EU Commission.

SYSTEM & STRATEGIES

Develop cross-boundary networks to put pressure for integrated collaboration within a catchment



II-IV. Conclusion

LEARNING FROM THEORY

HEAVY-ENGINEERED INFRASTRUCTURE

hard infrastructure to control and regulate nature

hiding flows of resources

no consideration of relation between human activity and landscape operation

PROBLEMS

cumulative natural disasters, worsen by climate change

economy and efficiency driven, however, less efficient and economic in the long-term perspective (more external costs)

social conflicts regarding equity of resource distribution

negligence to landscape value and quality

over-exploitation of nature resources

LANDSCAPE AS INFRASTRUCTURE

make use of natural forces (topography, abundant rainfall)

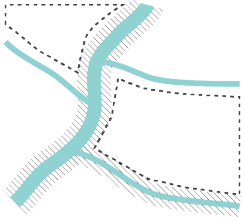
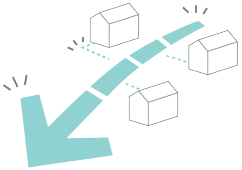
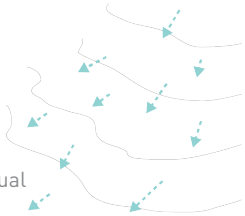
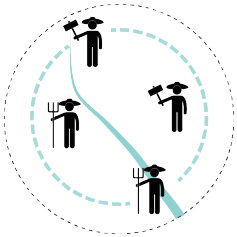
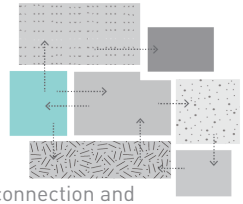
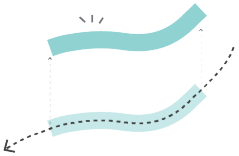
visible infrastructure arouse awareness and integration of people in the process. (transforming local industries)

multifunction of infrastructure and activities (hybridization of land use)

mutual supportive and interwoven water, green and transportation systems (multi-scale, multifunction, and multi-dependency in integrating different systems)

Integrate landscape quality with social, economic and ecological aspects in the process of transforming hard, mono functional and problem-causing infrastructures, has the potential to regain and enhance landscape quality as well as living ecosystem.

LEARNING FROM PRACTICES

INSTITUTION	STRATEGY	TOOLS
Landscape operative structures as future spatial framework 	Water management as visible public spaces  Multi-functional and multi-scale	Gravity as water carrier / distributor  Use of nature forces Minimal manual interference
Develop autonomous units  Water management as local collective work	Hybridization of agro-activity  Establish connection and sequence between activities	Use of underflow (hyporheic) water  Make use of the hidden flow and micro-topography
Increase cross-nation networks  put pressure for an integrated territorial landscape transformation	Maintain balanced proportion among different land uses  Harmonize give/take to/from the land Allow exchange among natural and artificial elements	Slope stabilization by local material and simple construction technique  Source: "Rehabilitar la Montana" project.

III. Diagnosis

III. Diagnosis

ANALYTICAL FRAMEWORK

This part of the report presents the various analyses in order to get a through-scale understanding of the cultural and technical contexts. The analyses will be presented three parts: first the cultural context, regarding the planning system of Taiwan and identify several characteristics that are related to the project. The second part of the analyses will examine the historical and current pattern of the relation between human activities and nature. The historical landscape evolution will be mapped to understand the changing interaction between human habitation and nature, the accumulated problems as well as the left-behind landscape and social potentials that can become recovered with a spatial strategy. The technical analysis and socio-economic situation will also be conducted to understand the suitability of the natural condition of the land for different human activities, and the possible connection between different parts of the river valley. Lastly, a synergetic discussion of the main activity and their influence to/by the current water infrastructure and water management will be presented as the conclusion and the determinant considerations for the proposal of the main strategy.

III-I. Cultural Context: Spatial Planning in Taiwan

Spatial planning in Taiwan shows a specific situation of the political and cultural factors influences. The complex regime changes influenced also by the international political relationship in the late 19th to mid 20th Century has led to the scrappy establishing of the modern planning system. Spatial planning in Taiwan can regarded as 1) over-concentrated on economic dimension while neglecting the environmental importance in the past, and 2) the land-use approach and weak legislation lead to the difficulty of cross-territory, interdisciplinary integration, and , and 3) the lack of local inclusiveness and visioning for future.

On the other hand, the current planning system is going though some fundamental changes in the recent years, that are the National Land Planning Law enacted in 2015, and the change of political party in the Central Government. This part of the research will give some brief of the characteristics of the field of spatial planning in Taiwan, the benefits and drawbacks of the change in planning legislation and system, then conclude with the challenges to the thesis project brought by the institutional and cultural context.

CHARACTERISTICS OF SPATIAL PLANNING IN TAIWAN

1) Regarded as an colonial resource-repository for military supply, the modern urban planning introduced by the Japanese planners structured the landscape to support the logistic network for production and excavating of materials. Shortly after the colonial regime, defeated in the civil war by the Communism Party, the central government retreated and settled to the territory of the mountainous island. Then for more than half century, the tense and intricate cross-strait relationship between Taiwan and People's Republic of China led to an over concentration on economic planning, (Council for Economic Planning and Development, 2005) and the detriment of environmental issues, and current it has led to stagnation and lack of political will in any attempt to revise what are now seen as increasingly antiquated planning laws (Bristow, 2010). This emphasis on economy permeates through most of the planning policy and mechanism, neglecting not only the environmental concerns but more influentially, in the author's opinion, the lack of an in-depth cultural and philosophical investigation, research and rhetoric to establish a more contextualized planning system merged with Oriental culture-rooted contemporary theory and philosophy.

The landscape of Taiwan, though recognized with the unique character of high alpine density and biodiversity, has not been acknowledged and integrated with its potentials for social and cultural engagement. Many professionals both in academy and government, could not specify strong arguments to guide the future direction of landscape because they are at the first step lost in constructing a cultural identity. Even though the

global discourse regarding landscape urbanism and the increasingly serious natural hazards have aroused the awareness in Taiwan, and the environmental ecology importance has been largely more considered in the planning thinking today, the debates, however, are dichotomized between extreme conservation and economic development. The role of landscape as an medium to integrate nature and human habitation has not yet been explored. Instead, the planning system today is more a like piece-assembled vehicle that simply imports Western theories or copy practice examples from other countries. Considering also that the planning process (fig.75) and decision making mostly controlled in the hands of the administrative bureaucracy whose elective term is only 4 years (maximum 8 years), the spatial policies are often swaying between political extremities, and easily amended to cater to the popular opinions.

2) The Japanese Urban Planning Act of 1936 consolidated the aspects of land use control, building regulation and land replotting (sub-division) into one planning law (Chen & Shih, 2010), divided the land into different types of uses. The following amendment of the planning laws further multiplied the number of types, each has to follow complicated rules. Land use planning in Taiwan today formally divide the land into two categories, the urban planning districts and the non-urban lands (fig.76), and their issues are usually related and overlapped, yet the compatibility of land uses between adjacent urban and non-urban areas is seldom considered.

According to the current planning system, the Regional Plans suppose to coordinate the urban and non-urban areas, bridge sectoral actions of all branches from central to local governments in terms of spatial policies and capital investments, and are also meant to guide the local development of counties and towns. However, with the lack of any formal implementation mechanism and effective integration platform and working models, regional plans ended up again regulating land use. In fact, from the national scale to the local detail plans, the different scale's planning works are basically controlling

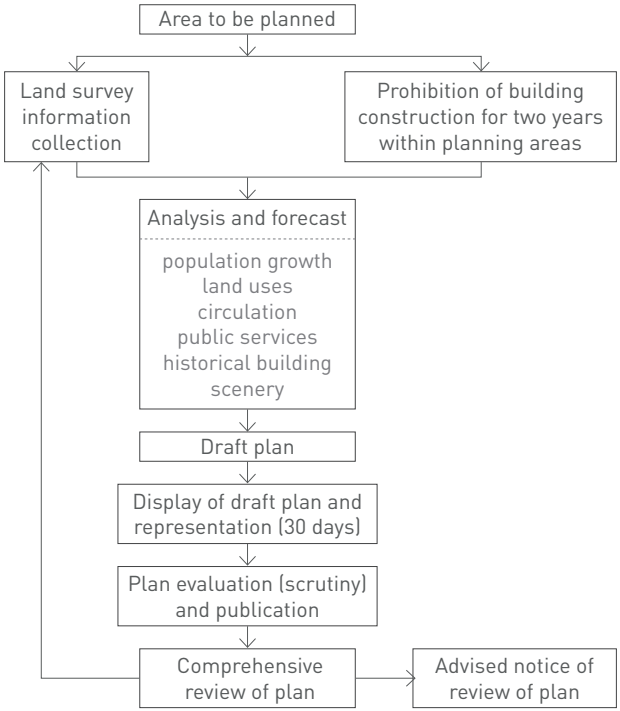


fig.75 The local planning process in Taiwan
Source: Urban Planning Law of Taiwan.

fig.76 Current and future planning system and applied laws of Taiwan. Source: edited by the author based on data from Urban Planning Law and National Land Planning Law.

the activities on each patches to follow the regulation of the Land Use Regulations. This has resulted that at the local scale, the real implementation and administration level of spatial works, when each land development is evaluated by the Commission for approval of land use category change or permission, it is often considered separately according to certain regulations and rules without reference to any regional development plan due to the lack of sufficient detail in reality (Hua, 2009). In short, the land use approach in all levels of planning could not provide effective methods or specific frameworks for the cross-sector or spatial coordination of government policy measures. The mutually exclusive categorization of urban and rural lands also lead to separation of responsibilities with the lack of evaluation system and weak enforcement of the administration.

Added with the inefficiency and weak enforcement of legislation, a long-term visioning for an integrated urban development is almost impossible, or remain as empty slogans or manifestations. In recent years, as many spatial problems began to show, debates has also been aroused. However, also influenced by the political polarization, these debates gradually dichotomized the local opinions into increasingly bitter confrontations in almost all spatial issues, especially those by nature controversial and complex, of which the debates should have been more about finding a mutuality with decision making rather than choose between black and white. The impossibility of real communication resulted in lack of trust, and had progressively formed an passive, anti-fraud attitude, with which as a consequence urban planners and implementers devote most of their efforts in dealing

with the inflexibility of regulations and acquiring permits through the tedious long process of different types of reviews across Commissions and bureaus. The situation has further demoralized innovation and public-inclusion willingness for many stakeholders and actors in both public sectors and private developers, which is the third characteristic observed.

3) Internationally, the approach of landscape urbanism are more and more appreciated to have an active engagement in the spatial development. Urbanism has been gradually regarded as a process of preparing a set of decisions for action in the future, directed at achieving goals by preferable means (Dror, 1935). Or as specified by Beauregard (2001) that they could mediate market-driven forces, and act as a catalyst for democratic deliberations and practical dialogue which integrates the science with craft, and that "it is also an ideology and thus infused with prescriptive judgements and normative visions." The role of landscape, has even been recognized with its capacity to critically engage the meta-physical and political programs that operate in a given society in shaping its cultural identity, and, due to its bigness of scale and scope, enables differences to play themselves out (Corner, 1999).

However, in implementation, this approach requires a delicate manipulation with complexity and diversity. Planning in this sense could not anymore avoid addressing knowledge from other disciplines. While the technical challenges may be considerable, the spatial and cultural challenges are by far the largest (Nijhuis & Jauslin, 2015). In real practice, working against the implementation of projects derived from the ideas of landscape urbanism is that they resist easy communication (Mossop, 2006). Besides proposals of place-making, planners today, as described by Bristol (2010), also require skills of facilitation and mediation if they are to be more inclusive and skilled in influencing the ways of the many varied players and stakeholders in the world of practical place delivery. In other words, community involvement becomes an inevitable dimension if a plan wants be comprehensive and operating in a sustainable working model.

In Taiwan, in the issue of participatory planning, the encouragement of community involvement in improving local neighborhoods is real, but the issue is that at present such initiatives remain very local, and fail to connect directly into the zoning and other local planning work that is undertaken (Bristol, 2010). Collaboration now has extended in the form of public hearing or i-Voting, both only involve the related stakeholders in discussion (or sometimes even simply presentation) before the final decisions are made, or imprudently put the serious responsibility of decision making on public preferences. Both situations could not rally let different stakeholders understand the essential and complexity of issues, or empower them with physical capability to change the living environment, therefore the interest remains low and successful example are rarely seen. As a consequence, participation in Taiwan now only recognized workable at the level of small sites and neighborhood project (Bristol, 2010), and as only a passive part to get better-informed. Moving upward to the citywide or regional scales, or as an active role in strategy and policy-making, are still fraught with many difficulties.

THE CURRENT CHANGES OF THE PLANNING SYSTEM

In the newly passed National Land Planning Law, as well as several project proposals in the Foresight Infrastructure Plans, the influence of national and regional-scale planning has been increased as the enforcement power has been given via the legislation process, the planning responsibility is also raised to the highest administrative bureau of the country, the Executive Yuan. This means now spatial framework will have a superior dominance to the issues of the other governmental sectors. The new framework (fig.76) could provide clearly hierarchy in spatial issues via the new categorization of lands to improve regional integration and compatibility of boundary areas between administrative borders. The legal power and the leveling-up of highest responsible institution also enhance the efficiency of implementation. Nevertheless, a new ambiguity might appear with the new categorization of lands, and the centralization of planning power could hardly be expected to introduce a better inclusiveness and transparency in the planning system.

Another aspect is that with the framework of 63% of the national land being Conservation Area being ensured. And to counteract the long-criticized over-concentration on economic dimension, a regulation of "development fee" will be required in the future for all development plans. The dimension of environment ecology is obviously getting more concern, and if the integrity and accountability of legislation is also secured, the devastation of natural environment can be expected with an optimistic decrease. However, the socio-economic aspect of marginalized community might be even more endangered if flexibility and adaptation is not addressed in the process of planning, and to replace the function of some existing environmental-damaging infrastructures, an absolute distinction between development and conservation areas might rake the society more cost for supporting the functioning in dense populated areas. In other words, the reciprocal role of land(scape) planning engagement in development still is not yet recognized, which is actually essential in construction a more sustainable planning model for the future. The "development fee" mechanism, on the other hand, though might be able to stop some profit-oriented development, could very possibly discourage as well the willingness for innovation and participation of both academic field and public sectors, local population, as well as mall and medium enterprises even if they aim to prosper their business and in the meanwhile provide positive feedback to the landscape.

OPINIONS FROM THE ACADEMIC FIELDS

Two phone-call interviews and several email interviews has been carried out during the process of this thesis, with scholars in the fields of ecology, hydrology, and urbanism. Some of them also has experiences in the public sectors, as administrative officers or committee members. The interviews intend to collect opinions from different disciplines regarding urbanism as medium for integrated river basin planning.

interview #1: Professor Wang, Jing-ming

date: 13 March 2017
interviewee: Ecology and Environmental Education Scholar, Professor of National Taiwan Normal University, consulting committee member of Public Construction Commission, consulting committee member of Water Resource Agency Landscape and Ecology Northern Sector, Chairman of Society for Wildlife And Nature.

Source: J.M. Wang.

Ecology, instead of pure preservation, should be considered comprehensively with culture, art, social and urban issues in a broader sense.

Mountain agricultural is an unique asset of Taiwan, we should invest in researches for ecology-friendly ways of farming, rebranding it as part of the cultural identity based on our landscape quality.

Reservoir is indeed giving impact to the environment, but it reduces impact to a limited section of the river, the conservation of catchment environment need to be emphasized.

Dajia river supplies the water resources for Taichung Metropolis, but it relationship with the metropolitan area is rather weak.

interview #2: Professor Lee, Hong-yuan

date: 06 April 2017
interviewee: Hydrology Engineering Scholar, Professor of National Taiwan University. Former Minister of the Interior, former Vice Mayor of Taipei County. Former Chairman of Public Construction Commission. Former Chairman of Water Conservancy.

Source: Common Wealth Magazine [http://www.cw.com.tw/].

Though I'm a hydrologist, I oppose to constructing new reservoirs. Instead, we should look for non-engineering solutions.

Currently there's no matured technology regarding how to demolish a reservoir, but it is be an issue many countries will be facing soon.

The government should raise the unit water price, this will stimulate the growth and innovation of water-saving industries and researches.

For having these alpine fruits and tea, the society has been paying too much economic and social cost. I suggest to move these agriculture activities to lower-altitude hills. However, the economic concern of alpine communities need to be well-considered instead of bluntly blaming them for damaging the environment.

Spatial planning should think ahead of future, we have been running behind problems for too many decades.

interview #3: Professor Huang, Shu-li

date: 07 &10 March 2017
interviewee: Scholar of urban planning and urban ecology, Professor of National Taipei University. Chairman of Center for Global Change and Sustainability Science in Taipei University.

Source: http://ntuweb.brightideas.com.tw/

Water management has long been limited by land-use regulations, the new NLPL might push forward some integrated projects.

Landscape urbanism concept is acknowledged by many scholars, but in implementation there are many institutional limitations.

Participative planning is more adopted in the neighborhood scale projects, in the level of regional planning, is carried out through committee composed of professionals.

interview #4: Professor Wang, Chung-he

date: 12 March 2017
interviewee: Scholar of global warming and earth science; Vice Chairman of Institute of Earth Science, Academia Sinica. Researcher at Research Center for Environmental Changes, Academia Sinica.

Source: Institute of Earth Science, Academia Sinica

"Sponge Taiwan" water management has been adopted in some local municipalities. The concept needs to be push further in the academic field.

Interdisciplinary integration is necessary for facing the future climate changes. In Taiwan we have many specialist in different fields, but communication and cooperation is weak. Perhaps the NGOs can play a role to initiate bottom-up guidance for the government regarding spatial and environmental issues.

OPINIONS FROM THE LOCAL RESIDENTS

The opinions of the local residents are gathered from news and interview videos from the internet. In general, in the upstream area, local population suffer from the weakened accessibility after the 921 Earthquake in 1999, which caused the constant road-breakdown towards the western part of Taiwan, where the main metropolis and logistic clusters concentrate.

"After the road breakdown, the visitor decreased, and we need to produce more fruits because now the shipping cost has doubled if not tripled.[1]" However, the expansion of alpine agriculture has further damaged the environment and result in continuous conflicts between habitation and natural ecology.

Besides, the basic services remains very much in lack for many years. The waste management, for example, is barely taken care of (fig.77). Many errands, such as newspaper deliver and school-children pick-up, rely on the volunteer help of bus driver, with only one bus a day.

fig.77 Solid waste disposed on the slopes of Lishan area.
Source: photo from BuzzOrange.com

"Before it was over-excavation, now the forbid-cutting policy is rather over-correction for the forestry industry.[2]" said a wood factory owner. The once prosperous forestry villages in the midstream area now remained with many left-behind forestry people. Many land-owner or renters turned into fruit or tea farming, which in the end cause even more environmental damages. The wood consumption of Taiwan is around 6 million m^3, in which more than 99% relies on imported woods. "There are many artificial forests, yet we still import woods from broad. Actually our wood quality is very good[3]", said an forestry operator.

At the downstream, on the other hand, the main economic activity has been greatly affect by the increasingly frequent droughts, around one-third of the rice fields are forced to fallow. Besides, local residents also suffer from a lack of public spaces, poor public transportation, as well as deterioration of facilities such as houses and water pipes.

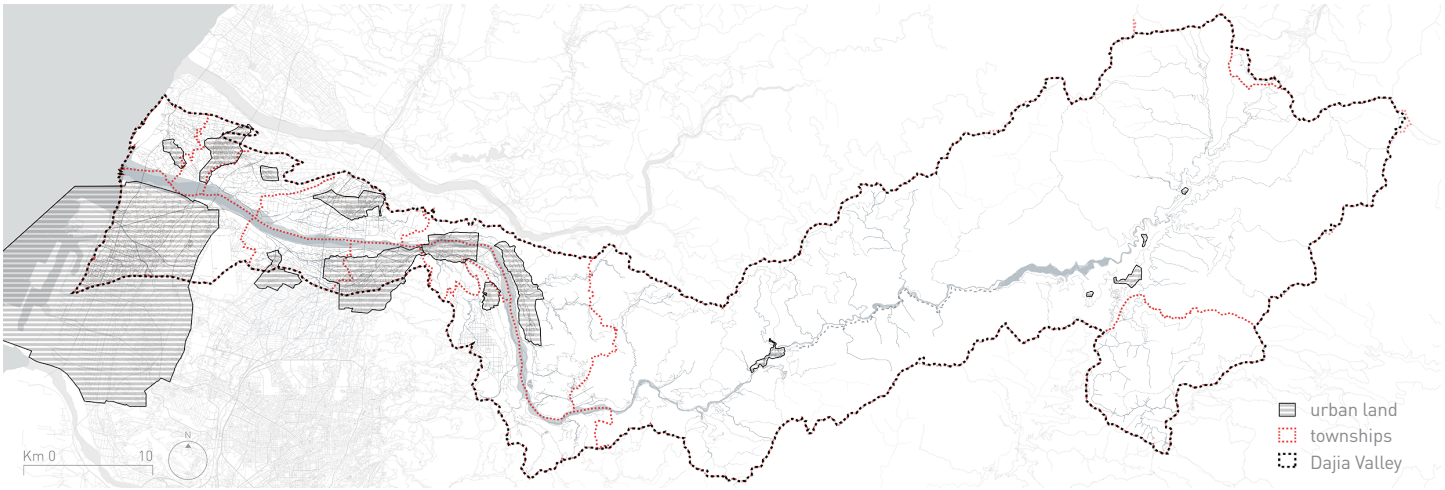
1. From Taiwan 1001 Stories Channel [online] available at:https://www.youtube.com/watch?v=xKNqSU9HY7I [accessed 27. Feb. 2017]
2. From Initium Media [online] available at: https://theinitium.com/article/20161201-taiwan-industry/[accessed 21. Apr. 2017]
3. From News & Market [online] available at: https://www.newsmarket.com.tw [accessed 02. May. 2017]

CONCLUSION OF CULTURAL CONTEXT DIAGNOSIS

In the problem field of integrated river basin planning addressed in this thesis research, observing the spatial development in the testing site Dajia River Valley (fig.78), the current planning system can be regarded as one of the main reason for many existing problems. The devastation of landscape ecology by the hard-engineered infrastructures as a result of over-concentration on economic planning; the lack of integration between places and disciplinary due to the compartmental working model and land use approach, as well as the negligence of inclusiveness and participation, that lead to the heavy societal cost to compensate for the marginalized areas with the accumulated social, economic, and ecological problems. Even though the new planning system might mitigate some problems such as environmental conservation, other aspects such as the socio-cultural aspect transformation of the current economic activities are apparently neglected. Especially considering this will first affect some more rural or marginalized areas in the territory, planning in this approach might eventually arouse more serious conflict between different social groups and industries.

This thesis intends to present another alternative, based on the landscape urbanism theories that natural and artificial world can operate in a reciprocal way with delicately-designed infrastructure as a medium. The landscape potential exploration thus will be the main objective in this research to address the most crucial problem of the water infrastructure. The potential implementation models will also be proposed in the later chapters, to be provided as a comparative feedback to the existing planning system of Taiwan.

fig.78 Administrative borders and urban-planning areas in Dajia River Basin.
Source: edited by author based on data from Taichung City Government.



III-II. Mapping the Landscape Context

DIVERSITY OF LANDSCAPES AS A POTENTIAL

From upstream towards downstream, the landscapes of the river balley comprise alpine agriculture farms, infrastructures (reservoir, dams, and power plants), valley villages, the dense populated metropolitan areas (Taichung city, the third biggest city in Taiwan), as well as a fishing port and protected wetlands at the river-mouth (fig. 79). The Dajia river scape provide a compact case for developing a strategic plan for the whole river basin, especially focusing on the relation between different environmental contexts, the network model which addresses economic and ecological values for the city in connection with landscape quality, an alternative water-resource model, and zoom-in design interventions possible in the alpine area, the valley villages, as well as where the river enters the sea.

Kaomei wetland
Protected for its ecological importance, threaten by tourists influx.The villages nearby on the other hands, suffer frequently from droughts causing the rices fields forced to partially fallow. With poor accessibility and facility, the villages are quite marginalized.

Taichung port
The construction of the port resulted in the sediment accumulation at river-mouth, formed the wetland landscape of Kaomei area, but also the marginalization of the agricultural settlements nearby.

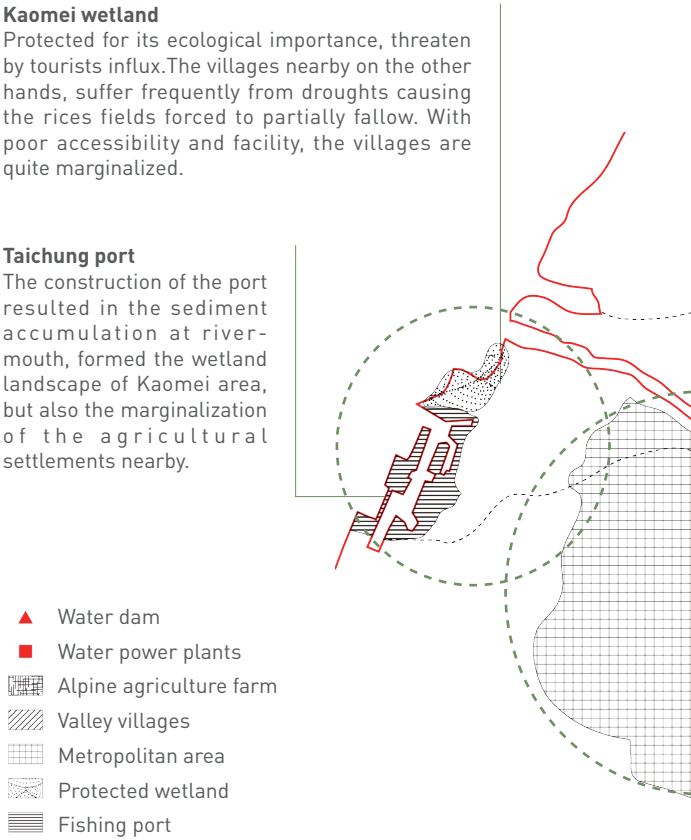
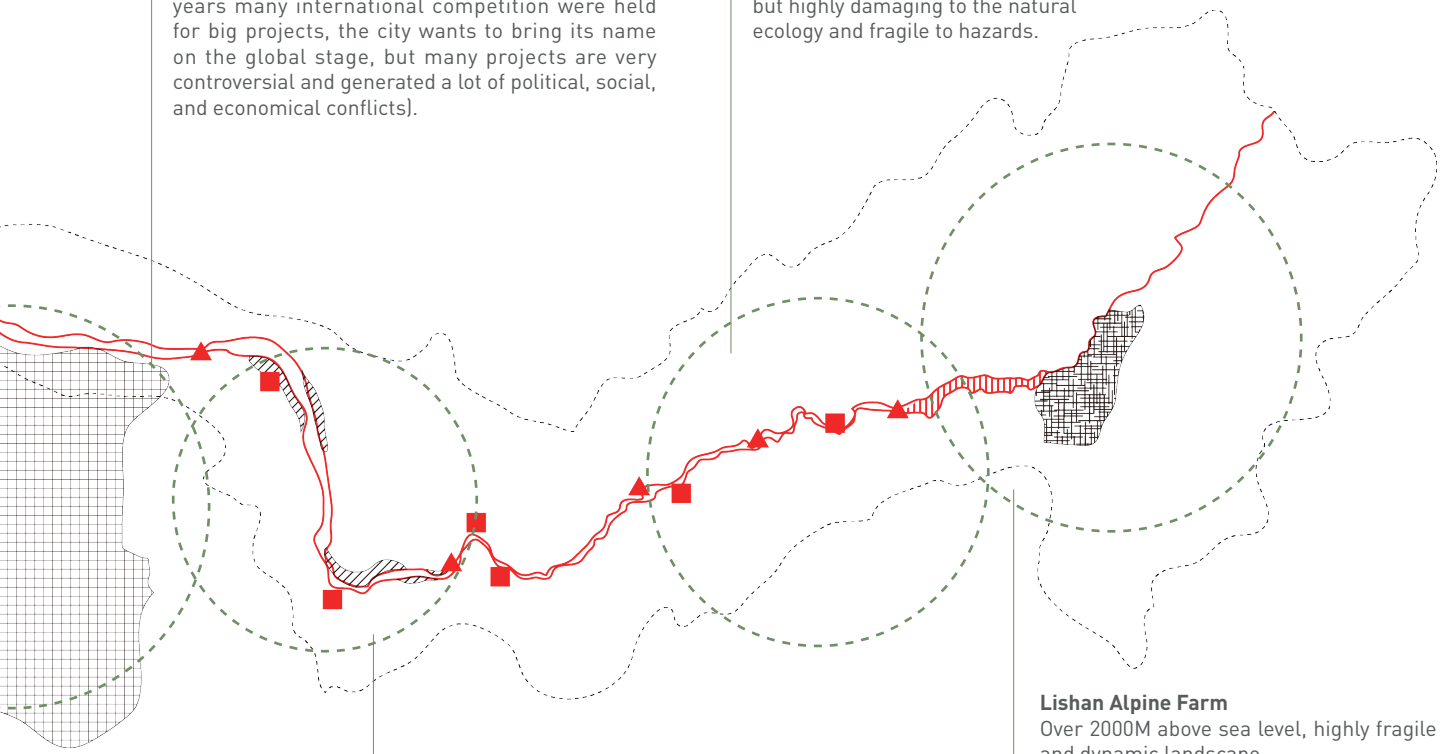


fig.79 The diverse environmental contexts and urban mophologies of Dajia river valley
Source: made by author

Taichung City
Third largest city of Taiwan,with many urban planning problems and lost of its identity (in recent years many international competition were held for big projects, the city wants to bring its name on the global stage, but many projects are very controversial and generated a lot of political, social, and economical conflicts).

Heavy engineered infrastructures
Deji Reservoir, 6 power plants and 5 dams. Abundant water resources but highly damaging to the natural ecology and fragile to hazards.

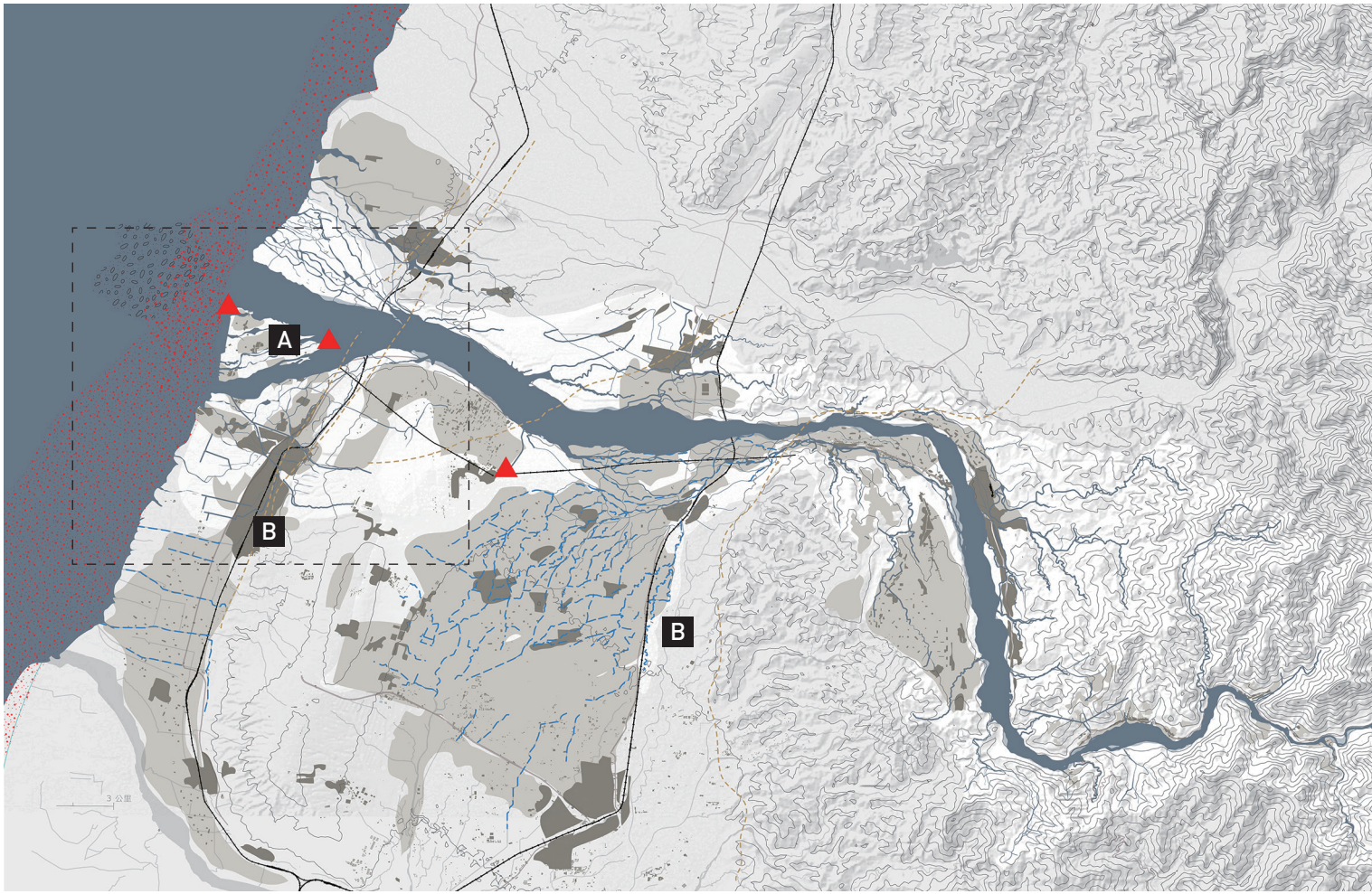


Valley villages
Threatened by natural disasters caused by the unstable and fragile landscape as well as drastic water and sediment flows from the upstream.

Lishan Alpine Farm
Over 2000M above sea level, highly fragile and dynamic landscape.
Economic importance: Alpine agriculture production values over 20 million euros per year; alpine tourism popular point. The alpine activities have significant impact to the environment.

HISTORICAL PATTERNS

BEFORE 1850s: NATURE-DRIVEN DEVELOPMENT

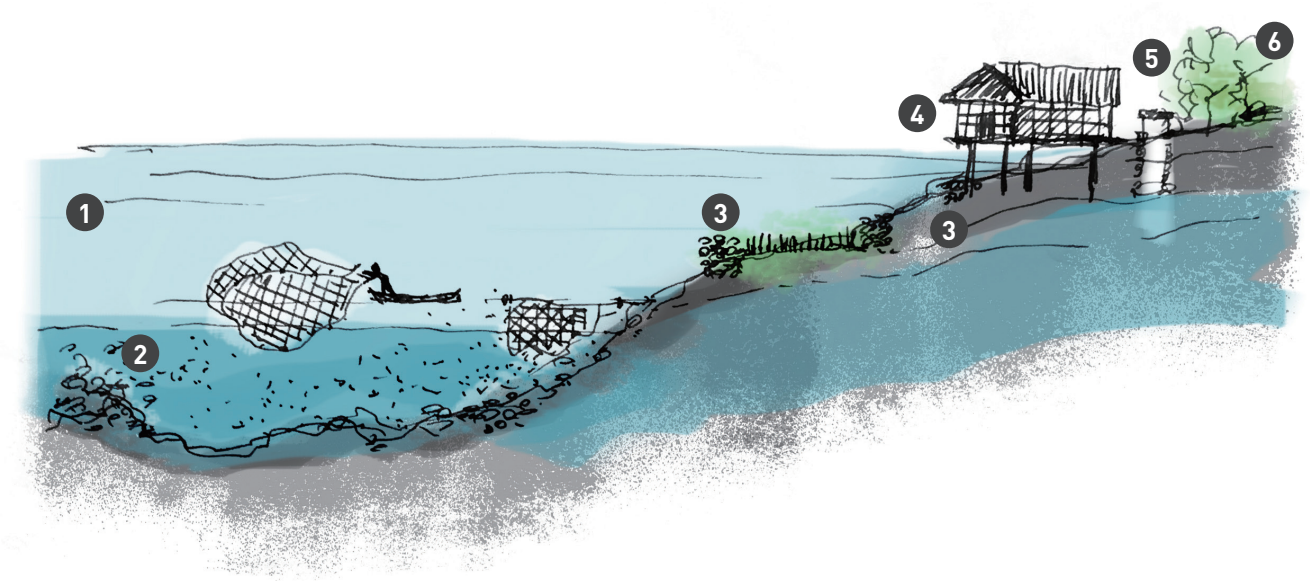


Early settlements development nearby water, especially at the flooding plains at the river mouth(A), and the contact of coastal mountains and plain, where due to some geological faults passing by, there were many springs in the area (B). In the upper streams, within the mountains, on the other hand, are mostly lived by aborigines who maintain their life by hunting and fishing in the streams(C).

fig.80 Mapping of human activities in relation to the Dajia river landscape of the time from before 1850s.
Source: by the author based on data from historical maps, historical descriptions, google maps, and GIS databases.

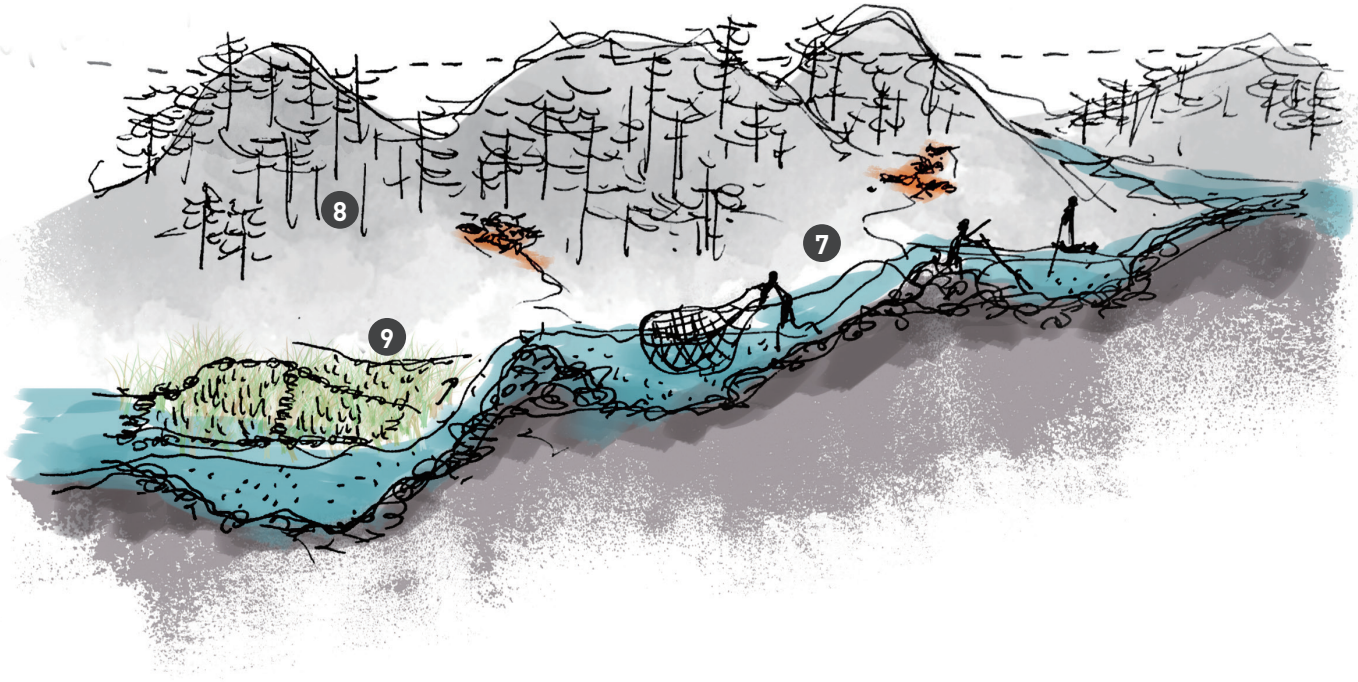
BEFORE 1850s: NATURE-DRIVEN DEVELOPMENT

Lifestyle with water at downstream of Dajia river.



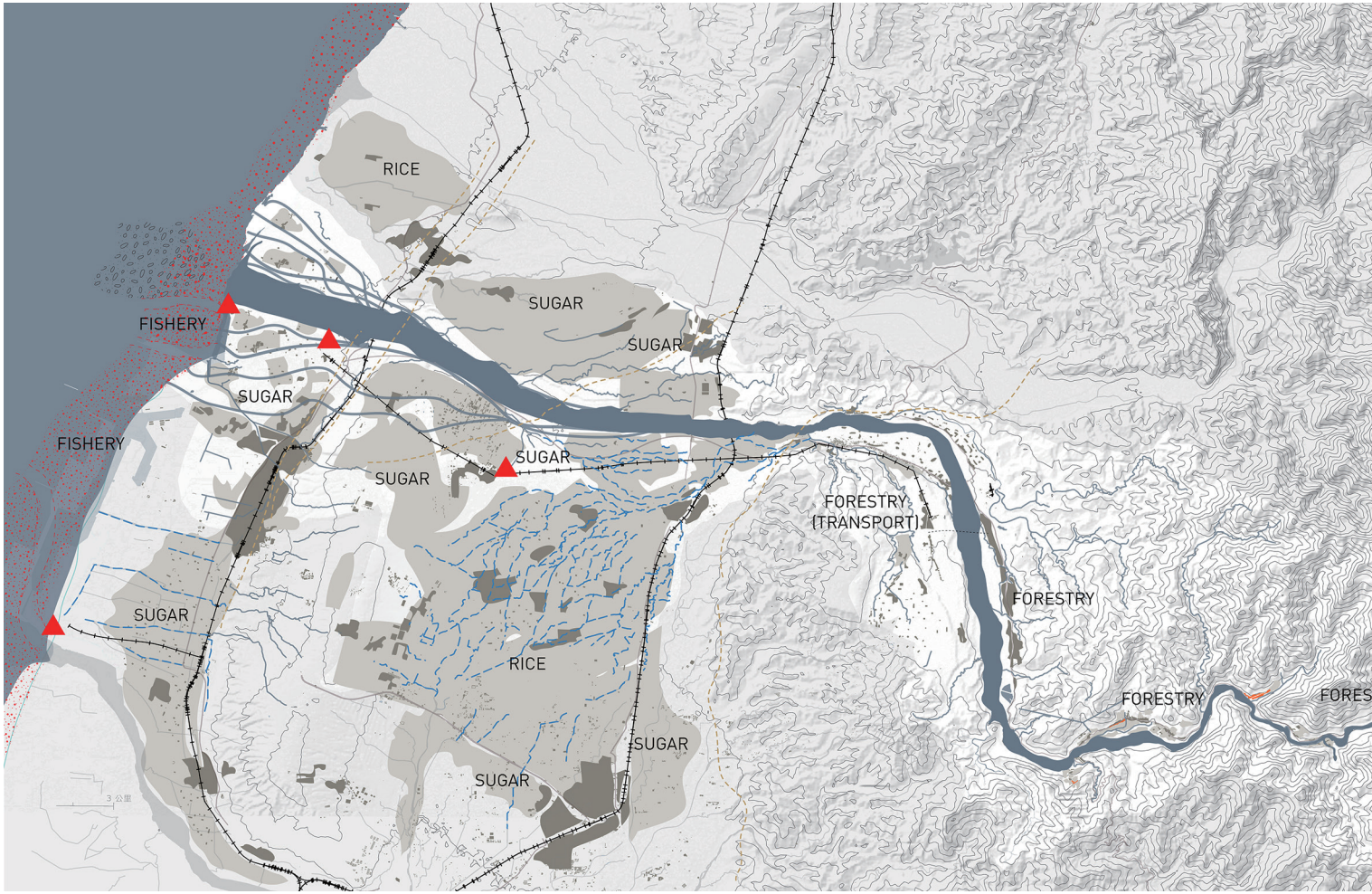
1. large tidal difference up to 5 meters
2. submerged reef + sediments full of nutrients results in rich of fishes
3. pebbles from the river were used for structuring agricultural fields along the river; also used as bases for architecture
4. pole column architecture to cope with flood-prone environment
5. wells were often used for getting ground-water
6. springs from hills allows vegetation, and therefore wildlifes for hunting

Lifestyle with water at upstream of Dajia river.



7. migratory fish and other fishes usually seen in the rivers; the river corridor is the main resources of life for the aborigine tribes.
8. mountains full of pine and cypress woods, with forest line up to 3500m
9. small alluvial fans were used for growing grains.

1850 - 1950s: NATURE REGARDED AS RESOURCES REPOSITORY



The late Qing dynasty and Japanese colonization regarded the area as resource repository, plains are largely cultivated for suger and rice production (A), with infrastructure such as railway, irrigation drentches, and small harbours constructed to support the industries. In the mountains, the precious woods (B) were largely cut and shipped downstream for construction and exporting.

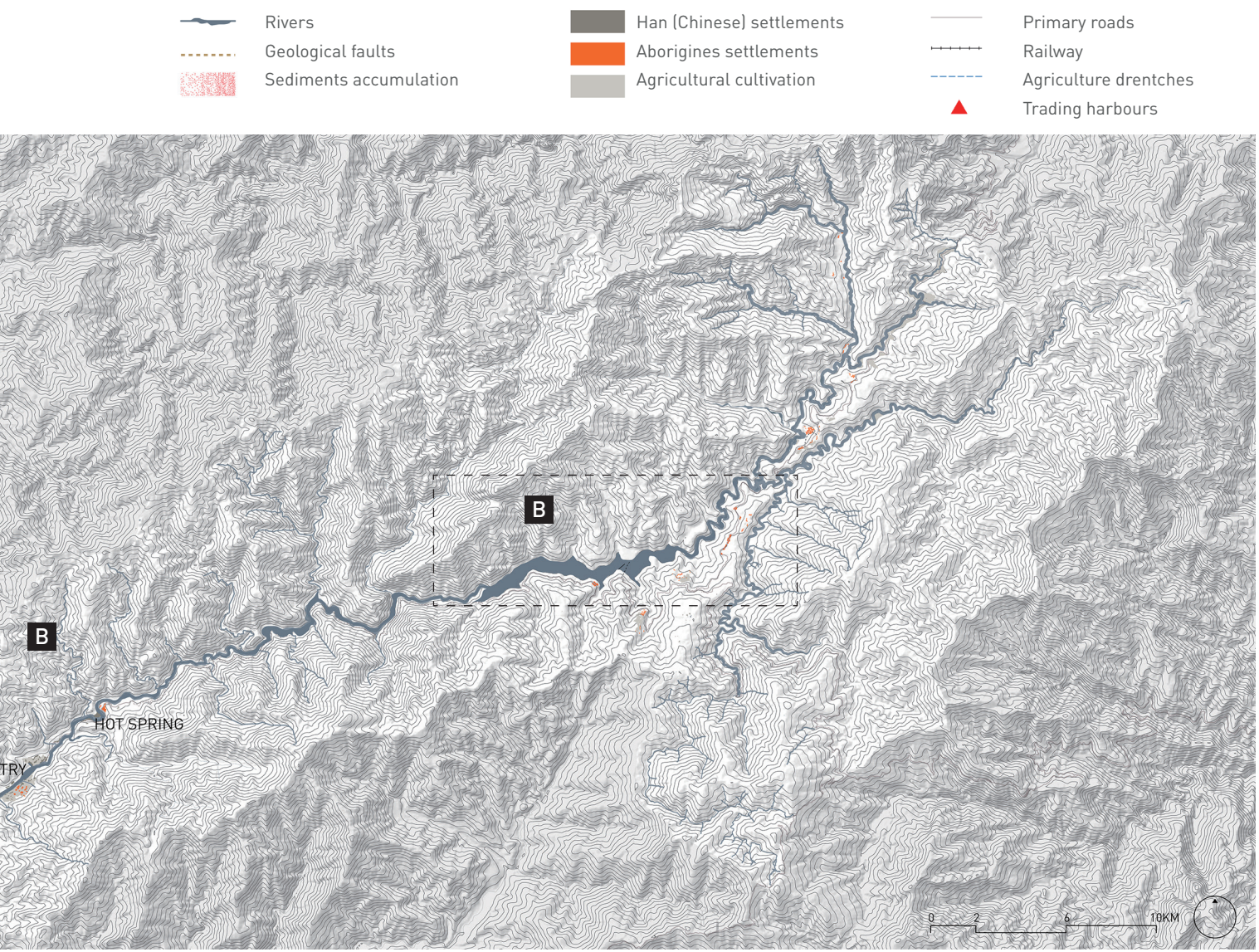
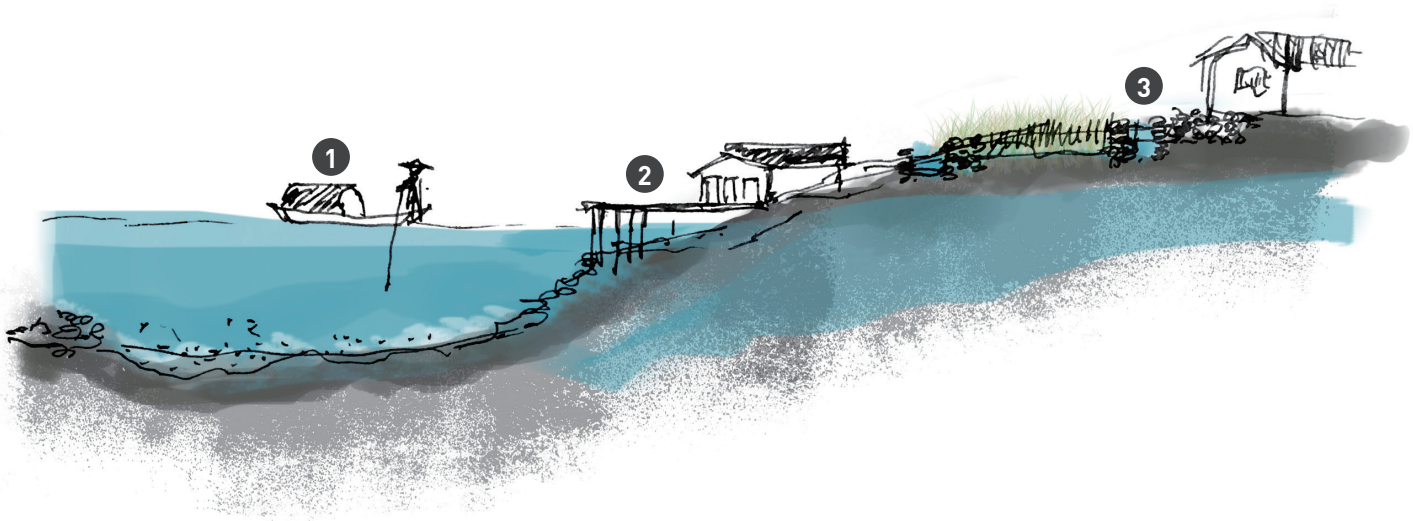


fig.81 Mapping of human activities in relation to the Dajia river landscape of the time from 1850s till 1950s.
Source: by the author based on data from historical maps, historical descriptions, google maps, and GIS databases.

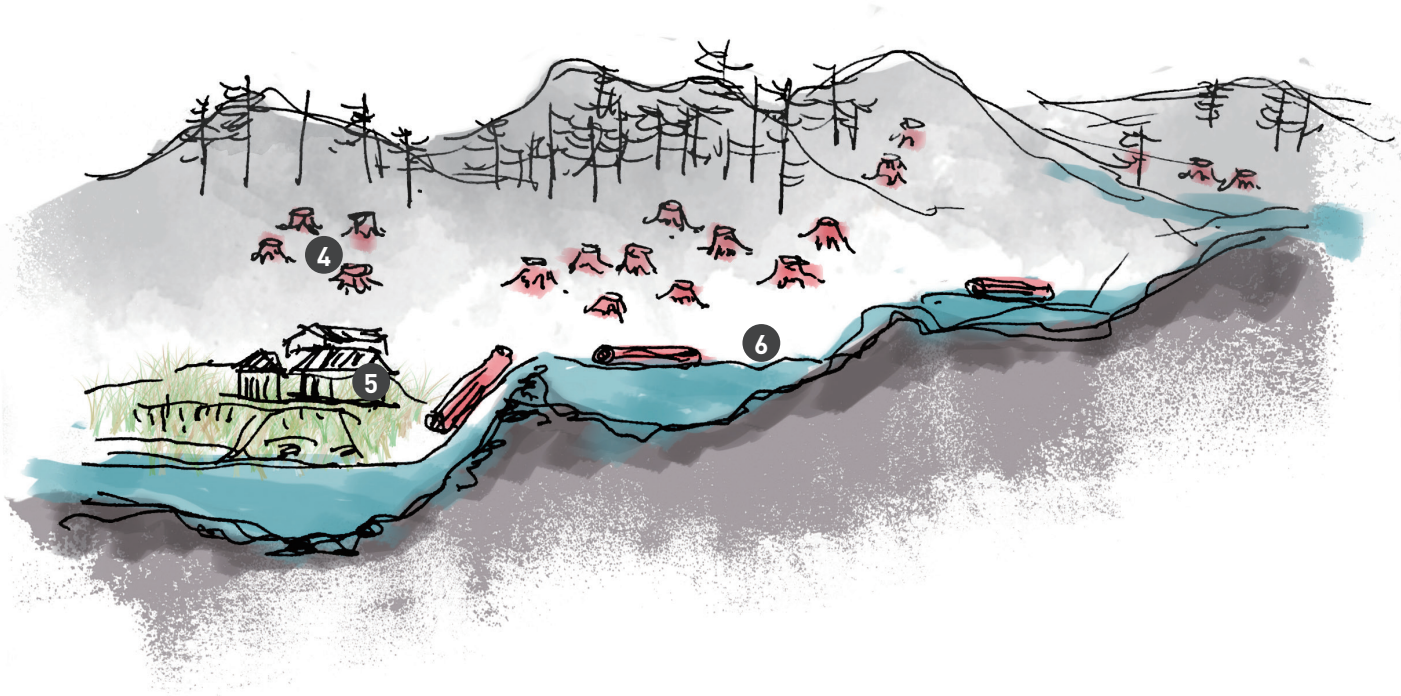
1850 - 1950s: NATURE REGARDED AS RESOURCES REPOSITORY

Lifestyle with water at downstream of Dajia river.



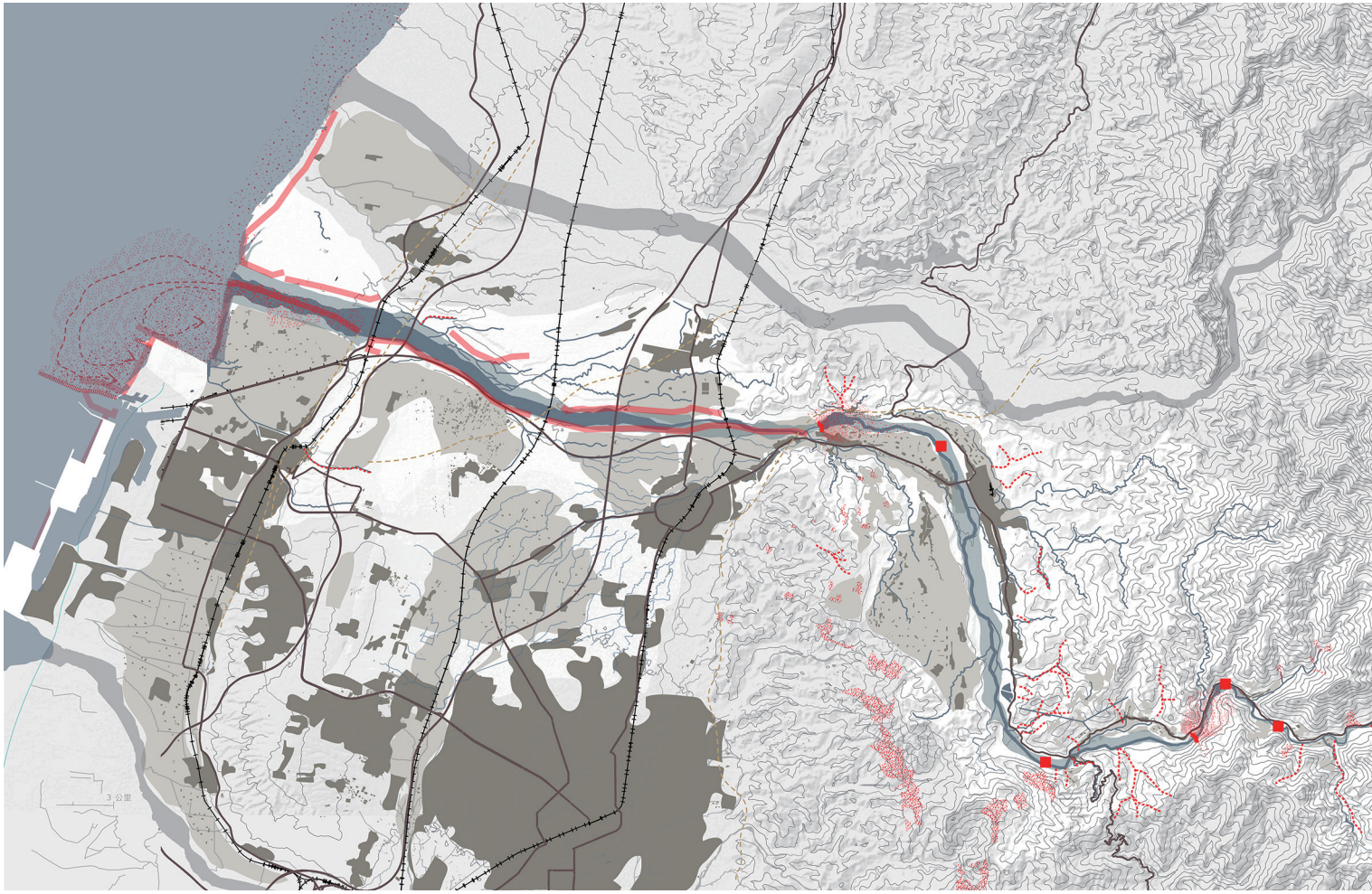
1. Free crossing-river services provided by local municipalities
2. Trading harbours for exporting goods and agricultural products
3. Pebbles from the rivers are used for construction irrigation drentches or used as base for constructing houses.

