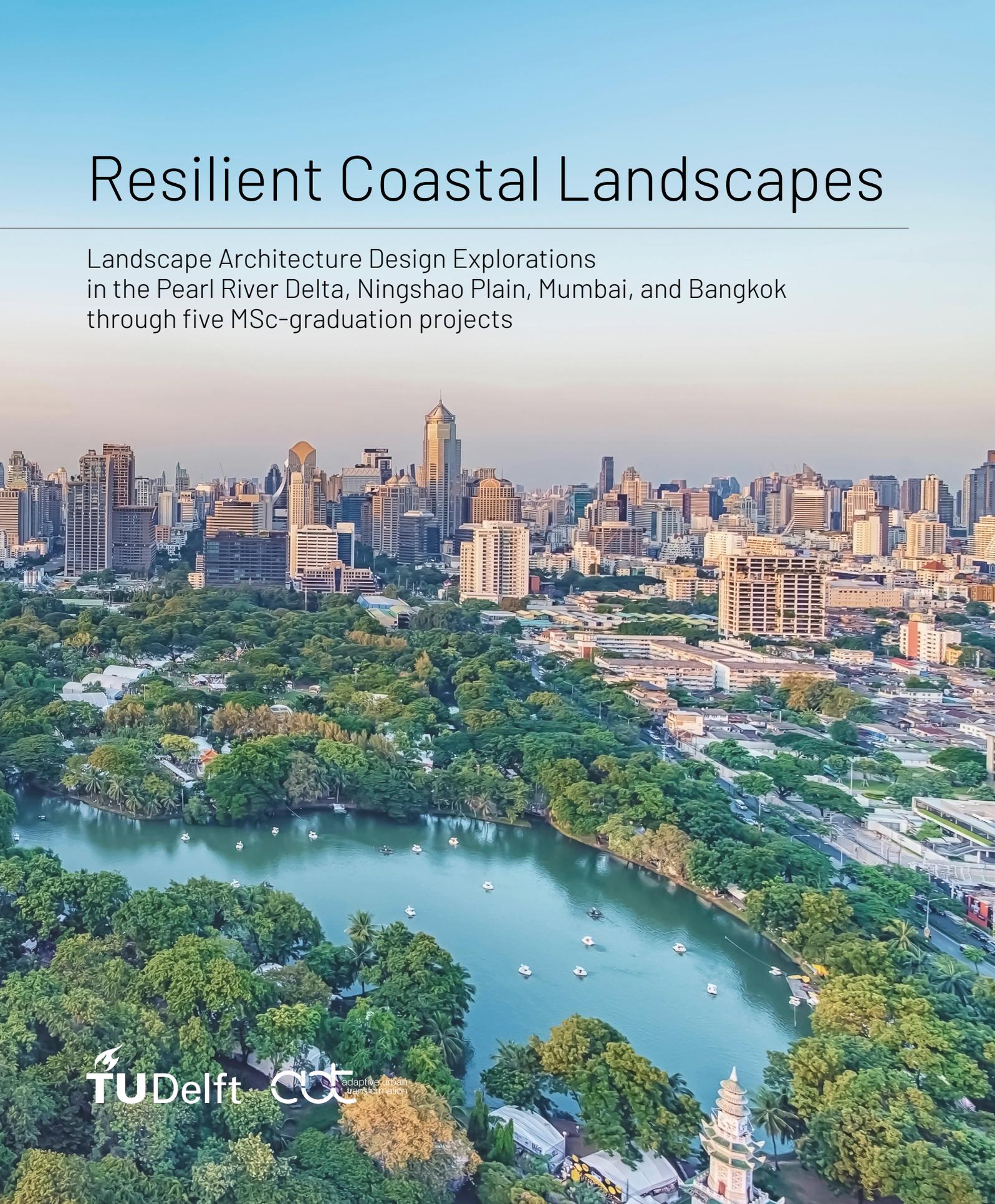


Resilient Coastal Landscapes

Landscape Architecture Design Explorations
in the Pearl River Delta, Ningshao Plain, Mumbai, and Bangkok
through five MSc-graduation projects



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Photo: Stockbym / Alamy Stock Photo - Lumpini Park Bangkok

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This publication presents five MSc graduation projects of the **Resilient Coastal Landscapes Lab**. It consists of the students from the Landscape Architecture and Urbanism track, under the guidance and coordination of Dr Steffen Nijhuis. The weekly studio sessions have been where all five of us share ideas and work progresses and, in the process, also improve and sharpen our methods and perspectives, evolving the topic of landscape-based design and planning and landscape resilience. For these reasons, we would like to express our utmost gratitude to Steffen for his attentiveness to our curiosities, project and personal issues, and questions. His insightful comments and suggestions, while clarifying, have never failed to spark even more interest and our urges to learn. We would also like to thank our genuinely supportive panel of mentors: Dr Gregory Bracken, Dr Daniele Canatella, Dr Fransje Hooimeijer, and Dr Lei Qu, for their continuous encouragement and dedication.

