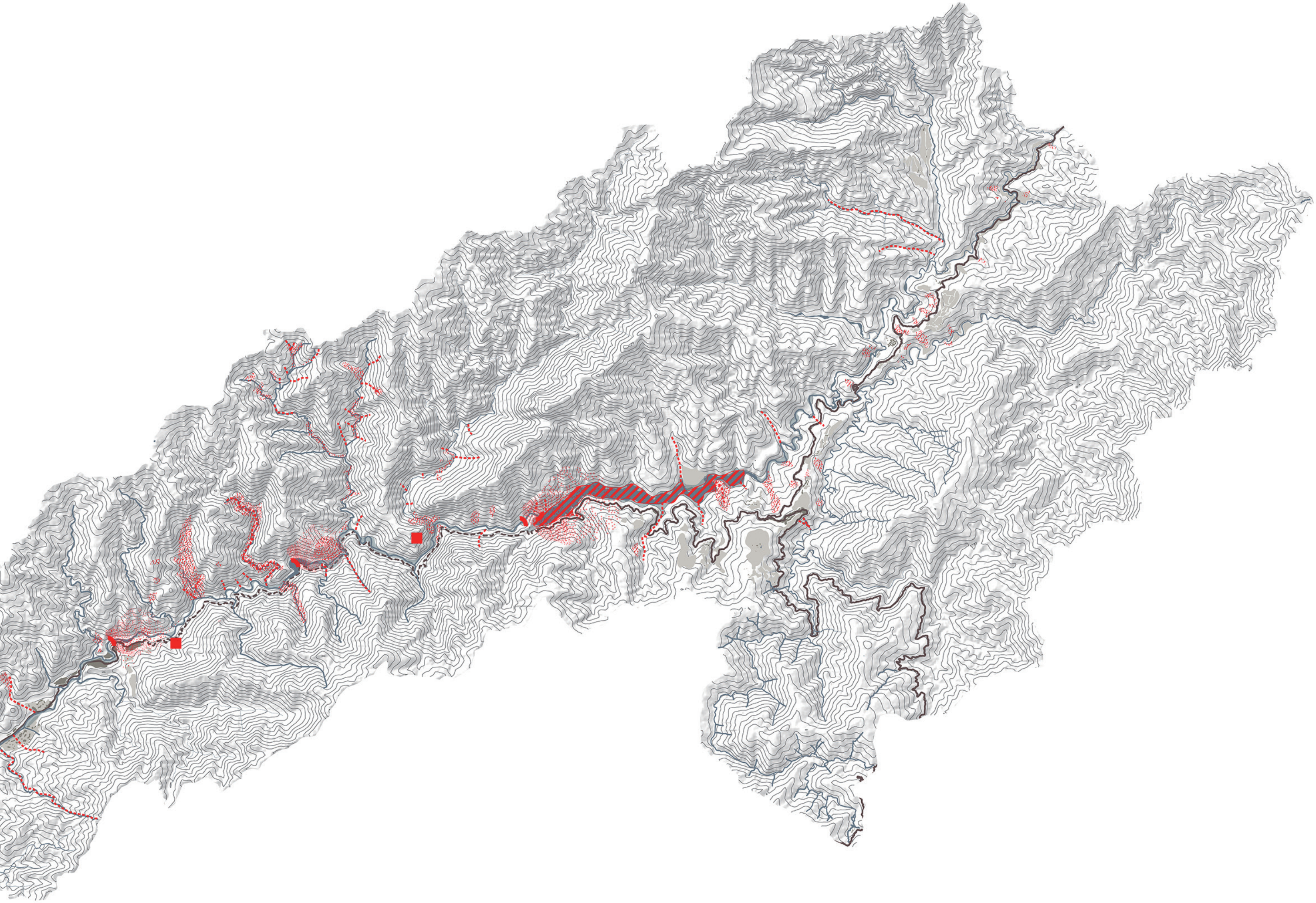


The sensitive river scape, the sinuous territory

The transformation of mountainous river landscape as territorial infrastructure

Yun-shih Chen

Colophon

P4 PRESENTATION REPORT

Yun-shih Chen
European postgraduate Master in Urbanism Strategies
and Design for Cities and Territories
TU Delft – Faculty of Architecture and Built Environment

Dr. S. Steffen Nijhuis
TU Delft – Faculty of Architecture
Department of Landscape Architecture

Prof. dr. ir. V.J. Han Meyer
TU Delft – Faculty of Architecture
Department of Urbanism

Prof.dr.arch. Paola Viganò

european postgraduate masters in URBANISM strategies and design for cities and territories

Contents

fig. 01 The landscape of Dajia river upstream area, with alpine agriculture activities 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]

"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

I. 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, which is the steepest river with the most water resource, as an example, the project intends to develop a landscape-based strategic plan which will provide a showcase with toolkits, methodology, as well as propose a framework with possible intervention projects dealing with different cases of interaction between human activities and water condition. Furthermore, 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. It is expected that the result of the project can contribute to the field of landscape urbanism in terms of spatial planning and urban design with water in mountainous river scape.

II. Problem Statement

Riverscape and urbanism

Water was the origin of all things, as was specified by the Greek philosopher Thales, while mountains are the origin of water.

The discourse of water management has evolved from technical approaches of hard engineering and hydrology towards landscape urbanism notions in the recent decades, and the role of water in the city is changing (Shannon, K., 2014). Many research teams around the world has been working on this paradigm shift of water management with socio-economic, environmental and spatial transformation. Water urbanism has been coined as an notion and the integration between urban and river scape is largely studied and developed especially in the flood-prone alluvial plains. Nevertheless, the ascending of the discourse of water urbanism towards the mountains, where the high volumes of water and topography create special vulnerabilities (Wiegandt, E., 2008) and thus adds another layer of complexity to the course of water management, is still at the beginning stage.

Being an island born from orogeny and situated at the converging realm of two Earth's plates, with 70% of the lands mountainous and even 28% over 2500 meters above the sea level, the landscape of Taiwan is highly dynamic, sensitive, and fragile. Five mountains stand as the ridge structure of the island at the central axis, which results in all of the rivers in the country relatively short, and most of them flows rapidly and swiftly, running through drastic elevation change in short distances.

Though there is a huge amount of yealy rainfall, the natural landscape character of rivers has made it difficult for keeping water. Besides, the development of human settlements through history can be regarded as gradually invading uphill along the rivers, from agricultural cultivation settling at the alluvial plains towards valleys, and finally entered in the alpine regions, nature was regarded as resource repository and thus activities such as forestry and alpine agriculture were installed into the hilly areas.

The river scape has hence been incrementally infrastructuralized, as shown in the figure 02, which not only deteriorate the ecological quality but also resulted in devastation of landscape which accumulated through years led to the land even more fragile.Added with the impact of earthquake and climate change issues, natural disasters are more and more often seen in recent years, proving that the lack of integration between artificial and natural approaches could not be the answer for the future of mountainous river scape. 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.'

However, considering the compactness of the river scape in terms of the diversity of ecosystem, land-use change, and drastic topography, the cases of Taiwanese rivers has the potential to provide a showcase with methodology and toolkits for a diverse kinds of water-urban relationships, studying how human activity has influenced the natural system and vice versa, and derive from which strategies and spatial frameworks to support a better integration between artificial and natural environments. In the thesis project the basin of Dajia river is selected as the study area, for it is the most illustrative river possessing the steepest route, the largest amount of water resources, complex patterns of land-use change, infrastructure construction, natural disaster problems, as well as local social and economical issues. It is expected that the result of the project can provide an reference in terms of water urbanism for mountainous river scape in other areas in the world.

fig.02 The heavy-engineered infrastructures to manage water resources in the Dajia river valley. Source: photo from mapio.net

... there exist a fertile and necessary opposition between the artifice of the world and the natural condition of the earth, realizing that the one is symbiotically conditioned by the other and vice versa.

--- Martin Heidegger, 1953

III. Problem Analysis

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.

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.

THE LANDSCAPE CHARACTER OF TAIWAN

MOUNTAIN LANDSCAPE

1. Highly dynamic, sensitive, and vulnerable

Taiwan has the highest alpine density among the world. 70% of the nation's land is mountain, 28% of the land is even over 2500M above the sea (fig. 03). With the population density also high, the inhabited area is inevitably overlapping mountainous lands.

Situated at the contact of two Earth's plates, namely the Eurasian Plate and the Philippine Sea Plate, which has been compressing since 6 million years ago and the processes are still ongoing (fig. 04). Therefore the landscape of Taiwan is extremely dynamic, sensitive, and fragile in many aspects. On the other hand, there is also high biodiversity and geo-diversity due to the lively processes of nature.

As impacts of climate change is predicted to bring extremely uneven distribution of rainfalls, as well as shift its seasonality. The high volumes of water and the topography create special vulnerabilities. (Wiegandt, E., 2008) The dynamic, sensitive and fragile characteristic of the landscape make it even more difficult for managing water resources in the mountains of Taiwan.

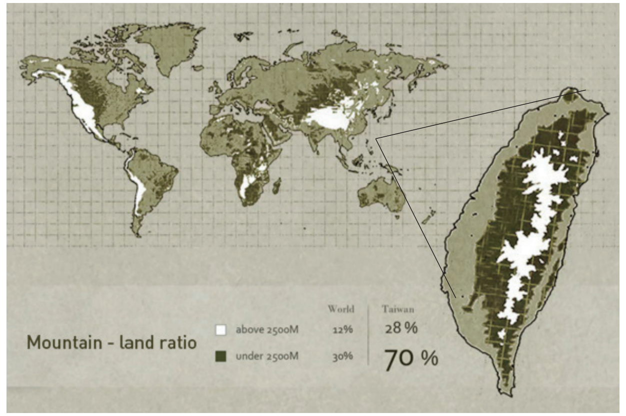


fig.03 World topography & mountain percentage of Taiwan
Source: edited by author based on data from: http://lawr.ucdavis.edu/

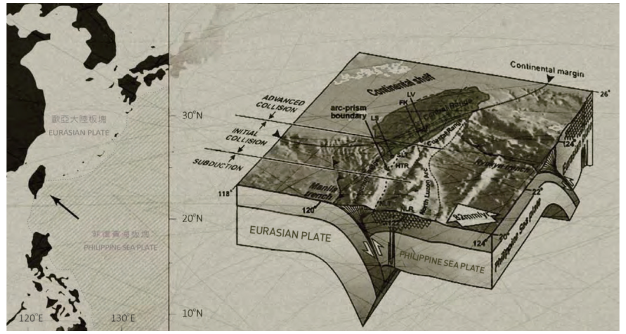


fig.04 The still-ongoing converging process of two Earth's plates, the Eurasian Plate and Philippine Sea Plate, had formed the island of Taiwan.
Source: edited by author based on data from NCU Geology GIS database.

2. Economic importance: alpine agriculture

Alpine agriculture (tea, vegetable and fruits) has been an important part in the nation's agriculture sector. Figure 5 shows that the alpine tea of Taiwan has been exported all over the world. Alpine tourism also attracts a certain amount of tourists. However, both activities caused significant impacts to the ecology, reduces the slope's capacity of absorbing and infiltrate water. From figure 6 it is obvious that the "terracing" of the slopes has reduced the coverage of forest, causing the slopes more vulnerable to erosion and prone to collapse.

The historically dominant activities brings even more challenges for managing water, for its compete with industry, leisure, domestic and energy sectors for mountain water. The decrease of the local economy due to retreating of the industry or the breakdown of connections (e.g. the recurrent collapse of motor road), on the other hand, can be perceived as the trigger of transformation of the local activity. In other words, it is essential to take the chance of transformation of local industry to develop a new water model that maintains a balance between local economy as well as water resource management.

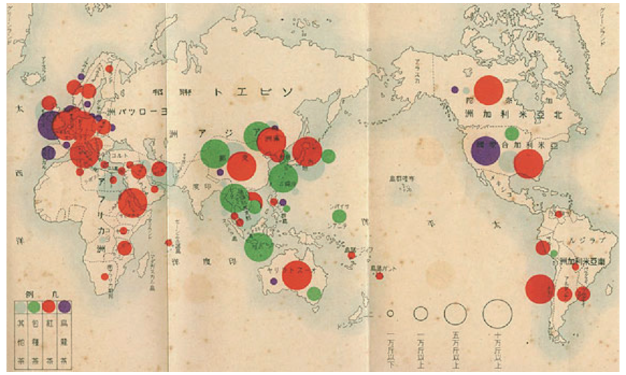


fig.05 Map showing Taiwan's different kinds of tea exporting to the world in 1939. Source: http://www.rhythmsmonthly.com/

fig.06 Over-cultivation of alpine agriculture in the alpine areas.
Source: http://www.rhythmsmonthly.com/

RIVER LANDSCAPE

1. Short and steep rivers

The characteristic of the landscape result in most of the rivers flowing rapidly and swiftly, running through drastic elevation change in short distances. Figure 7 shows that the rivers in Taiwan are generally short, with the longest one only 186 kilometers and many even less than 50 km. Figure 8 shows that compare many rivers in the world, the rivers in Taiwan are relatively short and steep. This has also caused intense erosion, displayed as fragile and dynamic river-basin landscapes, with the over excavation of the mountainous lands and natural disasters such as earthquake and typhoons which further weaken the soil structure, landslides, collapse are more and more often seen in the mountainous villages.

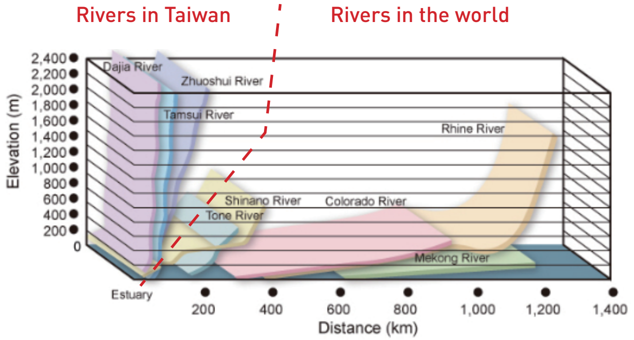


fig.08 Steepness of rivers in Taiwan and in the world
Source: Water Resources Agency, MOEA, Taiwan Government

fig.07 Main rivers in Taiwan
Source: edited by author based on data from Water Resources Agency, MOEA, Taiwan Government

2. Difficult for maintaining water resources

Taiwan has 250% of the world's average rainfall amount, however, only 18% of the world's average water per person (fig.09). The steep routes of the rivers also result in difficulties of keeping water. Today, most of the water resources are captured by building reservoirs and dams (fig.06), which not only further worsen the problems of erosion and sediments, but also breaks the vertical and horizontal corridors, causing enormous impact on ecology and land capacity.

Unit-area Yearly Rainfall (mm/year)	Country	Water resource per capita (cubic meter/year/person)
830	U.S.A	36,500
800	U.K.	3,490
760	France	7,810
810	Germany	3,360
980	Italy	5,330
790	Canada	344,000
660	Spain	9,470
840	China	9,720
1,220	India	6,600
1,630	Brazil	130,000
1,820	Japan	6,060
2,510	Taiwan	4,595
world average: 730		world average: 28,300

fig.09 Comparison of rainfall and average water resources
Source: edited by author based on Data from National Taiwan Museum Water Resource exhibition

3. The decreasing life-span of reservoirs

To keep the water requires reservoirs. However, the fragility of the landscape character has limited the possible locations for building reservoirs in some specific dam sites. Today, there is almost no more dam sites available to construct new reservoirs (see figure 10).

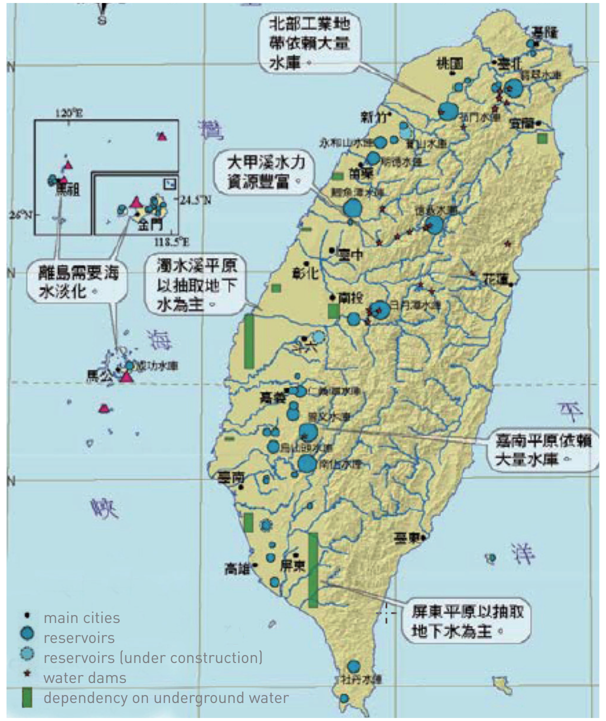


fig.10 Reservoirs and water dams in Taiwan Source: Water Resources Agency, MOEA, Taiwan Government, translated by the author

Furthermore, with most of the river's sediment-transport volume already high and was worsened after the big earthquake in 1999, which has loosen the soil and geology of the mountainous lands, and thus largely increase the amount of sediment accumulated into the reservoirs. Now averagely 30% of the effective storage spaces in the reservoirs have been filled with sediments, with some even over 60% filled (fig.11).

In fact, it is estimated that in 2030, the total volume capacity of all reservoirs together will lose 50% due to sediment accumulation. This will cause about 4.5 million people living in lack of water daily. And it is almost impossible to dredge and clean the sands and muds out of the reservoirs both in terms of fiscal cost and physical spaces for trucks and putting sediments.

fig.11 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]

NATIONAL PLANNING V.S. LANDSCAPE

1. Population concentration in Northern Taiwan

Today there is almost fifty percent of the population concentrate in northern Taiwan (fig. 12), and the trend still goes on. The imbalanced population distribution caused many problems such as unfair resource distribution, young-people leaving in the central-west and southern Taiwan, as well as the over congestion, unaffordable housing, social conflict and land capacity problem in northern Taiwan which is further threatened by risks of soil liquidation.

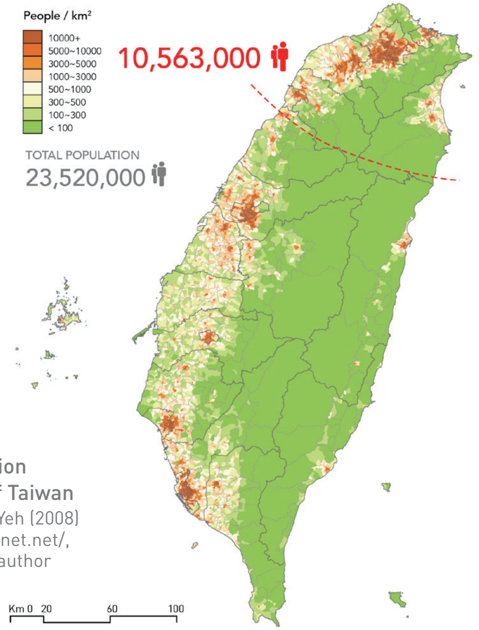


fig.12 Population Distribution of Taiwan
Source: Map by Yeh (2008) http://richter.pixnet.net/, modified by the author

2. Neglected landscape quality and potentials

There is a lack of attraction and identity of the other cities in Taiwan, while Taiwan's landscape character can be regard as a nature "green heart" with "blue outlines", and the river scapes can be perceived as diverse territorial corridors, with the cities in these river territories being important node that contributes to the shared river scape and derive identity from the landscape quality (fig. 13).

Therefore, this project aims at exploring the landscape potential of Taiwan, by taking Dajia river scape as an example, in developing a landscape-based territorial strategy which will integrate social, economical and ecological aspects in transforming the landscape as infrastructure.

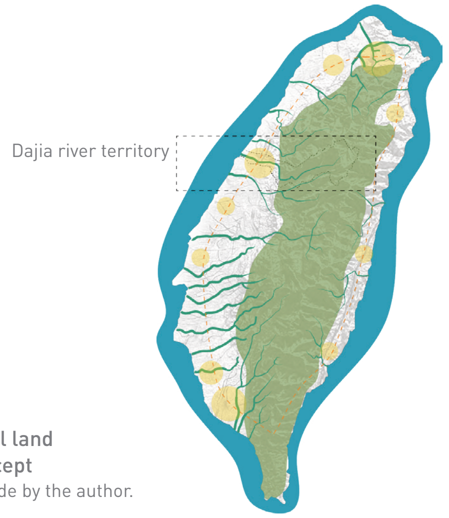


fig.13 The national land development concept
Source: diagram made by the author.

Dajia river catchment: an extreme case

Dajia river located 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, with slopes ranging from 1/16 to 1/100, being the steepest river in Taiwan (fig. 14 and 16), and is a typical riverscape which flows rapidly and swiftly with strong erosion and 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 (see fig.15), with as large as around 2,500 mm difference between mountainous and plain areas, representing the extremely uneven distribution of precipitation in the territory. The annual runoff is about 2.6 billion cubic meters, and the peak discharge at the river mouth is 10,300 in 100-year return period (which is currently used as discharge management standard).

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. Dajia river has the highest amount of water resources among all rivers in Taiwan. There are currently 6 reservoir/dams and 5 power plants along Dajia river, the density of reservoir is also the highest among the whole country. From figure 17 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 is a serious sediment accumulation in all the reservoirs.

The hydro-electricity generation, though demonstrating sustainable energy symbols, the 6 power plants all together produces however less than 1% of the total electricity consumption in Taiwan. Besides, their frequent collapse during typhoon and heavy rains have been taking more economical and social costs than the benefit they could generate (Chang, 2013).

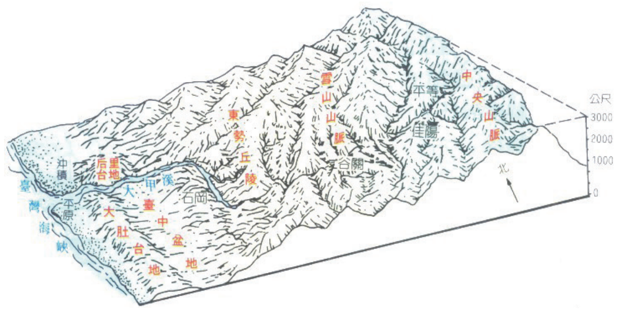


fig.14 Topography of Dajia river valley
Source: http://www.tlsh.tp.edu.tw/

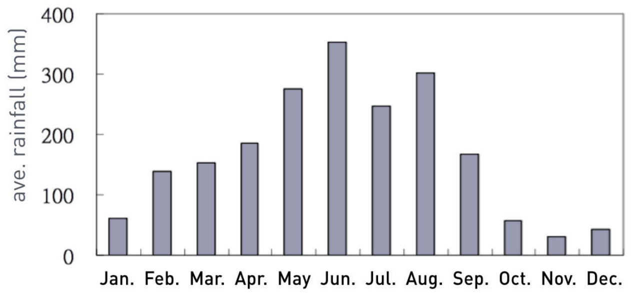
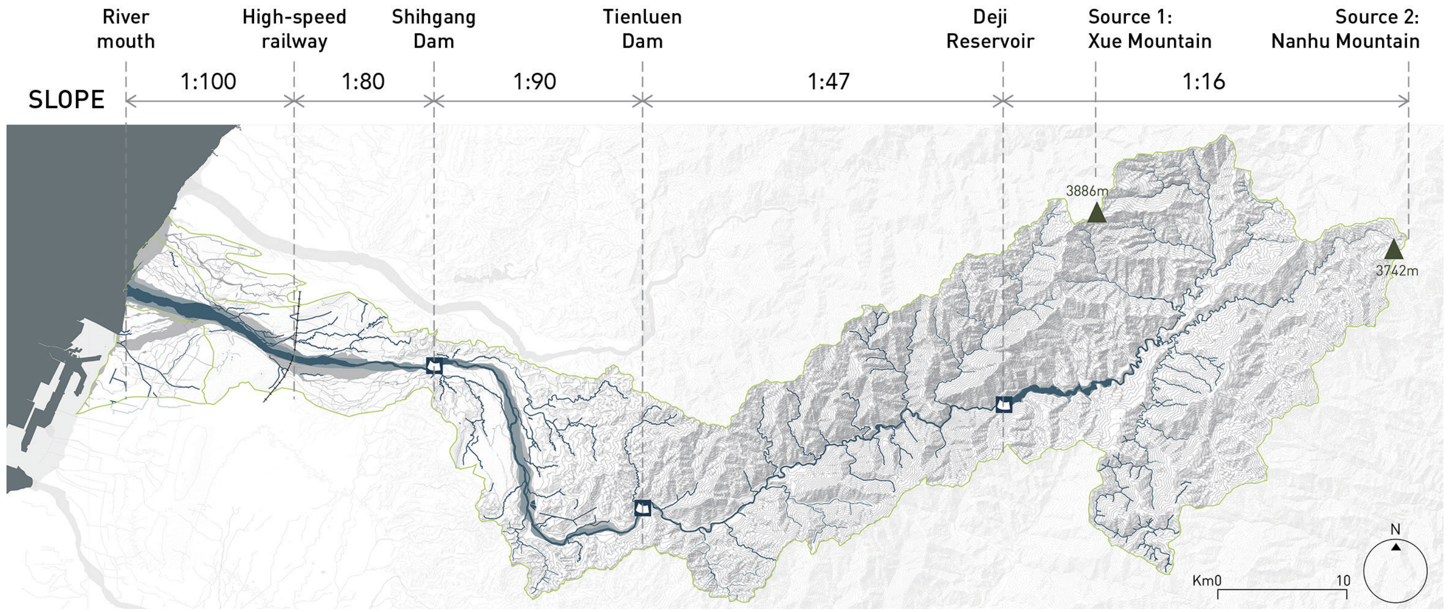


fig.15 Monthly average rainfall in Dajia catchment
Source: Water Resources Agency, MOEA, Taiwan Government

fig.16 (above) 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



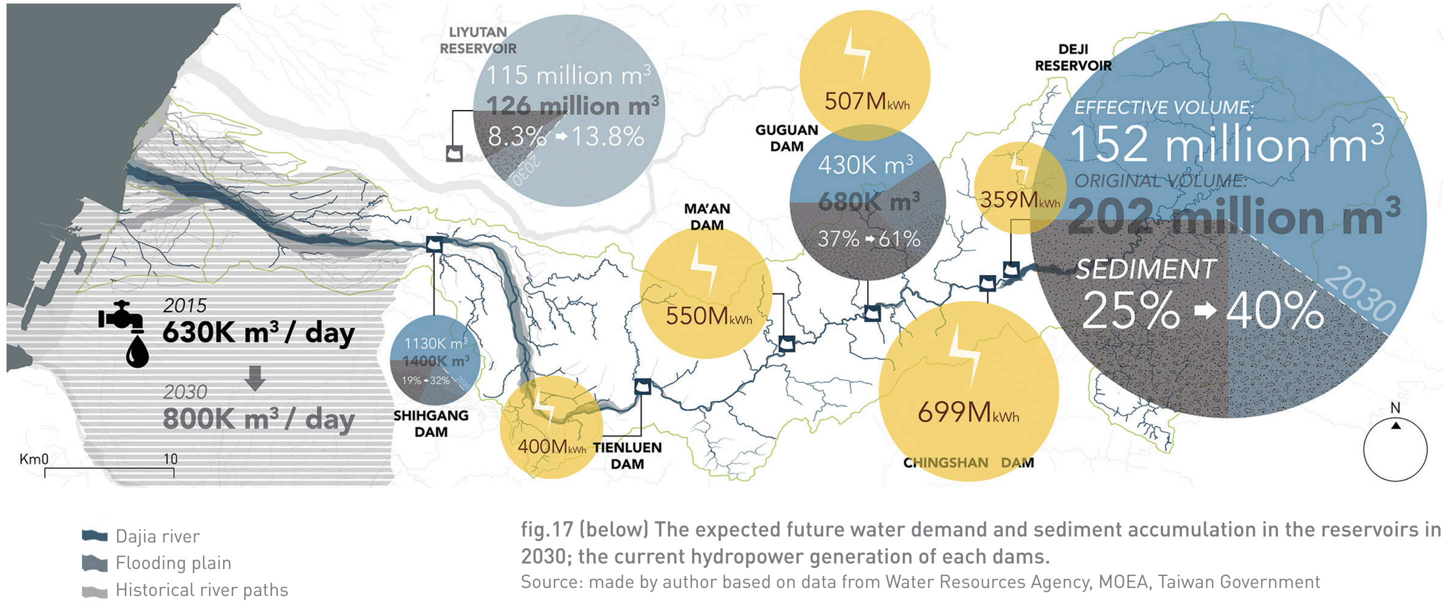


fig.17 (below) The expected future water demand and sediment accumulation in the reservoirs in 2030; the current hydropower generation of each dams.
Source: made by author based on data from Water Resources Agency, MOEA, Taiwan Government

DIVERSITY OF LANDSCAPES AS A POTENTIAL

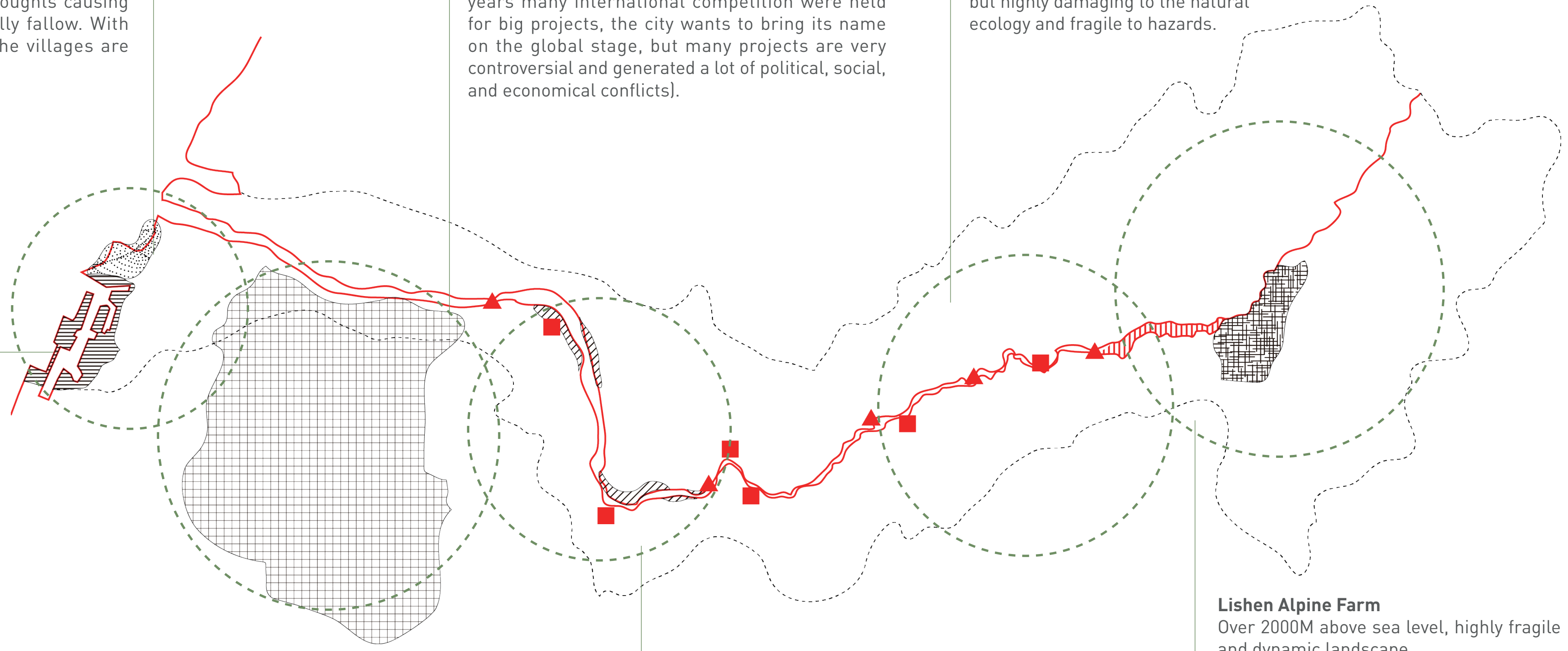
From upstream towards downstream, the landscapes of the river balley comprise alpine agriculture farms, infrastructures (reservoir, dams, and power plants), valley villages, the dense populated metropolitan areas (Taichung city, the third biggest city in Taiwan), as well as a fishing port and protected wetlands at the river-mouth (fig. 18). 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 with 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 rivermouth, formed the wetland landscape of Kaomei area, but also the marginalization of the agricultural settlements nearby.

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.

Lishen 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.

fig.18 The diverse environmental contexts and urban mophologies of Dajia river valley
Source: made by author

Future water risks of Dajia River catchment

THE INCREASING THREATS

The increasing influence of climate change has resulted in the overall situation of weather become even more extreme. In recent years, the supposedly rare situation of extreme 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 draughts are increasing significiently (fig. 19).

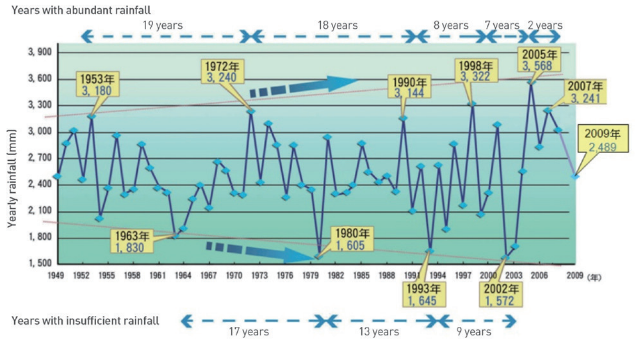


fig.19 Statistic charts showing the extreme rainfall events in the recent 60 years. Source: Speech slide of Lee, H.Y. (2014) [online] available at: https://www.slideshare.net/codefortomorrow/how-can-goverments-be-smart [accessed 10 Apr, 2017]; translated by the author

fig.20 Photo of farmers protest for lending water to Taichung industrial area and science park. The current water infrastructure unable to fulfill the water resource demand, which very often generates social conflicts. Source: photo from Appledaily news [online] available at http://www.appledaily.com.tw/ [accessed 9 Mar. 2017]

RISK = VULNERABILITY x THREAT

The maps on the following pages show the estimation done by Water Resources Agency of Taiwan government, the water resource related risks in the Metropolitan area of Taichung, whose water supply currently rely heavily on the water infrastructures along Dajia river, according to the vulnerability characteristics of each district. It can be observed that within the range of the Dajia river catchment, many of the districts suffer higher than average the risks of life and property in the events of big rainstorms. Though heavily engineered, the infrastructure system could not adapt to the coming future threats in dealing with water both within the catchment itself as well as the related metropolitan area. This can result in conflicts between different stakeholders in competition of water and investment in facility, which is already taking place in many events. For instance the conflict between agriculture and industrial areas in distribution of water during draughts, leading to a growing distrust between people and government, making integration of resources even more difficult (fig. 20).

