

## The sensitive river scape, the sinuous territory

The transformation of mountainous river landscape as territorial infrastructure

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## COLOPHON

### P2 Presentation Report

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fig. 01 The landscape Dajia river upstream alpine agricultural cultivation on hill-tops.  
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

## ABSTRACT

This project explores the landscape potential of Taiwan in terms of integrating water and river management with urbanism within the context of a compact environmental diversity. 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.



## PROBLEM STATEMENT

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.

The natural condition of the rivers are difficult for keeping water despite the amount of yearly rainfall is high.

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.



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fig.02 The 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

## 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. Osborne, 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.

## PROBLEM ANALYSIS

### MOUNTAIN LANDSCAPE OF TAIWAN

#### 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.

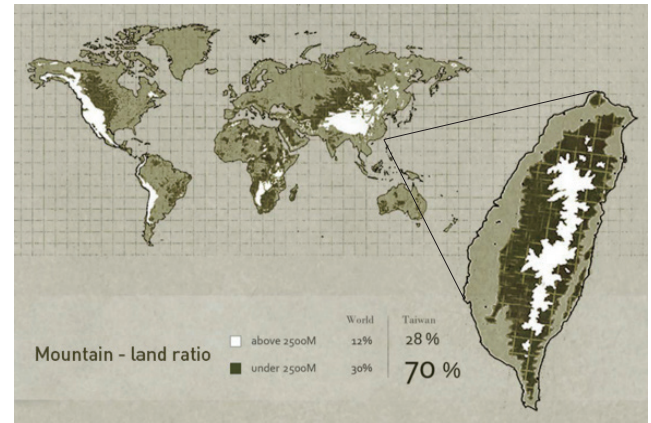


fig.03 World topography & mountain percentage of Taiwan

Source: edited by author based on data from: <http://lawr.ucdavis.edu/>

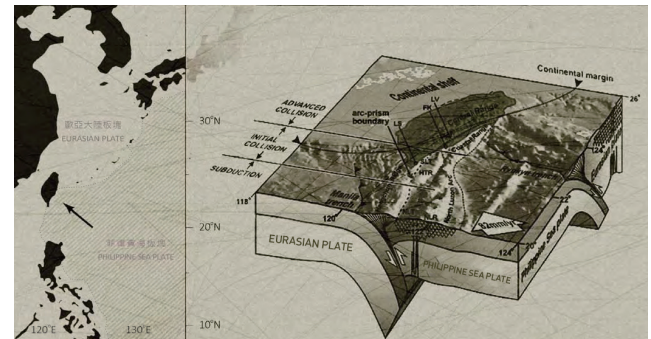


fig.04 The converging of Earth plates forming the island of Taiwan

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.

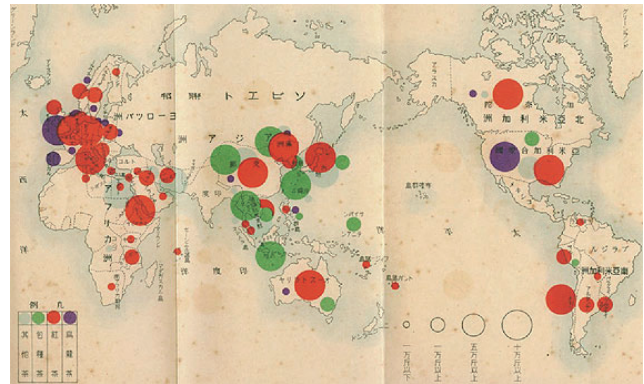


fig.05 Map showing Taiwan's different kinds of tea exporting to the world in 1939. Source: <http://www.rhythmsmonthly.com/>



fig.06 The over cultivation of alpine agriculture in the alpine areas. Source: <http://www.rhythmsmonthly.com/>



## PROBLEM ANALYSIS

### RIVER SCAPE OF TAIWAN

#### 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.

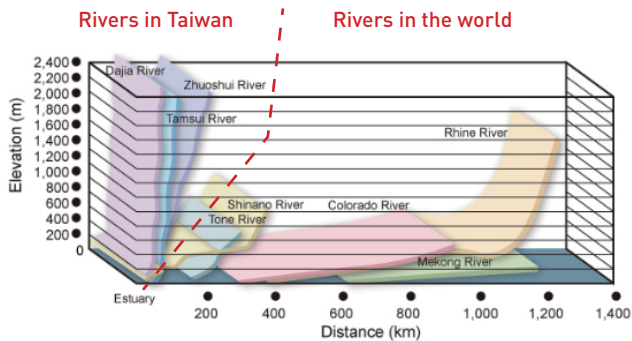


fig.08 Steepness of rivers in Taiwan and in the world  
Source: Water Resources Agency, MOEA, Taiwan Government

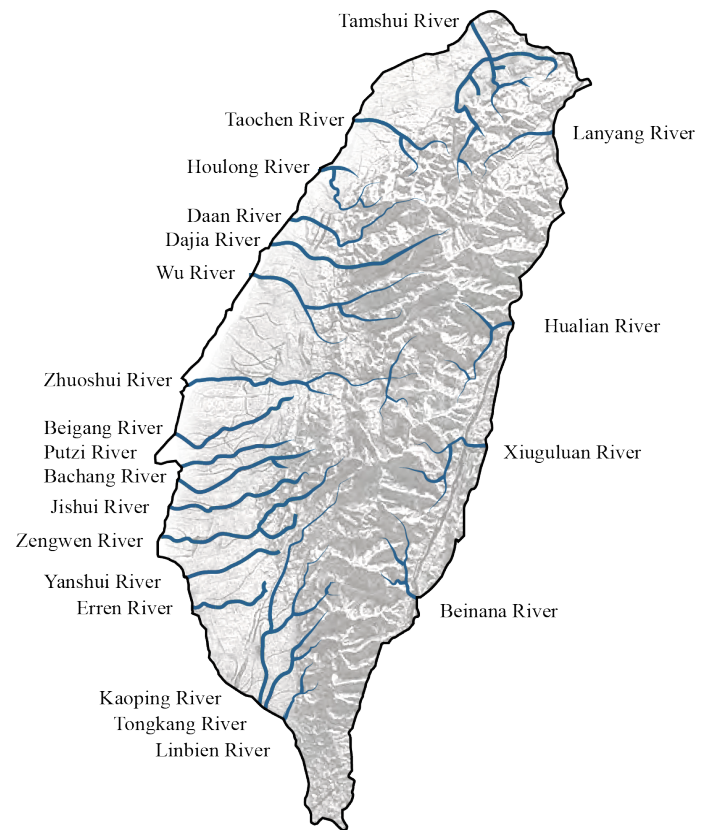


fig.07 Main rivers in Taiwan  
Source: edited by author based on data from Water Resources Agency, MOEA, Taiwan Government

2. Difficulty in 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		Country	Water resource per capita	
(mm/year)			(cubic meter/year/person)	
2,000	1,000		20,000	40,000
		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 lifespan of reservoirs

The fragility of the landscape character of Taiwan has limited the possible location for building reservoirs in some specific dam sites. Currently, 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

## PROBLEM ANALYSIS

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 65% filled with sediment  
Source: Taiwan Academy of Ecology epaper (2013) [Online] <http://enews.url.com.tw/> [accessed 20. Feb. 2017]

## NATIONAL PLANNING OF TAIWAN

### 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.

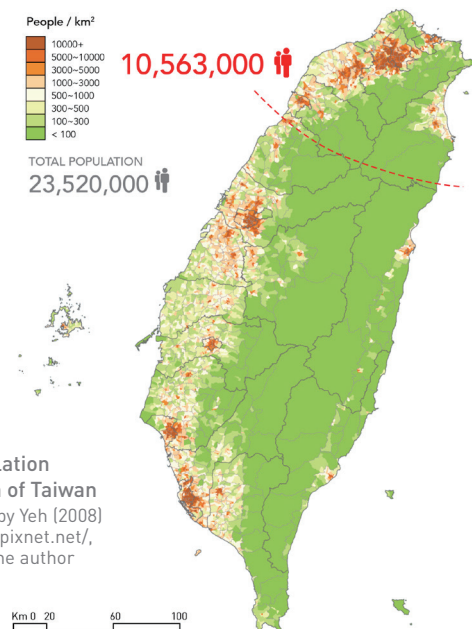


fig.12 Population Distribution of Taiwan  
Source: Map by Yeh (2008)  
<http://richter.pixnet.net/>,  
modified by the author



### Neglected landscape quality and territorial potentials

There is a lack of attraction and identity of the other cities in Taiwan, while Taiwan's landscape character can be regarded 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 nodes that contribute 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 BASIN**

Dajia river is the steepest river in Taiwan (fig.14). It contains the largest water resources, both in terms of water amount and electricity generation. From upstream to downstream, the river basin composes alpine agriculture farms, infrastructures (reservoir, dams, and power plants), valley villages, the third biggest city in Taiwan, as well as a fishing port and protected wetlands at the river-mouth.

The Dajia river scape provide a compact case for develop 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.

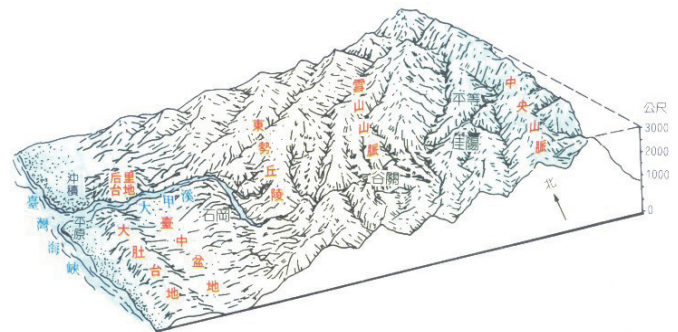


fig.14 The topography along Dajia river  
Source: <http://www.tlsh.tp.edu.tw/>

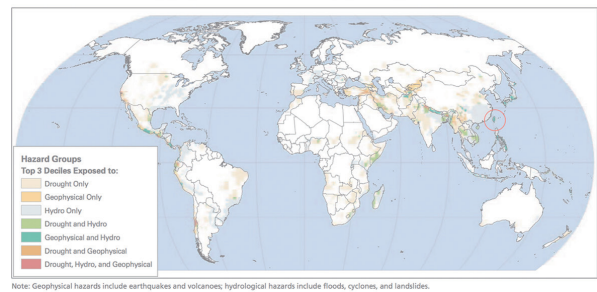
THEORETICAL FRAMEWORK

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.15) 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



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.	16.4	13.5	3
Antigua and Barbuda	100.0	100.0	2	People's Rep. of			
Hong Kong, China	100.0	100.0	2	Lao People's	15.2	12.6	3
Taiwan	99.1	98.9	4	Dem. Rep. of			
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.15 Taiwan being highly exposed to natural hazards.

Source: The World Bank (2005) Natural Disaster Hotspots: A Global Risk Analysis

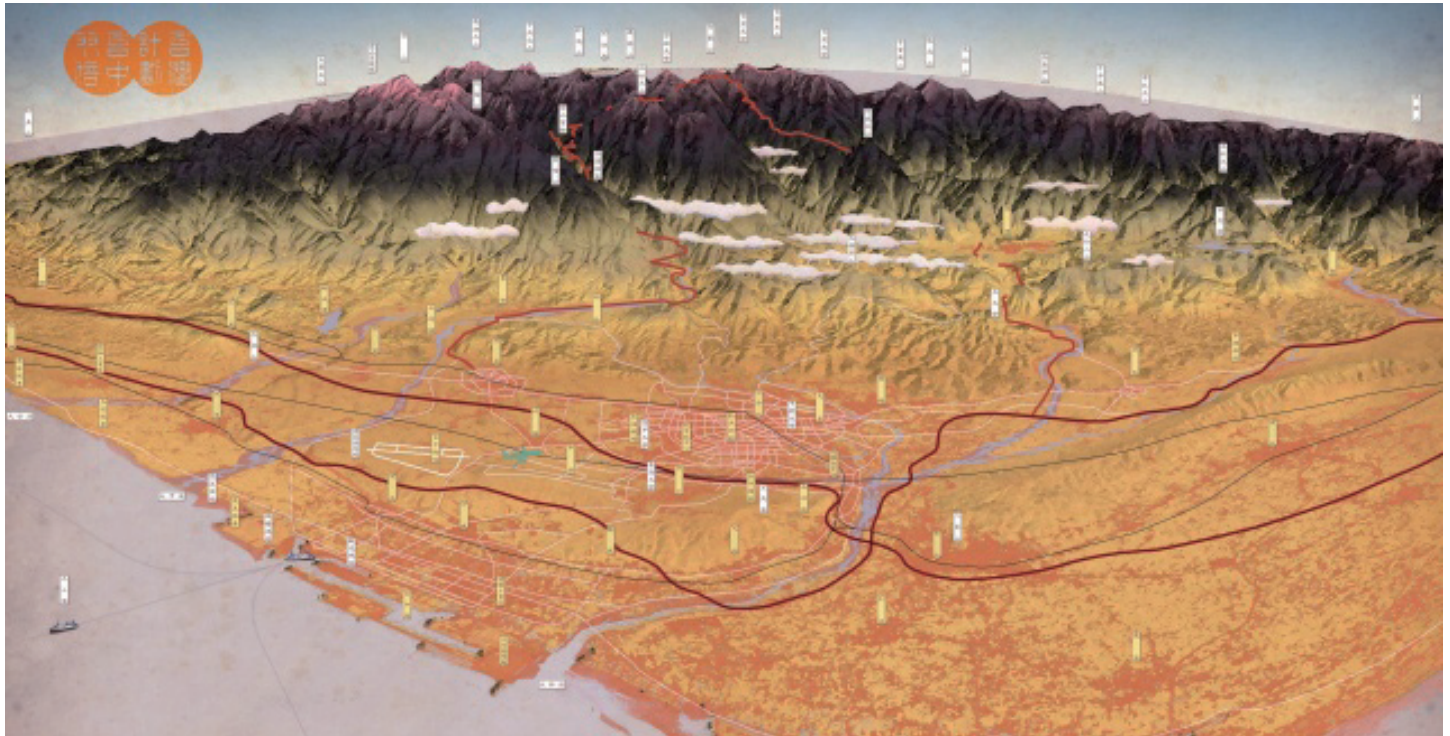
## LANDSCAPE URBANISM AS A BODY OF KNOWLEDGE

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. 16).

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.16 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.17) or the collapse of dams and hydropower station along Dajia river in 2005 (fig.18) have, as many other natural disaster around the world, demonstrated the limits of engineered controls,



fig.17 The recurrent collapse and restoration of the Guguan section of Central Cross-island Highway.

Source: Lee, H.Y. (2014) "How Can Governments Be Smart" speech slides [Online] available at: <https://www.slideshare.net/codefortomorrow/how-can-governments-be-smart> [accessed 19 March 2017]



fig.18 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]

and the shortcomings of rational efficiency. Its over-exertion has now made 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.

## RESEARCH QUESTIONS

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?

### 01. How does it work?

- How has the river scape been influencing human activities and vice versa? What lessons 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?

#### Methodologies to be applied:

3 time-scale analyses; mapping; literature of mountain and water-related issues; literature of history and geography of the area.

### 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)?

#### Methodologies to be applied:

3 time-scale analyses; mapping; case study; literature of sustainable water management and technological possibilities; interviews (or documentaries) of stories from the territory.



### 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?

#### Methodologies to be applied:

case study; scenario exploration; research by design; interview with different stakeholders.

### 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?

#### Methodologies to be applied:

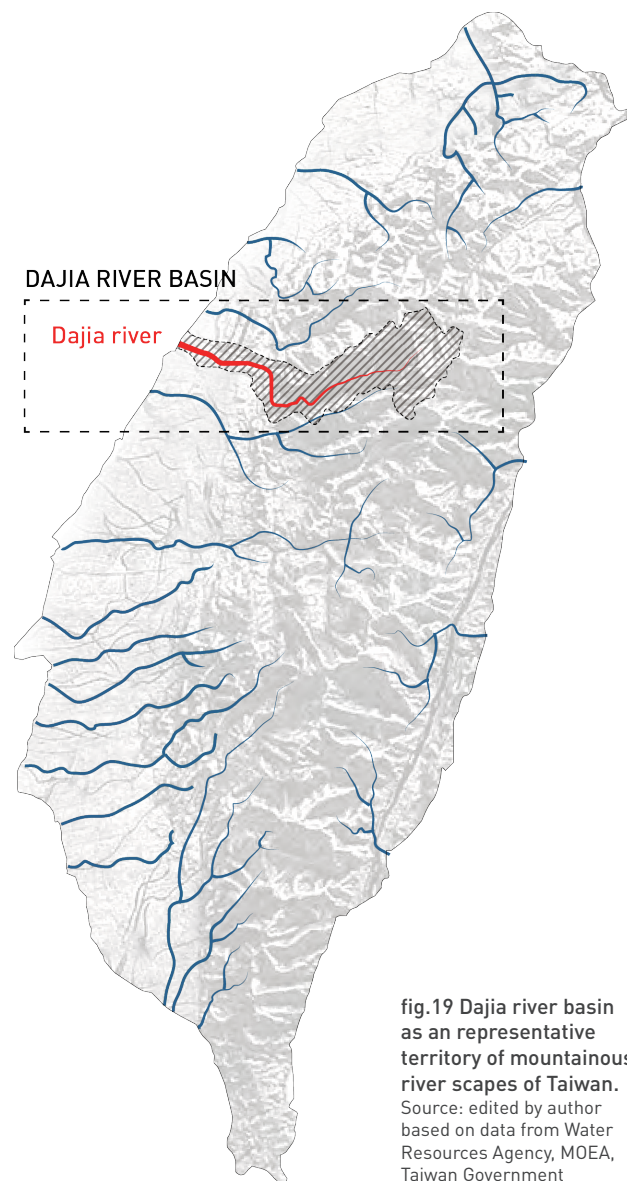
case study and analysis;

## AIM & 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.19) 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.