Lifestyle with water at upstream of Dajia river.



4. Riverside settlement began to expand in order to support excavating industries such as forestry to excavating natural resources.
5. Woods were cut, though the roots were kept, the erosion from rain fall were increased, with earthquake hits, the land became even more fragile
6. Wood logs were shipped downstream for exporting of developing constructions at the plain area.

1950s - TODAY: LIMITATION OF THE HEAVY ENGINEERED INFRASTRUCUTRE



After the over excavating of nature resources such as cutting of woods, cultivation of alpine agriculture, construction of reservoirs and water power plants; added with the hit of earthquake and typhoons, the river scape became increasingly vulnerable. At the upper stream, the sediment accumulated in the river can result in river level rise in the next 10 years up to 20 meters high (A). At the mid-stream, the roads were controled only for local

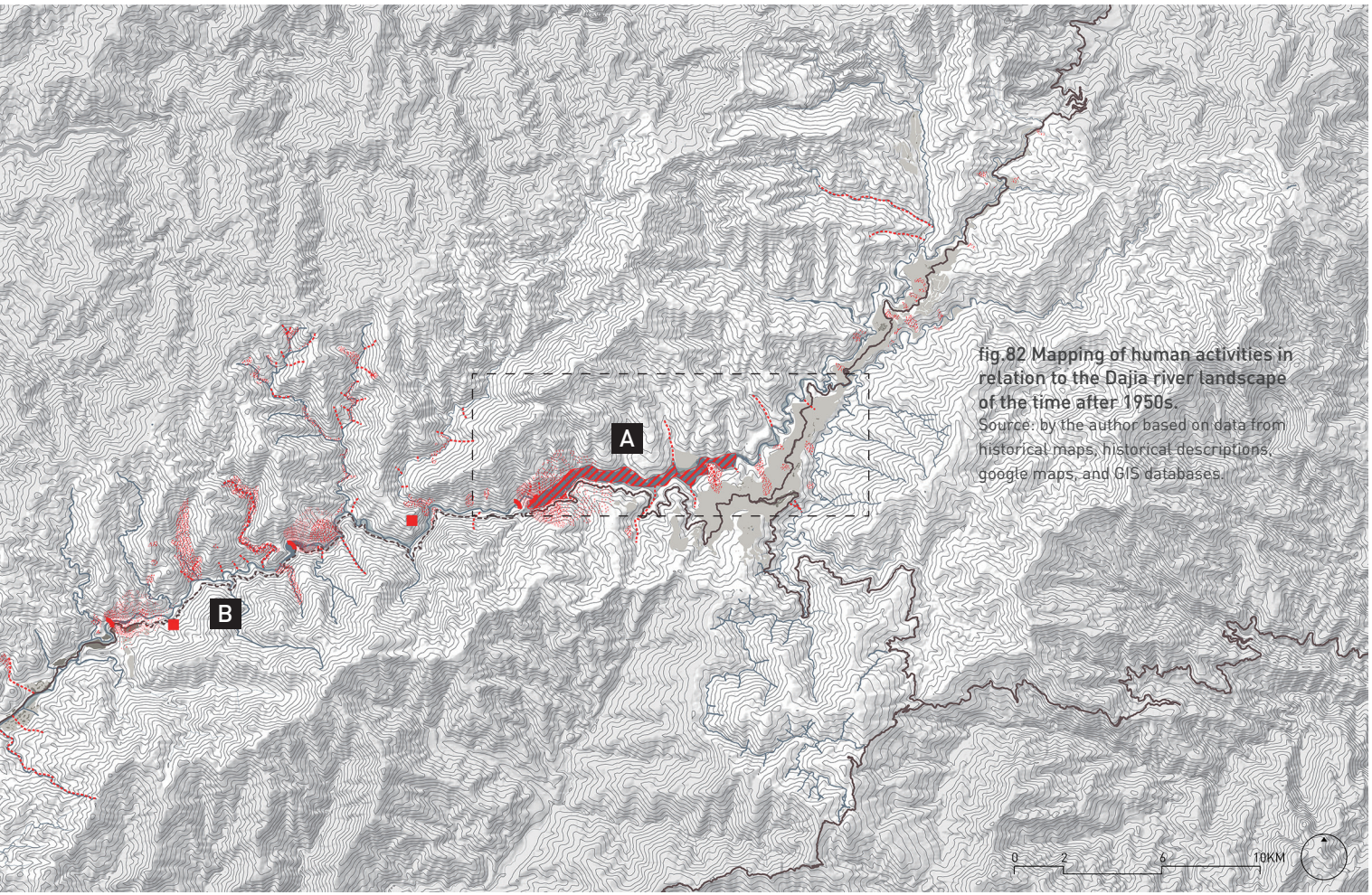
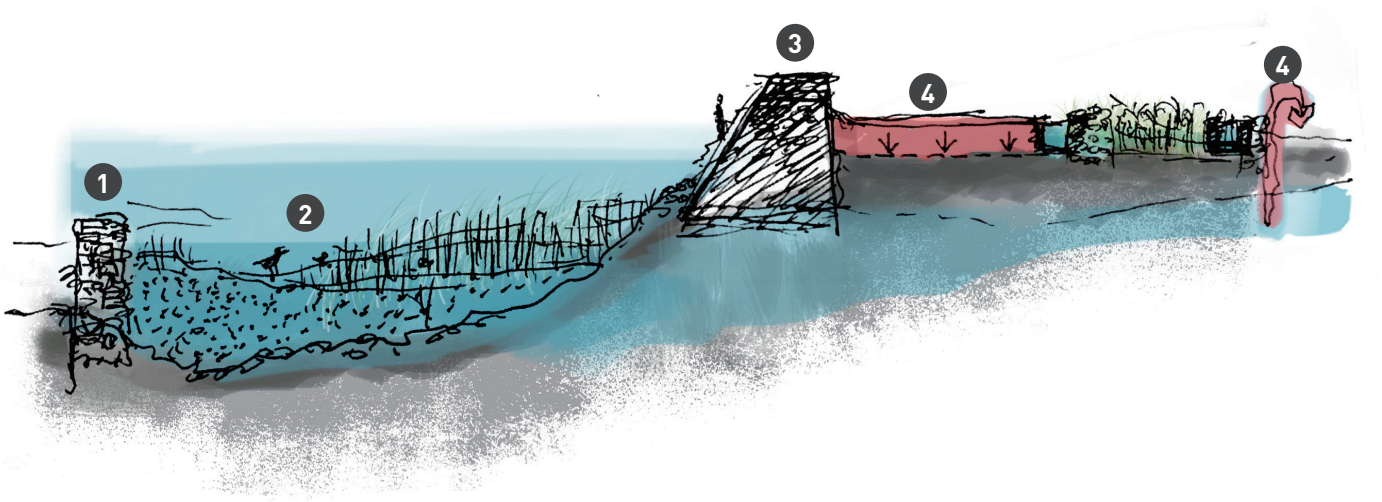


fig.82 Mapping of human activities in relation to the Dajia river landscape of the time after 1950s.
Source: by the author based on data from historical maps, historical descriptions, google maps, and GIS databases.

residence due to the fragility of the land and the landslide and collapsing threats in the valley (B). The construction of anti-sand dikes for the Taichung port, on the other hand, has completely changed the ecology of river mouth of Dajia to become a wetland area rich of biodiversity (C). The wetland's beauty has attracted the influx of tourists which now threatens its ecology.

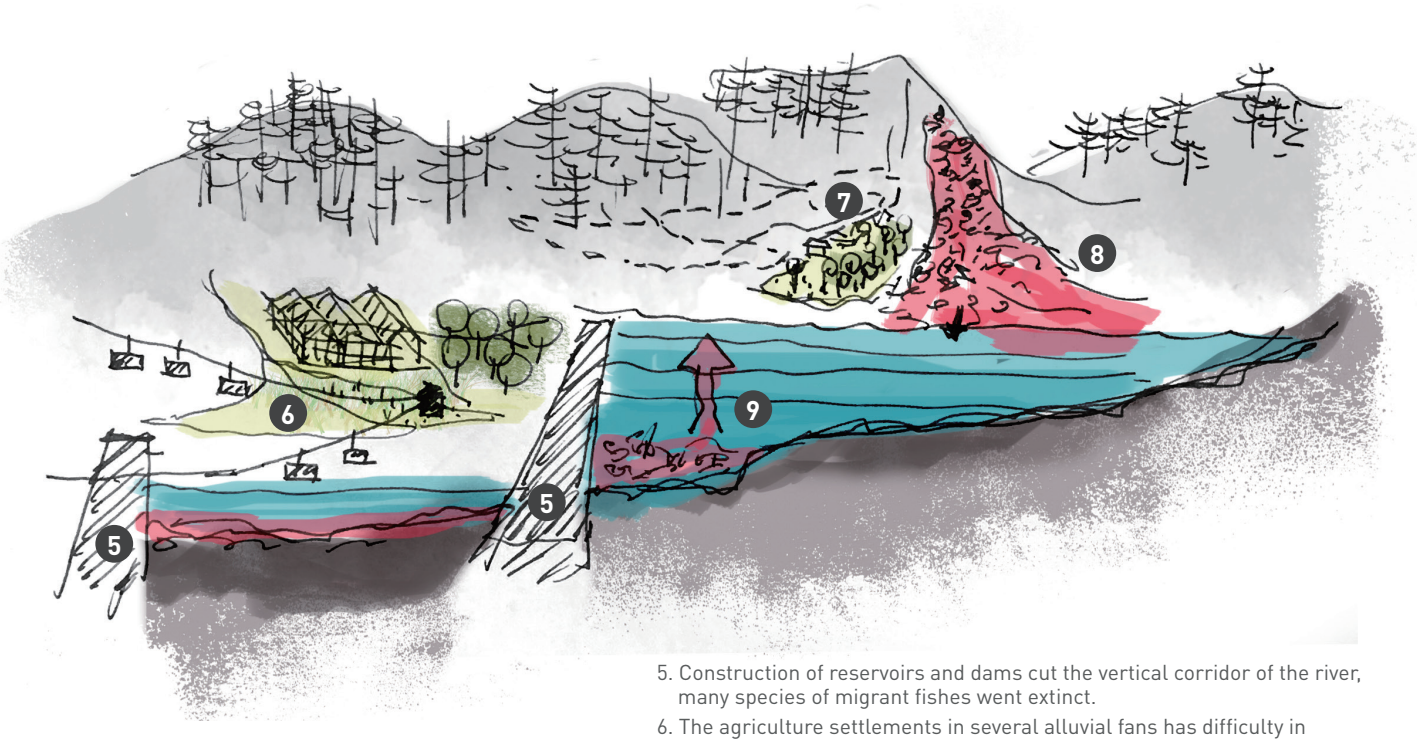
1950s - TODAY: LIMITATION OF THE HEAVY ENGINEERED INFRASTRUCUTRE

Lifestyle with water at downstream of Dajia river.



1. The construction of anti-sediment dike to protect Taichung Port resulted in the sediment accumulation largely increased and kept at the river mouth of Dajia river, which changed the area from a fishere site into wetland.
2. The climate and the sediment full of nutrient brought rich biodiversity to the wetland, such as migrant birds and special species of plants.
3. The inner land were protected by dikes, with little connection to the water.
4. Agriculture and aquaculture fisheries began to extract groundwater, the over-extraction caused land subsidence in the coastal areas.

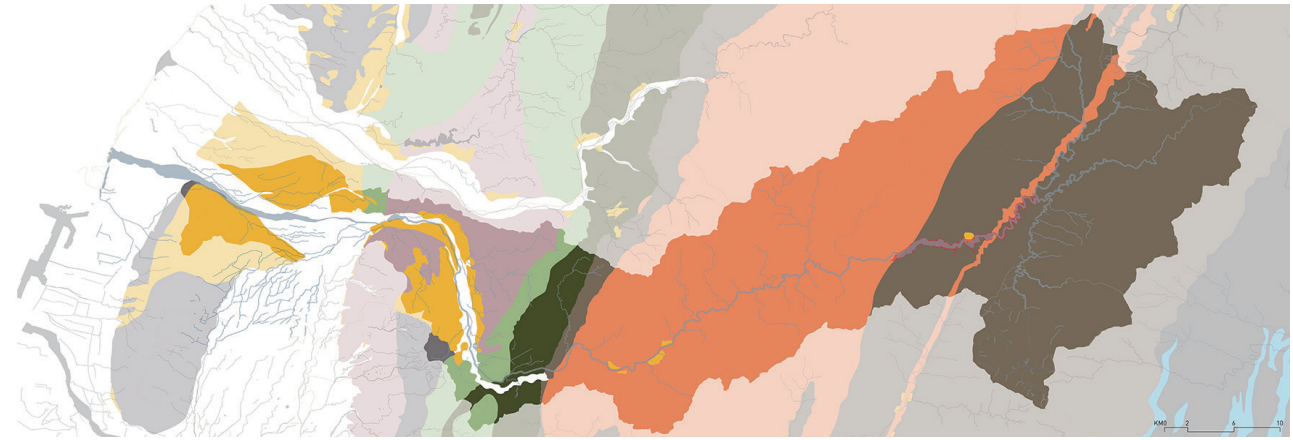
Lifestyle with water at upstream of Dajia river.



5. Construction of reservoirs and dams cut the vertical corridor of the river, many species of migrant fishes went extinct.
6. The agriculture settlements in several alluvial fans has difficulty in connection with the outer world, they use flowing cages to ship products and even people across the river (reservoir).
7. The wood industries were restricted, and with the decrease of alpine agriculture, many actors devote to recreational farms or park business.
8. The fragility of mountaineous lands resulted in landslides happening more frequently, thus more sediments accumulated and kept in the river.
9. It is estimated that the accumulation could result in river level rise over 20 meters in 10 years. Therefore currently, a lot of money is spent for dredging sands and muds from the river and reservoir.

GEOGRAPHIC CONDITION

GEOLOGY



- Terrace Deposits
- Pleistocene
- Lower Miocene Series
- Upper Miocene Series
- Pliocene
- Terrace deposits
- Slates

fig.83 Geology map of Dajia river valley
Source: map by the author based on data from GIS database

SURFACE SOIL

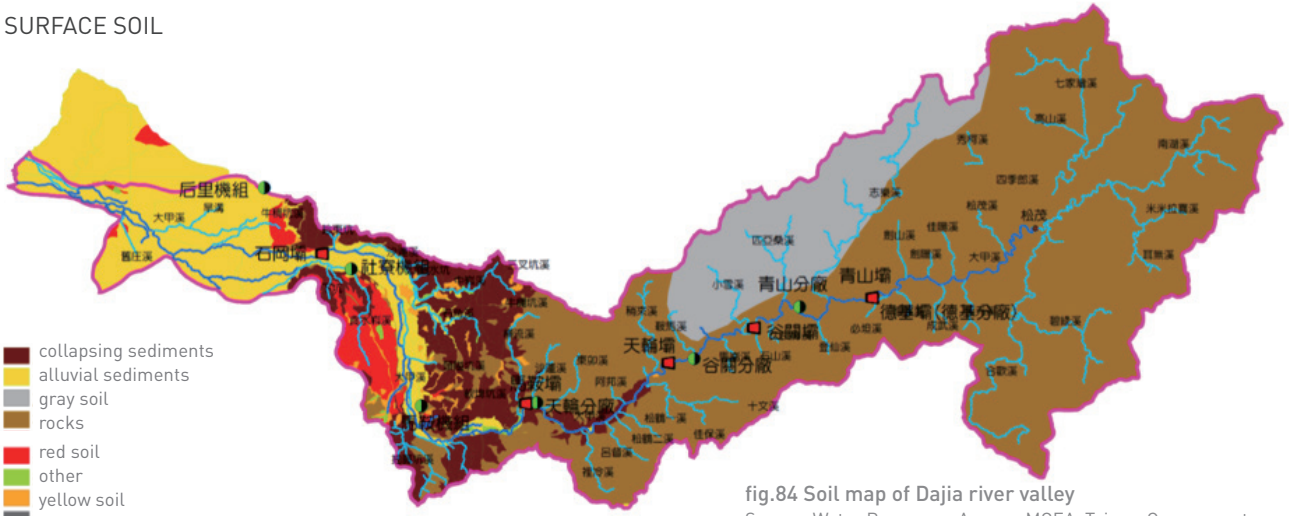


fig.84 Soil map of Dajia river valley
Source: Water Resources Agency, MOEA, Taiwan Government

SLOPE STEEPNESS

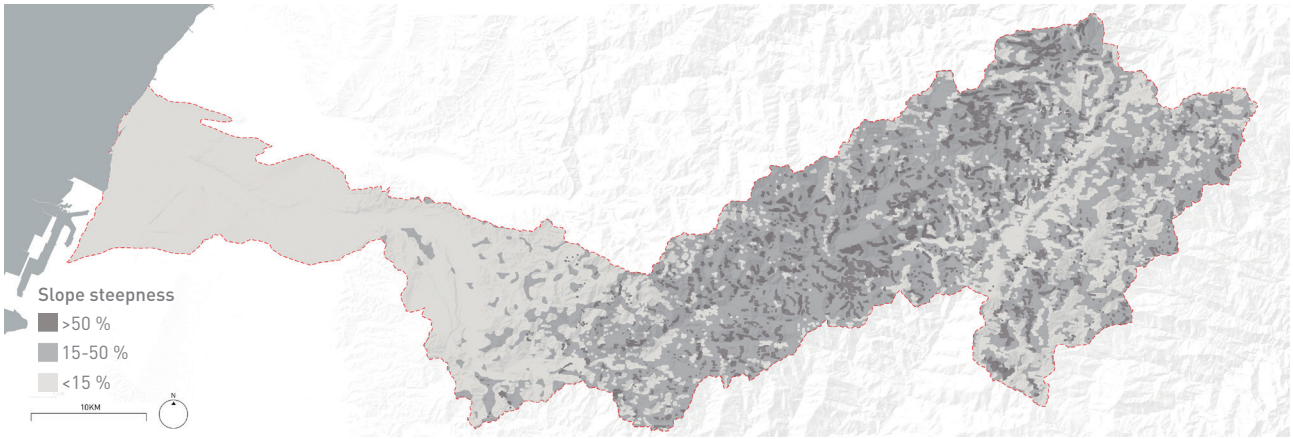


fig.85 Map of slope steepness in Dajia River Basin.
Source: made by the author based on data from Central Geological Survey, MOEA, Taiwan Government.

VULNERABILITY
TO RAINSTORM

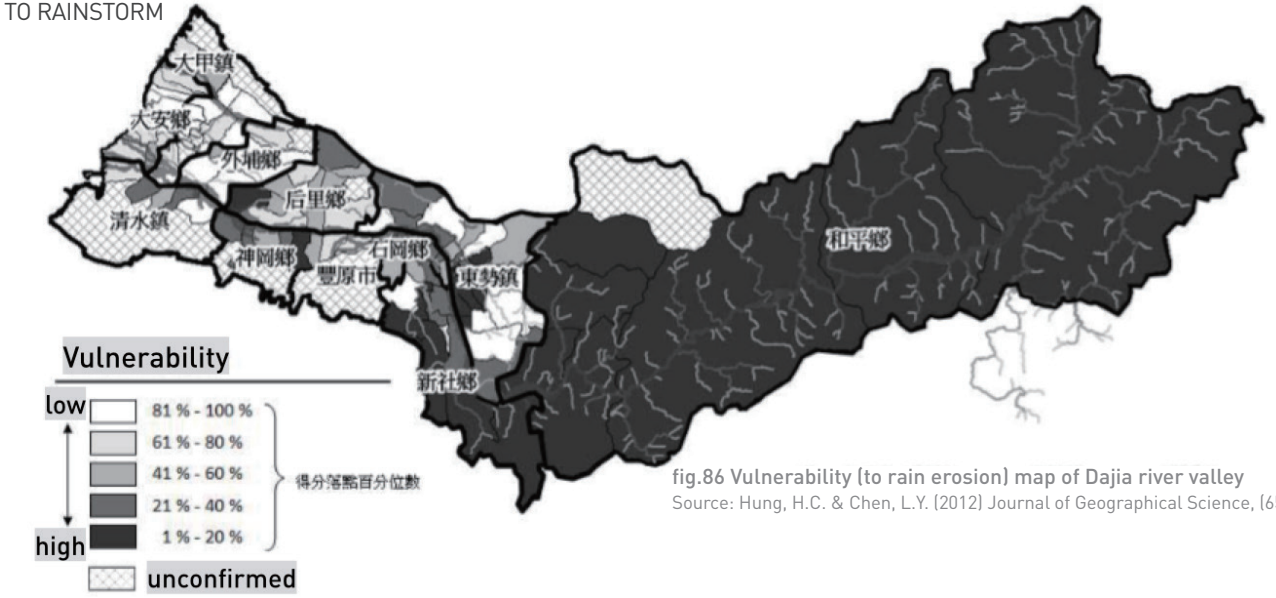
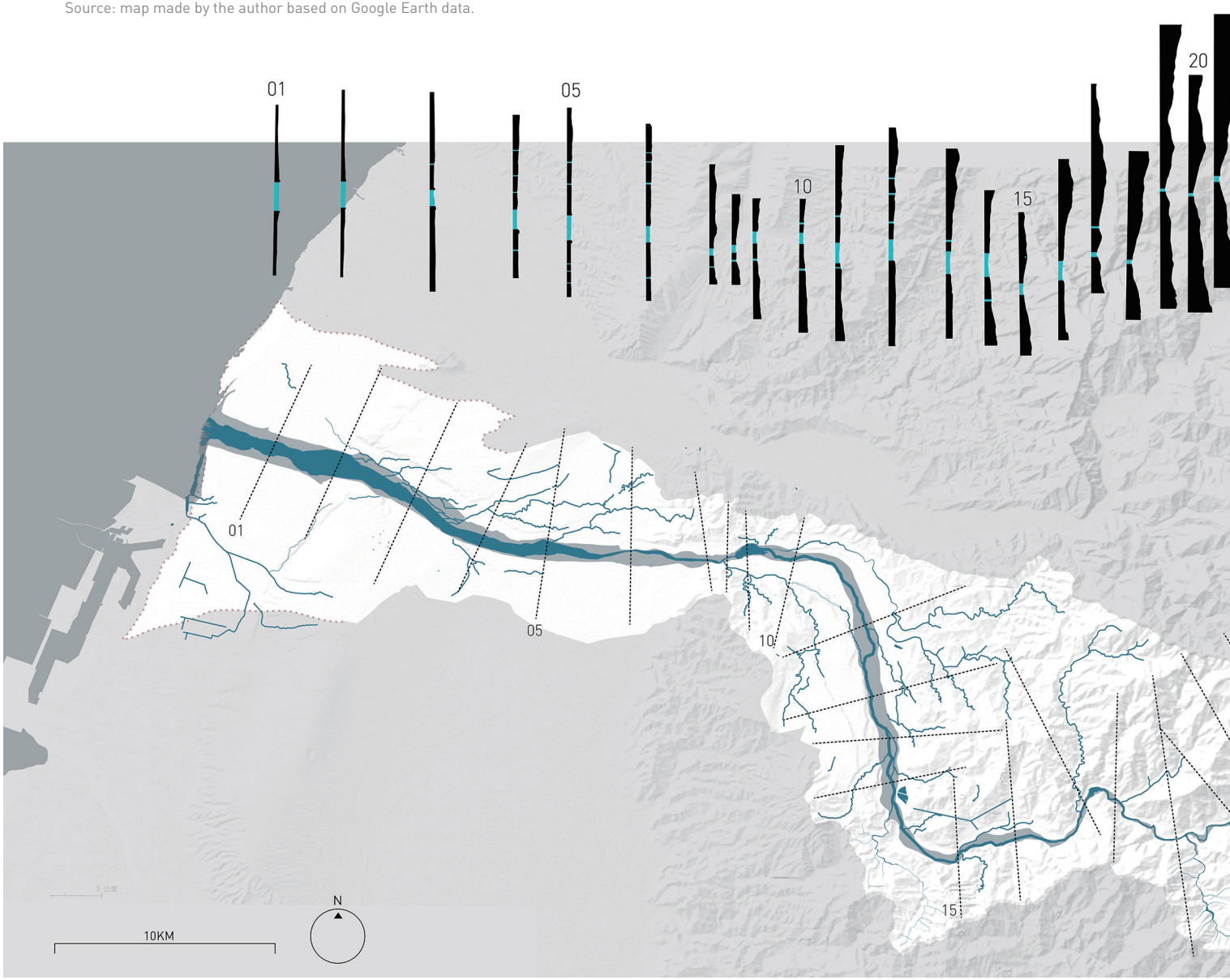
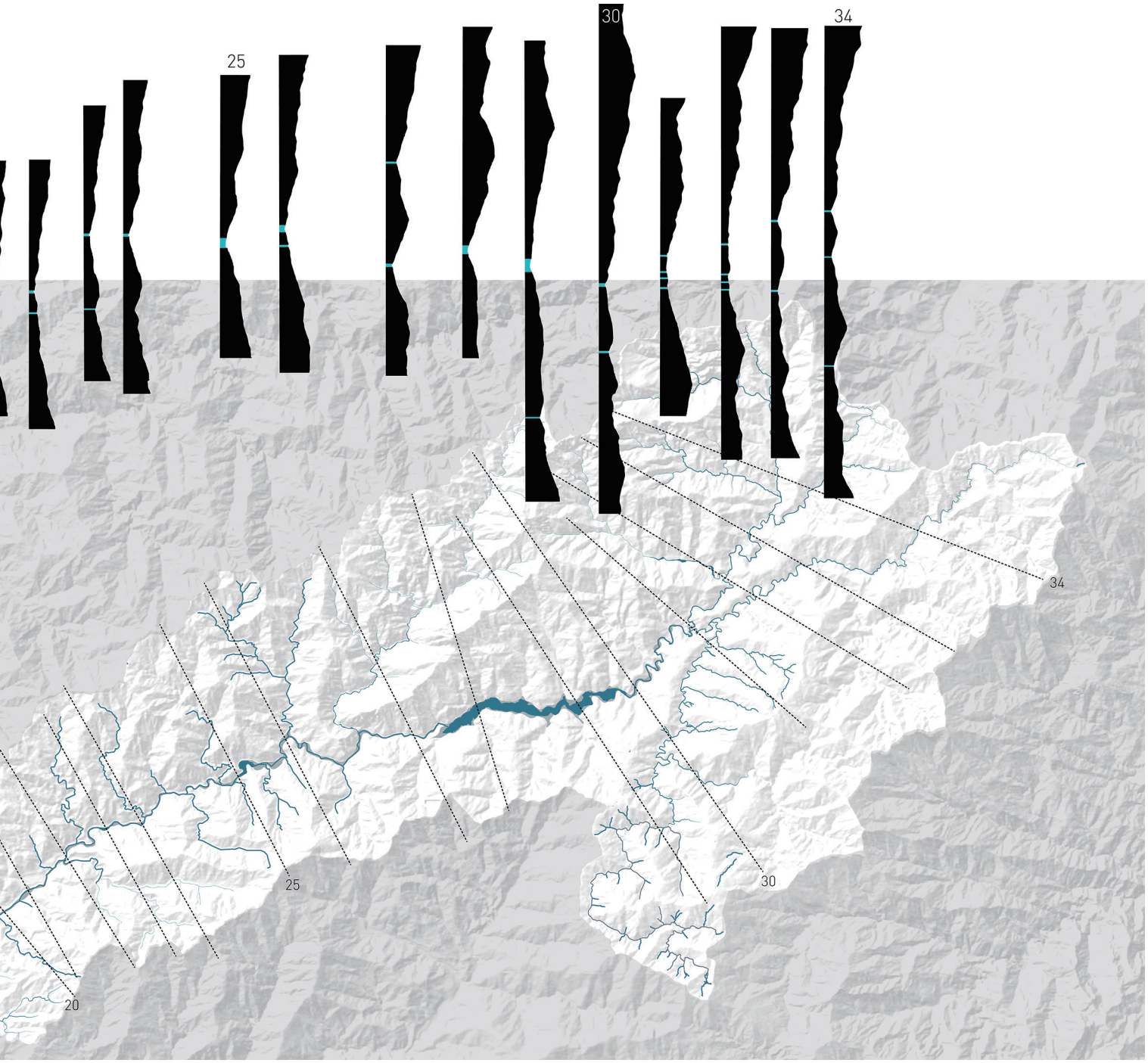


fig.86 Vulnerability (to rain erosion) map of Dajia river valley
Source: Hung, H.C. & Chen, L.Y. (2012) Journal of Geographical Science, (65)

TOPOGRAPHY

fig.87 Cross sections showing topographic condition along Dajia River.
Source: map made by the author based on Google Earth data.




25
30
34
20
25
30
34

SOCIO-ECONOMICAL ANALYSIS

Dajia River valley covers 1236km^2 and today has 626,000 residents (fig.88) with a diverse of urban morphologies (fig.89) The river of Dajia provides the water usage for the whole Taichung metropolitan area. Due to the development of science park and industrial areas in the 80s, the water supply became insufficient and requires the support of Liyutan Reservoir from Da'an river catchment. Therefore, the transformation of the territory could not be limited only in the river catchment range, a consideration with the whole Taichung Metropolitan area is important and influential.

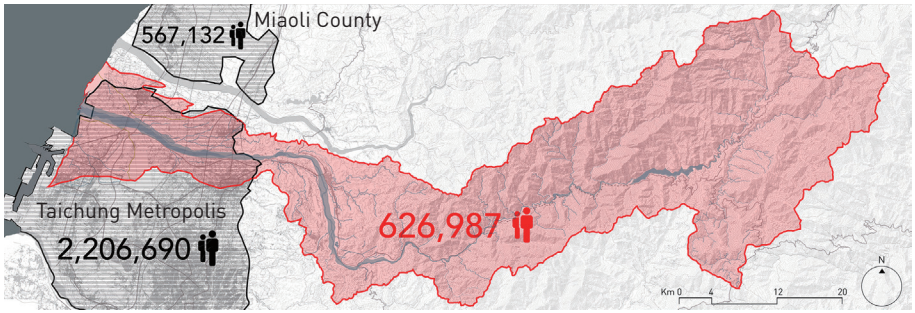


fig.88 Population of Dajia river valley and the neighboring metropolitan areas. Source: made by author based on data from GIS

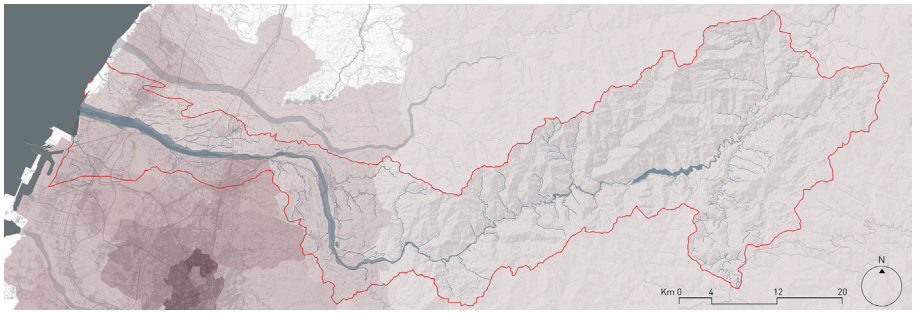


fig.89 Population Density of Dajia river valley and the nearby areas. Source: made by author based on data from GIS

Population density

10/km^2 20,000/km^2

Dajia catchment boundary

POPULATION PROPORTION WITH HIGHER EDUCATION

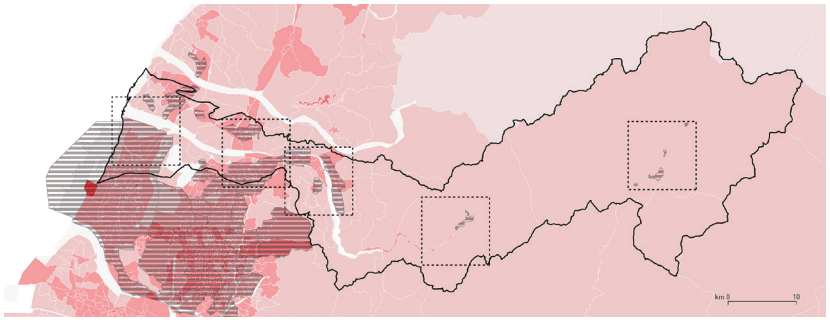


fig.90 Map of population with higher education (university study and higher) Source: map by the author based on data from SEGIS, MOI, Taiwan Gov.

Proportion of population

0 % 5 10 20 30 50 80

AVERAGE HOUSEHOLD SIZE

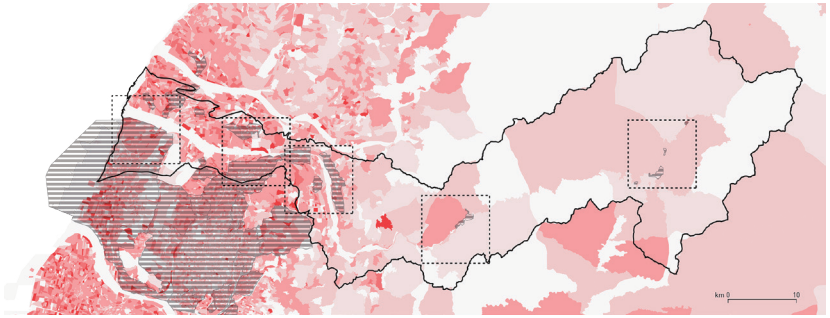


fig.91 Map of average household size.
Source: map by the author based on data from SEGIS, MOI, Taiwan Gov.

Average number of people in a family

0 1 2 3 4 5 30

POPULATION DEPENDENCY RATIO*

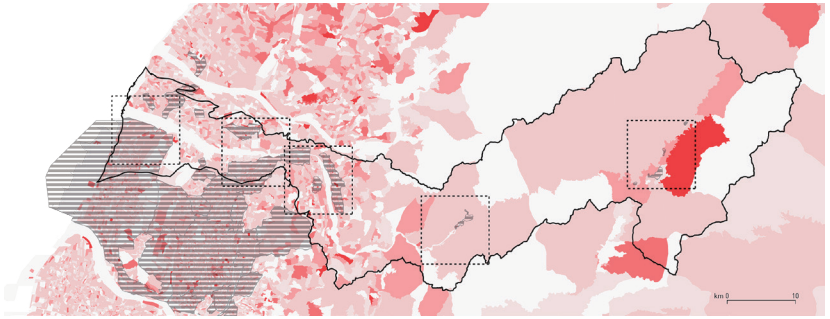


fig.92 Map of population dependency.
Source: map by the author based on data from SEGIS, MOI, Taiwan Gov.

* Dependency ratio is an age-population ratio of those typically not in the labor force (ages 0 to 14 and 65+) and those typically in the labor force (ages 15 to 64). It is used to measure the pressure on productive population (Wikipedia).

Number of non-working population proportion

0% 15 30 50 75 150 500

SENIOR POPULATION RATIO

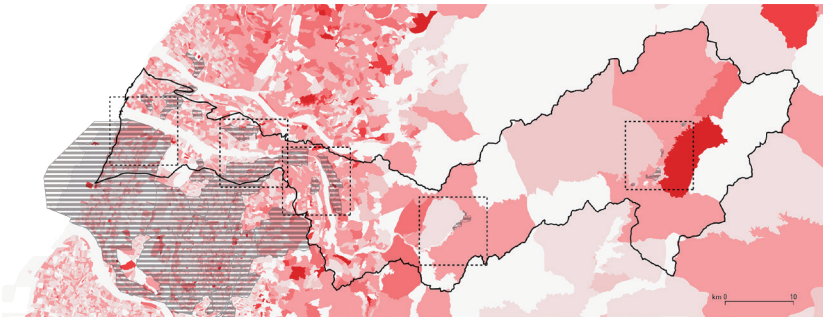


fig.93 Map of senior population ratio.
Source: map by the author based on data from SEGIS, MOI, Taiwan Gov.

Ratio of senior population over working population

0 %	0.05	0.15	0.2	0.4	0.8	1	4

CHILDREN POPULATION RATIO

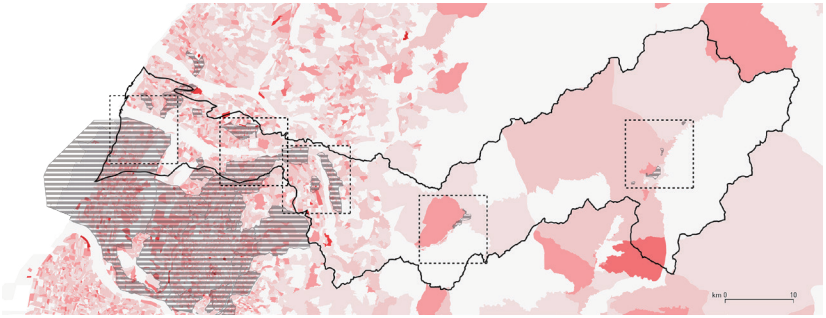


fig.94 Map of children population ratio.
Source: map by the author based on data from SEGIS, MOI, Taiwan Gov.

Ratio of population <15 years old over ages 15-65

0 %	0.05	0.15	0.25	0.5	0.8	1	3

AGING INDEX*

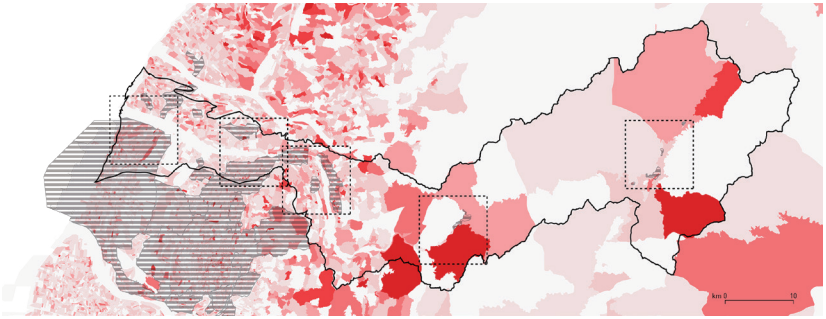


fig.95 Map of population aging index.
Source: map by the author based on data from SEGIS, MOI, Taiwan Gov.

* The Aging Index refers to the number of elders per 100 persons younger than 15 years old in a specific population (Springer).

Index of population >65 years old over ages <15

0	0.3	1	2	3.5	6	12	32

Dajia River catchment
Urban plans applied areas

POPULATION OF AGRICULTURE, FORESTRY, MINING, OR WATER-RELATED VOCATIONS

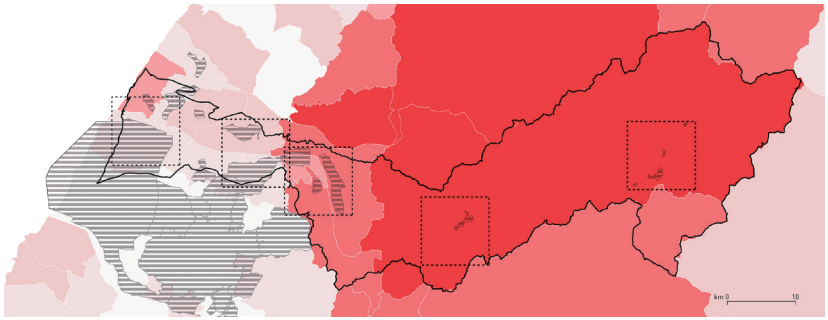


fig.96 Map of population in primary industrial sectors Source: map by the author based on data from SEGIS, MOI, Taiwan Gov.

Proportion of population

0 % 1 2.5 5 10 25 50

PROPORTION OF AGRICULTURAL LAND OF EACH TOWN

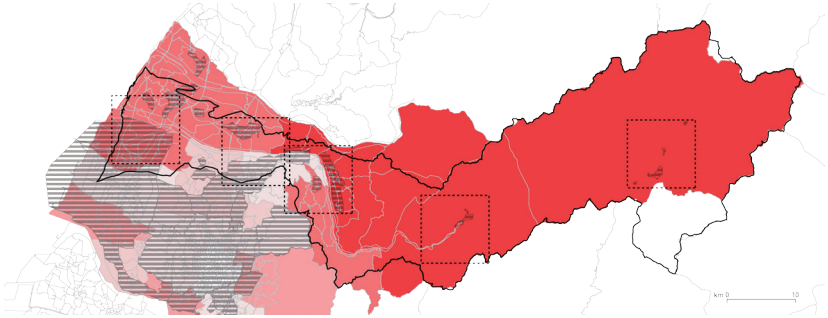


fig.97 Map of agriculture land use. Source: map by the author based on data from SEGIS, MOI, Taiwan Gov.

Proportion of land in agricultural use

0% 5 20 30 50 75 100

AGRICULTURE AND OTHER ECONOMIC ACTIVITIES

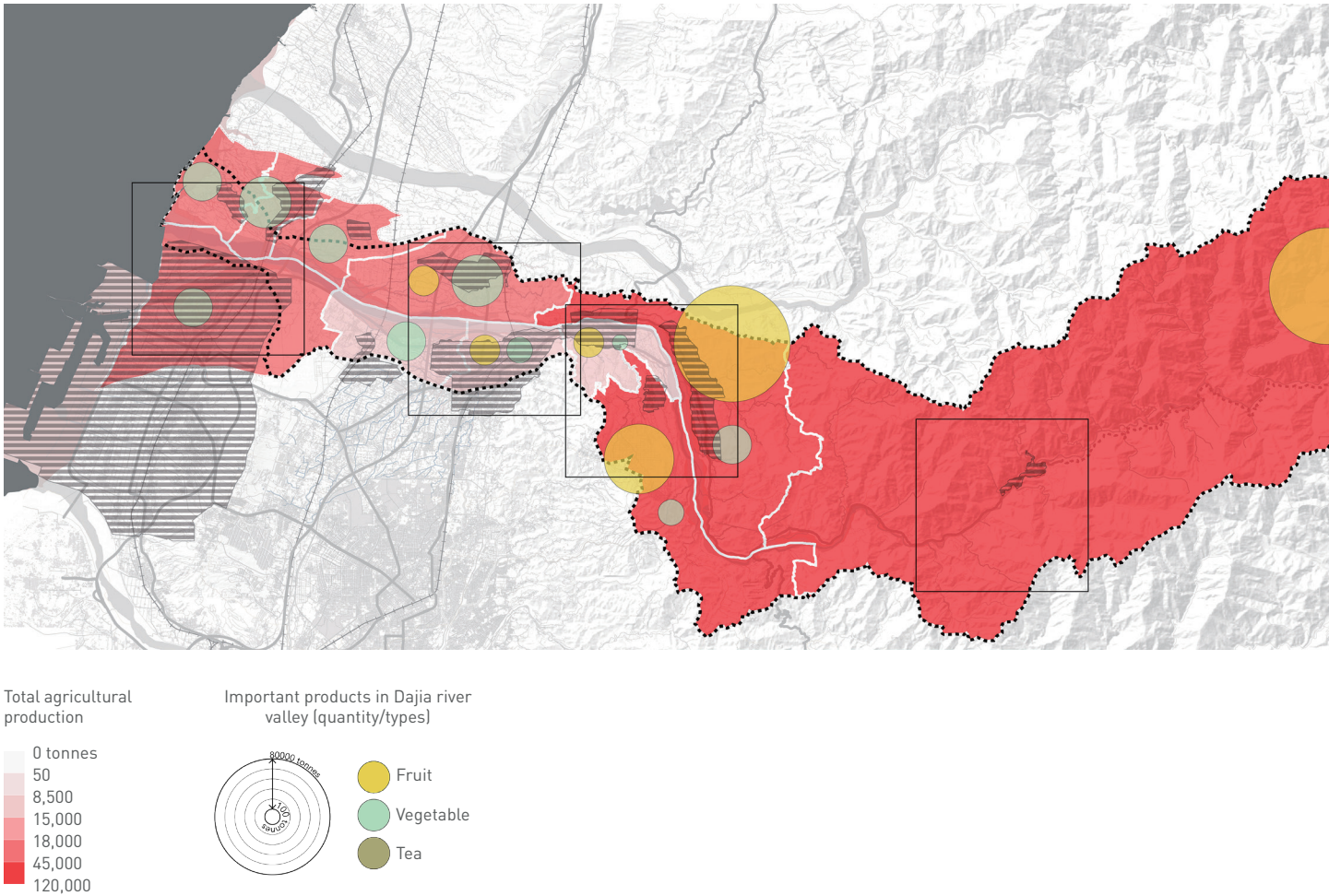
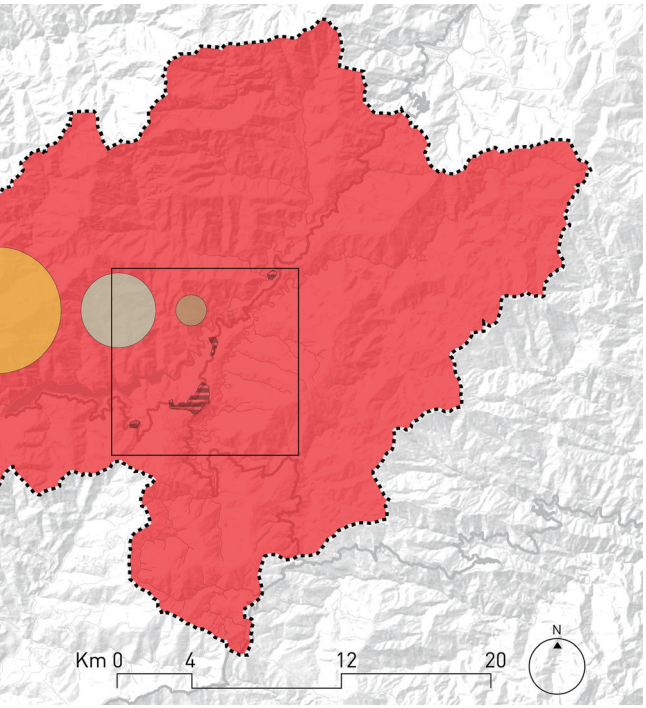
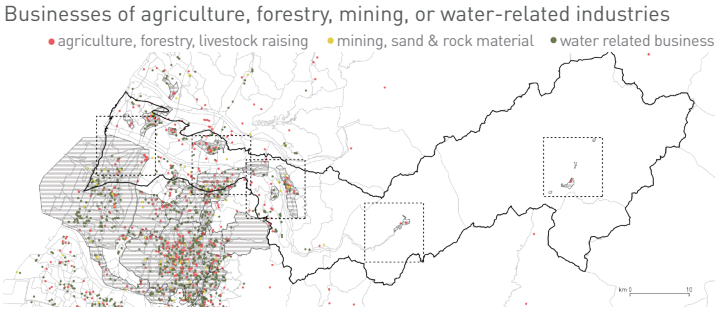
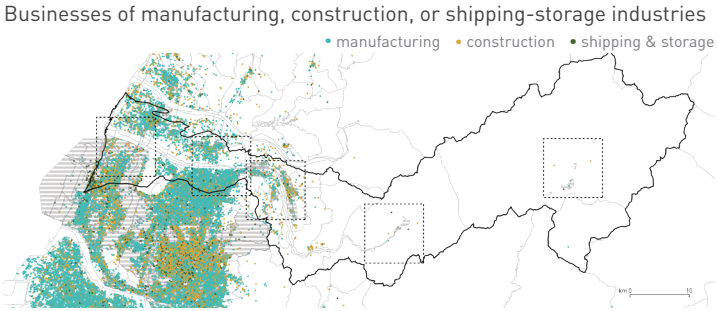
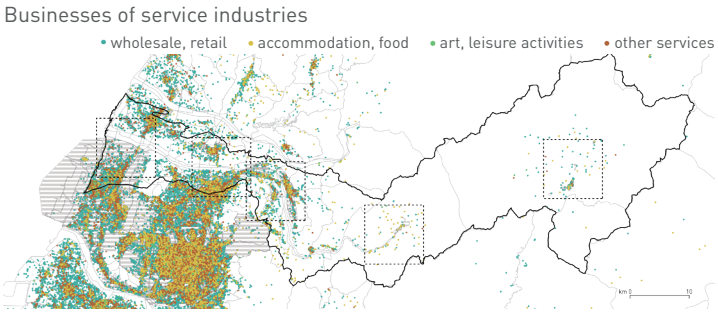


fig.98 Map of agricultural production and featured products. Source: map by the author based on data from SEGIS, MOI, Taiwan Gov.









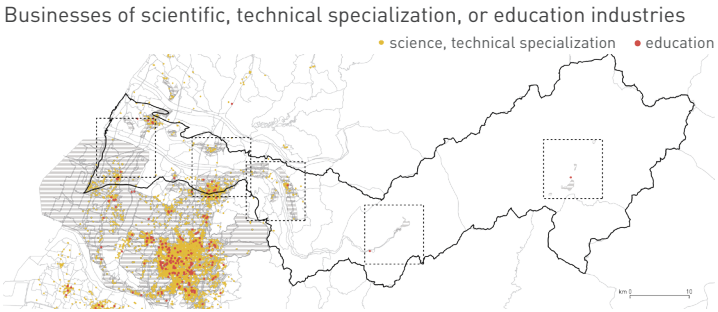


fig.99 (right four) Maps of businesses distribution of different categories of vocations. Source: map by the author based on data from SEGIS, MOI, Taiwan Gov.

SOCIAL AND ECONOMICAL POTENTIALS OF DAJIA RIVER VALLEY

PEOPLE AND SERVICE CLUSTERS

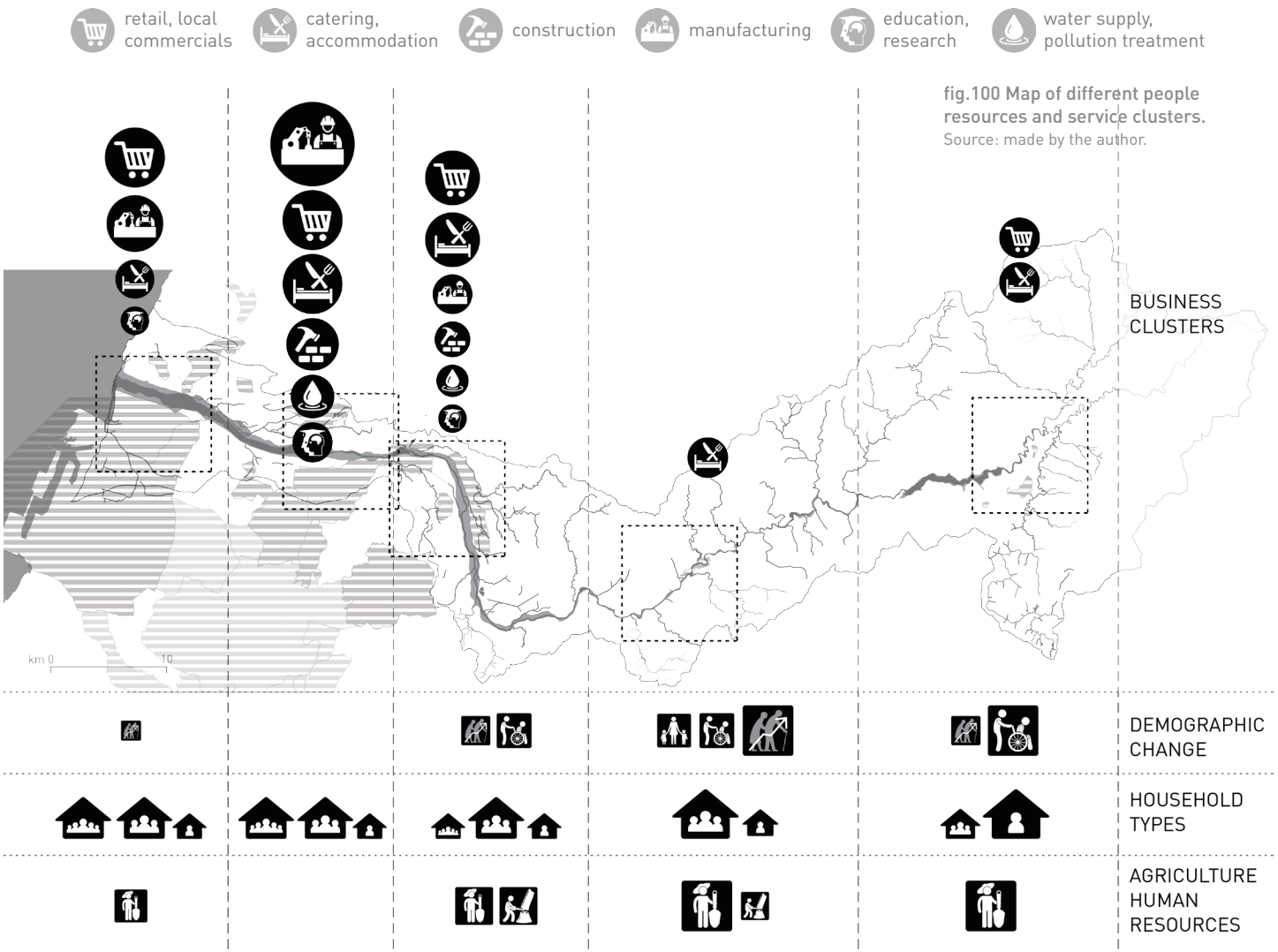


fig.100 Map of different people resources and service clusters.
Source: made by the author.

existing activities

decreasing or no longer exist activities

LOCAL ACTIVITIES AND POTENTIALS

Kaomei Town and wetland area
- Wet-land views
- Wind turbines
- Port for shipping and tourism

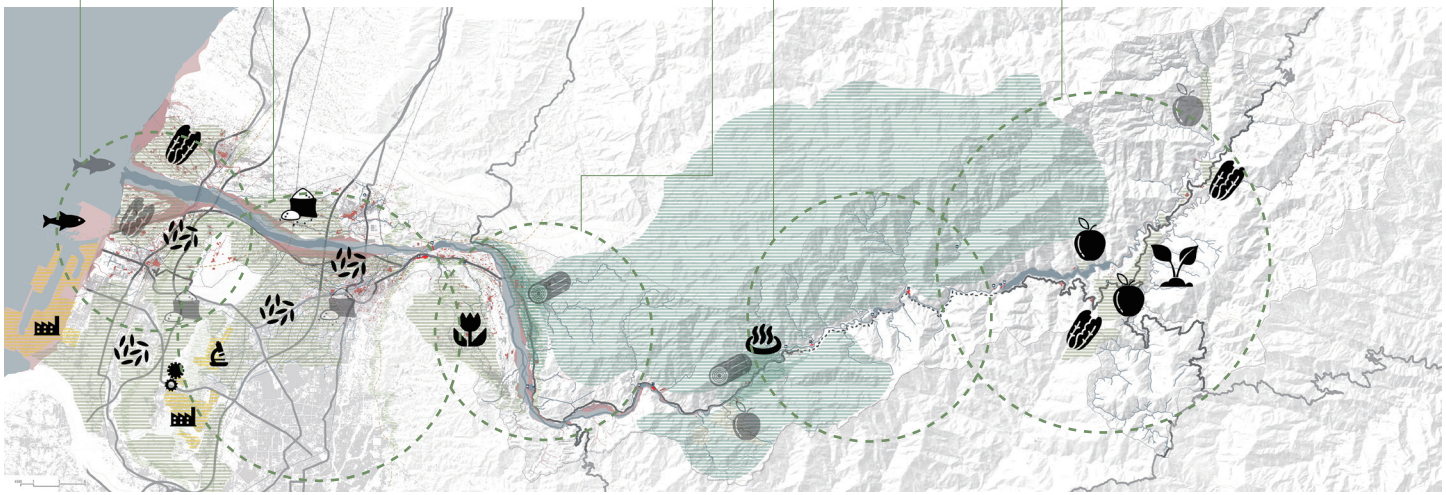
Satellite cities of Fengyuan and Houli, and Taichung Metropolitan area
- 3rd largest metropolitan area in Taiwan
- Image of landscape (Mountain facades at both east and west directions)
- River and city
- Airport to off-shore islands and China

Valley villages, Dongshih and Xinshe Townships
- Forestry history
- Forestry experts
- Flower agriculture
- Natural parks

Infrastructuralized landscape
- Water infrastructure transformation
- Control points of road
- Hot spring and early development

Lishen Alpine Farm
- Unique fish & bird species
- Alpine farms for fruits, tea, and herds
- Mountain climbing (Second highest mountain; ridge-line of Central mountains)

fig.101 Map of local industries and activities.
Source: made by the author.