FLOOD AREAS AFTER 24 HOURS OF RAINSTORM

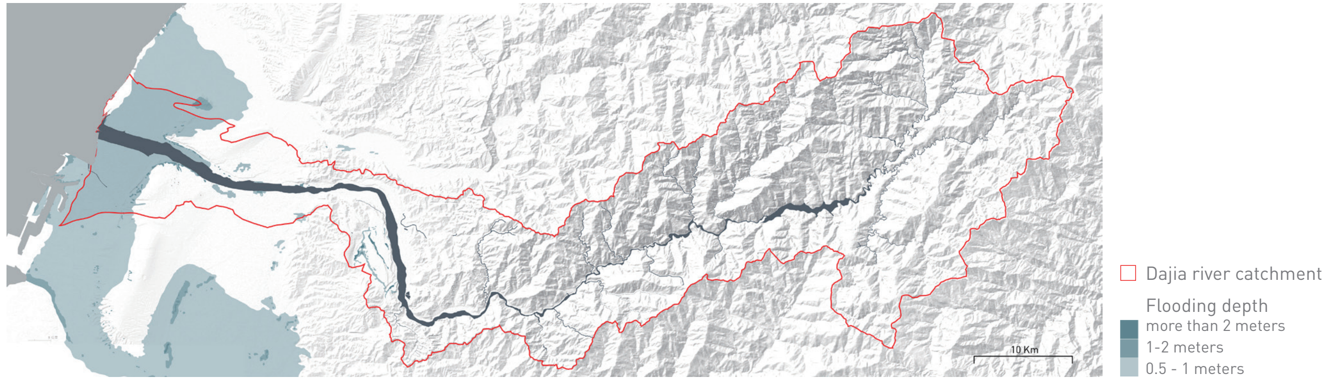


fig.21 Flood simulation in situation of 24 hours of continuous rainstorm (daily rainfall 500mm). Source: map redrawn by the author based on data from National Science and Technology Center for Disaster Reduction, NCDR, Taiwan Government.

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

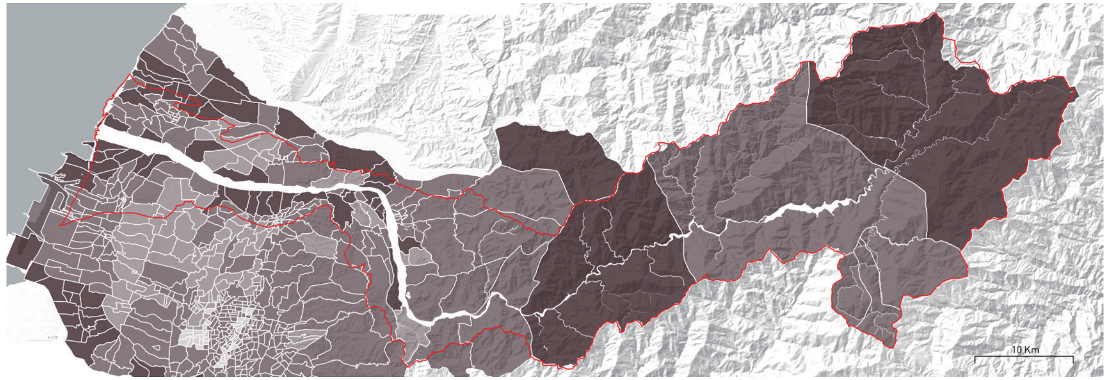


fig.22 Life risks in 24 hours of 200-year-return rainstorm of Taichung Metropolitan area in 2035.
Source: map redrawn by the author based on data from National Science and Technology Center for Disaster Reduction, Taiwan Government.

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

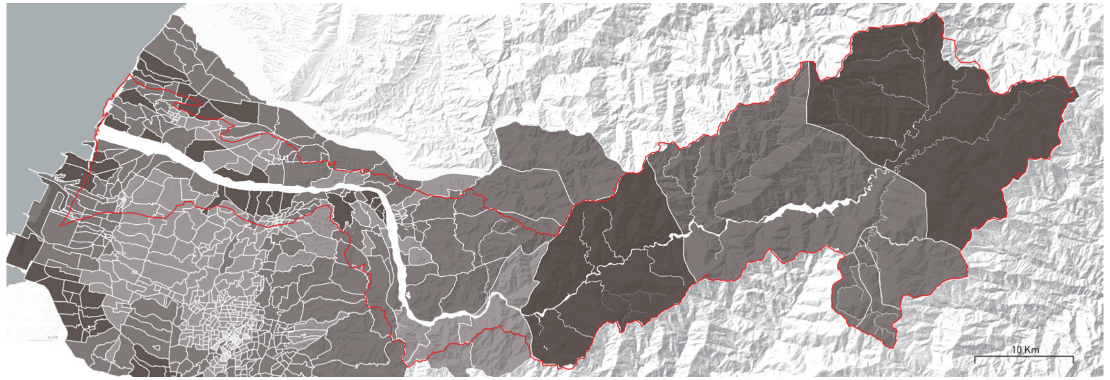


fig.23 Property risks in 24 hours of 200-year-return rainstorm of Taichung Metropolitan area in 2035.
Source: map redrawn by the author based on data from National Science and Technology Center for Disaster Reduction, Taiwan Government.

DRINKING WATER RISK IN 2035

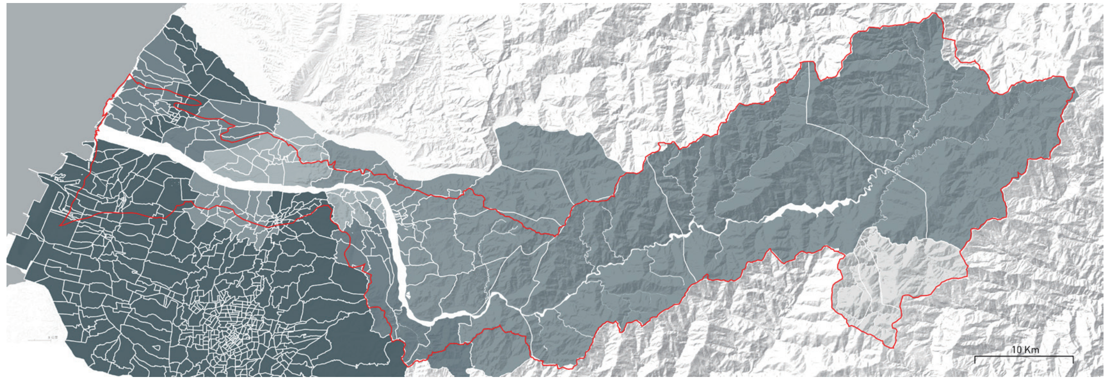


fig.24 Map of drinking water risks in 2035.
Source: map redrawn by the author based on data from Water Resources Agency, MOEA, Taiwan Government.

CURRENT URBAN OCCUPATION IN DAJIA RIVER VALLEY AND WATER DEPENDENT AREAS

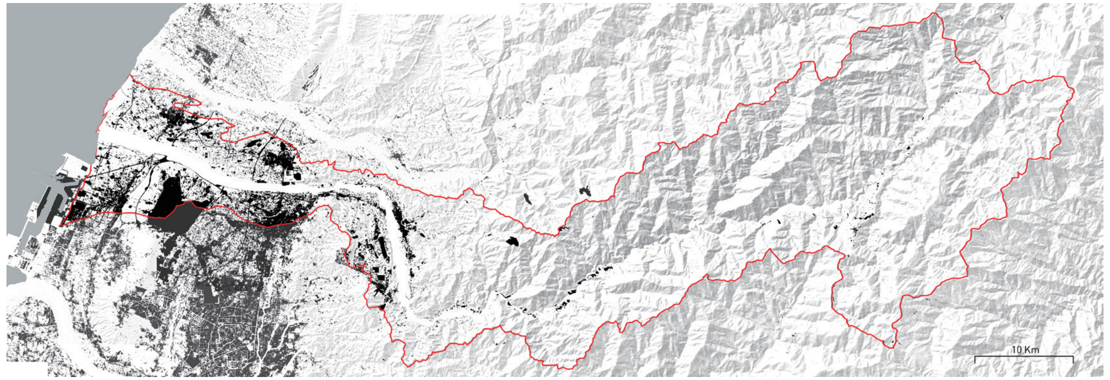


fig.25 Current urban occupation in the area dependent in water resources of Dajia river catchment.
Source: map made by the author based on data from National Land Surveying and Mapping Center, MOI.

AGRICULTURAL WATER RISKS IN 2035

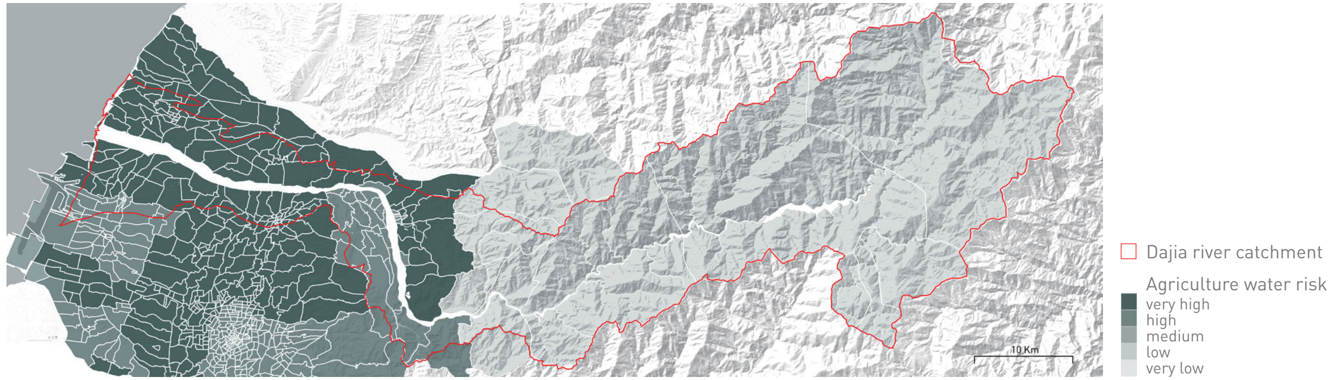


fig.26 Map of agriculture water risks in 2035.
Source: map redrawn by the author based on data from Water Resources Agency, MOEA, Taiwan Government.

CURRENT AGRICULTURAL DISTRIBUTION: DRY AND WET FARMING

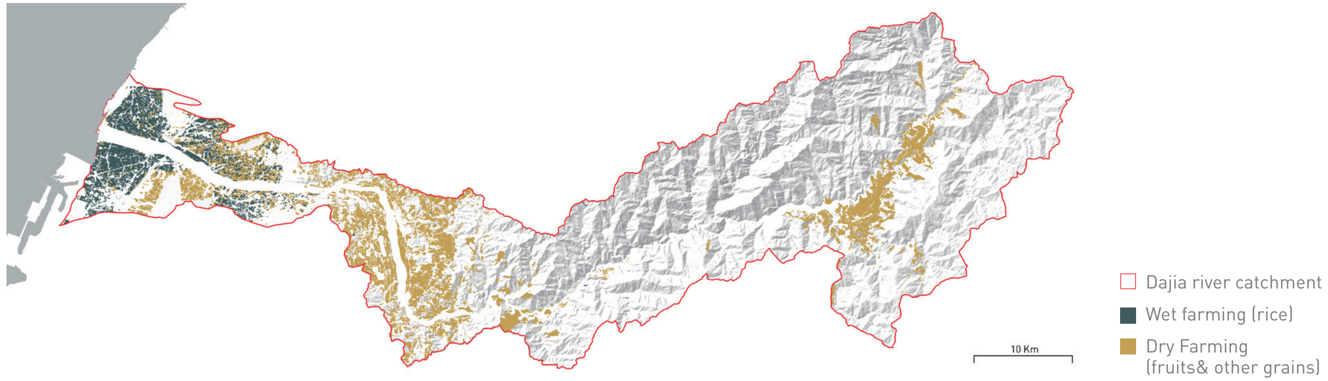


fig.27 Mapping of current agriculture types and distribution in Dajia river valley.
Source: map made by the author based on data from National Land Surveying and Mapping Center, MOI.

INDUSTRIAL-USE WATER RISKS IN 2035

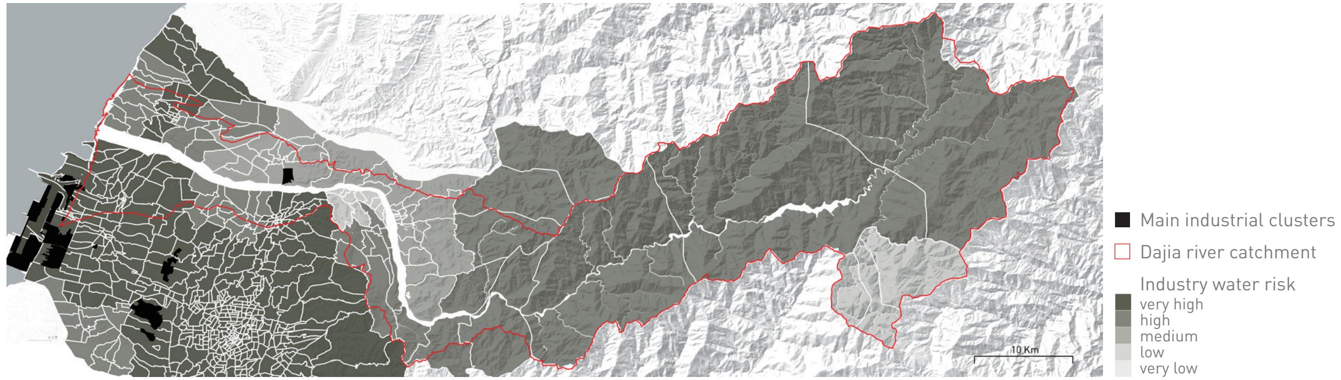


fig.28 Map of industrial-use water risks in 2035 in Taichung Metropolitan areas.
Source: map redrawn by the author based on data from Water Resources Agency, MOEA, Taiwan Government.

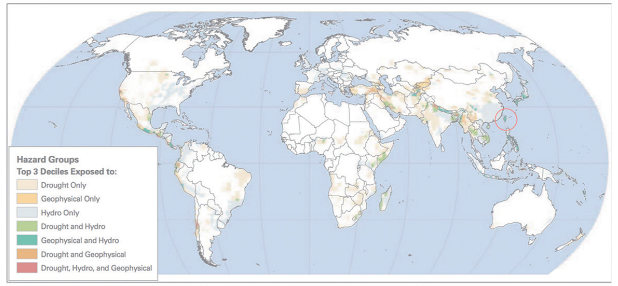
With the coming threat of future weather events getting unpredictable and drastic, as well as the water facilities (reservoirs, dams) displaying more often breakdowns due to weather hazards, which haven't found an effective solution, the existing water infrastructure of Dajia river requires a transformation with a more integrated strategy and a better synergy of natural flows, human activities and landscape quality

IV. Theoretical Framework

This thesis explores the landscape potentials of a representative Taiwanese river valley territory. Decades of urbanization and infrastructure installation for extracting resources -- water, power, food, etc -- to support urban functioning manifested a straightforward, simplified, hard engineering to control natural forces or geology limitations. With the inherent volatility and fragility of the land, the accumulating patterns of human-modification has made the river valley highly water-sensitive and maintaining of water resources extremely difficult. Increasingly common events of flooding and water outages have proven the current water infrastructure unable to deal with the more and more frequent extreme weathers, nor able to compensate for the irreversible damage to the ecology and socioeconomic deterioration of local communities. Moreover, the augmentation of unpredictability and density of extreme hazards (fig.29) is inevitable in a future that is far closer than expected. In the highly uncertain environment, it is however certain that the present model of water infrastructure, already incapable to maintain existing quality, will only be unable and inflexible to adapt to the coming rapid changes.

Therefore, this thesis seeks a landscape-based alternative for the water infrastructure which is able to prompt an integration of space structuring elements with the territorial context, so that the infrastructure not only serves utilitarian demands, but performs operation that is responsive to ecological, cultural, economic, and social aspects of the environment. The notion of landscape urbanism regarding landscape as a model for space making (Allen, 2001) will be commenced as the body of knowledge and within which, the theories of landscape as infrastructure will be explored in this project. Furthermore, as topography adds another layer of complexity to the context, several principals of designing landscape as infrastructure, and as structuring elements for the urban spaces, will be derived from case studies of mountainous water management worldwide.

Global Distribution of Areas Highly Exposed to One or More Hazards, by Hazard Type



Note: Geophysical hazards include earthquakes and volcanoes; hydrological hazards include floods, cyclones, and landslides.

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				
Hong Kong, China	100.0	100.0	2	Lao People's Dem. Rep. of	15.2	12.6	3
Taiwan	99.1	98.9	4				
Vanuatu	80.8	75.6	3	Turkey	15.1	11.3	3
Costa Rica	80.4	69.2	4	Panama	15.0	12.6	3
Philippines	62.2	73.8	5	Swaziland	14.3	14.2	2
Nepal	60.5	51.6	3	Nicaragua	12.4	49.8	3

fig.29 Taiwan being highly exposed to natural hazards.
Source: The World Bank (2005) Natural Disaster Hotspots: A Global Risk Analysis

LANDSCAPE URBANISM AS A BODY OF KNOWLEDGE

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 is capable of describing the radically decentralization urbanization in the context of complex natural environment. The landscape discipline has seen an intellectual and cultural renewal. (C. Waldheim, 2006) The concept of landscape is transforming, 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". Therefore, it is important to rethink the landscape as urbanism, aiming for a better integration between the artificial and natural environment.

In traditional Asian philosophy of space making -- the construction of city, the configuration of building mass, the arrangement of household interior -- emphasized on "feng-shui" (風水), which literally means wind and water, meaning the design of spaces follows the logics of nature. The symbolic meaning of this concept also respond to many local religion and rituals that respect all the elements of nature in the environment, perceiving that there are spirit, god or goddess existing in all objects. In this sense, the power of nature had been well-respected. The traditional agricultural settlements or aborigines tribes in Taiwanese mountains also 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. 30 at next page).

After the over-extraction of woods and over cultivation of hill-tops in the mountains for war resources supply, and for the rapid urbanization and population growth in the post-war period, civil-engineering construction had been leading the urban development and resource management. The aggrandization of economy and efficiency had taken its cumulative toll in the form of deterioration of ecology and severe damages brought by more and more frequent natural disasters. Environment concerns has coming into focus in the design of urban infrastructure and public spaces. However, the urbanism system and engineering expertise and many other related knowledge fields had long been working in compartments. As is or was in many other countries around the world, stated by Pierre 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

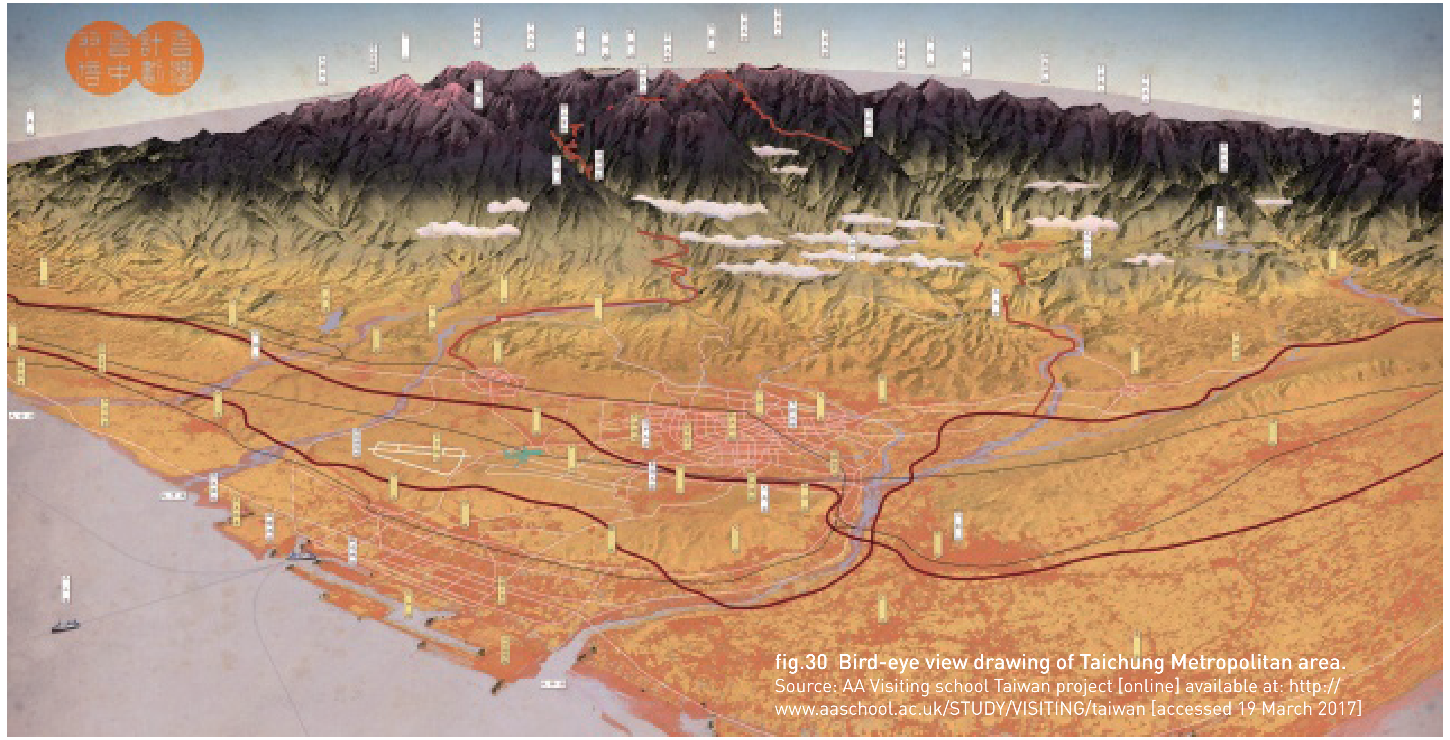


fig.30 Bird-eye view drawing of Taichung Metropolitan area.
Source: AA Visiting school Taiwan project [online] available at: http://www.aaschool.ac.uk/STUDY/VISITING/taiwan [accessed 19 March 2017]

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". However, in the latest decade, more and more people in different disciplines started to recognize the potential of this synergy of cross-disciplinary, through-scale and context-related integration of living and designing with nature. Despite the missing of a cooperation platform and synthesis model, the erosion of the existing engineered structures and the high fiscal and societal cost of recurrent destroying and restoration from 1999's big earthquake onwards had been pushing forward the urgency of rethinking an integration of landscape as urbanism.

Landscape as Infrastructure: The Need of Redefining Infrastructure

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 challenges most of the cities around sooner or later, more or less will be facing: globalization and climate change.

The former challenge 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 their land context. 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 challenge of climate change, on the other hand, has confronted the traditional ways of infrastructure construction. Recent events such as the recurrent breakdown of Central Cross-Island Highway from 1999 onwards (fig.31) or the collapse of dams and hydropower station along Dajia river in 2005 (fig.32) 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

fig.31 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/how-can-goverments-be-smart [accessed 19 March 2017]

fig.32 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]

apparent the impermanence and limited lifespan of infrastructure (Bélanger, 2012). Some 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, which will bring an early end to the lifespan of these infrastructures couldn't yet find a feasible solution, meanwhile the capacity of the nation's land provides very little possibility of expansion or new construction of infrastructure. A rethinking and transformation of infrastructure is urgently necessary.

2. SIMPLIFICATION AND 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 a highly mono-functional 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.

3. THE IMPORTANCE OF VISIBILITY OF FLOWS

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). From infrastructure as landscape to landscape as infrastructure, the 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).

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.

V. Research Questions

MAIN QUESTION:

How to rethink the river landscape and living environment to achieve a more sustainable integration between artifact and nature? Further on, how to build a stronger identity for the territory through the process of integrating river landscape with the living spaces of communities in the cities and villages?

SUB-QUESTIONS:

01. How does it work?

- How has the river scape 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 urgent natural disasters and problems are taking places in the territory? What consequences will occur if we don't integrate the solutions with urbanism thinking?

02. What can we do?

- How to develop a strategy that strengthens the relationship between living space, human activities and water for the villages and cities in the territory?
- How to gradually transform the basin of Dajia River to help managing water resources in a more sustainable way?
- What important elements and features can we identify for different environmental contexts (both ecological and cultural)?

03. How do we apply them?

- What difference/similarity in the strategies and methods can we propose when different landscape and cultural contexts are taken into consideration?
- The local industries distributed within the mountain area, which also affects the alpine environments. How can the left-behind people who used to specialized in local industries be the main actors to transform the river scape in order to integrating of natural landscapes with human inhabitance?
- How can the concepts and principals of "ecology corridor", "alpine conservation corridor", "eco-tourism", "porosity" ..etc., help developing the through-scale strategy and methods for transforming the river scape?
- What if we develop a "Sponge Taiwan" that absorbs and maintains water in a local and more sustainable way, instead of huge infrastructure that brings big impact to the landscape?

04. What can we learn from that?

- How to categorize the strategies, methodologies and proposals of interventions in the project into a toolkit for different contexts in mountainous river scape?
- What difference/similarities can we identify when we compare the approaches of water urbanism in alluvial plains and mountainous areas?

Aim and Expected Result

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

The intention is to construct a spatial framework for which the mountainous river landscape 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, and thus better integration of landscape and living environment can be achieved not only in ecological, but also economical and social points of view.

The project takes the basin of Dajia river (fig.33) 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. It is expected that the project for the territory can act as a showcase providing portable methodology, toolkits, and intervention proposals for different cases of interaction between human activities and water of the mountainous rivers. The project will also argue that a good integration between artifact and nature will help the inhabitant build a stronger territorial identity through the landscape quality.

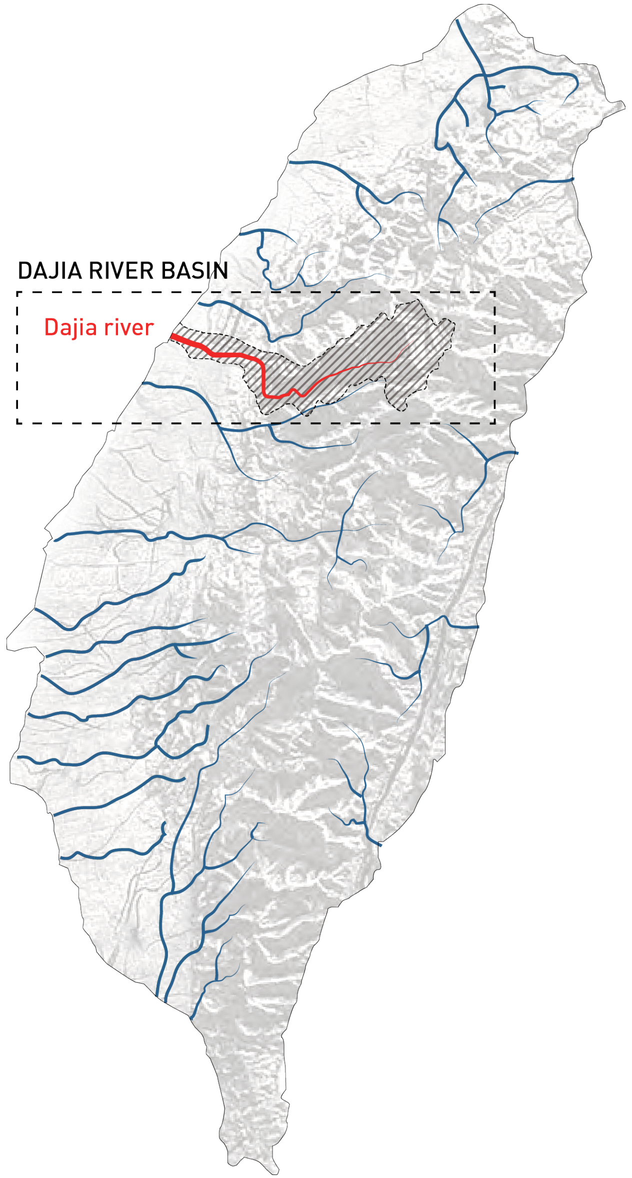
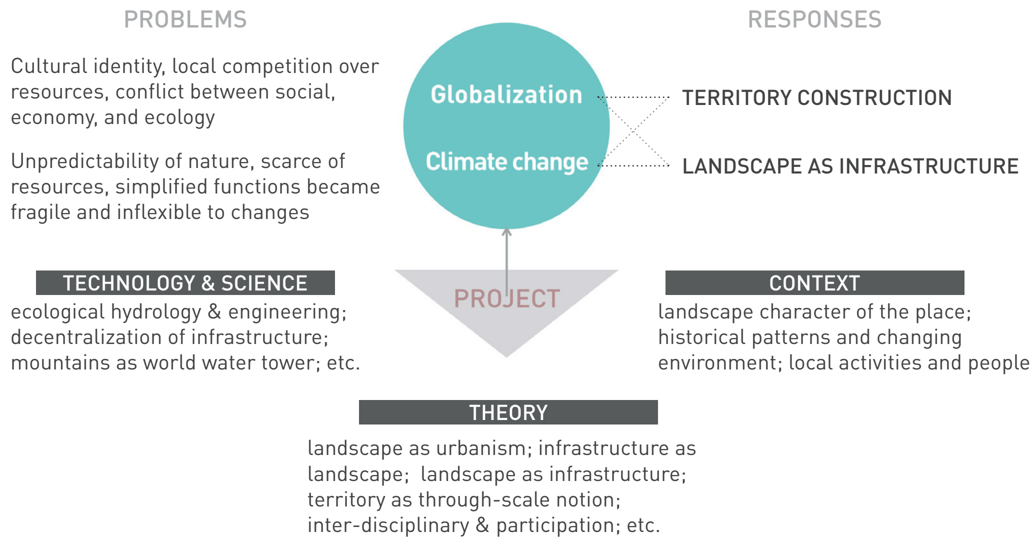
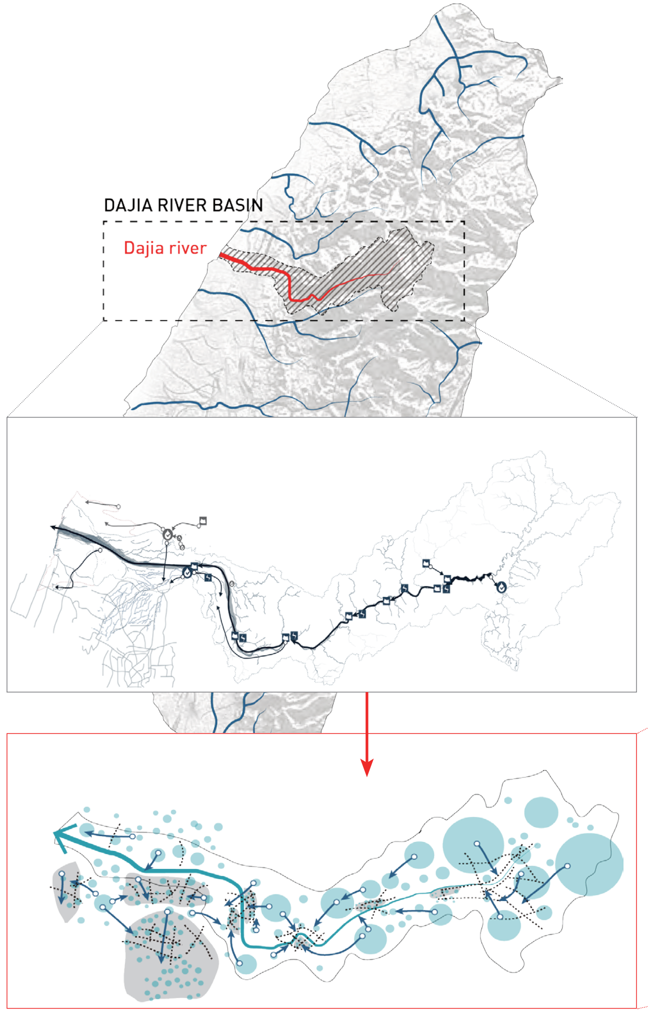


fig.33 Dajia river basin as an representative territory of mountainous river scapes of Taiwan.
Source: edited by author based on data from Water Resources Agency, MOEA, Taiwan Government

At a larger scale, 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 local context-backed 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.



Scenario and Hypothesis



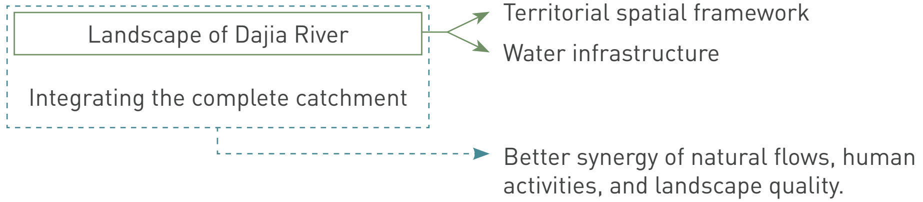
Current water infrastructure:
linear-monofunctional system

SCENARIO: sponge-net system

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?