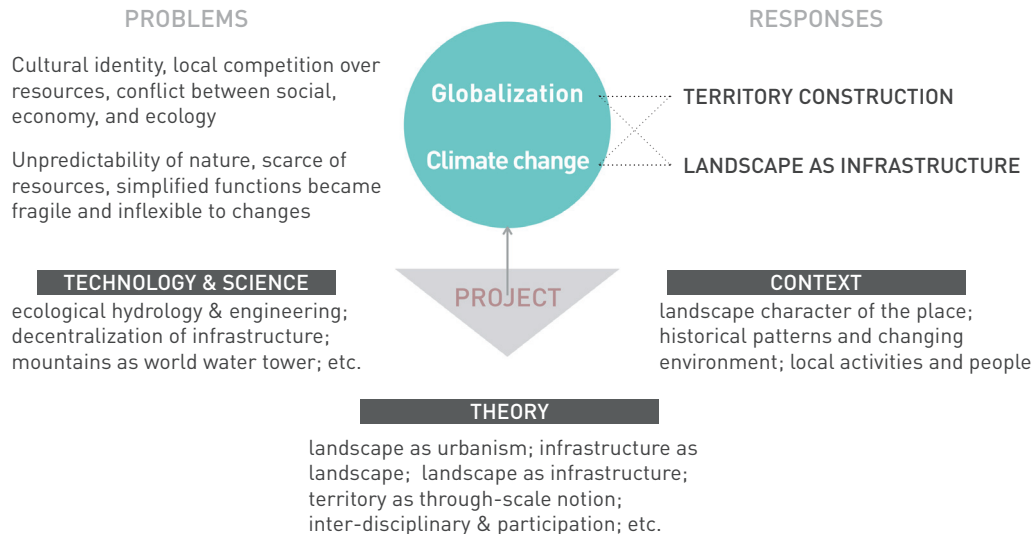


**fig.19 Dajia river basin as an representative territory of mountainous river scapes of Taiwan.**

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.



## CONTEXT

### DAJIA RIVER VALLEY

Dajia river located at central-western Taiwan. Originated from the Central 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 [see fig.21], being the steepest river in Taiwan, and a typical rapid river. 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.20), 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).

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 the highest among the whole country. From figure 22 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).

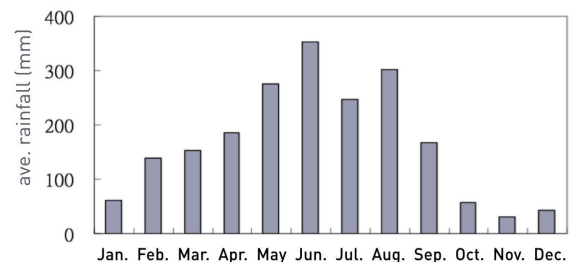
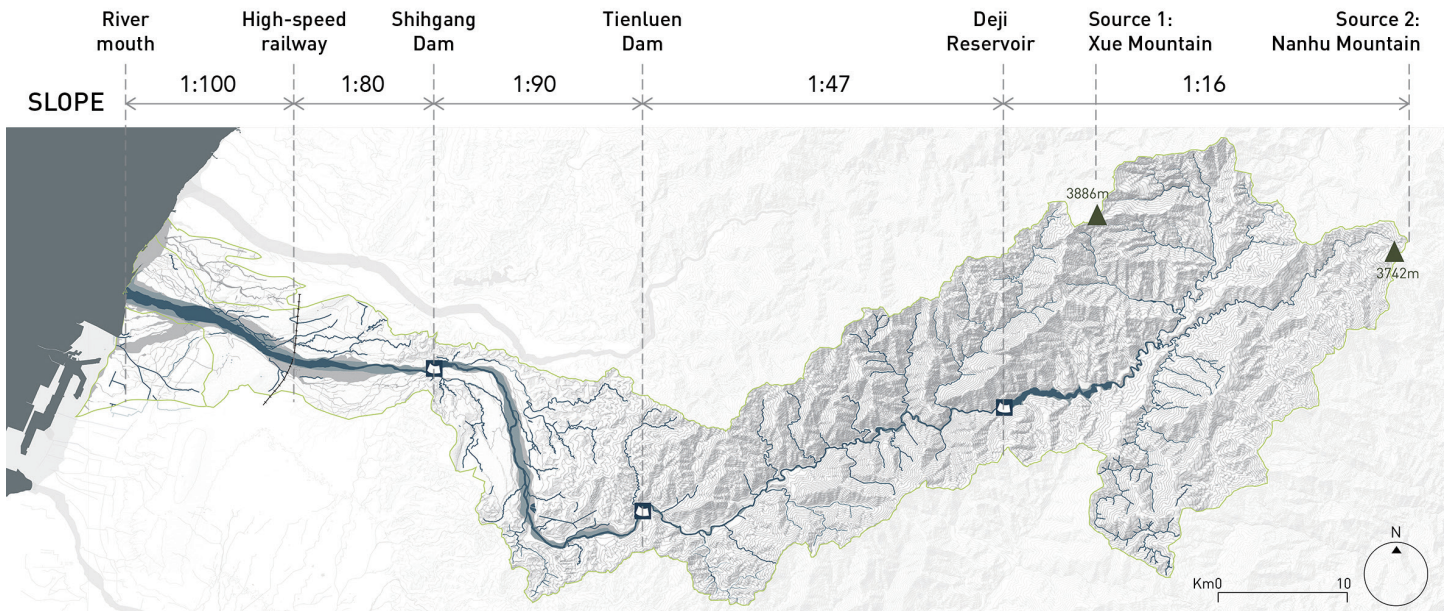


fig.20 Monthly average rainfall in Dajia catchment

Source: Water Resources Agency, MOEA, Taiwan Government



fig.21 Slopes at different sections of Dajia river Source: made by author based on data from GIS and Water Resources Agency, MOEA, Taiwan Government



027

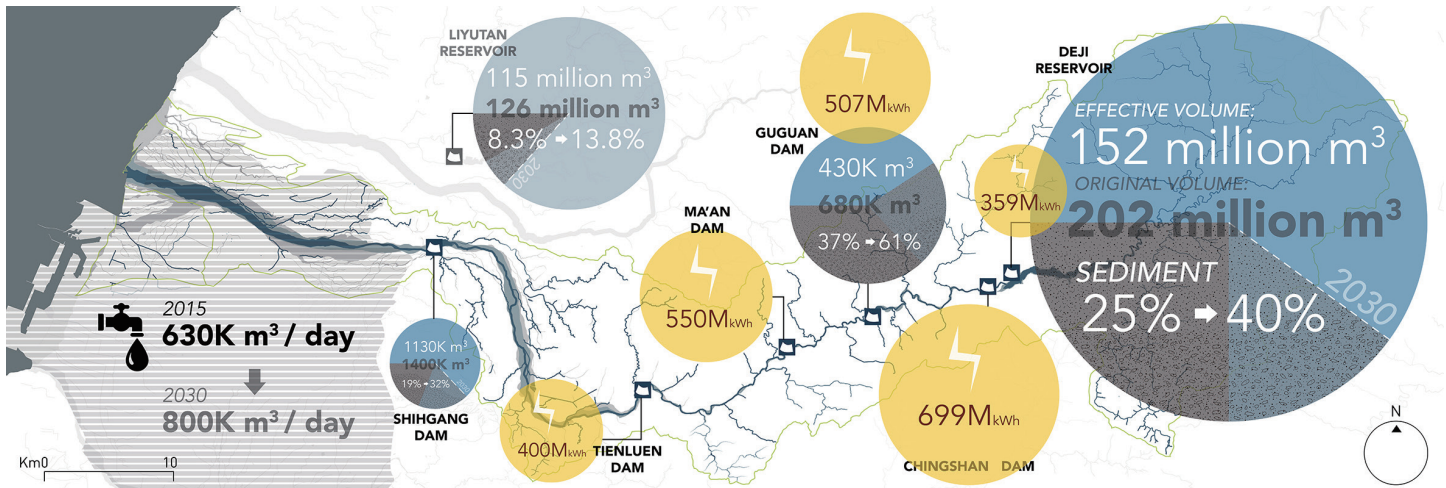


fig.22 Water resource infrastructures along Dajia river, the expected future water demand and sediment accumulation in the reservoirs.

Source: made by author based on data from Water Resources Agency, MOEA, Taiwan Government

- Dajia river
- Flooding plain
- Historical river paths

## CONTEXT

### POPULATION AND URBAN AREAS

Dajia River valley covers 1236km<sup>2</sup> and has 626,000 people (fig. 23) with a diverse of urban morphologies (fig. 24 & 25) namely (from upstream to down stream) alpine farms and tribe communities, mountain villages, double villages looking at each other on two sides of the river, satellite cities to the Taichung metropolitan area, as well as diffuse agricultural and aquacultural villages and port industrial areas at the river mouth. 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.23 Population of Dajia river valley and the neighboring metropolitan areas.

Source: made by author based on data from GIS

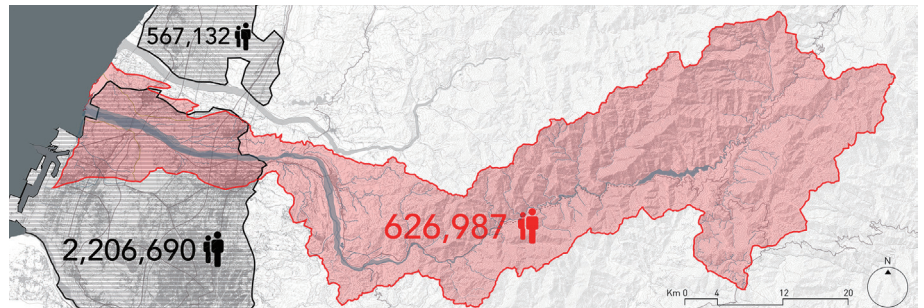
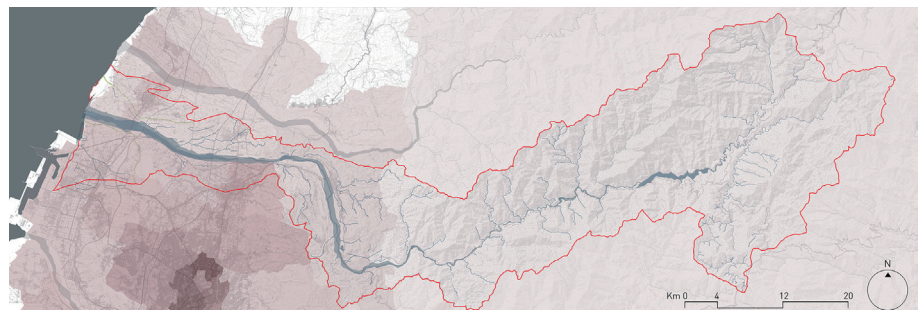
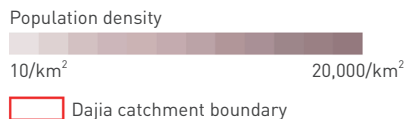


fig.24 Population Density of Dajia river valley and the nearby areas.

Source: made by author based on data from GIS



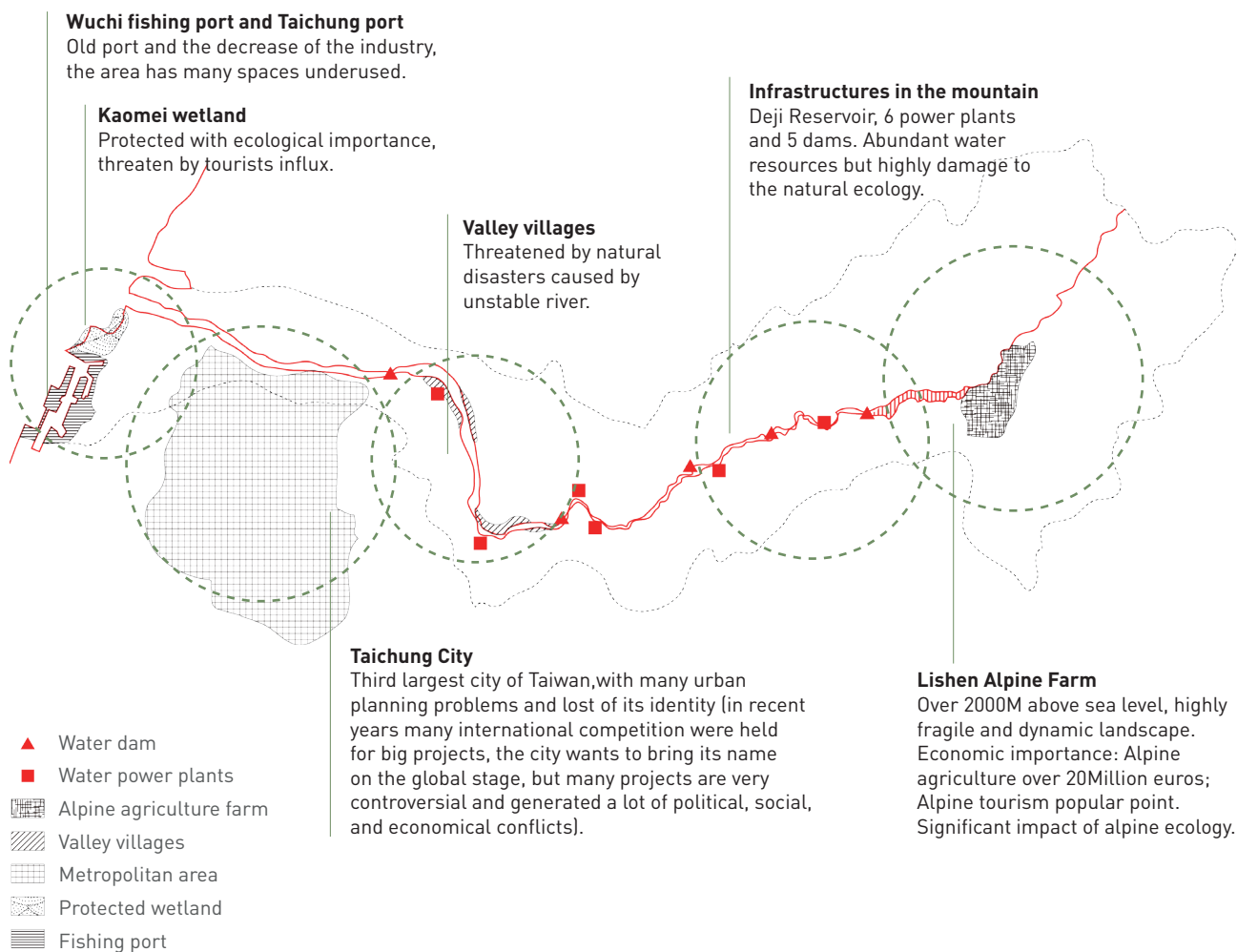
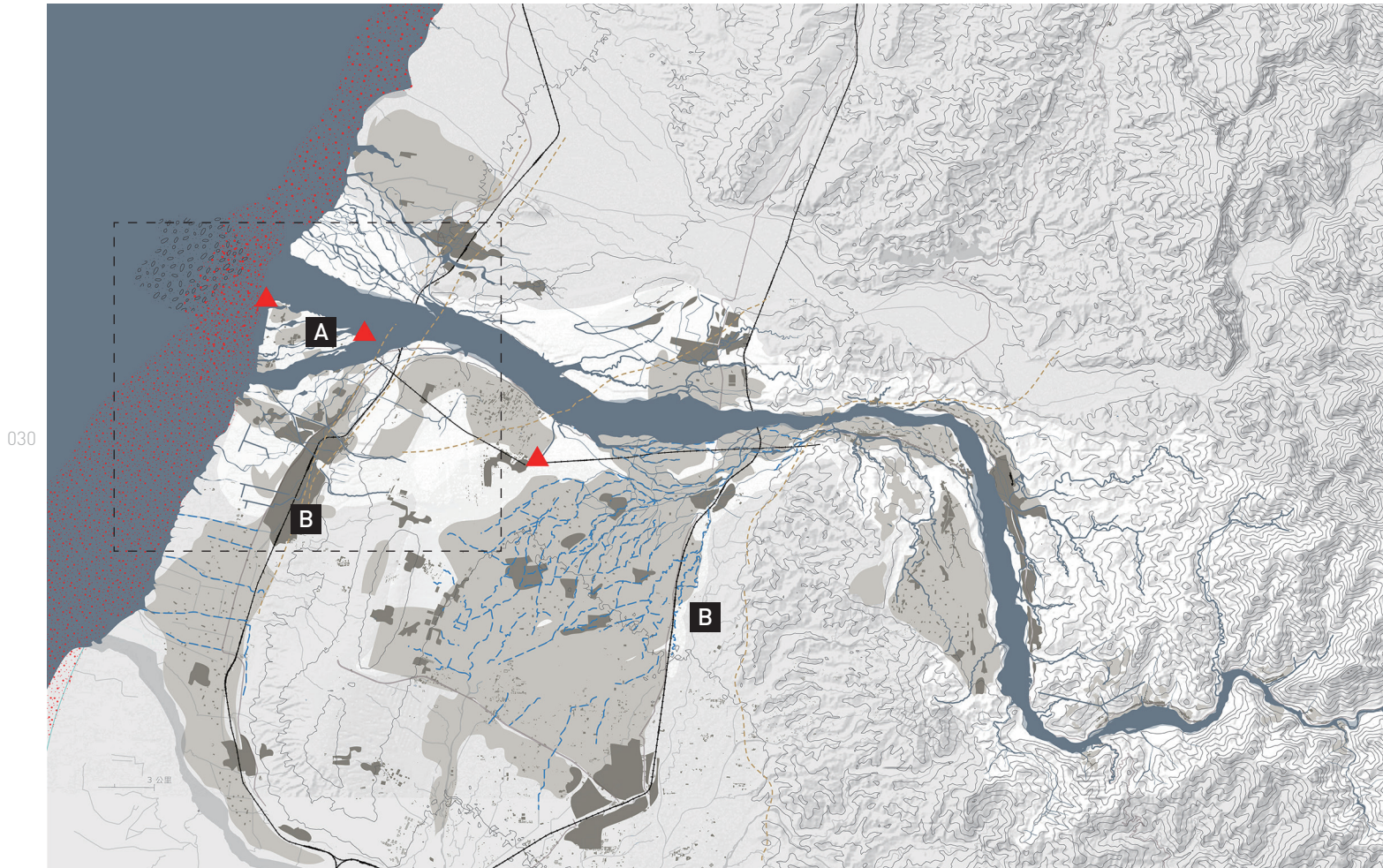


fig.25 Diverse environmental context and urban morphologies in Dajia river valley  
Source: made by author