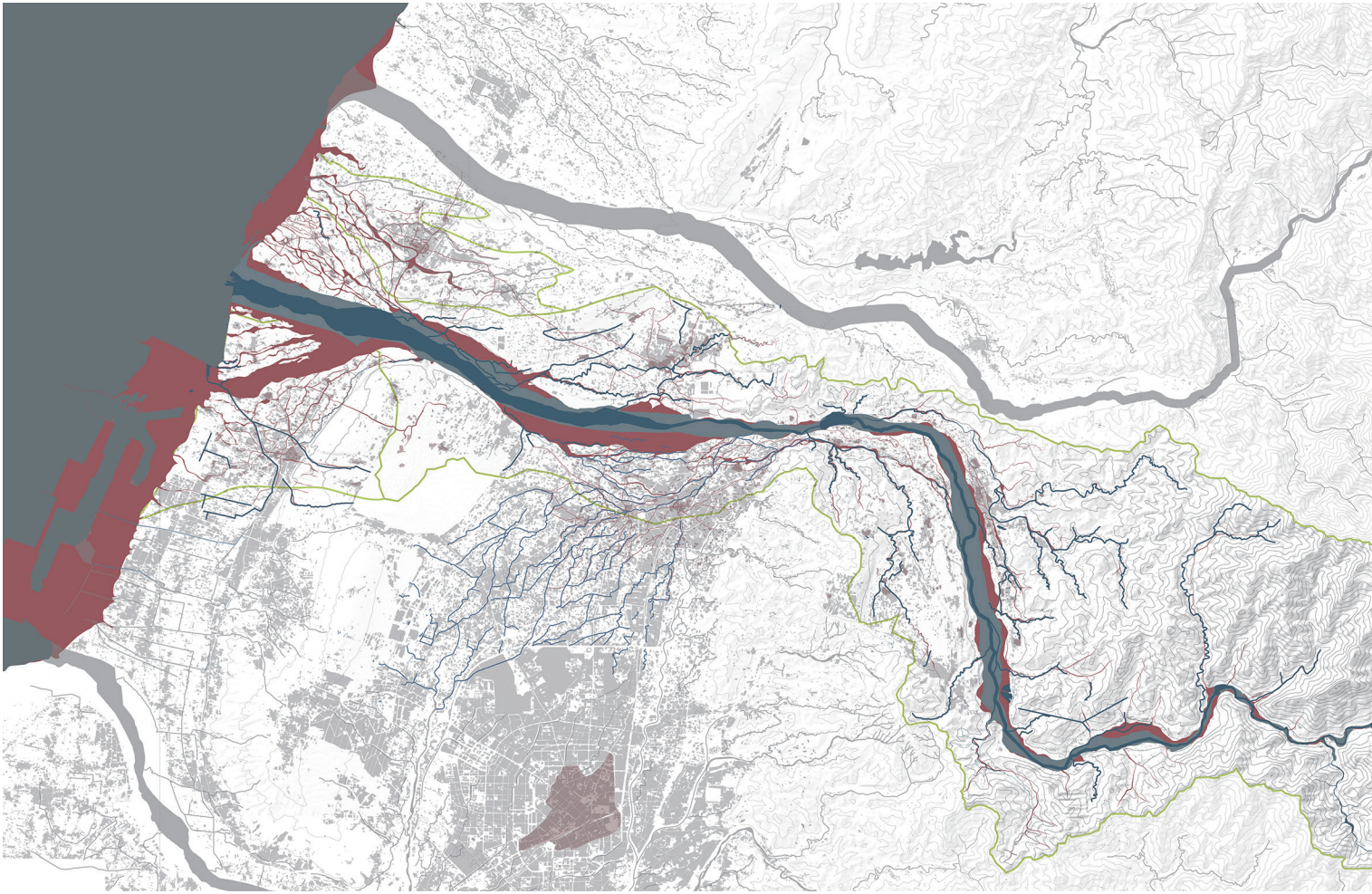


Forest conservation areas
- Forestry
- Hot-spring recreation tourism

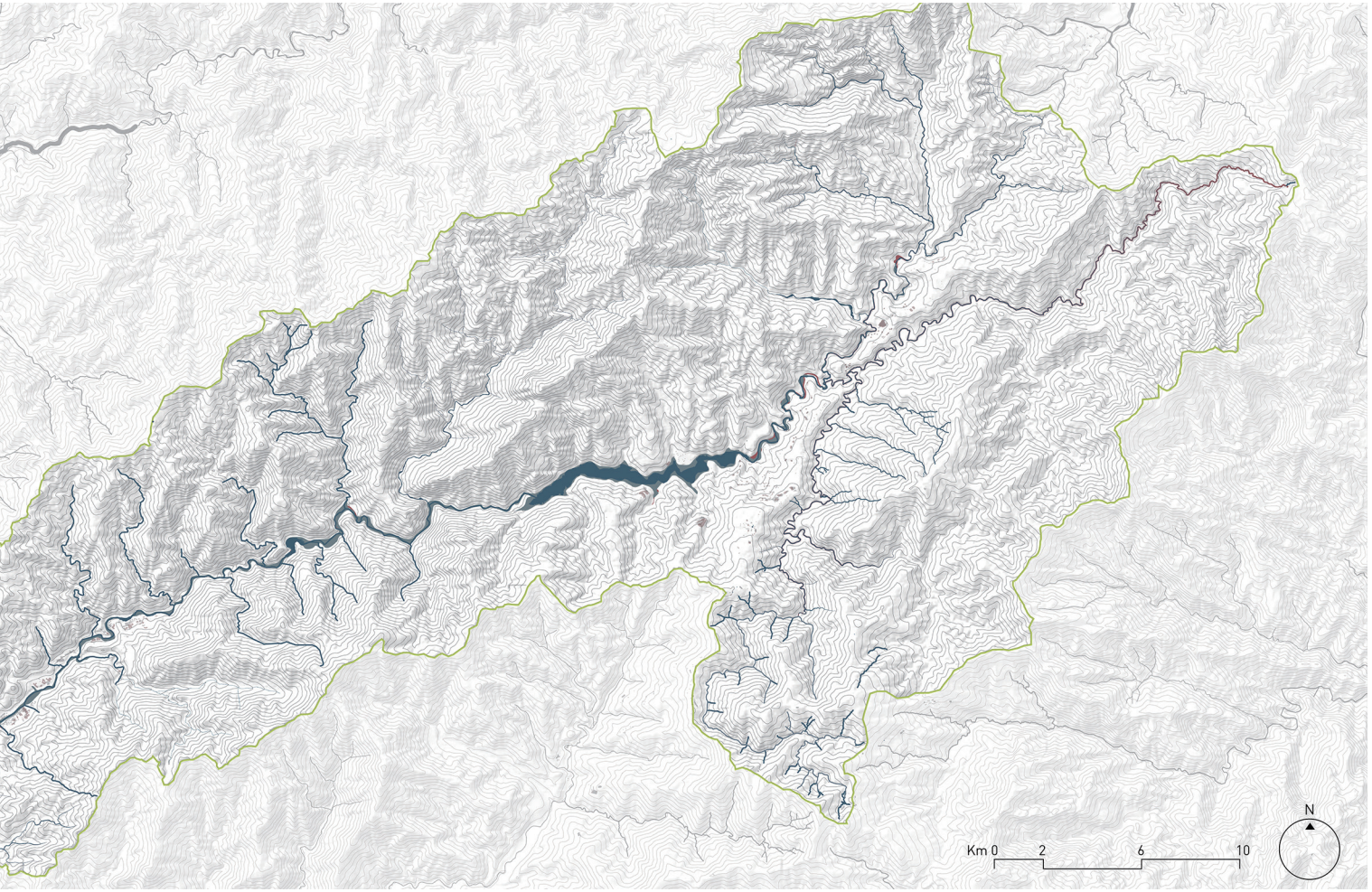
Agricultural areas
- Paddy rice farms
- Sugar canes
- Flower
- Vegetable
- Fruits
- Tea
- Fishery

Industrial and technological areas
- Science park
- Precision Machinery Innovation Technology
- Industrial area

THE CONSTRAINED RIVER SCAPE



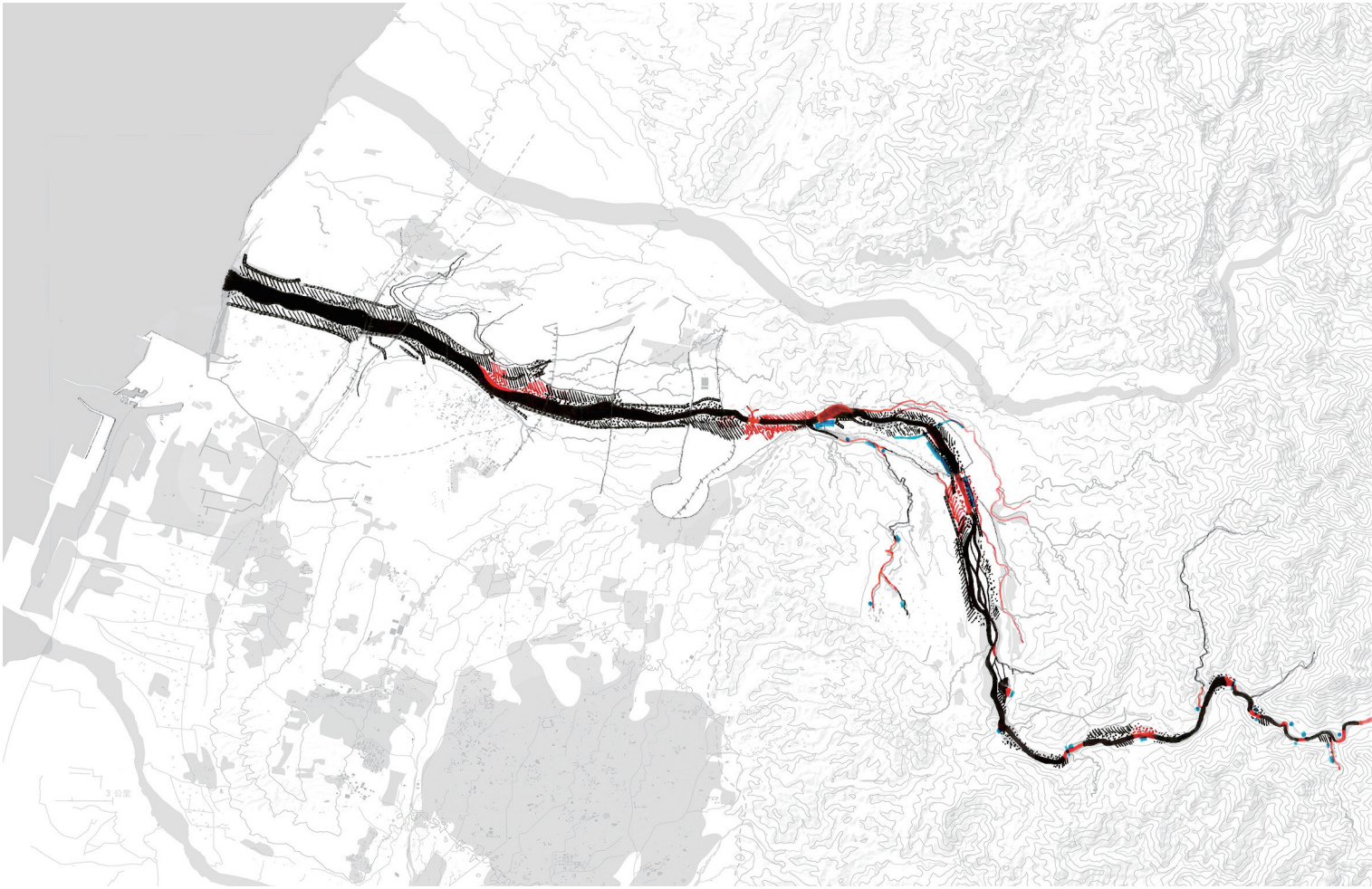
Compare the historical river courses with the current ones, it's obvious that the river has been largely constrained with artificial infrastructure, especially at the downstream area. In other words, the room for river has largely decreased.



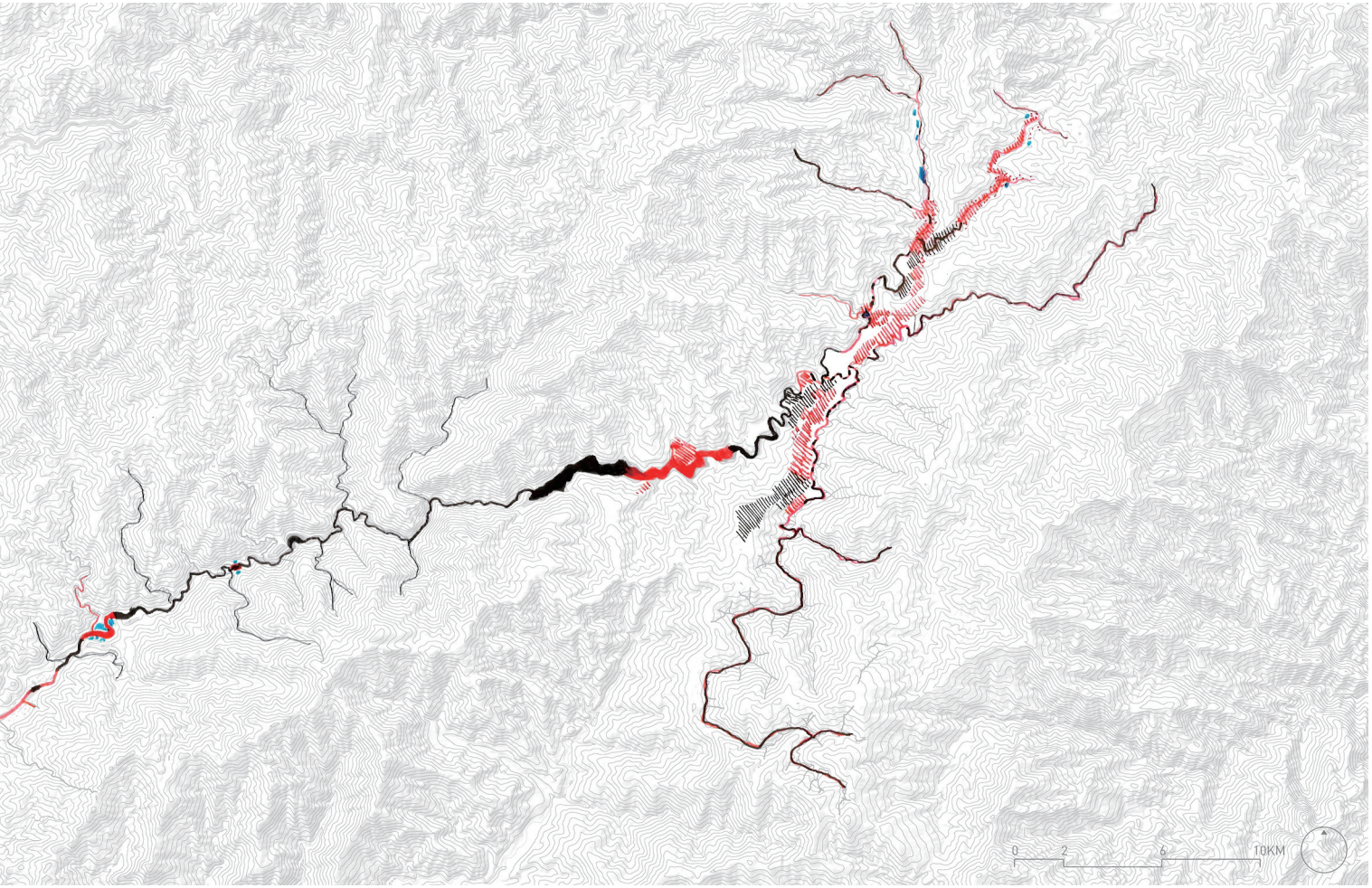
Dajia river paths before 1890s
Current Dajia river area
Current Dajia flood plain
Other rivers
Current urbanized areas
Early urbanization
Dajia catchment boundary

fig.102 The historical river courses and urbanized areas.
Source: by the author based on data from historical maps, historical descriptions, google maps, and GIS databases.

ATTITUDE TOWARDS THE RIVER



A large part of the river is treated as problem and threat to the living environment and local activities. This attitude has led to the gradual infrastructuralization which attempts to "control" nature in order to "solve" the problems.



River treated as threat, backyard, detached or inaccessible

River embraced by the living environment and local activities

Public spaces to enjoy water

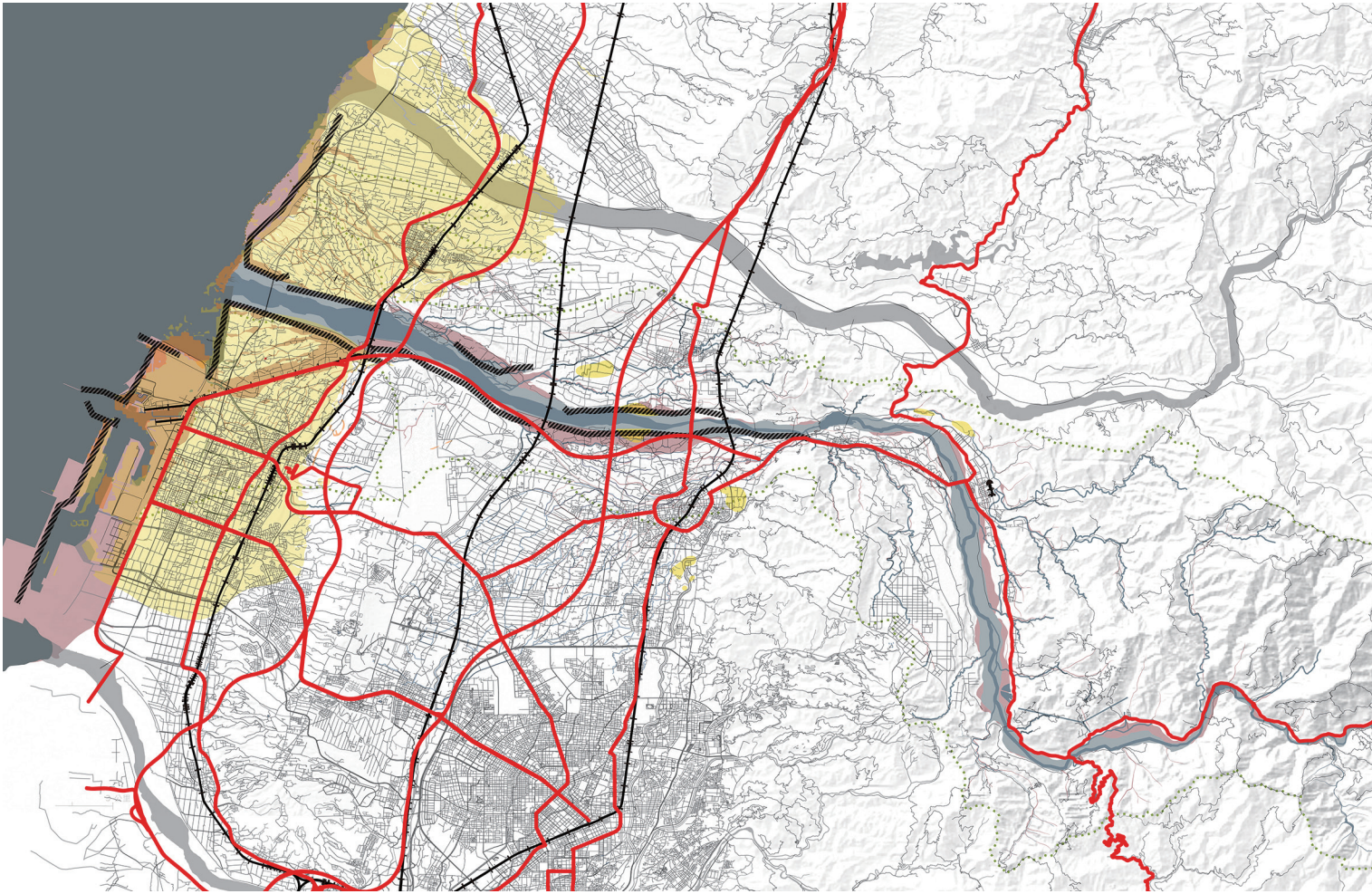
Dikes

Riverside agriculture

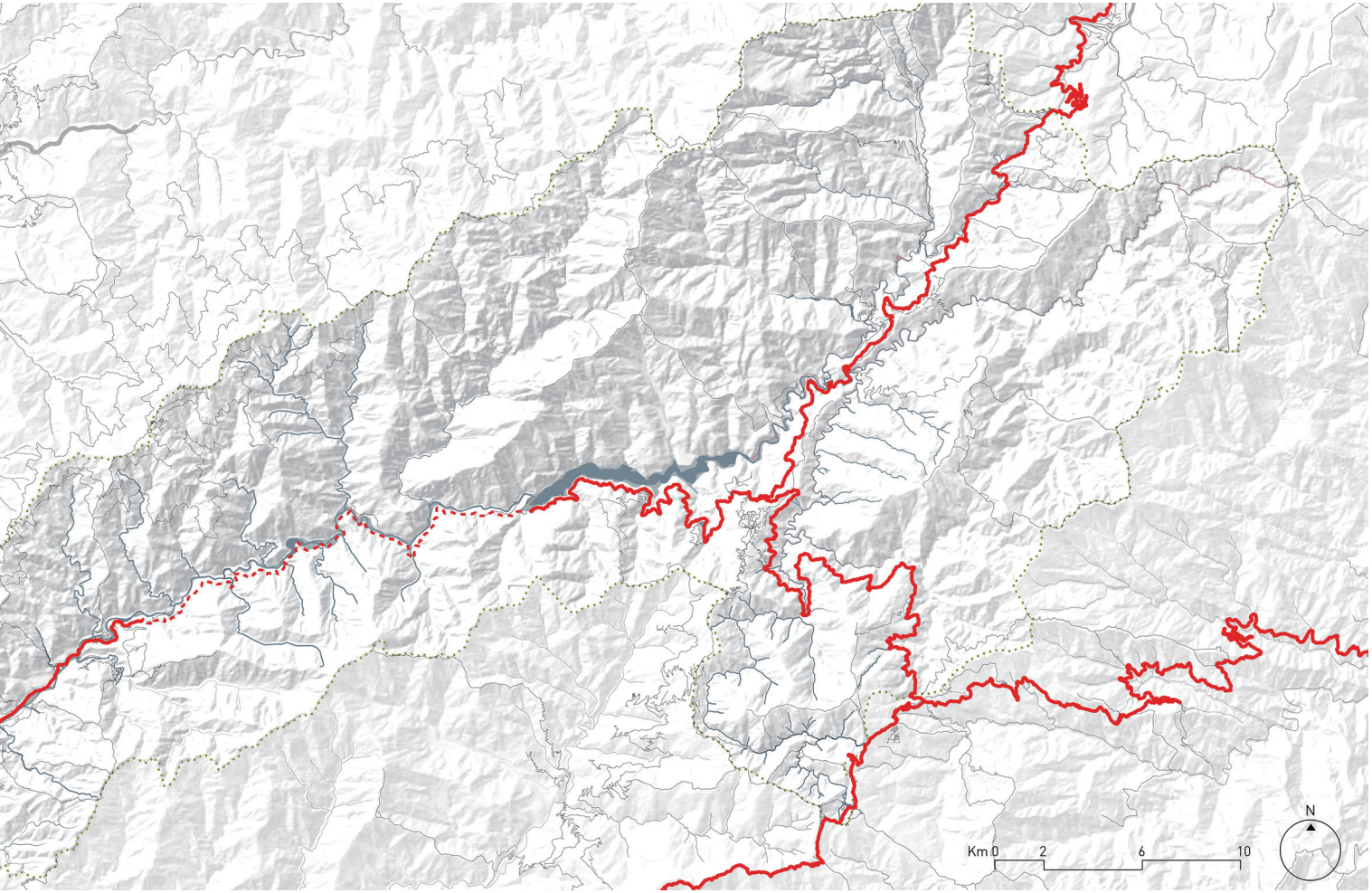
Riverside meadow/grass

fig.103 The current water supply infrastructure system. Source: by the author based on data from WRA, MOEA, google maps, and GIS databases.

THE TRANSPORTATION & PROTECTING INFRASTRUCTURES



Though many infrastructure has been constructed along and crossing the river, the mobility and flood-protecting remains problementic for many areas in the river basin.



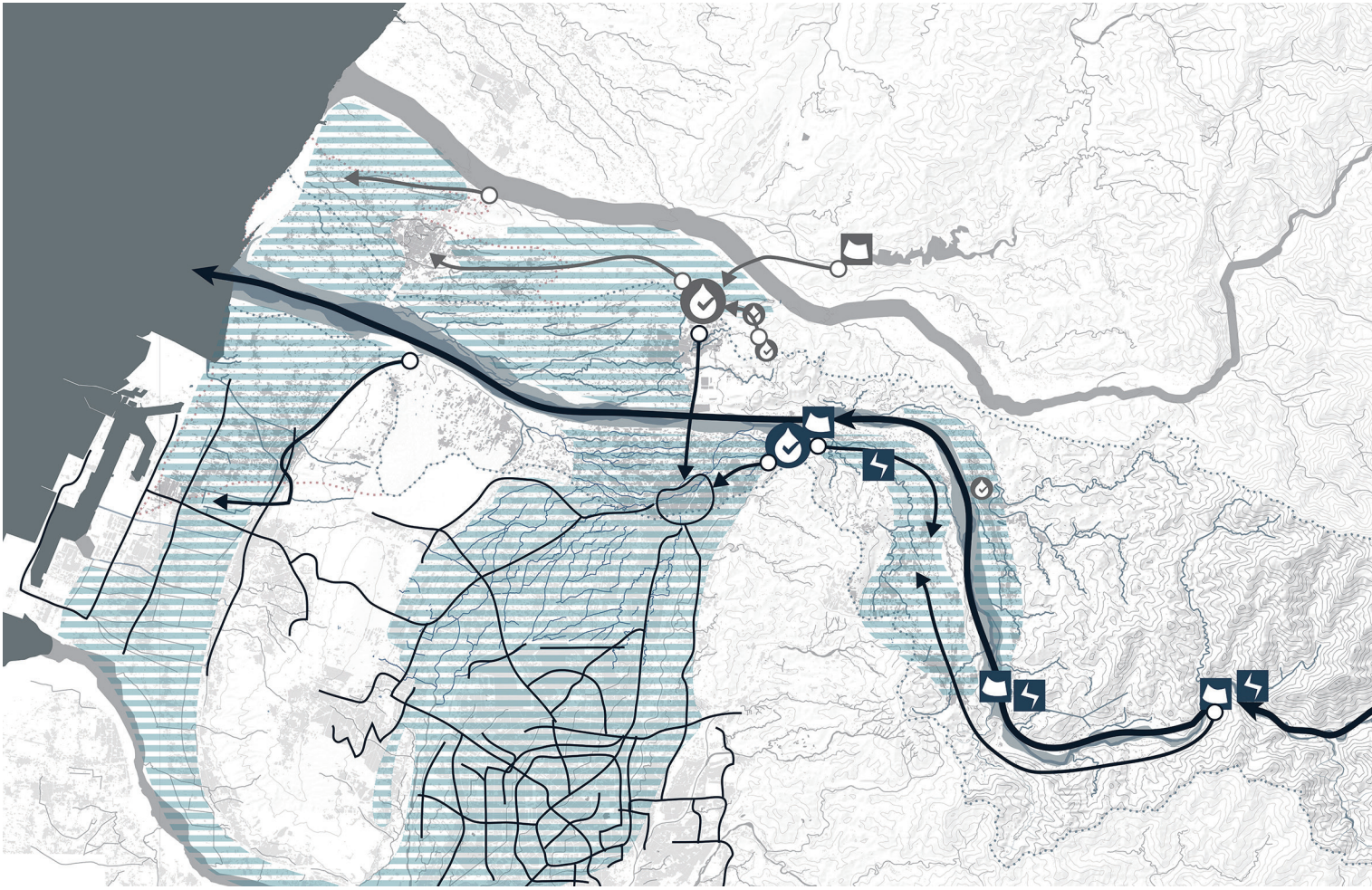
Railway and high-speed railway
Primary roads and motorway
Other roads
Dajia river catchment boundary
Dikes

Flooding of 1-2m in situation of 600mm rainfall in 24 hours.

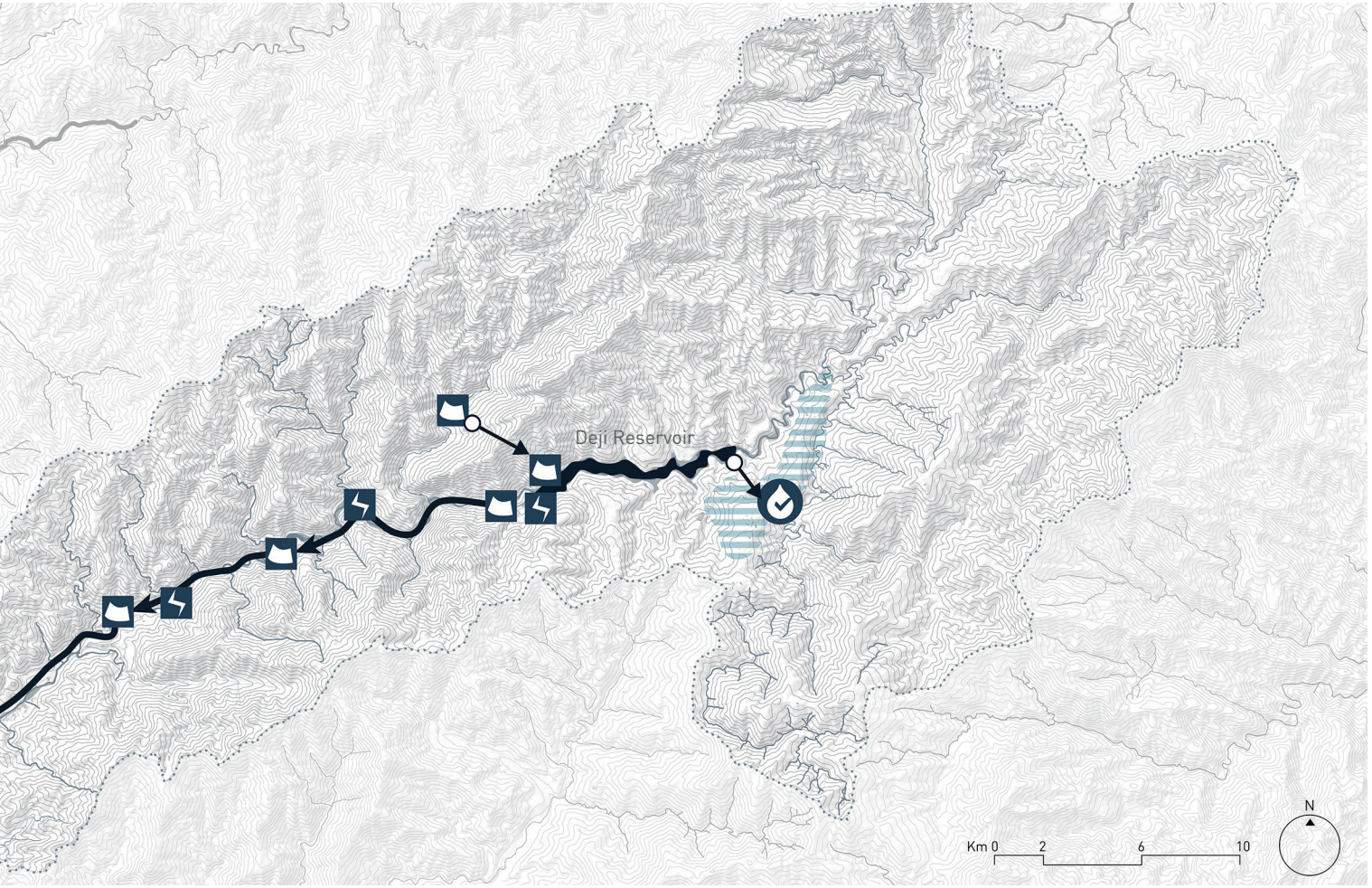
Flooding of 0.5-1 m in situation of 600mm rainfall in 24 hours.

fig.104 The transportation infrastructure in Dajia river valley and Taichung Metropolitan area.
Source: by the author based on data from GIS databases.

THE WATER INFRASTRUCTURE SYSTEM



The current water infrastructure displays a linear system, in which one breakdown of a part will cause the whole system unable to operate. Currently, the system is not sufficient to fulfill the growing water demands. Therefore, it requires supply from Liyutan Reservoir in Da'an River Basin. Yet actually, only 22% of the river water has been translated into resources by the current system (WRA, MOEA, 2012)



Dam or reservoir along Dajia river
Dam or reservoir of other river
Hydro-power plants
Agricultural irrigation demanded areas
Water treatment plant for Dajia river
Water treatment plant for other rivers
Source or water supply
Main line or pipes of water supply

fig.105 The current water supply infrastructure system. Source: by the author based on data from WRA, MOEA, google maps, and GIS databases.

EXTENSIVE AGRICULTURE ACTIVITIES

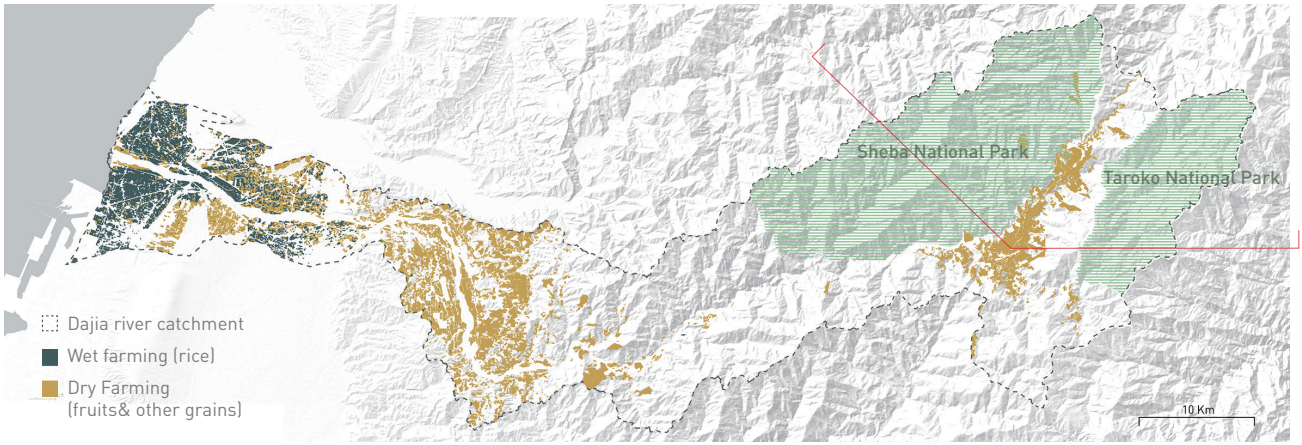
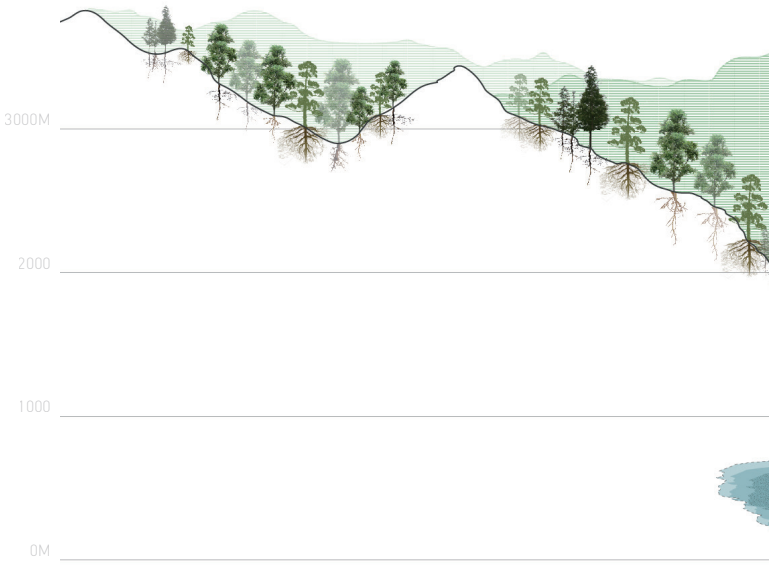
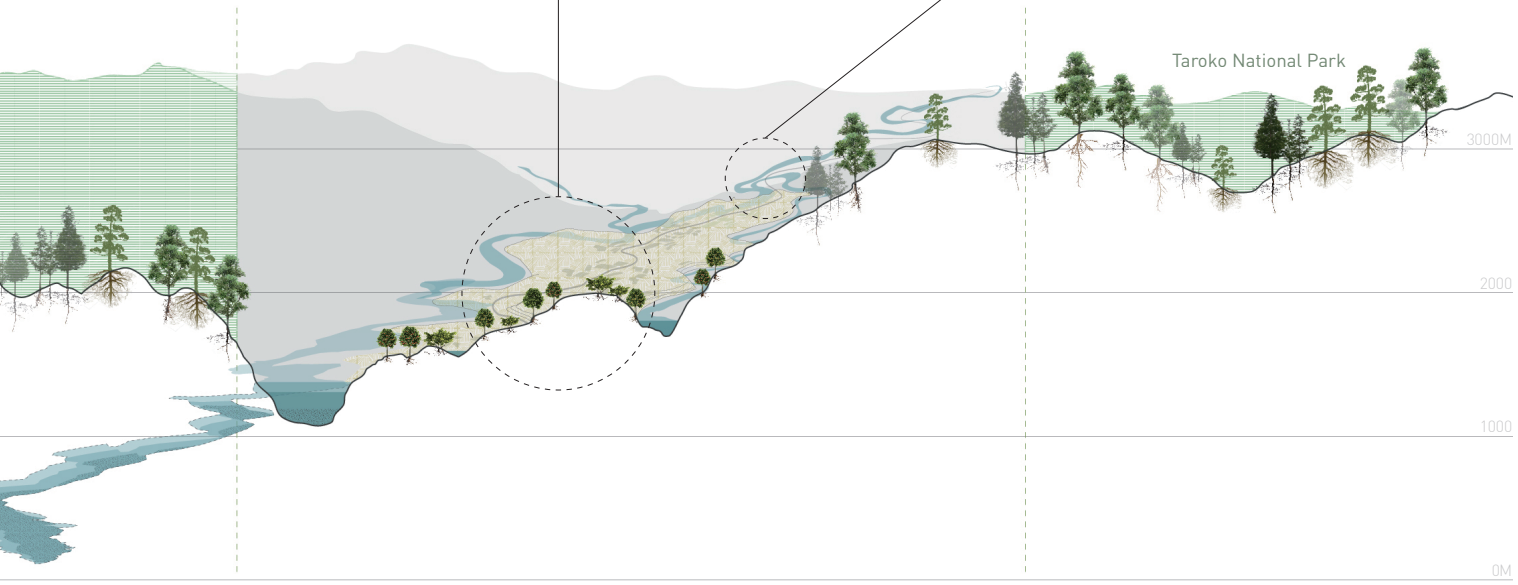


fig.105 Mapping of wet and dry farming in the Dajia River Basin. Source: map made by the author based on data from

A closer look of the agriculture activity shows an extensively distributed dry (fruit, dry grains) farming at the upstream area of Dajia River basin. This part of the river is above the reservoir, thus the quality of water and the conservation of the environment is of essential influence of the resources at mid and downstream. Though there are two national parks defined to enhance ecological protection, the agriculture stripe that extends between them (fig.105, 106) has been one of the main factor for the increasingly serious environmental devastation along the river. The main reason is because most of the originally-grown deep-root trees were replaced by the shallow-root fruit trees which has much less capability to preserve the soil. The cultivation also increases direct exposure of the surface soil to intense rainfall, which further increases erosion and results in landslide risks threatening the mountain community.



Intersection of rivers attracts water and biodiversity.



III-III. Conclusion

fig.107 Photo of agriculture activities on the slopes threatened by landslides. Source: photo from Yannlinphoto [online] available at: http://picssr.com/photos/yl22438771/ [accessed 20 Mar. 2017]

fig.108 Photo of heaby-engineered infrastructures for managing water resources in steep valleys.
Source: photo from Yannlinphoto [online] available at: http://picssr.com/photos/yl22438771/ [accessed 20 Mar. 2017]

An synthetic analysis of the human activity and natural conditions of the land shows an increasing conflict between nature and habitation. Most seriously, there is an obvious discordance in the natural and cultural patterns of water flows (fig.109). At the area with the most abundant rainfall, the upstream alpines, the main economic activity is dry farming (fig.107), which not only consumes less water, but even increases erosion and runoff, results in the narrowest section of the river undertaking the passing-through of a large quantity of water and sediments. With the current water infrastructure that look for an heavily-engineered solution (fig.108), this task has not been so successful, causing sediment accumulation in the reservoirs and frequent disasters of landslide and avalanche.

The downstream area, bearing the consequences of natural hazards and agricultural pollution, the water available to be used become limited. With large water-consuming activities such as rice farming, several industrial platforms and science parks, as well as a big metropolis of 3 million population, the water supply is very often insufficient. With other factors such as the policy of water-usage prioritizing industrial area and many other institutional limitations, the current water system has been taking a heavy toll to the society for many decades.Comparing the historical and current river paths and urban patterns, we can see that the river has been structuring the morphology and network system of the early urbanizations. With the excavation of water and other natural resources, the river is gradually constrained and simplified as a linear water supply system.

Today, the linear infrastructure is neither able to fulfill

THE MISMATCH OF HUMAN ACTIVITIES AND NATURAL CONDITION OF LANDS

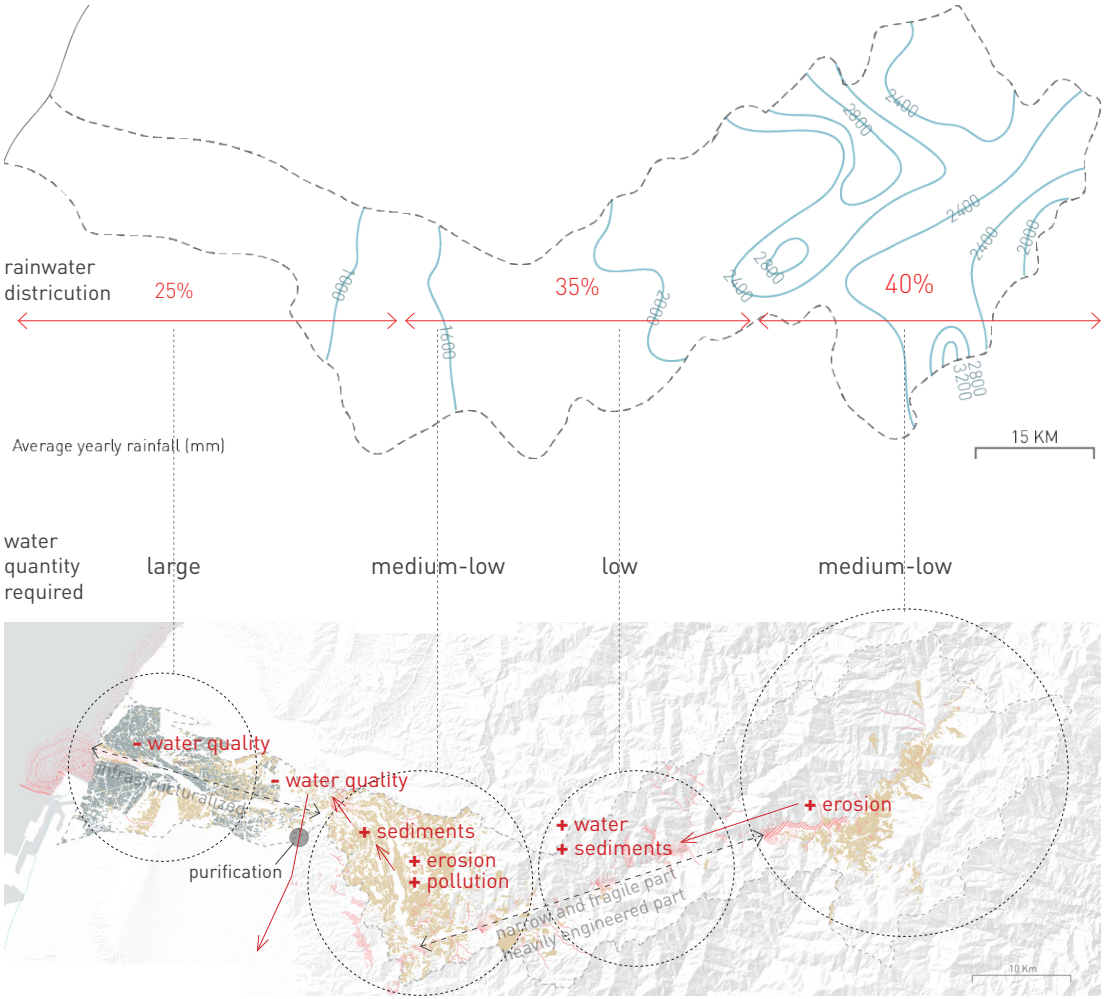


fig.109 Comparison of water patterns provided by rain fall and activity influences. Source: map made by the author based on data from National Land Surveying and Mapping Center, MOI.

Dajia river catchment
Wet farming (rice)
Dry Farming
(fruits& other grains)

the current resource demand, nor has it been able to adapt to the future changes. In some areas, the water supply is even pumped against slopes, which means the landscape condition is not well considered and used. The problematic infrastructure not only creates many social and economical costs and conflicts, the heavy facility for maintaining the infrastructures has even further disconnected people from the river (fig.110).

From the mobility analysis we can see, the hard infrastructuralization of the Central Cross-island Motorway could not support the recurrent damage of natural disasters (fig. 111 & 112). Now the access towards the alpine communities has been limited, resulting in the decrease of local industries and socio-economic conditions. The water and transportation infrastructure along Dajia river has gradually limited itself into a difficult dilemma and has been debated between different groups of people such as local residents, politicians, ecologists, enterprises.

fig.110 (above) Photo of dikes near the river mouth.
Source: photo by ccl.smai [online] available at http://www.panoramio.com/user/2820532 [accessed 14 Mar. 2017]

fig.111 (middle) Photo of the highly infrastructuralized section of Central Cross-island Highway.
Source: photo from Nature Campus [online] available at http://nc.kl.edu.tw/watch/ [accessed 12 Mar. 2017]

fig.112 (below) Photo of tunnels during rainstorm at the Guguan section of Central Cross-island Highway.
Source: photo from Appledaily news [online] available at http://www.appledaily.com.tw/ [accessed 9 Mar. 2017]

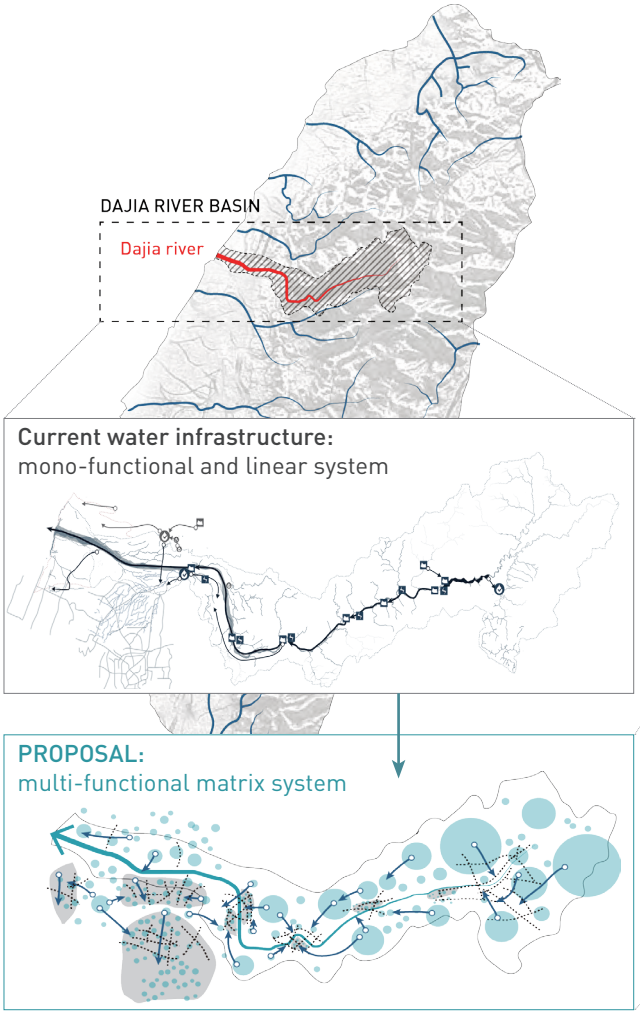
As a conclusion, as the landscape character of Dajia River is inherently difficult for keeping water, the approach of the infrastructures also did not consider the natural condition of the land when they were designed. Instead, they have even led to the inappropriate distribution of human activities which further worsen the situation.

Consider the increasingly extreme weather, more and more frequent heavy rains and intense discharges, brought by climate changes, a rethinking of the water infrastructure together with the socio-economical patterns of the territory is necessary. The transformation of the infrastructure can be considered as an opportunity to integrate different actors and environmental contexts, and as a process to recover the landscape potential of Dajia River Valley.

IV. Regional Strategy and Principles

IV. Regional Strategies and Principles

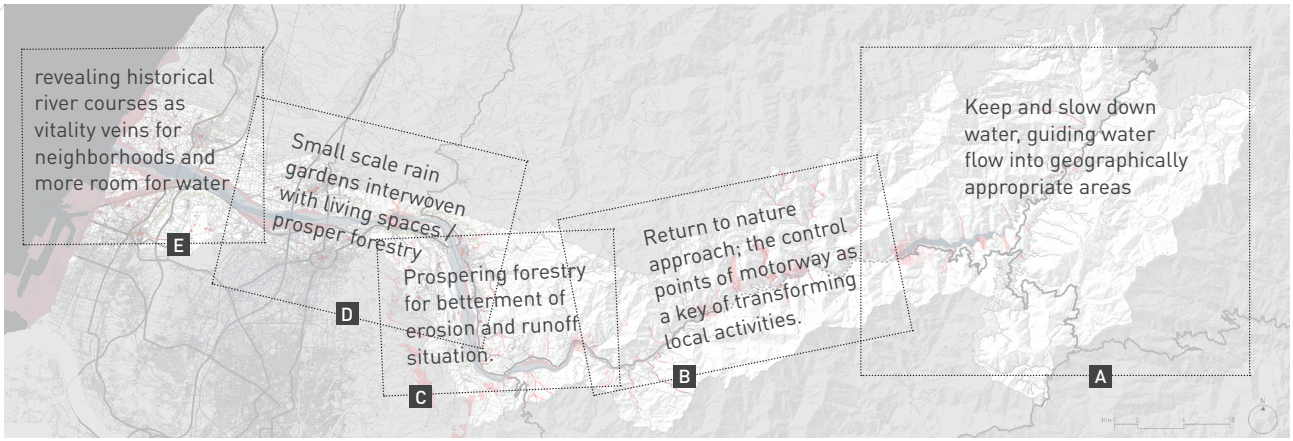
The overall concept is to propose an alternative water system through transformation of the landscape - the urban spaces and human activities. The proposed system is expected to be composed of decentralized, multi-scaled, and mutual connected spaces that act as both water infrastructure and landscape elements in various forms which can contribute to the common good and in the meanwhile take care of its own situated context. The new system can be perceived as a matrix with sponges which absorbs when water influx and releases with a mild pattern, allowing various amount of moisture without introducing drastic impacts to the ecology. The system will also allow mutual adjustment between local areas (fig.113) within the system, creating tangible connections for the people to their land and to each other, building a stronger territorial identity through landscape transformation.



What if the transformation of landscape works in the meanwhile as a new water infrastructure system to gradually reduce the reliance on heavy-engineered infrastructures such as the current dams and reservoirs?

What if the landscape as infrastructure eventually replace the roles of these hard infrastructures?

GOALS OF DIFFERENT PARTS OF THE RIVER BASIN



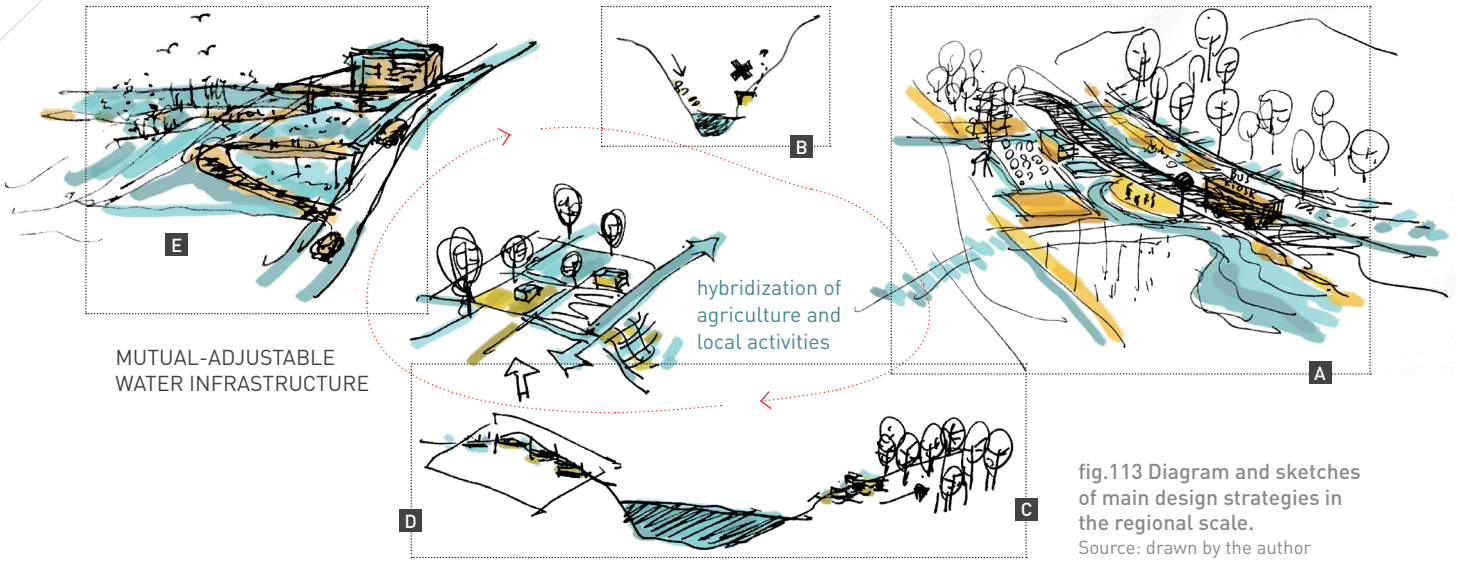


fig.113 Diagram and sketches of main design strategies in the regional scale.
Source: drawn by the author

IV-I. General Principles

PRINCIPLE 1: ADAPT TO FLUCTUATION OF WATER INFLUX

Considering Dajia river's large fluctuation of water amount, which has been one of the main factors causing difficulties in maintaining current infrastructures, has brought huge impacts to both the natural and human habitats, the new sponge-net system will take the peak-discharge volume of 200 years return period as criteria for quantifying the amount of spaces for water the new system will provide (fig. 114). This is also due to the recent extreme weathers has shown the theoretically once every 200 year heavy rainfalls taking place almost twice a year. If there are more rooms in small and dispersed patterns scattering among the area, some in the form of dense forests with highly permeable grounds, some in forms of floodable public spaces in the communities, etc. The porosity of the land in terms of absorbing drastic water fluctuation can be increased.

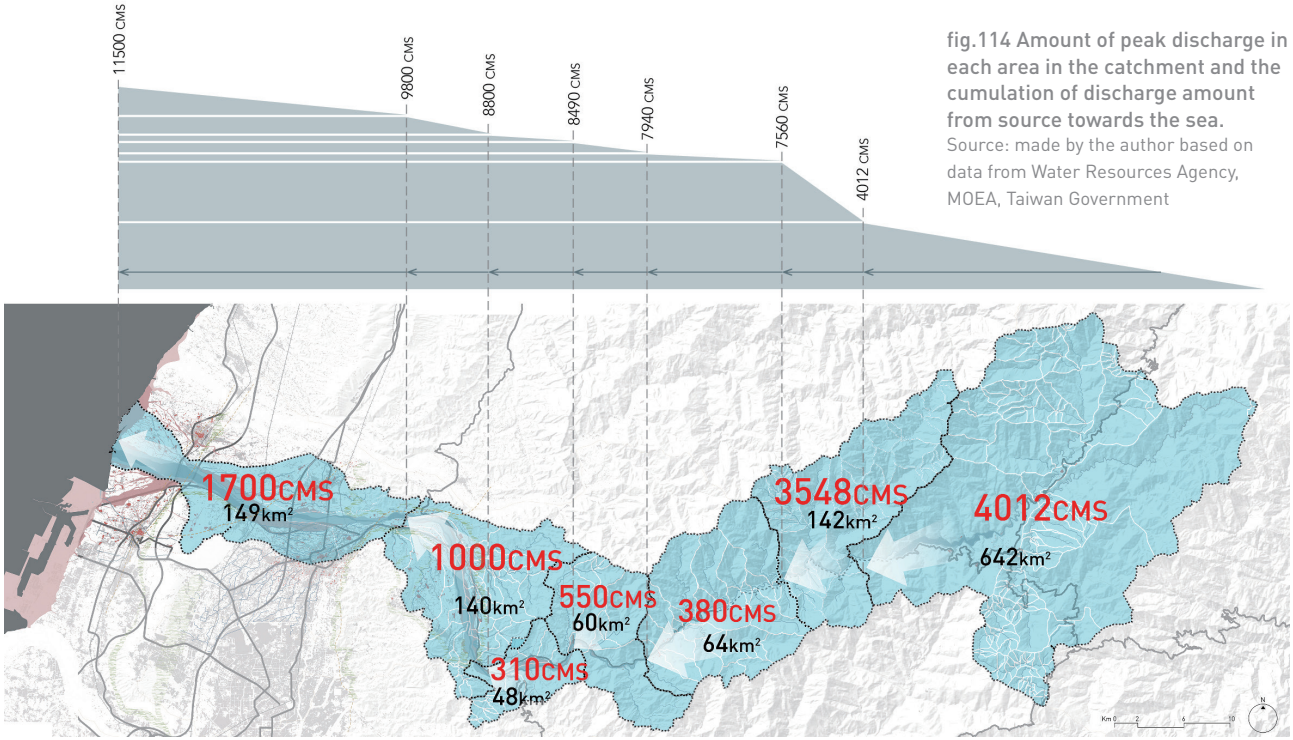


fig.114 Amount of peak discharge in each area in the catchment and the cumulation of discharge amount from source towards the sea.
Source: made by the author based on data from Water Resources Agency, MOEA, Taiwan Government

PRINCIPLE 2: DESIGNING VISIBLE AND RESPONSIVE LANDSCAPE AS INFRASTRUCTURE

Based some examples of mountainous community where The visibility, and the passive vigilance provided by neighboring landowners, helps the distributors in ensuring that traditional procedures are followed (Trawick, 2008).