HYPOTHESIS:



RESEARCH BY DESIGN

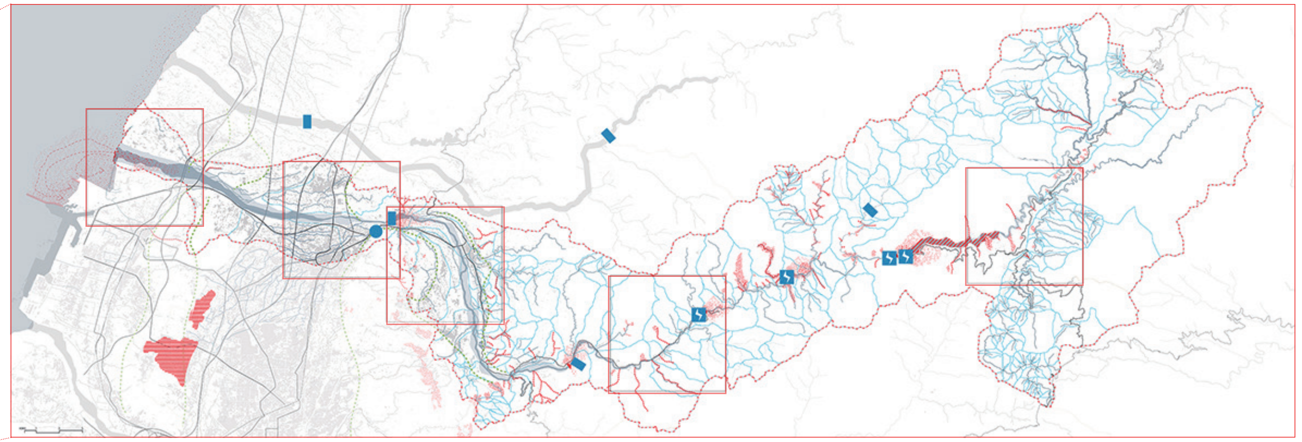
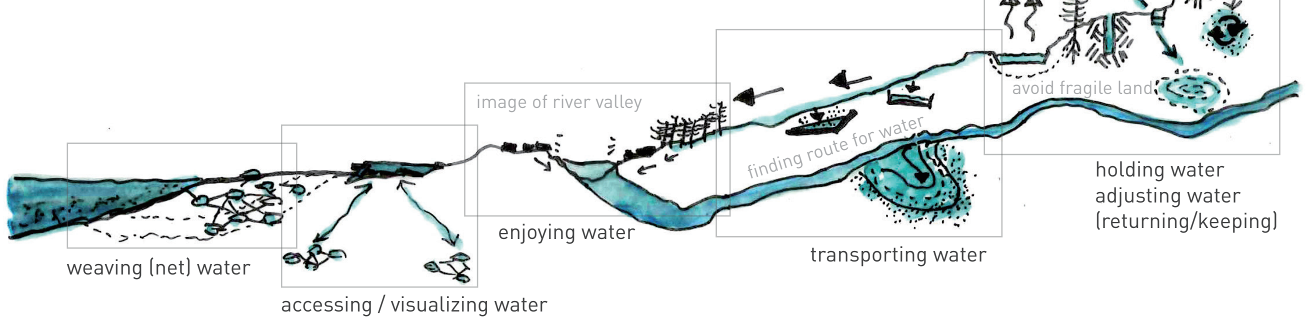


fig.34 Diagram section showing different roles of each area in the mutual connected system of water landscape as infrastructure.
Source: draw by the author



VI. Context

Historical patterns

BEFORE 1850s: NATURE-DRIVEN DEVELOPMENT

- Rivers
- Geological faults
- Sediments accumulation
- Han (Chinese) settlements
- Aborigines settlements
- Agricultural cultivation

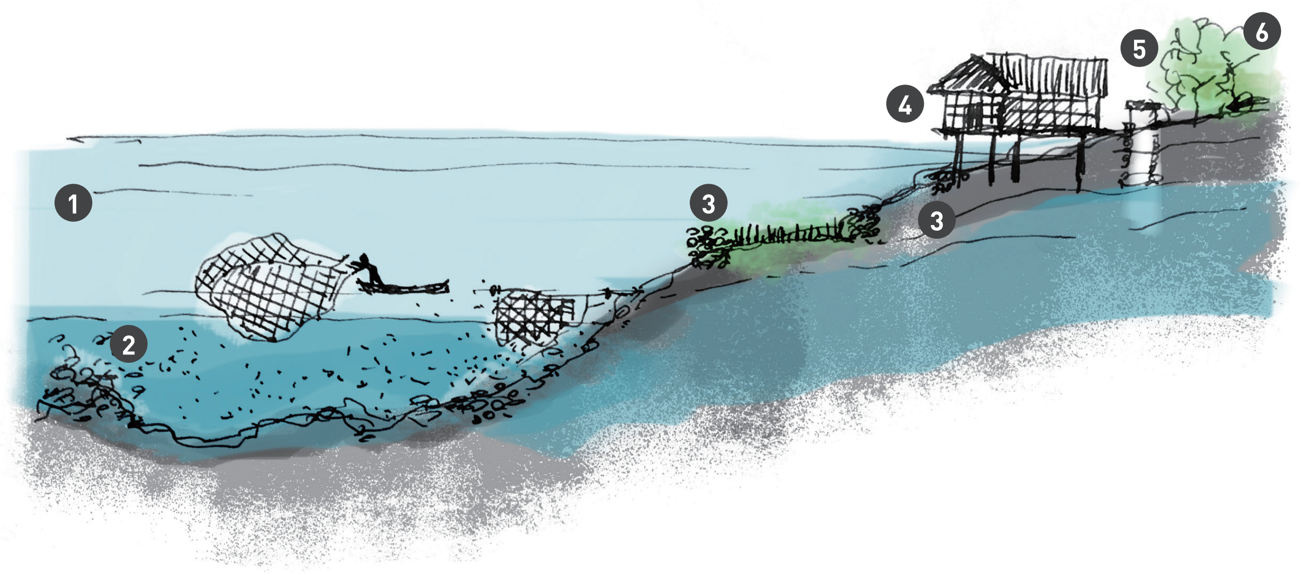
Early settlements development nearby water, especially at the flooding plains at the river mouth(A), and the contact of coastal mountains and plain, where due to some geological faults passing by, there were many springs in the area (B). In the upper streams, within the mountains, on the other hand,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

fig.35 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

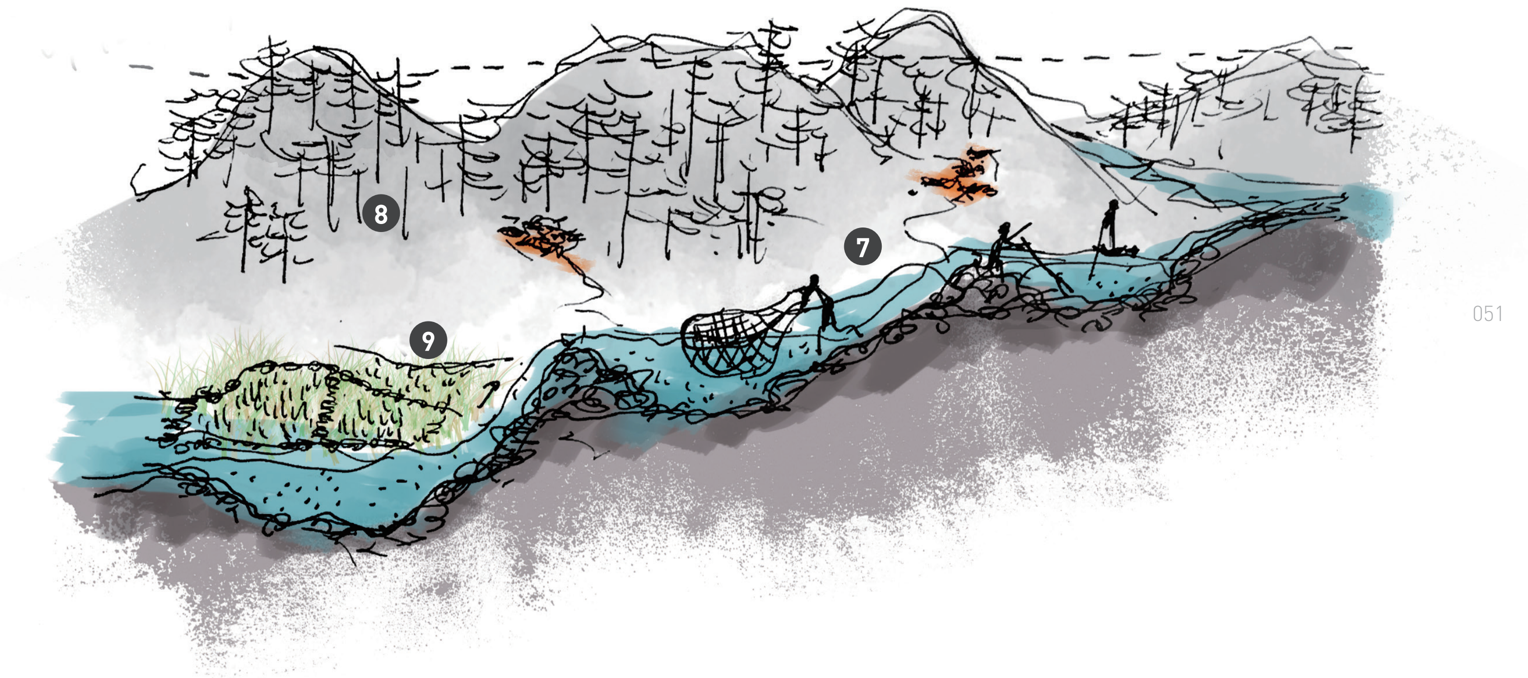
fig.36 Sections of human activities in relation to the Dajia river landscape before 1850s; upstream and river mouth.
Source: by the author based on data from historical maps, historical descriptions, google maps, and GIS databases.

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

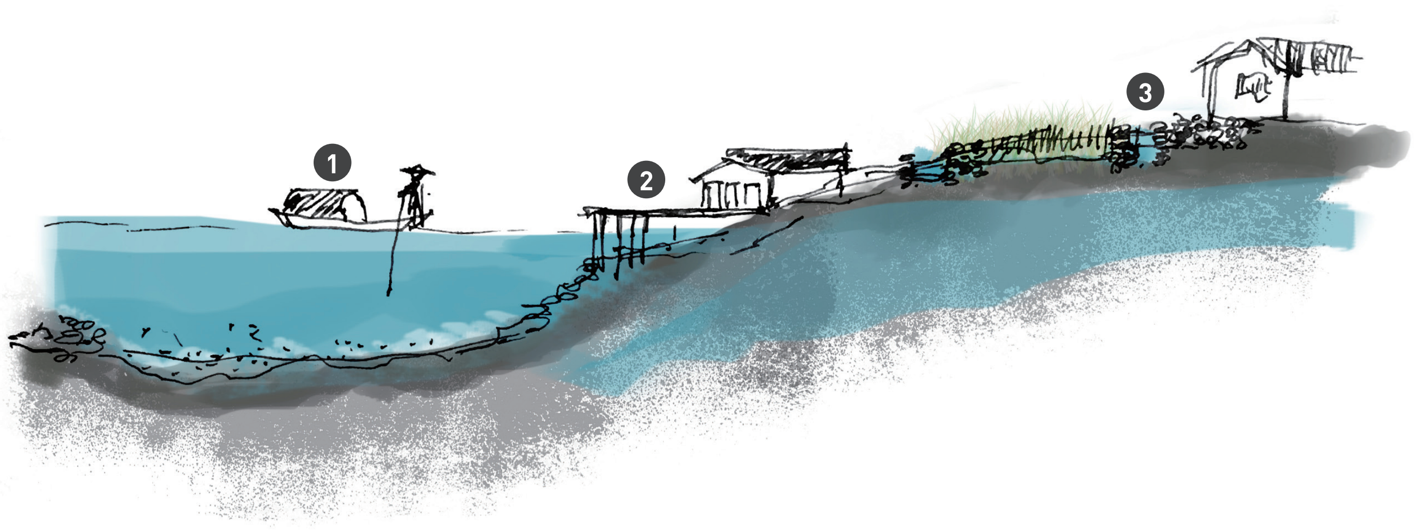
The late Qing dynasty and Japanese colonization regarded the area as resource repository, plains are largely cultivated for suger and rice production (A), with infrastructure such as railway, irrigation drentches, and small harbours constructed to support the industries. In the mountains, the precious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

fig.37 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

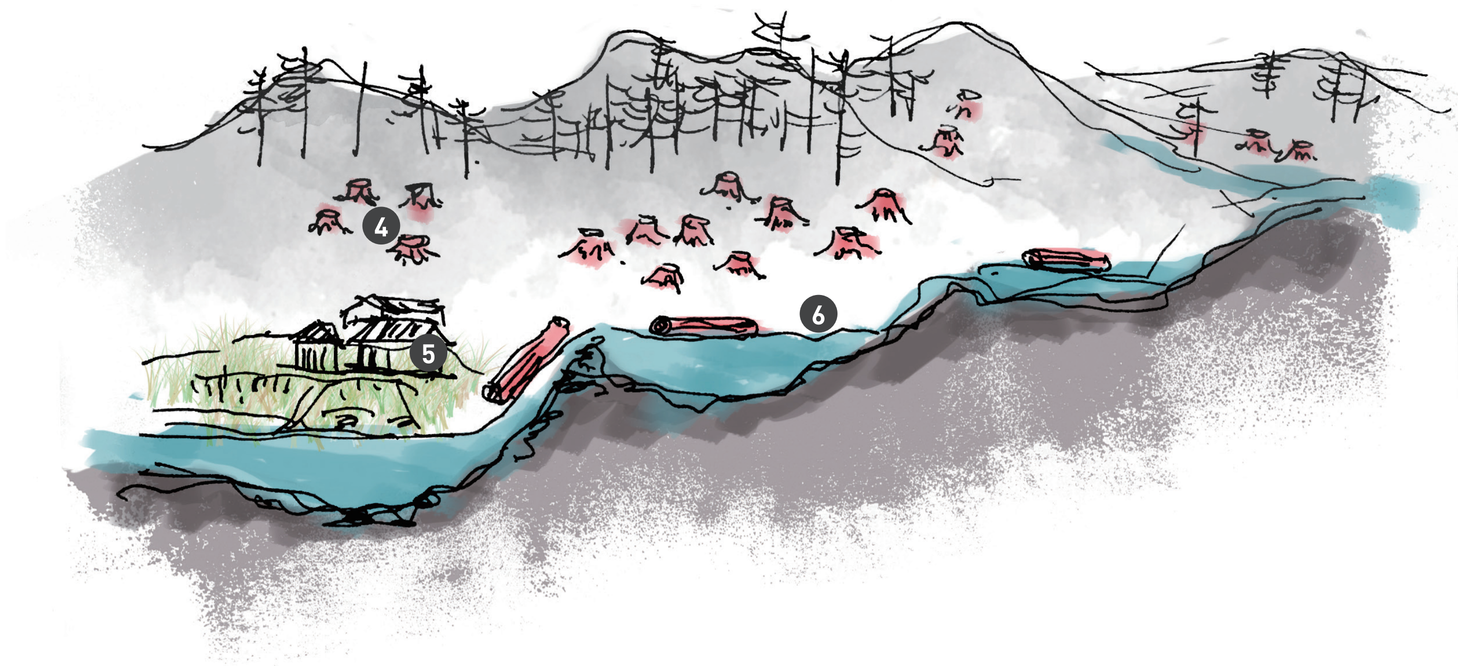
fig.38 Sections of human activities in relation to the Dajia river landscape at upstream and river mouth from 1850 to 1950s
Source: by the author based on data from historical maps, historical descriptions, google maps, and GIS databases.

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

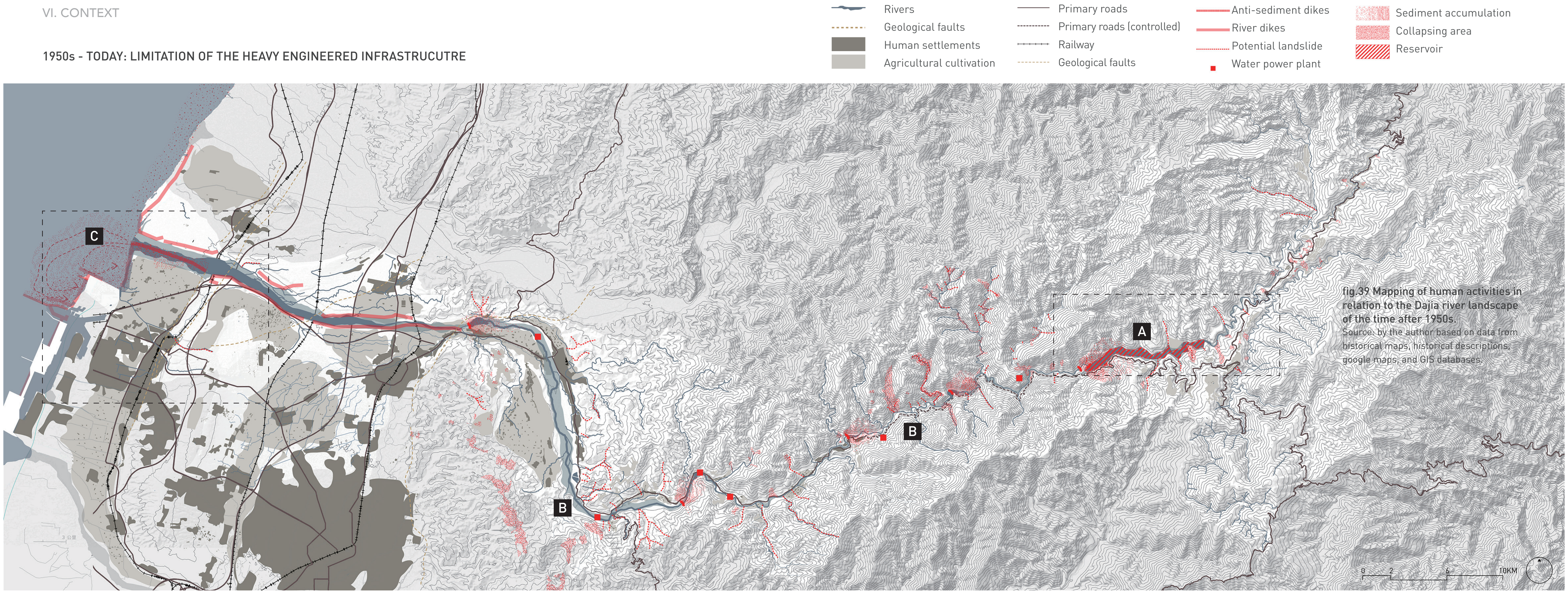


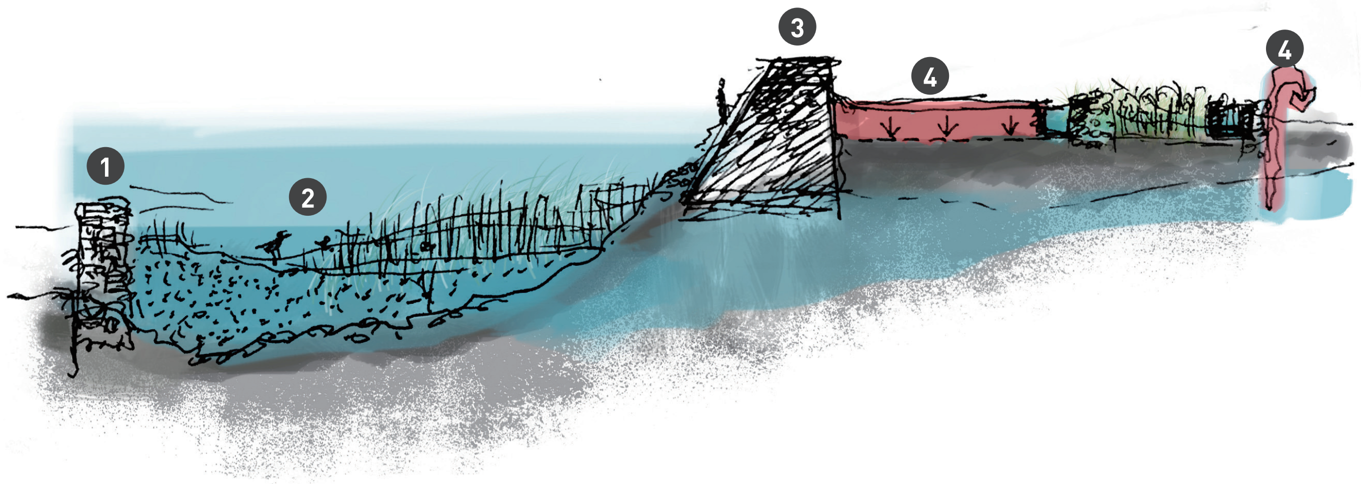
fig.39 Mapping of human activities in relation to the Dajia river landscape of the time after 1950s.
Source: by the author based on data from historical maps, historical descriptions, google maps, and GIS databases.

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 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

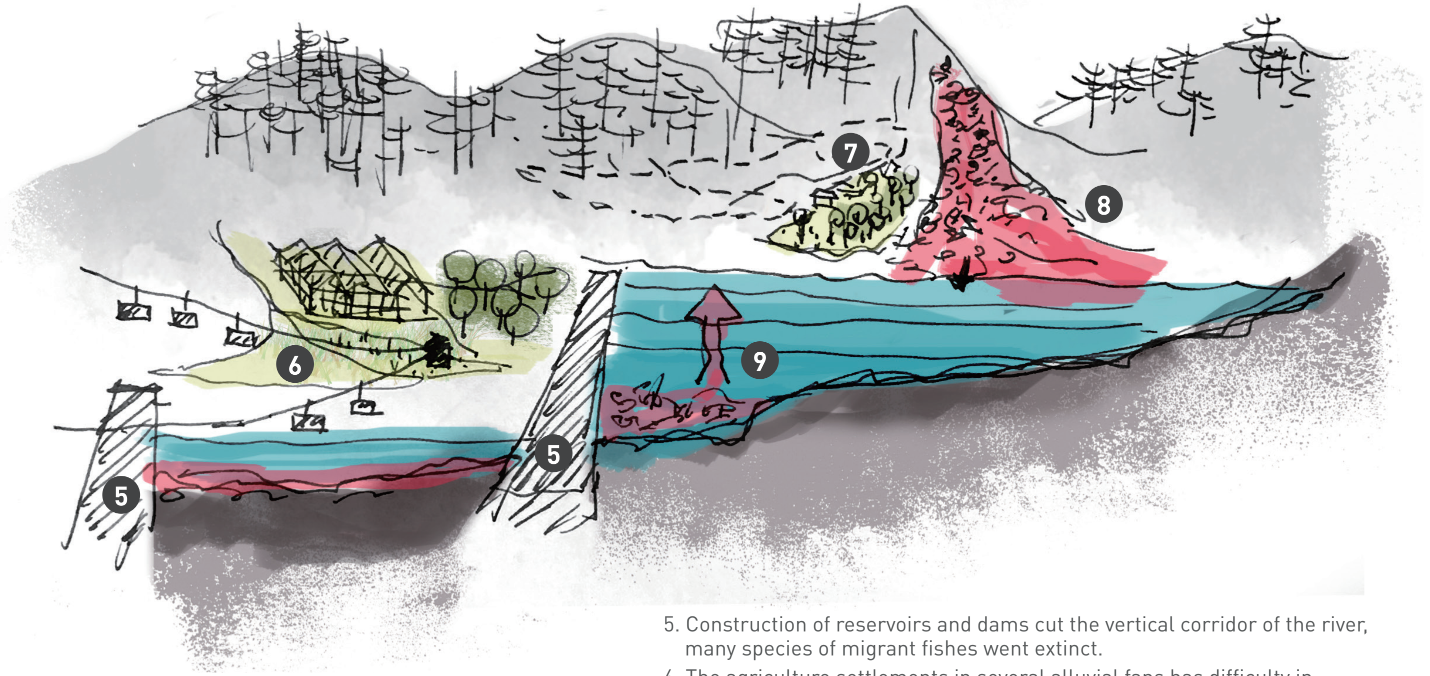
fig.40 Sections of human activities in relation to the Dajia river landscape at upstream and river mouth after 1950s.
Source: by the author based on data from historical maps, historical descriptions, google maps, and GIS databases.

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.

THE CONSTRAINED RIVER SCAPE

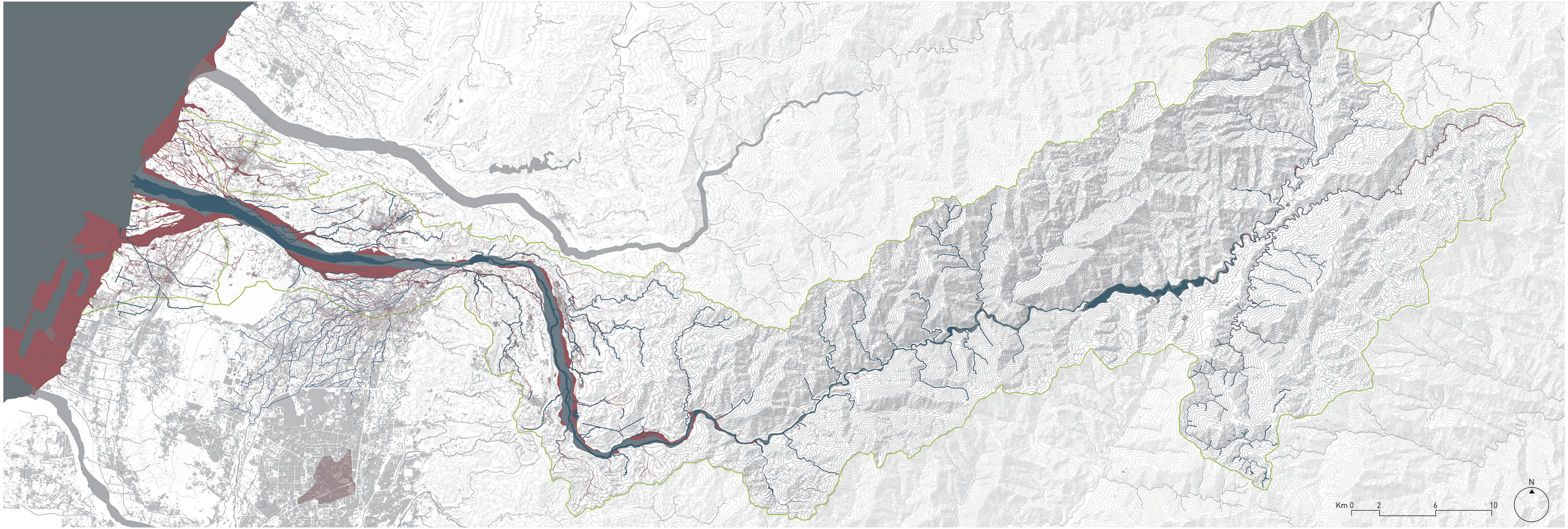
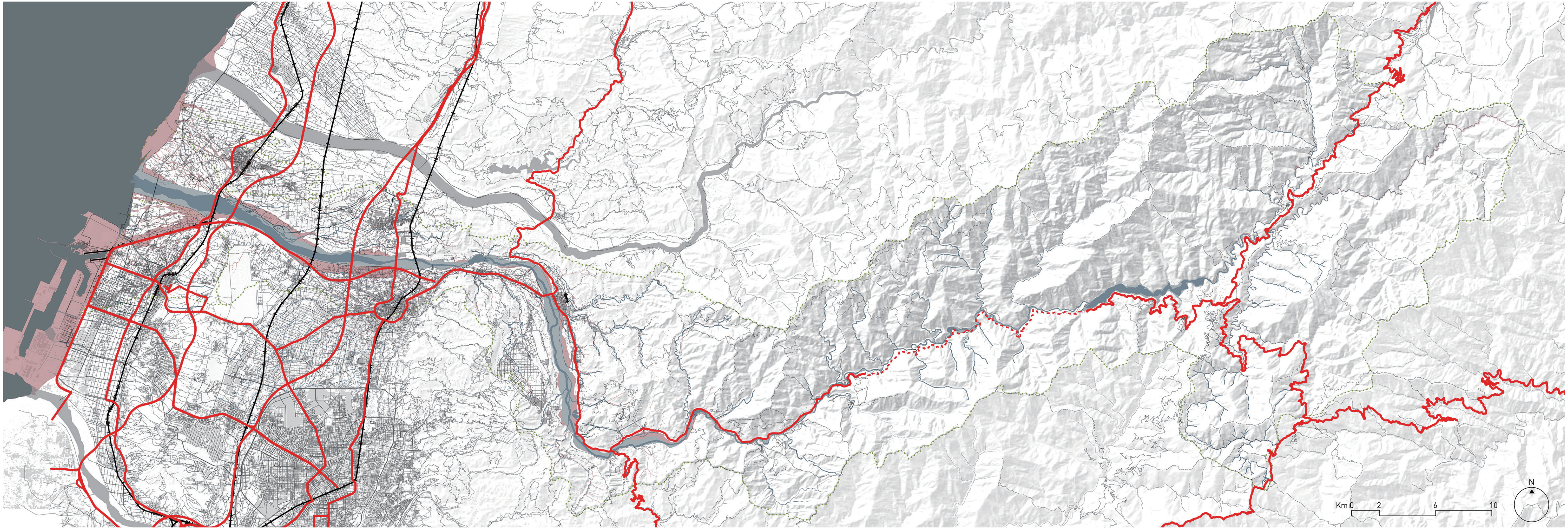


fig.41 The historical river path and urbanized areas.
Source: by the author based on data from historical maps, historical descriptions, google maps, and GIS databases.

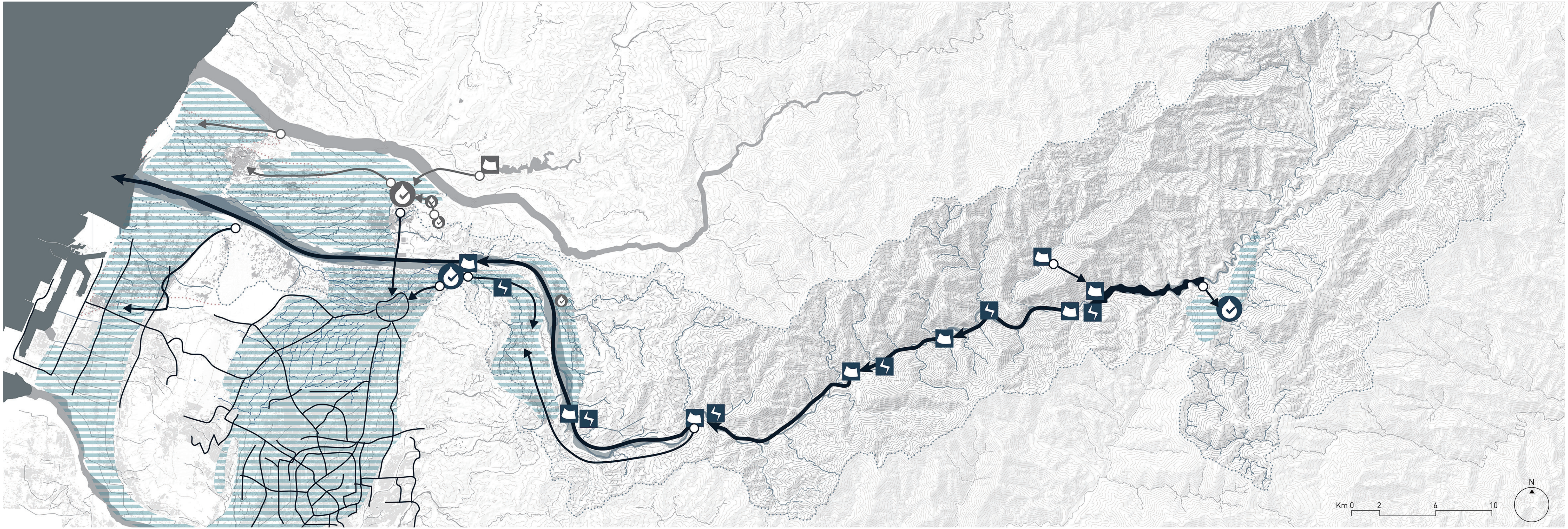
THE GRADUAL INFRASTRUCTURALIZATION: MOBILITY SYSTEM



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

fig.42 The transportation infrastructure in Dajia river valley and Taichung Metropolitan area.
Source: by the author based on data from GIS databases.

THE LINEAR AND MONOFUNCTIONAL WATER INFRASTRUCTURE SYSTEM



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

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 (see fig. 43 at page 67).

Today, the linear infrastructure is neither able to fulfill the current resource demand, nor has it been able to adapt to the drastic climate changes bringing more and more frequent heavy rains and intense discharges. 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 original flows of the landscape.