## CHANGING PATTERN OF DAJIA RIVER VALLEY - BEFORE 1850s: nature-driven development



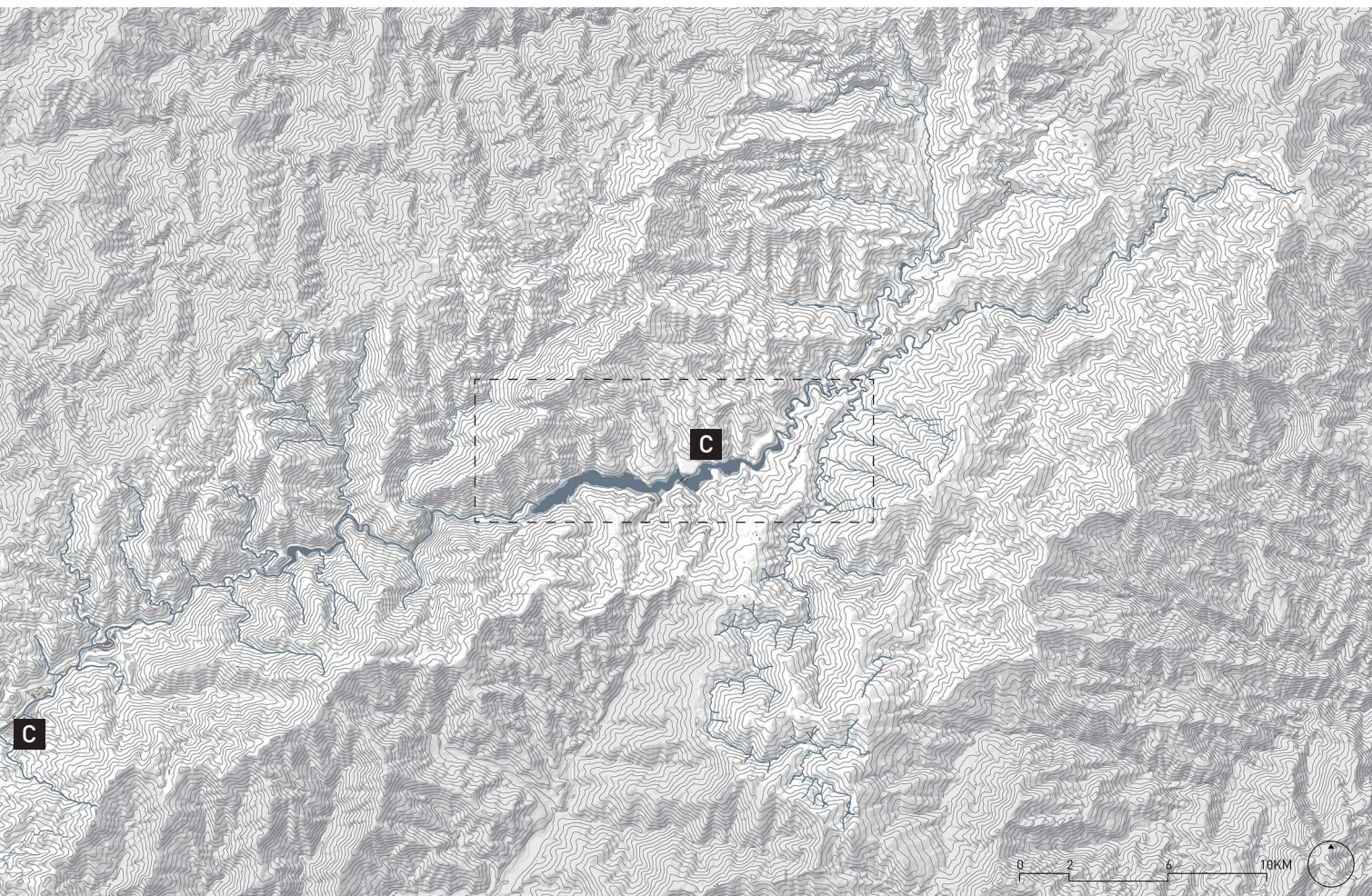
Early settlements development nearby water, especially at the flooding plains at the river mouth[ A], and the contact of coastal mountains and plain, where due to some geological faults passing by, there were many

springs in the area [B]. In the upper streams, within the mountains, on the other hand, are mostly lived by aborigines who maintain their life by hunting and fishing in the streams[C].









fig.26 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.



031

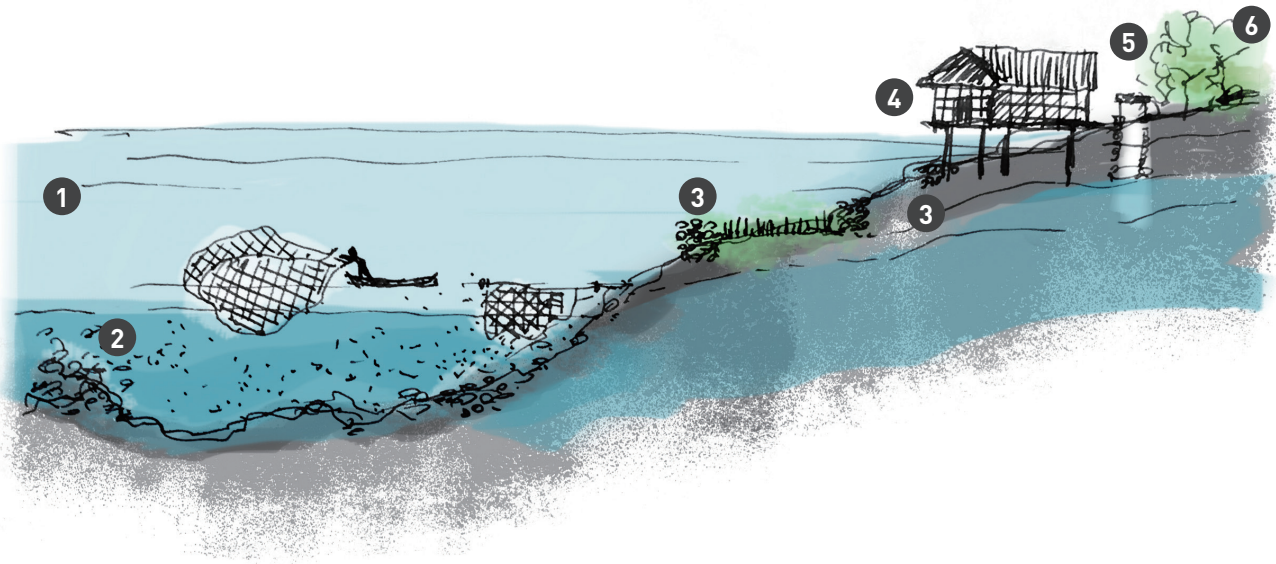
 Rivers  
 Geological faults  
 Sediments accumulation

 Han (Chinese) settlements  
 Aborigines settlements  
 Agricultural cultivation



## CHANGING PATTERN OF DAJIA RIVER VALLEY - BEFORE 1850s

Lifestyle with water at downstream of Dajia river.

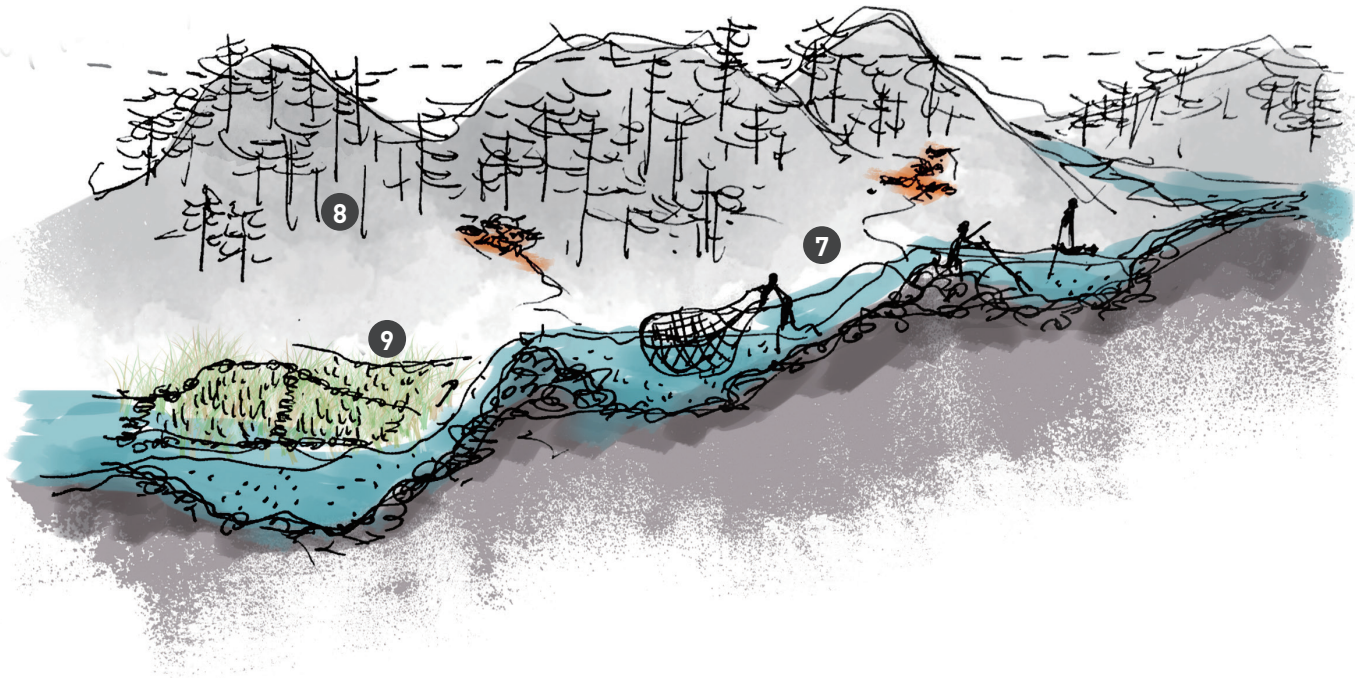


1. large tidal difference up to 5 meters
2. submerged reef + sediments full of nutrients results in rich of fishes
3. pebbles from the river were used for structuring agricultural fields along the river; also used as bases for architecture
4. pole column architecture to cope with flood-prone environment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

fig.27 Sections of human activities in relation to the Dajia river landscape before 1850s; upstream and water mouth.

Source: by the author based on data from historical maps, historical descriptions, google maps, and GIS databases.

Lifestyle with water at upper stream of Dajia river.

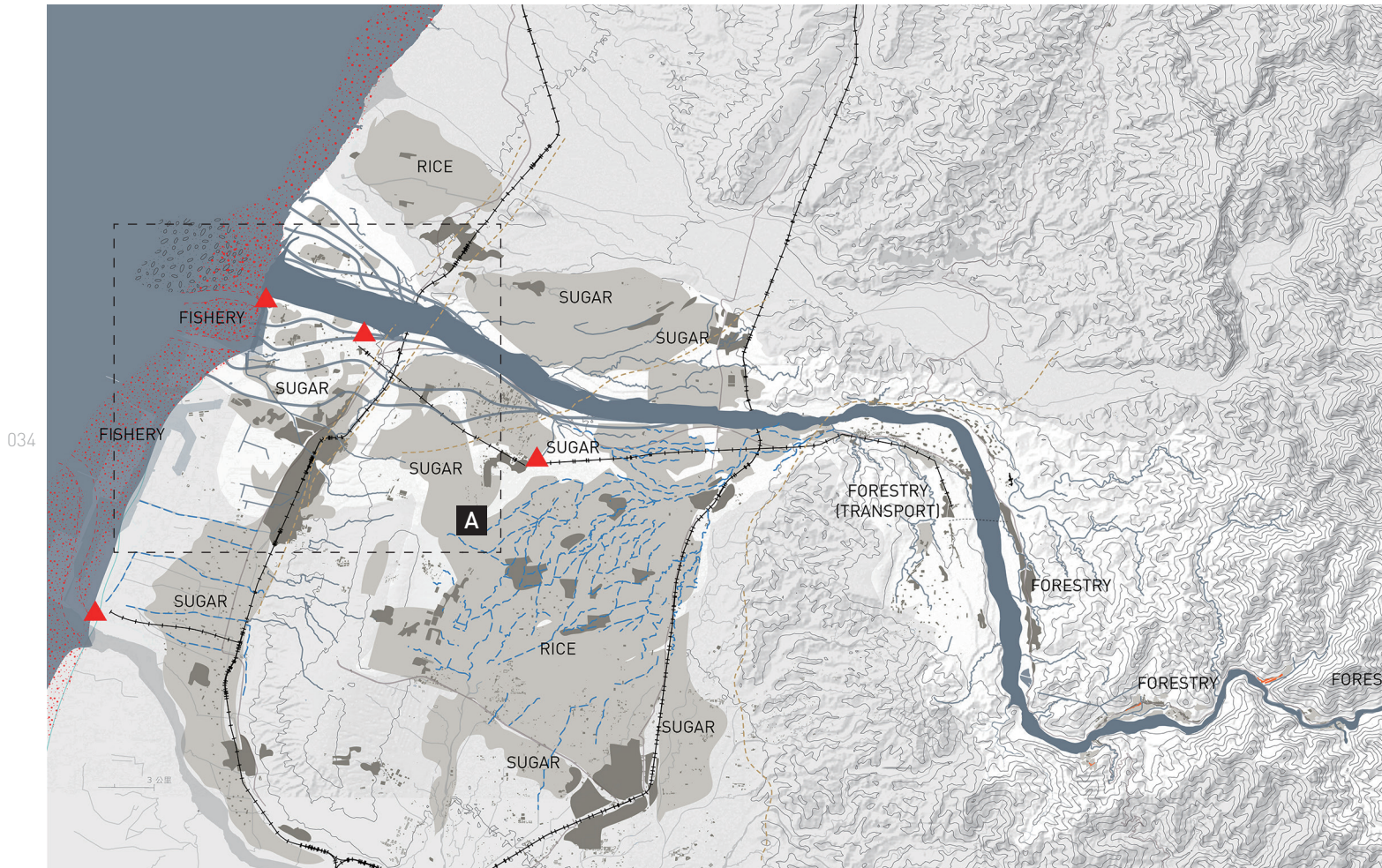


033

- 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.



## CHANGING PATTERN OF DAJIA RIVER VALLEY - 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 sugar and rice production (A), with infrastructure such as railway, irrigation ditches, 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.28 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.