Furthermore, designing visible infrastructures provides the potential to use the visual power of landscape element to create a tangible connection of the natural forces and flows with the spaces and objects of everyday life. They (infrastructure) can be designed with a formal clarity that expresses their importance to society, at the same time creating new layers of urban landmarks, spaces and connections. (Strang, 1996).

Another common criteria of successful ancient mountainous water management is the responsive of the infrastructure. Not only can users directly operate the system on their own, managing their own resources, but in case of a deficiency, the mechanism allows the whole community to share the lost and risk. In integrating local population and industry into the process of infrastructure and landscape transformation, the principal of visible and responsive should be taken into consideration.

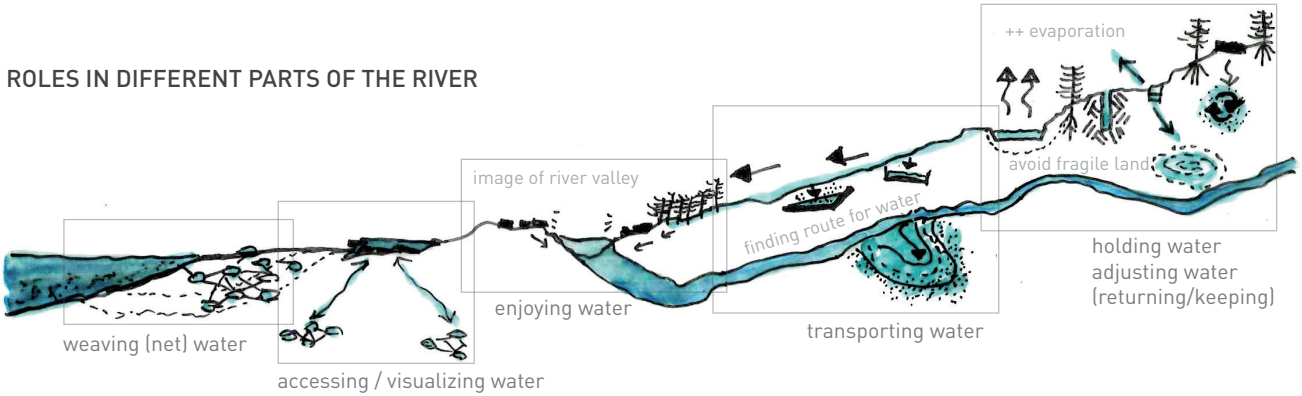
PRINCIPLE 3: MAINTAIN RIVER LANDSCAPE QUALITY AND SCENOGRAPHY OF THE CITY SCAPE

Elaborating on the principal of visibility to a larger scale, the visual power helps extending the connection of community space to the territory. For example, the extending form of infrastructure has the potential to prompt imagination of relation and motivation of physical traversing. The maintenance of landmarks and important elements, for example, the visibility of ridge lines of Central Mountains, of the facades of mountains displays as the common memory for the whole metropolitan area since long ago (fig.115), helps territory residents to construct innovation, responsibility and more delicate consideration in planning for the places where they live.

fig.115 Taiwan ancient map in Kangshi Emperor of the Ching Dynasty in 1704. Source: collection from National Taiwan Museum

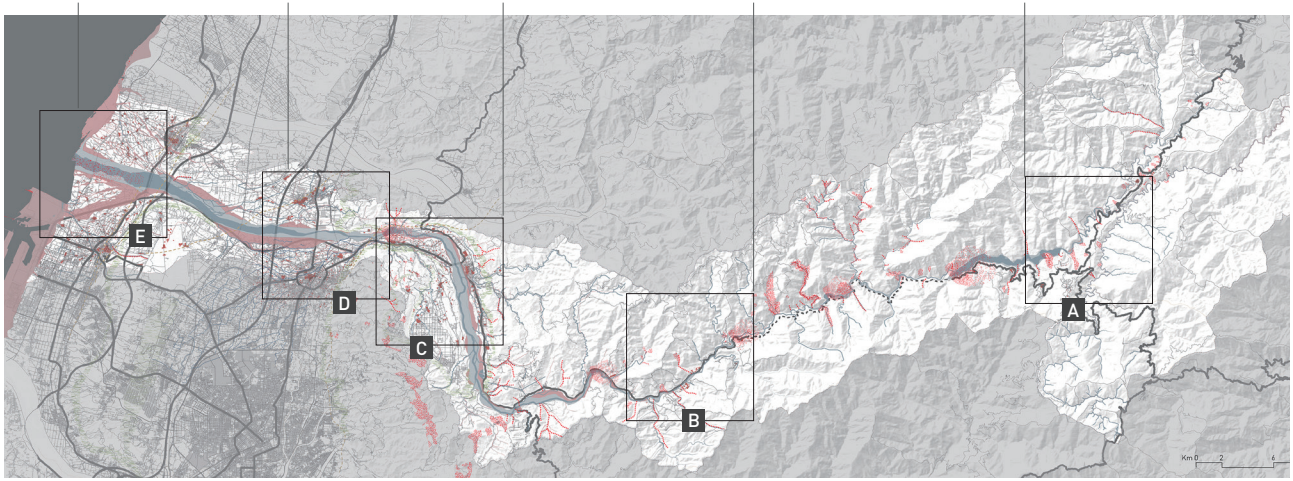
IV-II. REGIONAL STRATEGY

ROLES IN DIFFERENT PARTS OF THE RIVER



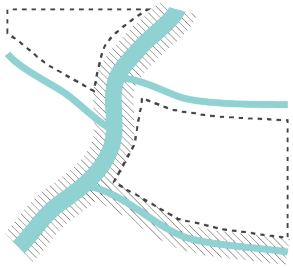
CONCERNED URBAN MORPHOLOGIES

KAOMEI	HOULI & FENGYUAN	DONGSHIH & XINSHE	GUGUAN	LISHAN & HUANSHAN	LOCATION
historical river pattern defined space form; wetland and dispersed villages.	satellite cities with higher density, elevated plain before entering mountainous areas	double village at two sides of the river, past and present industries: agri-tourism & forestry	village prospered by forestry and hotspring, now as the control point of cross-island highway	alpine farms, retired military villages, and tribe communities. economy decrease	MORPHOLOGY
3,500	221,000	76,500	1,900	3,250	POPULATION

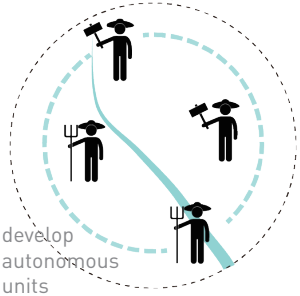


STRATEGIC TOOLS

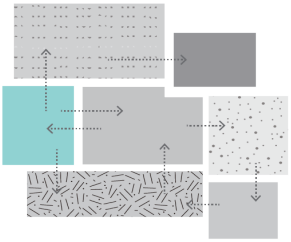
Landscape operative structures as future spatial framework



Water management as local collective activity

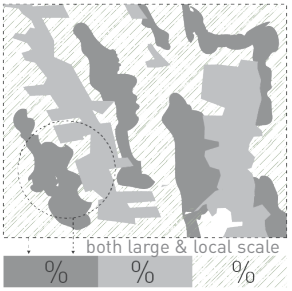


Hybridizing local activities

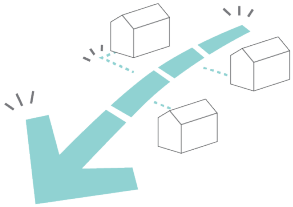


Establish connection and sequence between activities

Maintain balanced proportion of different land uses

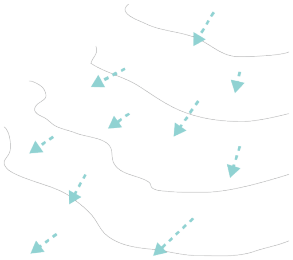


Water infrastructure as visible public spaces



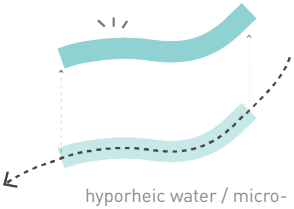
multi-functional + multi-scale

Make use of (micro) topography



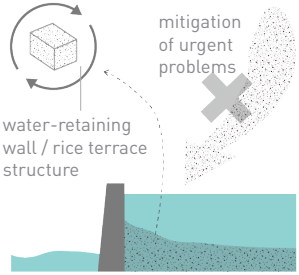
gravity as flow carrier

Ricover the hidden flows

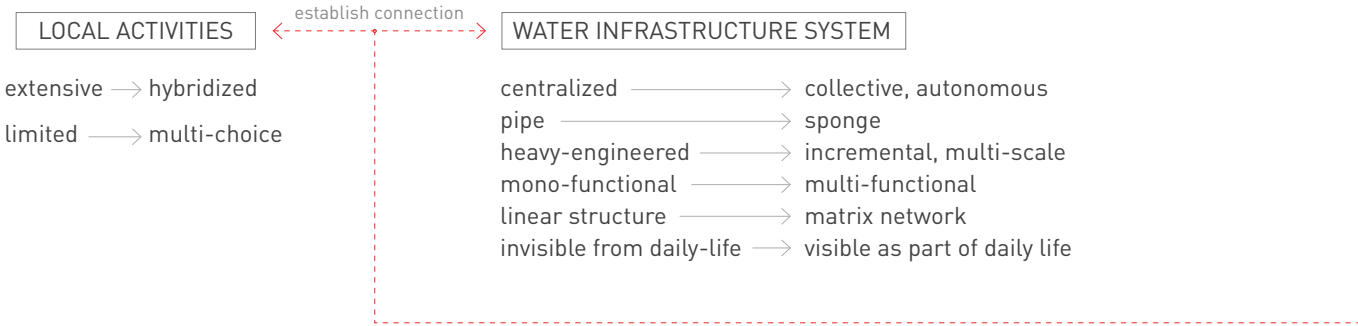


hyporheic water / micro-topography / historical river courses

Sediment (from erosion) recycle and reduction



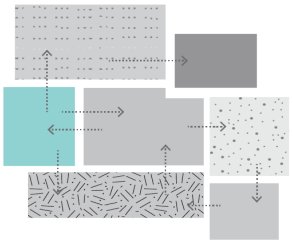
MATCHING THE WATER FLOWS AND ACTIVITY PATTERNS



According to the conclusion of context diagnosis, a continuous conflict between natural water flow and human activity patterns is observed. A transformation is needed to establish better synergy between nature and human life. Therefore, the hybridization of local will be introduced as the main thread through the whole river catchment, with a large part being agriculture hybridization. That is to increase activity that consumes water or holds water (by reducing run-off or creating spaces for retention) at the upstream, where the intense rainfall provides abundant water resources. At the downstream area, on the other hands, the hybridization of activities along historical river course will recover the waterway landscapes, not only as symbolic visual elements, but as the vitality vein to activate the area.

Agricultural hybridization, according to the practice experience and research theories, is a farming style that requires more delicate management, but can accommodate more diversity and complexity and establish closer connections between activities and elements in an area. It also has the potential to create metabolic cycles, ensure resilience and sustainability of human habitation. In Bavaria, Germany, the agriculture policy has been promoting hybridized farming for many years, encouraging each field to change at least three types of crop every year, so as to ensure the soil quality, as well as training farming families to integrate side-activities with their nearby resources, such as farming-experiencing tourism, woodwork crafting, etc (EPLR Bayern, 2014).

Considering the increasing uncertainty of the climate, a hybridized agriculture along with other activities will prepare the area more adaptive to the future changes.



HYBRIDIZING LOCAL ACTIVITIES
as the leading thread to initiate the transformation process

extensive mono-crop farming

hybridized multi-activity farming

allow interaction between different elements

betterment of environmental diversity and resilience to external impacts

integrating other activities

recycling center

reduce waste, biomass

agrarian facility sharing

reduce enter-cost of farmers

attract young people

education

agricultural research testing fields

natural-farming method consultation

contract platform

vv

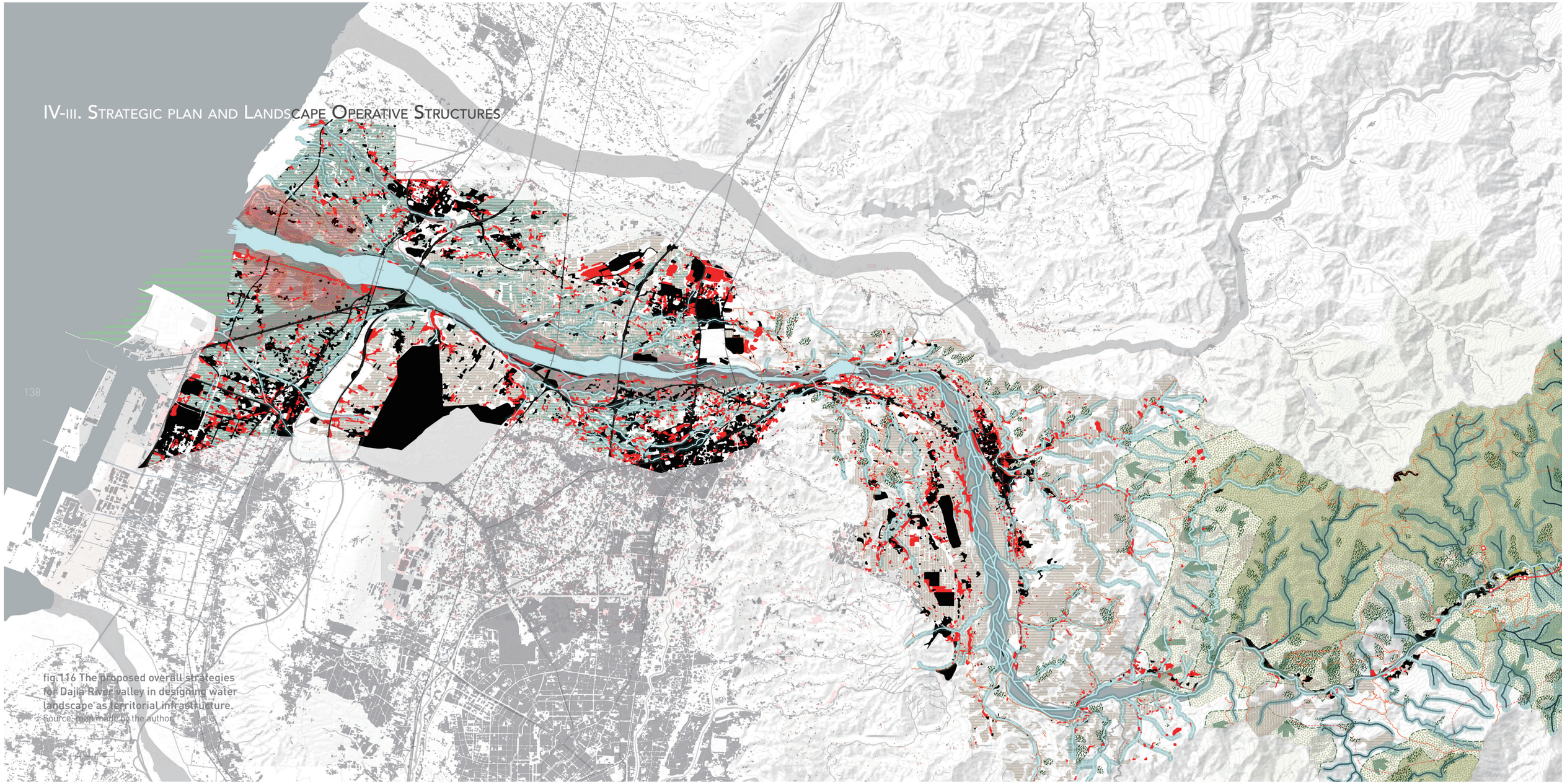
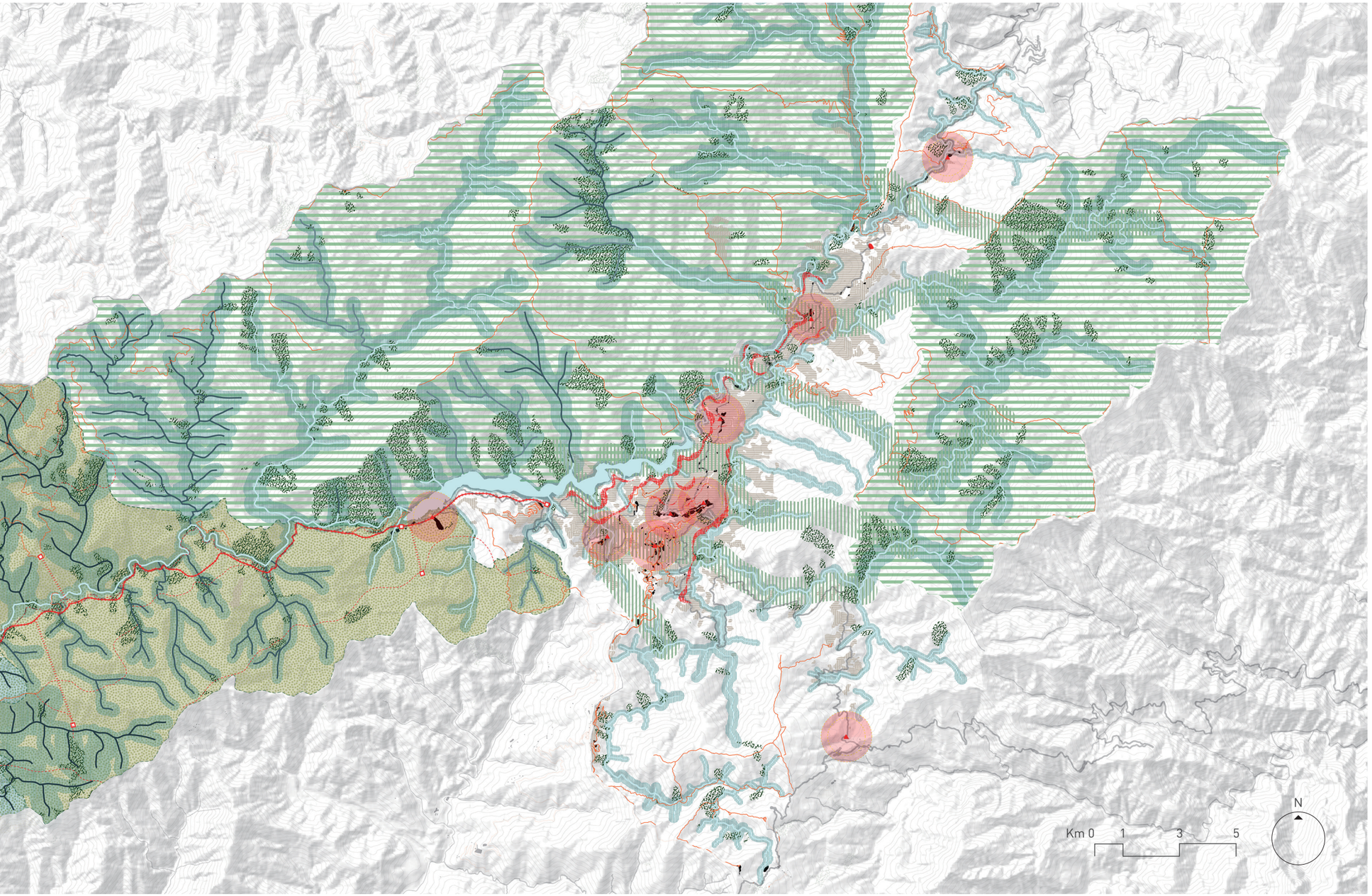


fig.116 The proposed overall strategies for Dajia River valley in designing water landscape as territorial infrastructure.
Source: map made by the author.



OPERATIVE STRUCTURES

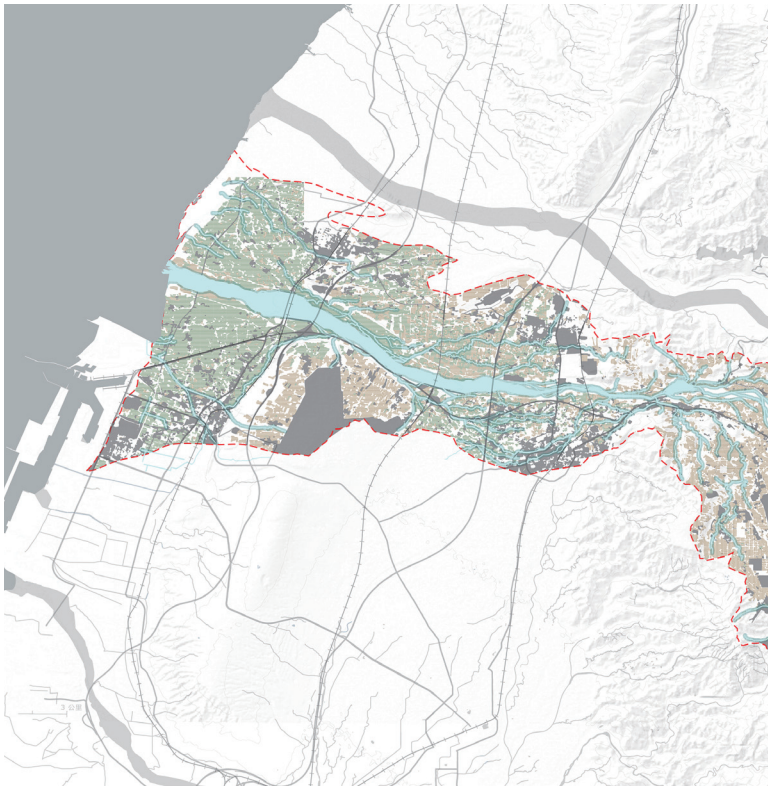
WATER x CORRIDOR
WATER x SLOPE
WATER x TRANSPORTATION
WATER x PUBLIC SPACES

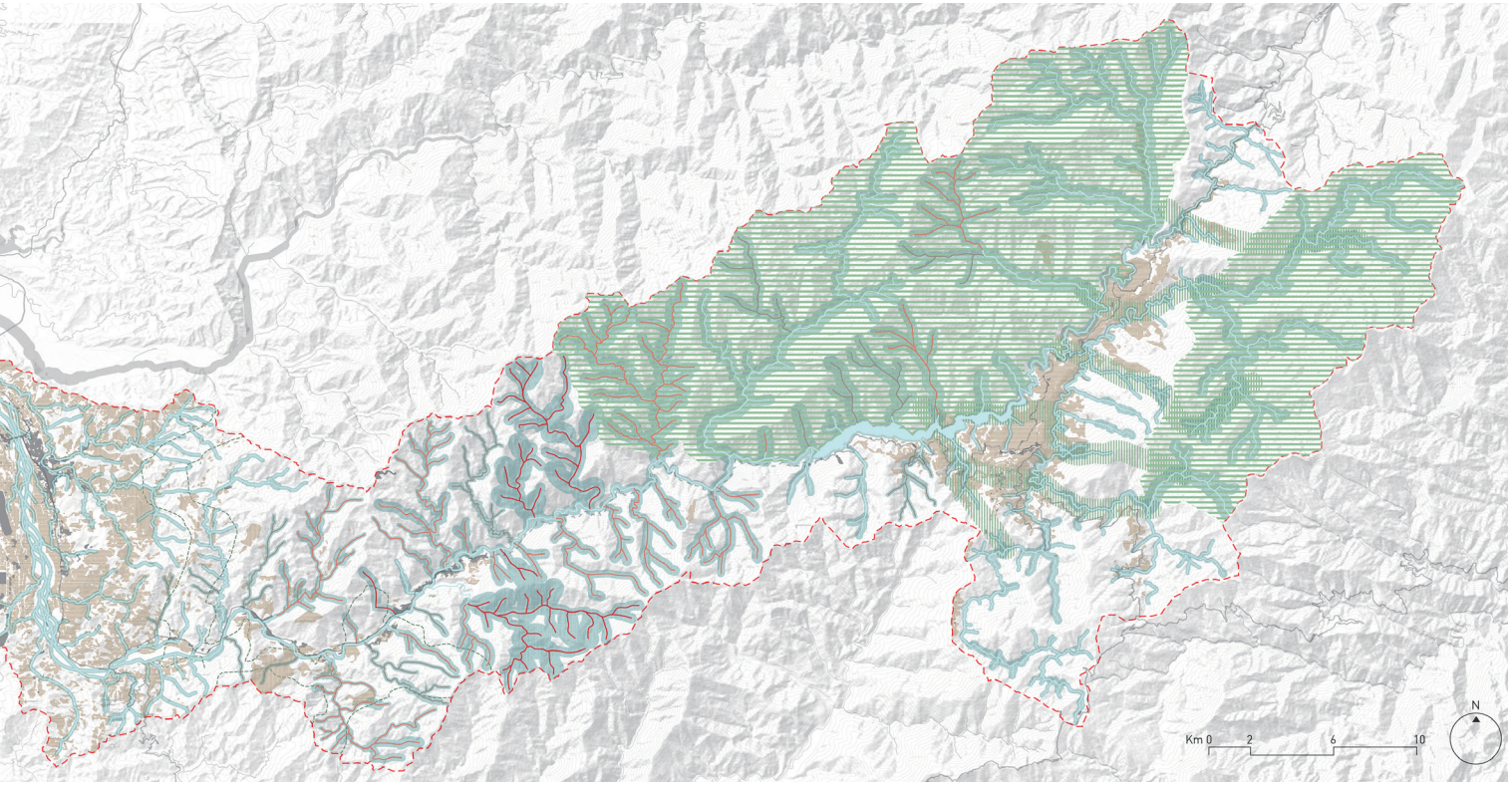
- National Park
- Horizontal corridor between national parks
- Agriculture - dry farming (fruits/tea/grains)
- Agriculture - wet farming (rice)
- Vertical corridors along streams
- normal streams
- low mudslide risk streams
- medium mudslide risk streams
- high mudslide risk streams
- Slope stablization
- Existing protected forestry
- Prospering forestry
- Existing forestry trails
- New forestry / slopework trails
- Machinary track for shipping
- Maintainence points
- Public transporation stops + moving kiosk & evacuation points (1 km coverage)
- Existing habitation
- Water infrastructure interventions
- Groundwater infrastructures
- Historical river courses

Operative structure 1: water x corridors

The term corridor by definition means the passing spaces for elements, species, and flows. Today, the term sometimes has been taken too much by the architectural analogue of its form of orders, which results in selecting a function while excluding another reduces the complexity of a given space to remove any ambiguity from its configuration(Cavalletti, 2005). From an ecological point of view, this means reducing the resilience of an ecosystem, its ability to adapt and / or react to disturbances (Pickett et al., 1999).

This project defines the term corridor as an operative structure, which will work as a spatial device. The ambiguity of this spatial device is proven by the fact that it links, while it separates, the bodies and the regions of space by crossing them; even better, it is a figure allowing continuity of fluxes and discontinuity of matter which constitutes those fluxes, serving the physical support where it is situated (Guida, 2015). In short, the operative structure of water and corridor ensures the vertical and horizontal ecological continuity, and in the meanwhile allows permeability of elements and interaction of activities, ensuring the inclusion character of the spaces.





National Park
Horizontal corridors
Agriculture - dry farming (fruits/grains)
Agriculture - wet farming (rice)
Existing habitation

Vertical corridors along streams
normal streams
low mudslide risk streams
medium mudslide risk streams
high mudslide risk streams
Dajia river catchment

fig.117 Corridor structure proposal for the Dajia Riverscape project.
Source: map made by the author based on GIS data and data from Water Resources Agency, MOEA, and Central Geological Survey, MOEA, Taiwan Government.

1-a. DETERMINING THE SCALE OF VERTICAL CORRIDORS

Geological studies has found that the steeper the slopes, the stronger the erosion forces of streams. Besides, geological and geographical experts have identified several streams in the Dajia river valley with mudslide risks, these streams are categorized as high, medium and low mudslide risks. The following map (figure 118) shows the identified streams of high, medium, and low mudslide risks, and the steepness information. The scales of vertical corridors are determined based on the information of mudslide risk and slope values (figure 119), so that the vertical corridors also ensure land conservation and safety of life and properties of habitation.

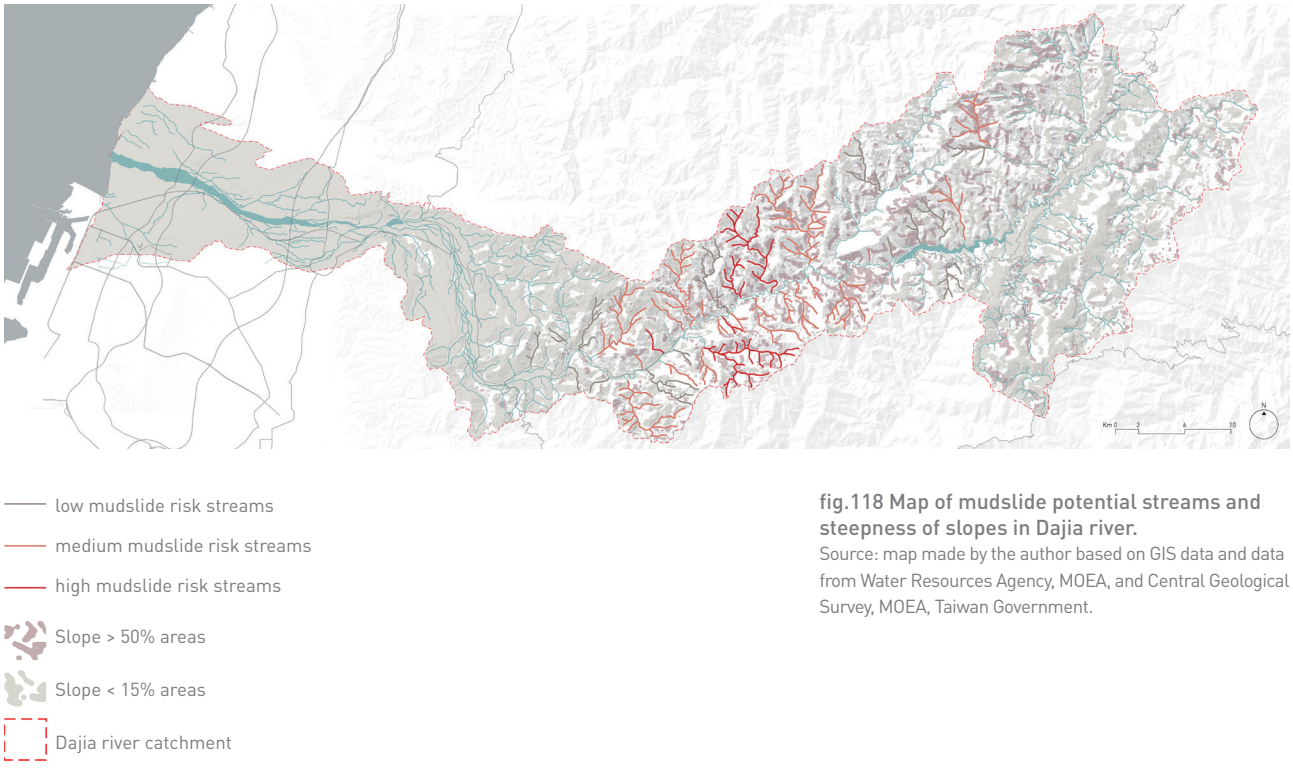


fig.118 Map of mudslide potential streams and steepness of slopes in Dajia river.
Source: map made by the author based on GIS data and data from Water Resources Agency, MOEA, and Central Geological Survey, MOEA, Taiwan Government.

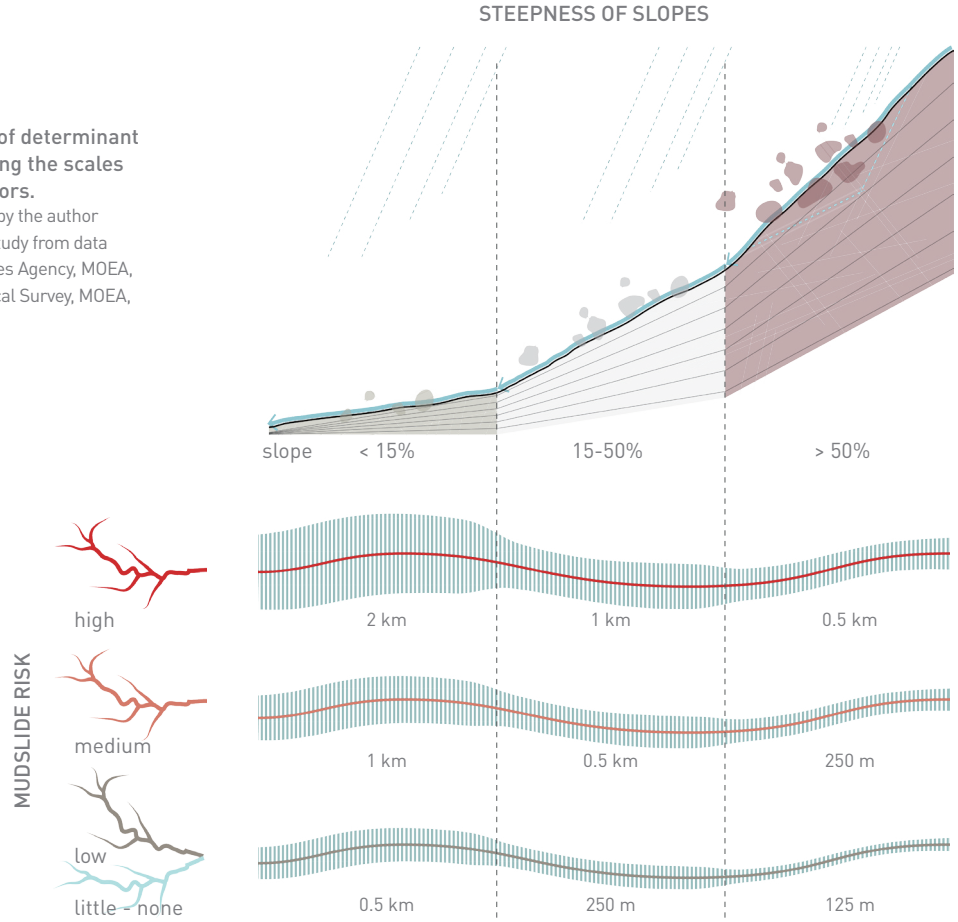


fig.119 Diagram of determinant factors for defining the scales of vertical corridors.
Source: chart made by the author based on research study from data from Water Resources Agency, MOEA, and Central Geological Survey, MOEA, Taiwan Government.

1-b. ENSURING THE HORIZONTAL CORRIDORS

The upstream of Dajia River flows through the gap between the two national parks, Sheba National Park and Taroko National Park, containing the respective alpine areas of the two main tributary systems. Between these two alpine systems, the converging of the two tributaries results in a series of flatter higher lands which has been cultivated for planting of dry grains, tea, and fruits. Settlements of aborigine tribes and retired militaries expanded with urbanization in the form of several villages due to the prospered alpine agricultural.

As also mentioned previously, the upstream of Dajia River flows through the gap between the two national parks, Sheba National Park and Taroko National Park, containing the respective alpine areas of the two main tributary systems. Between these two alpine systems, the converging of the two tributaries results in a series of flatter hilltops which have been cultivated for planting of dry grains, tea, and fruits. Settlements of aborigine tribes and retired militaries expanded with urbanization in the form of several villages due to the prospered alpine agricultural. Today, the stripe of dry farmings has discontinued the tree-crown layer of the mountains, resulted in the disruption of horizontal connections between the ecological spheres of the two National Parks (fig.120). The shallow-root agricultural plants (fruit trees, tea shrubs, dry grains) also results in poor soil conservation.

The converging of the rivers, nevertheless, has the potential to retain water and attract biodiversity, which is also the primary criteria of alpine wetlands. The potential horizontal corridor axis will be determined by identifying the converging points of branch streams, as well as the extension of vertical corridors (fig.121). Then, the extension of these areas towards the two National parks will structure the horizontal corridors (fig. 122) at the upstream area of Dajia River.

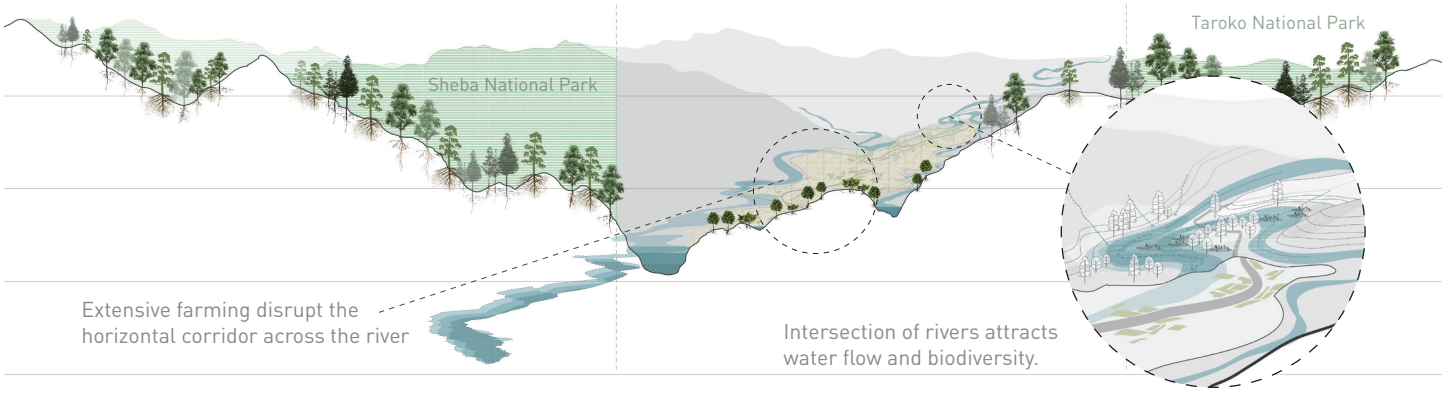
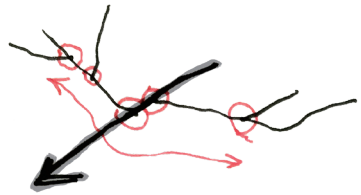
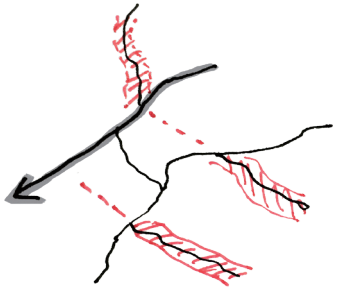


fig.120 The alpine agriculture stripe between two National Parks. Source: map made by the author based on GIS data and data from Landuse Investigation of Taiwan, NLSC, Taiwan Government.



Converging points of branch streams



Extension of vertical corridors

fig.121 Diagrams showing methods for identifying potential nodes to compose horizontal corridors. Source: drawn by the author.

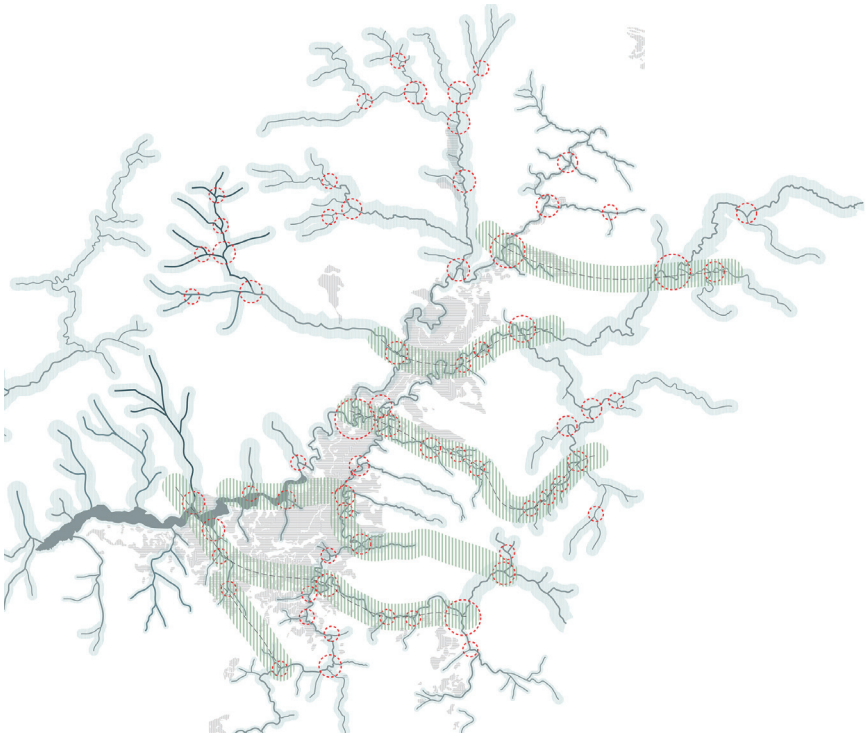


fig.122 The horizontal corridor landscape operative structure proposal. Source: map made by the author.

vertical corridors
horizontal corridor (proposed)
agriculture areas
converging points of branch streams (size of circles refer to the scale of sub-catchments)

Operative structure 2: water x slope stablization

Natural hazards, environmental devastation, and the fragile landscape create the vicious cycle of life-threatening risks for the mountain communities (fig.123). Besides, the increased erosion and sediments also affects the downstream area, with reducing capacity of water infrastructures and quality of water supply. Stabilization works need to be done to the dangerous slopes as soon as possible. This can be achieved through reforestation and installing simple structures on the slopes. The slope works can also integrate local residents, instead of only growing fruits on the hills, incentives will be provided for those who are willing to become slope guardians, or sustainable forestry operators. The reforestation and sustainable forestry will suppress further extensive agricultural sprawl uphill, and increase of the deep-root trees will also reduce soil erosion and runoff during intense rainfalls. A better water retention ability of the land will be achieved.

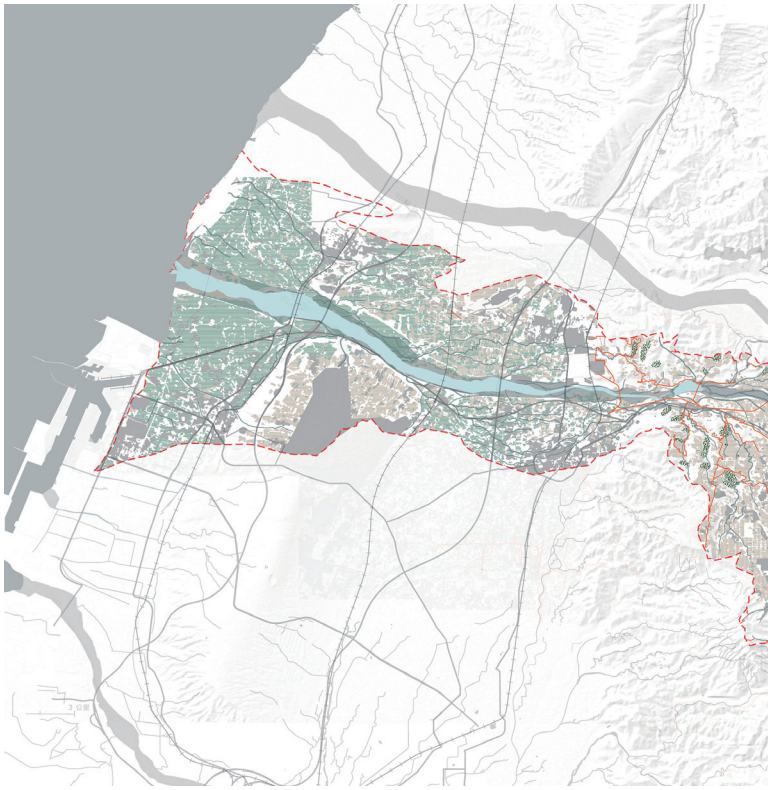
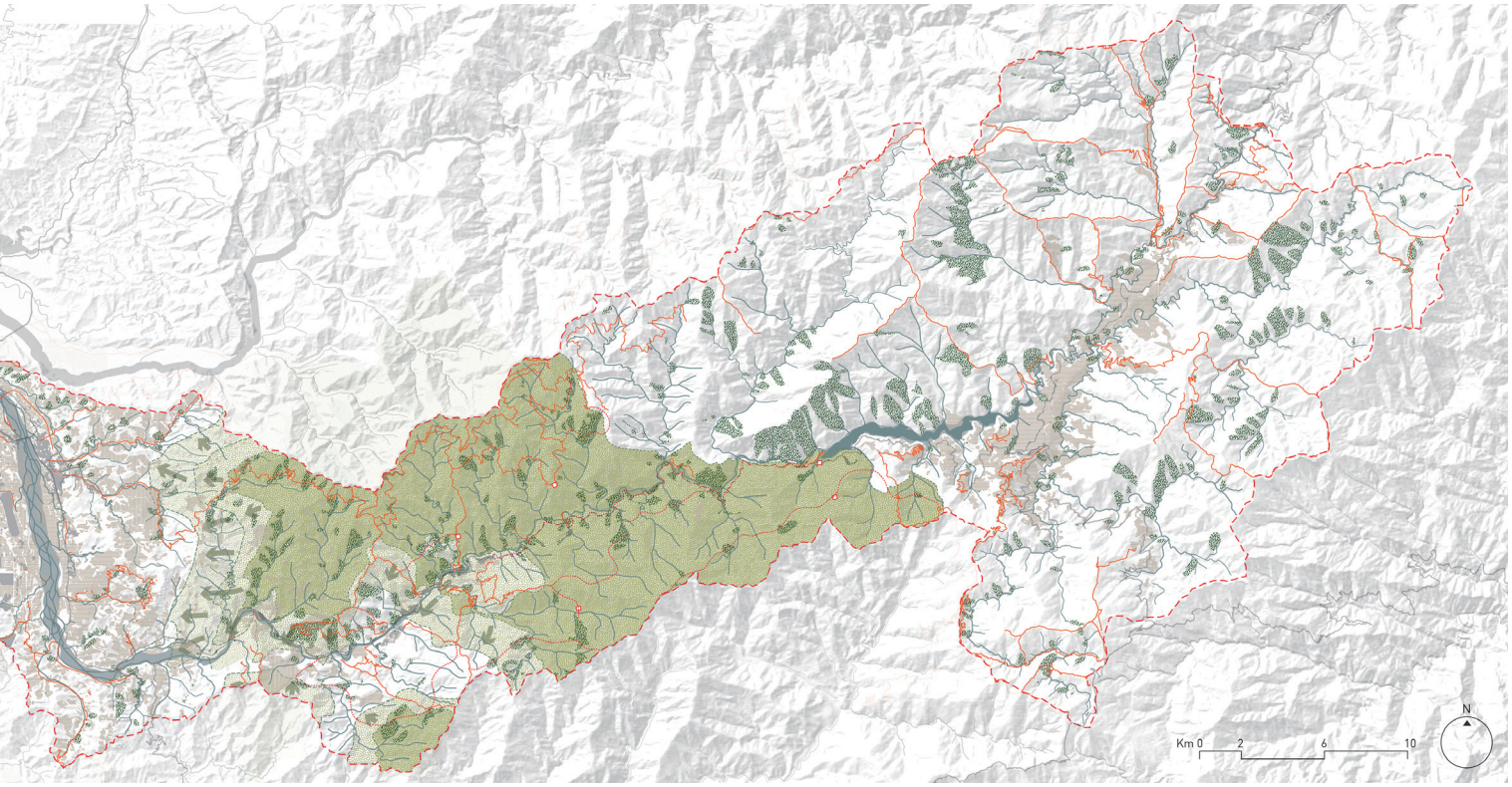


fig.123 (left) Photo of avalanched situations in the mountain areas of Dajia river valley. Source: photos from Taiwan Academy of Ecology ePaper



Existing forestry trails
New forestry / slopework trails
Maintainence points
Existing habitation
Dajia River catchment

Existing protected forestry
Prospering forestry
Agriculture - dry farming (fruits/tea/grains)
Agriculture - wet farming (rice)

fig.124 Slope stablization structure proposal for the Dajia Riverscape project.
Source: map made by the author based on GIS data and data from Water Resources Agency, MOEA, and Central Geological Survey, MOEA, Taiwan Government.

2-a. SLOPE STABLIZATION

Slope stabilization works will first take care of avalanched lands and dip sloped areas with high and medium risk or collapsing. The structuring elements (fig.126) are modules made of materials that can be grown on-the-spot, which would be bamboo and woods, thus will boost the activities of bamboo and tree planting. Besides, the modules are designed with small-scale devices that make use of water flows to generate hydro-energy. The once dangerous lands will be transformed as water infrastructures to incentivize local participation in achieving a hybridized slope landscape.

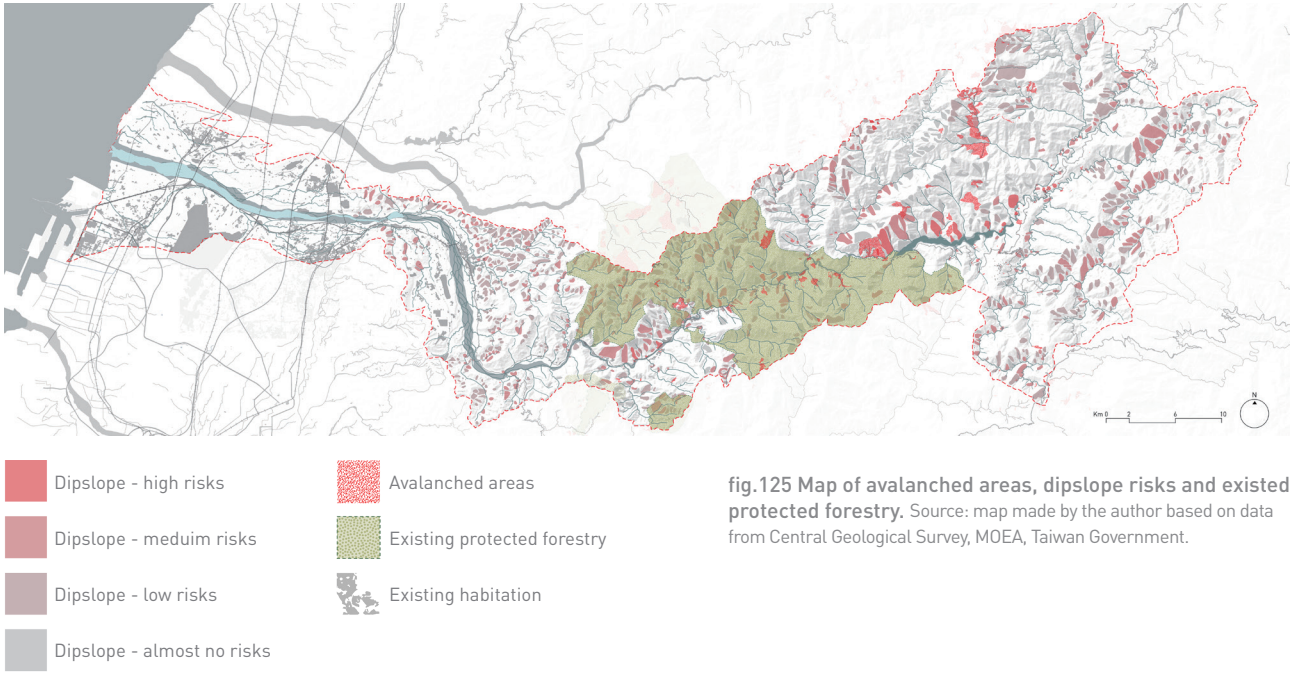


fig.125 Map of avalanched areas, dipslope risks and existed protected forestry. Source: map made by the author based on data from Central Geological Survey, MOEA, Taiwan Government.

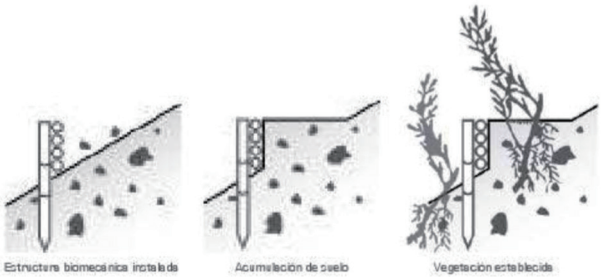
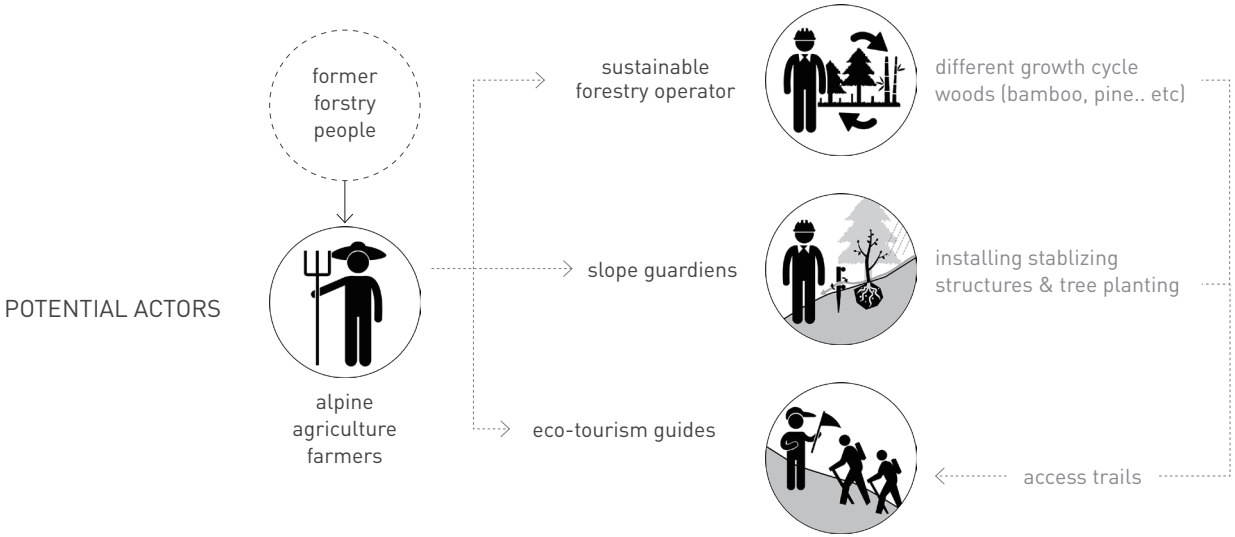


fig.126 Photo and diagram of slope stabilization structures.
Source: Report of "Rehabilitar la Montana", municipality of Medellin.



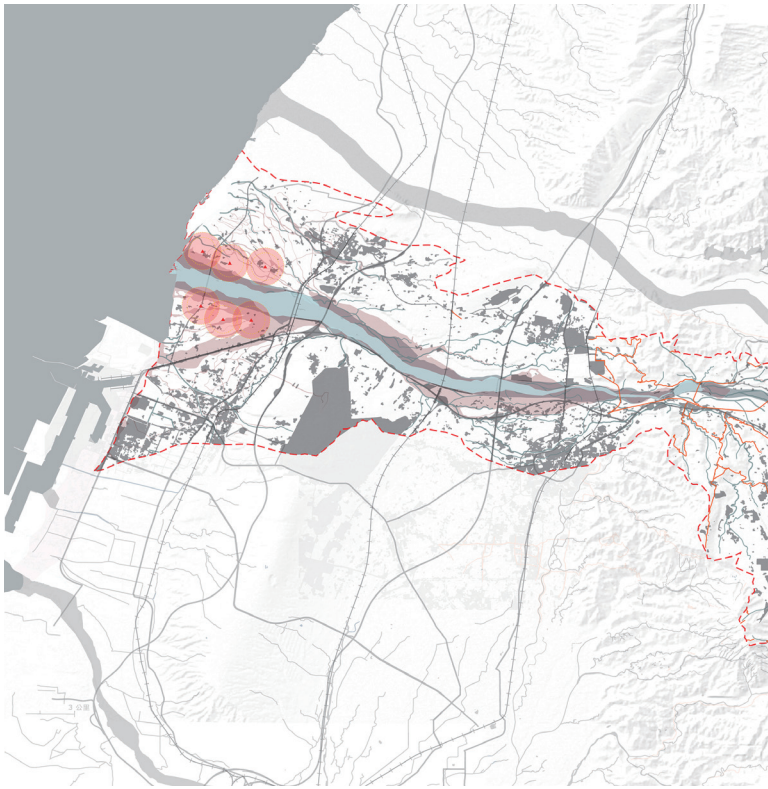
Operative structure 3: water x mobility

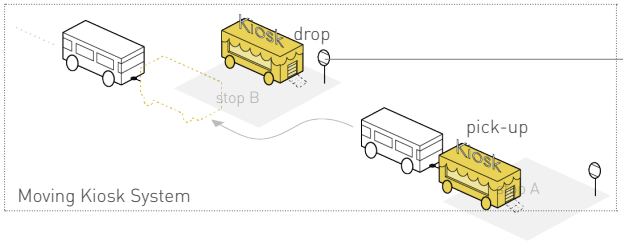
The daily-life necessities will be provided by the proposed bus routes which also serves as moving kiosks for the area, and supported with the strengthened link at the upstream area towards the Eastern Taiwan cities. With this change, a more performative public transportation stops can act as activity organizers and induce multi-functional common spaces.