From the transportation maps we can see (fig. 42 at page 65), the hard infrastructuralization of the Central Cross-island Motorway could not support the recurrent damage of natural disasters. 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, the debate between different groups of people such as local residents, politicians, ecologists, enterprises. The transformation of the infrastructure is necessary, and this can be considered the opportunity to integrate different actors and environmental contexts.

fig.44 The infrastructure that constraints river has also disrupted the relationship between river and city. The photo shows the dike at the near the river mouth at Kaomei area.
Source: photo by ccl.smai [online] available at http://www.panoramio.com/user/2820532 [accessed 14 Mar. 2017]

fig.45 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.46 Photo of tunnels constructed at the Guguan section of Central Cross-island Highway. For 15 years the recurrent destroy and restoration of the roads has caused huge fiscal costs and still cannot solve the problem. Source: photo from Appledaily news [online] available at http://www.appledaily.com.tw/ [accessed 9 Mar. 2017]

Landscape context of Dajia catchment

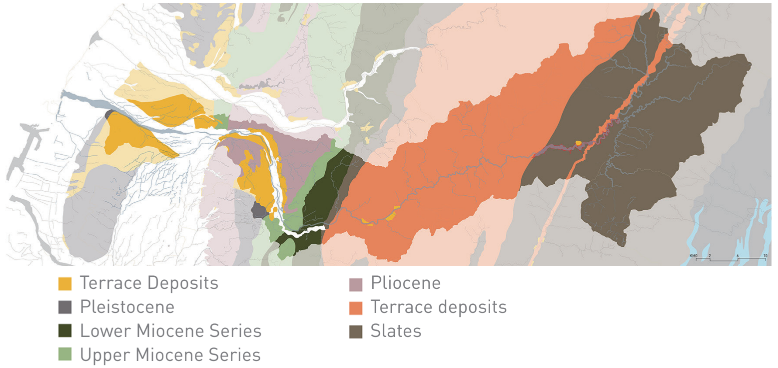


fig.45 Geology map of Dajia river valley
Source: map by the author based on data from GIS database

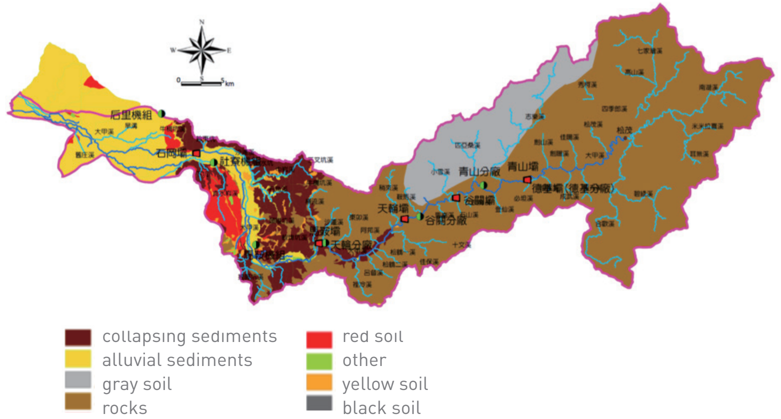


fig.46 Soil map of Dajia river valley
Source: Water Resources Agency, MOEA, Taiwan Government

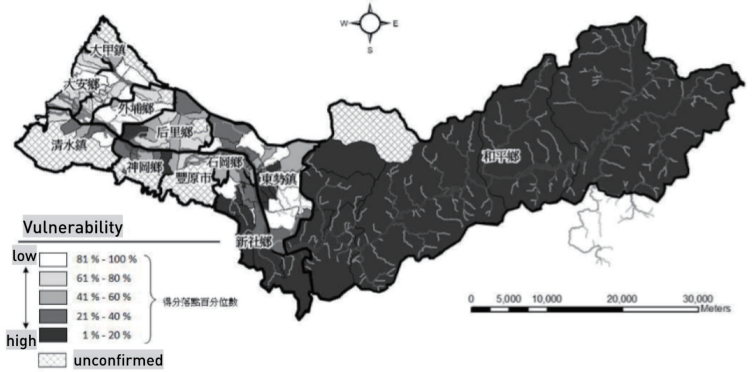


fig.47 Vulnerability (to rain erosion) map of Dajia river valley Source: Hung, H.C. & Chen, L.Y. (2012) Journal of Geographical Science, (65)

Population and demographic understandings

Dajia River valley covers 1236km^2 and today has 626,000 residents (fig.48) with a diverse of urban morphologies (fig.49) 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, the integration with the whole Taichung Metropolitan area can be important and influential.

fig.48 Population of Dajia river valley and the neighboring metropolitan areas. Source: made by author based on data from GIS

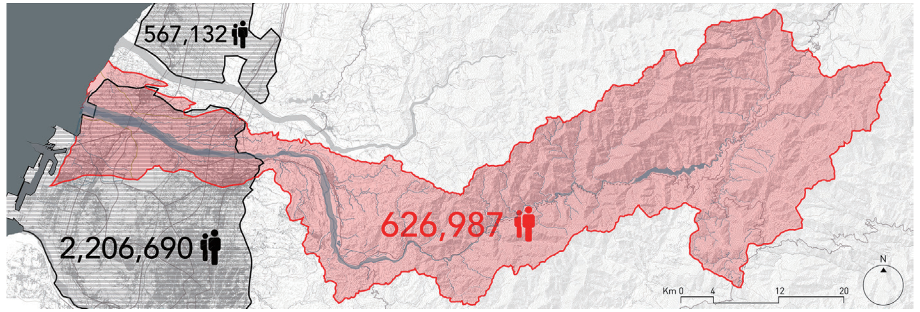
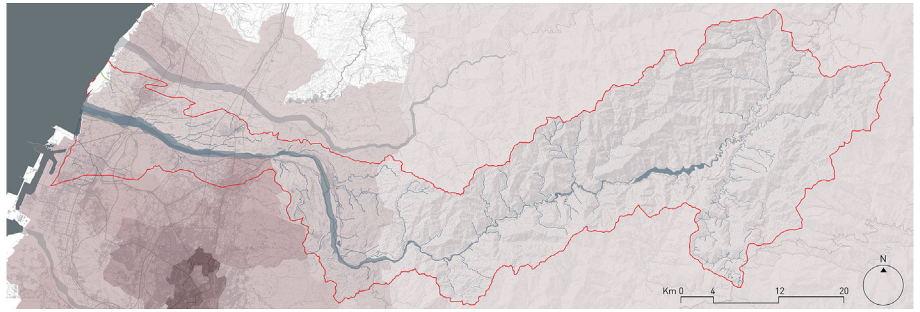


fig.49 Population Density of Dajia river valley and the nearby areas. Source: made by author based on data from GIS

Population density
10/km^2 20,000/km^2
Dajia catchment boundary



☐ Dajia River catchment
▤ Urban plans applied areas

POPULATION PROPORTION WITH HIGHER EDUCATION

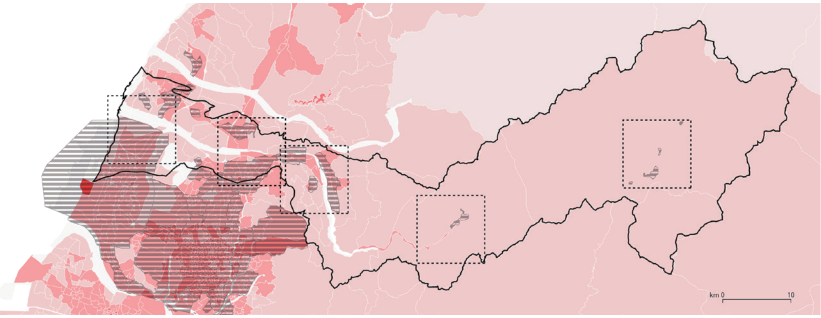


fig.48 Map of population with higher education (university study and higher) Source: map by the author based on data from SEGIS, MOI, Taiwan Gov.

Proportion of population
0 % 5 10 20 30 50 80

AVERAGE HOUSEHOLD SIZE

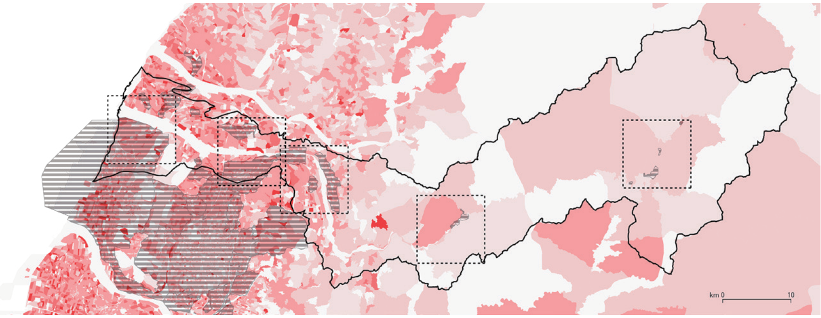


fig.49 Map of average household size.
Source: map by the author based on data from SEGIS, MOI, Taiwan Gov.

Average number of people in a family
0 1 2 3 4 5 30

POPULATION DEPENDENCY RATIO*

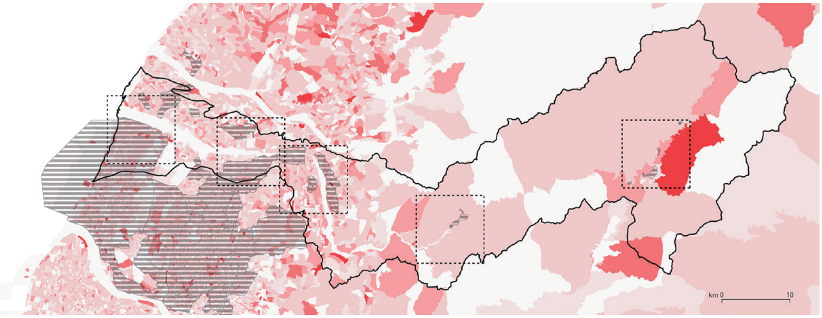


fig.50 Map of population dependency.
Source: map by the author based on data from SEGIS, MOI, Taiwan Gov.

* 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

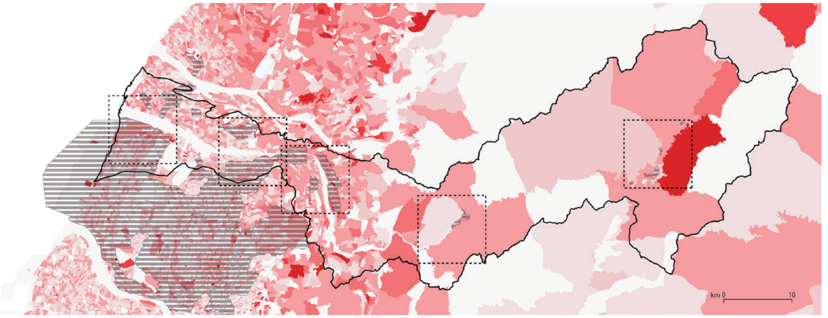


fig.51 Map of senior population ratio.
Source: map by the author based on data from SEGIS, MOI, Taiwan Gov.

Ratio of senior population over working population
0 % 0.05 0.15 0.2 0.4 0.8 1 4

CHILDREN POPULATION RATIO

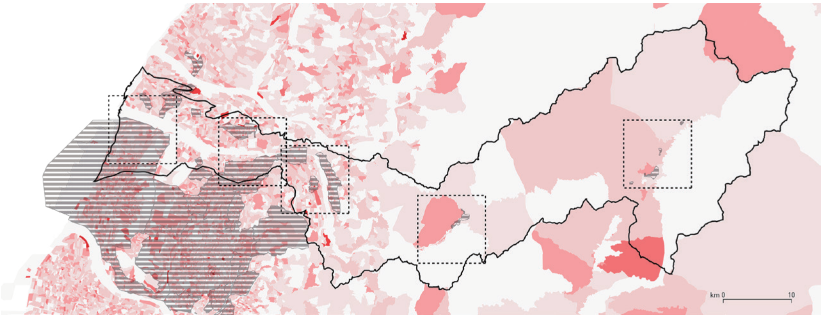


fig.52 Map of children population ratio.
Source: map by the author based on data from SEGIS, MOI, Taiwan Gov.

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*

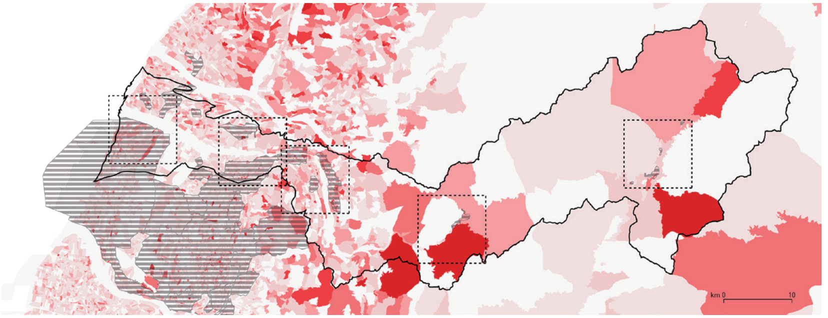


fig.53 Map of population aging index.
Source: map by the author based on data from SEGIS, MOI, Taiwan Gov.

* 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

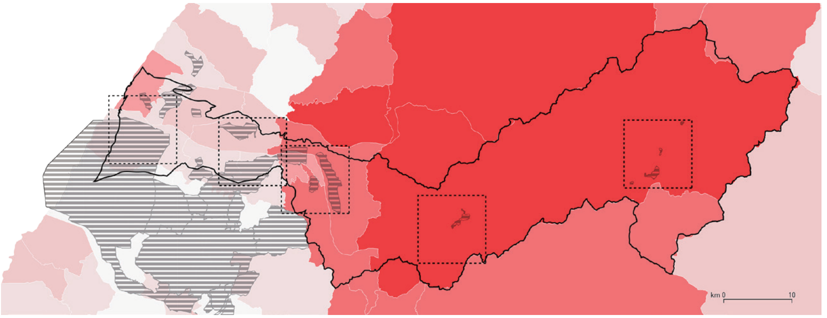


fig.54 Map of population in primary industrial sectors Source: map by the author based on data from SEGIS, MOI, Taiwan Gov.

Proportion of population
0 % 1 2.5 5 10 25 50

PROPORTION OF AGRICULTURAL LAND OF EACH TOWN

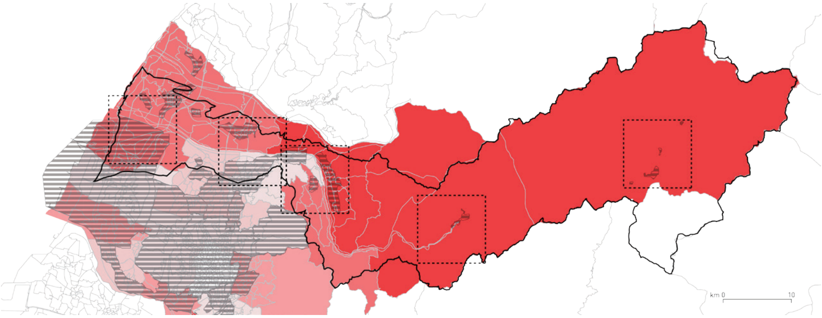
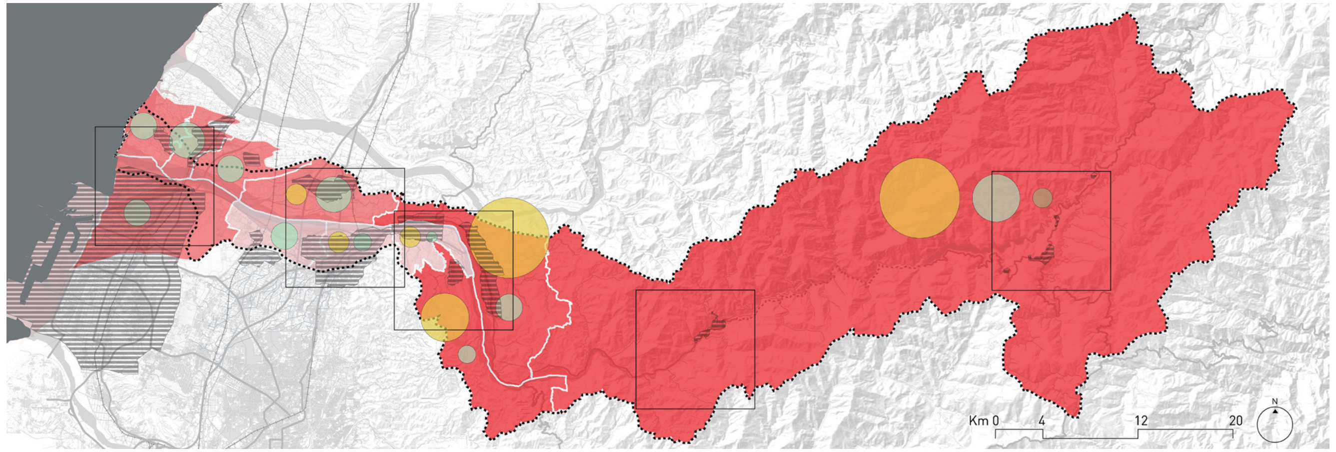


fig.55 Map of agriculture land use. Source: map by the author based on data from SEGIS, MOI, Taiwan Gov.

Proportion of land in agricultural use
0% 5 20 30 50 75 100

MAP OF AGRICULTURAL PRODUCTION DISTRIBUTION IN DAJIA RIVER VALLEY



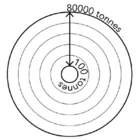
MAPS OF VOCATION DISTRIBUTIONS

fig.57 (right four) Maps of businesses distribution of different categories of vocations. Source: map by the author based on data from SEGIS, MOI, Taiwan Gov.

fig.56 (left) Map of agricultural production and featured products.
Source: map by the author based on data from SEGIS, MOI, Taiwan Gov.

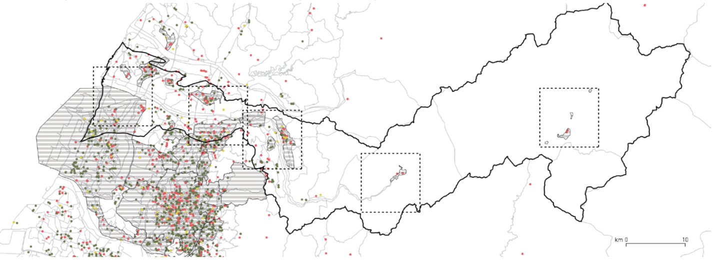
Total agri-production
0 tonnes
50
8,500
15,000
18,000
45,000
120,000

Important products in Dajia river valley (quantity/types)

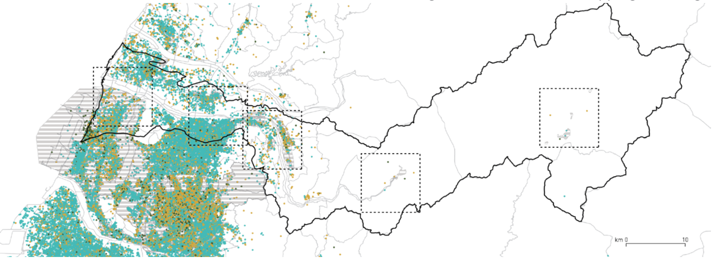


Fruit
Vegetable
Tea

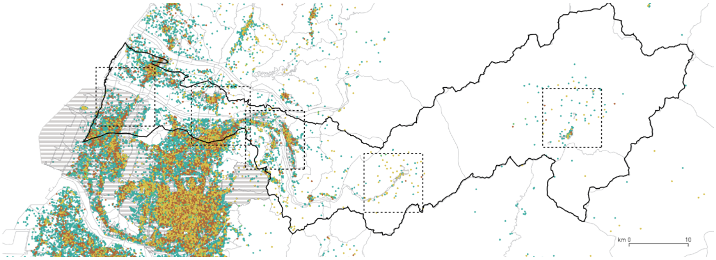
Businesses of agriculture, forestry, mining, or water-related industries
• agriculture, forestry, livestock raising • mining, sand & rock material • water related business



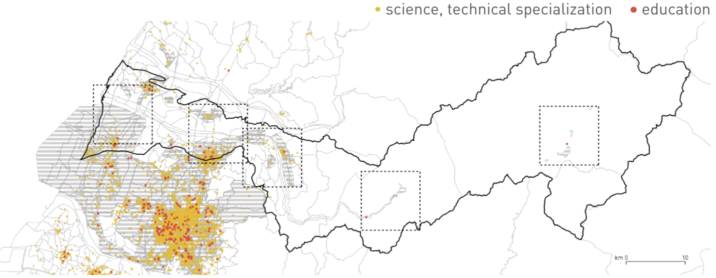
Businesses of manufacturing, construction, or shipping-storage industries
• manufacturing • construction • shipping & storage



Businesses of service industries
• wholesale, retail • accommodation, food • art, leisure activities • other services



Businesses of scientific, technical specialization, or education industries
• science, technical specialization • education



Social and economical potentials of Dajia River Valley

PEOPLE AND SERVICE CLUSTERS

retail, local commercials · catering, accommodation · construction · manufacturing · education, research · water supply, pollution treatment

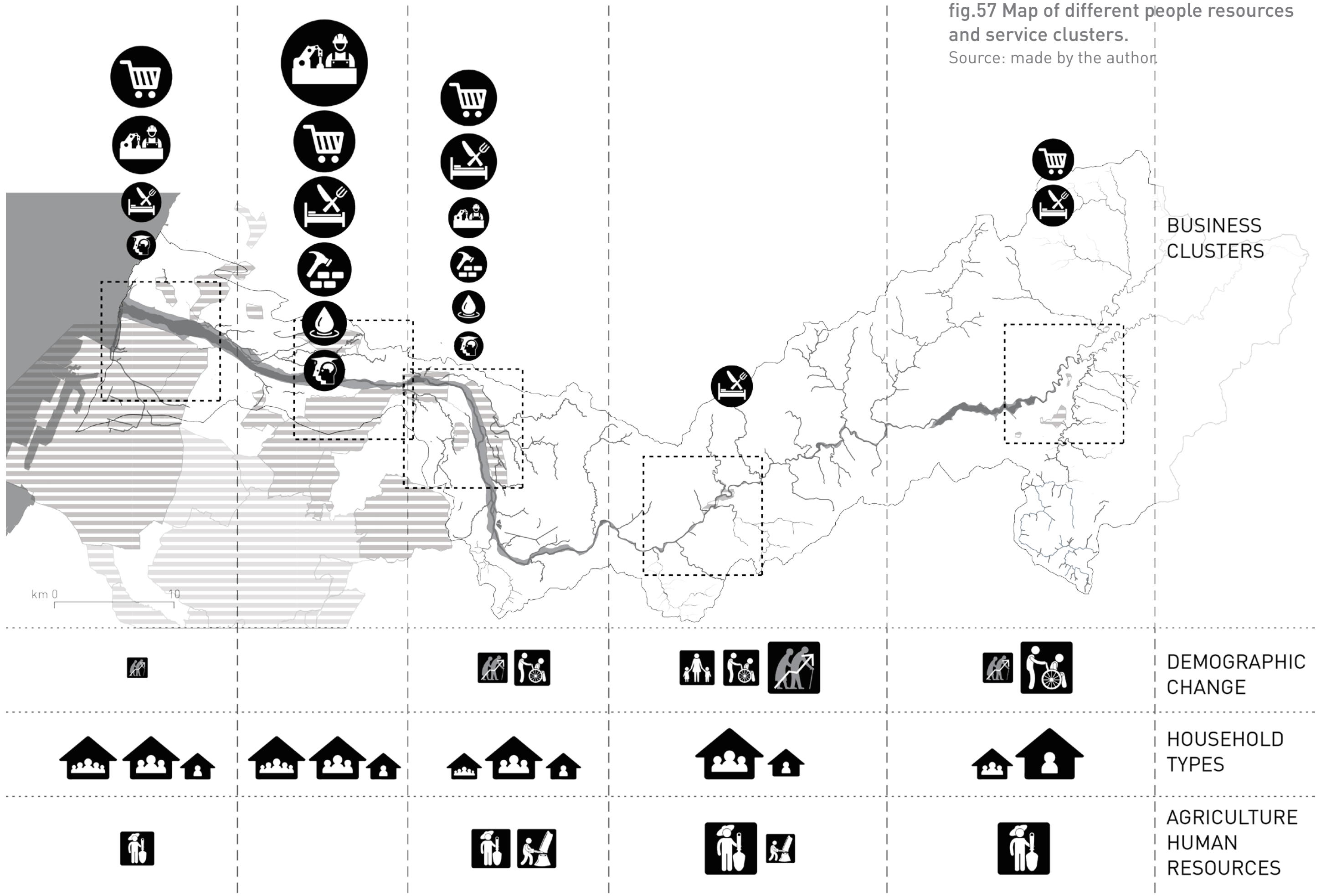


fig.57 Map of different people resources and service clusters.
Source: made by the author

LOCAL ACTIVITIES AND POTENTIALS

fig.58 Map of local industries and activities. The black ones shows the existing activity, the light-grey ones are decreasing in terms of prosperity or no longer exists.
Source: by the author based on data from historical maps, historical descriptions, google maps, and GIS databases.

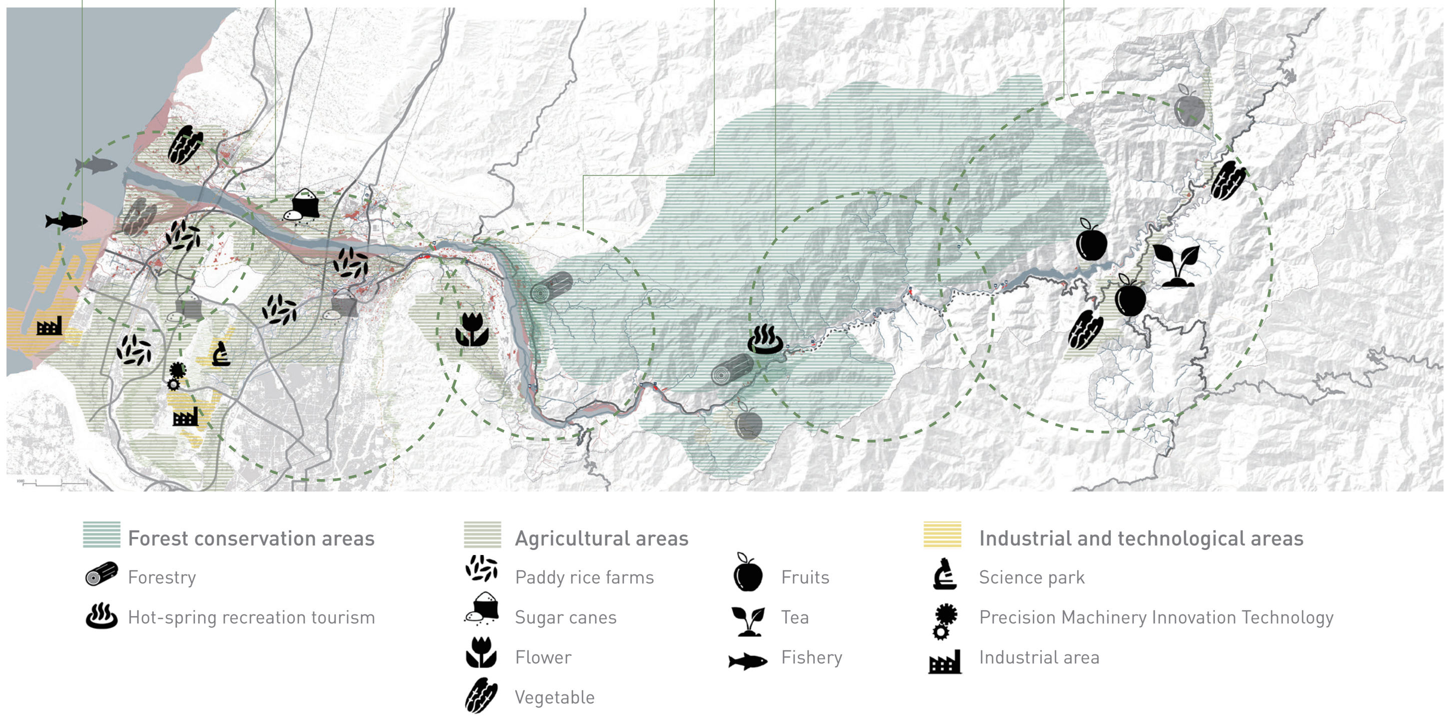
Kaomei Town and wetland area
- Wet-land views
- Wind turbines
- Port for shipping and tourism

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)



Conclusion of territorial challenges

CONFLICT BETWEEN HUMAN LIFE & ECOLOGY

Generally speaking, the landscape of Taiwanese rivers exhibit the conflict between human life and nature. The picture on the right (fig. 59) shows the debate regarding whether the government should keep restore the roads or not. The alpine communities growing fruits and vegetables upstream urgently need a better connection towards the metropolitan area where consumers are. However, the recurrent breakdown of the roads after the 921 Earthquake in 1999 has been taking huge social and economical costs from the society.

The water resource, on the other hads, is essential to the downstream areas, for both daily-life drinking water, industrial platforms, as well as agricultural activities. Due to the uneven distribution of rainwater both timewise and spatial-wise (fig. 60). The rain falls mainly in the mountainous areas while the steep slope (fig. 61) of the mid and upstream makes it difficult to keep water. The mitigation of the irregular water source requires spaces for water storage, accommodating water in case of excess to avoid flood, while maintaining stable water supply in times of draught. Currently, these water managing works are done by the series of reservoirs and dams along the Dajia river from upstream towards midstream, and it is still insufficient due to the growing demands (the construction of new industrial platforms and science parks), and the increasingly frequent of draughts.


傷痕中橫 封山16年
生態、生存在拔河
921大震 封山迄今 梨山人:還我農產生路
聯合報

fig.59 News paper describing the conflict between living and ecology, and that the roads to the alpine agricultural villages has broken down for 16 years.
Source: photo from http://www.taiwanhot.net/

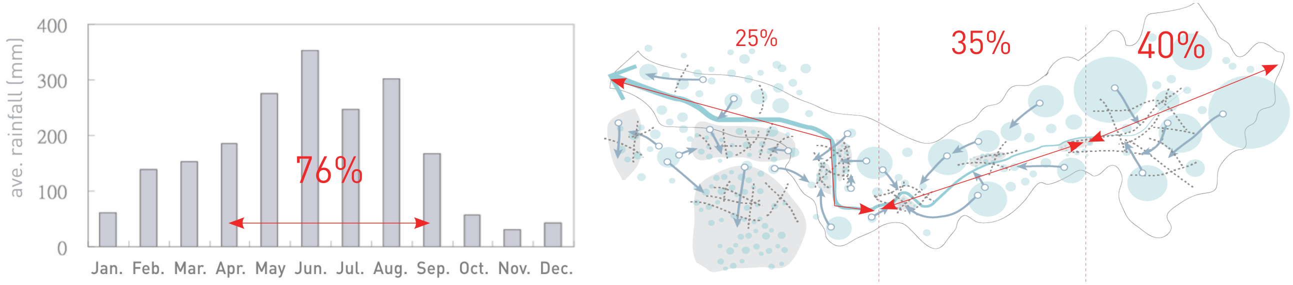


fig.60 Diagrams of yearly rainfall distribution and proportion of rainfall in different parts of catchment.
Source: made by the author based on data and statistic chart from Water Resources Agency, MOEA, Taiwan Government

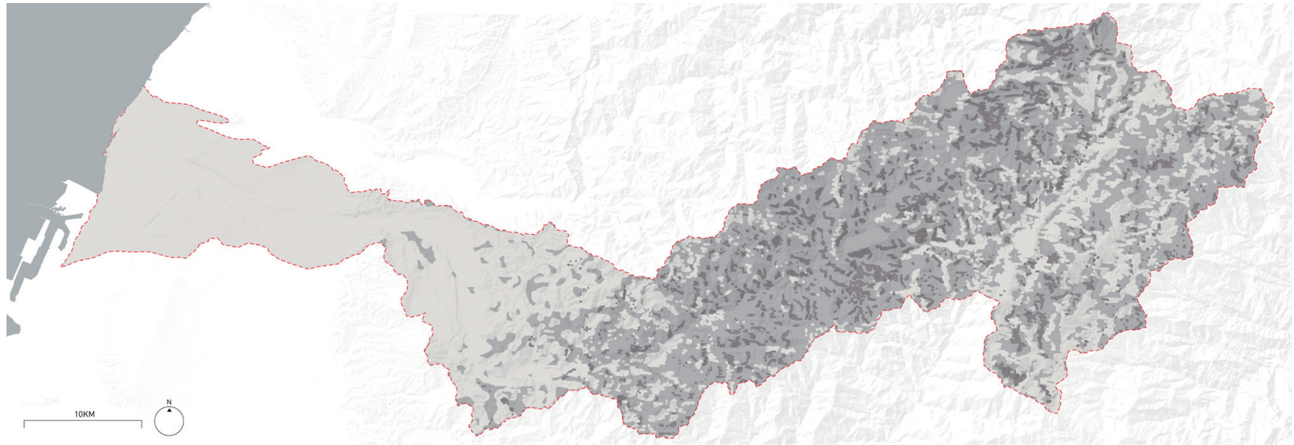


fig.61 Map of steepness of slopes in Dajia river catchment.
Source: made by the author based on data from Central Geological Survey, MOEA, Taiwan Government.

Slope steepness
- >50 %
- 15-50 %
- <15 %

CHALLENES OF THE TERRITORIAL WATER SYSTEM

Through 40 years, the gradual infrastructuralization of the river has been causing enormous ecological impacts to the environment, threatening the lifes of alpine communities, as well as accumulating in vulnerability of facing natural hazards in the riverscape. There are huge debates of the dilemmas ongoing:

- To restore the road (Central Cross-island Highway) or not?
- To clean the sediments out of the reservoirs or not? (is it possible?)
- To remove agriculture from alpine areas or not?

Considering the decreasing capacity of reservoirs, the economic shifts, and the increasingly drastic climate changes, the current water infrastructure system is facing a huge bottleneck and needs an transformation for an alternative water management.

How to provide an alternative plan for the water related activities and mitigate water-caused problems in the fragile, dynamic and sensitive river valley landscape is an essential and urgent challenge in the territory.

fig.63 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]

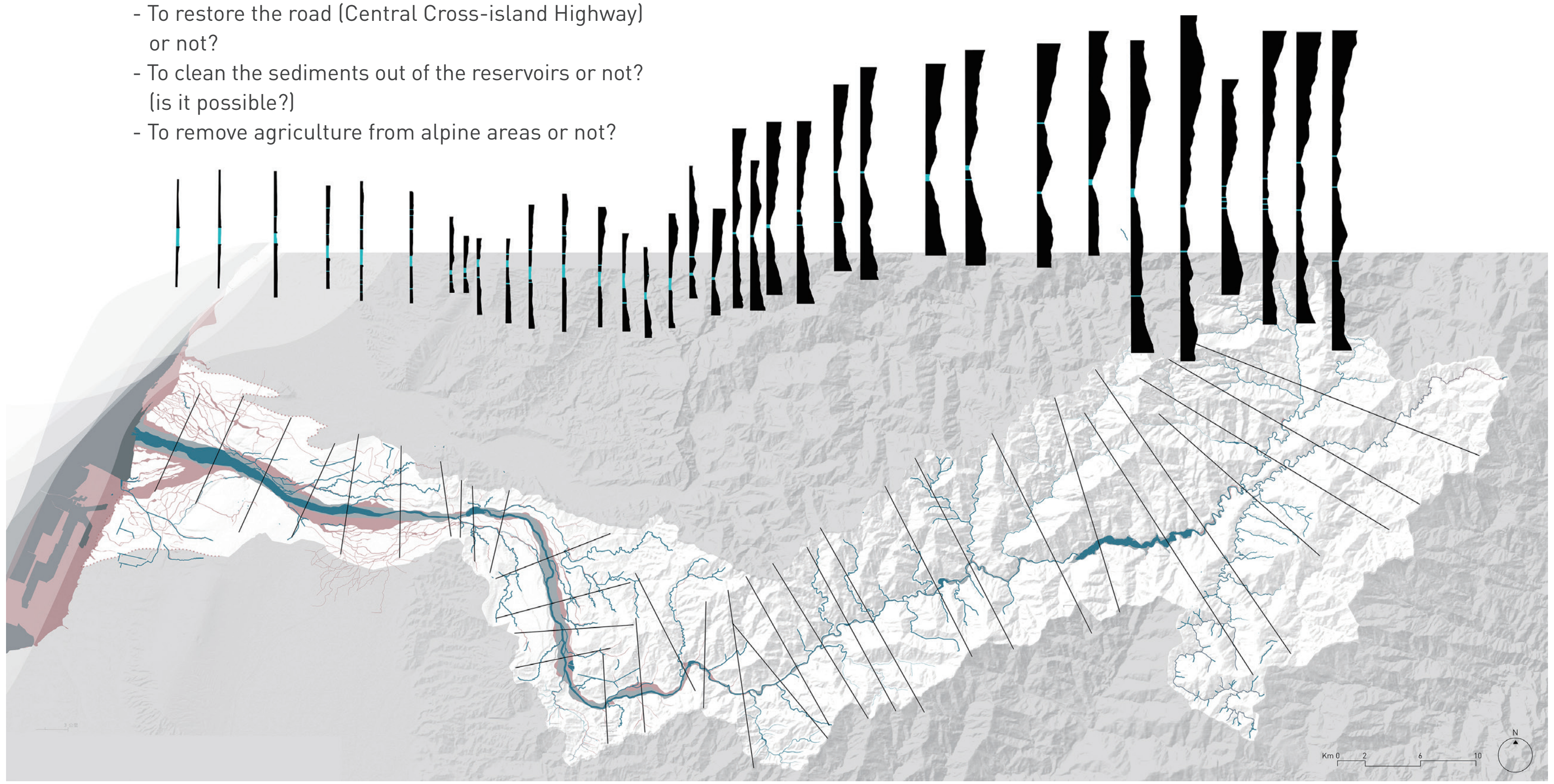


fig.62 Cross sections along Dajia River valley showing the drastic topographical situations add up to the complexity of water management challenges.
Source: map made by the author based on Google Earth data.

fig.64 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]

VII. Strategies and Principles

THE STRATEGY IN THE LANDSCAPE INFRASTRUCTURE APPROACH

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?

fig.65 Diagram of proposed transformation of water infrastructure system into a sponge-net model.
Source: diagram by the author.