035



Rivers  
Geological faults  
Sediments accumulation



Han (Chinese) settlements  
Aborigines settlements  
Agricultural cultivation



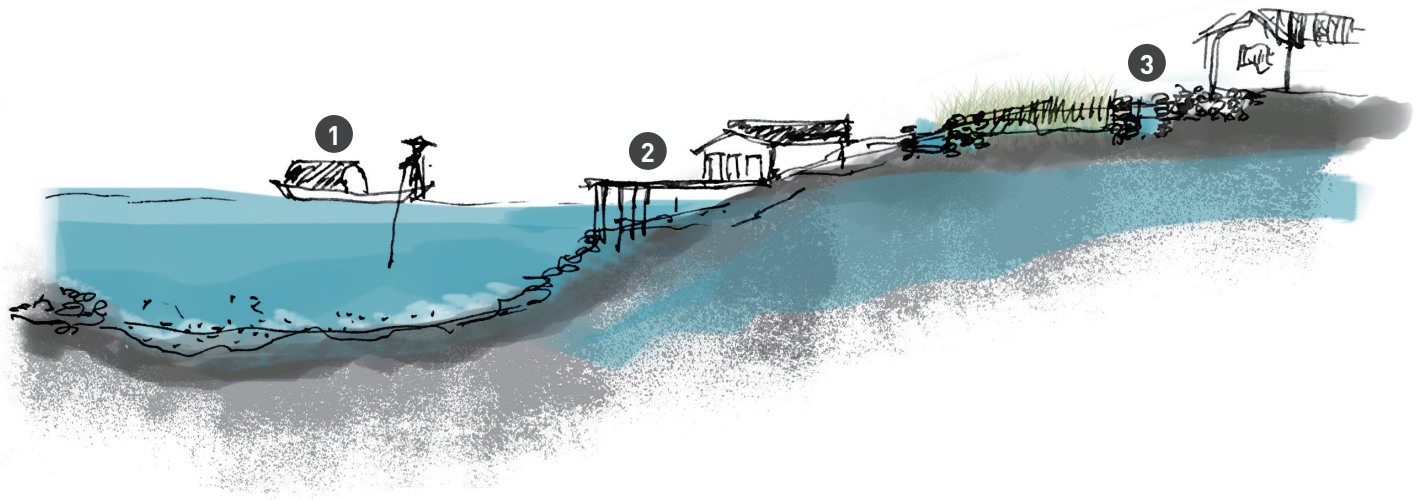
Primary roads  
Railway  
Agriculture drenches  
Trading harbours



## CHANGING PATTERN OF DAJIA RIVER VALLEY - 1850 - 1950s

Lifestyle with water at downstream of Dajia river.

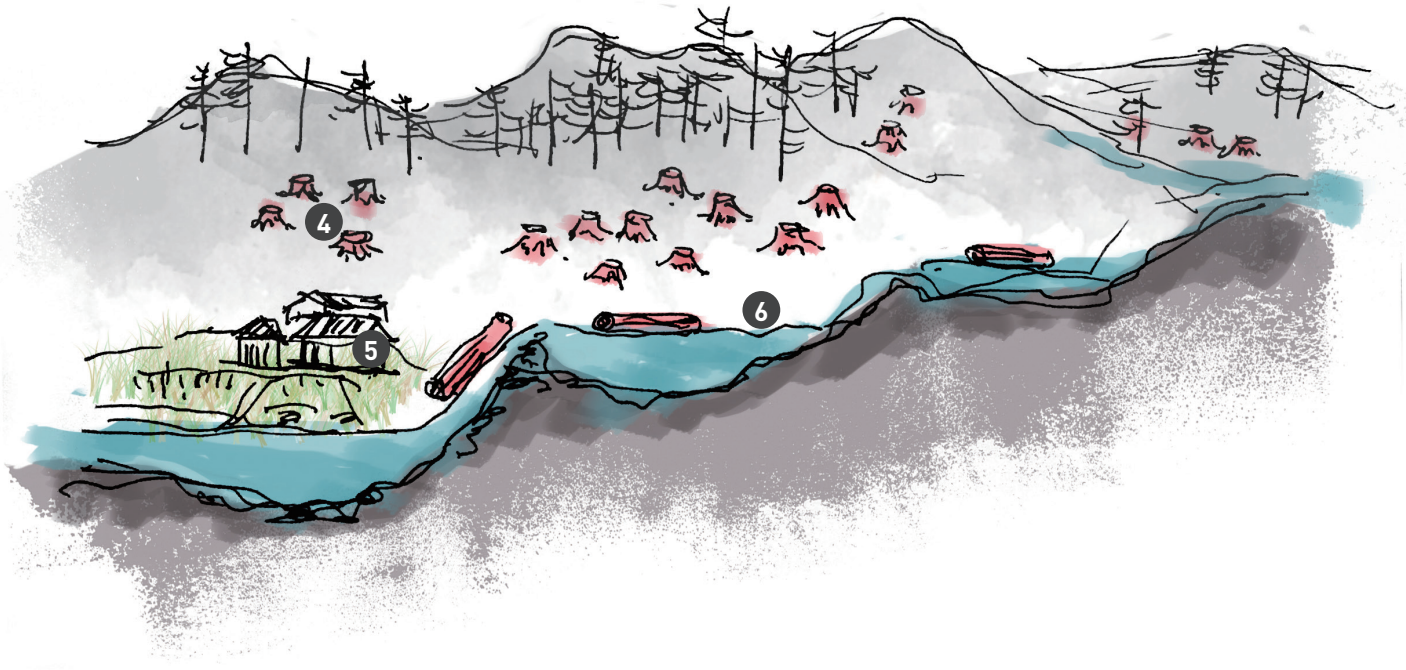
036



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 drenches or used as base for constructing houses.

fig.29 Sections of human activities in relation to the Dajia river landscape at upstream and water 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 upper stream of Dajia river.

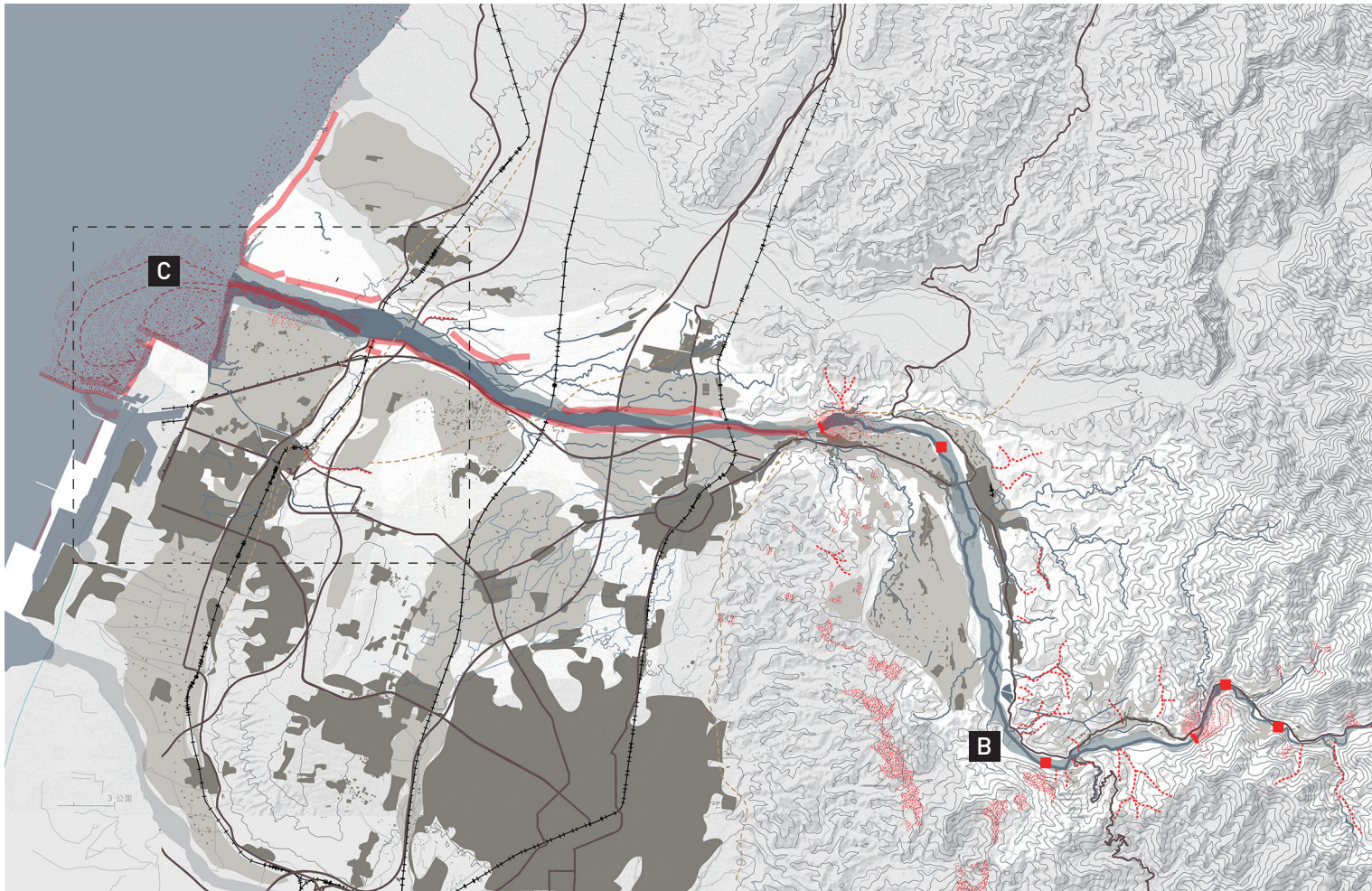


037

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.



## CHANGING PATTERN OF DAJIA RIVER VALLEY - 1950s - today: limitation of the traditional infrastrucutre



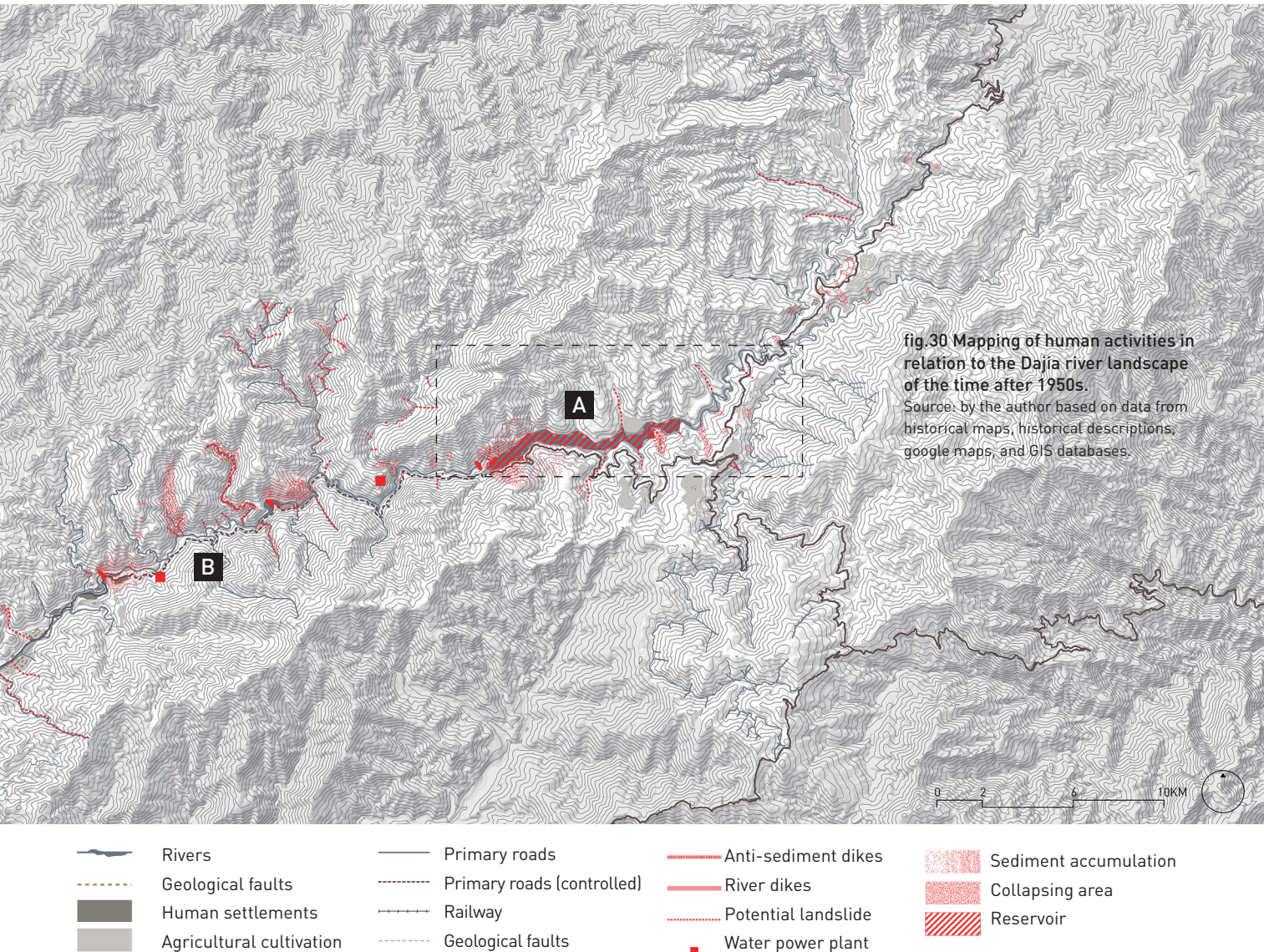
After the over excavating of nature resources such as cutting of woods, cultivation of alpine agriculture, construction of reservoirs and water power plants; added with the hit of earthquake and typhoons, the river scape

became increasingly vulnerable. At the upper stream, the sediment accumulated in the river can result in river level rise in the next 10 years up to 20 meters high (A). At the mid-stream, the roads were controlled 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 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.

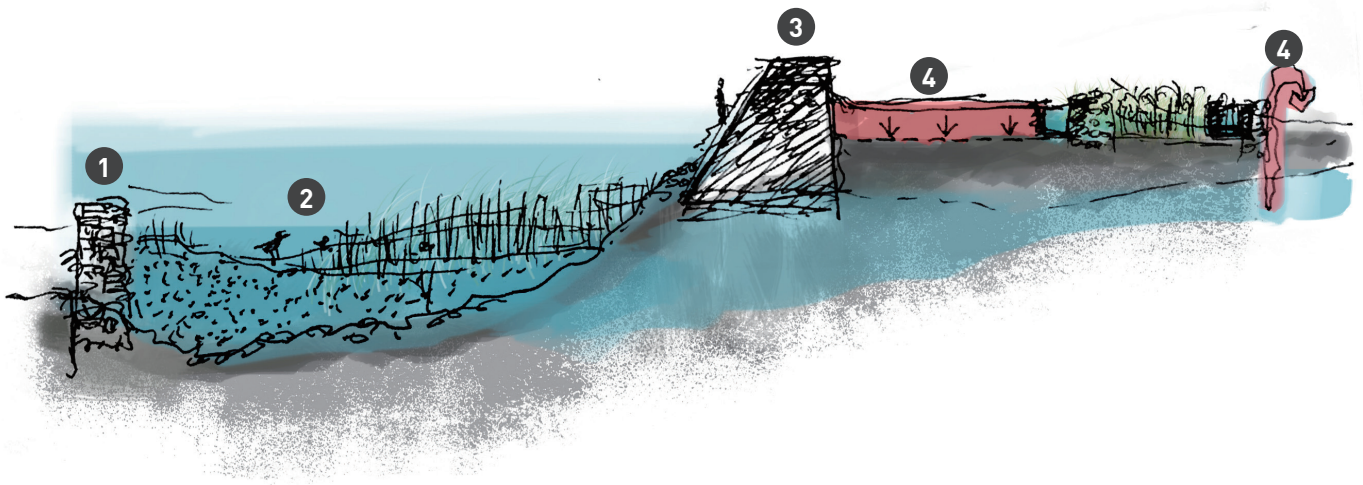




## CHANGING PATTERN OF DAJIA RIVER VALLEY - 1950s - today

Lifestyle with water at downstream of Dajia river.