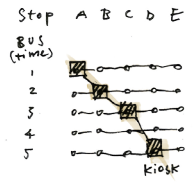
The recurrently breakdown of the mountain motorway, mainly used by agricultural product shipping, can be replaced by lighter infrastructure such as cables and flowing cages (fig.127) which could be operates by smart technology to reduce life risks. This could also stimulate logistic industries at two ends of the track, and include local farmers to join the transformation process.

alpine farmers

maintainence and management of the machinery track for shipping agricultural products.







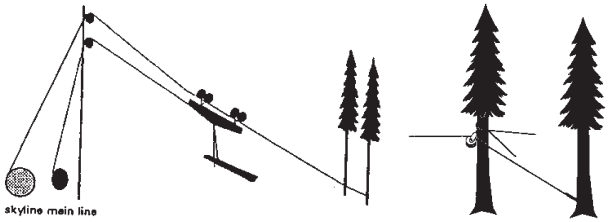
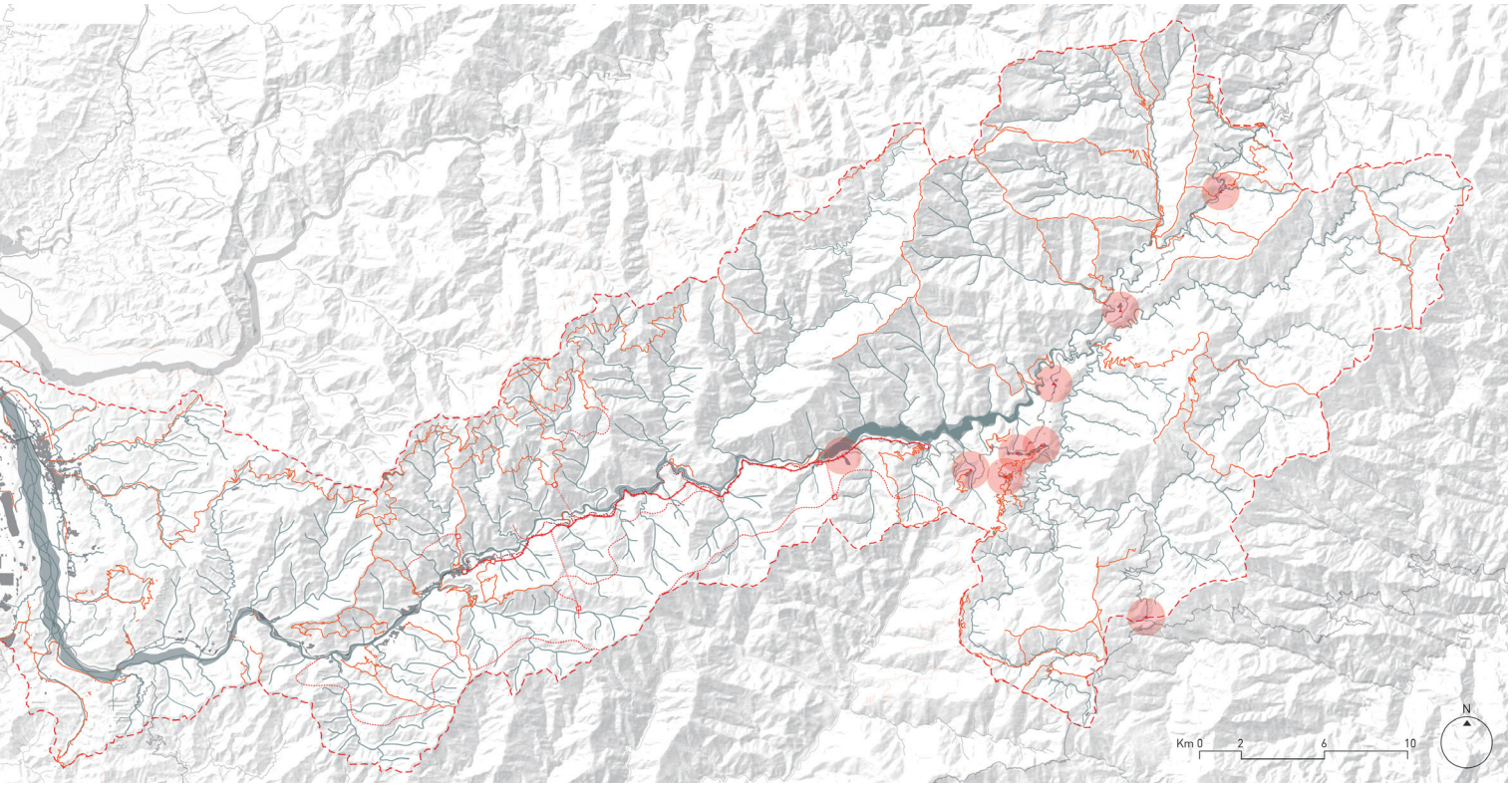


fig.127 Diagram and photo of possibilities of replacing motorway by lighter infrastructure.
Source: FAO, UN; Ayo Websites, NUTN.

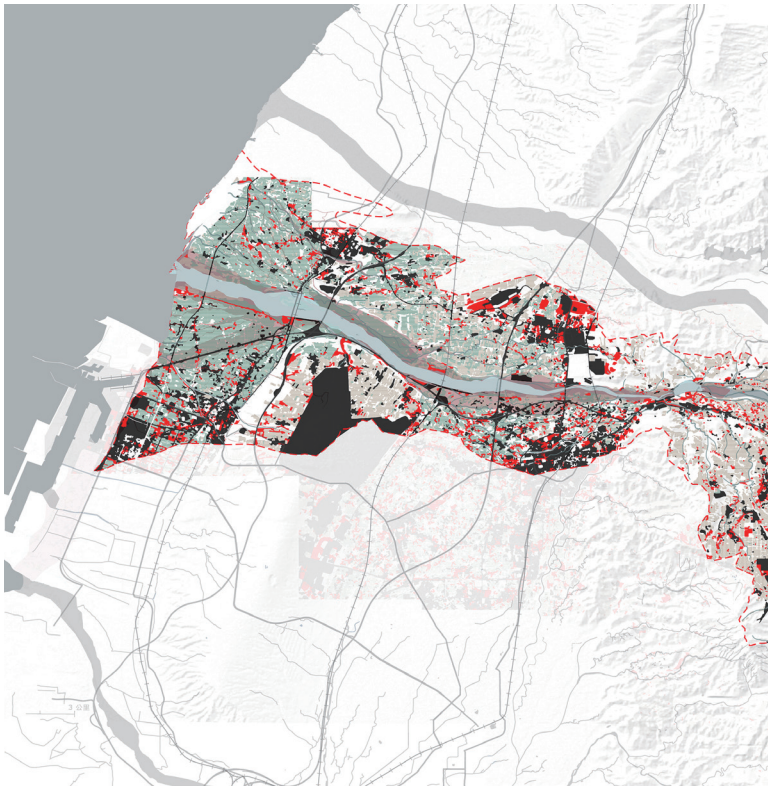


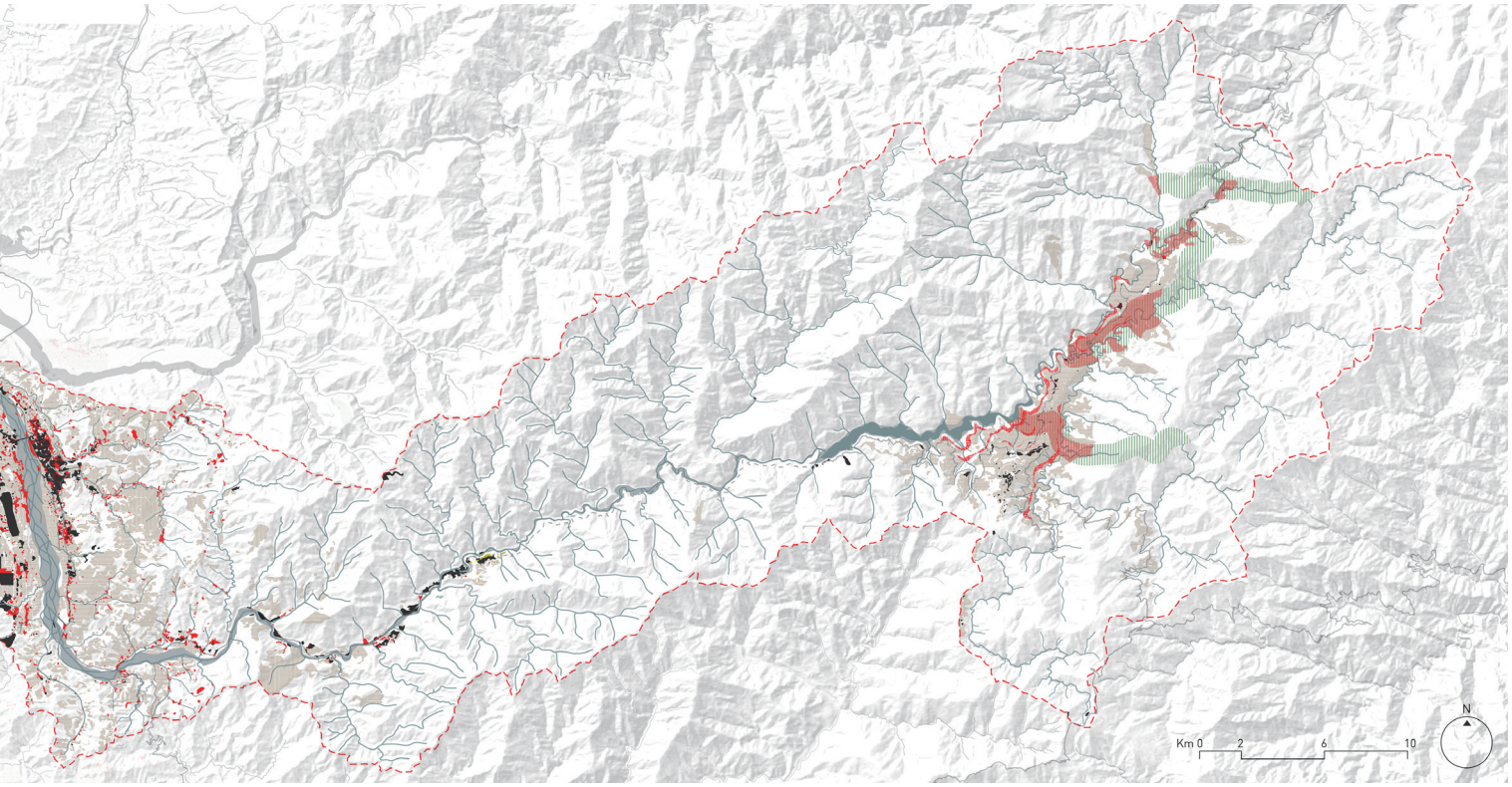
Existing forestry trails
New forestry / slopework trails
Maintainence points
Machinary track for shipping
Public transporation stops + moving kiosk & evacuation points (1 km coverage)
Existing habitation
Dajia River catchment
Historical river courses

fig.128 The mobility operative structure proposal for the Dajia Riverscape project.
Source: map made by the author based on GIS data and data from Water Resources Agency, MOEA, and Central Geological Survey, MOEA, Taiwan Government.

Operative structure 4: water x public spaces

Integrated design interventions of water storage spaces can be carried out firstly at the empty lands and fallowed fields in the area. These water storage functions can also be designed as public spaces for the community, making water infrastructure visible and as part of the urban landscape, integrated with the daily-life of people.





Horizontal corridors

Targeted agricultural transformation

Water infrastructure interventions

Groundwater infrastructures

Historical river courses

Existing habitation

Dajia River catchment

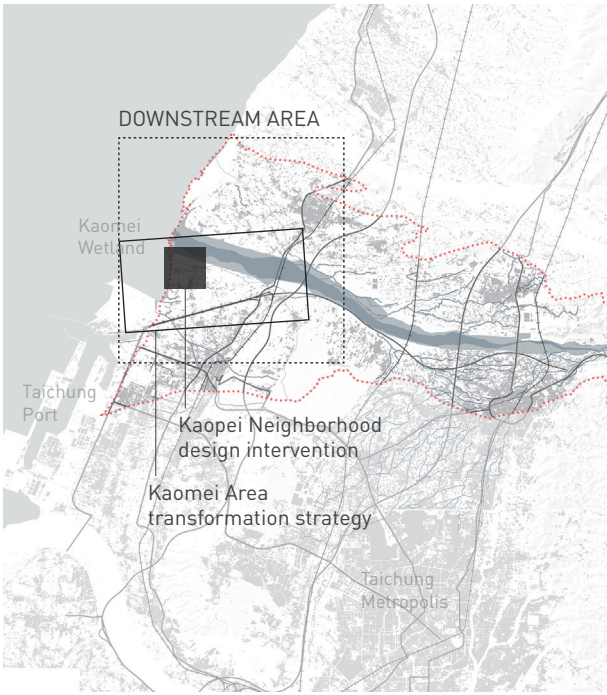
fig.129 Water-public space structure proposal for the Dajia Riverscape project.
Source: map made by the author based on GIS data and data from Water Resources Agency, MOEA, and Central Geological Survey, MOEA, Taiwan Government.

V. Design Intervention

V. Design Intervention

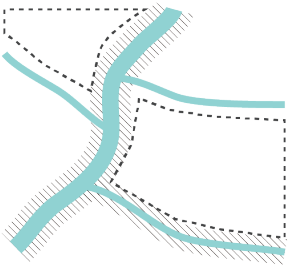
DEMONSTRATION AREAS

- landscape operative structures
- local area strategic plans
- zoom-in site interventions

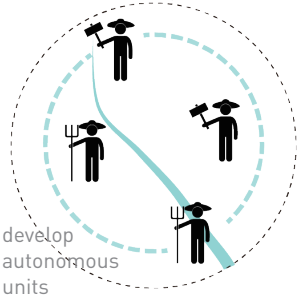


STRATEGIC TOOLS

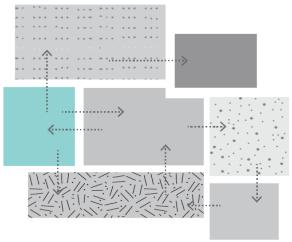
Landscape operative structures as future spatial framework



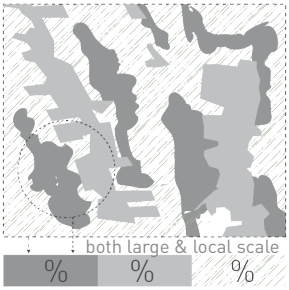
Water management as local collective activity

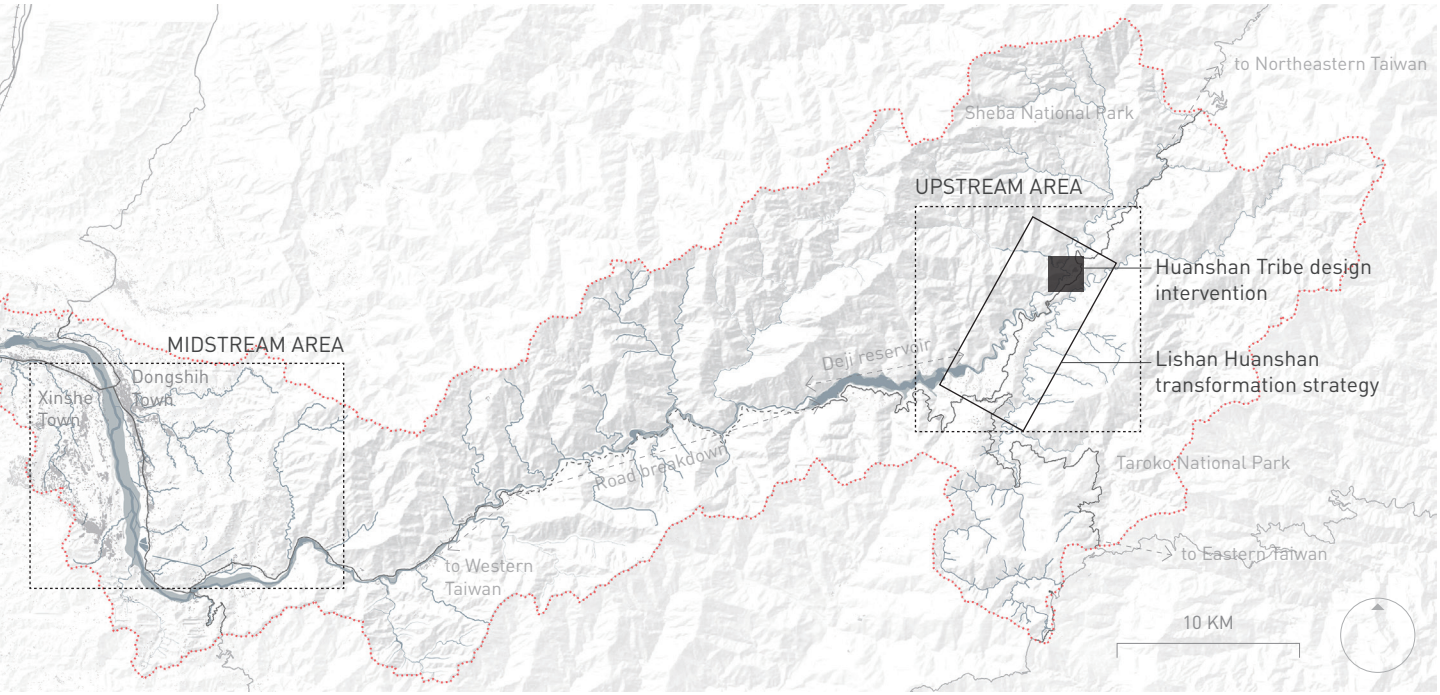


Hybridizing local activities

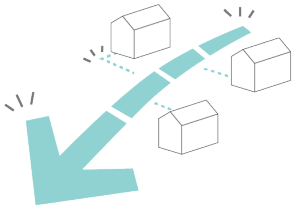


Maintain balanced proportion of different land uses



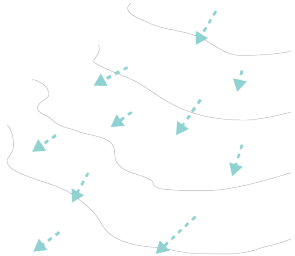


Water infrastructure as visible public spaces



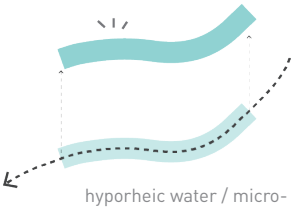
multi-functional + multi-scale

Make use of (micro) topography



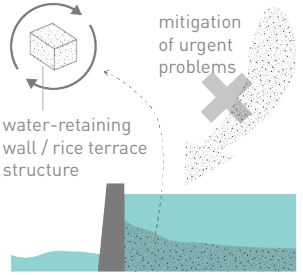
gravity as flow carrier

Ricover the hidden flows



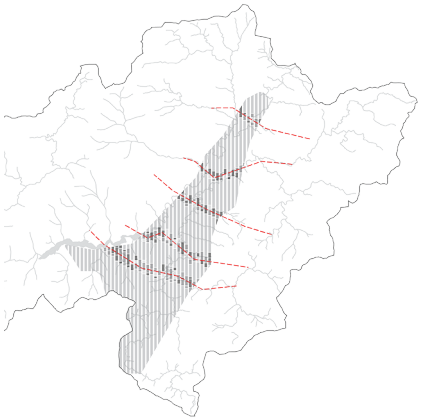
hyporheic water / micro-topography / historical river courses

Sediment (from erosion) recycle and reduction



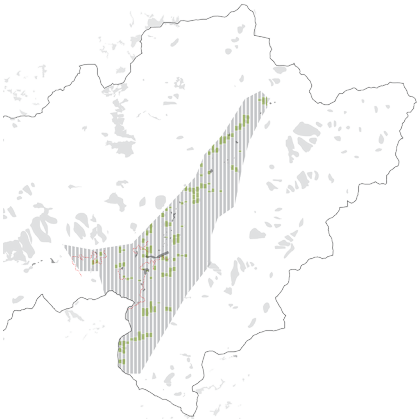
V-I. Upstream intervention: Lishan - Huanshan areas

OPERATIVE LANDSCAPE STRUCTURES



CORRIDOR

Hybridization agriculture starting from horizontal corridor axis.



SLOPE

Slope stabilization through forestation or installing stabilizing structures.

MOBILITY

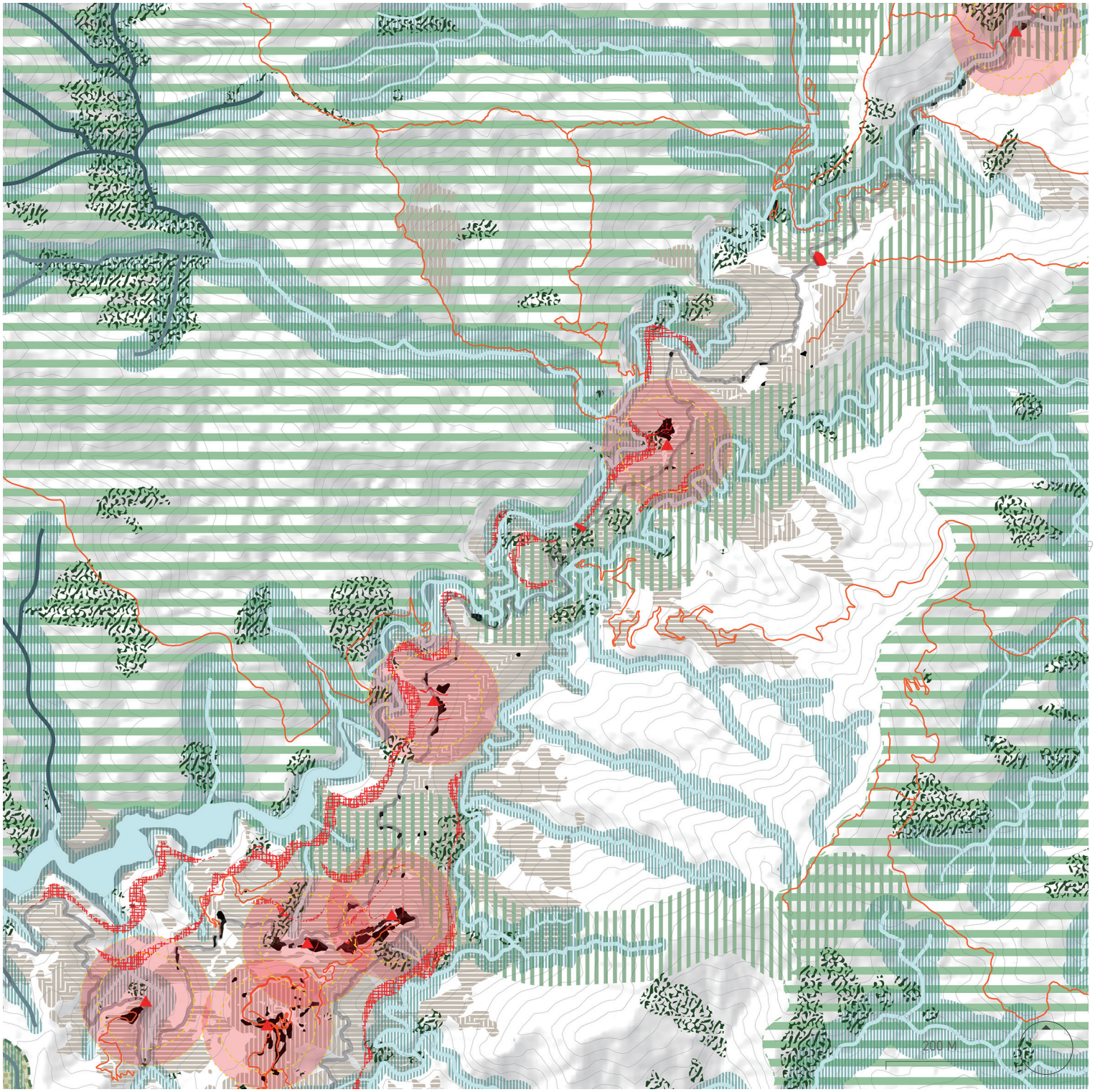
Circular route of multi-functional public transport stops.

PUBLIC SPACE

Water-collection at empty spaces and fallowed fields.

fig.130 Landscape operative structures at upstream area.
Source: map & diagrams made by the author.

- National Park
- Horizontal corridor between national parks
- Agriculture - dry farming (fruits/tea/grains)
- Agriculture - wet farming (rice)
- Vertical corridors along streams
- normal streams
- low mudslide risk streams
- medium mudslide risk streams
- high mudslide risk streams
- Slope stablization
- Existing forestry trails
- New forestry / slopework trails
- Public transporation stops as moving kiosk & evacuation points (1 km coverage)
- Existing habitation
- Water infrastructure interventions
- Groundwater infrastructures


200 M

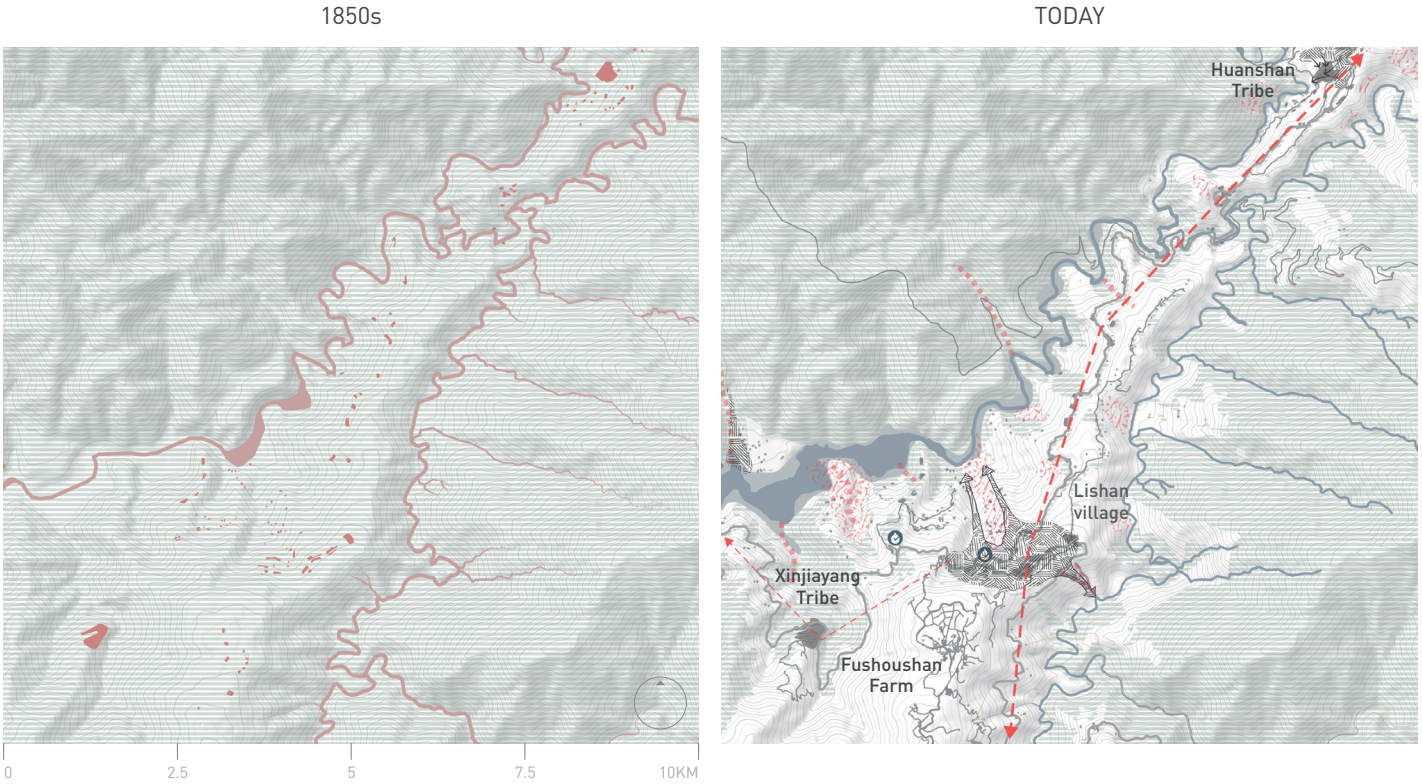


fig.130 Maps of Lishan-Huanshan area in 1950s (left) and today (right).
Source: made by the author based on data from GIS database, google maps, and historical maps.

The landscape of the upstream area shows an extensive agricultural cultivation on the hilltops alone Dajia River. The alpine fruit-farming started with the development plan in the 1950s, which was to construct the central cross-island highway (provincial road T8), and to encourage redundant military people move uphill to plant high-economic-value fruits. Gradually, the extensively cultivated fruit-farming stripe has increased erosion, result in increased sediments flow into the reservoir, and the slopes at high landslide risk, threatening the life and property safety of the mountain communities.

fig.131 Aerial view of Dajia River upstream area.
Source: screenshot from video clip by Shen [online] available at https://www.youtube.com/watch?v=MISj8s-6SSw.

CURRENT WATER INFRASTRUCTURE

Self-installed water facilities purchased from water company. Unable to ensure sufficient water supply, fragile to intense rain, and result in pipes (also easily broken) scattering on the hills, in the streets, and above the neighborhood buildings.

fig.132 Photos of water facilities and human activities in Lishan-Huanshan area. Source: photo from Google street views, Paul Chuang, & Walkerland.com.tw.

In order to have more sufficient and stable water supply, some people build simple water storage on their own on empty lands or in the field.

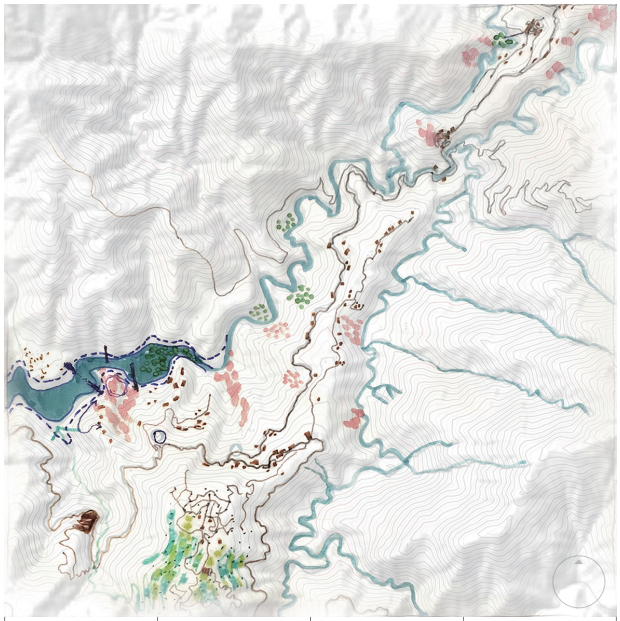
HABITATION AND SLOPE ACTIVITY

Both public and private open spaces are sealed with concrete or impermeable pavements.

Fruit farming result in poor ground protection of the slopes.

MAIN CONCEPTS

DESIGN WITH NATURAL FLOWS



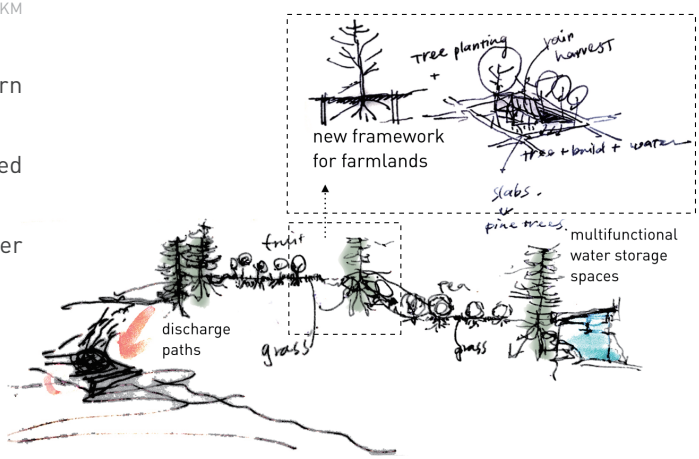
hybridized agriculture to match activity pattern with water flows

elements guiding sediments and water at desired areas

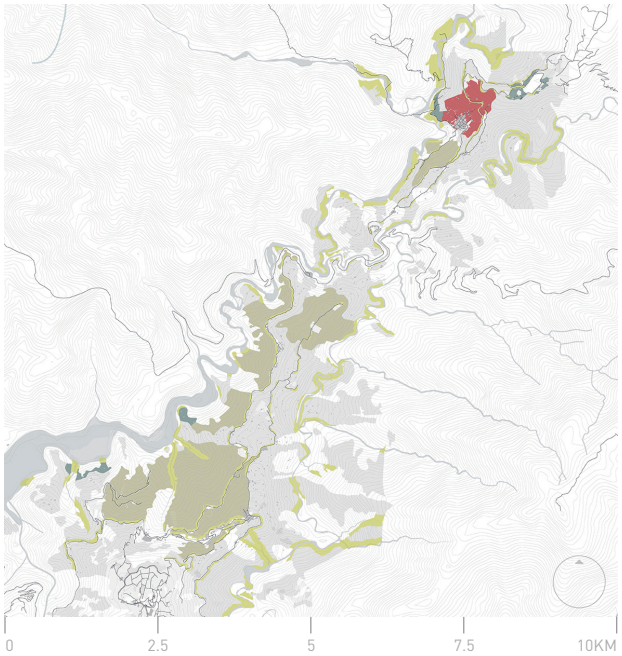
induce the formation of alpine wetlands at river converging point

Reference alpine potential:
Alpine wetland ecological garden in Hakone, Japan.

fig.133 Photos of Hakone Alpine Ecological Garden.
Source: https://kknews.cc

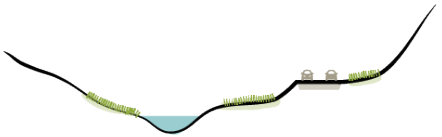


SLOPE AGRICULTURE CATEGORIZATION



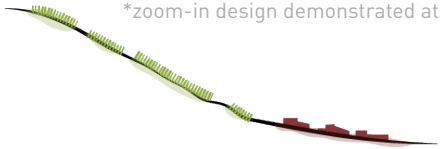
The extensive alpine agriculture need to be restructured in order to provide better interaction between water and human activity, as well as ensure sustainability and safety of habitation. The agriculture x living environment are categorized into four types, each with appropriate transformation strategies and different possibilities.

type a: road-side/ riverside agricultures

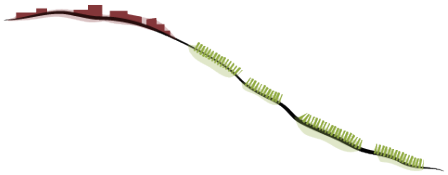


type b: agriculture on slopes above community

*zoom-in design demonstrated at page 170



type c: agriculture on slopes below community



type c: converging points of branch streams

existing slope agriculture (fruit/dry crops)

Regional design

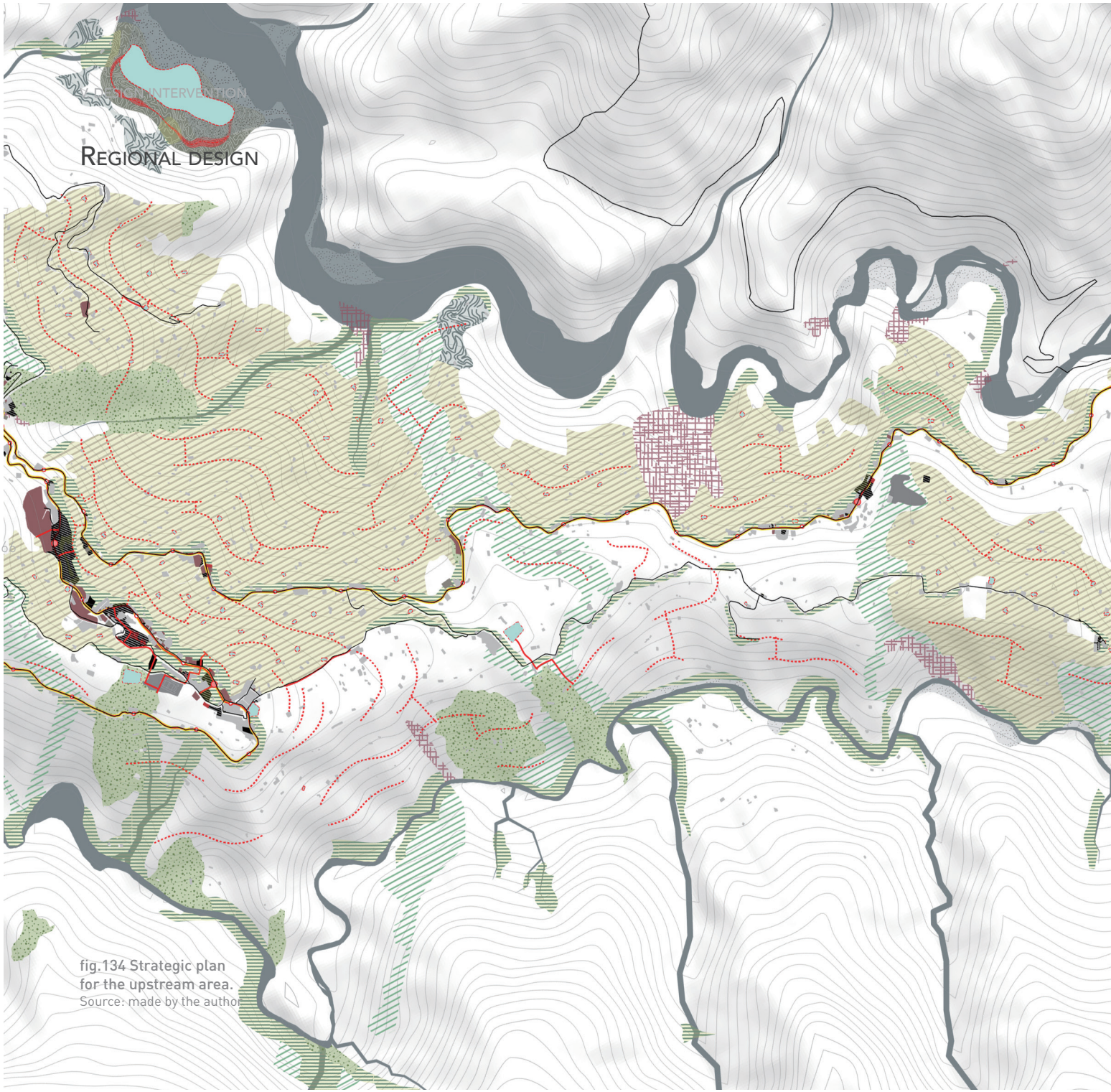
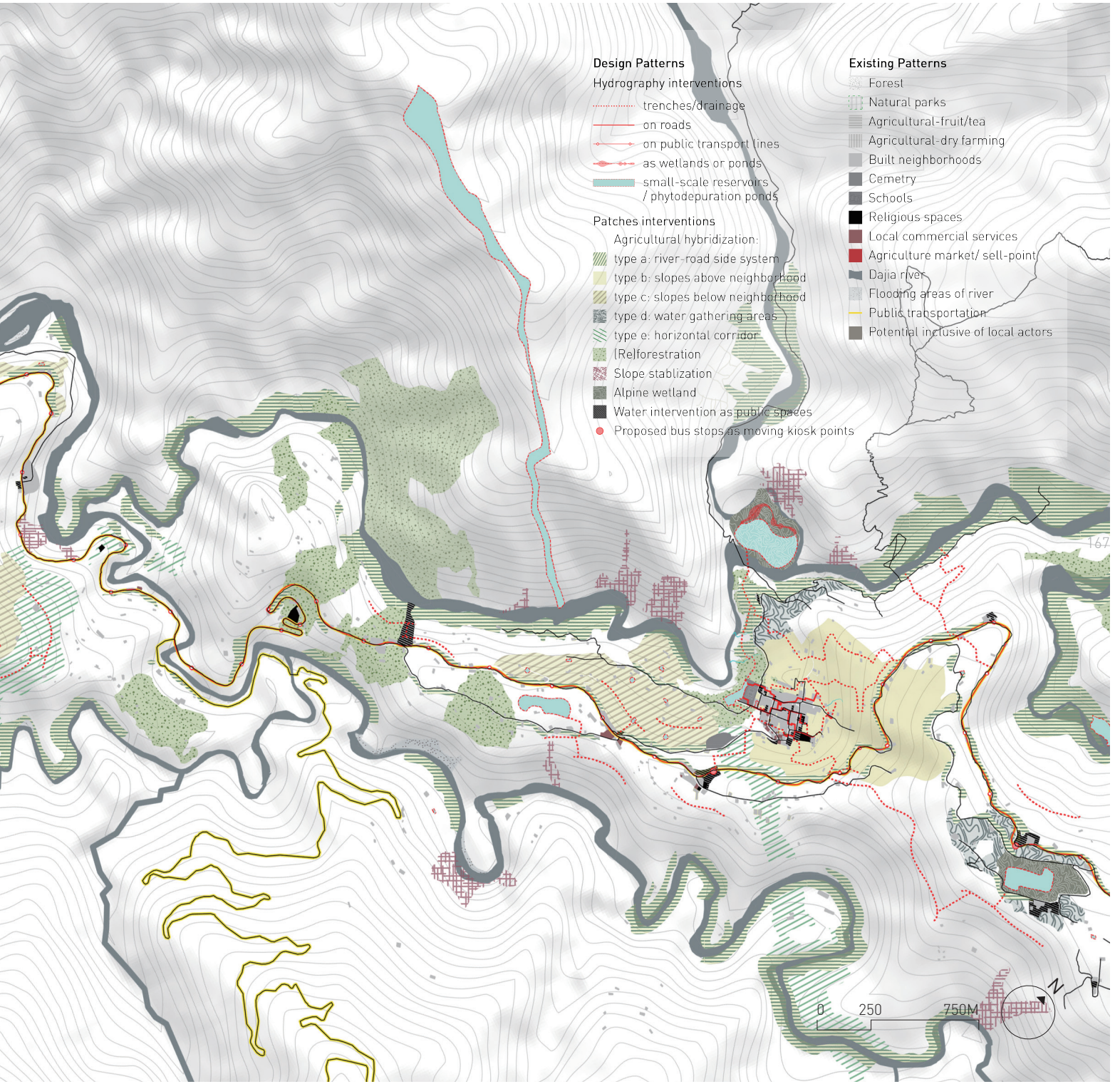
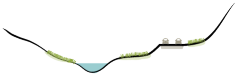


fig.134 Strategic plan for the upstream area.
Source: made by the author

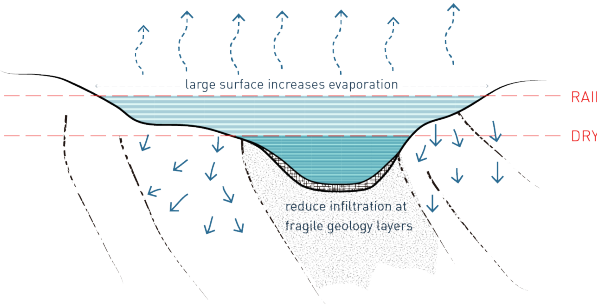

Design Patterns
Hydrography interventions
trenches/drainage
on roads
on public transport lines
as wetlands or ponds
small-scale reservoirs / phytodepuration ponds
Patches interventions
Agricultural hybridization:
type a: river-road side system
type b: slopes above neighborhood
type c: slopes below neighborhood
type d: water gathering areas
type e: horizontal corridor
(Re)forestration
Slope stablization
Alpine wetland
Water intervention as public spaces
Proposed bus stops as moving kiosk points
Existing Patterns
Forest
Natural parks
Agricultural-fruit/tea
Agricultural-dry farming
Built neighborhoods
Cemetry
Schools
Religious spaces
Local commercial services
Agriculture market/ sell-point
Dajia river
Flooding areas of river
Public transportation
Potential inclusive of local actors
0
250
750M
N



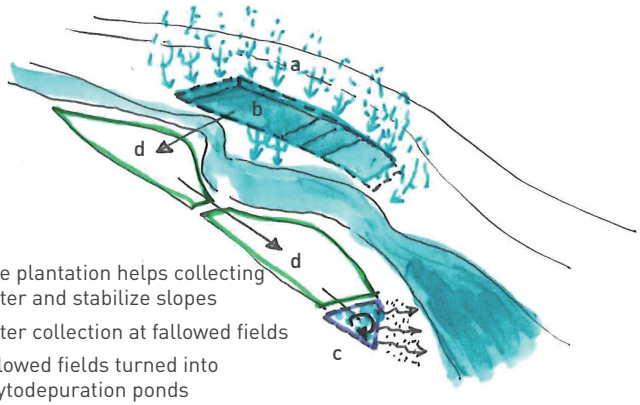
type a. on roadside/riverside agriculture patches

fig.135 Photos of spaces between river and road installed with small agri patches. Source: photo by hnchung via Google Earth

Water storage detail

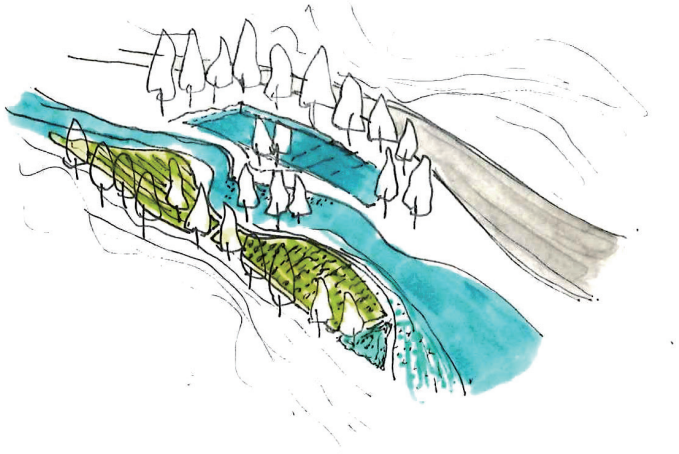


Water system



a. tree plantation helps collecting water and stabilize slopes
b. water collection at fallowed fields
c. fallowed fields turned into phytodepuration ponds
d. working fields with crops arranged by the sequence of water usage

Intervention visulization



*zoom-in design demonstrated at page 170

type b. extensive fruit farming at slopes above community spaces

fig.136 Photos of slopes above community areas solely planted with fruit trees.
Source: photo from Google street view (above) and 灰狼 e 族 (below)

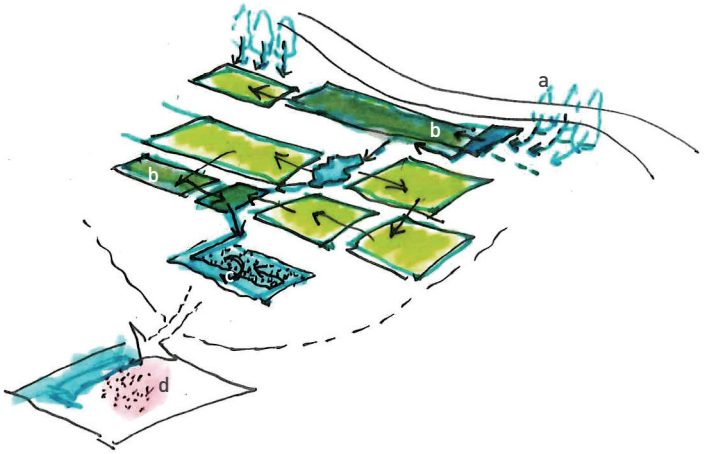
a. tree plantation helps collecting water and stabilize slopes

b. release some fields as water collector ponds

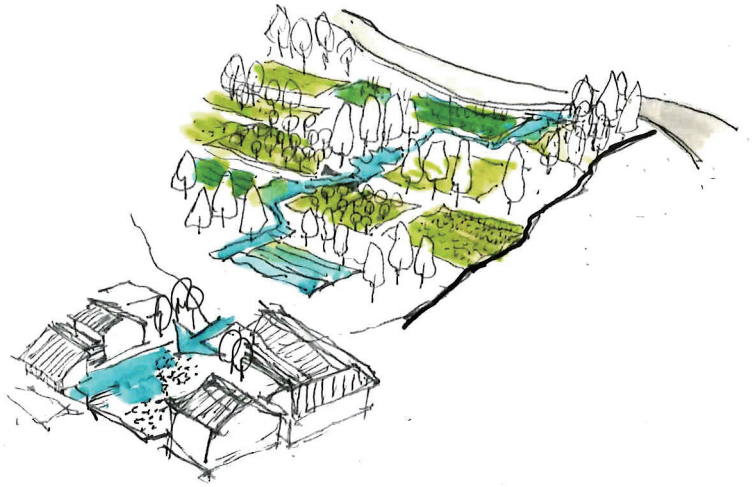
c. release some fields as phytodepuration ponds

d. guide the flow of water and sediments at public terraces within the community

Water system

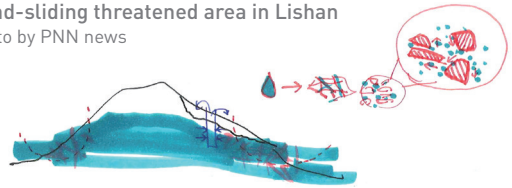


Intervention visulization



wells and channels to reduce infiltration at fragile areas

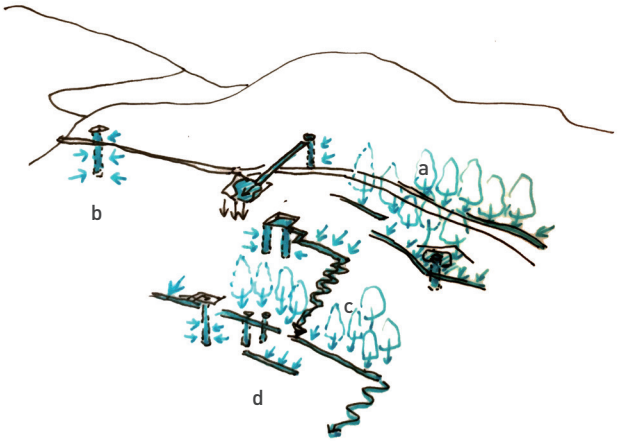
fig.137 Land-sliding threatened area in Lishan
Source: photo by PNN news



infiltration of water at fragile lands increases fragility

a. tree plantation helps collecting water and stabilize slopes
b. deep wells to extract underground water
c. vertical channels to transport water
d. horizontal channels allow water to be extracted from ground

Water system

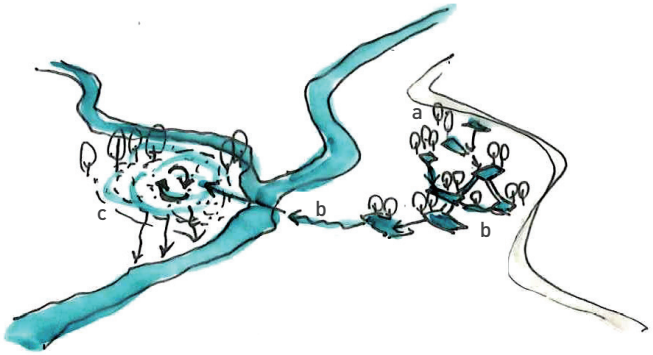


Intervention visulization

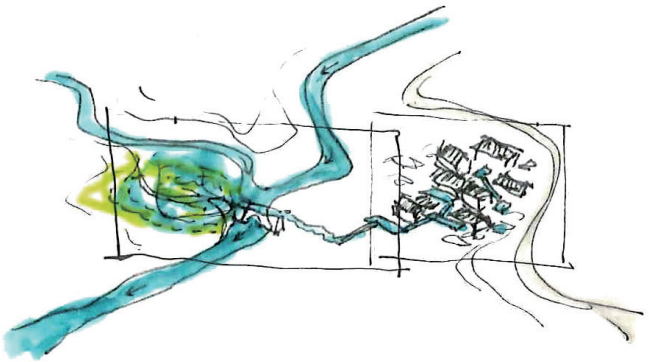
slope as distributor and the converging points of branch streams

fig.138 Underused terraces within Huanshan community
Source: photo from Google street view

Water system



Intervention visulization

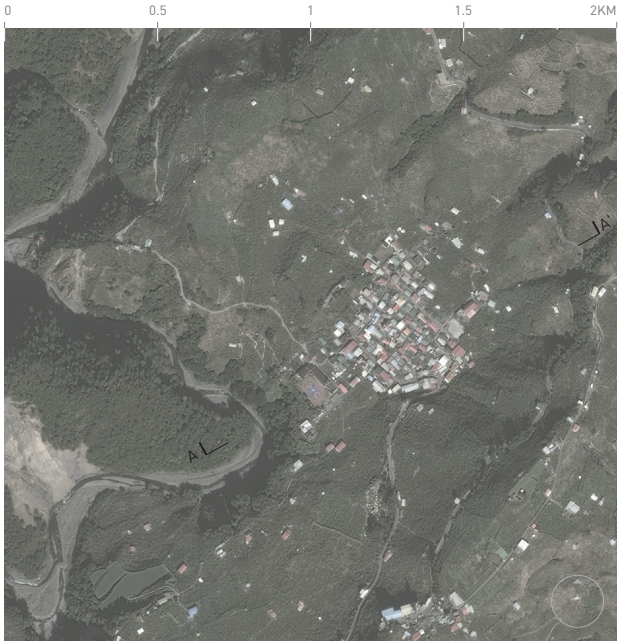


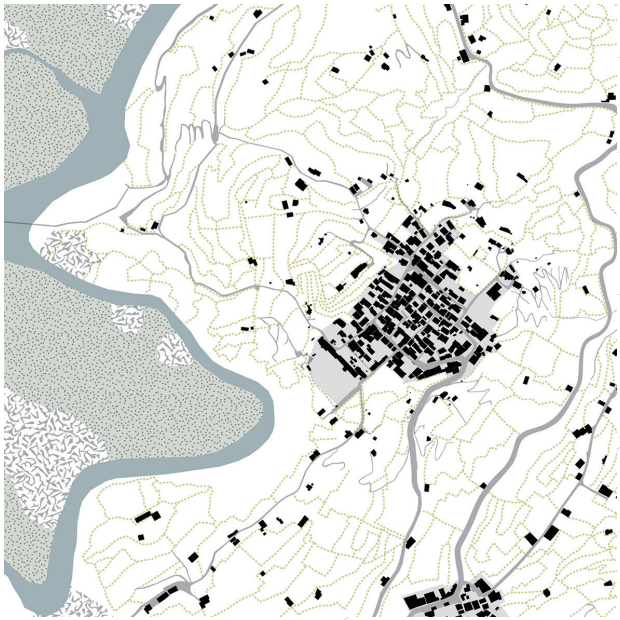
a. tree plantation helps collecting water and stabilize slopes

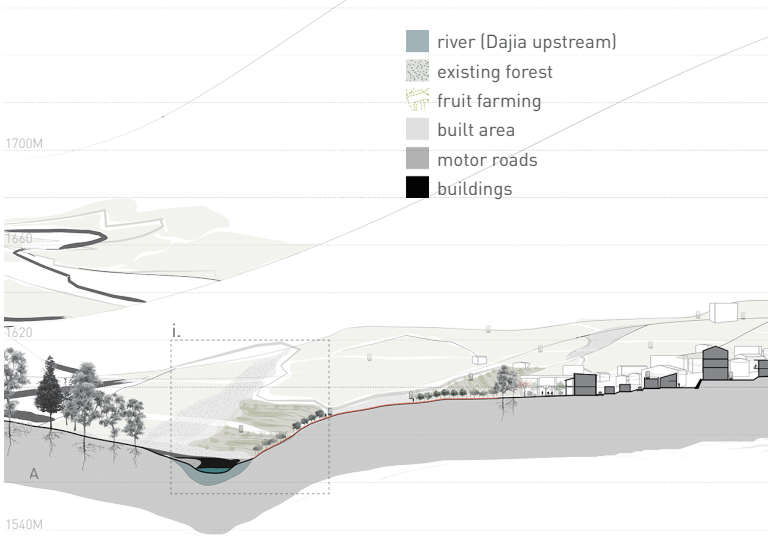
b. water collection/distribution along slopes within community spaces, and designed as public spaces

c. adjusting of the topography so that wetland formed at intersection of rivers, performed as purification for community

DESIGN ELABORATION: HUANSHAN ALPINE TRIBE





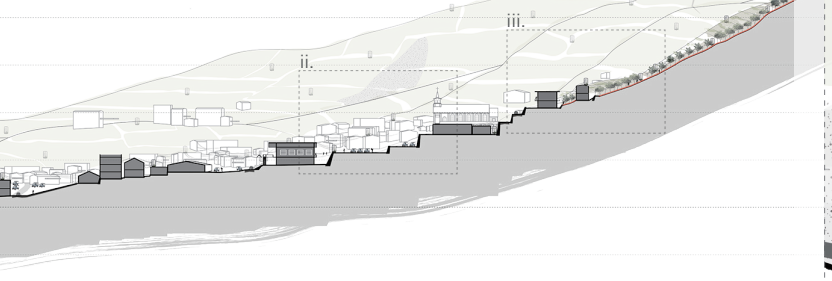


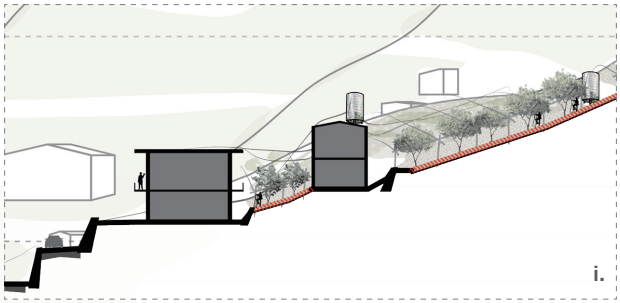
CURRENT SITUATION

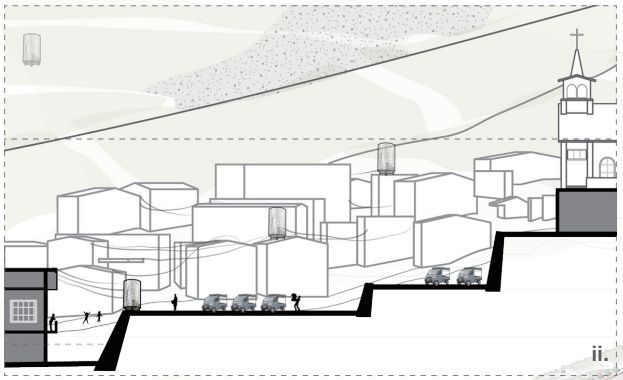
fig.139 Aerial photo of Huanshan tribe.
Source: photo by Iyhou Chiu

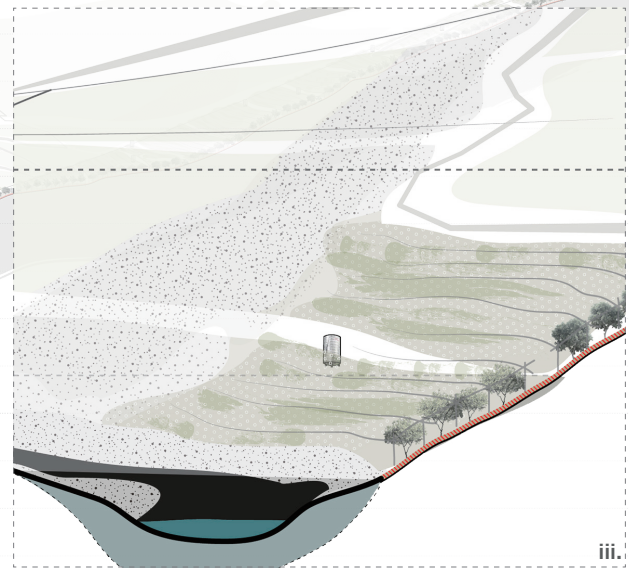
Huanshan Tribe was an aborigine settlement developed around 300 years ago. The name Huanshan, means "surrounded by mountains". The Atayal ethnic people used to maintain an autonomous lifestyle with hunting, fishing, and growing wheat, millet rice, and sweet potato as main economic activity. In 1960s, with the cross-island motorway constructed, more people moved in from the plain area and introduced high-economic-value fruits to replace the original agriculture. The slopes around the village were then extensively covered by fruit farming, scattered with self-installed water facilities to support the agriculture. The improved accessibility also attracted tourists to buy fruits and vegetable directly from farmers.