To propose transforming the landscape of the territory into water storing, distributing and adjusting system. 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 goal and in the meanwhile take care of its own situated context. The new system can be perceived as a system of 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 also allows mutual adjust between local areas within the system, creating tangible connections for the people in the region to their land and to each other, building a stronger identity for the territory.

PRINCIPLES TO MITIGATE THE IMPACT OF IRREGULAR WATER SOURCES

PRINCIPLE 1: ADAPTABLE TO LARGE 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. 66). 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.

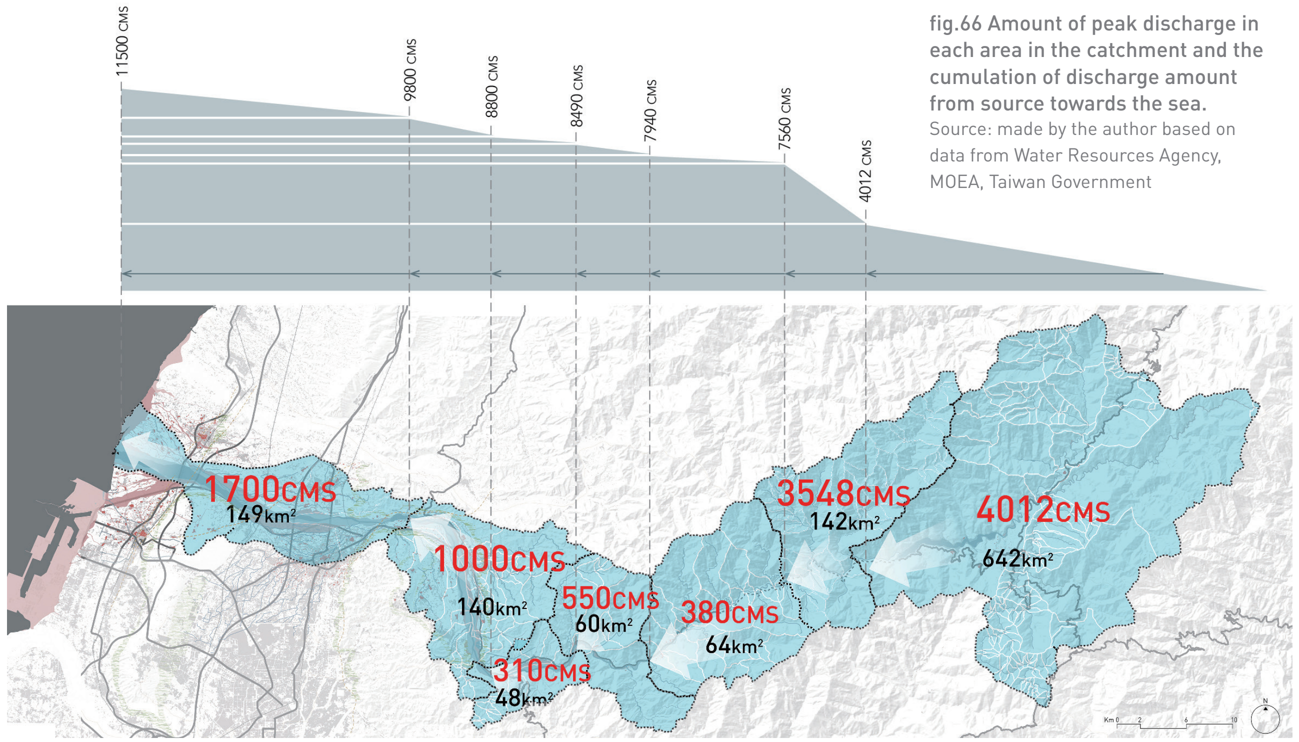


fig.66 Amount of peak discharge in each area in the catchment and the cumulation of discharge amount from source towards the sea.
Source: made by the author based on data from Water Resources Agency, MOEA, Taiwan Government

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.67), helps territory residents to construct innovation, responsibility and more delicate consideration in planning for the places where they live.

fig.67 Taiwan ancient map in Kangshi Emperor of the Ching Dynasty in 1704. Source: collection from National Taiwan Museum

Based on the overall strategy and principals, five places are further identified to demonstrate the different possibilities of transforming the water infrastructure system into territory landscape, in responding to different environmental context and development patterns of human activities. For each area, there will also be sub-strategies and sub-principals according to the different context, while contributing to the shared concept and objective. The following part of the report introduces the five locations with their opportunities and principles in implementing the transformation of water infrastructure and urban scape into the landscape system.

LOCATION	KAOMEI VILLAGE, CHINGSHUI	HOULI CITY & FENGYUAN CITY	DONGSHIH & XINSHE	GUGUAN	LISHAN & HUANSHAN
MORPHOLOGY & CHARACTERISTICS	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
CONCERNED POPULATION	3,500	221,000	76,500	1,900	3,250

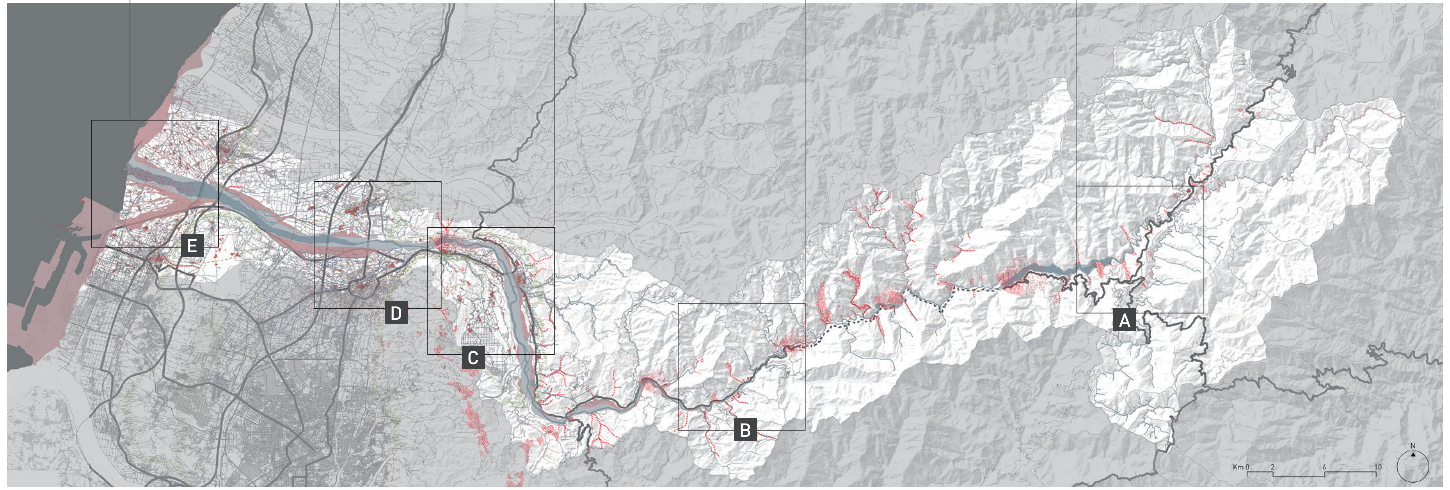
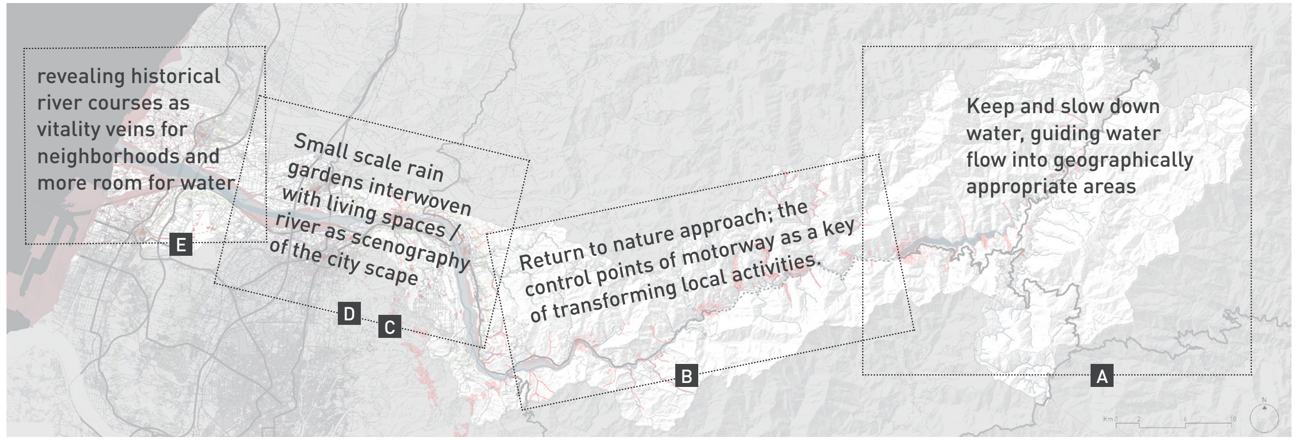


fig.68 Map idicating different contexts of settlement in the riverscape areas.
Source: made by the author based on data from GIS database, google maps, and national statistic data.

DESIGN STRATEGIES OF DIFFERENT AREAS IN CONTRIBUTION TO TERRITORIAL INTEGRATION



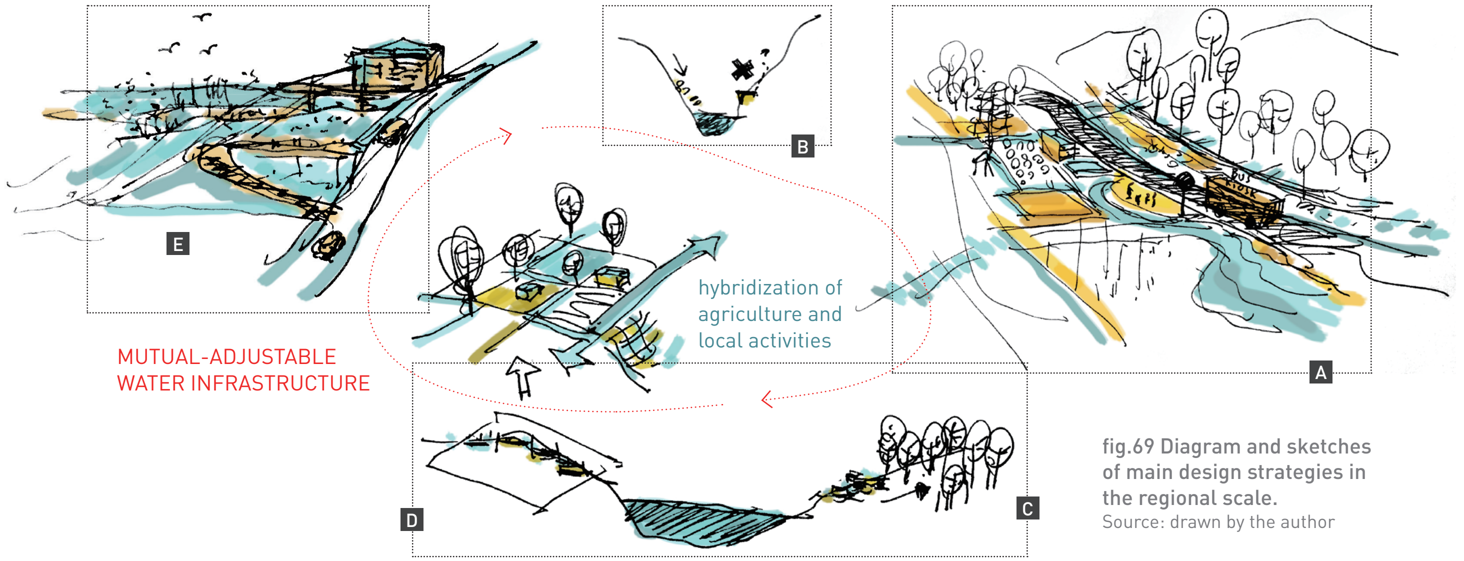


fig.69 Diagram and sketches of main design strategies in the regional scale.
Source: drawn by the author

TOOLS AND ROLES FOR WATER LANDSCAPE AS INFRASTRUCTURE

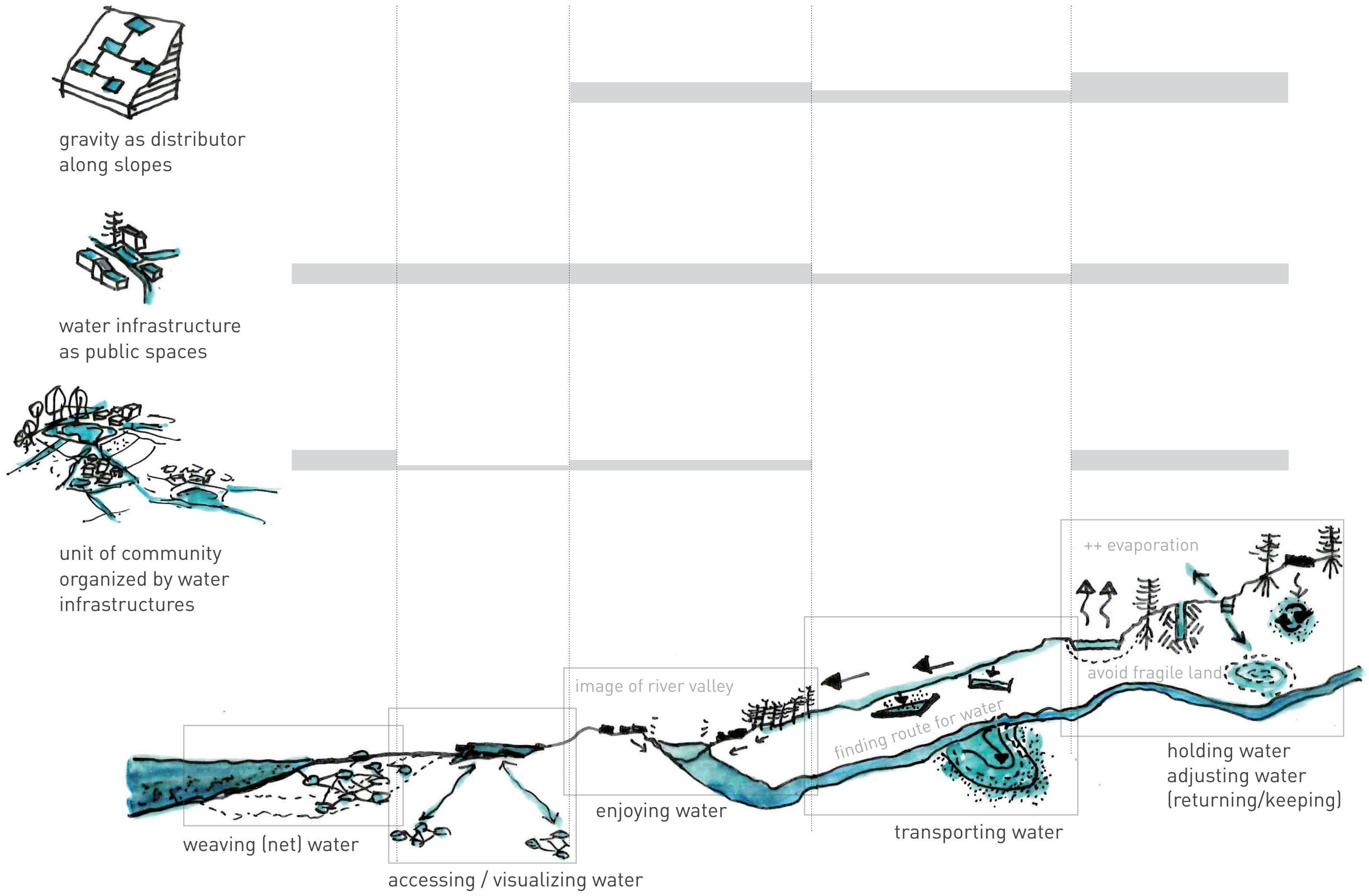


fig.70 Diagram section showing different roles and main design tools of each area. Source: draw by the author

VIII. Strategic Plan and Operative Structures

Strategic plan

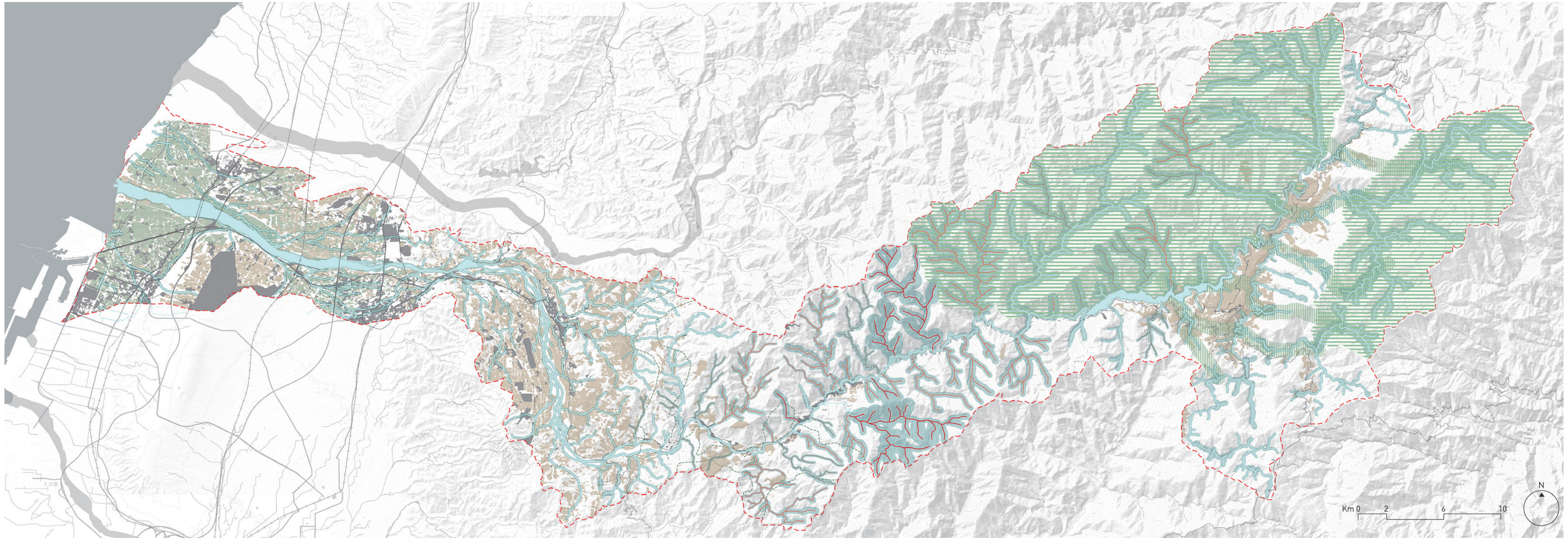
fig.71 The proposed overall strategies for Dajia River valley in designing water landscape as territorial infrastructure.
Source: map made by the author.

Operative structure 1: water x corridors

WATER X CORRIDOR

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 interwining of activities, ensuring the inclusion character of the spaces.

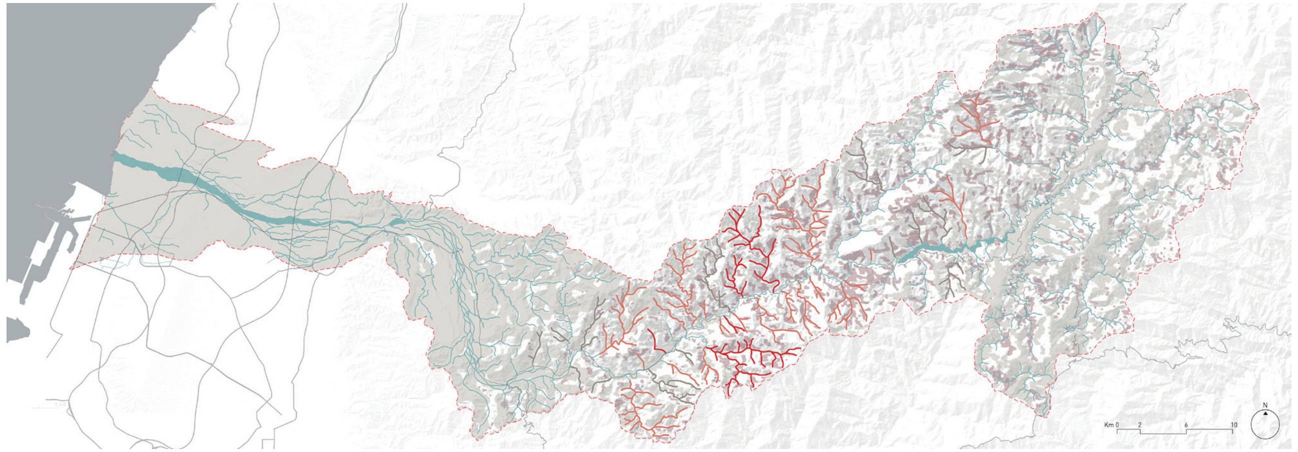


National Park
Horizontal corridors
Agriculture - dry farming (fruits/grains)
Agriculture - wet farming (rice)
Existing habitation
Vertical corridors along streams
normal streams
low mudslide risk streams
medium mudslide risk streams
high mudslide risk streams
Dajia river catchment

fig.72 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 xx) 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 xx), so that the vertical corridors also ensure land conservation and safty of life and properties of habitation.



- low mudslide risk streams
- medium mudslide risk streams
- high mudslide risk streams
- Slope > 50% areas
- Slope < 15% areas
- Dajia river catchment

fig.73 Mapping 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.

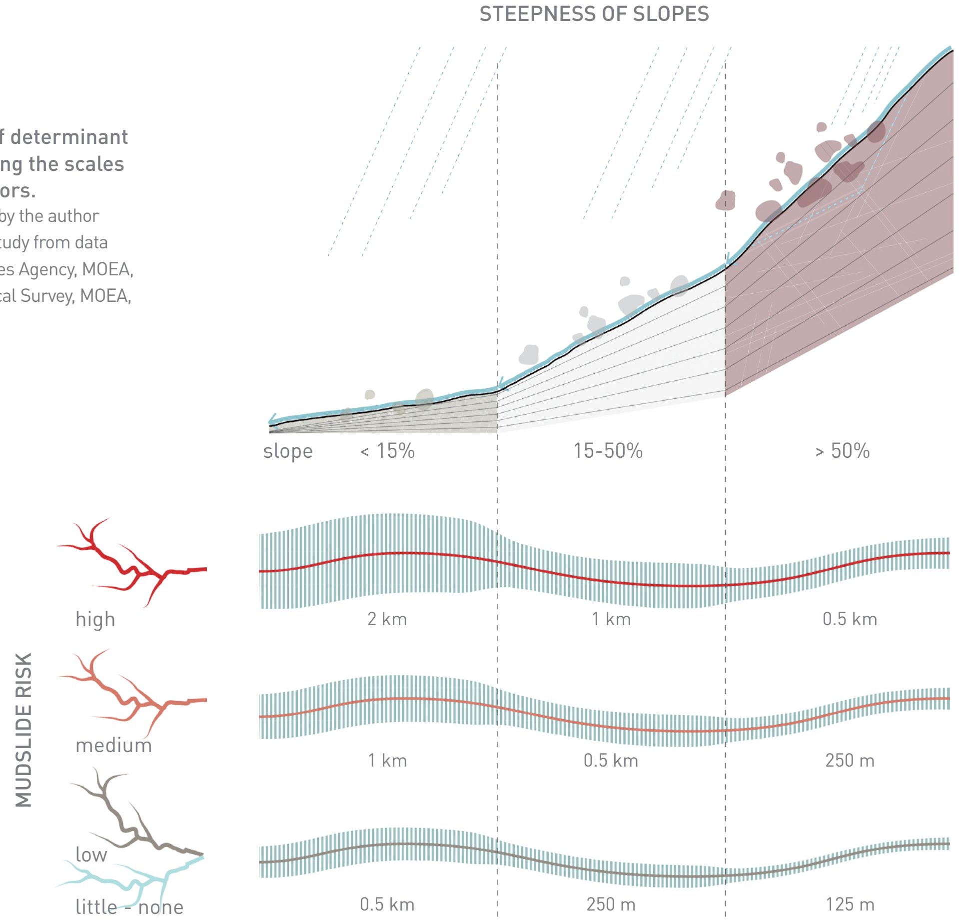


fig.74 Diagram of determinant factors for defining the scales of vertical corridors.
Source: chart made by the author based on research study from data from Water Resources Agency, MOEA, and Central Geological Survey, MOEA, Taiwan Government.

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. 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. 75). The shallow-root agricultural plants (fruit trees, tea shrubs, dry grains) also results in poor soil conservation.

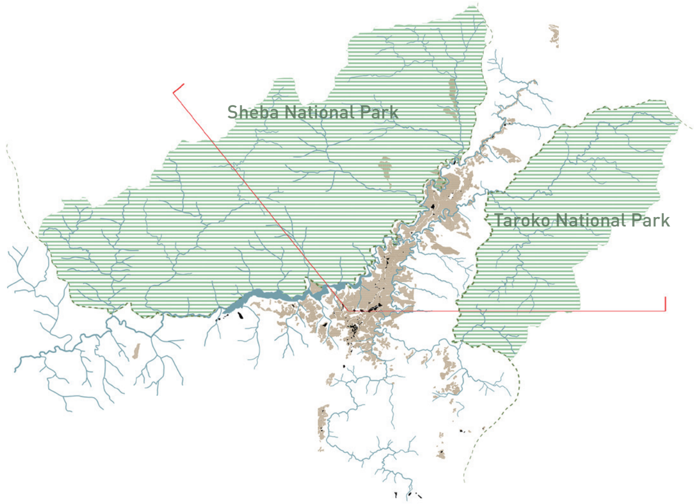
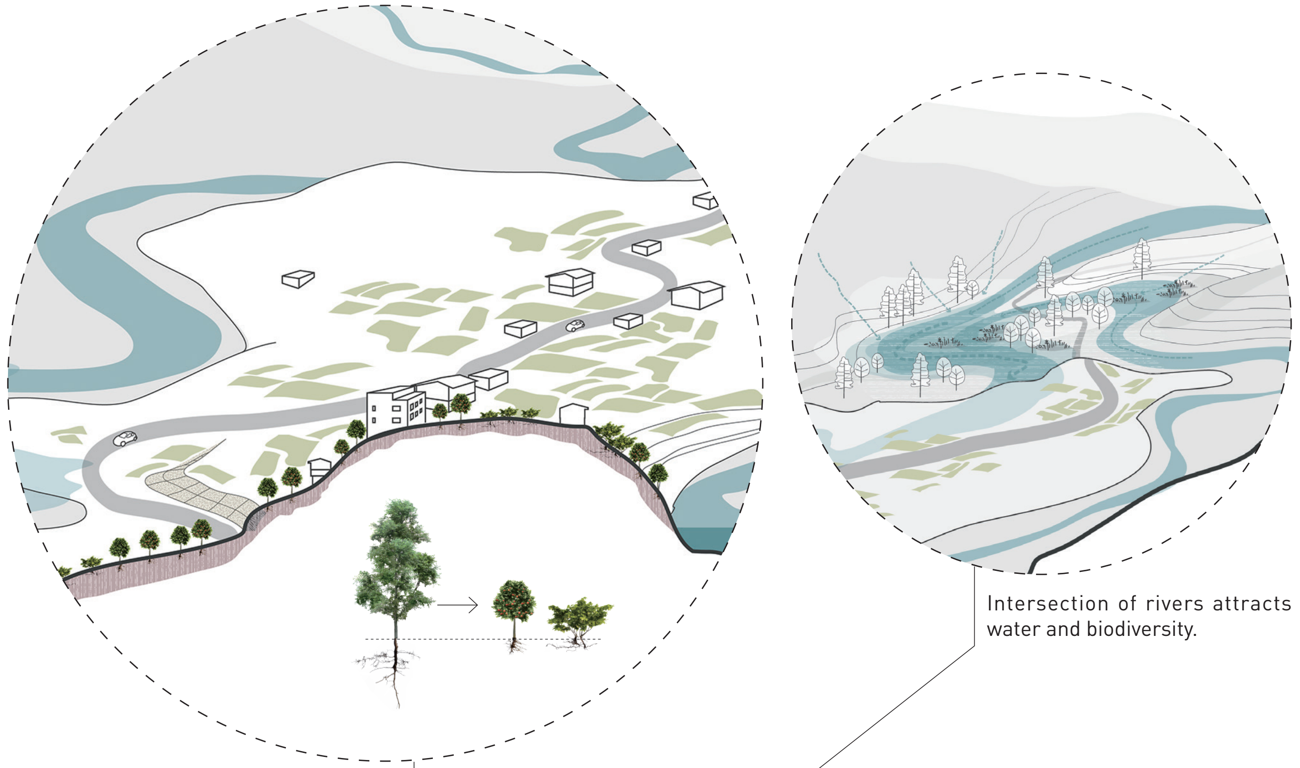


fig.75 The alpine agriculture stripe between two National Parks.
Source: map made by the author based on GIS data and data from Landuse Investigation of Taiwan, NLSC, Taiwan Government.



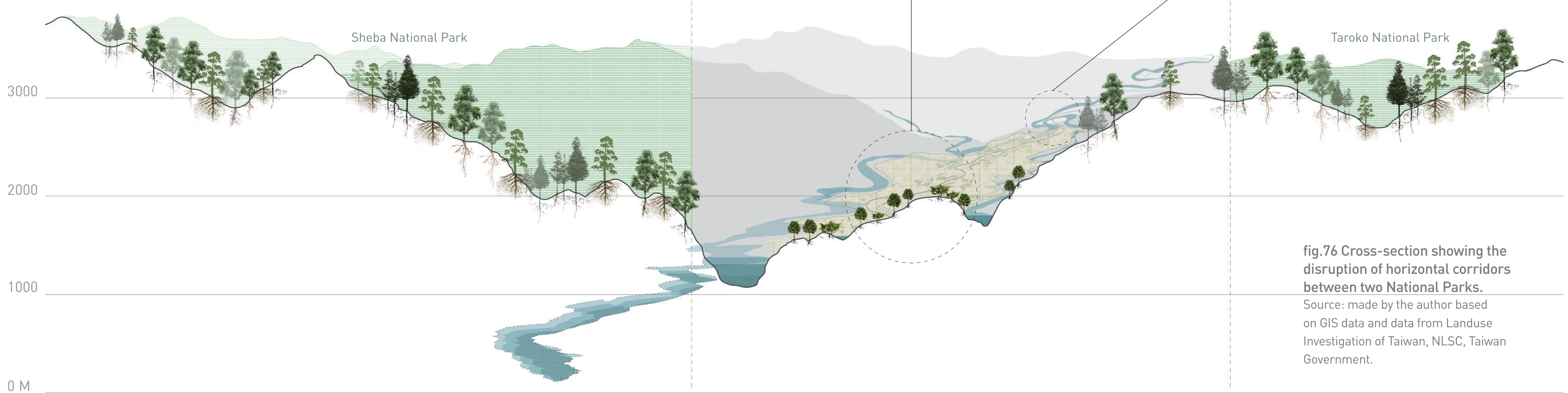
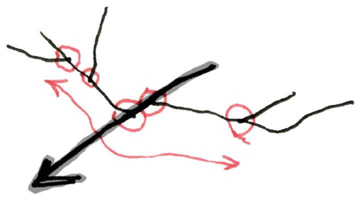


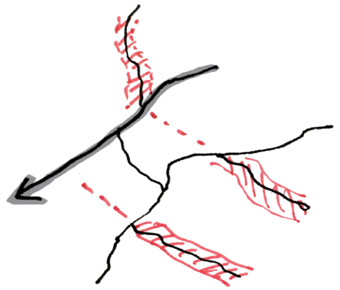
fig.76 Cross-section showing the disruption of horizontal corridors between two National Parks.
Source: made by the author based on GIS data and data from Landuse Investigation of Taiwan, NLSC, Taiwan Government.

The converging of the rivers has the potential to retain water and attract biodiversity, which is also the primary criteria of alpine wetlands. The potential horizontal proposals is determined by identifying the converging points of branch streams, as well as the extention of some vertical corridors (fig. 77).

The ensuring of the horizontal corridors will first look at the stream intersections, enhancing plantation and topographical potential in forming alpine wetlands. Then, the extention of these areas towards the two National parks will structure the horizontal corridors at the upstream region.