040



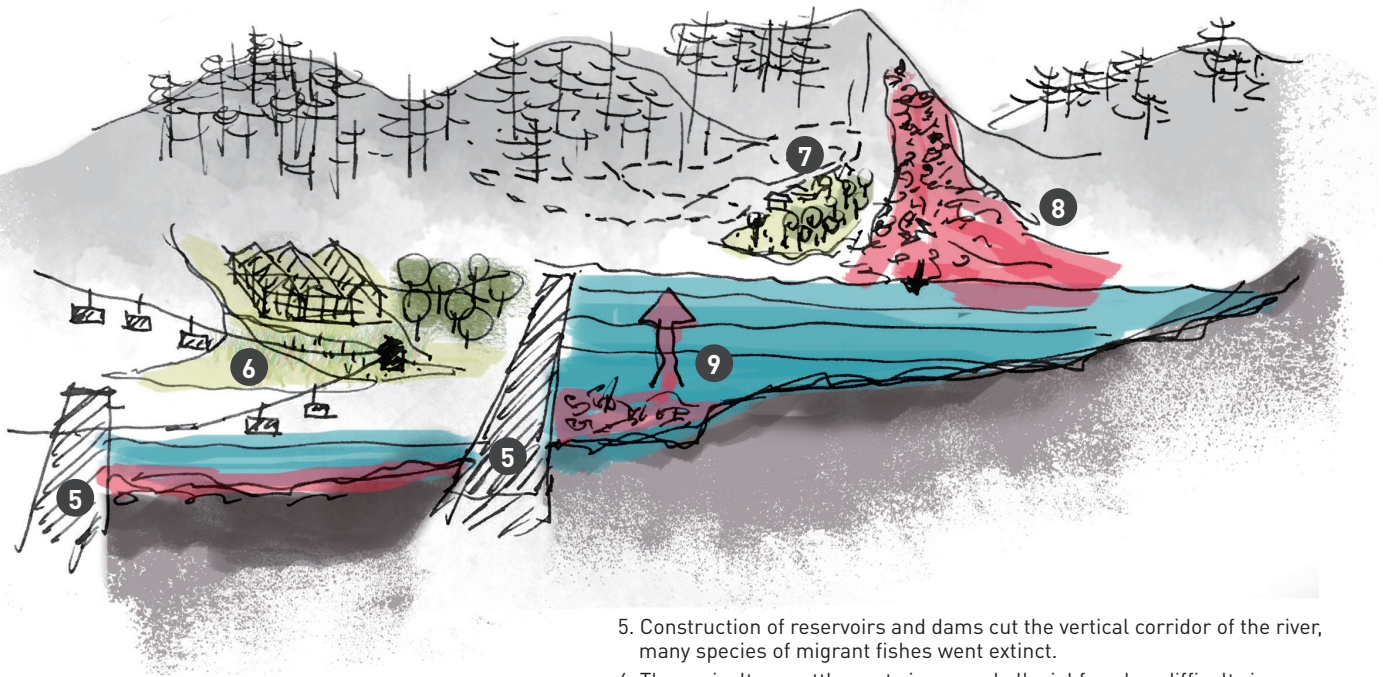
1. The construction of anti-sediment dike to protect Taichung Port resulted in the sediment accumulation largely increased and kept at the river mouth of Dajia river, which changed the area from a fishery site into wetland.
2. The climate and the sediment full of nutrient brought rich biodiversity to 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.



fig.31 Sections of human activities in relation to the Dajia river landscape at upstream and water mouth after 1950s.

Source: by the author based on data from historical maps, historical descriptions, google maps, and GIS databases.

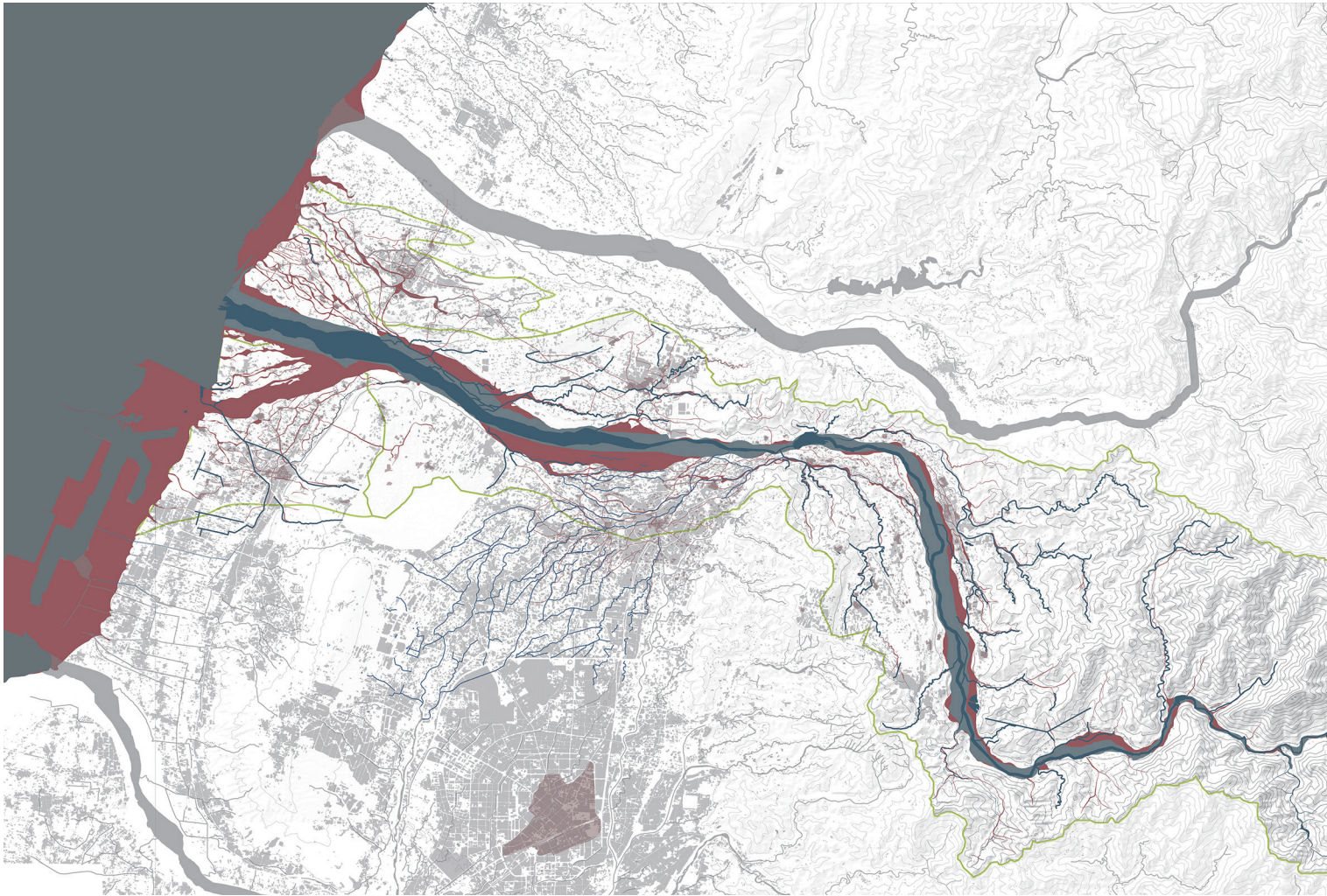
Lifestyle with water at upper stream of Dajia river.



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 mountainous 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

042

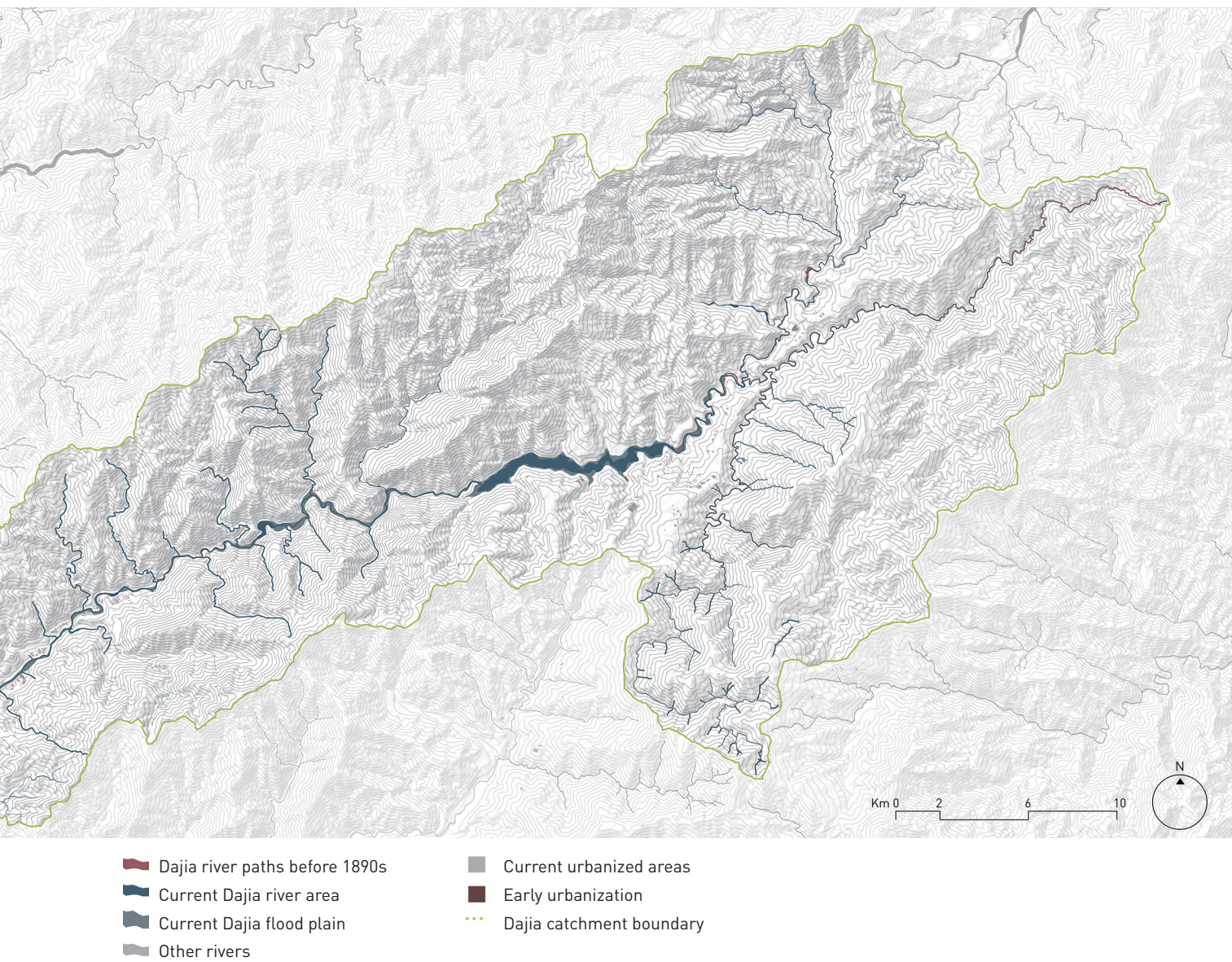


Comparing the historical and current river paths and urban patterns, we can see that the river has been structuring the morphology and network system of the early urbanizations. With the excavation of water and

other natural resources, the river is gradually constrained and simplified as a linear water supply system (see fig. 33 at next page). Today, the linear infrastructure is neither able to fulfill the current resource demand,

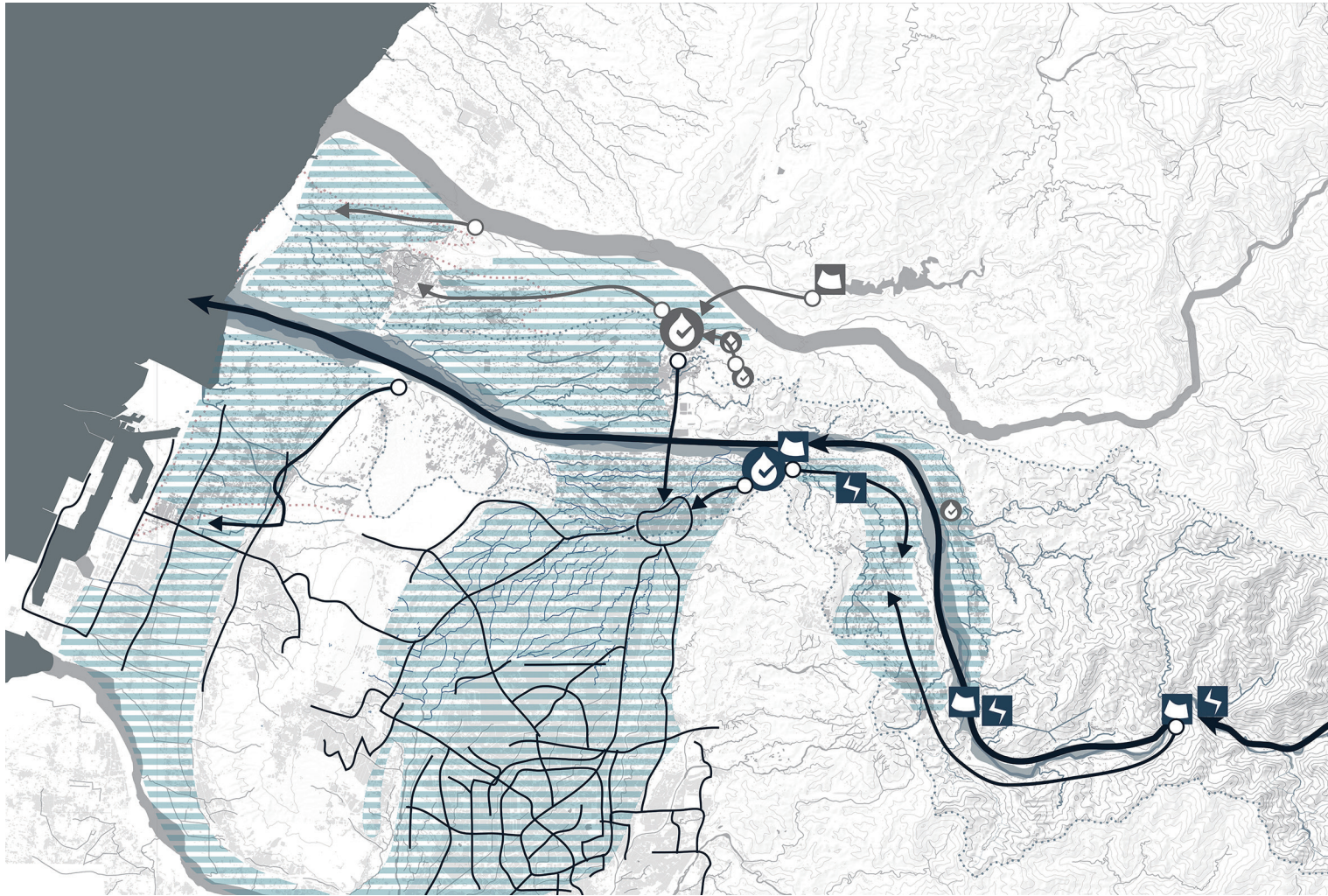


fig.32 The historical river path and urbanized areas.  
Source: by the author based on data from historical maps,  
historical descriptions, google maps, and GIS databases.





## THE LINEAR WATER INFRASTRUCTURE SYSTEM



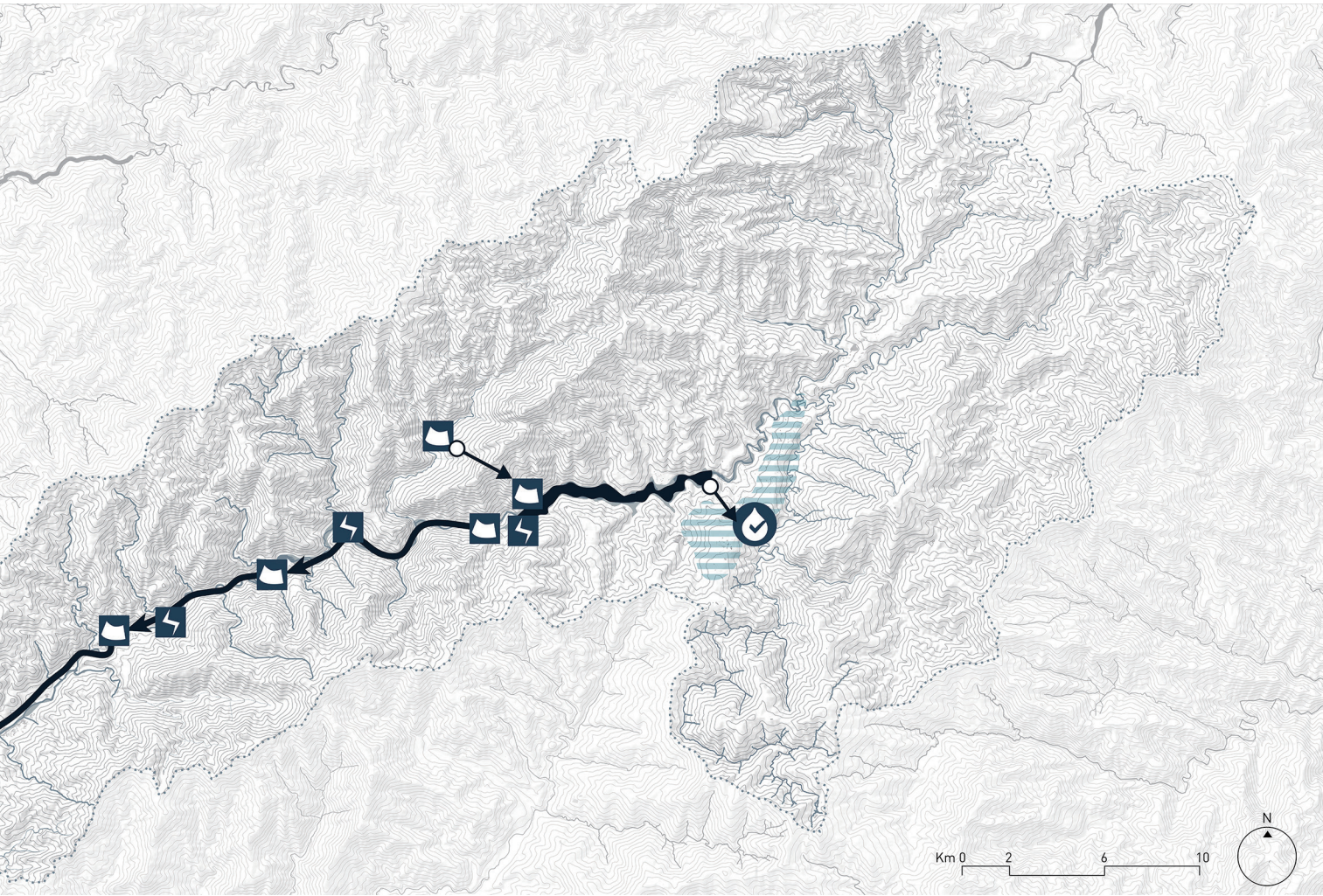
044

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



fig.33 The current water supply infrastructure system.  
Source: by the author based on data from WRA, MOEA, google maps, and GIS databases.