After the 1999 earthquake bringing the continuous breakdown of the roads, the cost of fruit farming has doubled, and more young people decide to leave for big cities. The weakened (by earthquake) land structure also increased fragility of slope and facilities to intense rainfall. The extensively cultivated slopes today is a huge risk threatening the life and property of the village. The agro-chemical flowing directly to the upstream rivers has also become a threat to the ecology and water resource. A rethinking for the slope activity together with the water infrastructure is needed.



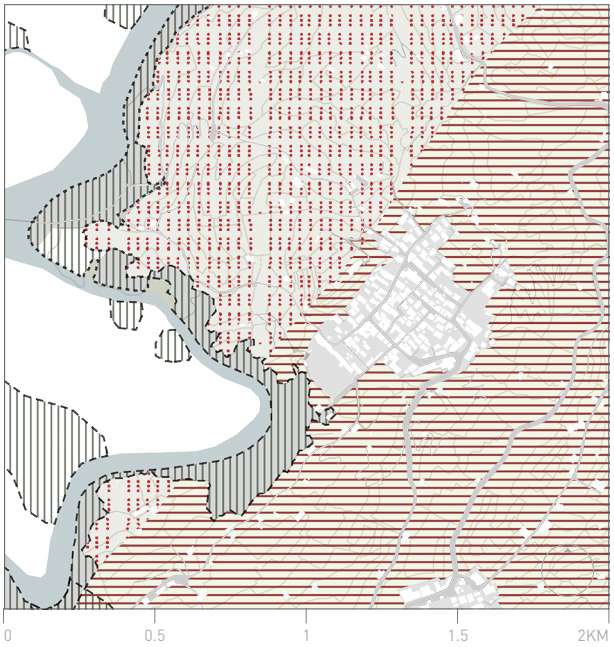




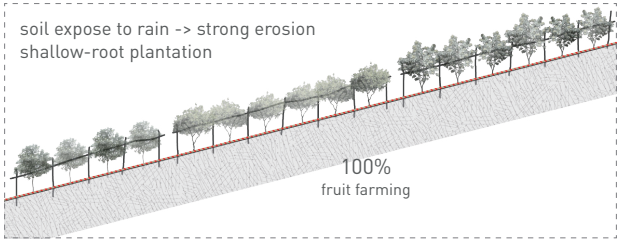


CONCEPTUAL SCHEMES

a. SLOPE ACTIVITY HYBRIDIZATION

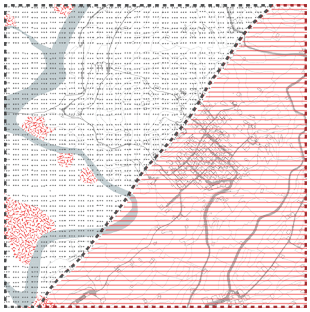


CURRENT SITUATION: EXTENSIVE FRUIT FARMING



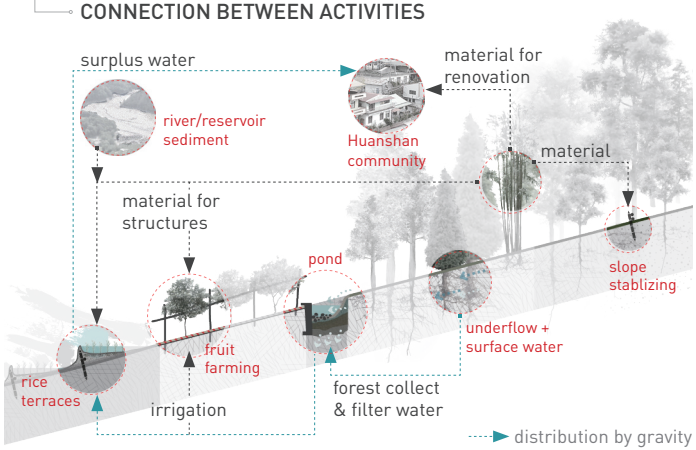
- slope activity hybridization type 1
- slope activity hybridization type 2
- reforestation and slope stabilization
- reforestation for river corridor

SLOPE GEOMORPHOLOGY

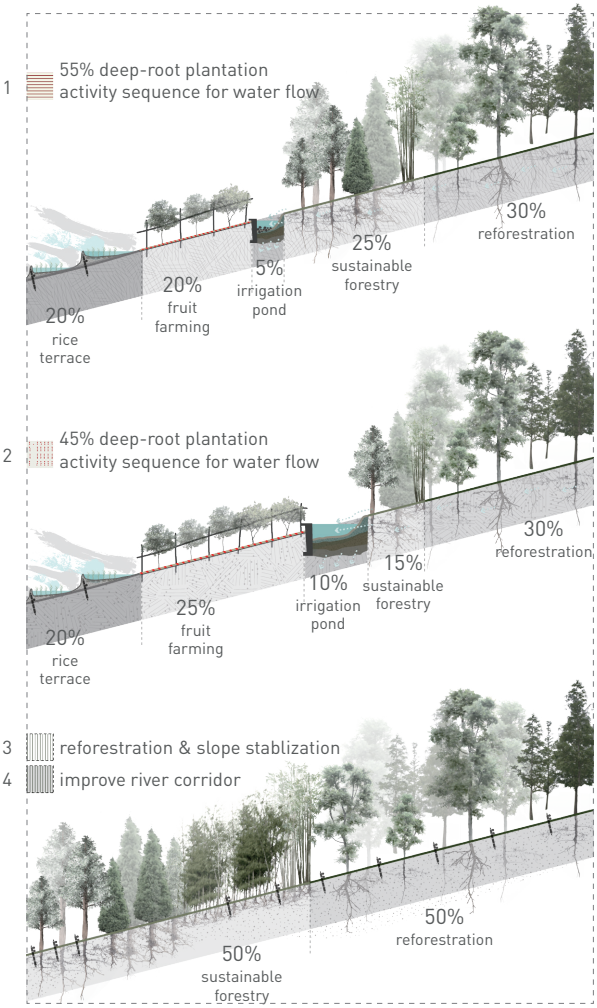


1. younger geology (Miocene) weaker land structure
2. older geology (Eocene) stabler land structure
3. avalanched area
4. river

CONNECTION BETWEEN ACTIVITIES



HYBRIDIZED ACTIVITY WITH APPROPRIATE PROPORTION



b. AUTONOMOUS WATER SYSTEM

village poulation: 850
slope agriculture area (within map): 25.4 ha

Dajia River upstream rainfall (CWB,MOTC) :
dry season: 125mm / month
rain season: 375mm / month

alpine area evaporation rate: ~ 20%

water consumption average (WRA, MOEA):
drinking water: 274 liter / person-day
dry farming: 1680 m^3 / ha-month
rice field: 800 m^3 / ha-month

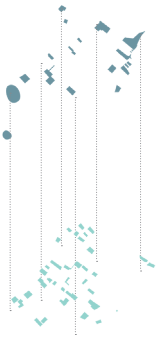
- public or public-oriented buildings
- private building for public/visitor service
- public-initiated water spaces
- private households joining rennovation
- DIY rain gardens

Instead of paying for easily destroyed (by rain) water facilities and result in chaotic pipes scattering the environment, the money could be invested in developing self-sufficient water system that provide and filter water, and in the meanwhile serves as public spaces. The first implementation can be led by local government to organize public or public-oriented actors such as schools, community center, and religious buildings (churches in the case of Huanshan Tribe). Space can be released by sharing facilities such as trucks, trolleys, tools, etc, instead every household owning one set of them. Then as the know-how and practical techniques are developed, the local residents are incentivized to renovate their houses with open spaces into rain gardens for their own drinking water supply. The water spaces built in the first phase (initiated by public) can turn into irrigation supply and waste water filtering, or other uses to provide more vitality input for the village.

WATER DEMAND / STORAGE SPACES (per month):

drinking water: ~ 8,000m^3

slope activity:
current situation ~ 20,320m^3
proposal ~ 13,110m^3



public-initiated water storage

surface area: 20,200m^2

assume half used for water spaces, with 1m depth -> 10,100m^3
enough for 1 month drinking water
-> surplus for agriculture irrigation

joined DIY water storage

surface area: 18,502 m^2

assume half used for water spaces, with 1m depth -> 9,251 m^3
enough for 1 month drinking water
-> surplus for agriculture irrigation

REQUIRED WATER COLLETING SURFACE AREA:

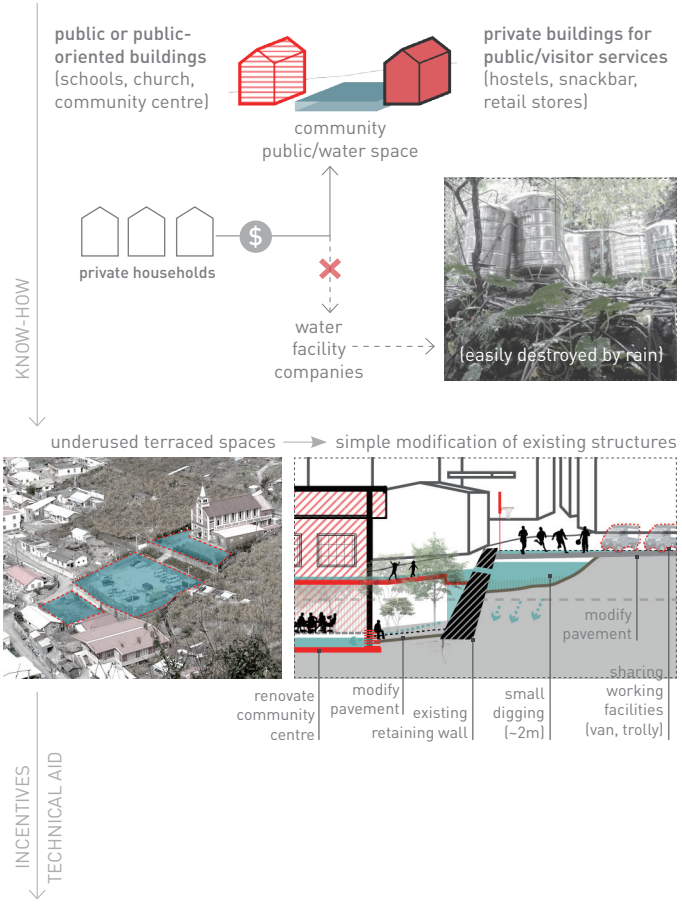
drinking water:
dry season: 64,000 m^2 rain season: 21,300 m^2

slope activity (proposal):
dry season: 104,880 m^2 rain season: 34,960 m^2

total area proportion:
dry season: 4.2 % rain season: 1.4%

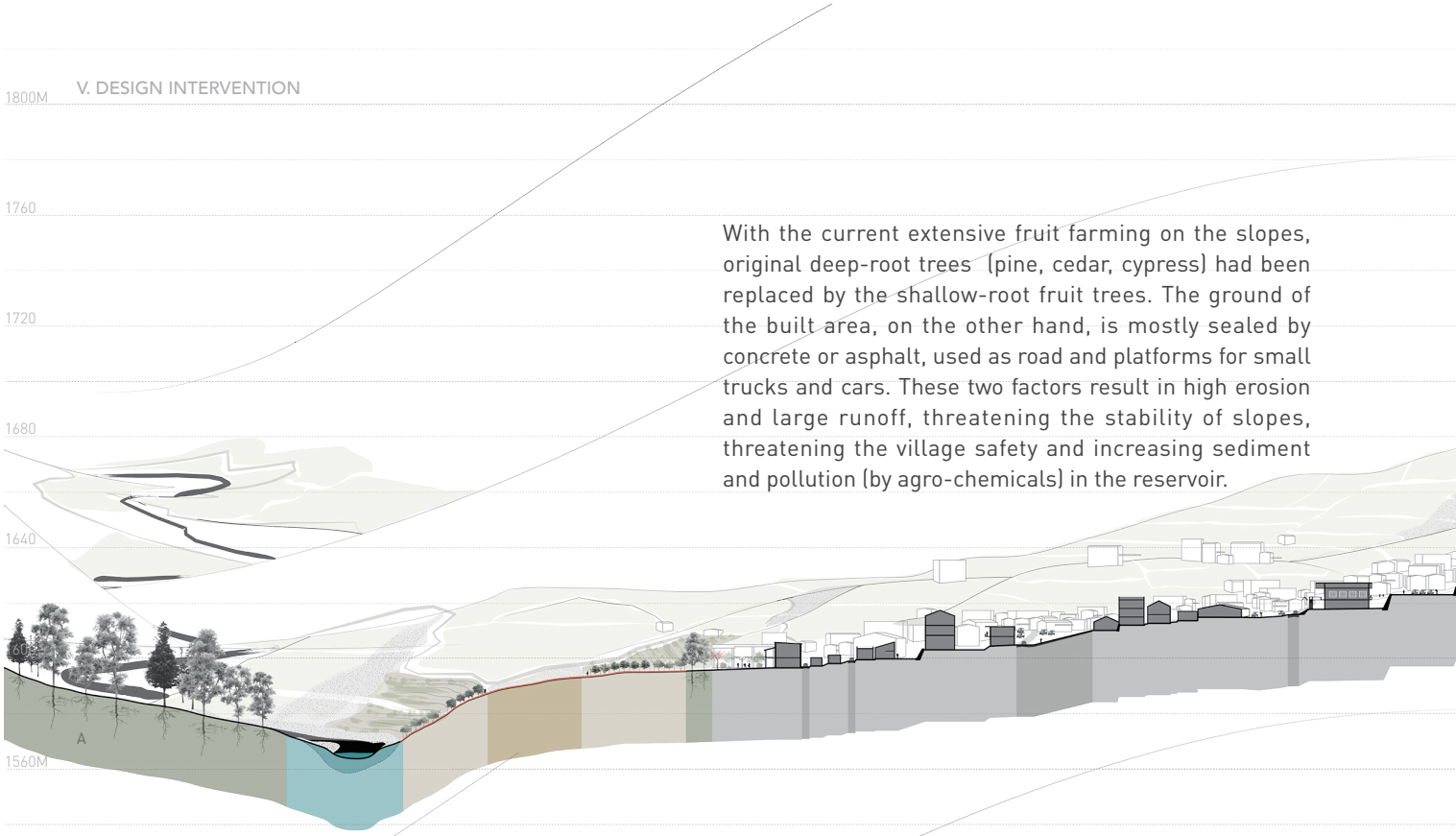
Even in dry season, required collecting surface only take 4.2% of the zoom-in site (4 million m^2), showing that land-use intensity is good enough for maintaining sufficient water supply. With appropriate design, a self-sufficient water system is achievable.

WATER SYSTEM AS PUBLIC SPACES

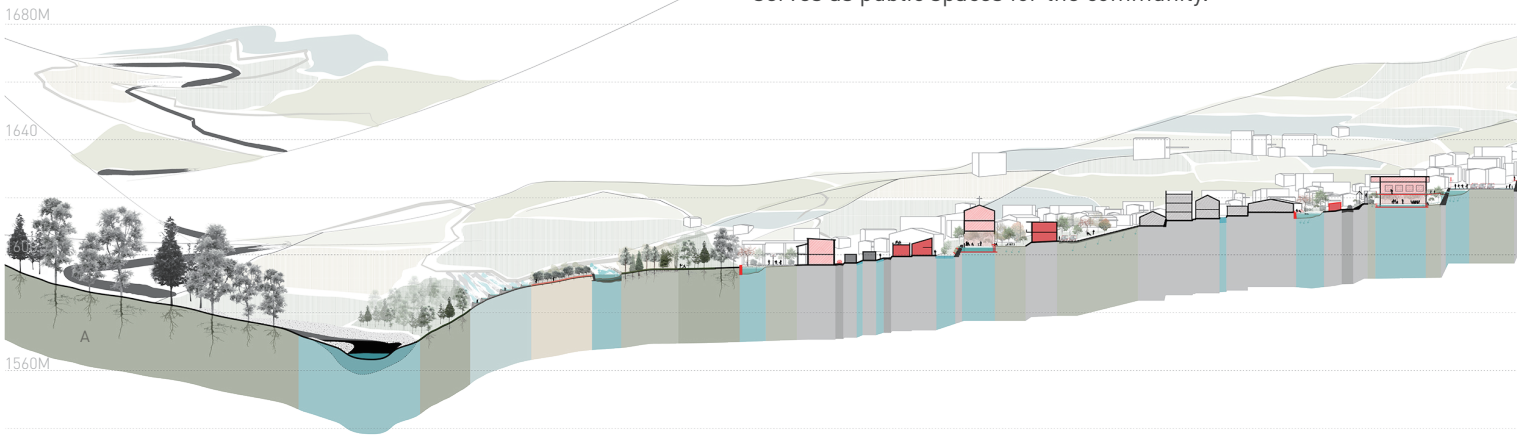


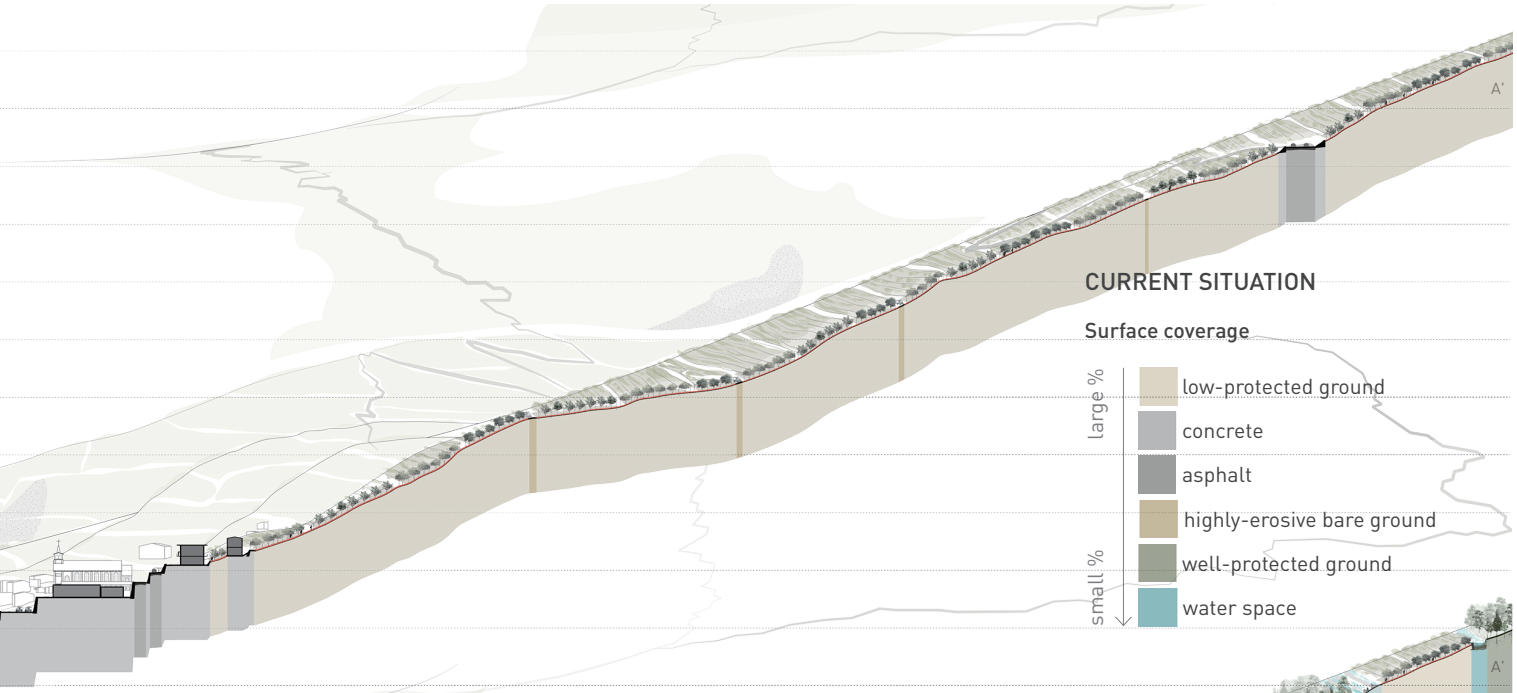
WATER SYSTEM IN DIY GARDENS

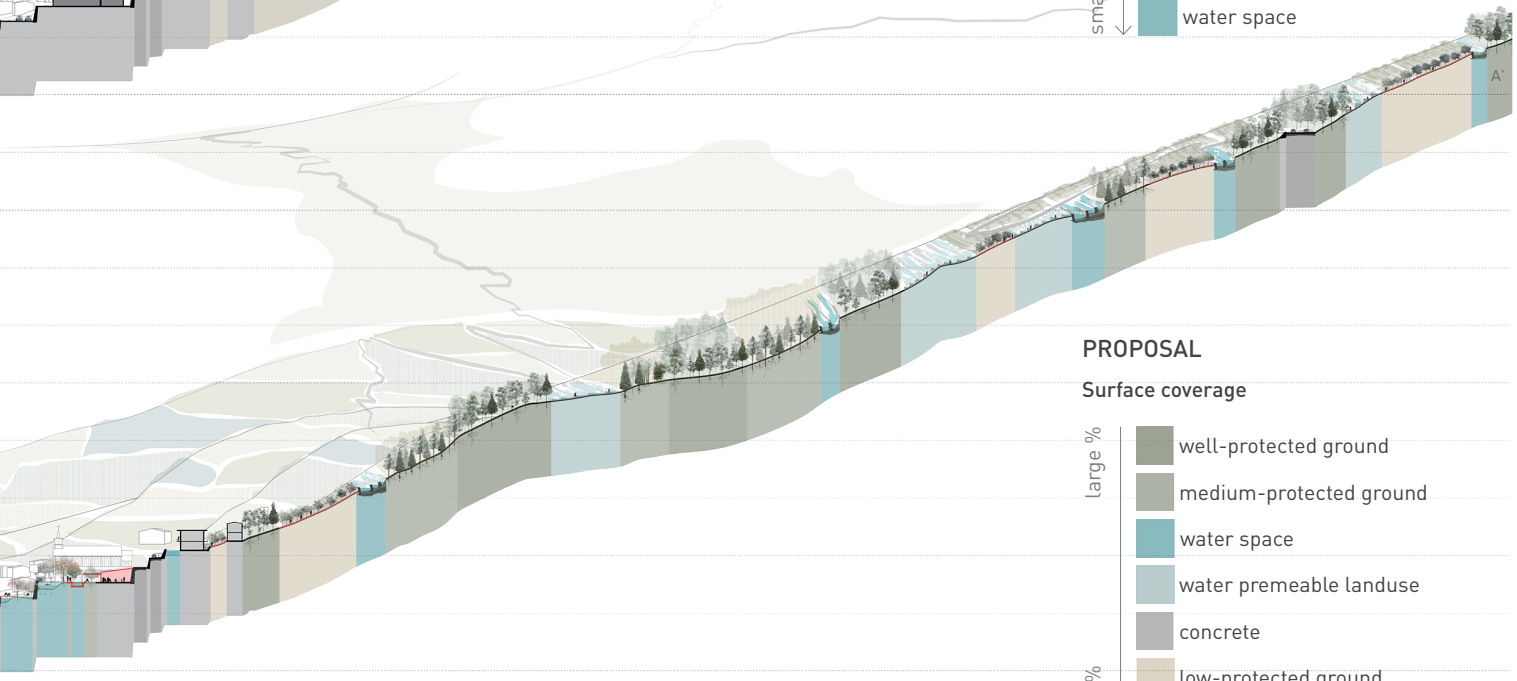
With the current extensive fruit farming on the slopes, original deep-root trees (pine, cedar, cypress) had been replaced by the shallow-root fruit trees. The ground of the built area, on the other hand, is mostly sealed by concrete or asphalt, used as road and platforms for small trucks and cars. These two factors result in high erosion and large runoff, threatening the stability of slopes, threatening the village safety and increasing sediment and pollution (by agro-chemicals) in the reservoir.



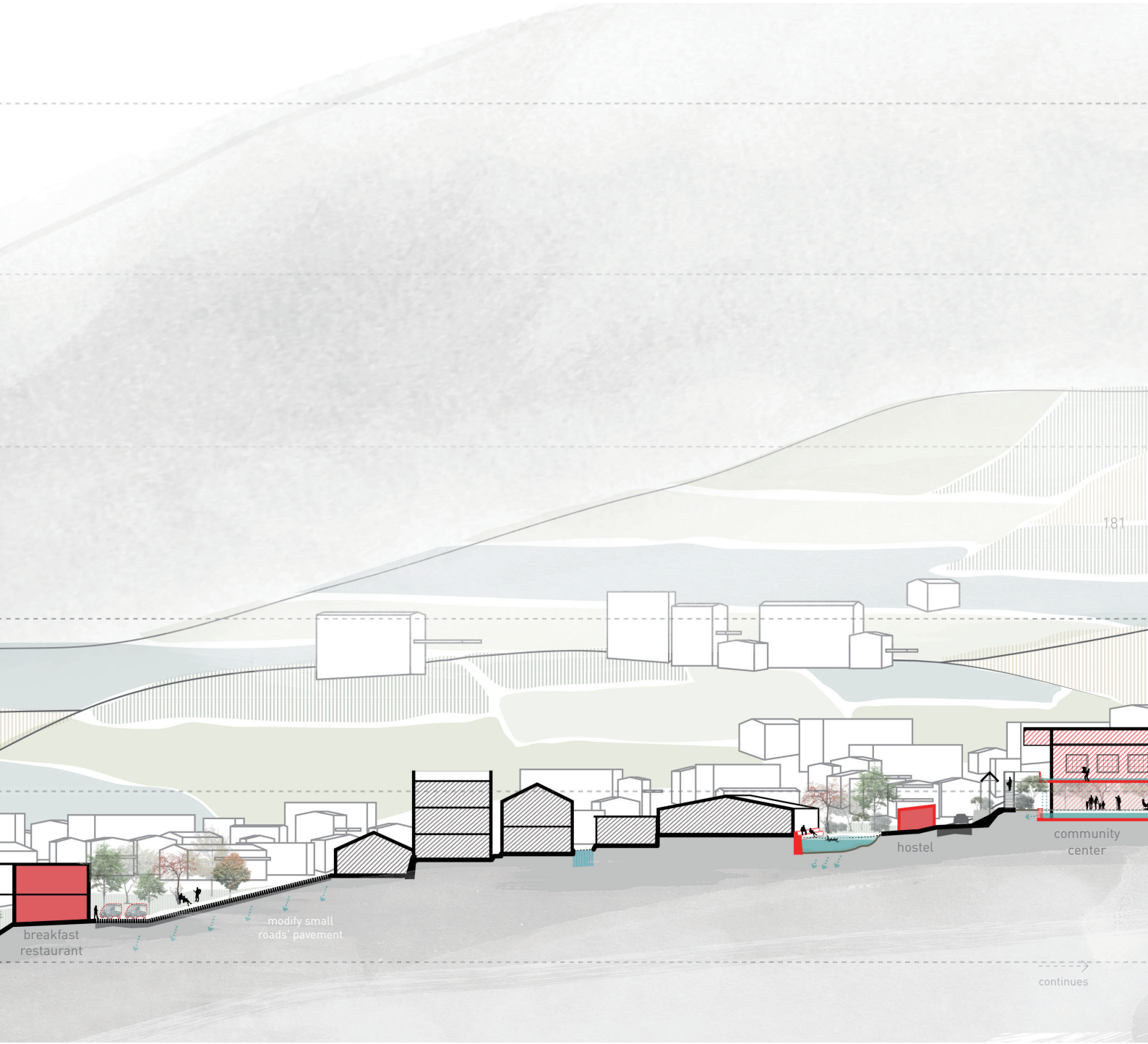
The proposal will achieve a more harmonious proportion of different slope activities, with more plantation coverage to reduce erosion, and spaces to keep water, which also serves as public spaces for the community.

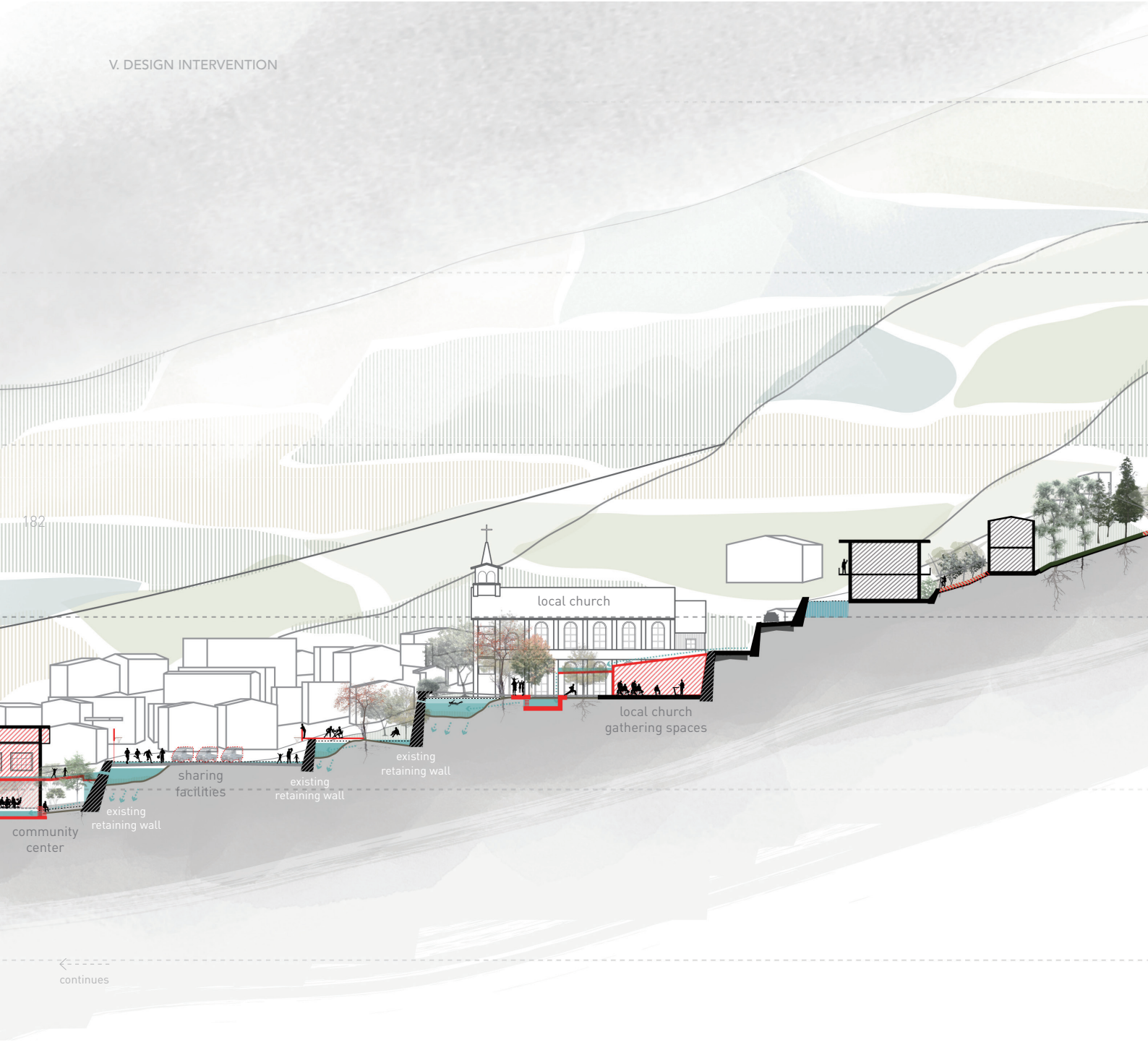



A'
CURRENT SITUATION
Surface coverage
large %
small %
low-protected ground
concrete
asphalt
highly-erosive bare ground
well-protected ground
water space

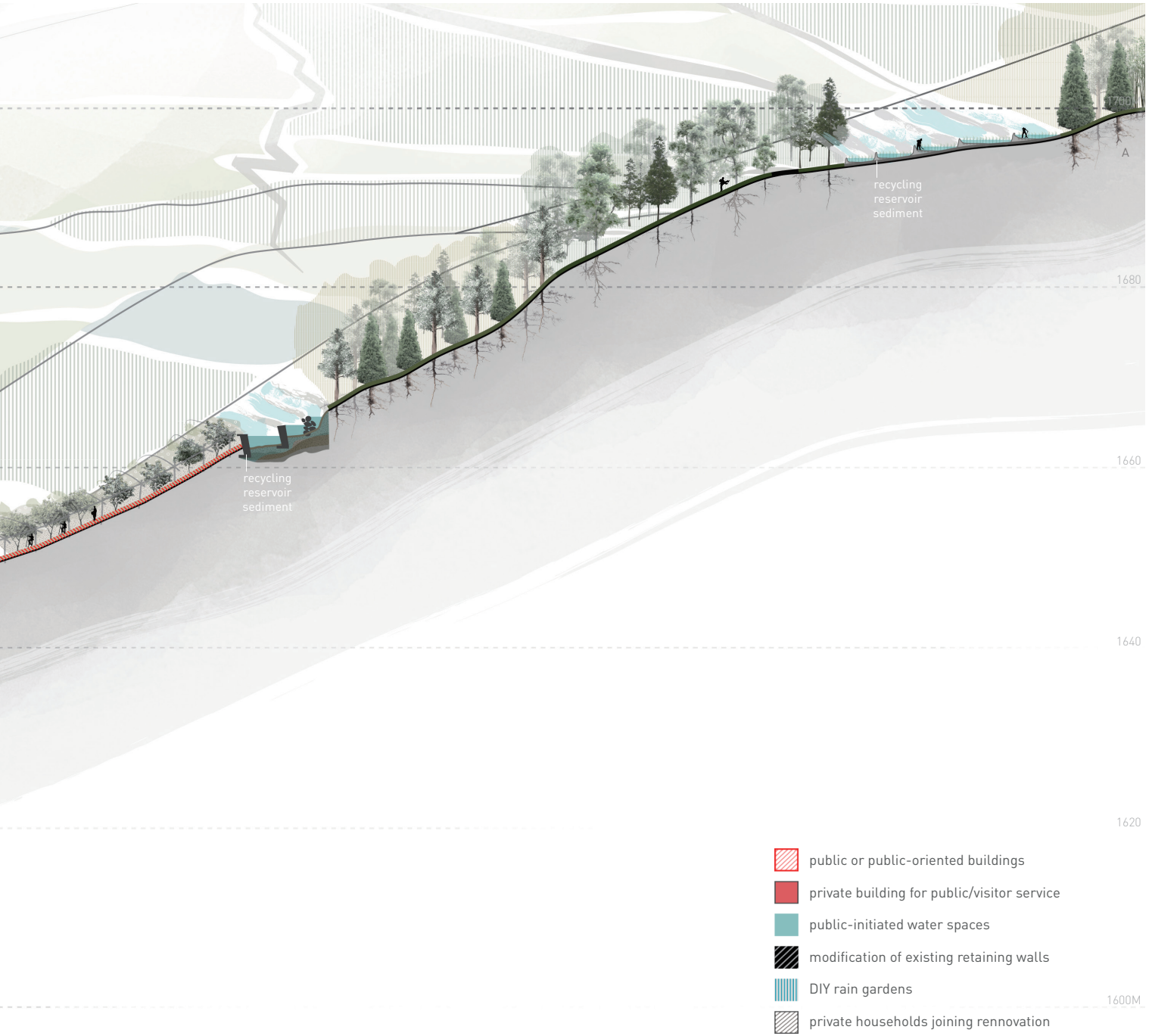

A'
PROPOSAL
Surface coverage
large %
small %
well-protected ground
medium-protected ground
water space
water premeable landuse
concrete
low-protected ground
asphalt


1700M
1680
1660
1640
1620
1600M
A
Pingdeng
Elementary
School
lodging / farmstay
existing
retaining wall
local church


breakfast
restaurant
modify small
roads' pavement
hostel
community
center
continues

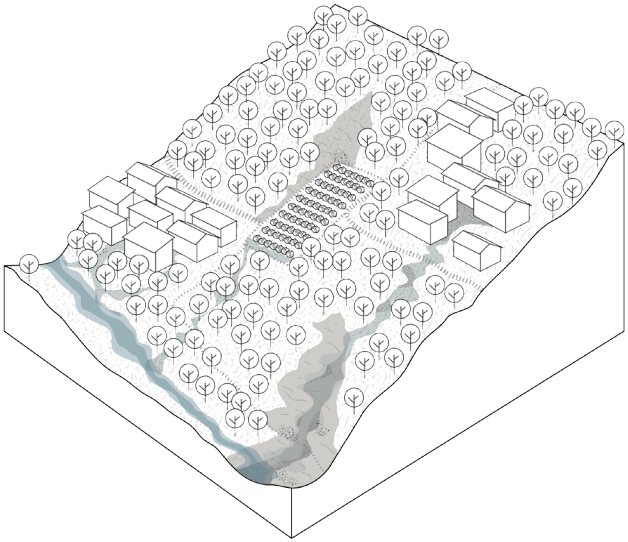

local church
local church
gathering spaces
existing
retaining wall
existing
retaining wall
sharing
facilities
existing
retaining wall
community
center

continues


1700M
A
recycling
reservoir
sediment
1680
recycling
reservoir
sediment
1660
1640
1620
1600M
public or public-oriented buildings
private building for public/visitor service
public-initiated water spaces
modification of existing retaining walls
DIY rain gardens
private households joining rennovation

LANDSCAPE TRANSFORMATION

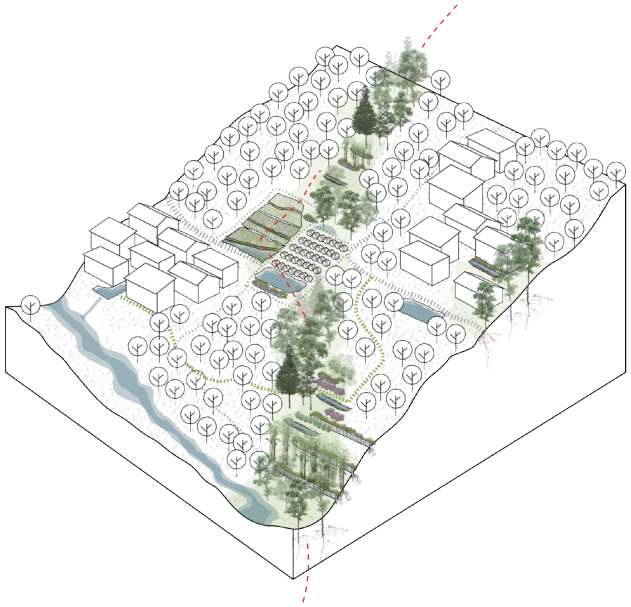
TODAY



2030 FIRST PHASE TRANSFORMATION

Large scale: Mitigation of the urgent problems by starting agrarian activity hybridization and slope stabilization along the designed corridor axis.

Local scale: Public-initiated water retention spaces.



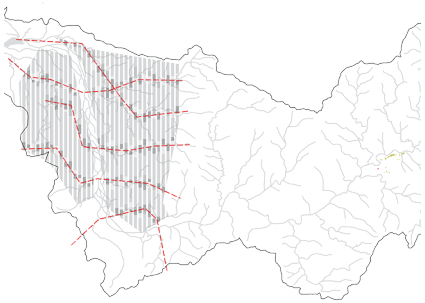
FINAL IMAGE

Incrementally transformed slope activities.

Incentivised private-joined renovation and DIY water-gardens.

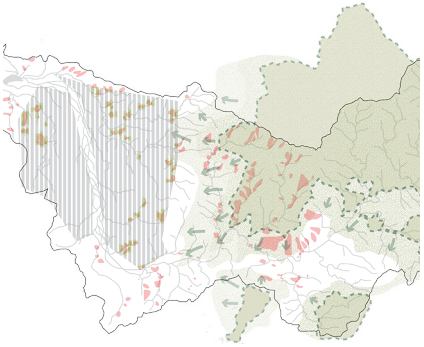
V-II. Design Interventions at Midstream Areas

OPERATIVE LANDSCAPE STRUCTURES



CORRIDOR

Hybridization agriculture initiated from the extension of vertical corridor along streams.

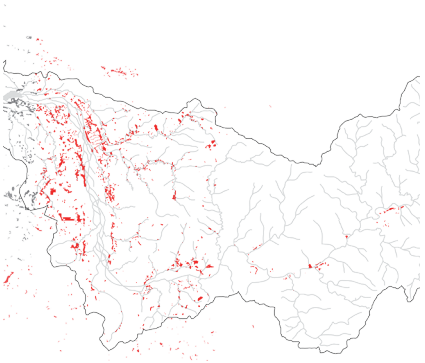


SLOPE

Slope stabilization as starting forestation and prosper forestry to stop agricultural sprawl on th the hills.

MOBILITY

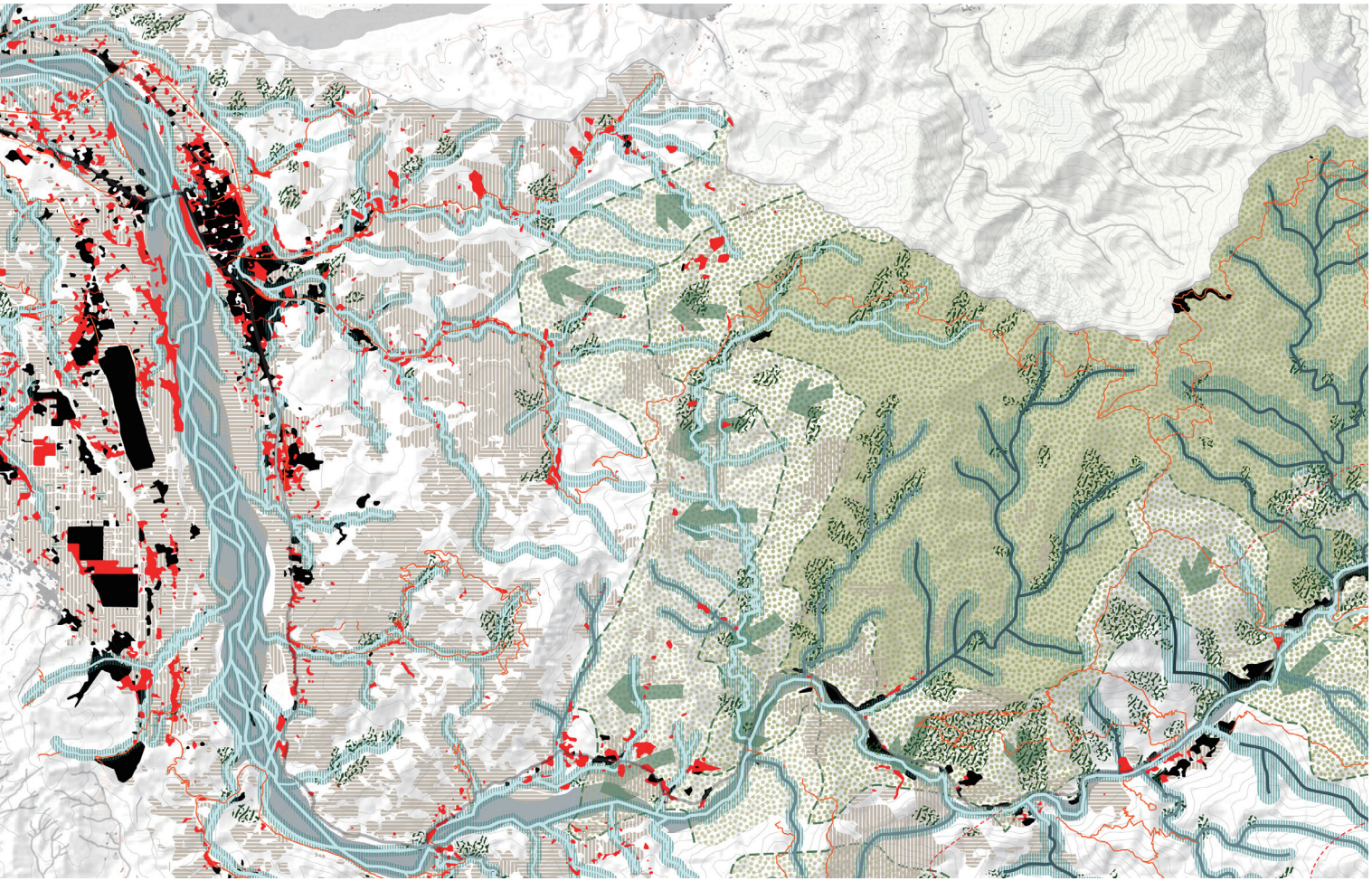
Forestry trails as ecotourism paths; product shipping support by technology & machinery.



PUBLIC SPACE

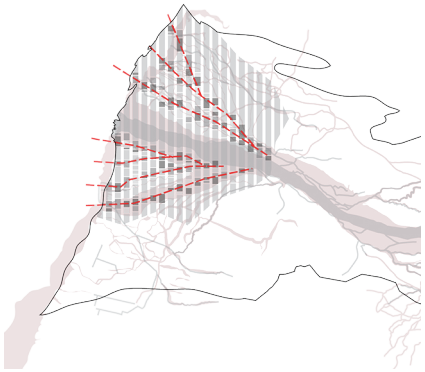
Water-collection and storage at empty spaces and fallowed fields.

fig.140 Landscape operative structures at midstream area.
Source: map & diagrams made by the author.

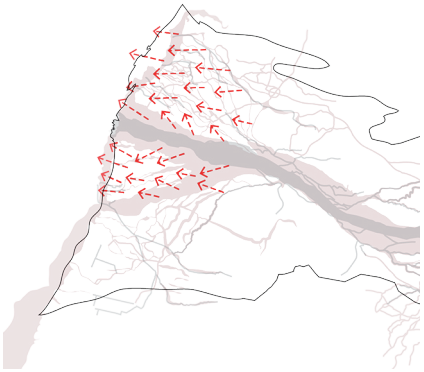


V-III. Downstream intervention: Kaomei areas

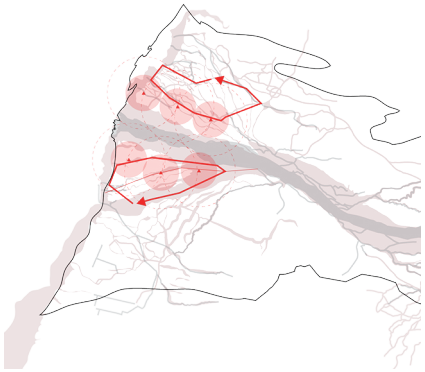
OPERATIVE LANDSCAPE STRUCTURES



CORRIDOR
Hybridization agriculture initiated from the courses of historical rivers



SLOPE
Micro-topography define flooding area and hidden water flow (hyporheic zone).



MOBILITY
Circular route of multi-functional public transport stops.

PUBLIC SPACE
Water-collection at empty spaces and fallowed fields.

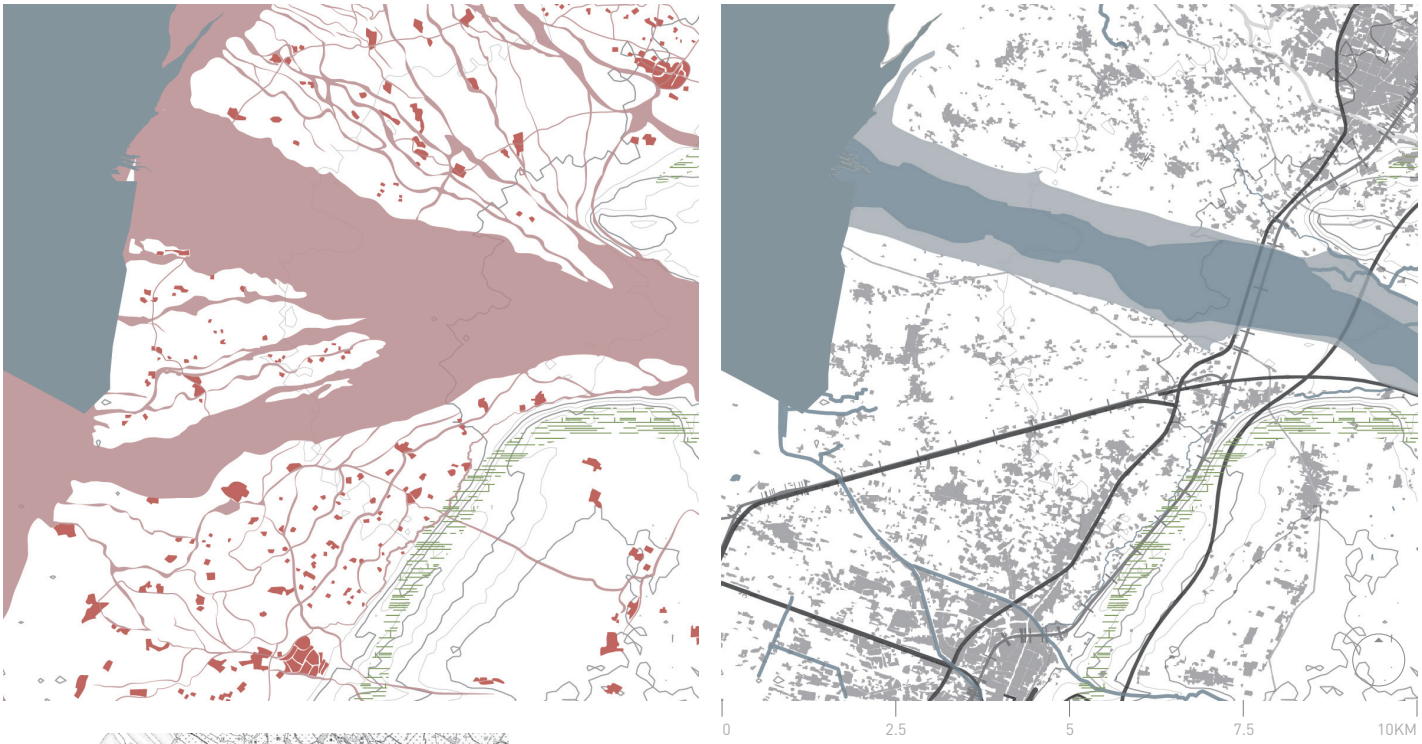
fig.140 Landscape operative structures at downstream area.
Source: map & diagrams made by the author.


200 M

fig.141 Maps of Kaomei area in 1890s (left) and today (right). Source: made by the author based on data from GIS database, google maps, and historical maps.

1850s

TODAY



contact of mountain and plain
historical river courses
historical urbanized area

primary roads
railway
contact of mountain and plain
current river courses
flooding plain
urbanized area

fig.142 Historical map of Kaomei area in 1898. Source: Tanwan 100 Years Map Centre [online] available at: http://gissrv4.sinica.edu.tw/gis/taichung.aspx [accessed 18. Apr. 2017]

fig.141 Maps of Kaomei area in 1890s (left) and today (right). Source: made by the author based on data from GIS database, google maps, and historical maps.

fig.143 Aerial photo of Kaomei area.
Source: www.gaomei.com.tw/gaomei

At the downstream area of Dajia River, settlement began with close relation to the river courses for agriculture irrigation and drinking water. Today, though living next to the water, the supply of water for daily life activities are actually provided by centralized infrastructures transporting water from the Shih-gang Dam 20 kilometers away. With the increasing frequent drought and the water policy prioritizing industrial platforms, farmers either extract groundwater on their own or force to fallow their fields. Besides, the hard-engineered dikes along the coastline and river-mouth has separated the area completely from the river. The current water infrastructure acts as a barrier between nature and human habitation.

OBSERVATIONS AT THE DOWN-STREAM AREAS

Agricultural paddy fields

fig.144 Photo of agricultural paddy fields in Kaomei area at the downstream of Dajia river. Source: Google street view.

Empty lands

fig.145 Photos of empty lands in Kaomei area, at the down-stream of Dajia river. Source: Google street view.

Fallowed fields

fig.146 Photos of fallowed fields in Kaomei area, at the down-stream of Dajia river. Source: f14mp5 (https://f14mp5.wordpress.com/); Google street view.