Converging points of branch streams



Extension of vertical corridors

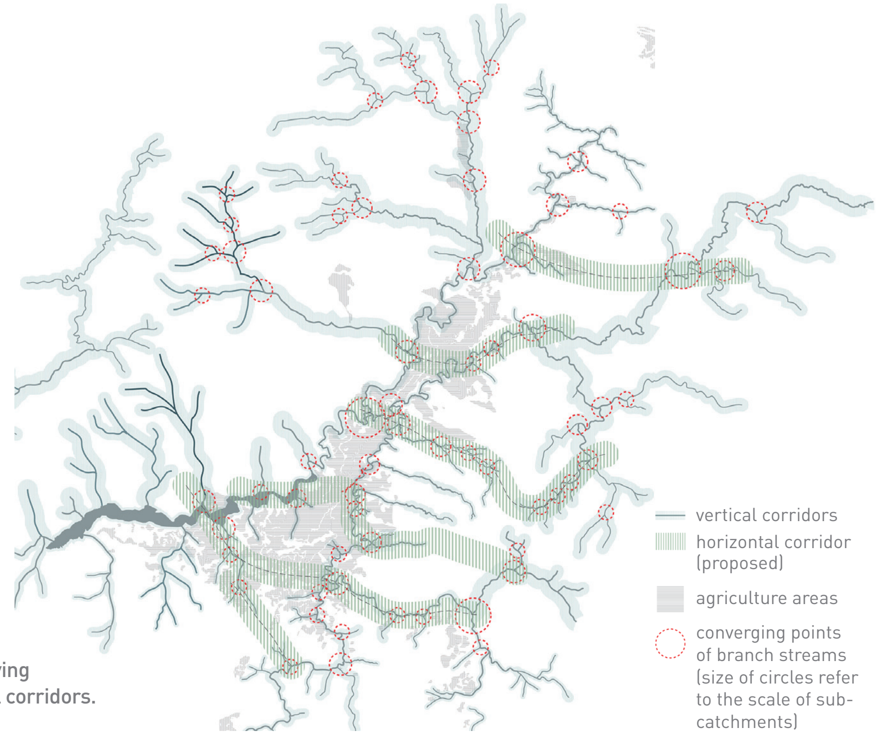
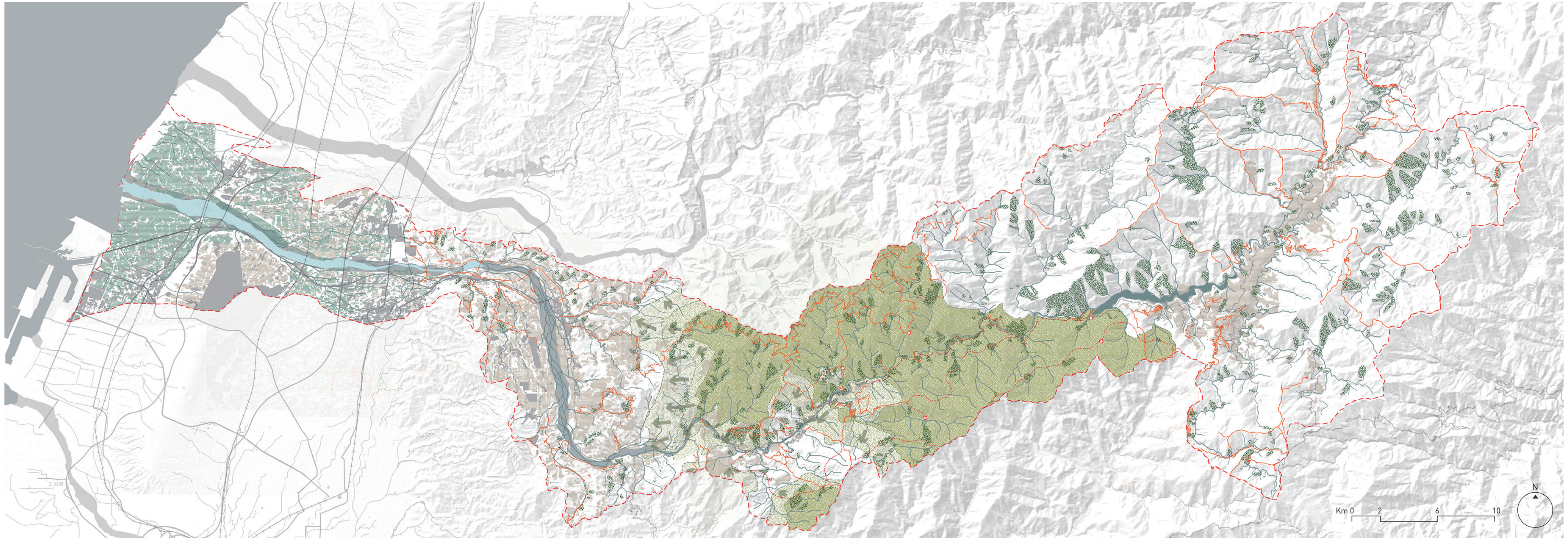


fig.77 Diagrams showing methods for identifying potential nodes to be connected as horizontal corridors.
Source: drawn by the author.

OPERATIVE STRUCTURE 2: WATER X SLOPE STABLIZATION

WATER x SLOPE STABLIZATION

- farmers -> slope stablization guardiens
- farmers -> sustainable forestry operators
- trajectory on abandoned forestry trails
- stablizing structures as small-scale hydropower devices
- farmers -> ecotourism actors
- farmers -> smart track maintence work (transportation structures)

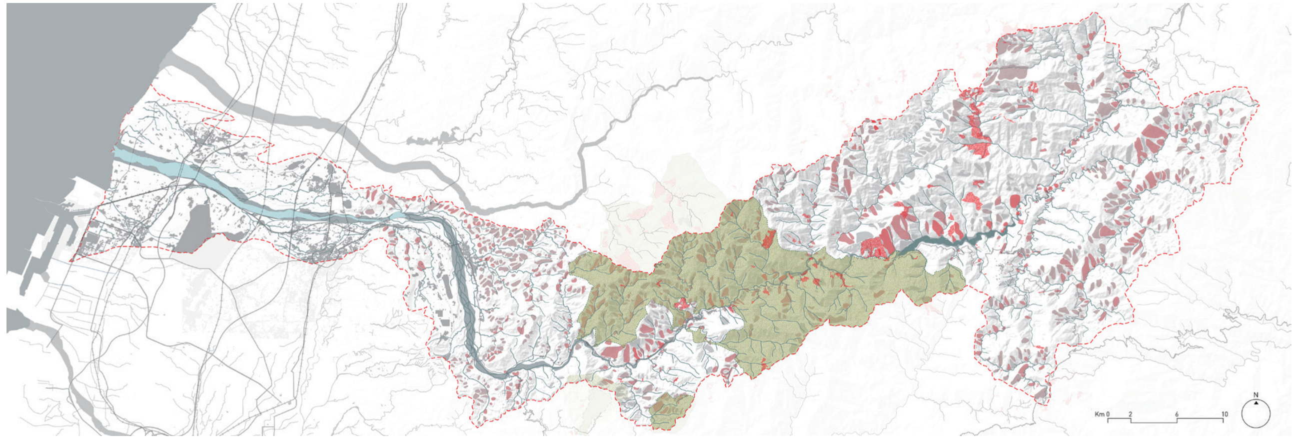


Existing forestry trails
New forestry / slopework trails
Maintainence points
Existing habitation
Dajia River catchment
Existing protected forestry
Prospering forestry
Agriculture - dry farming (fruits/tea/grains)
Agriculture - wet farming (rice)

fig.78 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 stablization works include installing stablizing structures and tree planting. These are combined with elements that guide surface water flows through avalanched lands and dip sloped areas with high and medium risk or collapsing. The structuring elements are modules made of materials that can be grown on-the-spot, which are 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 and incentivize local participation.



Dipslope - high risks

Dipslope - meduim risks

Dipslope - low risks

Dipslope - almost no risks

Avalanched areas

Existing protected forestry

Existing habitation

fig.79 (above) Mapping 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.

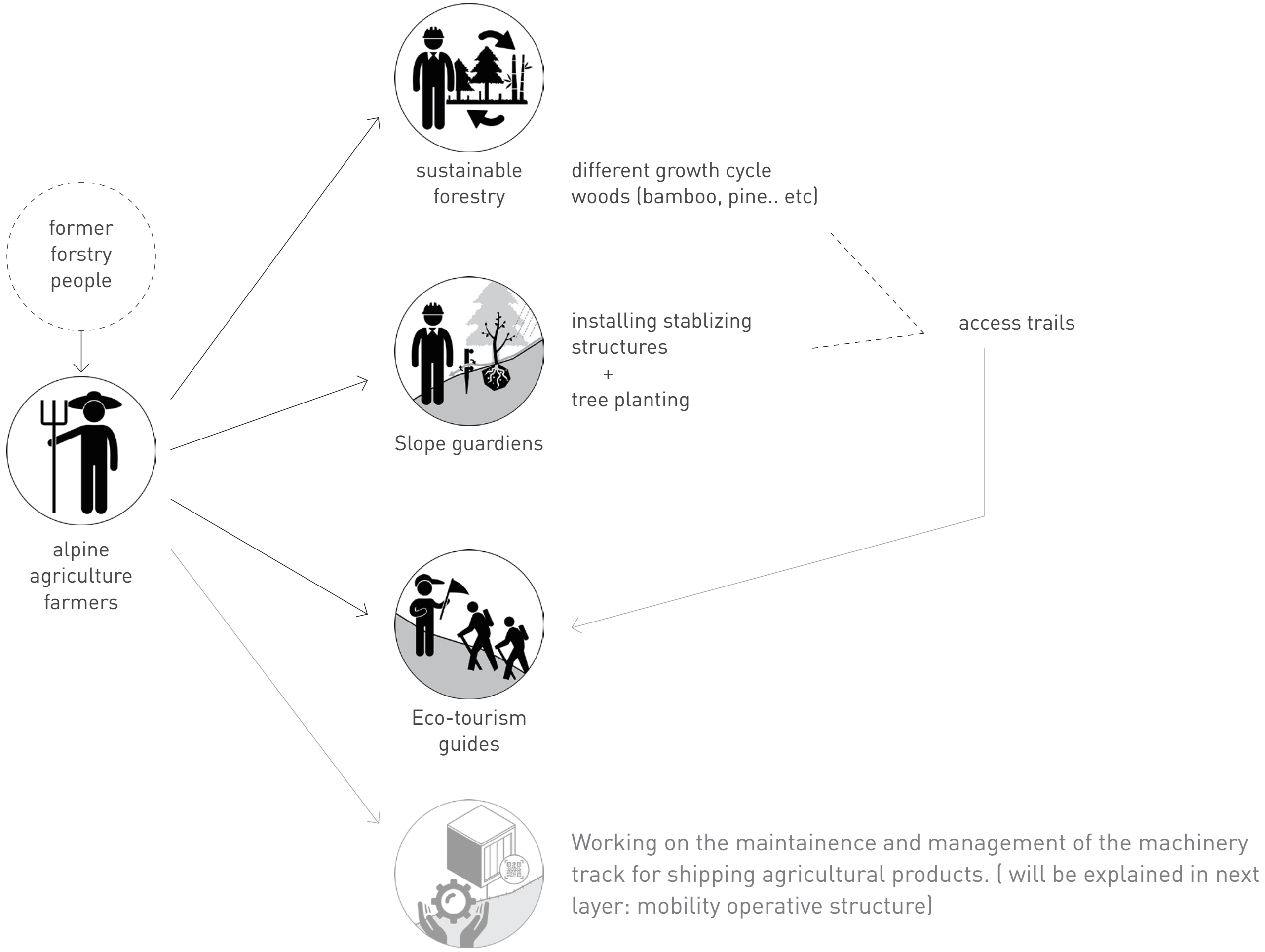


fig.80 (left) Photo of avalanched situations in the mountain areas of Dajia river valley.
Source: photos from Taiwan Academy of Ecology ePaper [online] available at: http://www.ecology.org.tw/epaper/view.php?id=442

fig.81 Diagrams of potential actors for the slope stablization intervention. Source: made by the author

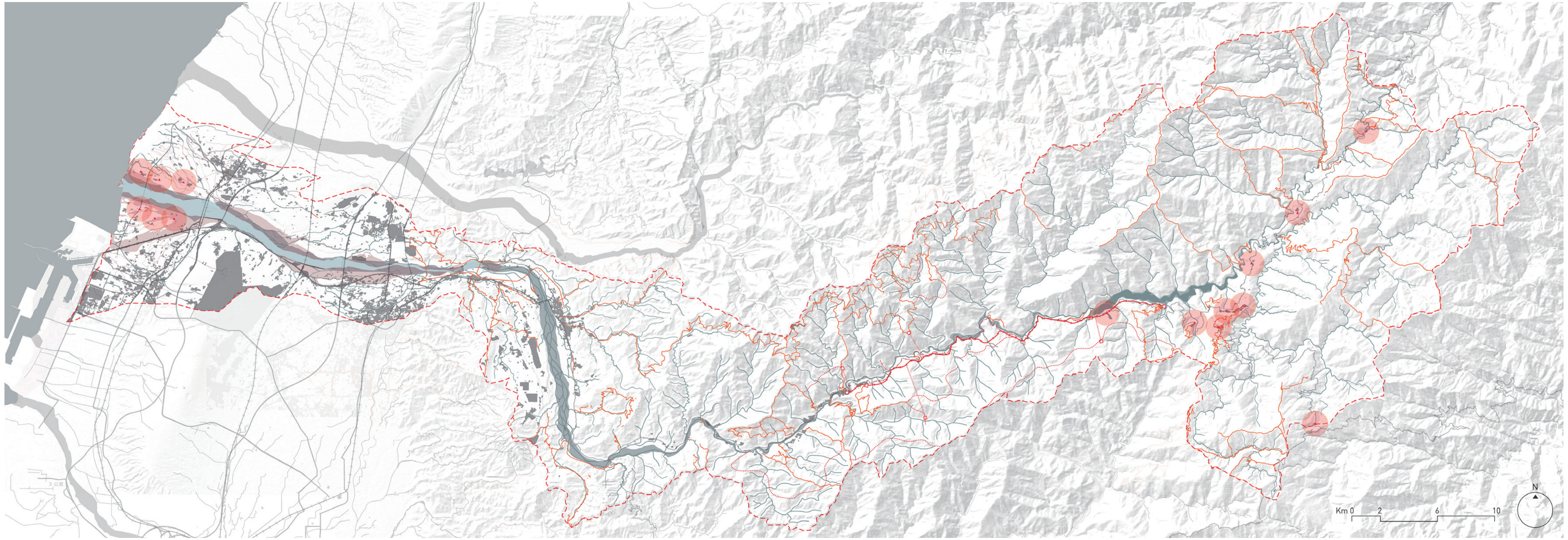
Operative structure 3: water x mobility

WATER x MOBILITY STRUCTURE

- farmers -> ecotourism actors

- farmers -> smart track maintence work

- More performative public transportation stops as activity organizors and induce multifunctional common spaces.



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.82 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

WATER x PUBLIC SPACE STRUCTURES

- More performative public transportation stops as activity organizors and induce multifunctional common spaces.

- Thousand water gardens in densly urbanized areas.

- Mxture of dry/wet farming agriculture.

- upstream corridor intervention

- downstream historical river course intervention

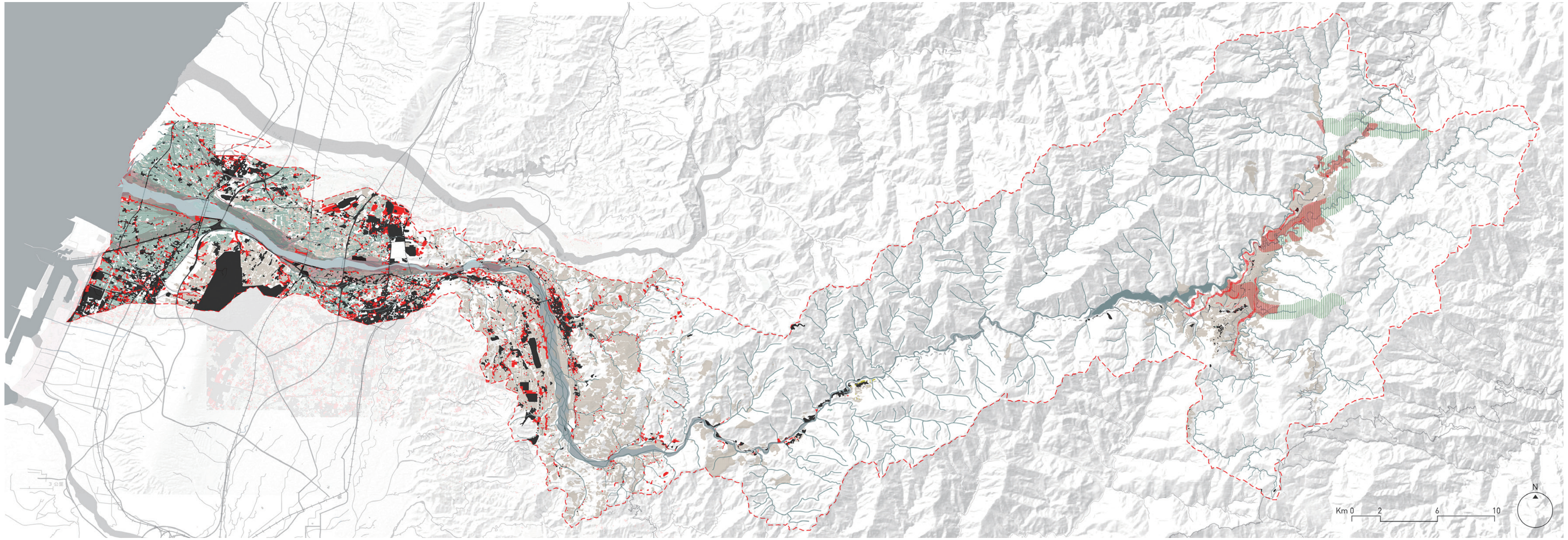


fig.83 Water-public space structure proposal for the Dajia Riverscape project.
Source: map made by the author based on GIS data and data from Water Resources Agency, MOEA, and Central Geological Survey, MOEA, Taiwan Government.

Operative structures at upstream: Lishan-Huanshan area

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

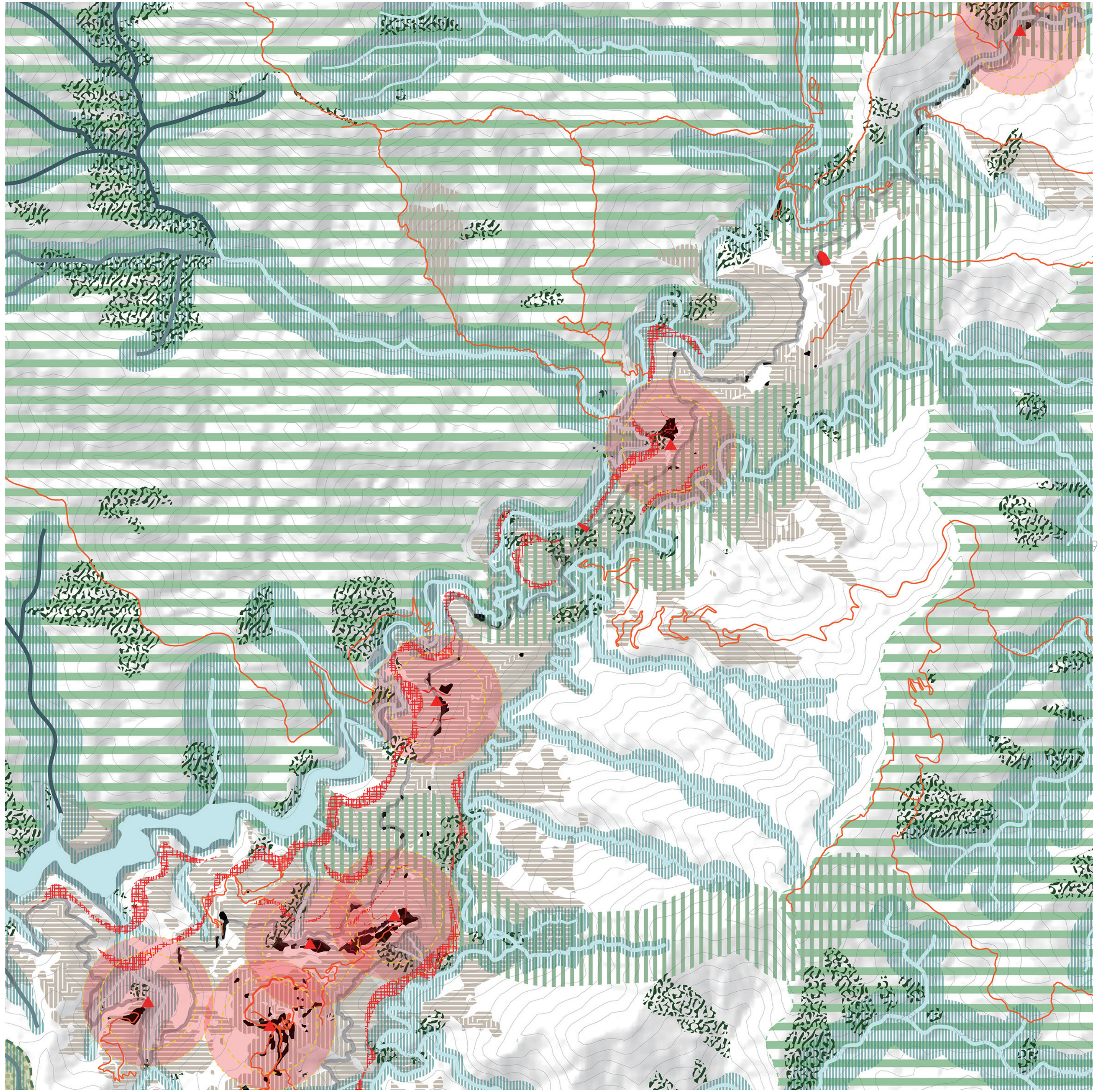


fig.84 Strategic plan showing the system of operative structures at upstream area.
Source: map made by the author based on GIS data and data from Water Resources Agency, MOEA, and Central Geological Survey, MOEA, Taiwan Government.

Operative structures at midstream: Guguan-Dongshih area

- 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

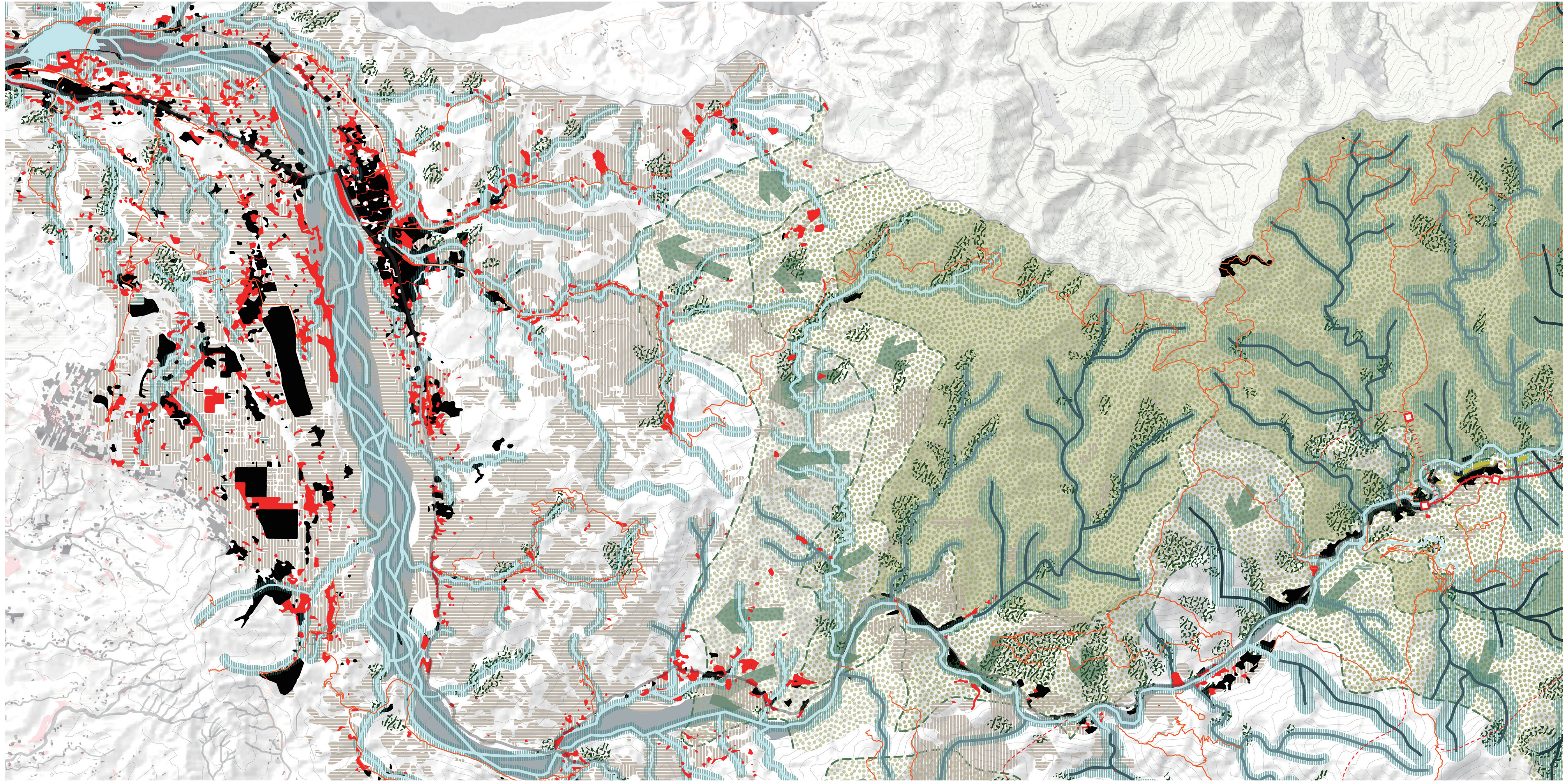


fig.85 Strategic plan showing the system of operative structures at mid-stream area.
Source: map made by the author based on GIS data and data from Water Resources Agency, MOEA, and Central Geological Survey, MOEA, Taiwan Government.

Operative structures at downstream: Kaomei area

- 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

fig.86 Strategic plan showing the system of operative structures at downstream area.
Source: map made by the author based on GIS data and data from Water Resources Agency, MOEA, and Central Geological Survey, MOEA, Taiwan Government.

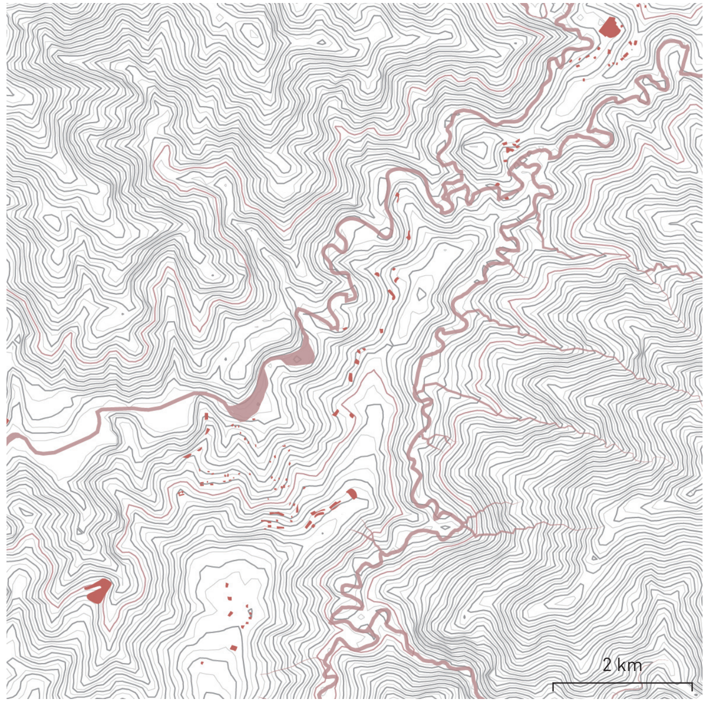
IX. Zoom-in Interventions

IX-1. UPSTREAM INTERVENTION: LISHAN-HUANSHAN AREAS

IX-2. DOWNSTREAM INTERVENTION: KAOMEI AREAS

DESIGN INTERVENTIONS AT UPSTREA AREA: TRANSFORMATION OF HILLTOP ACTIVITIES

1850s



today

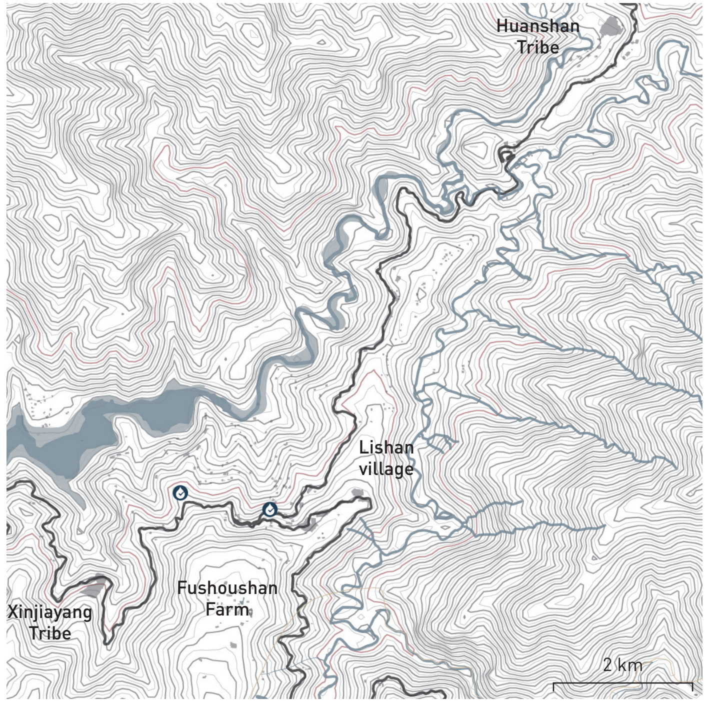
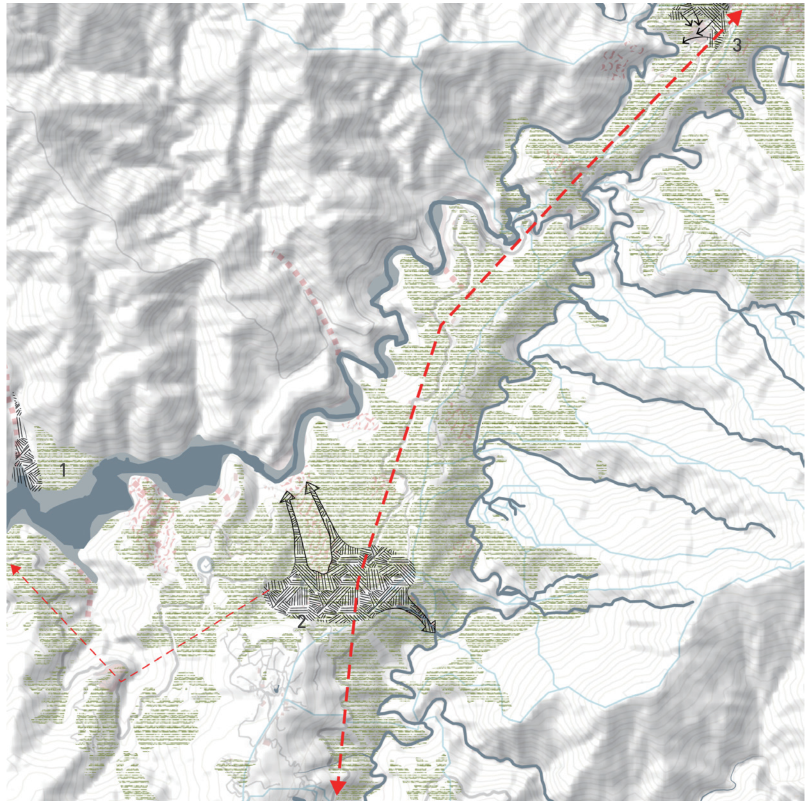
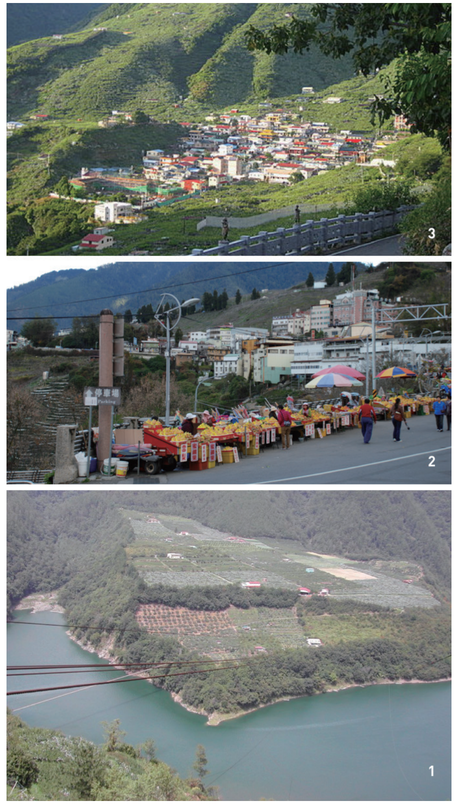


fig.87 Maps of Lishan-Huanshan area in 1950s (left) and today (right). Source: made by the author based on data from GIS database, google maps, and historical maps.