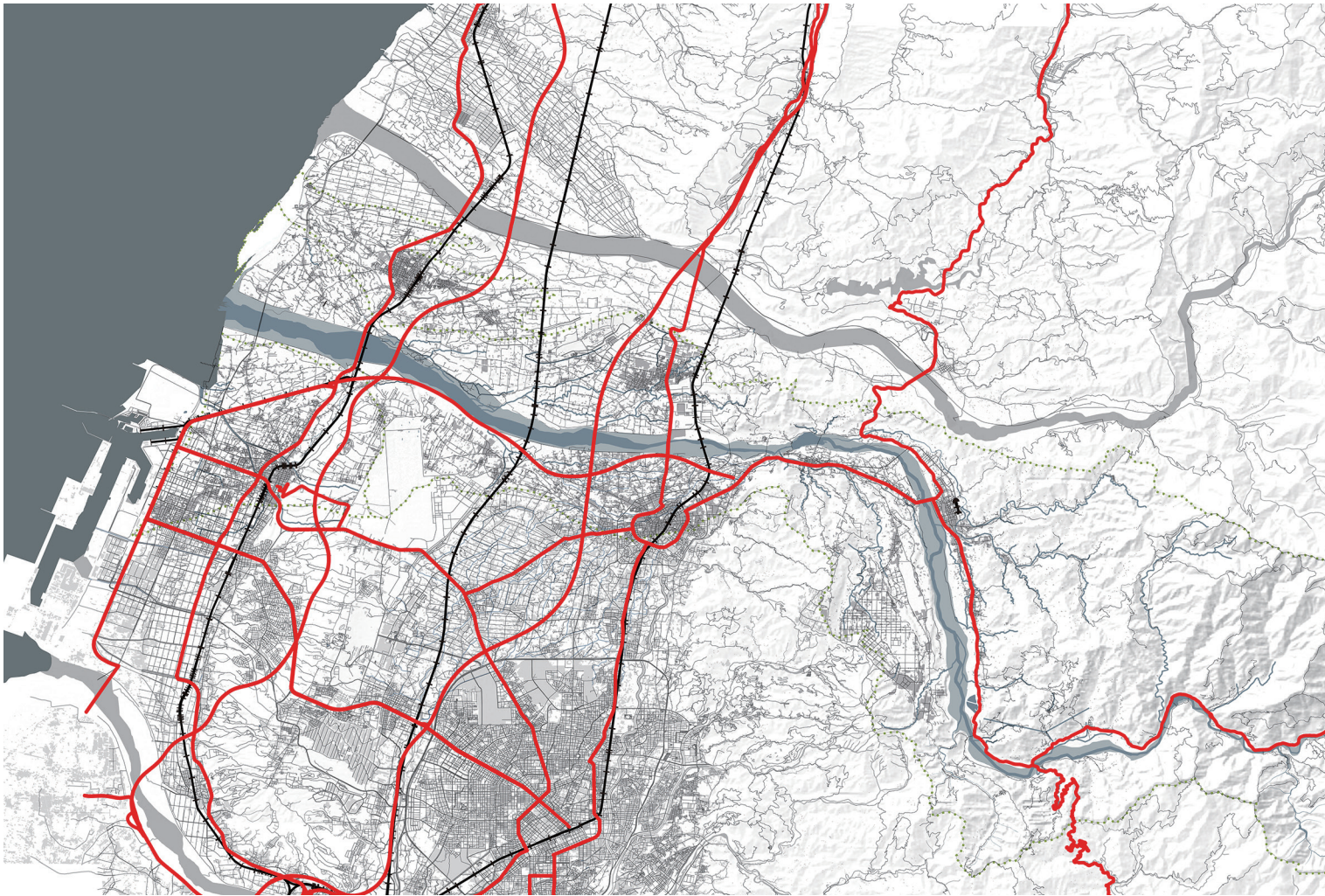
045

- 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



## THE TRANSPORTATION SYSTEM OF DAJIA RIVER VALLEY AND TAICHUNG METROPOLITAN AREA



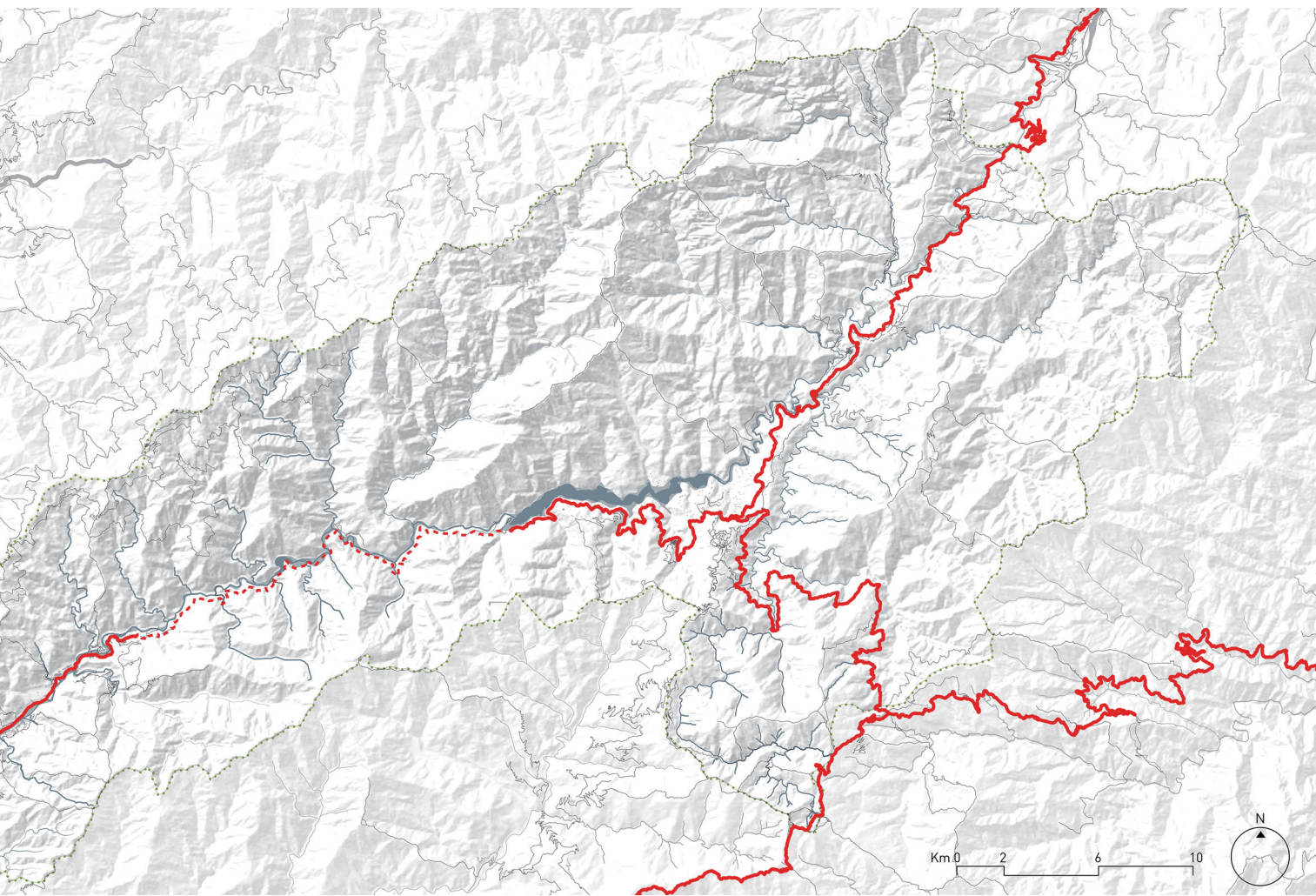
046

further disconnected people from the original flows of the landscape. From the transportation maps we can see, 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.



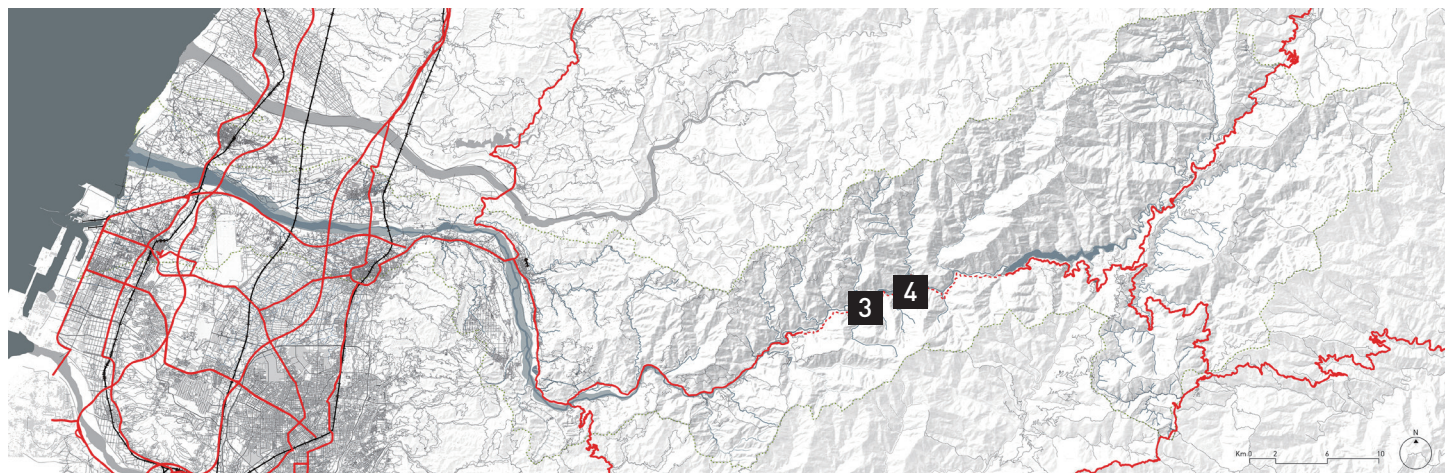
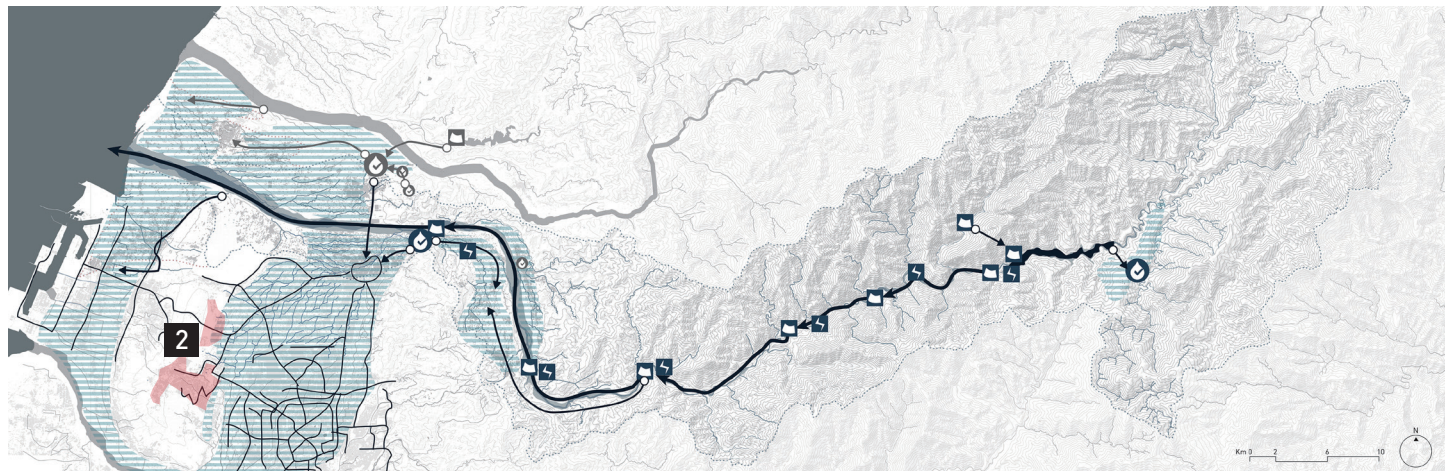
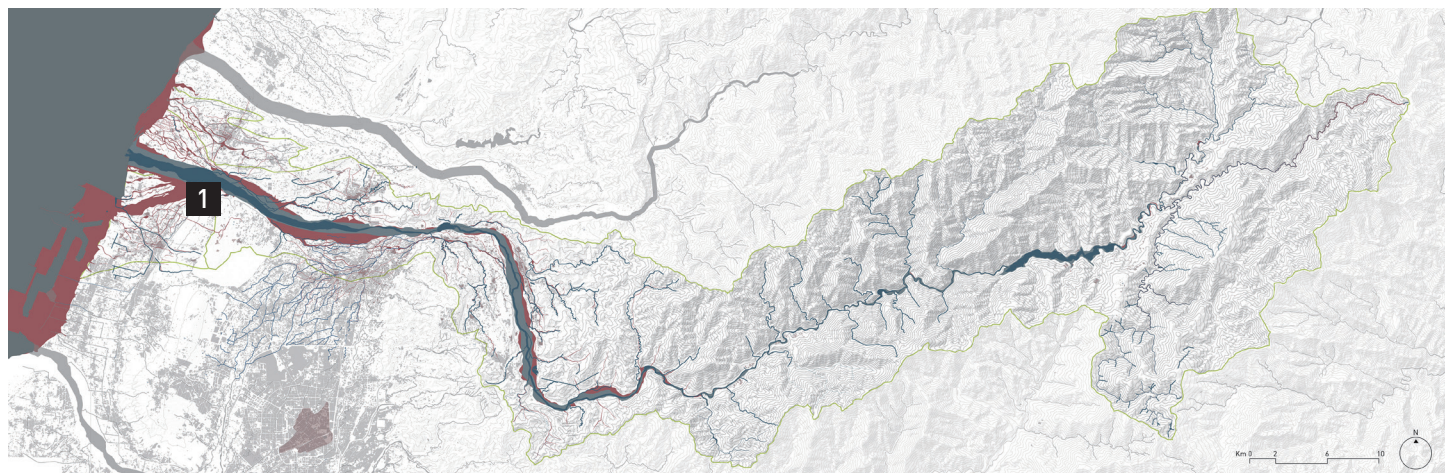
fig.34 The transportation infrastructure in Dajia river valley and Taichung Metropolitan area. Source: by the author based on data from GIS databases.



047

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







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.35 (top) 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.36 (2nd from top) 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]

fig.37 (3rd from top) 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.38 (bottom) 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]



01



02



03



04



LANDSCAPE CHARACTERISTICS ANALYSIS

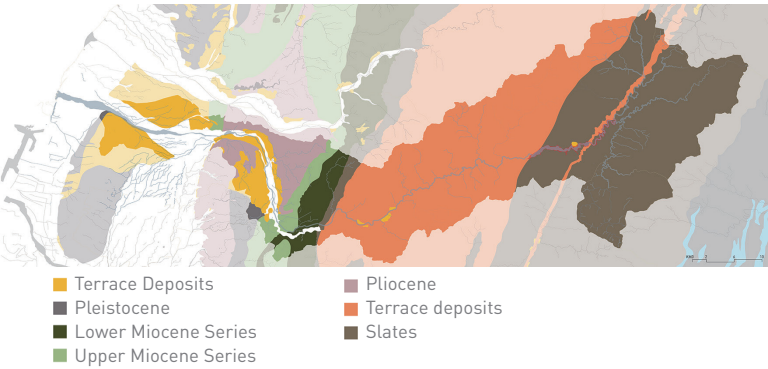


fig.39 Geology map of Dajia river valley  
Source: map by the author based on data from GIS database

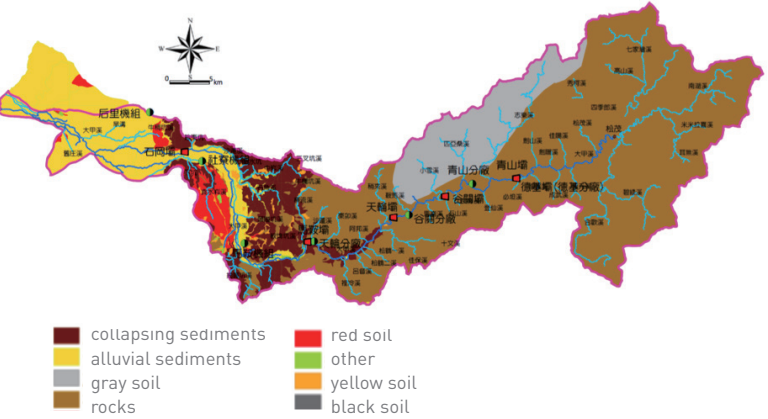


fig.40 Soil map of Dajia river valley  
Source: Water Resources Agency, MOEA, Taiwan Government

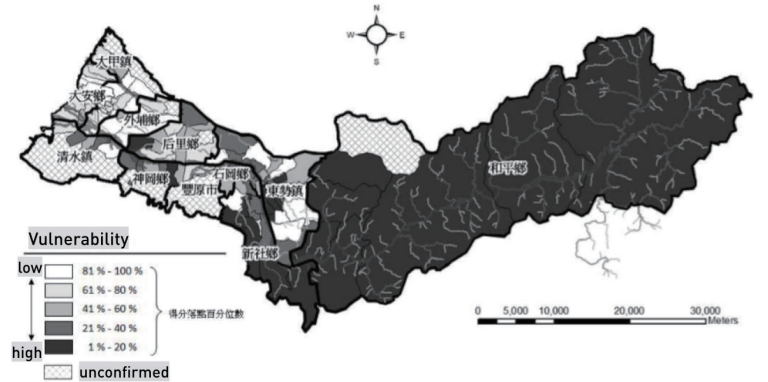


fig.41 Vulnerability (to rain erosion) map of Dajia river valley  
Source: Hung, H.C. & Chen, L.Y. (2012) Journal of Geographical Science, (65)

# LOCAL ACTIVITIES AND POTENTIALS

fig.42 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.