Regional design

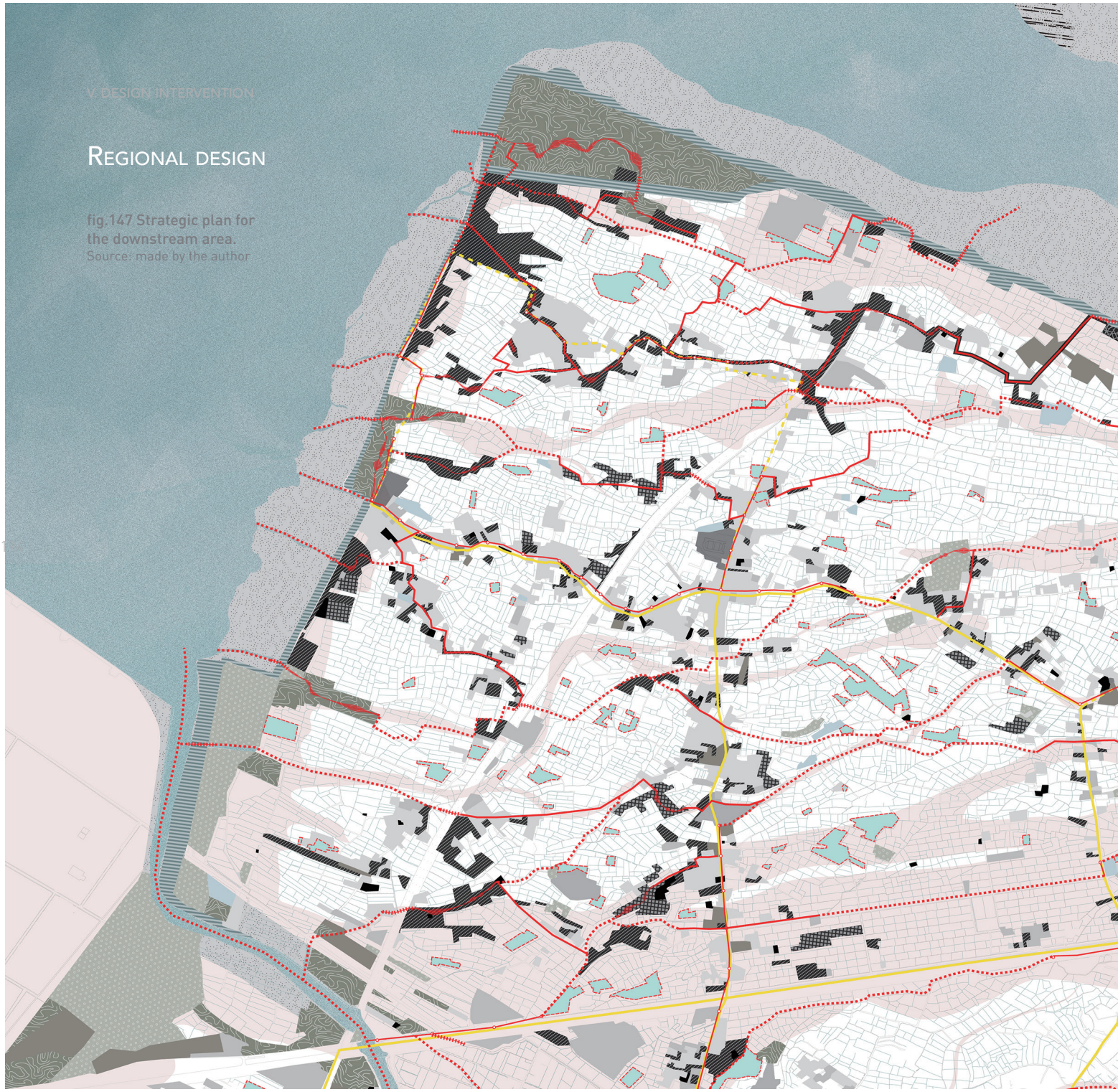
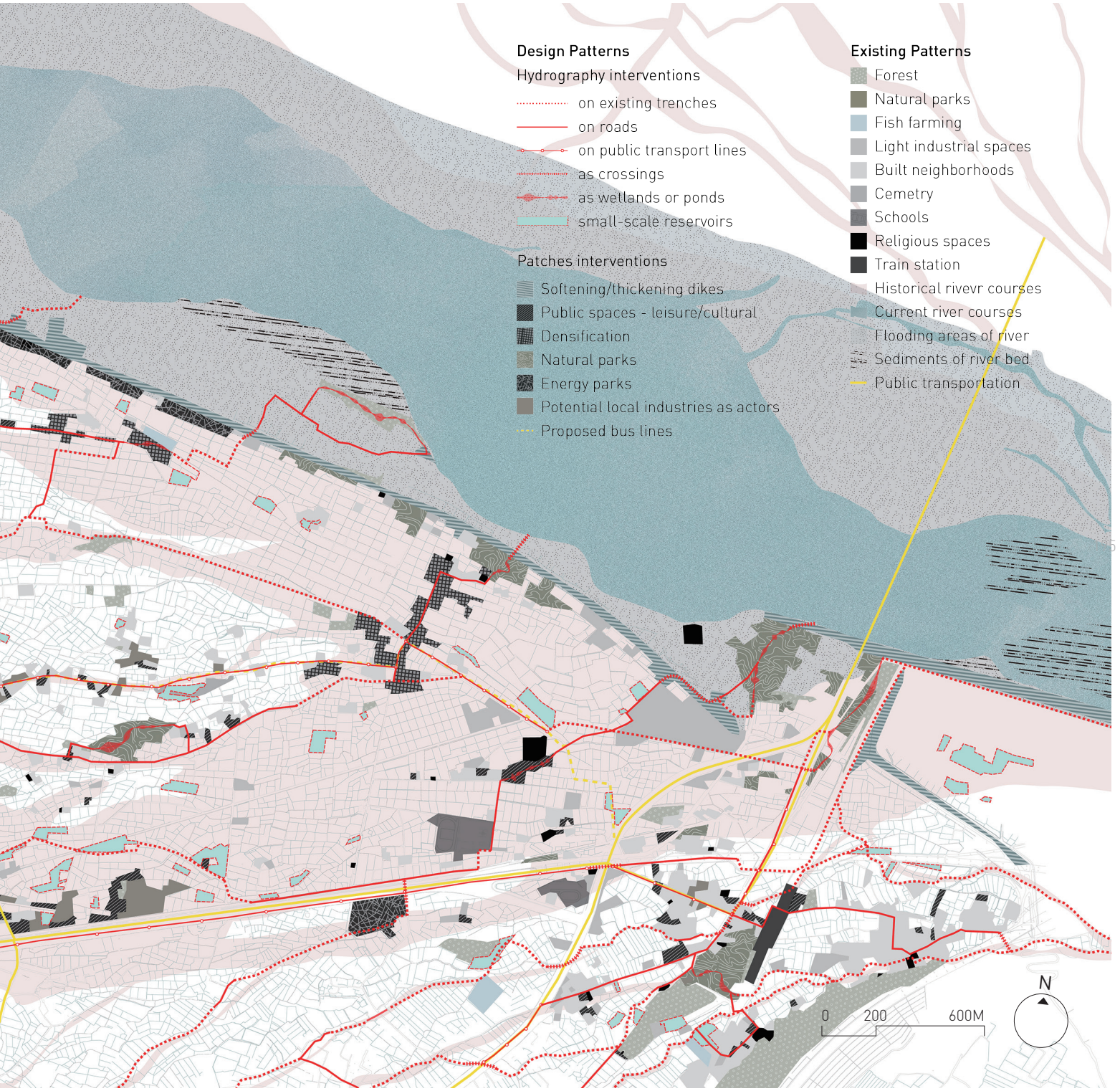
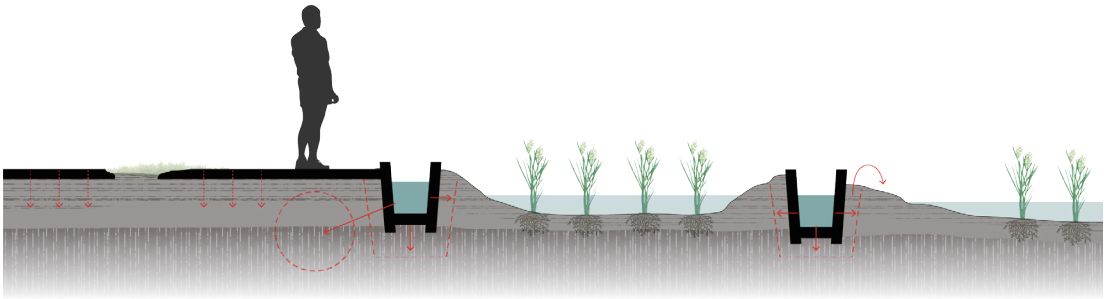


fig.147 Strategic plan for the downstream area.
Source: made by the author


Design Patterns
Hydrography interventions
on existing trenches
on roads
on public transport lines
as crossings
as wetlands or ponds
small-scale reservoirs
Patches interventions
Softening/thickening dikes
Public spaces - leisure/cultural
Densification
Natural parks
Energy parks
Potential local industries as actors
Proposed bus lines
Existing Patterns
Forest
Natural parks
Fish farming
Light industrial spaces
Built neighborhoods
Cemetry
Schools
Religious spaces
Train station
Historical rivevr courses
Current river courses
Flooding areas of river
Sediments of river bed
Public transportation
N
0
200
600M

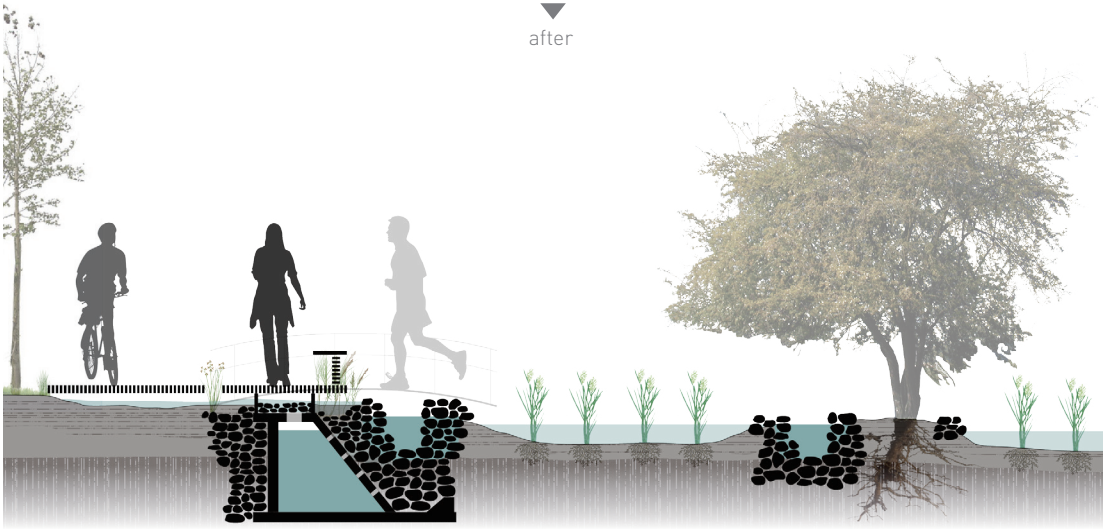
HYDROGRAPHICAL INTERVENTIONS

On irrigation / drainage

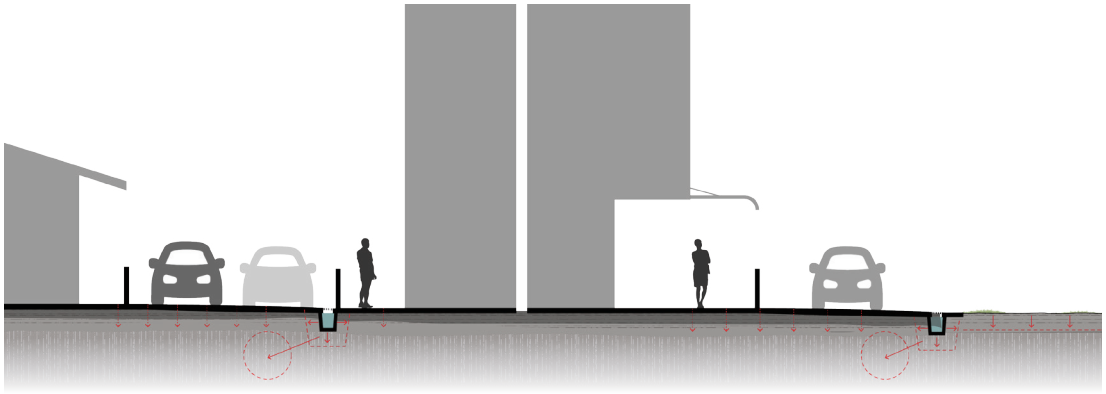


before

after

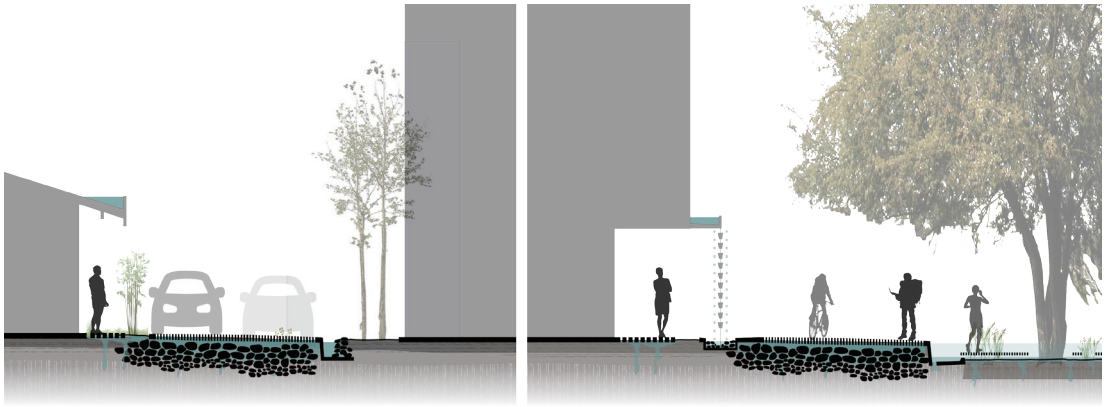


On roads

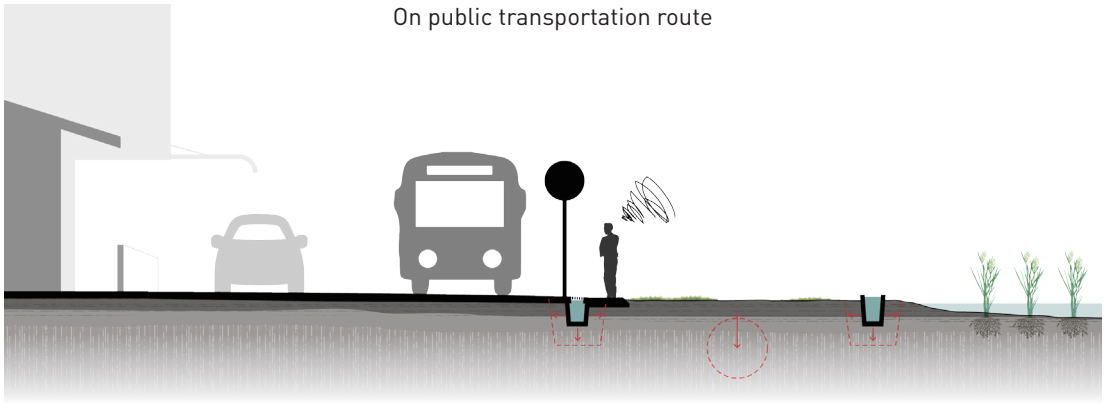


before

after

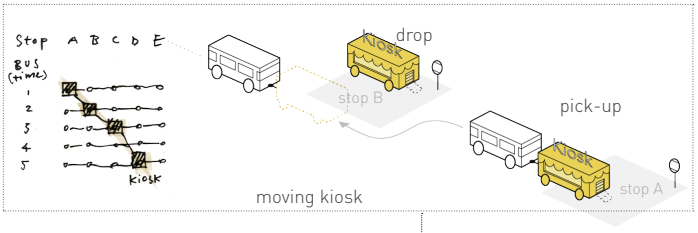


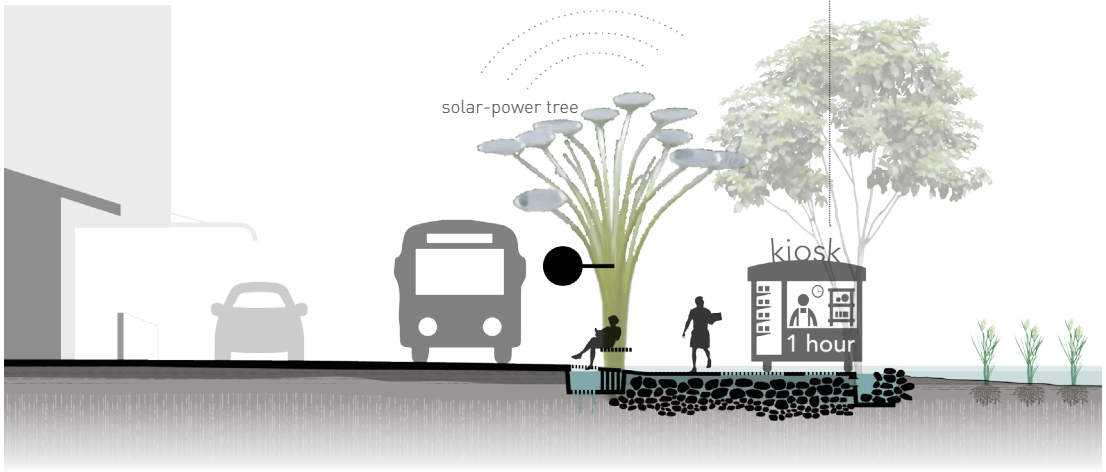
On public transportation route



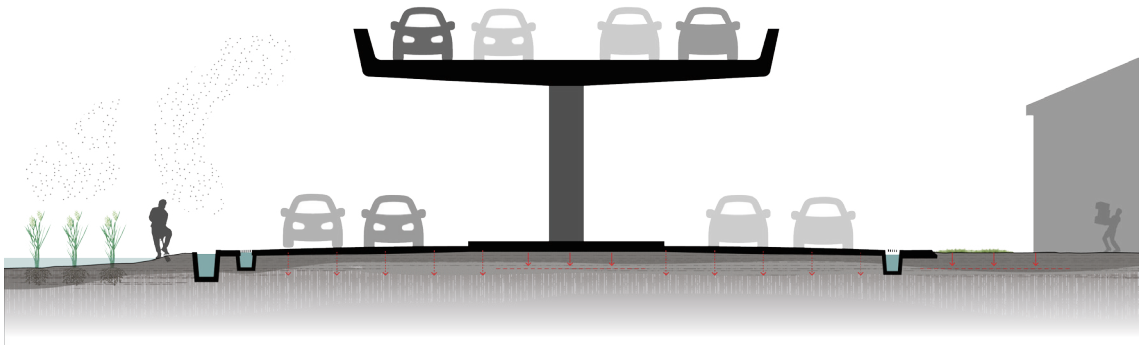
before

after



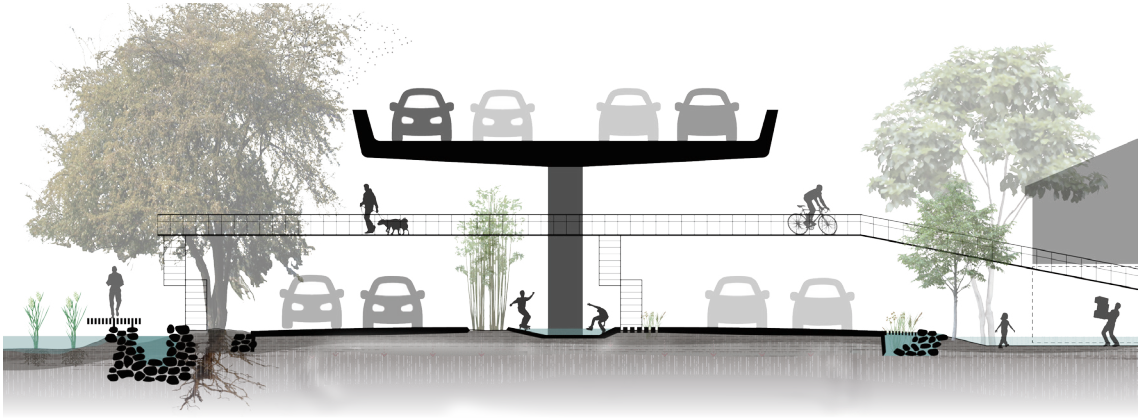


As crossings

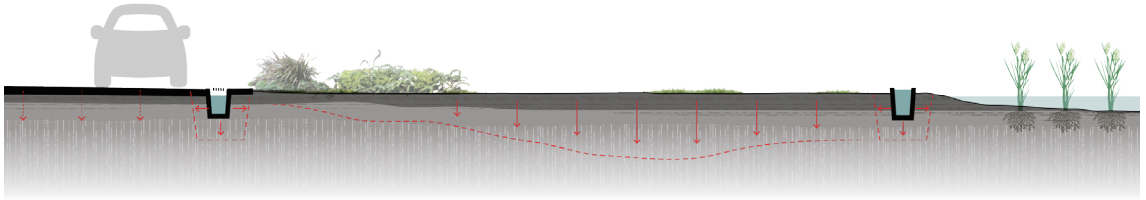


before

after

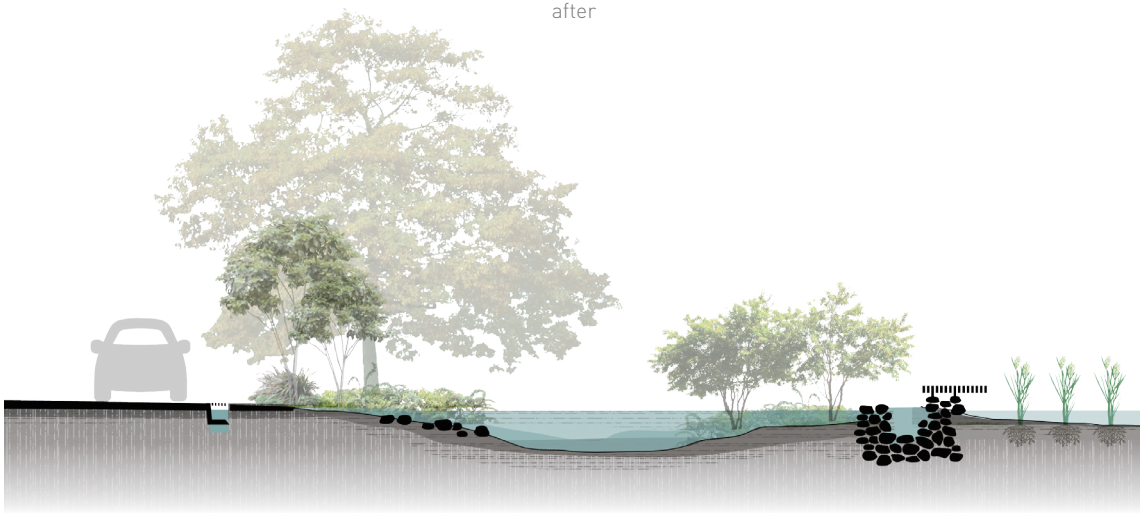


As wetland or ponds

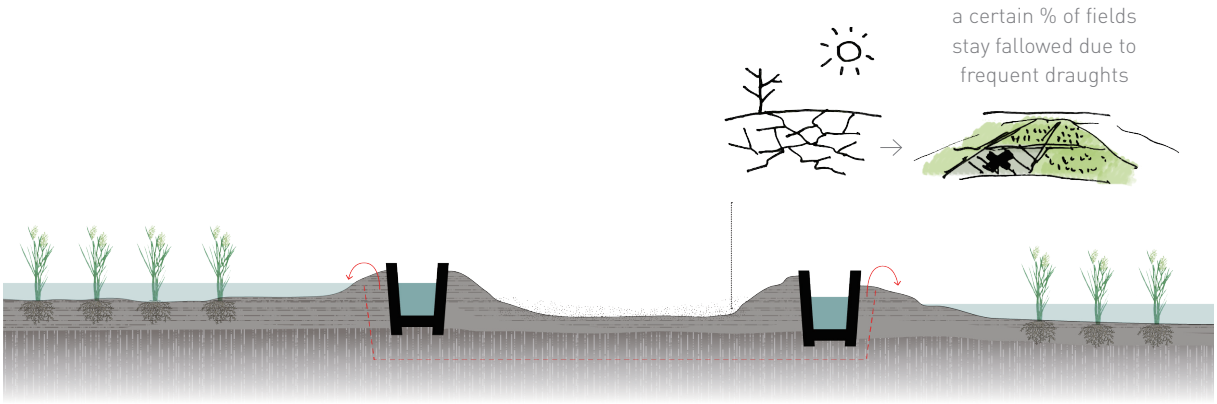


before

after

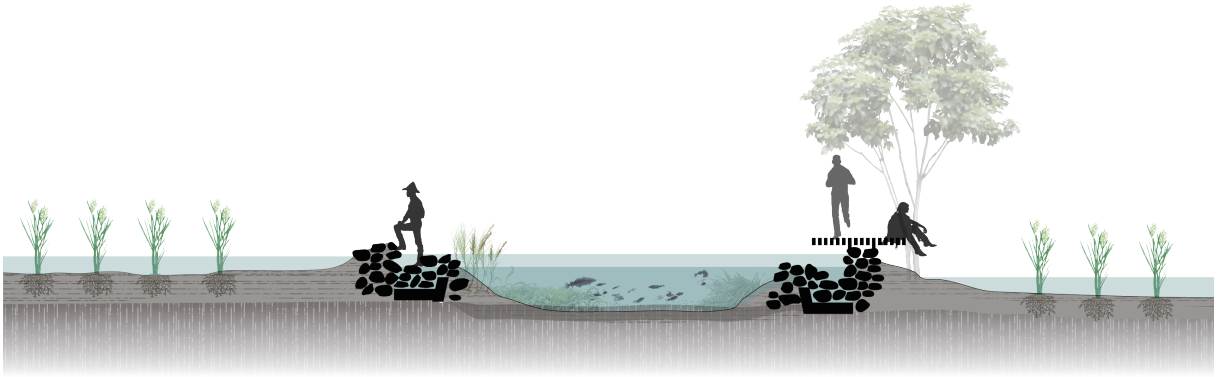


As small-scale reservoirs



before

after



DESIGN ELABORATION: KAO-PEI NEIGHBORHOOD

CURRENT SITUATION

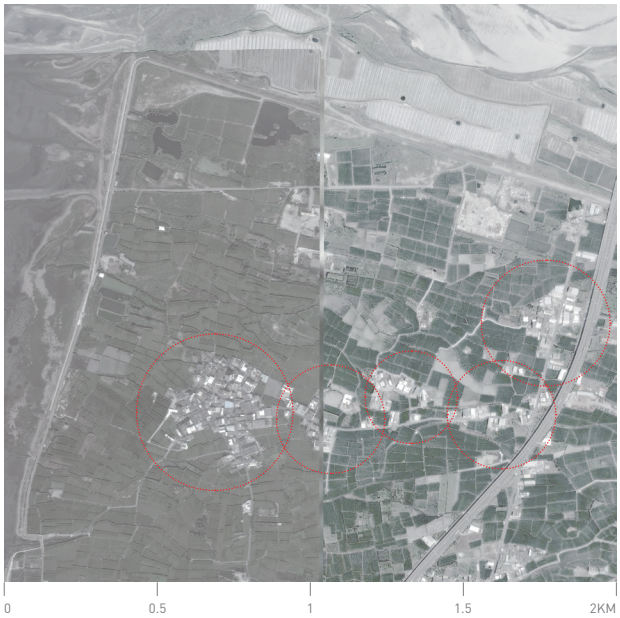


fig.148 Photo of marginalized condition of Kaopei neighborhoods. Source: Google street view.

Developed from five agricultural settlements, the living environment of Kaopei neighborhood currently exhibits a marginalized agricultural village, with poor accessibility and nearly no public spaces, not even local commercial services. The residents' daily-life needs rely on ordering from retailers or street venders. The total population is around 1500 with a trend of aging, young leaving, and decreasing. Observing the streets of Kaopei neighborhood, many empty spaces can be found, such are platforms for grain sunning, open spaces in front of religious buildings, courtyard of households, etc. Most of these empty are concrete-base, which has the potential to be incentivised with transformation for small rainwater retention spaces. The location of being close to Kaomei protected wetland and Dajia river mouth give the potential for the neighborhood to act as the transition interface between human-scale and wild-nature landscapes.

fig.149 Photo of traditional houses in deteriorated condition.
Source: Google street view.

fig.150 Photo empty lands used for grain sunning.
Source: Google street view.

fig.151 Photo of small religious temples in the fields.
Source: Google street view.

fig.152 Photo showing the segregation of neighborhoods by mobility infrastructures. Source: Google street view.

CONCEPTUAL SCHEME

a. RECOVERING HISTORICAL RIVER COURSES

The strategy is to encourage rice fields along the historical river routes (now turned into trenches) to deepen their fields by 1.2 meter, and turned into growing aquatic vegetables (fig.153) (which also has high economic value), and the changed leveling of ground will allow around 1 meter depth for flooding from intense rainfall. Other strategies include turning empty fields into irrigation pond, and intervention as water public spaces. These will be done first by incentives from the policy, which can release around 46% of the extreme flooding situation (600mm rain in 24hr).

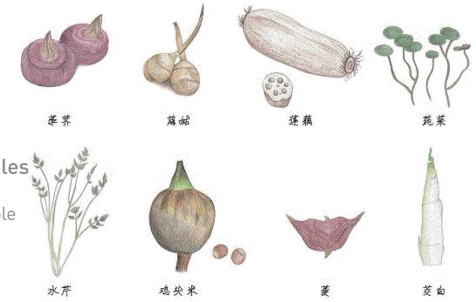
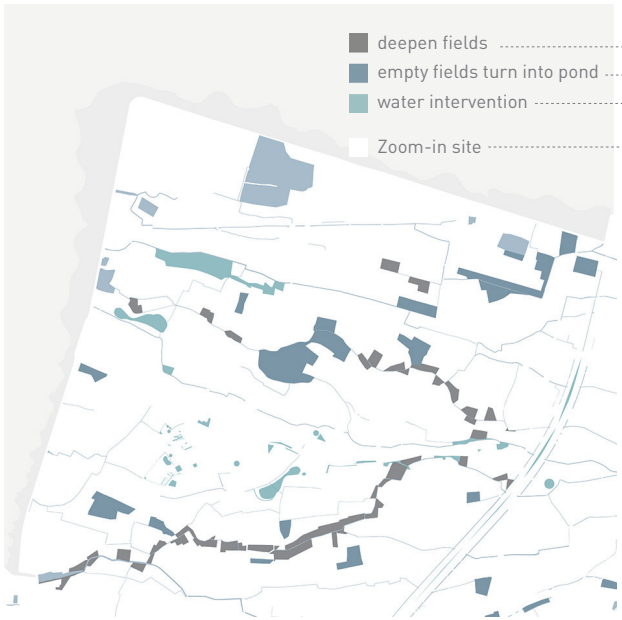


fig.153 Aquatic vegetables
Source: Daidaichuancheng New Media [online] available at http://sns.91ddcc.com/ [accessed 13.Jun.2017]



	GROUND LEVEL	AREA	WATER QUANTITY
deepen fields	- 1.2M	38,800 m^2	38,800 m^3 (1m floodable)
empty fields turn into pond	- 2.5M	64,500 m^2	97,000 m^3
water intervention	- ~1M	18,700 m^2	18,700 m^3
			322,800m^3
Zoom-in site		1,391,000 m^2	695,500m^3 (600mm-24hr: ~0.5m flooding)

46% released by + spaces for water

54% to be achieved by:

- joined-DIY water gardens
- improving permeability of pavement
- runoff slowing-down by plantation
- better discharge water routes

b. COLLABORATION BETWEEN ACTIVITIES

Densification of opportunities for water flows and storage in spaces within the community can be achieved through incentivizing cooperation of local actors, such as farmers, local industrial factory owners (which are very often illegal or unregistered), residents of deteriorated houses. Together these intervened patches recover the historical river courses, which will work as the vitality vein for the living environment. The design of potential patches can be categorized as the following seven typologies:

❶ Religious place + plaza + agricultural fields

❷ Grain sunning places + residential buildings

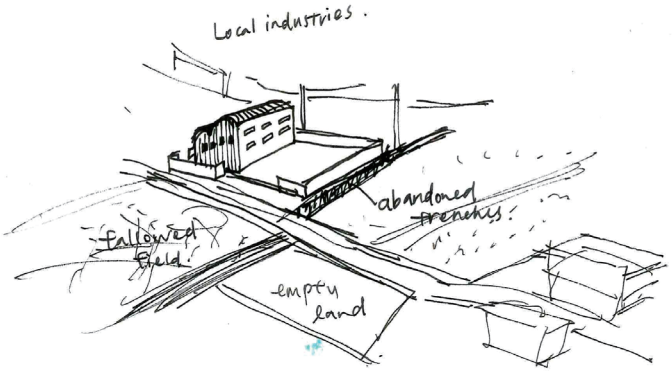
❸ Small industrial factory + multifunctional working area + fallowed fields

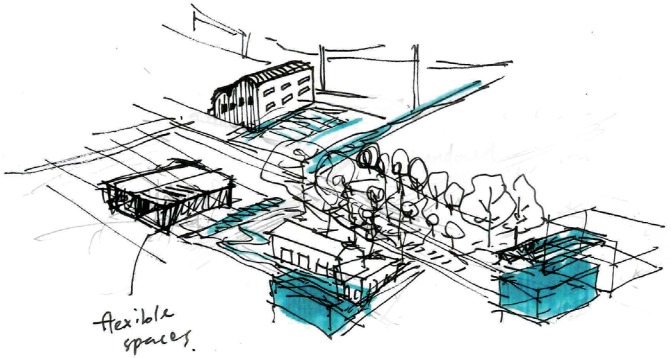
❹ Traditional houses in deteriorated state + courtyard spaces

❺ New/existing public transportation stops + empty lands

❻ Elevated motorway + agricultural fields

❼ Hard engineered dike along low-used road + empty land, fallowed fields, or salinated lands





DESIGN INTERVENTION PATCHES

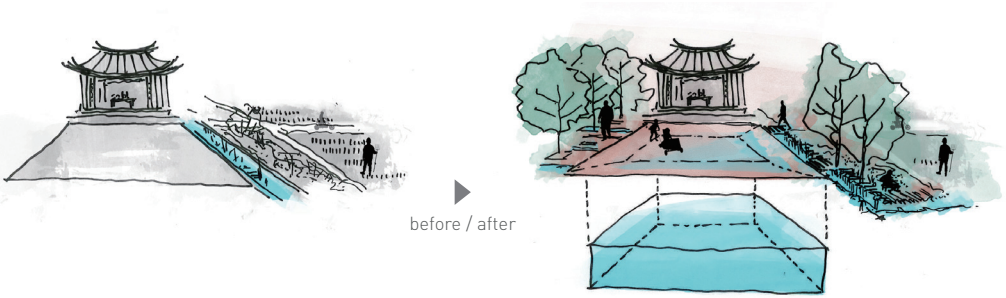
❶ RELIGIOUS PLACE + PLAZA + AGRICULTURAL FIELDS

Hydrography interventions

- on trenches
- small reservoirs

Operative structures

- corridor
- public space



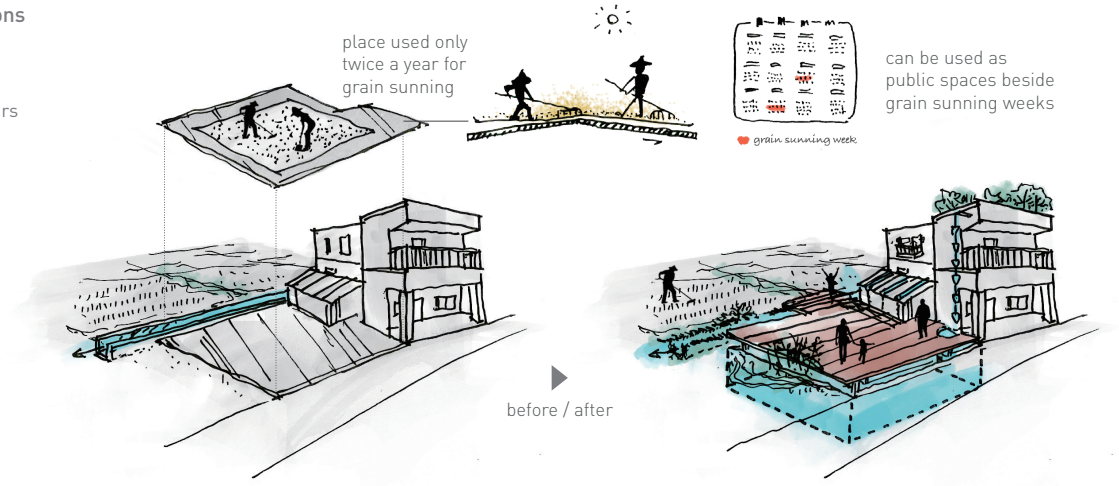
❷ GRAIN SUNNING PLACES + RESIDENTIAL BUILDINGS

Hydrography interventions

- on roads
- on trenches
- small reservoirs

Operative structures

- corridor
- public space



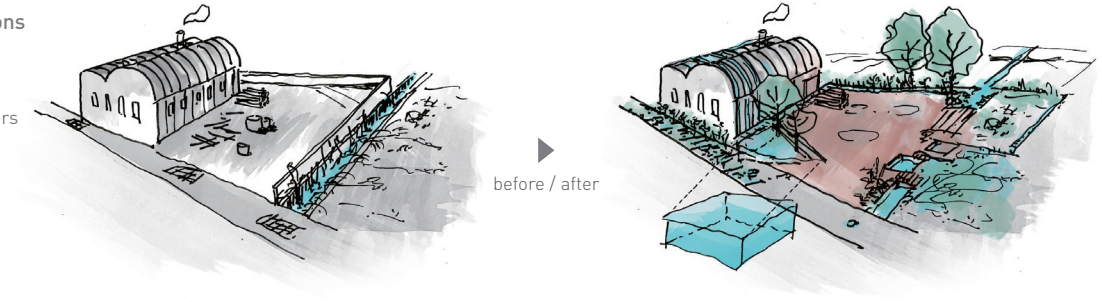
❸ SMALL INDUSTRIAL FACTORY + MULTIFUNCTIONAL WORKING AREA + FALLOWED FIELDS

Hydrography interventions

- on roads
- on trenches
- small reservoirs

Operative structures

- corridor
- public space



❹ TRADITIONAL HOUSES IN DETERIORATED STATE + COURTYARD SPACES

Hydrography interventions

- small reservoirs

Operative structures

- corridor
- public space

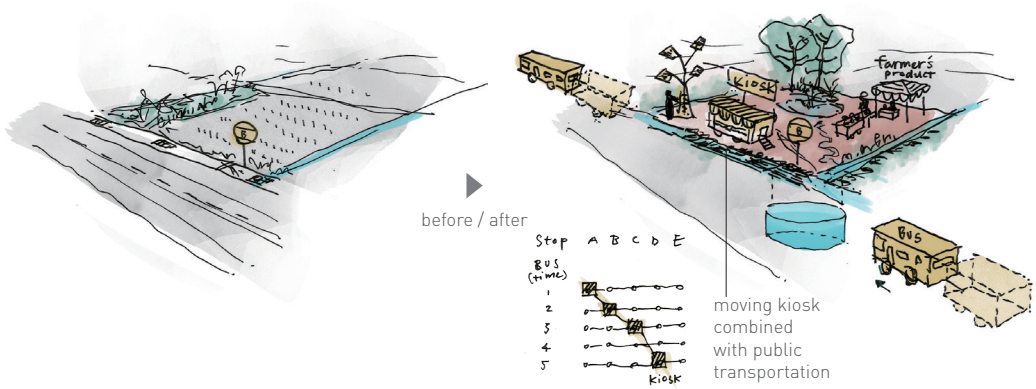
❺ NEW/EXISTING PUBLIC TRANSPORTATION STOPS + EMPTY LANDS

Hydrography interventions

- on roads
- on transport route
- small reservoirs

Operative structures

- corridor
- mobility
- public space



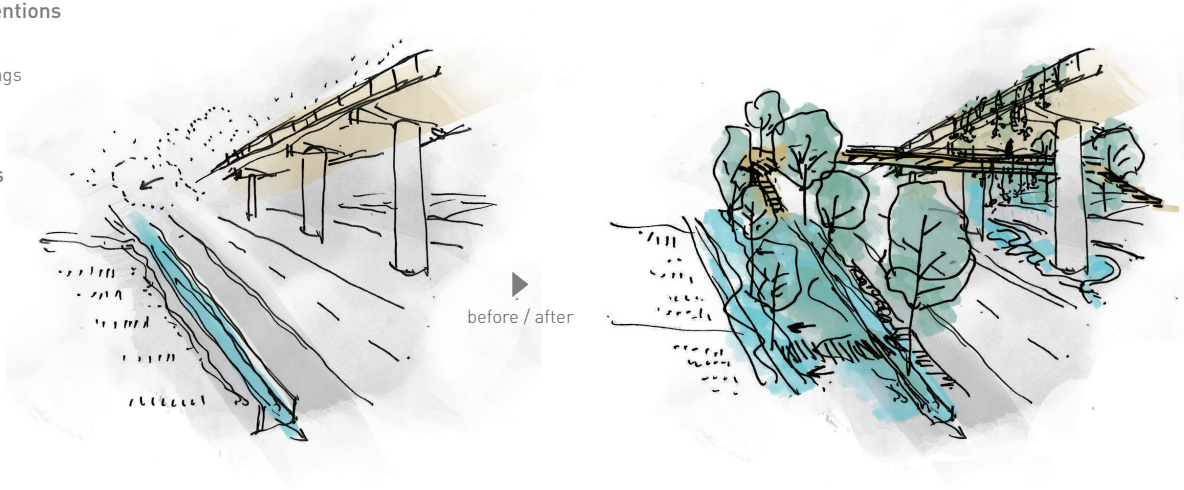
❻ ELEVATED MOTORWAY + AGRICULTURAL FIELDS

Hydrography interventions

- on roads
- as crossings

Operative structures

- corridor
- mobility



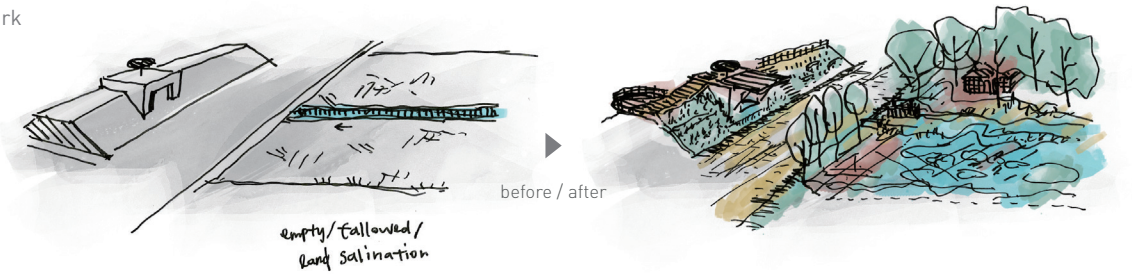
❼ HARD ENGINEERED DYKE ALONG LOW-USED ROAD + EMPTY LAND, FALLOWED FIELDS, OR SALINATED LANDS

Hydrography interventions

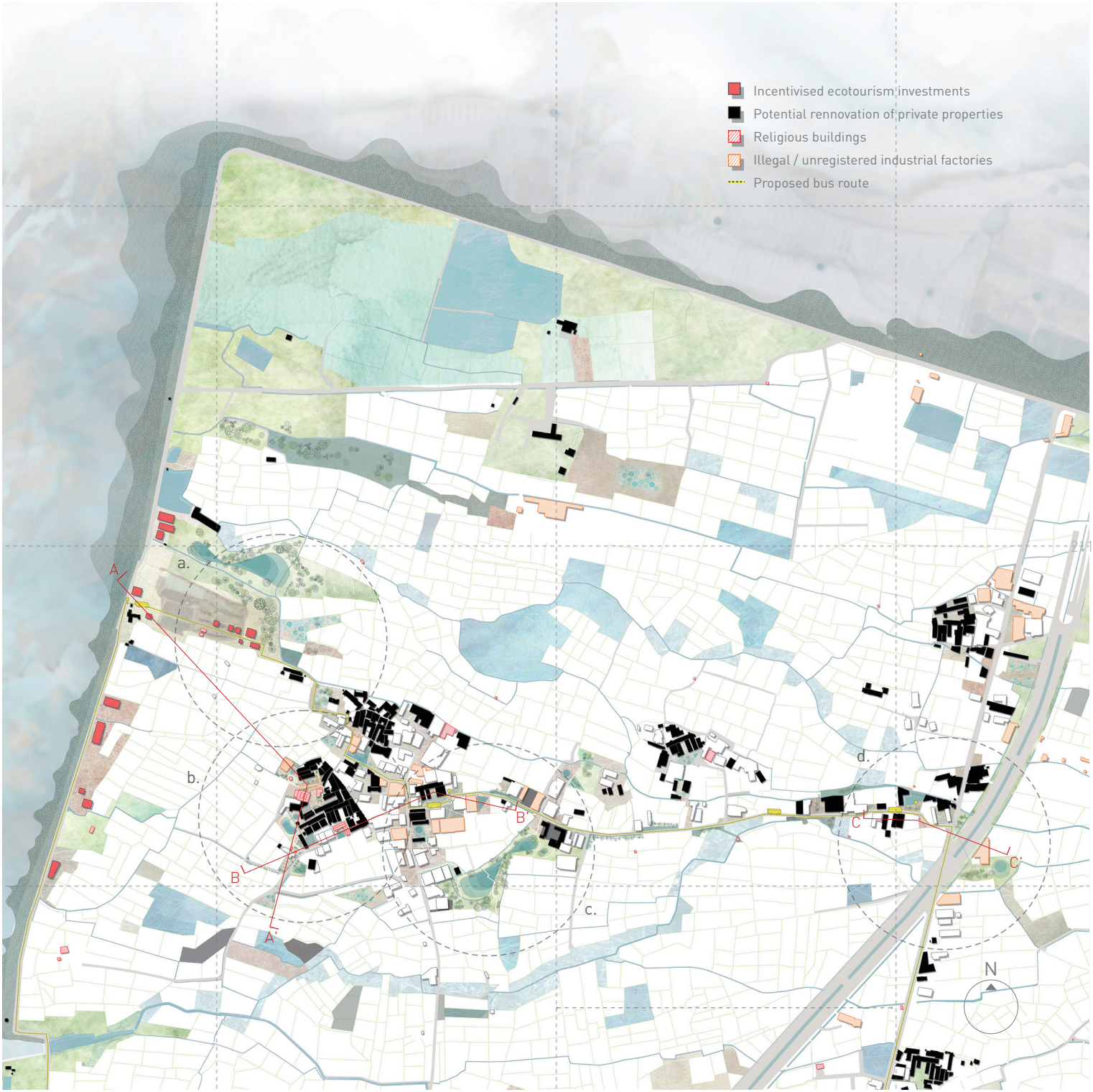
as wetland park

Operative structures

- corridor
- mobility
- public space



COMMUNITY REVITALIZED BY RECOVERING THE HISTORICAL RIVER COURSES

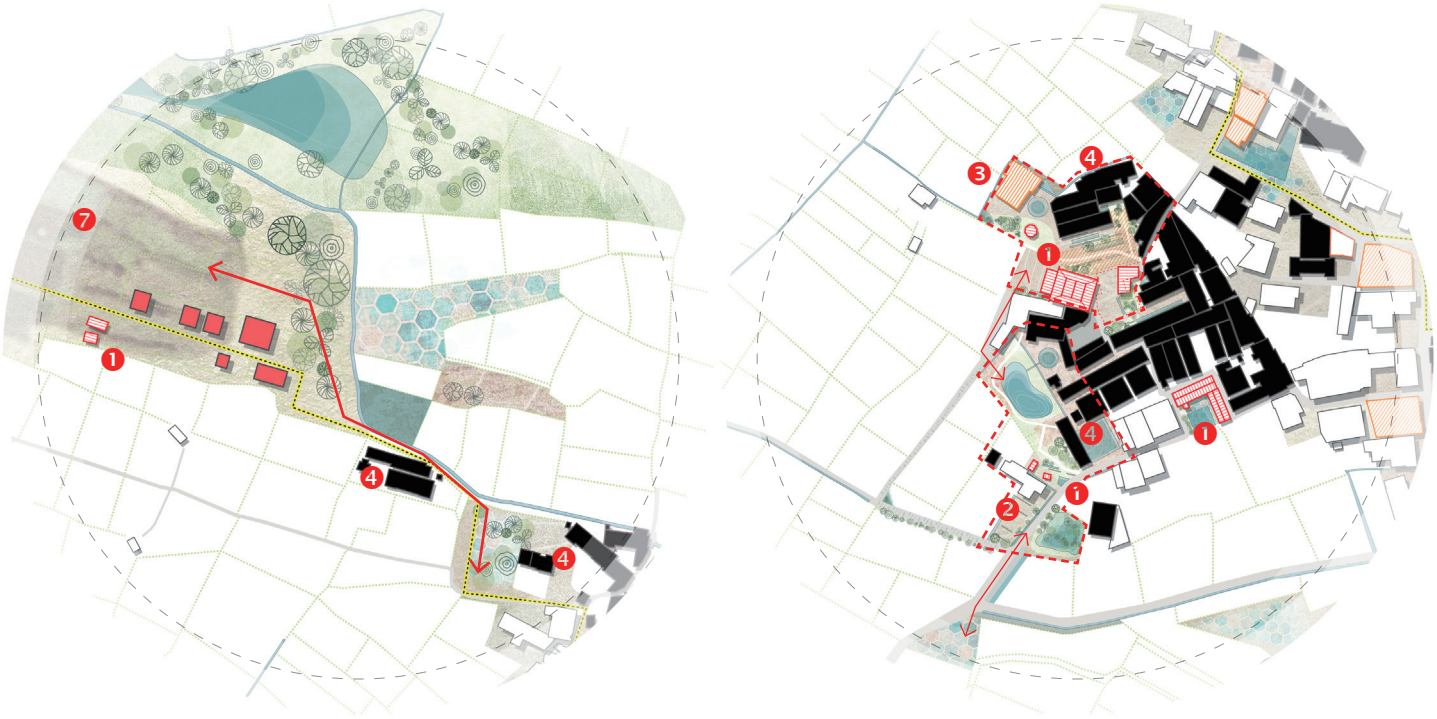

Incentivised ecotourism investments
Potential rennovation of private properties
Religious buildings
Illegal / unregistered industrial factories
Proposed bus route
a.
b.
c.
d.
A
A'
B
B'
C
C'
N

a.

Transitioning interface between small and large scale landscapes (i.e. neighborhood water gardens / wetland park as extention of coastal dike).

b.

Various possibilities of collabration between different actors and their spaces for accommodate water gardens and activate places. Together these patches reveals the historical river courses which will become the vitality vine for the living environment.



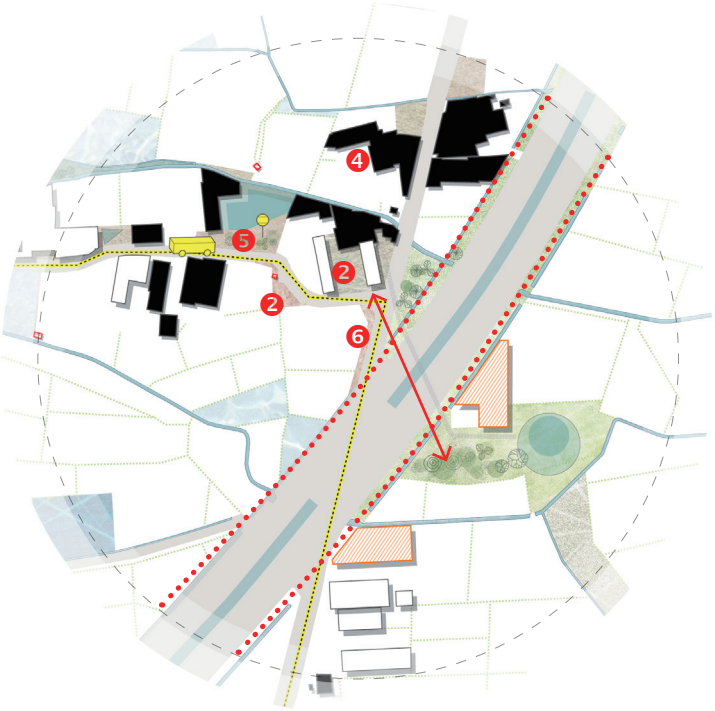
Incentivised ecotourism investments
Potential rennovation of private properties
Religious buildings
Illegal / unregistered industrial factories
Proposed bus route
1 - 7 Intervention patch typologies

c.

Public transportation stops will be more performative, located next places awaits regeneration. Several fallowed fields together form small-scale reserviors which not only release the other fields from draught, but also conditioned the vicinity with better tourism attractivity.

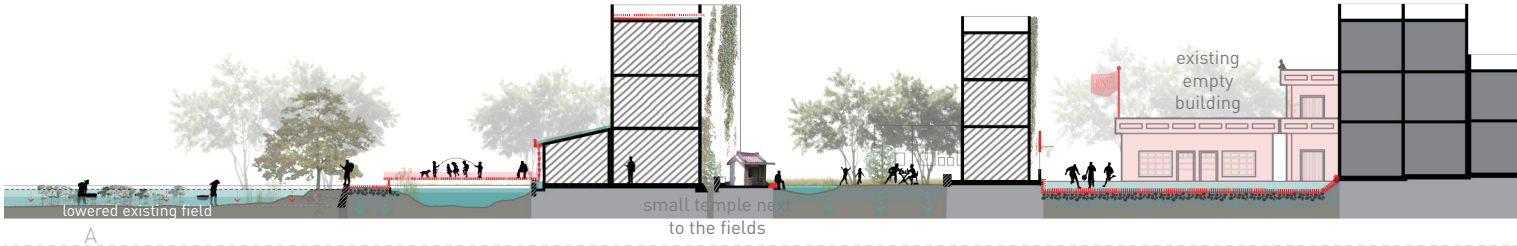
d.

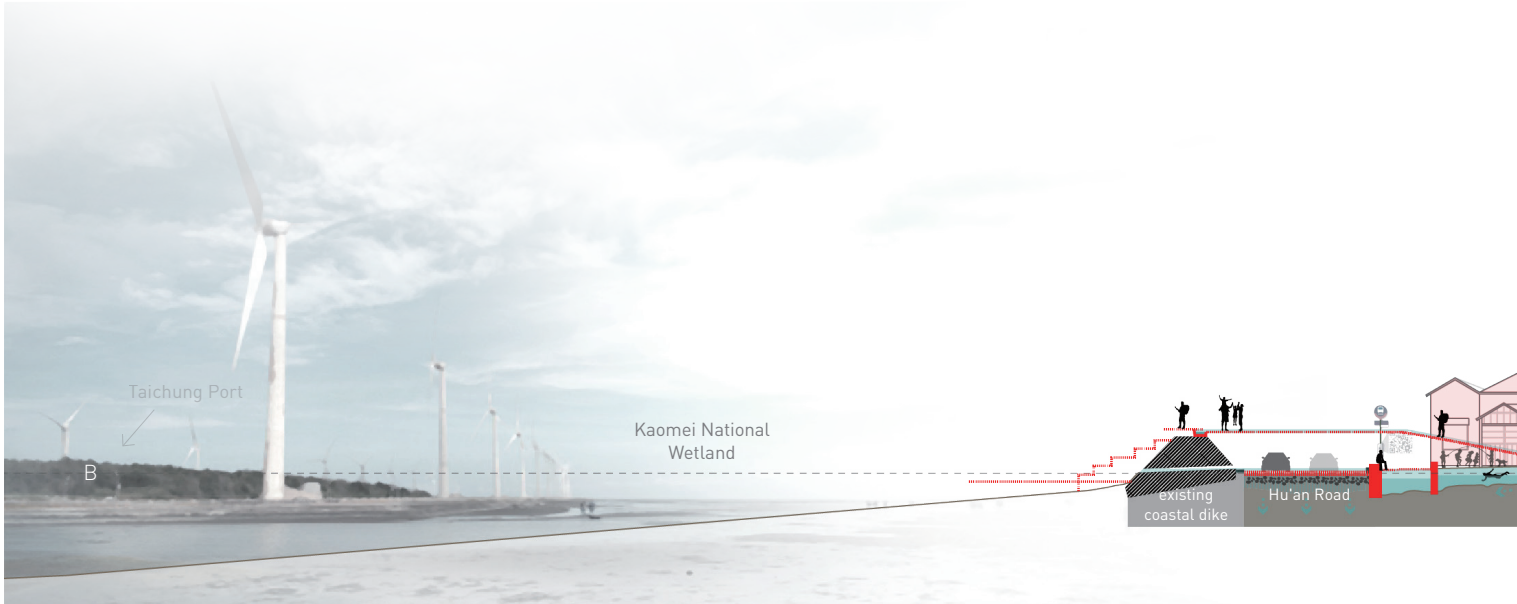
Integration of patches along the elevated motorway to overcome dominant segregation between the roads. The inclusion of water flows not only softens the infrastructure, but also reduces lead and carbon dioxide pollution emmited from the passing-through cars.