- Primary roads
- Contact of mountain and plain
- River path
- Flooding plain
- Historical river paths
- Urbanized area
- Historical urbanized area

- alpine agriculture (tea, fruit)
- one bus per day (moving kiosk)
- bad accessibility
- aborigine tribes
- retired soldiers accommodated in 1950s





- agriculture
- landslide affected community
- better connection
- poorer connection

fig.88 (left) Map of agriculture areas and landslide threatened community in Lishan-Huanshan area
Source: made by the author based on GIS data & google maps

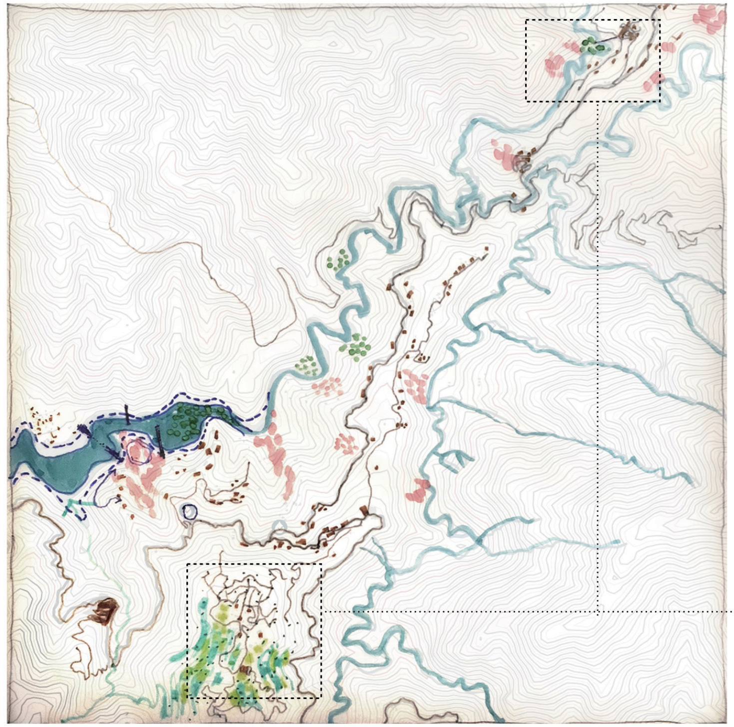
fig.89 (right) Photos of Huanshan tribe, Lishan community, and Xinjiayang. Source: google earth

OBSERVATION OF CURRENT WATER USAGE AT UPSTREAM AREAS

SELF-MADE WATER COLLECTORS - current water system fragile to rainstorms, pipes often easily broken.

fig.90 Photos of water facilities in Huanshan village
Source: photo from Google street views

DESIGN CONCEPT AND STRATEGIES FOR DIFFERENT CONTEXTS

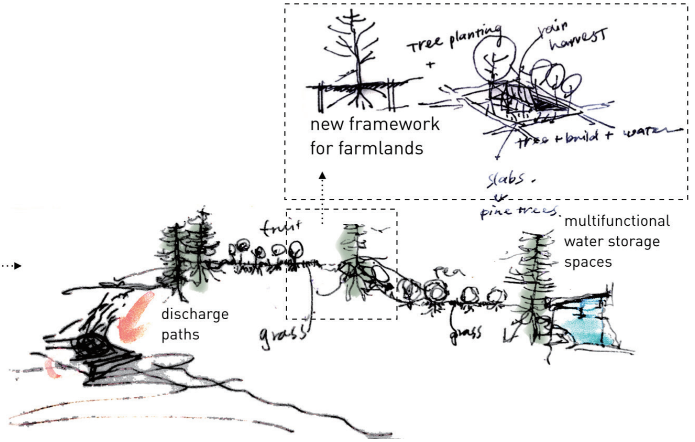


Strategies:

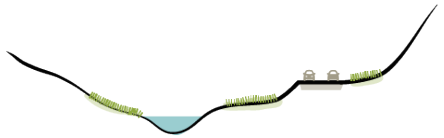
A1, A2  - ecological-friendly, hybridized agriculture with new framework structures

A3, A4  - elements guiding sediments and water accumulated at desired areas

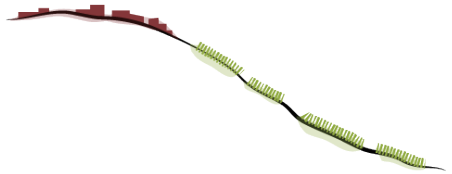
A3  - induce the formation of alpine wetlands along river side



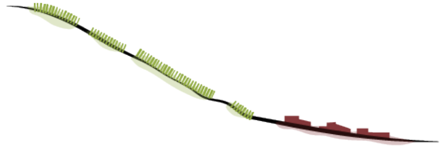
A1 road-side/ riverside agricultures



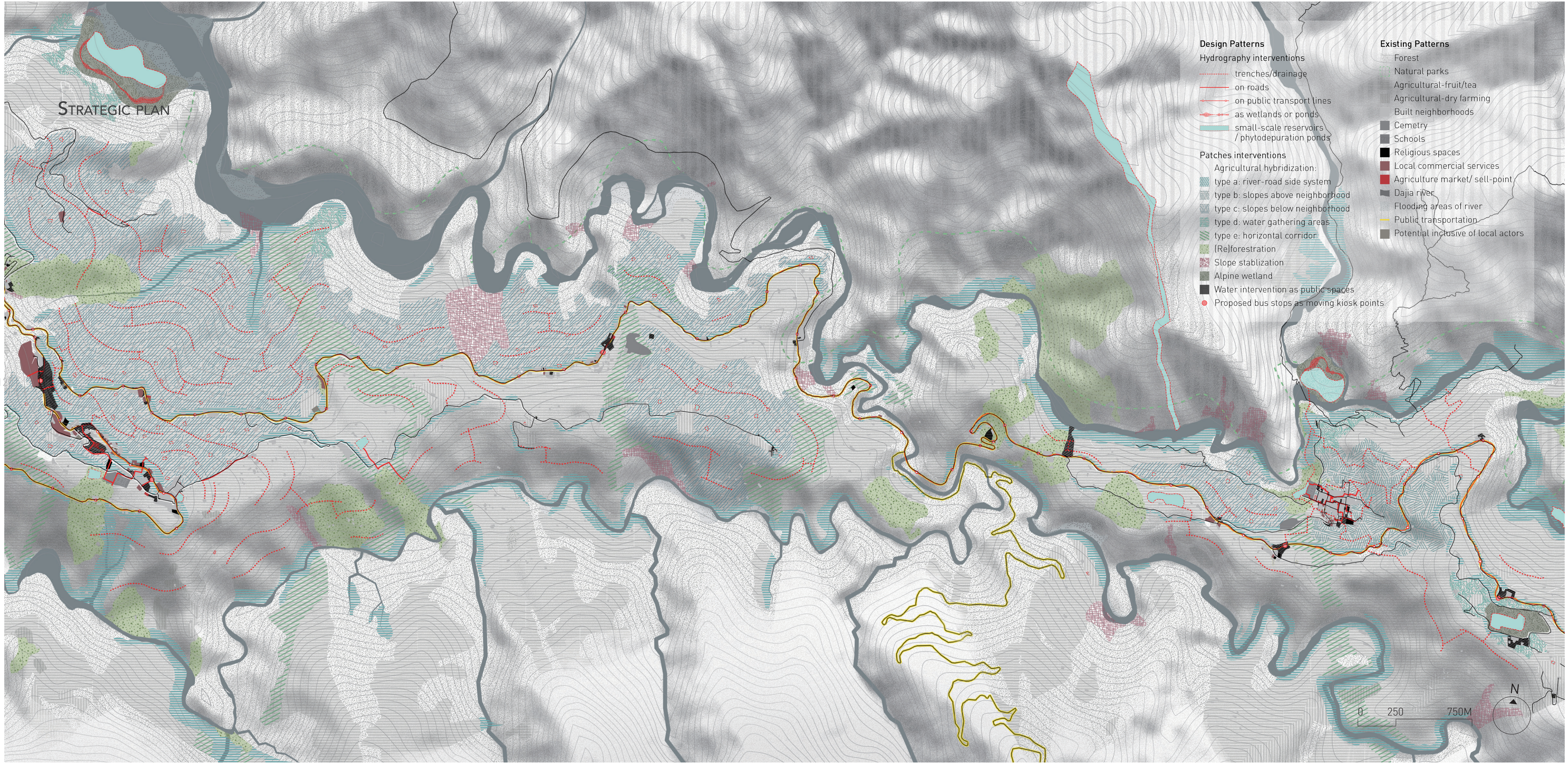
A3 agriculture on slopes below community

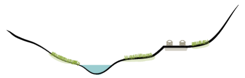


A2 agriculture on slopes above community



A4 converging points of streams close to community

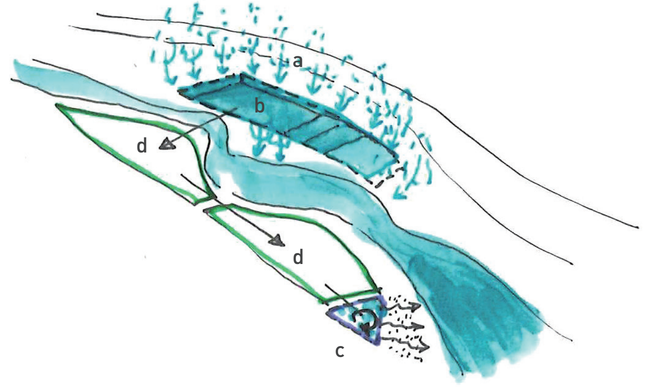

Strategic plan
Design Patterns
Hydrography interventions
trenches/drainage
on roads
on public transport lines
as wetlands or ponds
small-scale reservoirs / phytodepuration ponds
Patches interventions
Agricultural hybridization:
type a: river-road side system
type b: slopes above neighborhood
type c: 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



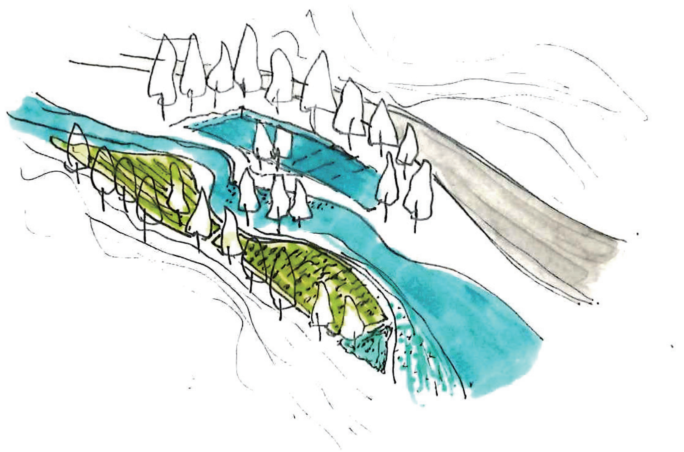
on roadside/riverside agriculture patches

fig.91 Photos of spaces between river and road installed with small agri patches. Source: photo by hnchung via Google Earth

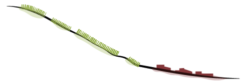
Logic of water system



Intervention visulization



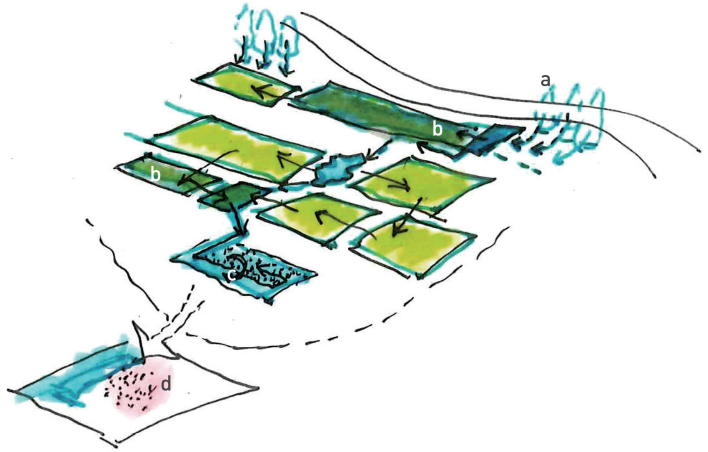
a. tree plantation helps collecting water and stabilize slopes
b. water collection at fallowed fields
c. fallowed fields turned into phytodepuration ponds
d. working fields with crops arranged by the sequence of water usage



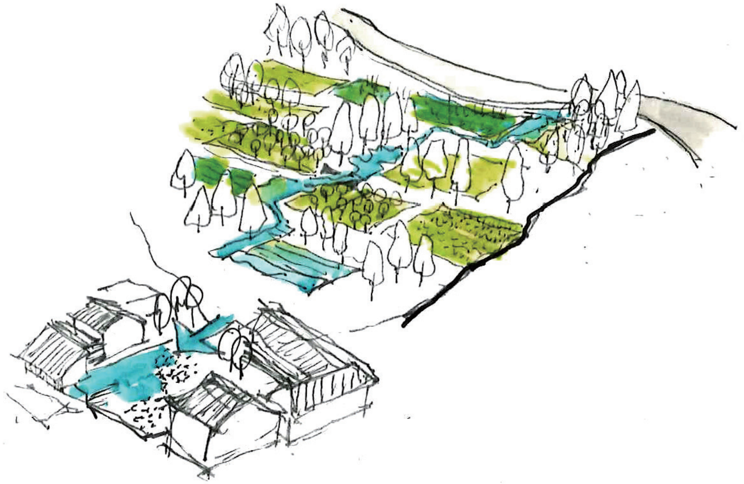
monotype agriculture at slopes above community spaces

fig.92 Photos of slopes above community areas solely planted with fruit trees.
Source: photo from Google street view (above) and 灰狼 e 族 (below)

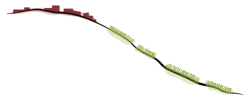
Logic of water system



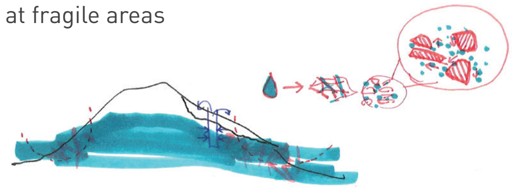
Intervention visulization



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



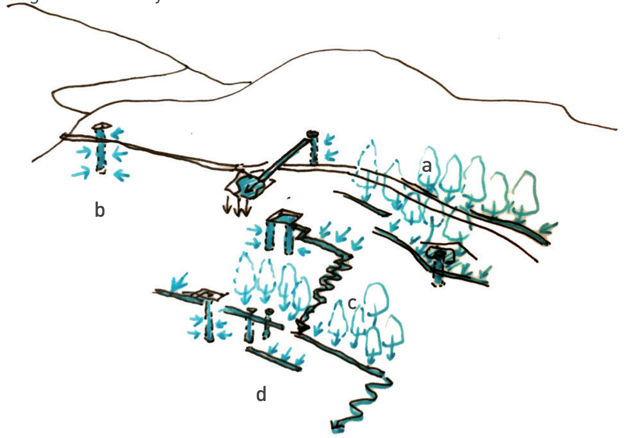
wells and channels to reduce infiltration at fragile areas



infiltration of water at fragile lands increases fragility

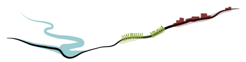
fig.93 Land-sliding threatened area in Lishan
Source: photo by PNN news

Logic of water system



Intervention visulization

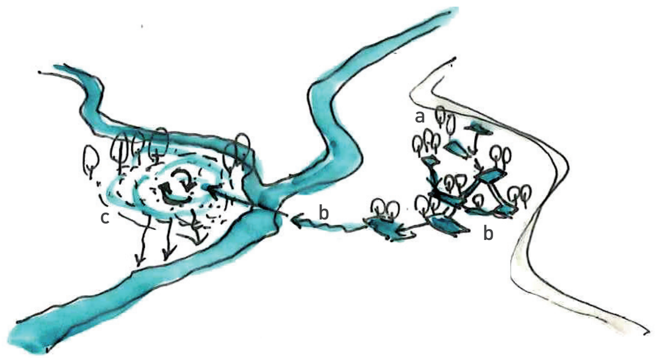
a. tree plantation helps collecting water and stabilize slopes
b. deep wells to extract underground water
c. vertical channels to transport water
d. horizontal channels allow water to be extracted from ground



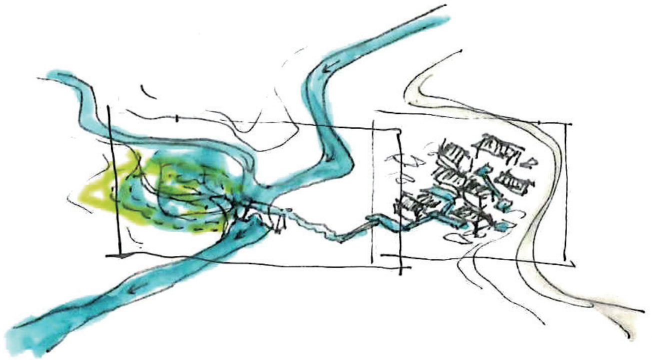
slope as distributor and the converging points of branch streams

fig.94 Underused terraces within Huanshan community
Source: photo from Google street view

Logic of water system



Intervention visulization



a. tree plantation helps collecting water and stabilize slopes

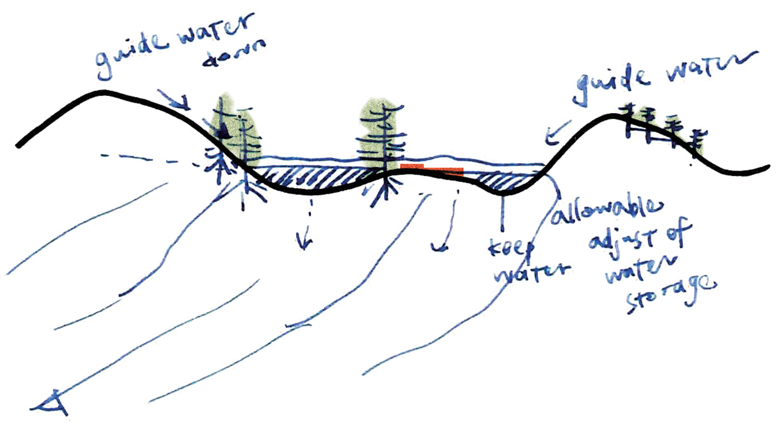
b. water collection/distribution along slopes within community spaces, and designed as public spaces

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

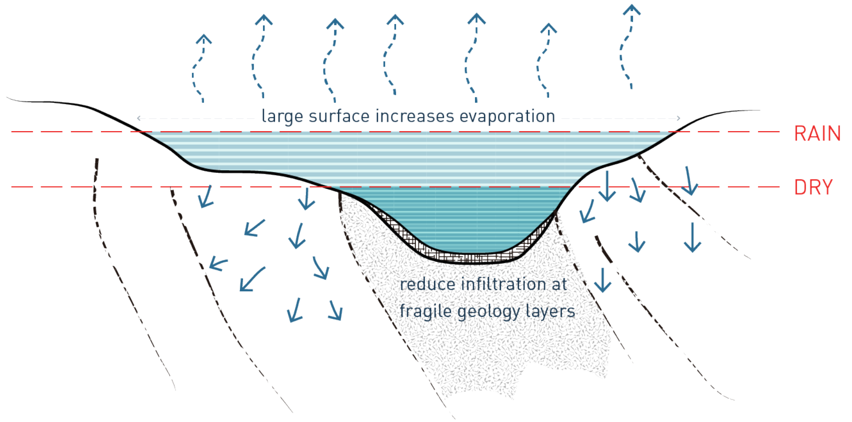
Design details

SECTION OF WATER COLLECTION PONDS OR DISCHARGE CHANNELS

Large scale



Detail scale



Demonstration area: Huanshan alpine tribe

CURRENT SITUATION

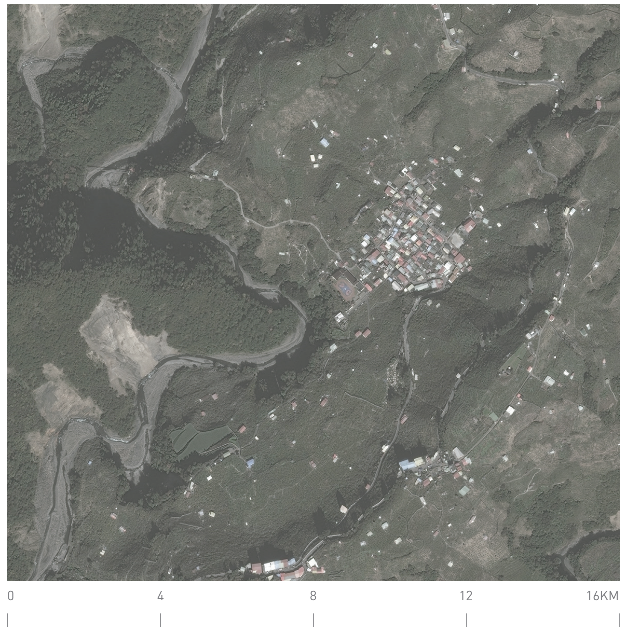
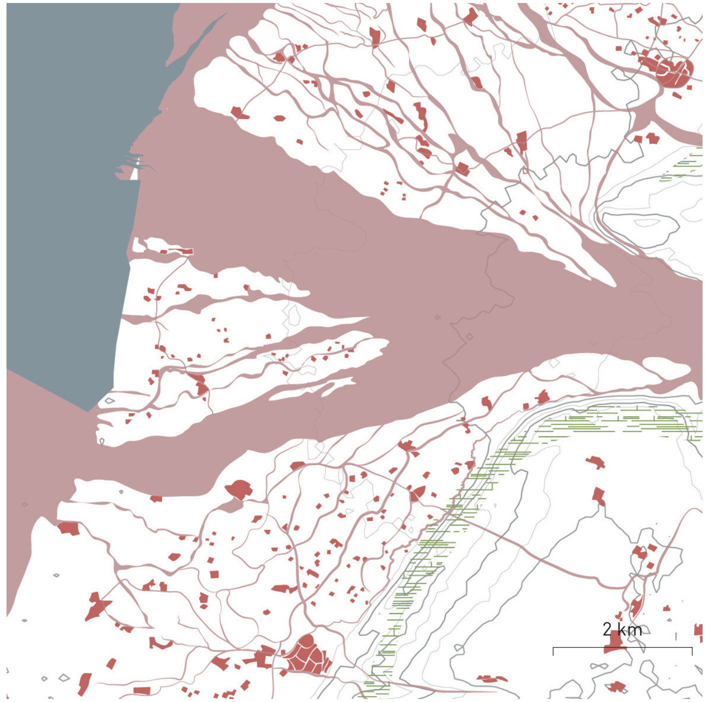


fig.95 Aerial photo of Huanshan tribe.
Source: Source: photo by Iyhou Chiu

IX. Zoom-in Interventions

Design interventions at down-stream: revision of historical river courses

1850s



today

- Primary roads
- Railway
- Contact of mountain and plain
- River path
- Flooding plain
- Historical river paths
- Urbanized area
- Historical urbanized area

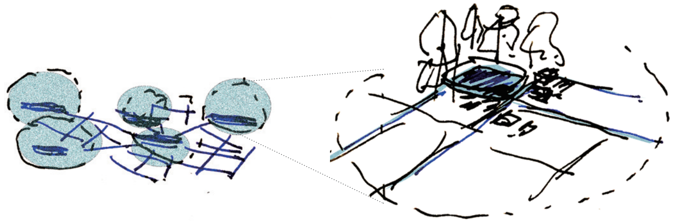
- historical rivers brings frequent floods
- soil are suitable for agriculture
- Rice fields frequently forced to fallow due to draught

fig.96 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.97 Aerial photo of Kaomei area.
Source: www.gaomei.com.tw/gaomei

The main concept is to make the historical route reappear to be the vitality vein for the neighborhoods, as well as more room for water.

Empty land and fallowed fields turn into small-scale reservoirs, and organize the irrigation units. The system will be mutual adjustable, reducing rely on water supply from reservoirs and conflict between water usage policy which prioritizing industrial platforms in case of draughts.



MORPHOLOGICAL OBSERVATION AT DOWN-STREAM AREAS

Agricultural paddy fields

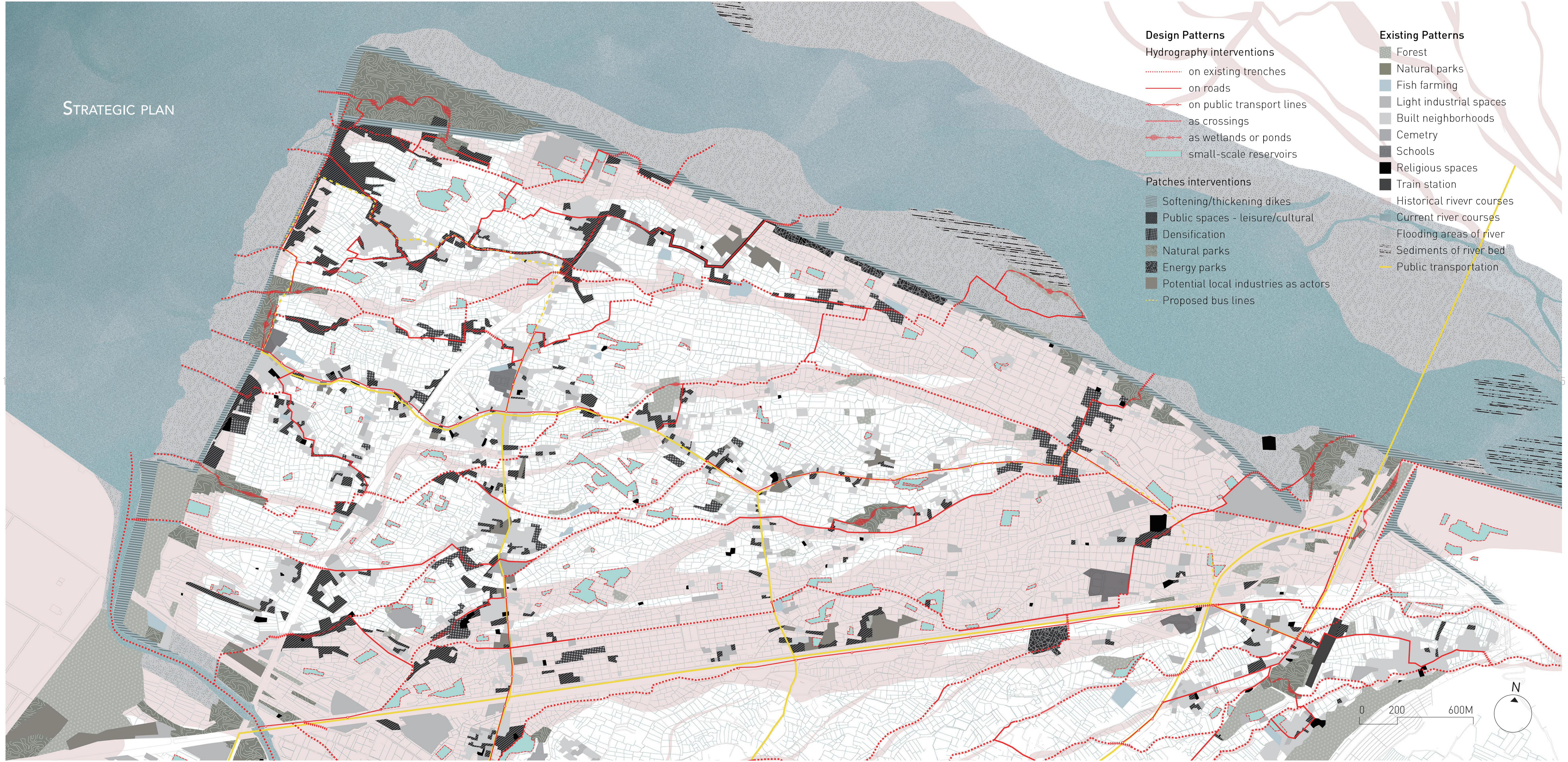
fig.98 Photo of agricultural paddy fields in Kaomei area at the downstream of Dajia river. Source: Google street view.

Empty lands

fig.99 Photos of empty lands in Kaomei area, at the down-stream of Dajia river. Source: Google street view.

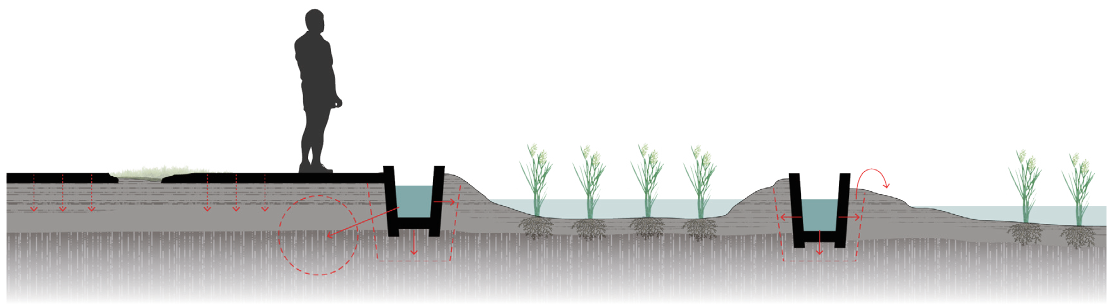
Fallowed fields

fig.100 Photos of fallowed fields in Kaomei area, at the down-stream of Dajia river. Source: f14mp5 (https://f14mp5.wordpress.com/); Google street view.


Strategic plan
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



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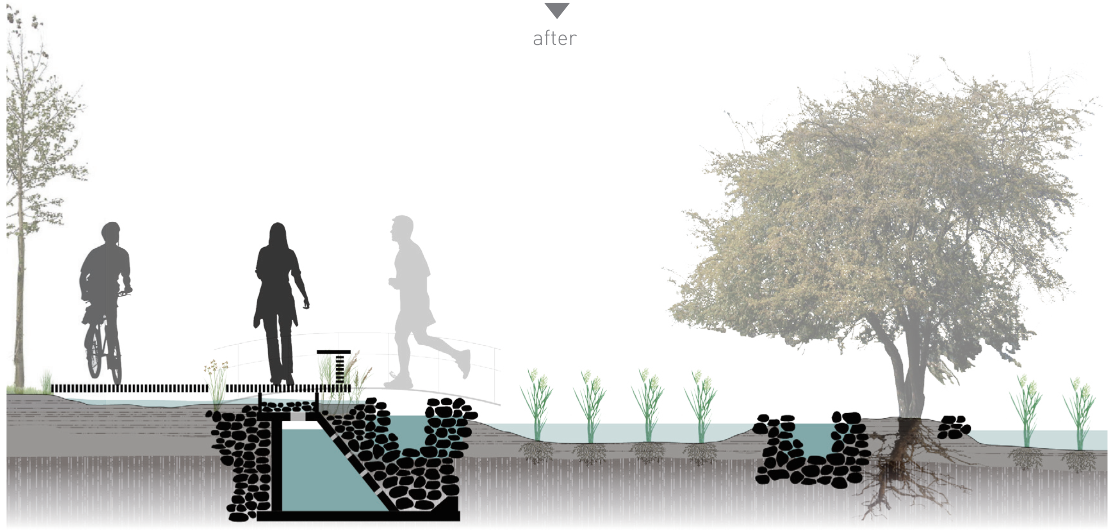
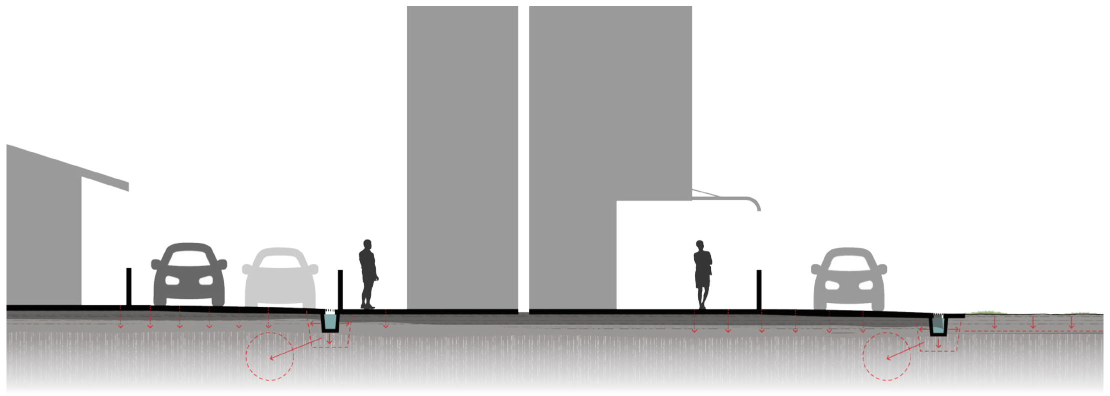


On roads



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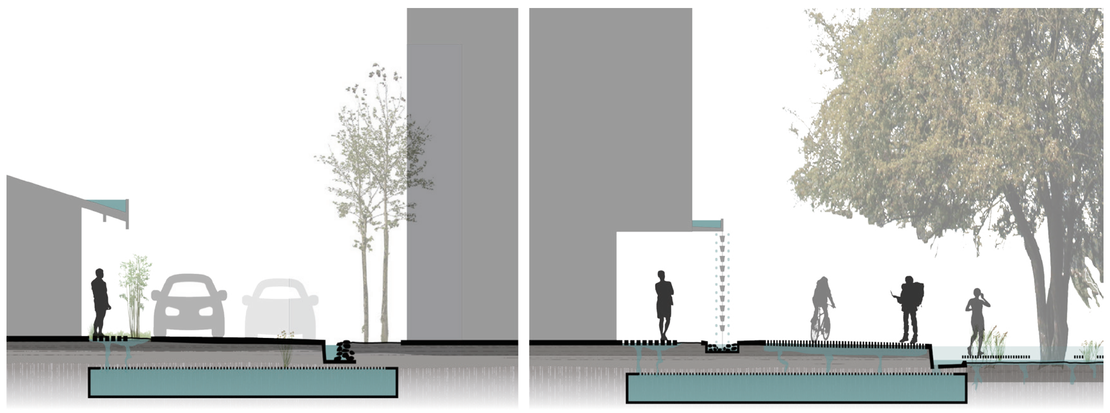
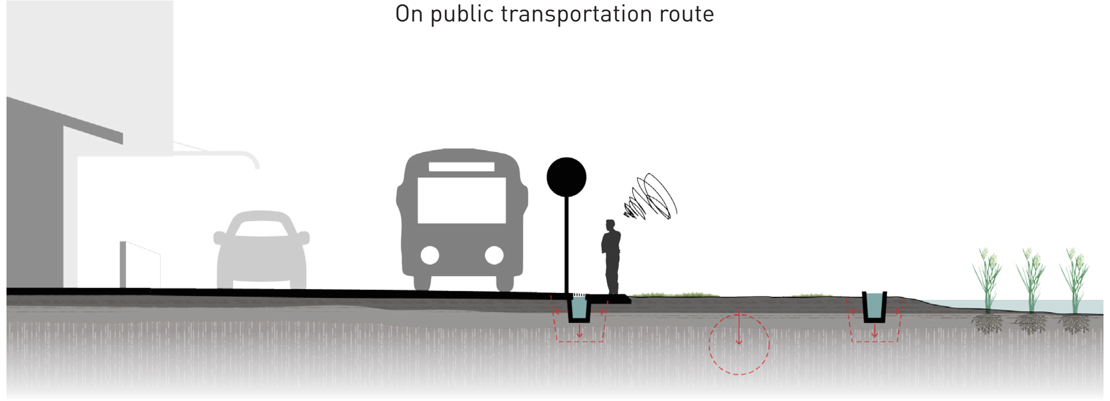