## Wuchi fishing port, Taichung port and Kaomei wetland

- 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

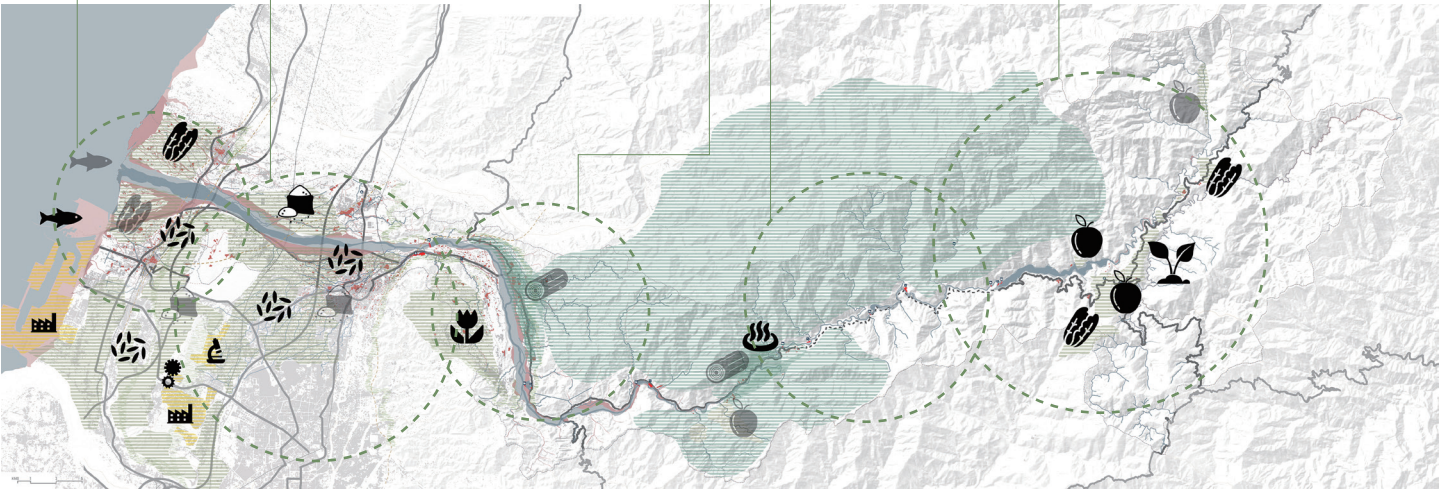
- Forestry history
- Forestry experts
- Flower agriculture
- Natural parks

## 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)



Forest conservation areas

Forestry

Hot-spring recreation tourism

Agricultural areas

Paddy rice farms

Sugar canes

Flower

Vegetable

Fruits

Tea

Fishery

Industrial and technological areas

Science park

Precision Machinery Innovation Technology

Industrial area

## STRATEGY AND PRINCIPLES

What if we consider a transformation strategy for the water infrastructure system that will incrementally remove or replace all the dams and reservoirs along the river?

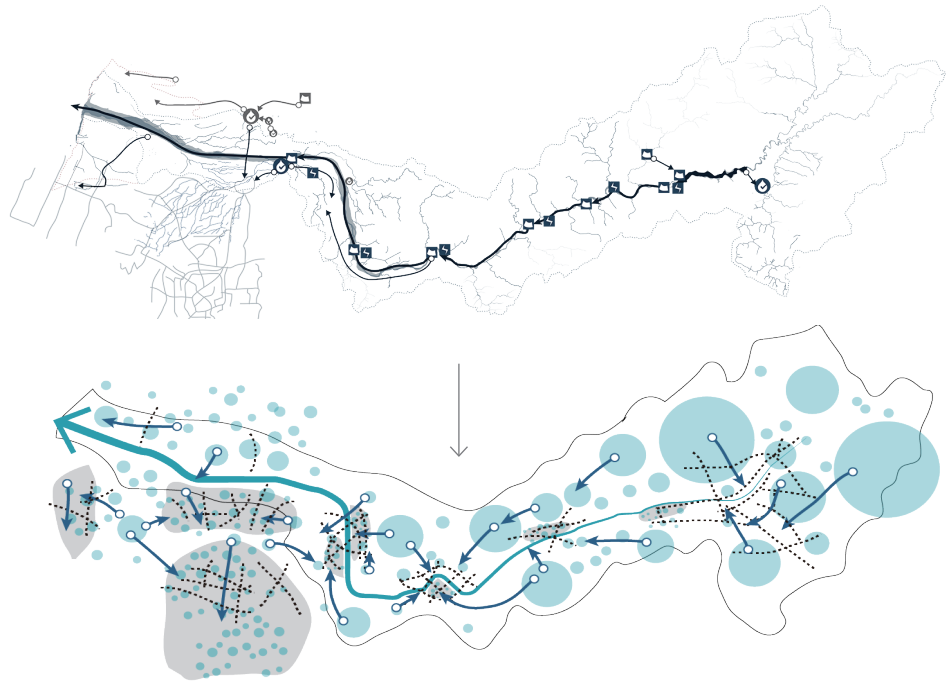


fig.43 Diagram of proposed transformation of water infrastructure system into a sponge-net model.

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

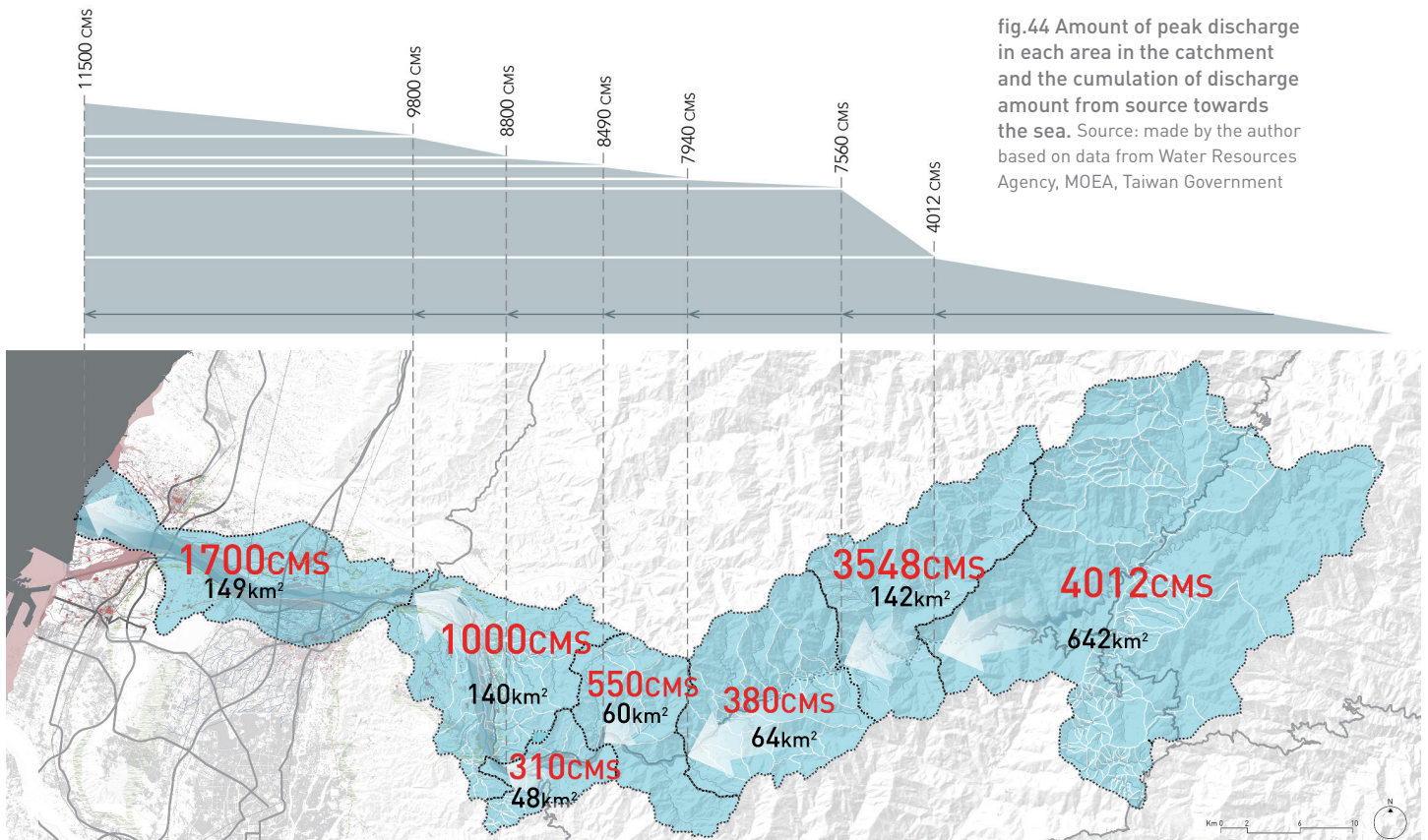
can be perceived as a system of sponges which absorbs when water influx and releases with a mild pattern, allowing various amount of moisture without introducing drastic impacts to the ecology. The system also allows mutual adjust between local areas within the system, creating tangible connections for the people in the region to their land and to each other, building a stronger identity for the territory.



## 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. 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.



## STRATEGY AND PRINCIPLES

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



fig.45 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.

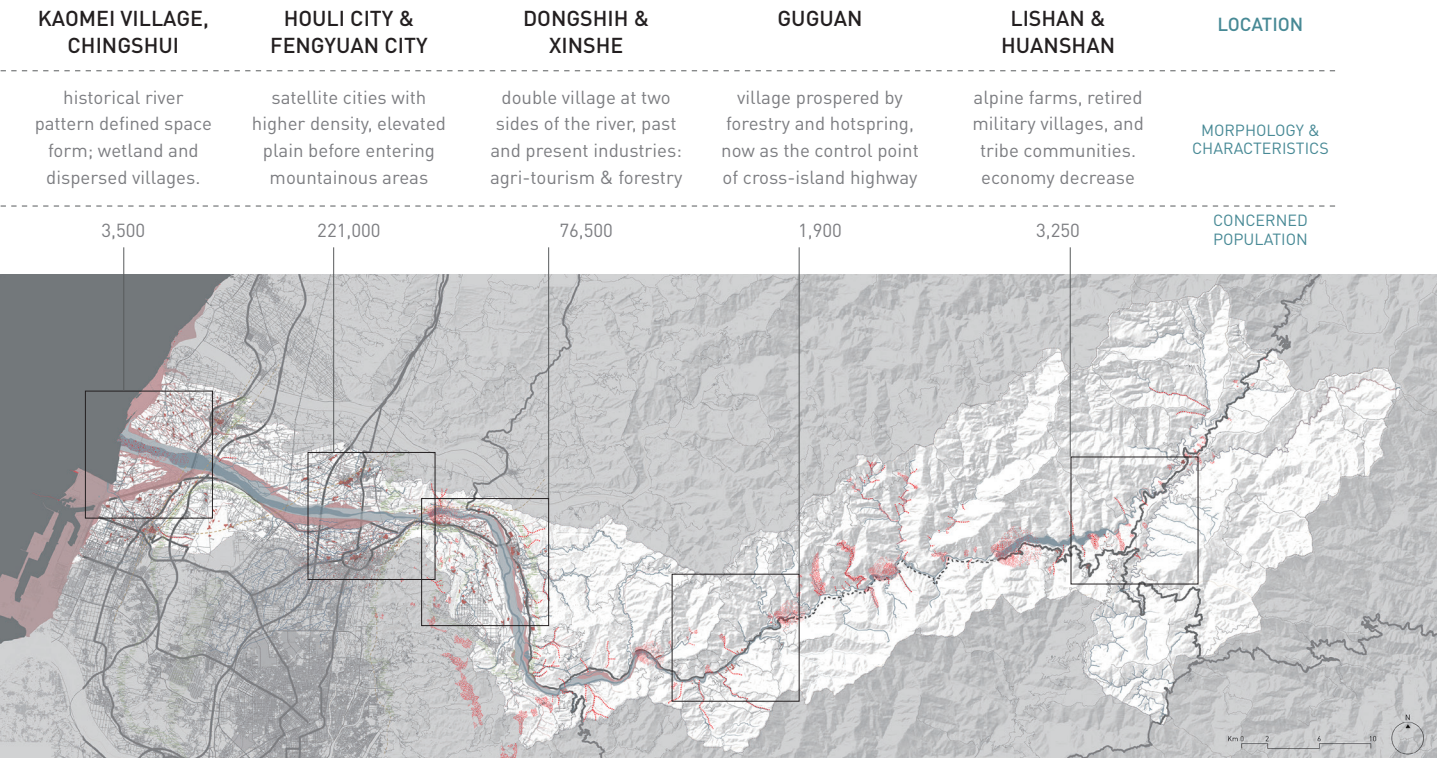


fig.46 Map indicating intervention areas. Source: made by the author based on data from GIS database, google maps, and national statistic data.