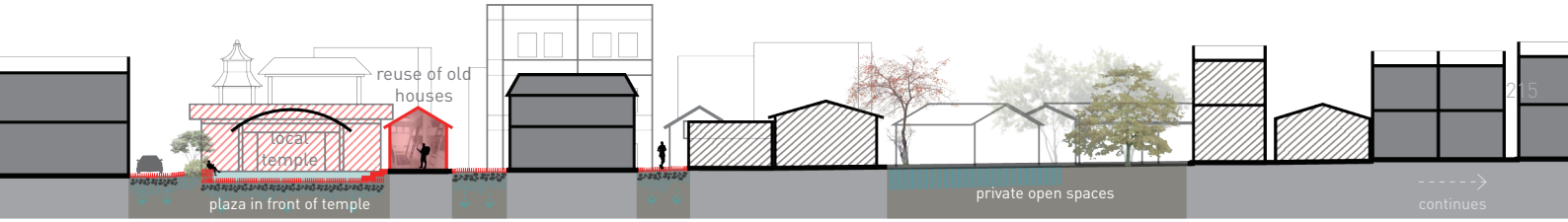


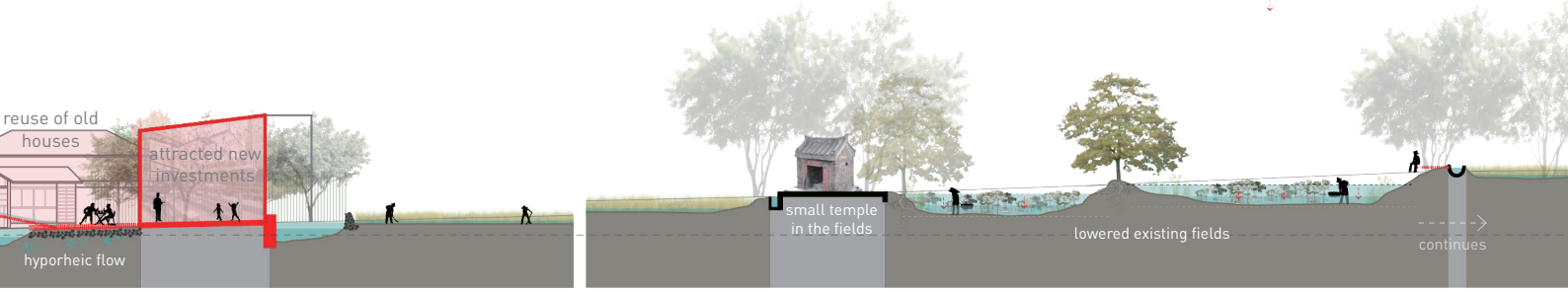
- public or public-oriented buildings
- private building for public/visitor service
- public-initiated water spaces
- modification of existing structures
- joined DIY rain gardens
- private households joining rennovation

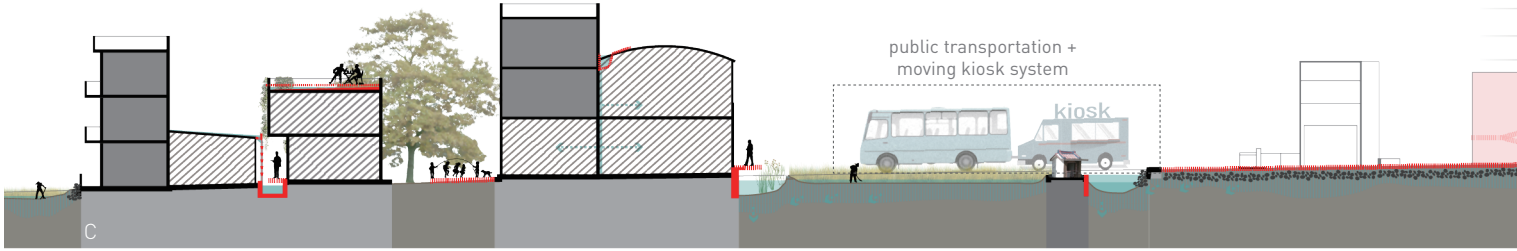
10 meters

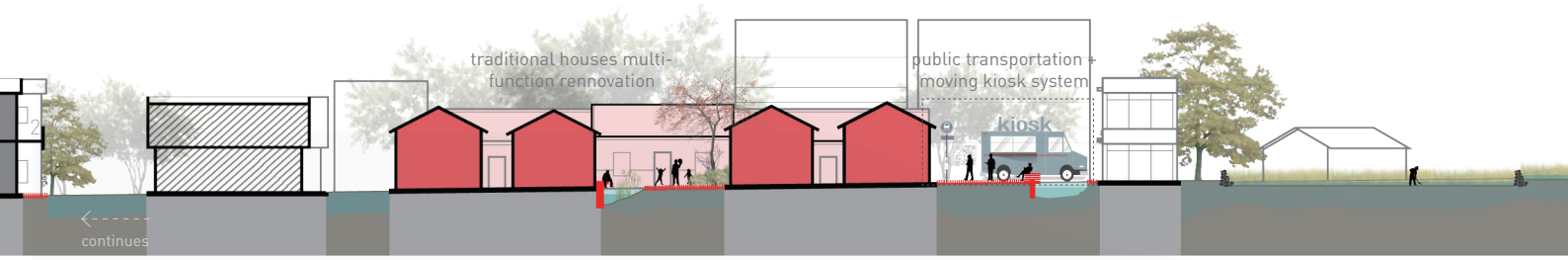


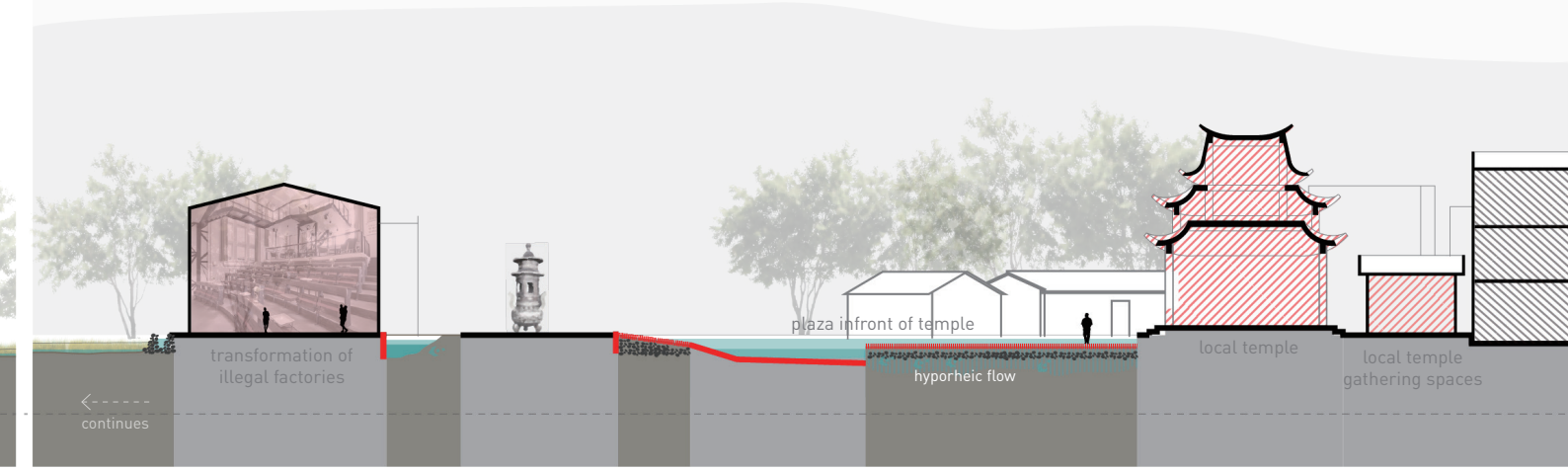


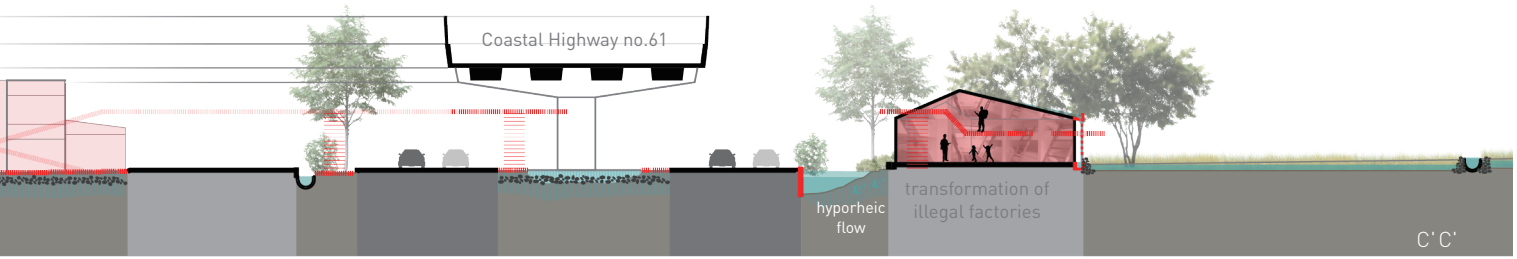

reuse of old houses
local temple
plaza in front of temple
private open spaces
continues

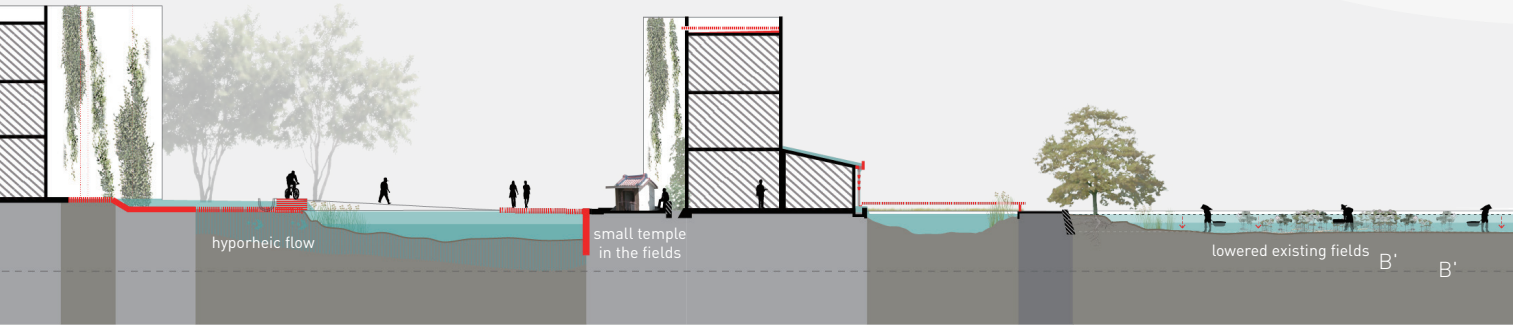

reuse of old houses
attracted new investments
hyporheic flow
small temple in the fields
lowered existing fields
continues


public transportation +
moving kiosk system
kiosk
C


traditional houses multi-
function rennovation
public transportation +
moving kiosk system
kiosk
continues
A'


transformation of
illegal factories
plaza infront of temple
hyporheic flow
local temple
local temple
gathering spaces
continues


Coastal Highway no.61
hyporheic flow
transformation of illegal factories
C' C'


hyporheic flow
small temple in the fields
lowered existing fields
B'
B'

VI. Implementation

VI-I. Phasing the Transformation

PHASE 1: TODAY - 2030

The first phase of the implementation aims at mitigating the urgent problems and initiating the transformation processes. The life-threatening threats of landslides and avalanche will be alleviated through the slope stabilization works and the commence of agriculture hybridization starting along the corridor structures, both actions insert better deep-root plantation coverage of the ground, reduce erosion and sediment for the river, and introduce self-sufficient water supply as part of the living environment that make use of natural flows, reducing the reliance on heavy-engineered water infrastructures. They will be continuous processes that go on towards the next phases. Also, with appropriate institutional mechanism and incentives, the local population can be provided with more choices for their main activities, and motivated in joining the place-making of their own daily-life spaces.

Another urgent problem concerns the basic needs in everyday life, which includes food, healthcare, mobility services, as well as water and accessibility support for maintaining operation of main economic activities. This part will be considered with separation of daily-life needs and logistic connections at the upstream (fig.154), and combine public transportation with public space and grocery services for the currently marginalized areas. This means at the upstream area, the daily needs will be supported by moving-kiosks combined with local buses, which will be doing errands upon requests, provide groceries, holding events, and work as people mover that establish stronger connection with the medium-size cities at the Eastern Taiwan. At the downstream area, similar moving-services combined with public transportation is suggested, and the process will start by initiating incremental interventions along the historical river courses, recovering the water landscape as the medium of engaging social interaction and economic vitality with common spaces.

Through the initiating process, the first phase construct the transformation method and collaboration model between different stakeholders, so that the incremental changes can proceed and adapt towards the next phases.

fig.154 Diagram of mobility structure proposal for the upstream area. Source: made by the author

2030

mitigate the urgent problems

ACTORS

local public transport

MULTI-SERVICE BUS ROUTE

agro-food market
grocery commerce
healthcare service

farmers

HYBRIDIZED ACTIVITIES

slope stablizing
hiking guide
farming tourism

(left behind) forestry specialists

SPECIALIZED INDUSTRY

sustainable forestry
wood industry
cultural/art crafting

PRODUCTIVE LANDSCAPE

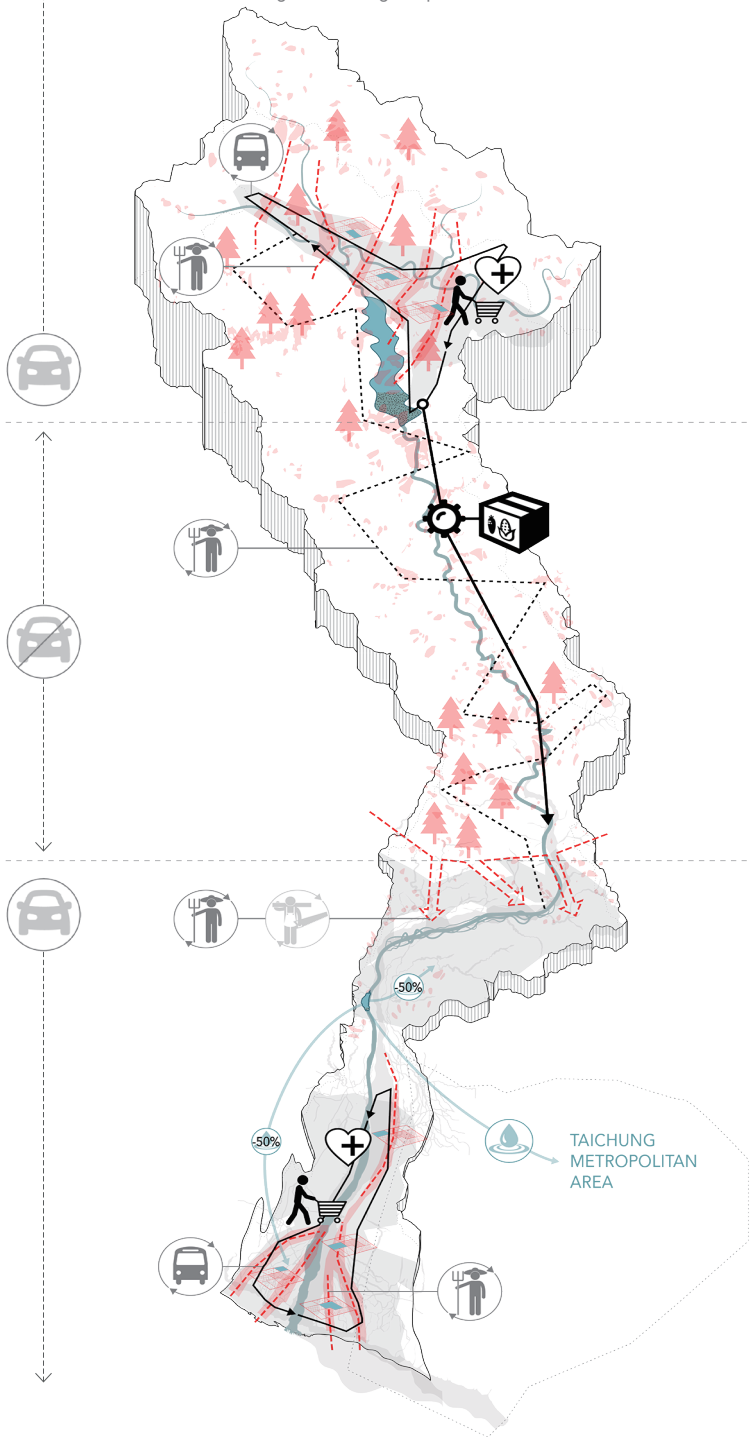
upstream

construct corridor through hybridization of alpine agriculture

prosper sustainable forestry to prevent agriculture sprawl on slopes

construct corridor through hybridization of coastal plain agriculture

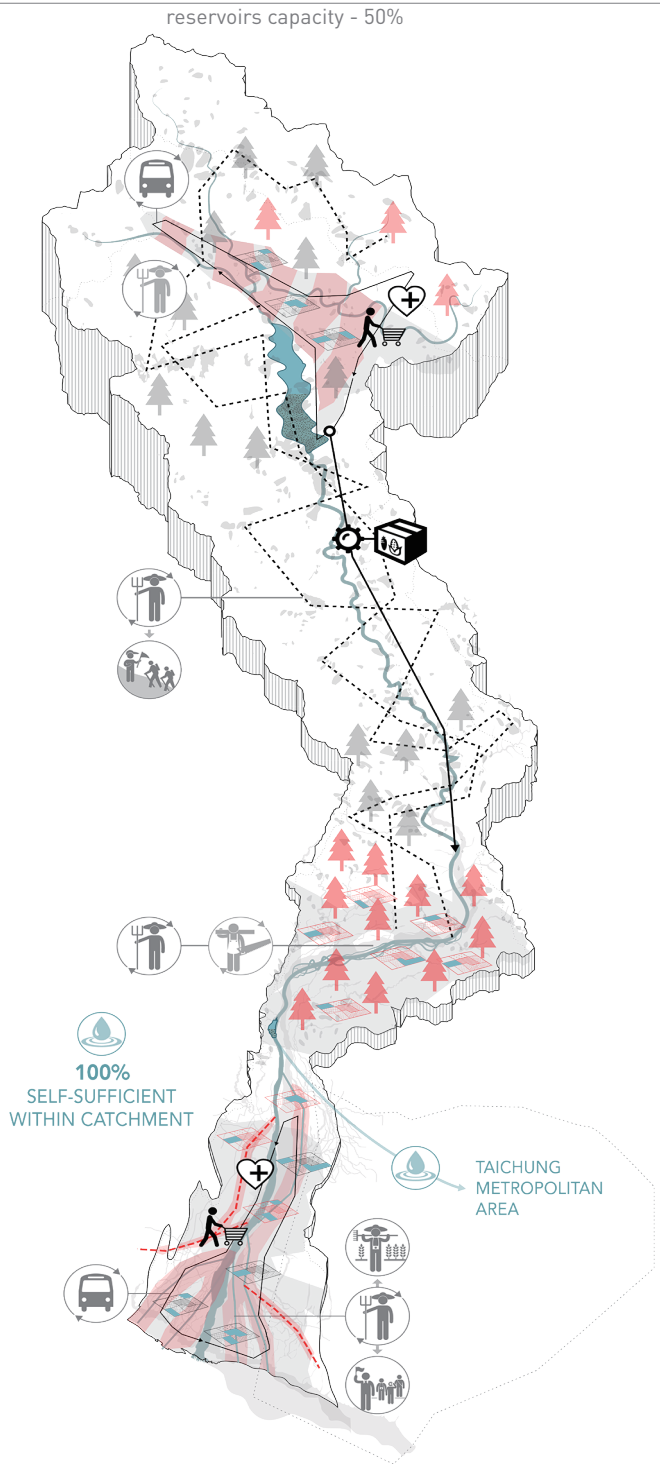
downstream



PHASE 2: 2030 - 2050

As the capacity of the reservoir is estimated to reduce 50% in 2050, the second phase aims at achieving self-sufficient water supply for the local inhabitants and activities within the river catchment area. Some simple calculation in the previous chapter for the design demonstration sites, the goal is achievable when the public-initiated and private-joined pocket spaces work together to be designed as storage space and surfaces for water collection. Released with the burden of part of the water supply, as well as the expensive cost to construct facility for resource transporting, the existing water infrastructure will focus the water supply for the metropolitan area, where another model of integrated transformation should also be expected to contribute to the issue of water management.

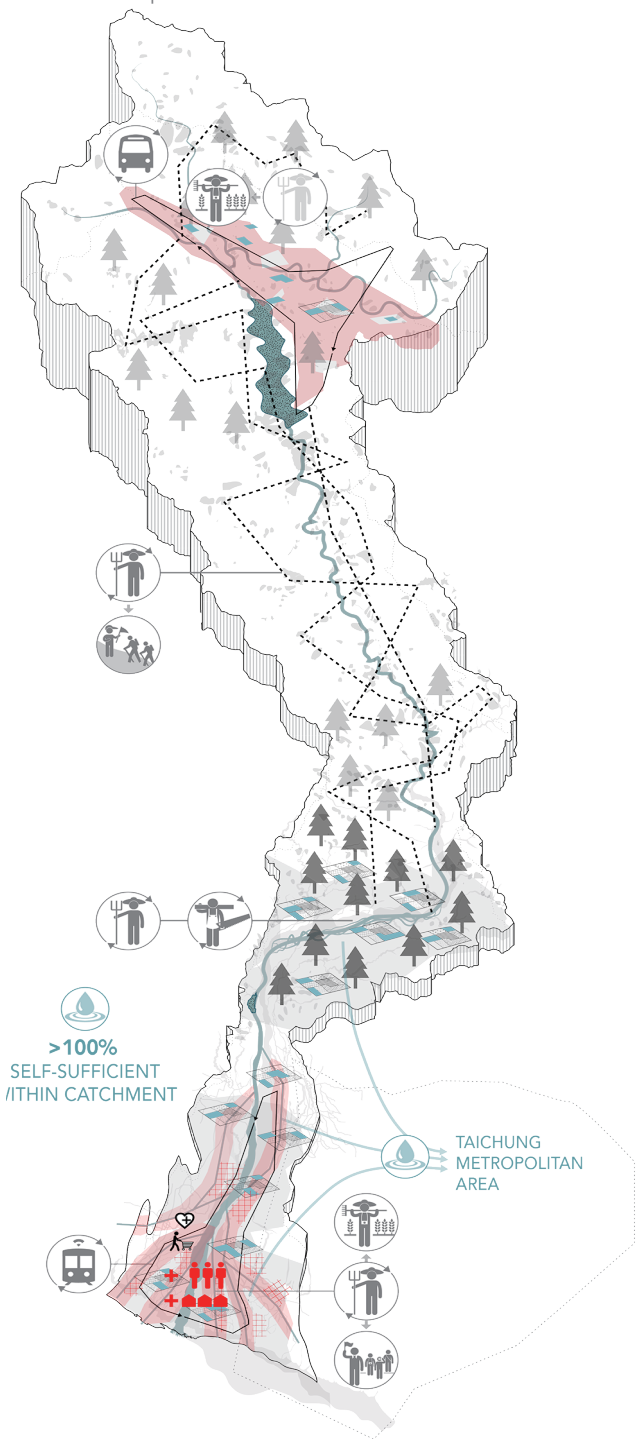
On top of this, the processes initiated in the first phase continue, and the leading linear thread of transformation will grow thicker. As the ongoing process has been establishing stronger connection of the local actors to the landscape, more opportunities will play themselves out. For example, the working trails of forestry and slope works, can also serve as routes to introduce ecotourism, in the form of hiking-with-guides that ensures the ecology quality, as well as provide other economic activities for the local actors.



PHASE 3: 2050-2100

It is estimated the reservoirs eventually will reach their end, considering the accumulation of sediments, the continuous damage to the environment, as well as the limitation of the heavy structures on the fragile lands. This means the ongoing transformation will not only provide self-sufficient water resources for the local communities, a surplus water retention to support the dense urban areas is also expected. With the metropolitan urban scape also transformed in terms of water management, and a more matured technology developed to design lighter, landscape-approached water infrastructures, the territory is ready to welcome the post-reservoir era.

Besides, the incremental hybridization and slope-guarding processes will reach a balanced land-use proportion. The once marginalized territory now maintain a dynamic resilience of productivity and sustainability, and could even allow appropriate densification to provide the society another choice of lifestyle, one that evaporates the water infrastructure into daily-life spaces, living closely with the quality of the mountainous river landscape.



VI-II. Institutional Framework

This part of the thesis consider the potential institutional framework for carrying out the transformation of Dajia River Basin as a water-sensitive landscape infrastructure. The ownership of the current lands (fig.155) provide the starting idea as of how the transformation could begin, what kind of instrument could be designed for the process to be more inclusive and sustainable in terms of management and as a continuous working model. These are also to be discussed with a comparative reflection according to the planning system of Taiwan.

1. DOWN-STREAM AREA

ownership

private-owned rice-farming and residential plots

situation

underused agricultural fields

frequent drought + water policy prioritizing industrial platforms

illegal factories or luxurious mansions

buildings with no community servicing facilities, polluting surrounding fields

deteriorated traditional houses

revenue from agriculture yields does not support even the cost of labour wages

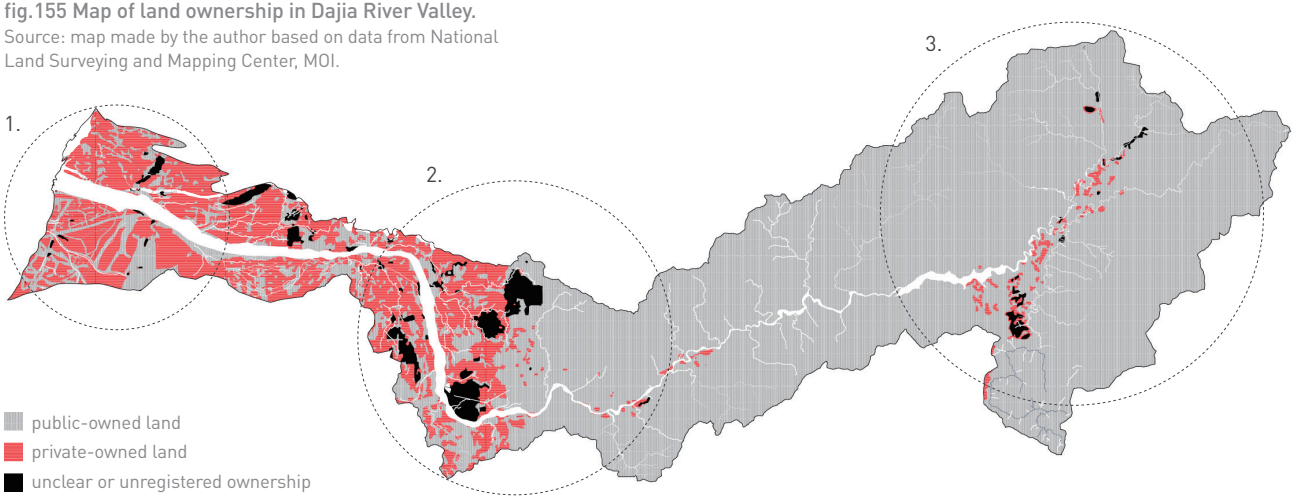
potential actors

farmer

illegal building owner

farmer family living in deteriorated houses

fig.155 Map of land ownership in Dajia River Valley.
Source: map made by the author based on data from National Land Surveying and Mapping Center, MOI.



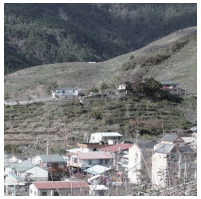
2. MID-STREAM AREA

private-owned dry-farming, reforested, and residential plots

large-surface cultivation of dry-farming fields
the agriculture sprawl uphill has increased soil erosion of slopes

illegal factories or luxurious mansions
buildings with no community servicing facilities, polluting surrounding fields

artificial reforested areas and forestry recreational parks
forestry banned for 30 years / wood highly rely on importing



farmer

illegal building owner

left-behind forestry worker

forest park operator

3. UPSTREAM AREA

private-operated, public-owned dry-farming and residential plots

increasing large-surface cultivation of dry-farming fields
road breakdown doubled costs, farmers gain back by planting more

conditionally-allowed illegal properties/activities; unregistered tourism services
law and does not allow renovation of houses, nor other uses, but lack of services and income encouraged the situation

farmer

environmental associations

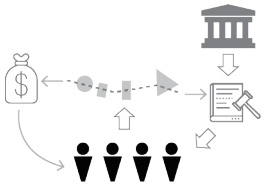
illegal house residents

tourism service provider

INSTITUTIONAL MODELS

1. DOWN-STREAM AREA

proposed institutional model

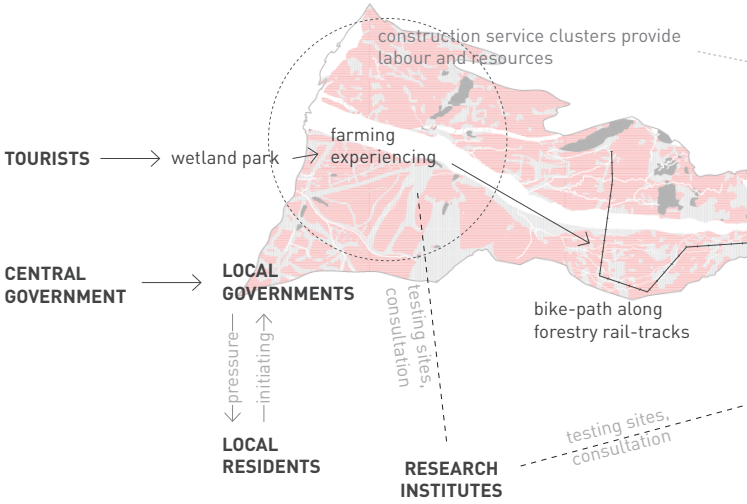


legitimacy pressure and profitable model to encourage bottom-up initiation through collaboration between local players.

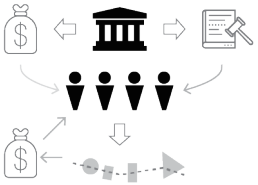
limitation

- Lack of participatory planning experience, consensus, and methodology.
- Participation and collaboration willingness discouraged by planning system.
- Lack of efficiency in legislation amendment and enforcement.
- Lack of private actors in sustainable industries and applicable eco-technology products.

STAKEHOLDERS



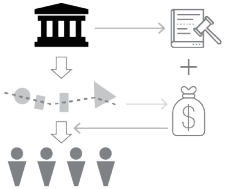
2. MID-STREAM AREA



legitimacy pressure, policy-change and incentives to encourage sustainable forestry activities and diversification of farming type.

- Lack of participatory planning experience, consensus, and methodology.
- Participation and collaboration willingness discouraged by planning system.
- Lack of legislation efficiency and enforcement.
- Lack of private actors in sustainable industries and applicable eco-technology products.
- Objection from extreme environmentalists.

3. UPSTREAM AREA



government-initiated projects to guide the transformation of activities with provided incentives or compensation.

- Lack of efficiency in legislation amendment and enforcement.
- Objection from other stakeholders such as extreme environmentalists.
- Lack of private actors in sustainable industries and applicable eco-technology products.
- Limitation from the fragile geology and land capacity.

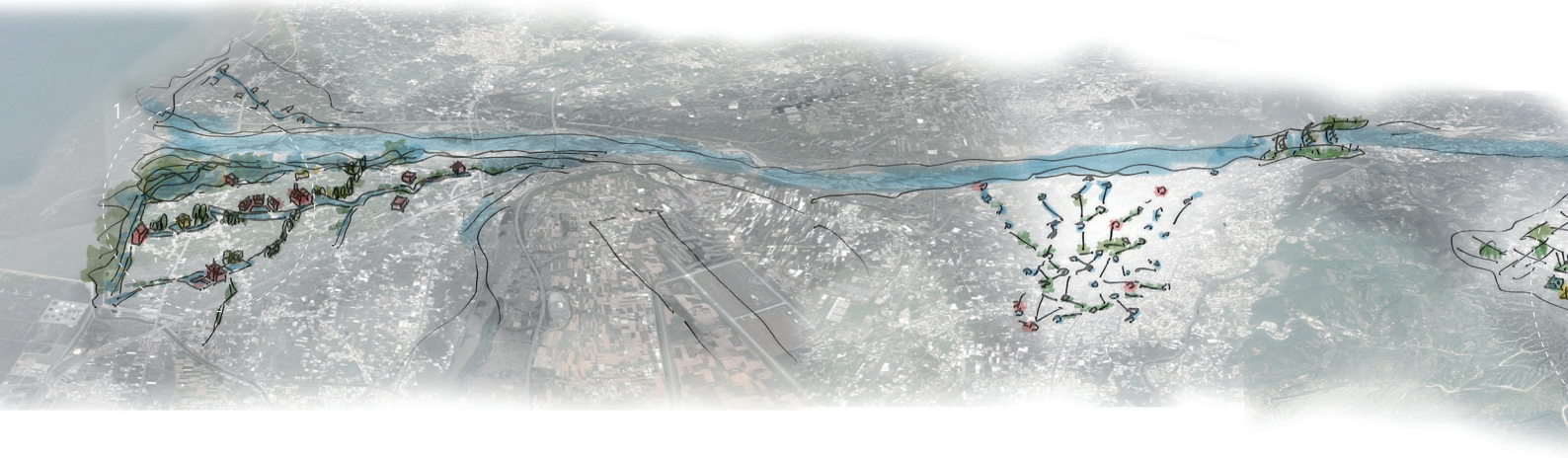
VII. Synthesis and Outlook

VII. Synthesis and Outlook

This chapter comprises two parts: the evaluation of the design proposal in terms of achievement in water retention and the mutual influences between different sites in the river basin, and then the second part, the reflection on the whole thesis project.

The first part examine the ideal effect of the proposed scenario as to which degree it could mitigate the problem impact and enhance living quality, and how the intervention on one area affect the water system of another. Then, in the reflection, it will be pointed out what we can learn from this thesis research along with the possible next steps, as well as give some suggestions to the planning system and urbanism field, and identify some interdisciplinary research topics integrating other academic and practice fields.

1



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3

VII-1. Project Evaluation

INFLUENCE BETWEEN DIFFERETN PARTS OF THE RIVER

A synthetic examination of the geomorphology, the current problems, and the objectives of different layers of the proposal, show that the influences of interventions at different parts of the river can be regarded in two aspects, water and sediments (fig.156). The water aspect includes water storage spaces and landscape structures to reduce or delay runoff. The sediment aspect is about provide better surface condition to reduce erosion and stabilize slopes, both contribute to the lessening of sediment.

The various projects can further be prioritized according to the geomorphological condition of the landscape, the relations of different parts of the river, as well as the seriousness of the issues they concerned. At the upstream area, due to the river courses will then enter into a narrow and fragile bottleneck after the alpine region, the reduction of sediment and water flow of the upstream area is crucial, since this also concerns the life and property safety of the mountain communities. The transformation of the motorway into lighter infrastructure is also essential as this could mitigate fragility in the bottleneck section of the river. The slope works will first prioritize the stabilization of the dangerous slope close to the inhabited areas, and then take care of the other ones scattering among the hills. At the downstream, priority goes to achieve self-sufficient water supply, so as to release the local economic activities from frequently unable to operate.

The diagrams on the right show the level of importance of the different components of the transformation, and how these interventions are mutual related (fig.157 & 158).

INTERVENTIONS REGARDING WATER, SEDIMENT, OR BOTH

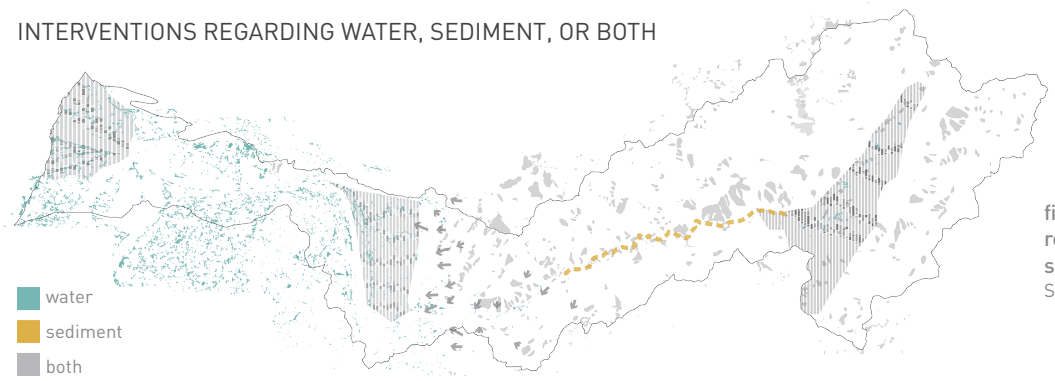


fig.156 Map of intervention regarding water and sediment aspects.
Source: made by the author.

GEOMORPHOLOGY AND INFLUENCES BETWEEN INTERVENTIONS

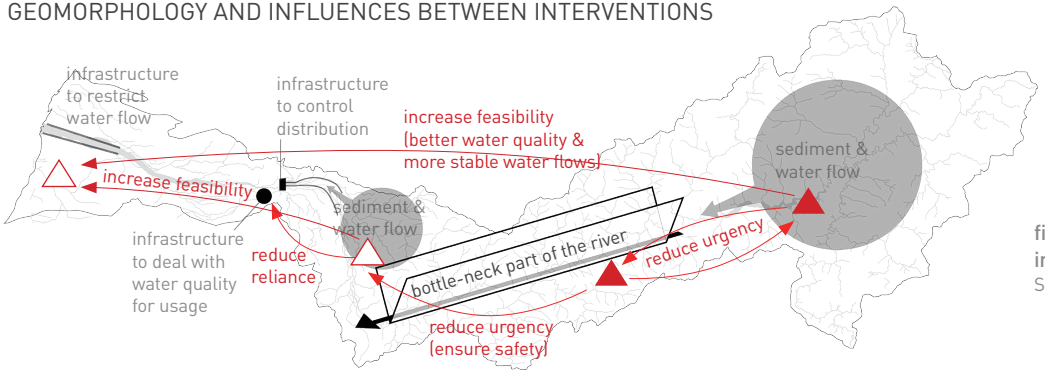


fig.157 Diagram of mutual influences of projects.
Source: made by the author.

LEVEL OF IMPORTANCE OF THE INTERVENTIONS

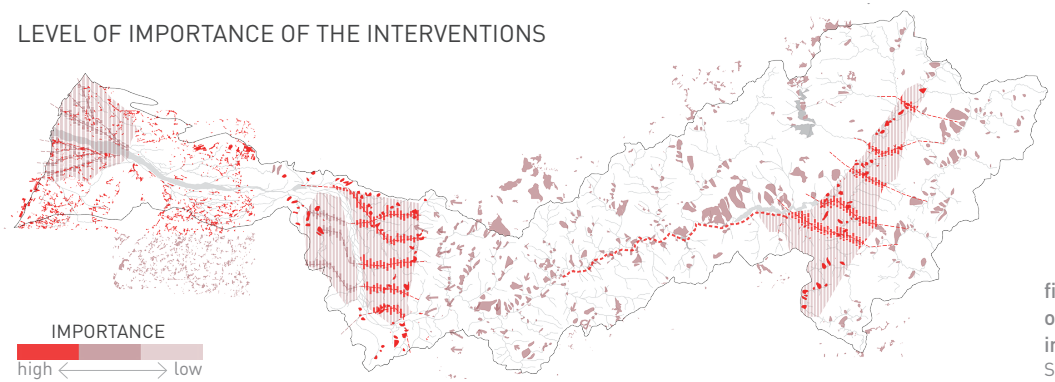
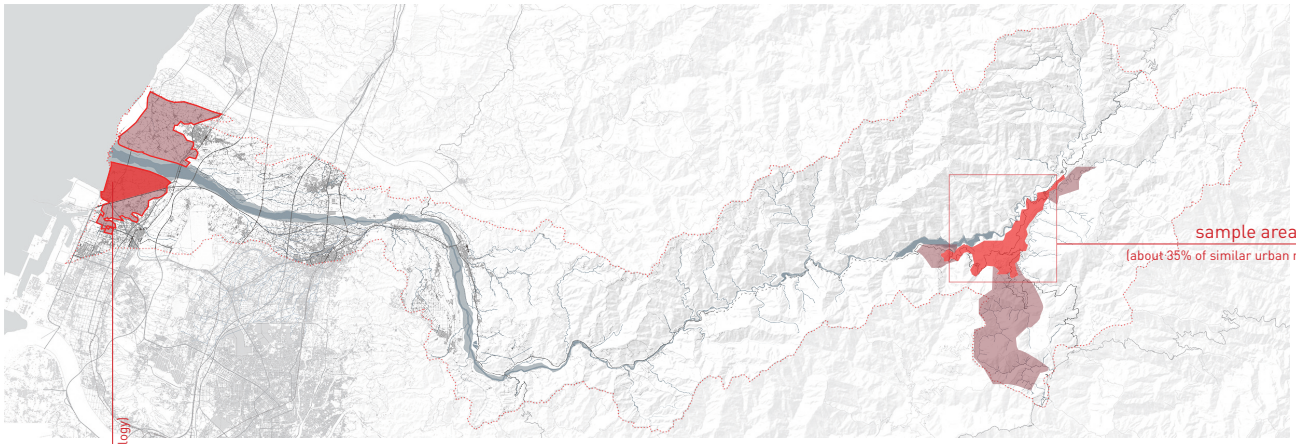
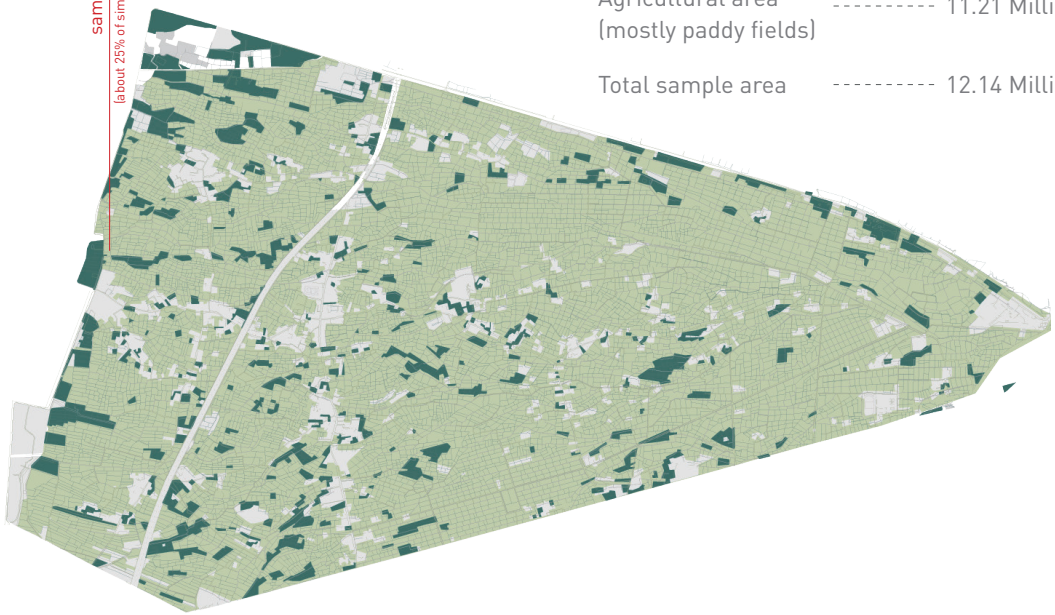


fig.158 Map of level of importance of the interventions.
Source: made by the author.

SPATIAL CAPACITY OF INTERVENTION

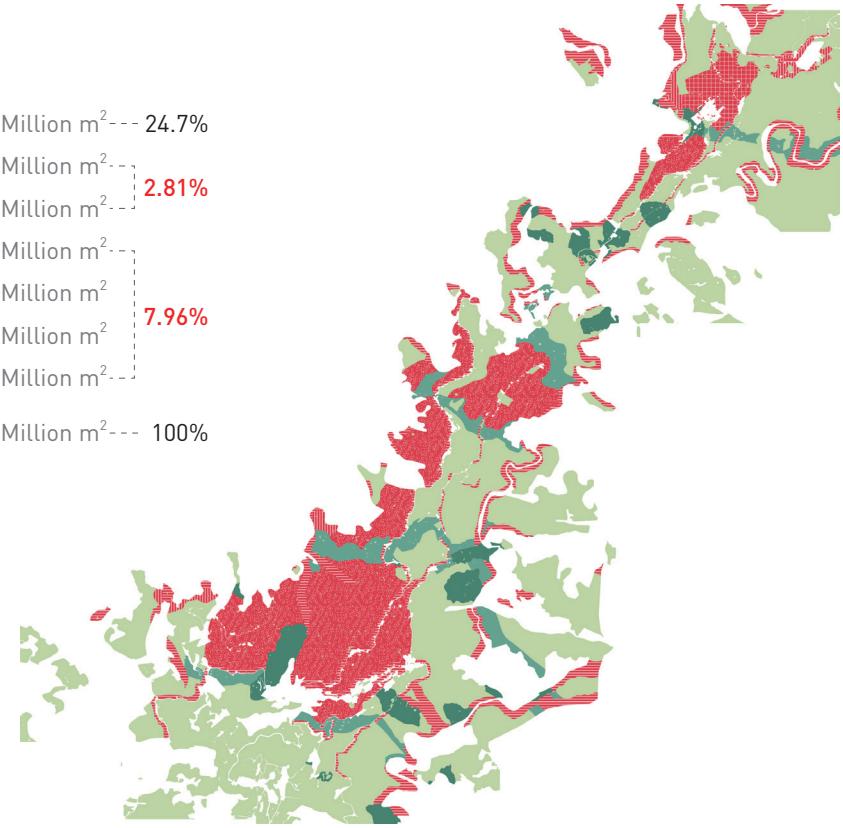


sample area
(about 25% of similar urban morphology)



Fallowed fields / Empty lands	1.18 Million m^2	9.54%
Agricultural area (mostly paddy fields)	11.21 Million m^2	76.4%
Total sample area	12.14 Million m^2	100%

Agricultural area (mostly fruit or dry grains)	24.70 Million m^2	24.7%
Reforestration	1.26 Million m^2	2.81%
Horizontal corridor	1.55 Million m^2	
Agri-transformation-type1	2.80 Million m^2	7.96%
Agri-transformation-type2	0.44 Million m^2	
Agri-transformation-type3	4.48 Million m^2	
Agri-transformation-type4	0.24 Million m^2	
Total sample area	100 Million m^2	100%



A rough calculation for both upstream and downstream interventions shows that in both areas, around 10 percent of the lands could potentially join the transformation process.

RUNOFF REDUCTION

At the upstream area, according to the design proposal demonstrated in chapter 5, it can be estimated that an ideal implementation will transform the surface coverage proportion will change (according to the NRCS runoff calculation methods) as follows:

land proportion	runoff %
pasture: 100%	78%

land proportion	runoff %
pasture: 30%	78%
wood: 50%	68%
other: 20%	72.5%

weighted average: 72%

According to the runoff characteristic for different types of land covers (pasture: 78% runoff, wood: 68% runoff, other: 72.5% runoff) a rough calculation shows that **the overall stormwater runoff can be reduced from 78% to 72%** if the full transformation of the upstream area could be achieved.

VII-II. Reflection

main research question:

How to rethink the river landscape as opportunities instead of obstacles, so as to achieve a more sustainable integration between artifact and nature? Further on, how to build a stronger identity for the living environment through the process of redesigning a mountainous landscape as water-sensitive infrastructure?

1. The potential of mountainous river landscape

This thesis explores the landscape potential of a mountainous river as territorial water infrastructure, testing the hypothesis that the natural condition of a mountainous river can be an opportunity instead of an obstacle for achieving a better integration of social, economic, and natural aspects of the living environment. Through the processes of theory and reference case study, context analysis, as well as research by design intervention, it is testified that by looking more carefully into the natural condition of the land (the topography, geology, the original flows of elements, etc), the changing pattern of socio-economic operations, as well as the cultural context of the society (the institutional system, the interdisciplinary debates, the conception of stakeholders, etc), a synergy can be constructed via establishing connection between different elements and activities, from local to regional scales. Through this connection-establishing process, changes in spaces, occupations, and the way things are done will be carried out, which is itself the incremental transformation of landscape as infrastructure. The study of cultural and institutional context, at this point, will be the foundation to develop a feasible mechanism to include local population to join this connection-establishing course. This space-making process recovers the tangible relationship of people to the land on which they live their daily lives, therefore, a stronger landscape identity and responsibility can be expected. Then the landscape potential, the experiences, methods and the steps taken in realizing these potentials will all contribute to help building a stronger identity, as stated by James Corner (1999), it is in this deeper sense that landscape as place and milieu may provide a more substantial image than that of the distanced scenic veil, for the structures of place help a community to establish collective identity and meaning.

2. Contribution of the thesis proposal

The project developed in this thesis, taking Dajia River Basin as a study case, exhibit the possibility of what kinds of connection an be established, what changes this will be displayed in physical spaces, and designed mechanism in the process of implementation as of how and when the local government and population can play their role, and the physical contribution they can make to the landscape infrastructure system. Through this research by design process, the project help the concerned readers to realize

the intricacy and urgency of the current water system problems and the potential it can bring to the future landscape. As Dajia River is one of the most illustrative case in the mountainous river landscapes, displaying an extremely sensitive, dynamic, and fragile land condition, the potential explored and the methods developed in this research are expected generalizable as a reference for other mountainous river basins around the world. More important contribution of this project to the academic field and societal issue is that it provides a specific process for the local people to participate, such that their socio-economic needs do not anymore regard as conflictual to the ecological conservation. On the contrary, their new habitation-activity model not only provide betterment to the natural ecology, but through the implementation process the landscape quality permeates into daily-life places and elements of the water-sensitive communities.

Another aspect of contribution concerns the feasibility of a integrated river basin management project, which includes the financial underpinning, and the institutional framework. Regarding the financial feasibility, the proposal of this project suggest an incremental process of transformation, identifying the crucial interventions that take care of life-threatening problems, and how the intervention at one part could influence the performance of landscape infrastructure at another place in the river basin. This is important because it does not require a huge investment at once, but allow an try-and-adapt evolvement to gradually reach the ultimate goal. The institutional mechanism proposed in this project, regarding in different local context and stakeholder compositions, who should be the initiative actor and what tools (laws, regulation, or incentives) can be applied. This also supports the incremental process within the framework defined by the landscape operative structure, which could allow diversity to play themselves out in the meanwhile achieving common goods, instead of resulting in conflicting, scrappy, purely profit-oriented developments.

3. Challenges and limitation

There are, of course, many challenges and limitation from the academic discourses, the existing planning system, the complexity of the issue itself, as well as the political position of the issue in the society.

3.1. The passive attitude of the academic field

According to the interviews, the field of urbanism is permeated with a passive attitude towards a better integration between nature and human habitation on the issue of water management, or on many other spatial-related issues. In general, scholars of urbanism in Taiwan ascribe most of the problems to the current planning system as one of the main hinderance towards an effective synergy and resource management. Despite the validity of the accusation, this passive attitude, in the author's opinion, results in the academic field fail to advocate innovation, communication, and is unable to translate knowledge and theory into physical reality. This situation, besides the problems of the current planning system, is also one of the fundamental reason to the non-existence of synergy in many water and spatial issues in Taiwan, which can be presumed also partially due to the deep-rooted political and cultural complexity of the

society, which are: first, the polarized political opinions due to the lack of cultural identity, and second, as a subsequent phenomenon, the incapability of being flexible and innovative in most of the spatial tasks.

The first phenomenon can be traced back to the modern history of the country. Receded from the Mainland-China territory to the Formosa Island, and the afterward intricate cross-strait relationship between Taiwan and People's Republic of China, has in the past led to over concentration on economic planning, (Council for Economic Planning and Development, 2005) and the detriment of environmental issues, and current it has led to stagnation and lack of political will in any attempt to revise what are now seen as increasingly antiquated planning laws (Bristow, 2010). This emphasis on economy permeates through most of the planning policy and mechanism, neglecting not only the environmental concerns but more influentially, in the author's opinion, the lack of an in-depth cultural and philosophical investigation, research and rhetoric to establish a more contextualized planning system merged with Oriental culture-rooted contemporary theory and philosophy. Many professionals both in academic and government, could not build up strong arguments to guide the future development because they are at the first step lost in constructing a cultural identity. Considering also that the planning process and decision making mostly controlled in the hands of the administrative bureaucracy whose elective term is only 4 years (maximum 8 years), the spatial policies are often easily amended towards an political extremity to cater to the popular opinions.
Added with the inefficiency and weak enforcement of legislation, a long-term visioning for an integrated urban development is almost impossible, or remain as empty slogans and manifestations. In recent years, as many spatial problems began to show, debates has also been aroused. However, very much influenced by the political polarization, these debates gradually dichotomized the local opinions into increasingly bitter confrontations in almost all spatial issues, especially those by nature controversial and complex, of which the debates should have been more about finding a mutuality with decision making rather than choose between black and white. The impossibility of real communication resulted in lack of trust, and had progressively led to the second phenomenon that the planning system become more inflexible and conservative. An anti-fraud attitude was formed, and urban planners and implementers devote most of their efforts in acquiring permits through the procedure controlled in the hands of Commissions composed of professionals appointed by the municipality. The situation eventually demoralized the innovation and public-inclusion willingness for many stakeholders and actors in both public sectors and private developers.

Therefore, this thesis advocates that the academic field of urbanism should take the optimistic and active role in the issue, and suggest that landscape infrastructure can be one of the potential dimension to develop cultural identity via spatial engagement.

3.2. The complexity of landscape as infrastructure

Another dimension of challenges come from the complexity of the issue (of designing landscape as infrastructure) itself. First of all, as the complexity both

in terms of scale and scope are embraced since the beginning, the dynamic and systematic quality of projects is much harder to grasp than an individual object or clear formal strategy of more traditional urban landscape designs (Mossop, 2006). The second aspect is that the landscape infrastructure system that works with natural processes also works with time, and, as Mossop (2006) also states, the formal outcomes of projects that rely on processes are difficult to predict, in a way that is often unacceptable to public agencies and other clients.

Considering the situation of Taiwan, the compartmental government system is a huge hindrance to overcome the first difficulty. In the case of integrated river-basin management addressed in this thesis, the related tasks are split into too many sectors with an unclear hierarchy of responsibility and power. Though a new organization in the governmental system has been announced in 2014 to deal with integrated river basin management, it still looks for a problem-solving approach, and the related laws and policies remain the same. In other words, the new proposed organization did achieved some works of data collection and task deployment in facing water management problems, but the part of visioning for future and proposing transformation for more sustainable operational systems are not considered or only mentioned in a vague way in the whole plan. As the participation experience in Taiwan now limited at very local-scale projects, and the new organization does not has the power in the legislation level, collaboration may extend only to a wish to involve other stakeholders affected by the planning decisions or plan-making in discussions before the final decisions are made, with the decision making power remaining firmly in the hands of the professional decision makers (Hua, 2010). In 2017, the new President initiated a Foresight Infrastructure Plan, in which the Water Environment Infrastructure is one of the main part of the project (fig.159). This plan has raise the responsibility of river basin management to the highest executive bureau in the government, with also the newly-passed law that gives national land planning an legal power. This has increase the possibility to enforce different sectors and local government to work together in achieving regional scale projects. However,

fig.159 The new organization for River Basin Comprehensive Management Plan strating in 2014. Source: Water Resource Agency, MOEA, Taiwan Government.

the centralization of power, and moreover, most of the proposals still look for heavy infrastructure constructions, in the long run is will still cause a heavy burden on the nation's economy, and hard to organize people in the marginalized area (which usually is also the area that mostly affect by water disasters) to develop a sustainable model. The missing of specific mechanism to encourage academic and public participation, make it almost impossible to overcome the second difficult.

3.3. The political position of river basins

Another aspect concerns the fact that the whole catchment for all rivers in Taiwan are completely within the border of a same country, with some even within the same municipality. This give some potential but also some weakness to the issue. Theoretically this could have avoid the international conflicts regard resource distribution, pollution, as well as development competition between countries at different parts of a river. However, this is only more possible while integrated river basin management is at high level of concern with an comprehensive sustainable working model, which is not the case of current Taiwan's planning system. On the other hands, the combativeness of the landscape also largely enhance the intensity of the risks, with little buffer to mitigate the impact of every natural or human-caused problems. Besides, without a higher level organization to stimulate or force the transform of system, or to encourage knowledge to be exchanged between neighboring countries and between highland and lowland areas (Viviroli, 2008). This can caused enormous negligence or delay regarding the issue while other issues are taking most of the attention, such as the political confrontations or economic competitiveness remain still the main focus in Taiwan. The River Basin Management Plan of European Union, for example, though the scale and complexity might be more intricate in the political aspect, but the role of a cross-country union with some contract power over nations, could more objective analyses to the situation, and push forward the urgency and necessity for the member countries to take action. As Taiwan's delicate political situation, it is difficult to expect the country to join an international union to utilize the international contract as enforcement power to change the planning system. Nevertheless, the pressure from some civil societal dimension might push the policy and institutional systems forward. Currently there are many organizations in the country that engage in the issues. If we could join more international NGOs, associations, and research forums, such as Alpine platform, FSC, CGIAR, ect., it might gain more superior-to-national pressure, objective analysis, knowledge exchange, and planning and designing consultation for an integrated river basin management to transform the water landscape as water infrastructure.

4. Cross-disciplinary integration through landscape urbanism

The recent global debates regarding the landscape urbanism in designing water-sensitive urban spaces, and the increasingly serious natural hazards, has influenced Taiwanese people's acknowledgement about the need to rethink the current water infrastructure, and the inappropriate model of the current planning system in dealing with water-related issues. In the interviews carried out during this thesis research with two

professors, H.Y. Lee, and J.M. Wang, both has identified the importance of establishing a synergetic model for comprehensive river basin management. According to them, water management could not anymore work in the traditional way which emphasizes hard-engineering approach in controlling nature, and that it is essential for the government to work in a smarter way to prevent further waste of the physical and socio-economic resources. The potential of education should also be utilized in arousing awareness, developing consensus, and building a platform (fig.160) for different disciplines to collaborate, accumulate, and exchange knowledge into a shared database. The fields of hydrology and ecology, which used to be purely engineering and scientific approached, have both recognized the need of interdisciplinary and multi-scale integration, and that urbanism should play its active role to act as a medium to include different concerns and to negotiate between government and people, academic and practice, as well as among technology, ecology and socio-economy.

5. Recommendations for further research

Last but not least, this thesis also intend to identify the related issues that needs to be future explores through further researches in the urbanism or other disciplines, or as potential application inventions for the concerned practices. These topics include the institutional framework of the planning system, the cultural ideology and philosophy, as well as many scientific or engineering technologies identified in this thesis such as utilizing the underflow water (or hyporheic flow), replacing shipping at geologically-fragile areas with machinery rails or cables controlled by smart technology, ecological-friendly fruit and tea agriculture, or the tough yet crucial task of reservoir/dam-dismantling, which still remain an unknown solution in the fields of hydrology engineering. An optimistic expectation could lead to the following: with the positive feedback and innovative outcome of the research from other professions, and the change of attitude in the planning field with more advocation and movement from the academic field, would eventually push forward the field of landscape urbanism in Taiwan to play an more active and critical role. Furthermore, with the extraordinary fragility, dynamic, sensitivity of the natural landscape of Taiwan, the example can also become important reference for other river catchment around the world in designing the water landscape as an integrated and sustainable infrastructure.

fig.160 The iWater envionmental education platform website proposed by professor J.M. Wang.
Source: diagram and screenshot from WRA, MOEA website.

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DATABASE AND WEBSITES

- Central Geology Survey, MOEA [http://www.moeacgs.gov.tw/]
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- Department of Irrigation and Engineering [http://doie.coa.gov.tw/]
- Disaster Risk Maps Archive, National Science and Technology Center [https://dmap.ncdr.nat.gov.tw]
- Government Opendata Platform [http://data.gov.tw/]
- Integrated River Basin Management Plan Website [http://iufm.cpami.gov.tw/iufm]
- MIT Taiwan TV Series [https://www.youtube.com/user/ctvmit]
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- News&Market [上下游] Platform, [https://www.newsmarket.com.tw/]
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- Taiwan Environmental Information Centre [http://e-info.org.tw/]
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