On public transportation route



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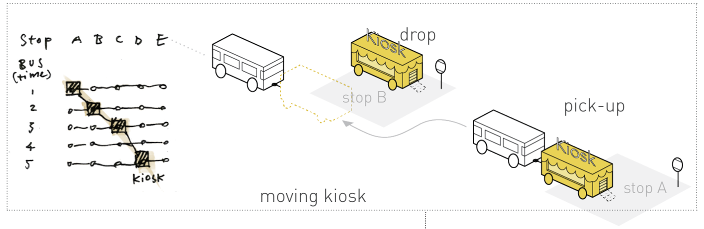
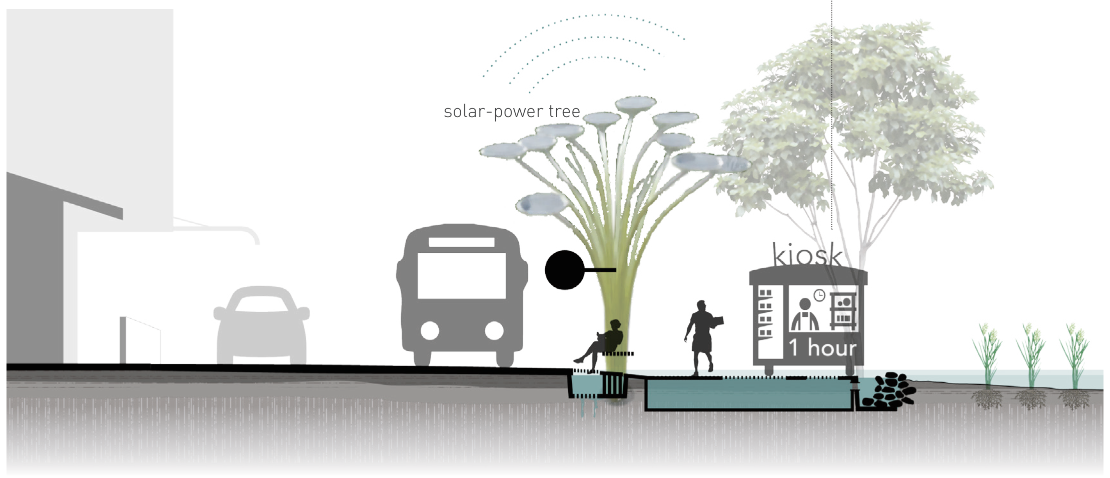
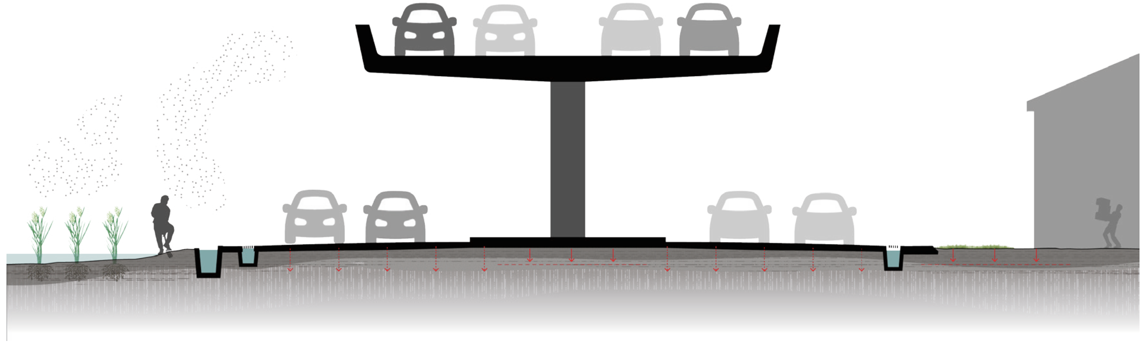




As crossings



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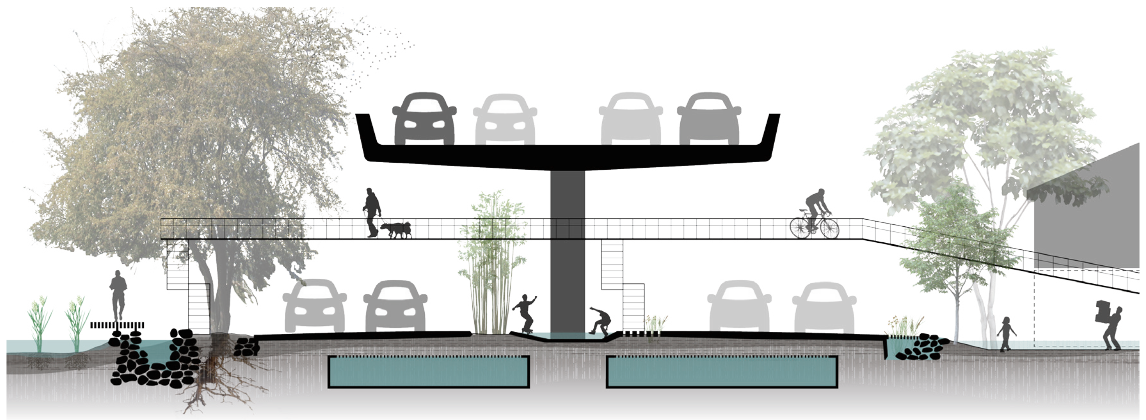
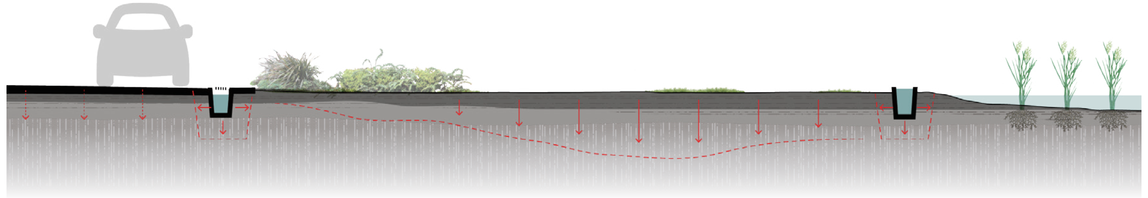


As wetland or ponds



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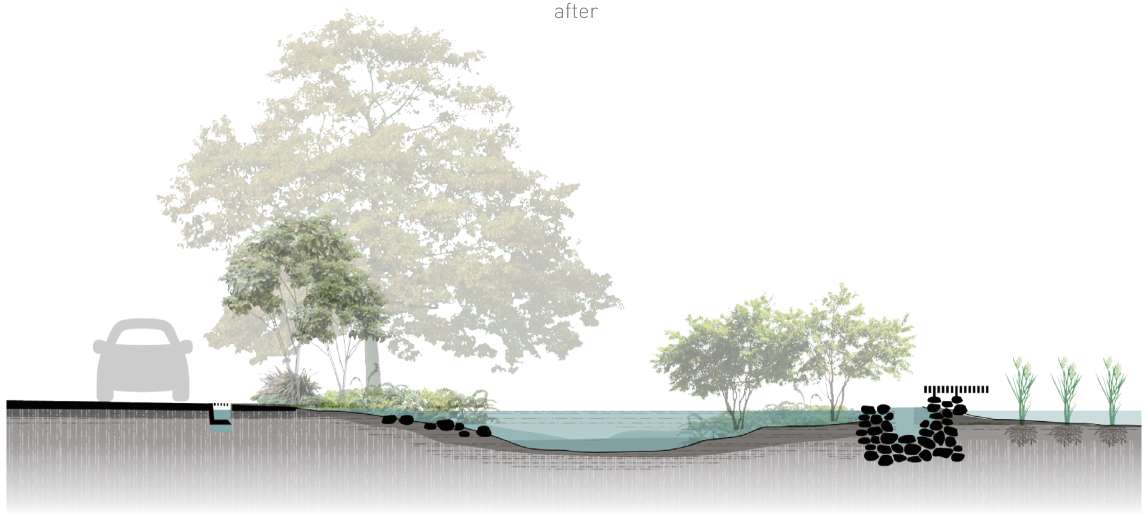
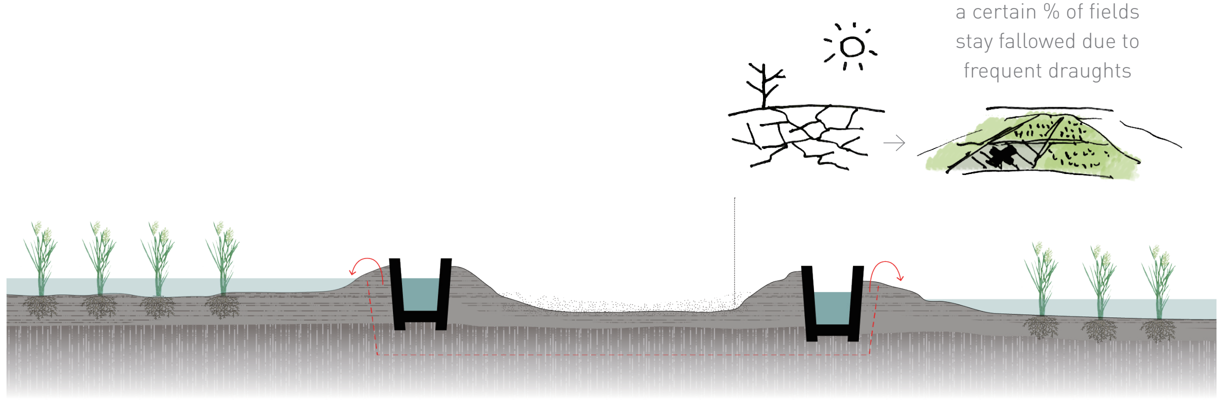


As small-scale reservoirs



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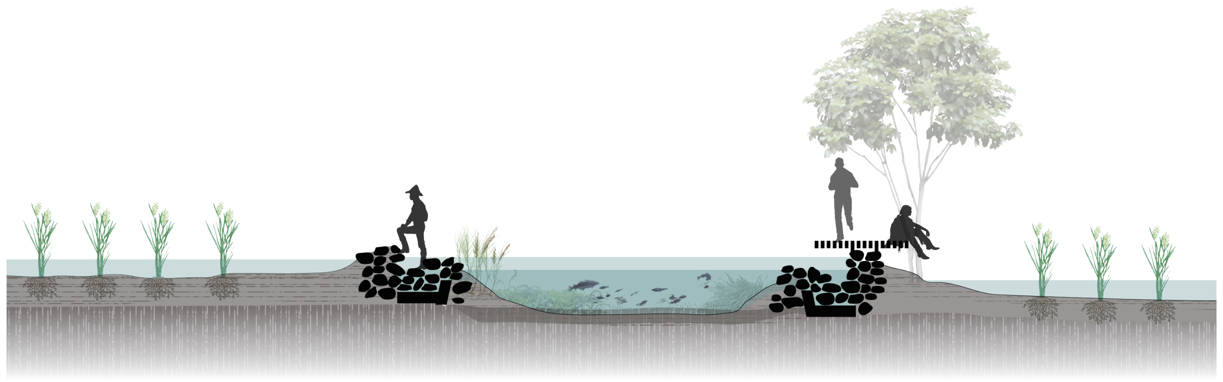


Demonstration area: Kao-pei neighborhood

CURRENT SITUATION

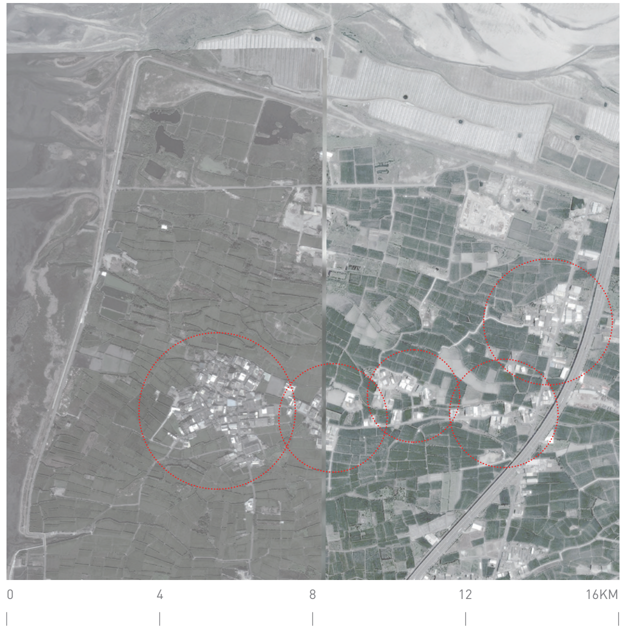


fig.101 Photo of marginalized condition of Kaopei neighborhoods. Source: Google street view.

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

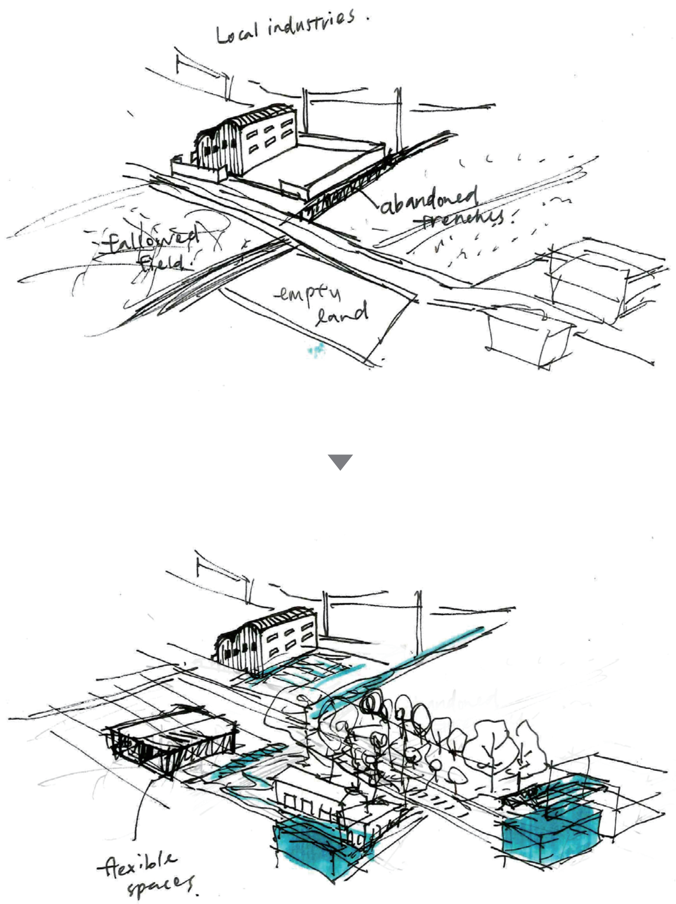
fig.103 Photo empty lands used for grain sunning.
Source: Google street view.

fig.104 Photo of small religious temples in the fields.
Source: Google street view.

fig.105 Photo showing the segregation of neighborhoods by mobility infrastructures. Source: Google street view.

DESIGN CONCEPT

Densification of opportunities for water flows and storage in spaces within the community can be incentivised through cooperation of local actors, such as facmers, local industrial factory owners, residents of deteriorated houses. Together these intervened patches make the historical river courses reappear, which will work as the vitality vein for the living environment. The design of potential patches can be categorized as the following seven typologies (see page xx for more visualized images):



❶ Religious place + plaza + agricultural fields

❷ Grain sunning places + residential buildings

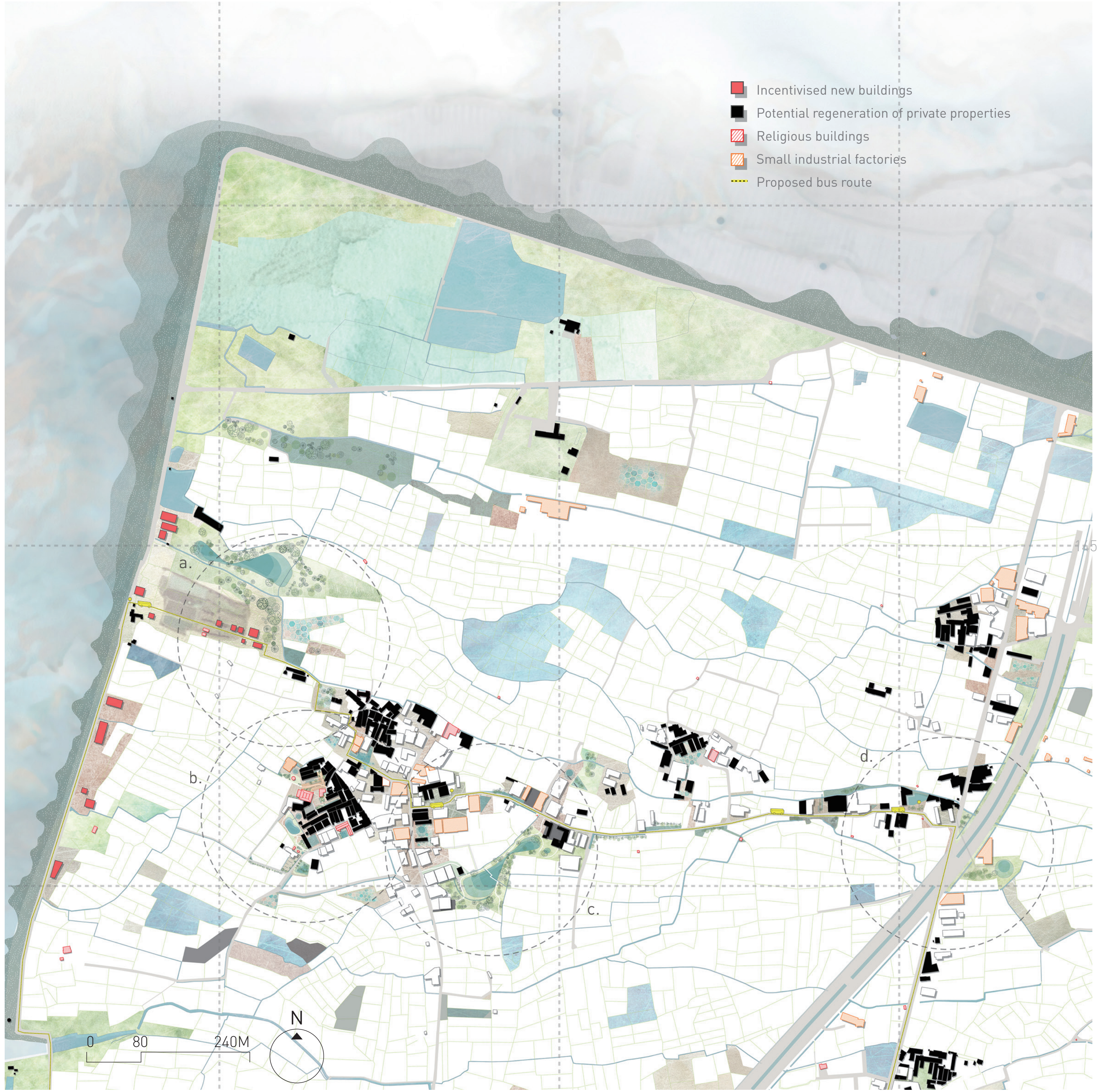
❸ Small industrial factory + multifunctional working area + fallowed fields

❹ Traditional houses in deteriorated state + courtyard spaces

❺ New/existing public transportation stops + empty lands

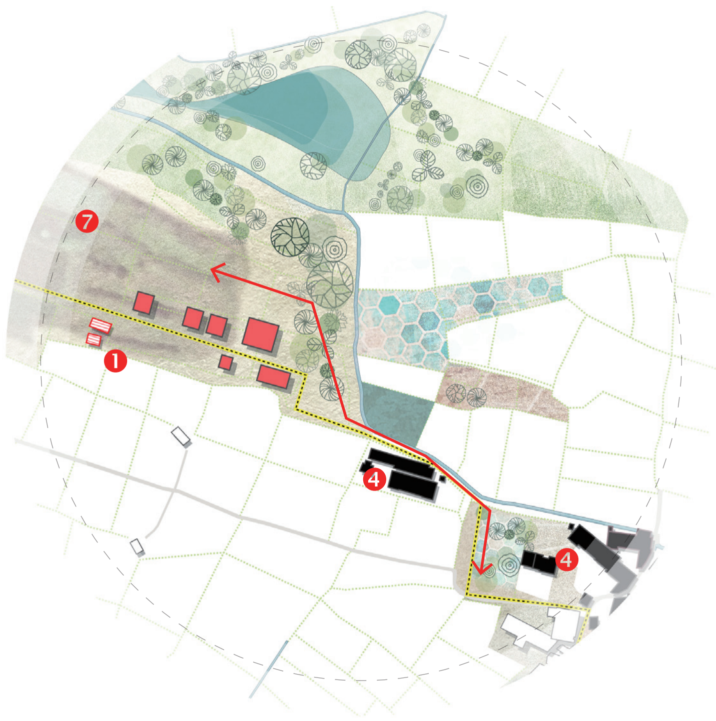
❻ Elevated motorway + agricultural fields

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



a.

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



b.

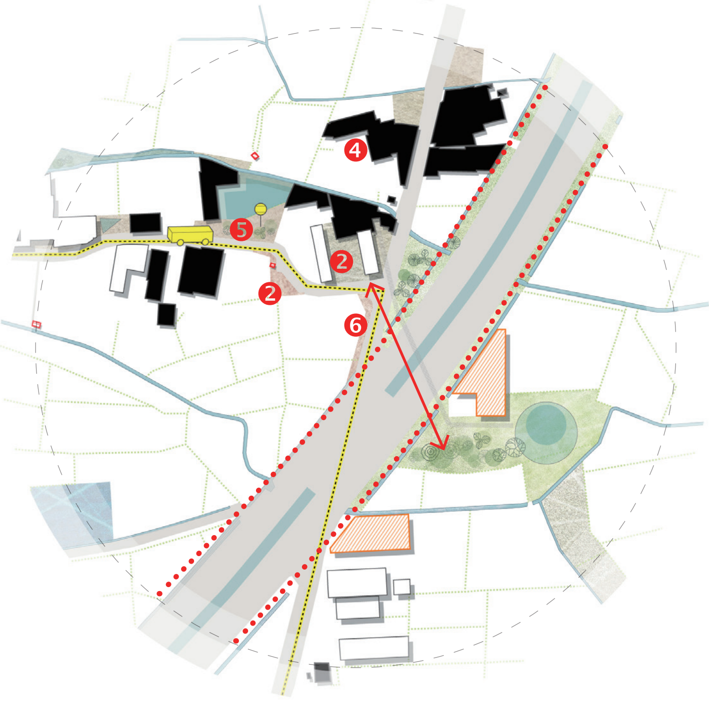
Various possibilities of collabration between different actors and their spaces for accommodate water gardens and activate places. Together these patches reveals the historical river courses which will become the vitality vine for the living environment.

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.



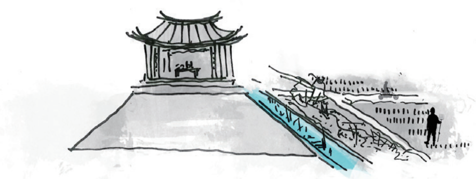
- Incentivised new buildings
- Potential regeneration of private properties
- Religious buildings
- Small industrial factories
- Proposed bus route
- 1 - 7 Intervention patch typologies

Design intervention patches

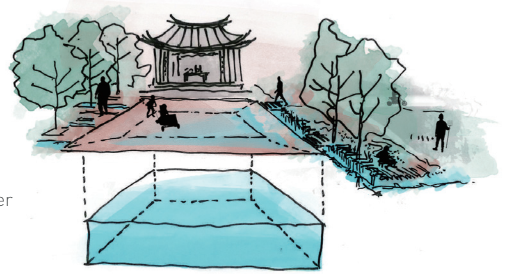
❶ RELIGIOUS PLACE + PLAZA + AGRICULTURAL FIELDS

Hydrography interventions
- on trenches
- small reservoirs

Operative structures
- corridor
- public space



before / after

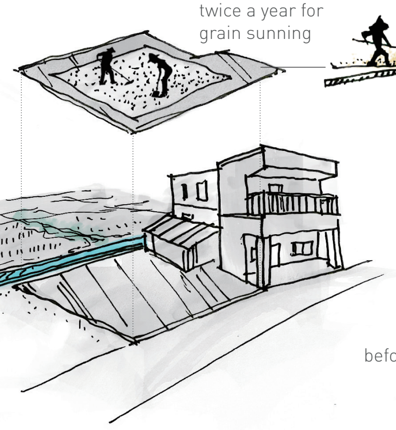


❷ GRAIN SUNNING PLACES + RESIDENTIAL BUILDINGS

Hydrography interventions
- on roads
- on trenches
- small reservoirs

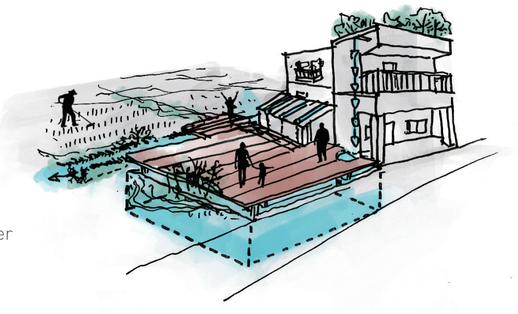
Operative structures
- corridor
- public space

place used only twice a year for grain sunning



can be used as public spaces beside grain sunning weeks

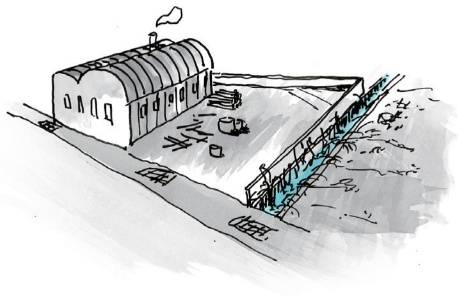
before / after



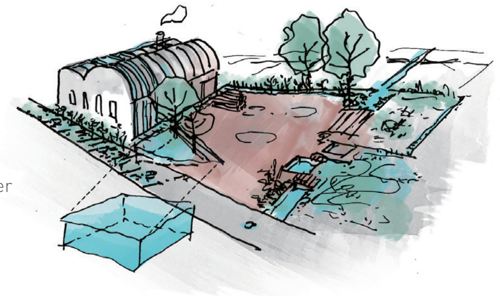
❸ SMALL INDUSTRIAL FACTORY + MULTIFUNCTIONAL WORKING AREA + FALLOWED FIELDS

Hydrography interventions
- on roads
- on trenches
- small reservoirs

Operative structures
- corridor
- public space



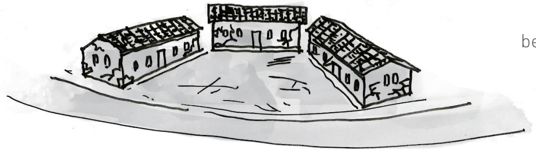
before / after



❹ TRADITIONAL HOUSES IN DETERIORATED STATE + COURTYARD SPACES

Hydrography interventions
- small reservoirs

Operative structures
- corridor
- public space



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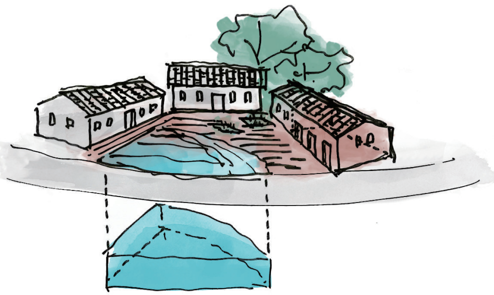
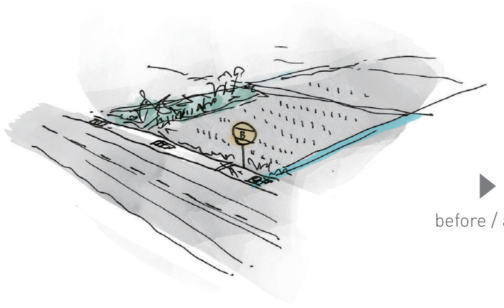


❺ NEW/EXISTING PUBLIC TRANSPORTATION STOPS + EMPTY LANDS

Hydrography interventions
- on roads
- on transport route
- small reservoirs

Operative structures
- corridor
- mobility
- public space



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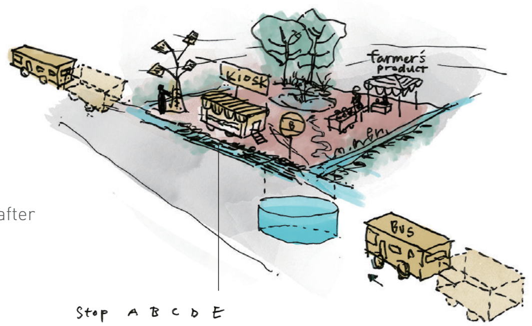
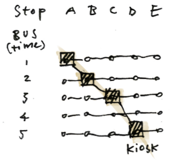


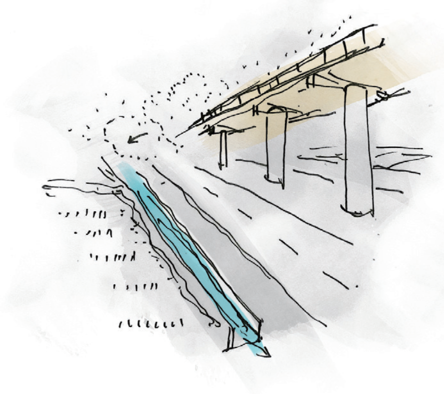


moving kiosk combined with public transportation

❻ ELEVATED MOTORWAY + AGRICULTURAL FIELDS

Hydrography interventions
- on roads
- as crossings

Operative structures
- corridor
- mobility

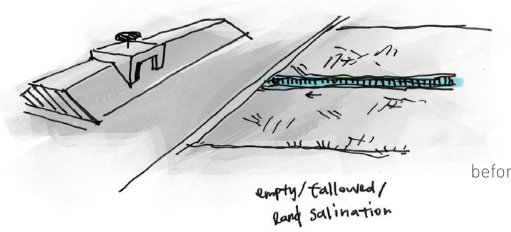


before / after

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

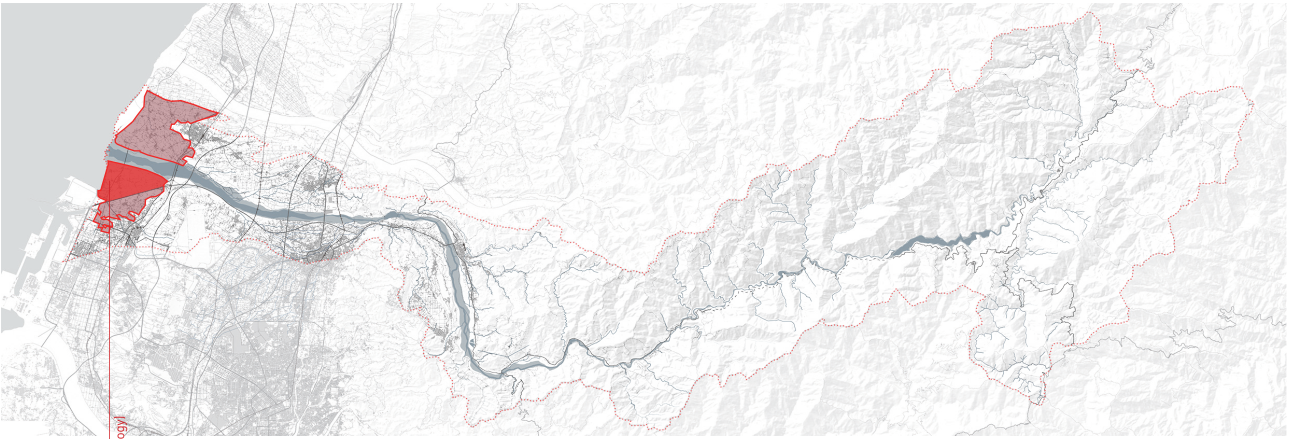
Hydrography interventions
- as wetland park

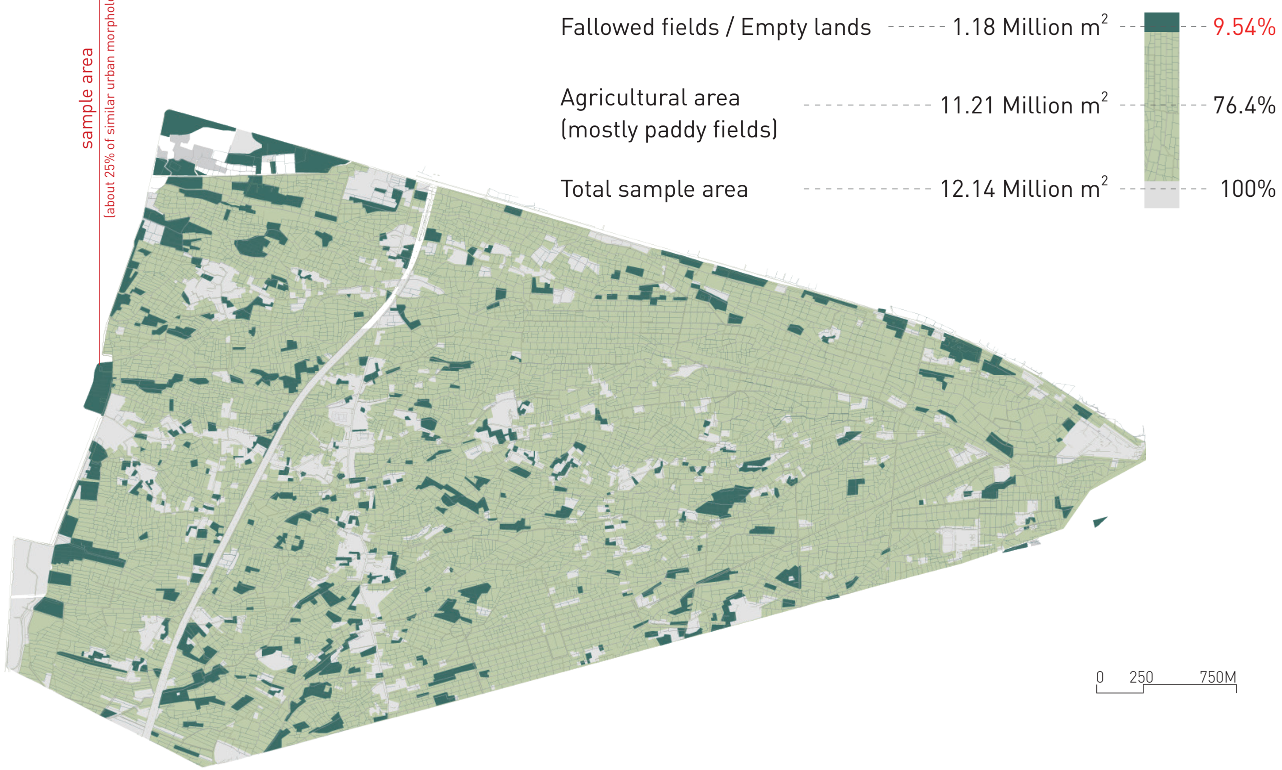
Operative structures
- corridor
- mobility
- public space



before / after

Design evaluation





X. Reflection

Reflection outlines

1. Limitation of the project considering the current Taiwan urban planning institutional frameworks.
2. Comparison of the existing official proposed regional plans, strategies, and projects.
3. Stakeholder analyses and interview with specialists in different disciplines.
4. Degree of achievable water adjustion and disaster mitigation, then lead to the short-term, mid-term, and long-term phasing of the regional plan.

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