## LOCAL OPPORTUNITIES: LISHAN-HUANSHAN AREA

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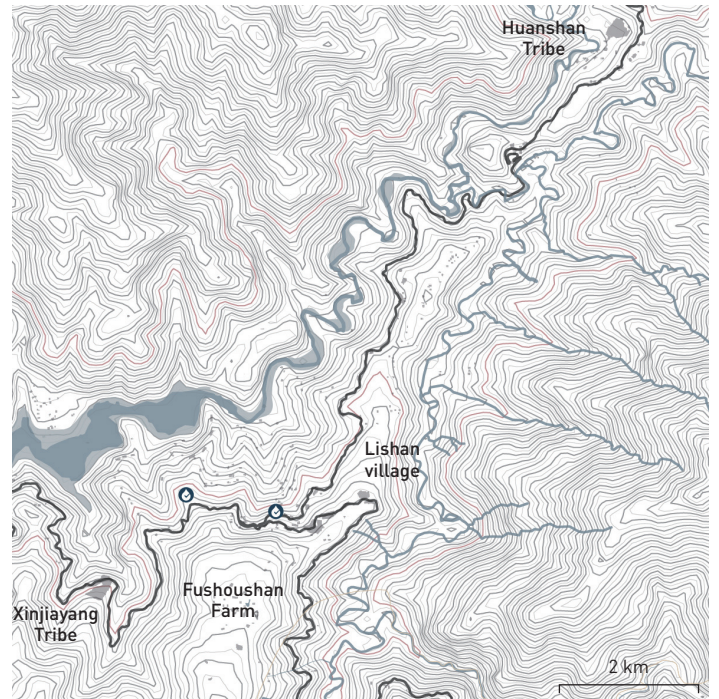
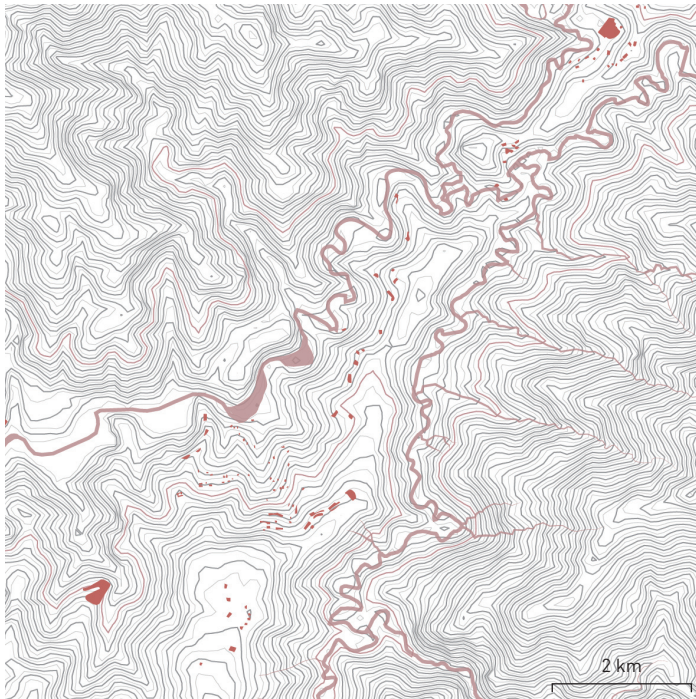
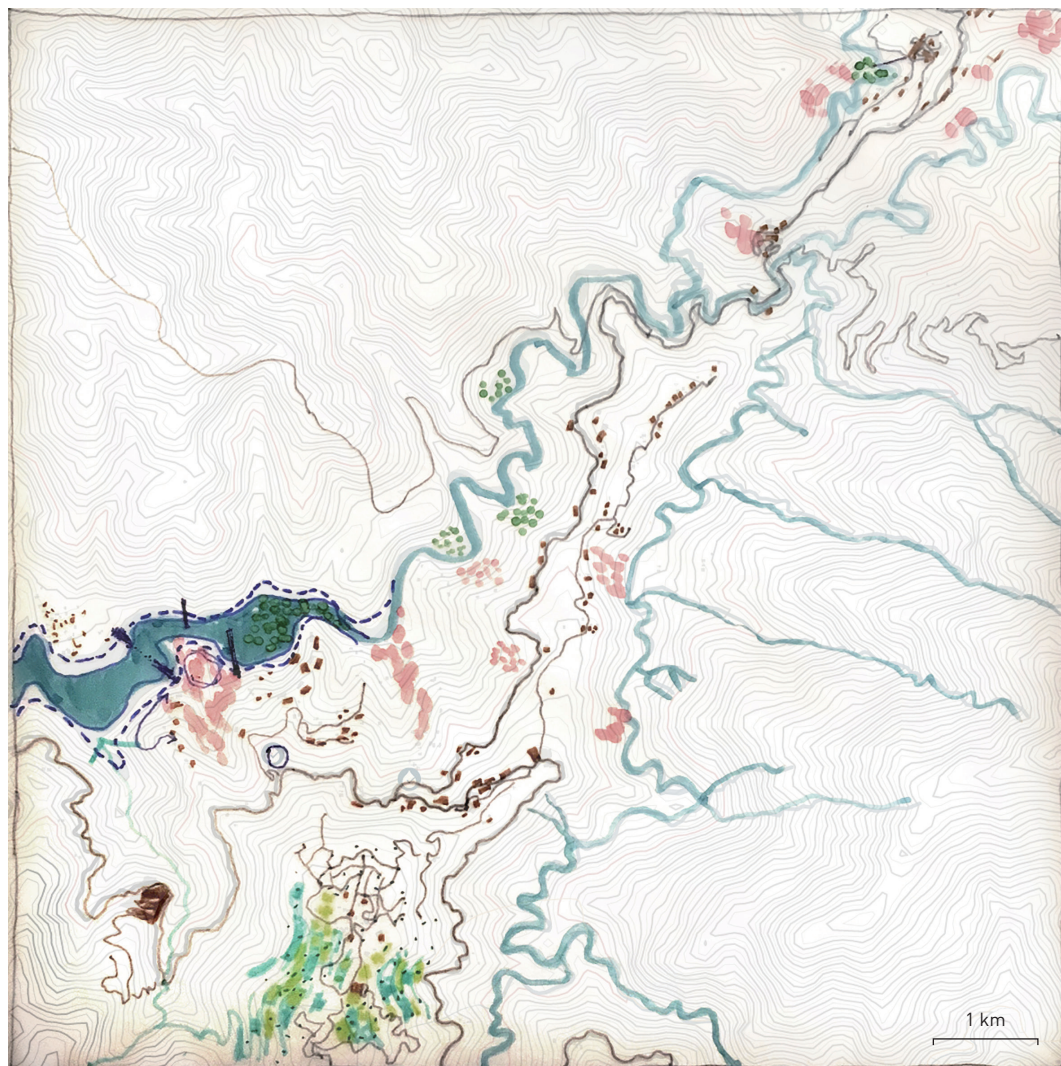


fig.47 Maps of Lishan-Huanshan area in 1950s (left) and today (right).

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



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### Proposed intervention for Lishan-Huanshan area



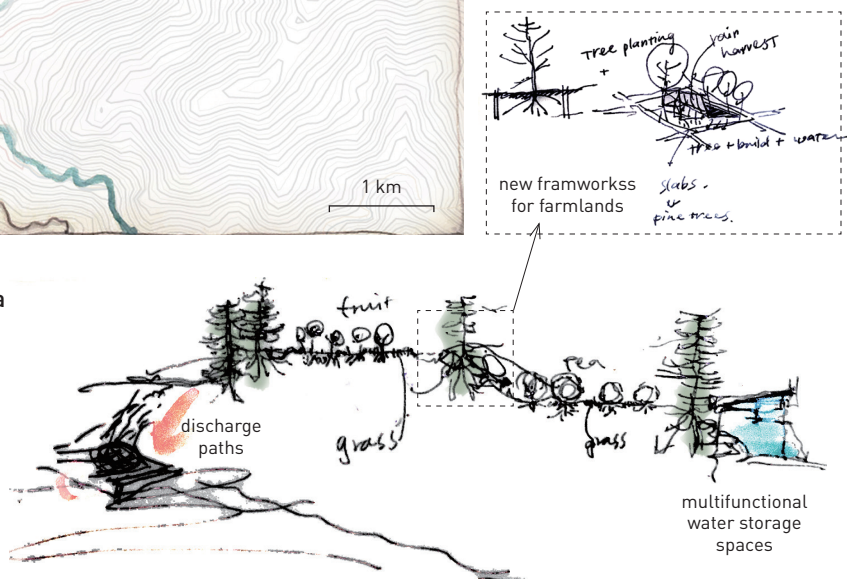
ecological-friendly agriculture with new framework structures composed of trees and water storage spaces



elements guiding sediments accumulated at desired areas with the possibility to form alpine wetlands



induce the formation of alpine wetlands along river side





## LOCAL OPPORTUNITIES: GUGUAN AREA

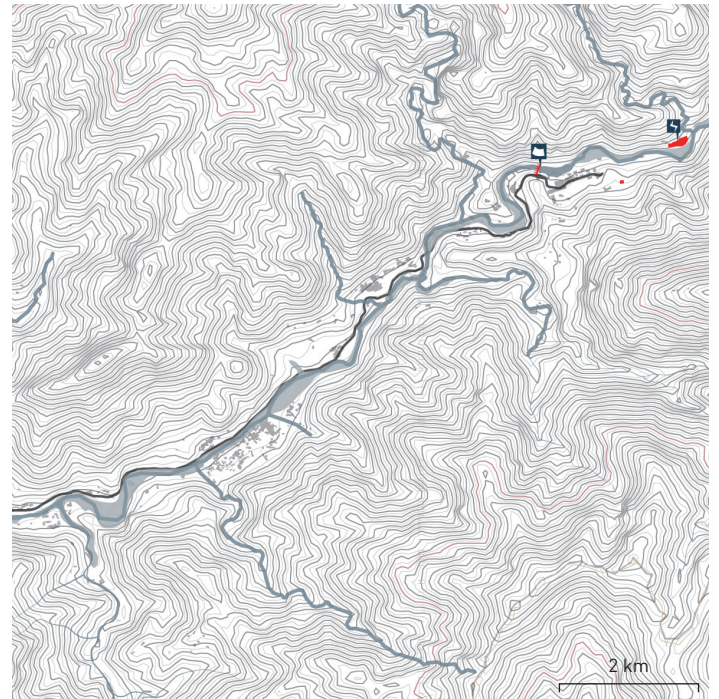
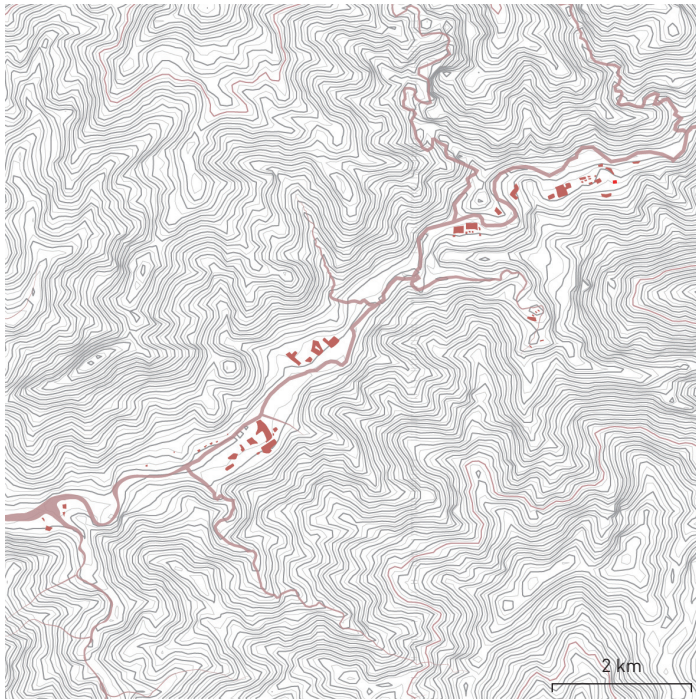


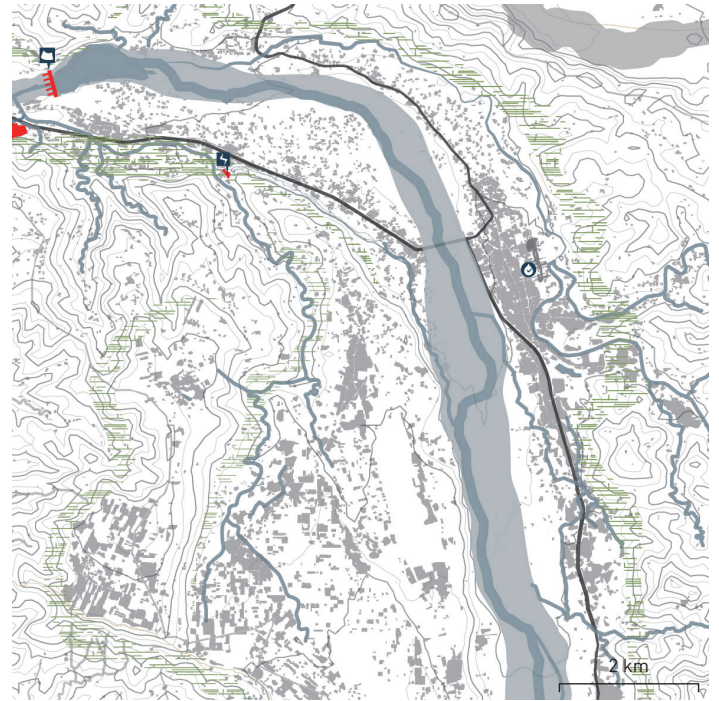
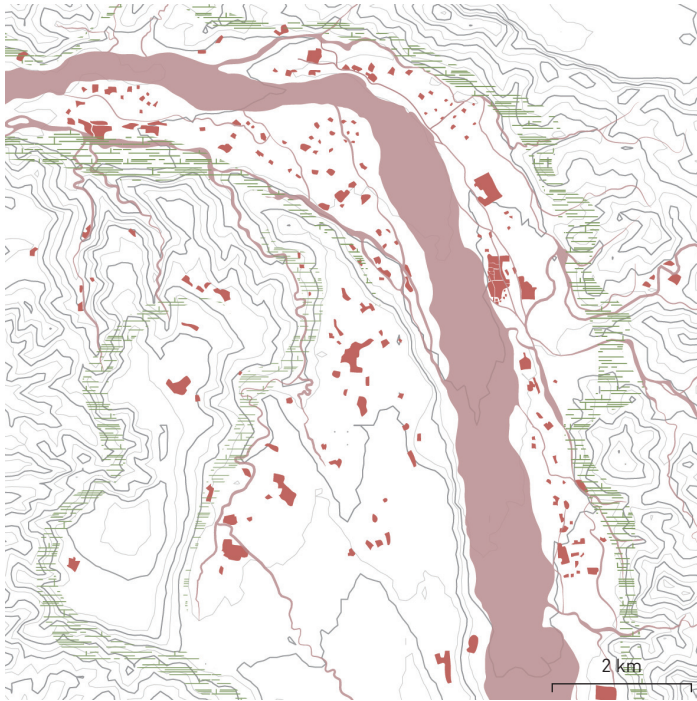
fig.48 Maps of Guguan area in 1950s (left) and today (right).  
Source: made by the author based on data from GIS database, google maps, and historical maps.

- Primary roads
- Contact of mountain and plain
- River path
- Flooding plain
- Historical river paths
- Urbanized area
- Historical urbanized area
- Hydro-power infrastructure
- Water dam or reservoir

- river banks largely infrastructuralized
- control point of motor-road from lower area
- hot-spring water/hot-spring tourism
- pollution and biology damage



## LOCAL OPPORTUNITIES: DONGSHIH & XINSHE AREA



- Primary roads
- Railway
- Contact of mountain and plain
- River path
- Flooding plain
- Historical river paths
- Urbanized area
- Historical urbanized area
- Hydro-power infrastructure
- Water dam or reservoir

fig.49 Maps of Dongshih and Xinshe area in 1890s (left) and today (right). Source: made by the author based on data from GIS database, google maps, and historical maps.

- forestry specialized, left-behind people
- forestry industry almost disappear
- small part turned into natural park
- water supplied by downstream
- over-cultivated hills on Xinshe side

## LOCAL OPPORTUNITIES: HOULI & FENGYUAN AREA

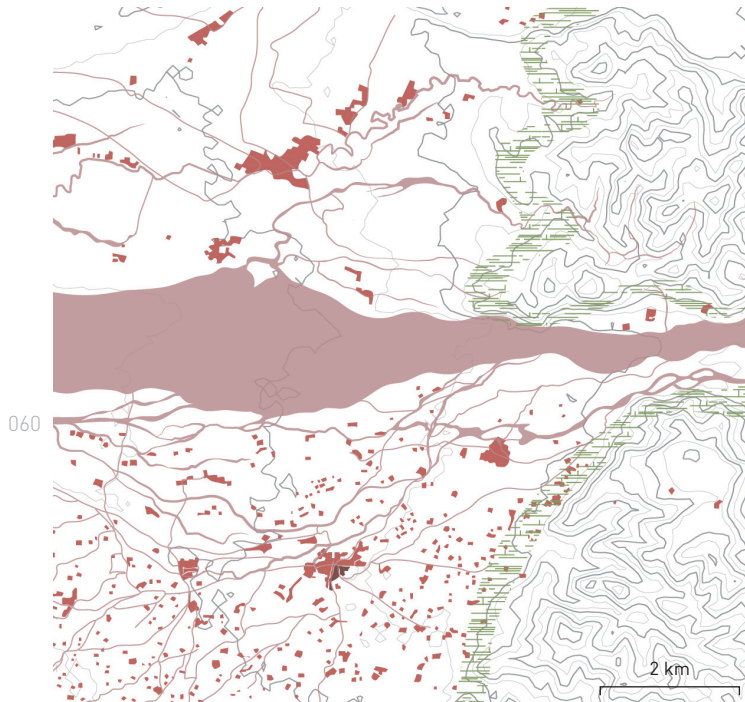


fig.50 Maps of Houli and Fengyuan area in 1890s (left) and today (right). Source: made by the author based on data from GIS database, google maps, and historical maps.

- Primary roads
- +— Railway
- Contact of mountain and plain
- River path
- Flooding plain
- Historical river paths
- Urbanized area
- Historical urbanized area
- Hydro-power infrastructure
- Water dam or reservoir

- dense populated
- old railway tracks turned into bike lanes
- control point of all Dajia water resources



## LOCAL OPPORTUNITIES: KAOMEI AREA

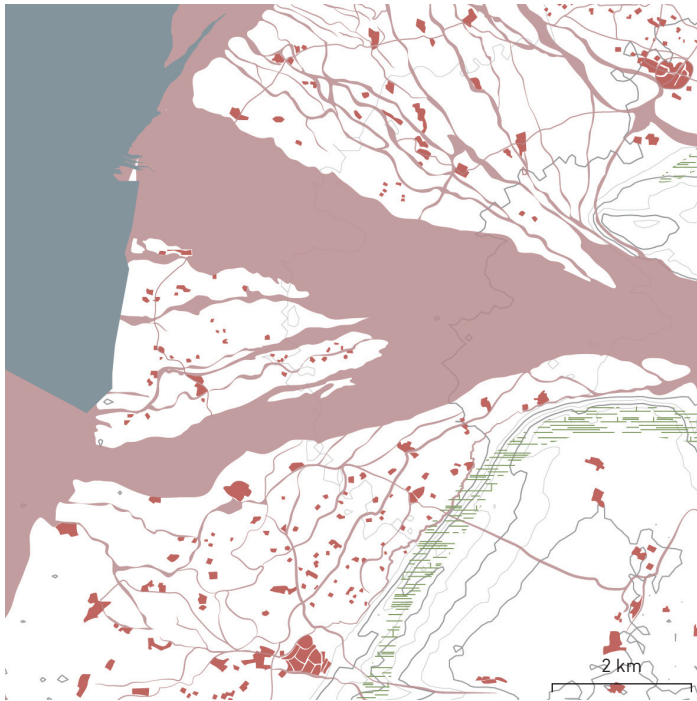


fig.51 Maps of Kaomei area in 1890s (left) and today (right).  
Source: made by the author based on data from GIS database, google maps, and historical maps.

- 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
- suitable for agriculture

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