Studying during the pandemic has been a journey of tested resilience, constantly demanding one to switch between online and offline locations. The journey has been as incredible as it is stressful but eventually rewarding. We hope that, with all of the hard work and effort we have put into our study, these five projects will reflect our intentions to create more resilient and inclusive designs in the face of a rapidly changing world. We also hope that our humbled contributions will spark a broader discussion about how the landscape-based approach can positively shape our cities to embrace natural flows and ensure a better and more sustainable symbiosis of humans and nature.

Resilient Coastal Landscapes lab graduates, June 2022

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FIG. 1 Mangroves under urban pressure in Florida: Mangroves provide a variety of critical ecosystem functions. Their function as effective coastal defence systems is likely most visible, as they frequently save properties and lives from the destructive impact of tropical storms. Less obvious is the critical role they play in moderating the rate of climate change. The enormous terrestrial forests of our world are well known as carbon sinks, but mangroves, through sediment burial, mineralization, and organic export, are hugely powerful parts of the carbon cycle. We are destroying them to make space for urban development, aquaculture, and industrial activity, yet the profits will be minimal in comparison to the cost of removing mangroves (Photo: Steffen Nijhuis, 2020)

Introduction

Coastal landscapes play a significant role in the world's ecosystems and the global economy. They accommodate large concentrations of population in particularly sensitive environments dominated by water systems. As a result, coastal landscapes face extreme vulnerability and multiple threats. To ensure a more sustainable future, spatial strategies and design solutions are needed in order to strengthen resilience, assist systems to cope with their vulnerabilities, and strengthen their capacity to face natural and human-made threats.

The Resilient Coastal Landscapes graduation lab focuses on these areas of land-water interfaces where multiple constituent natural processes interact and form unique landscape characteristics. These areas in focus do not only limit to the immediate coastlines and beaches but also expand to estuarine, deltaic, and riverine landscapes where rapid urbanisation takes place in many parts of the world. These places are "landscapes of gradients" under the pressure of human exploitation, rigid approaches in building and controlling nature, and deteriorating landscape resilience in coping with uncertainties such as climate change. The results of this reduced resilience include the loss of natural resources and biodiversity, increasing flood risks and water safety issues, disparities between urban and rural landscapes, human and nature disconnection, and many more.

Objective

This design lab explores landscape-based design approaches for resilient coastal landscapes. Here, design is employed as a multi-scale research strategy for exploring landscape architecture principles for socio-ecological inclusive design, heritage and water safety. Landscape-based regional design is regarded essential for developing resiliency and adaptive capacity (Nijhuis, 2022) by:

- Taking the landscape form and process as fundament; physiology of the natural and urban landscape as guide to shape spatial transformations;
- Creating and regenerating living systems; (bio)diversity and multi-functionality as the basis for socio-ecological inclusive and water sensitive urban landscapes;
- Developing resilient and adaptive spatial frameworks; strong structures for coherent development of region (long-term strategy), while setting conditions for local projects (short term intervention);
- A design-oriented multiscale and transdisciplinary approach: knowledge-based spatial design as integrating practice, involving people, academia, business, professionals, government officials.



FIG. 2 A landscape approach focusses on the planning and design of climate adaptive, healthy and social-ecological inclusive public spaces throughout the scales. Lively urban square in Shenzhen, China, with water, green, shade, opportunities to meet people and for children to play (Photo: Steffen Nijhuis, 2019)

This "landscape first" approach allows the design to be respectful of natural processes while using them as the basis to create a landscape structure or network that guides suitable urbanisation and socio-cultural development. The results are expected to be inclusive and sustainable and are reflected through the projects of the five different locations chosen by the lab students.

Five Projects

The projects are located in coastal landscapes in China, India, and Thailand, where the rapid urbanisation has created numerous conflicts between the cities and the landscapes they are built on. Embedded with distinct socio-ecological development, historical resilience aspects, and landscape characteristics, each project similarly benefits from the landscape-based approach which positively results in the multi-scalar and multi-faceted landscape framework, regional strategies, and local-scale design explorations and projects.

Flowscapes Studio

The lab is part of the Landscape Architecture MSc "Flowscapes" graduation studio that aims to explore dynamic landscape systems from different perspectives and in various contexts (Nijhuis & Jauslin, 2014). The studio encourages students to explore design strategies that address natural, social, and cultural issues at different scales through design research and research through design approaches (Nijhuis & De Vries, 2019). This approach is elaborated through different individual projects while generating knowledge in an exploratory research and design process.

From a didactic perspective the lab focuses on project-based learning: students explore real-world complex problems and challenges to acquire knowledge and skills. Student-centred and learning-outcome-based tutoring approach with emphasis on design-oriented methodologies. The design assignments tend to be open-ended and the design process is not pre-scribed leaving freedom of purpose and choice.

Adaptive Urban Transformation

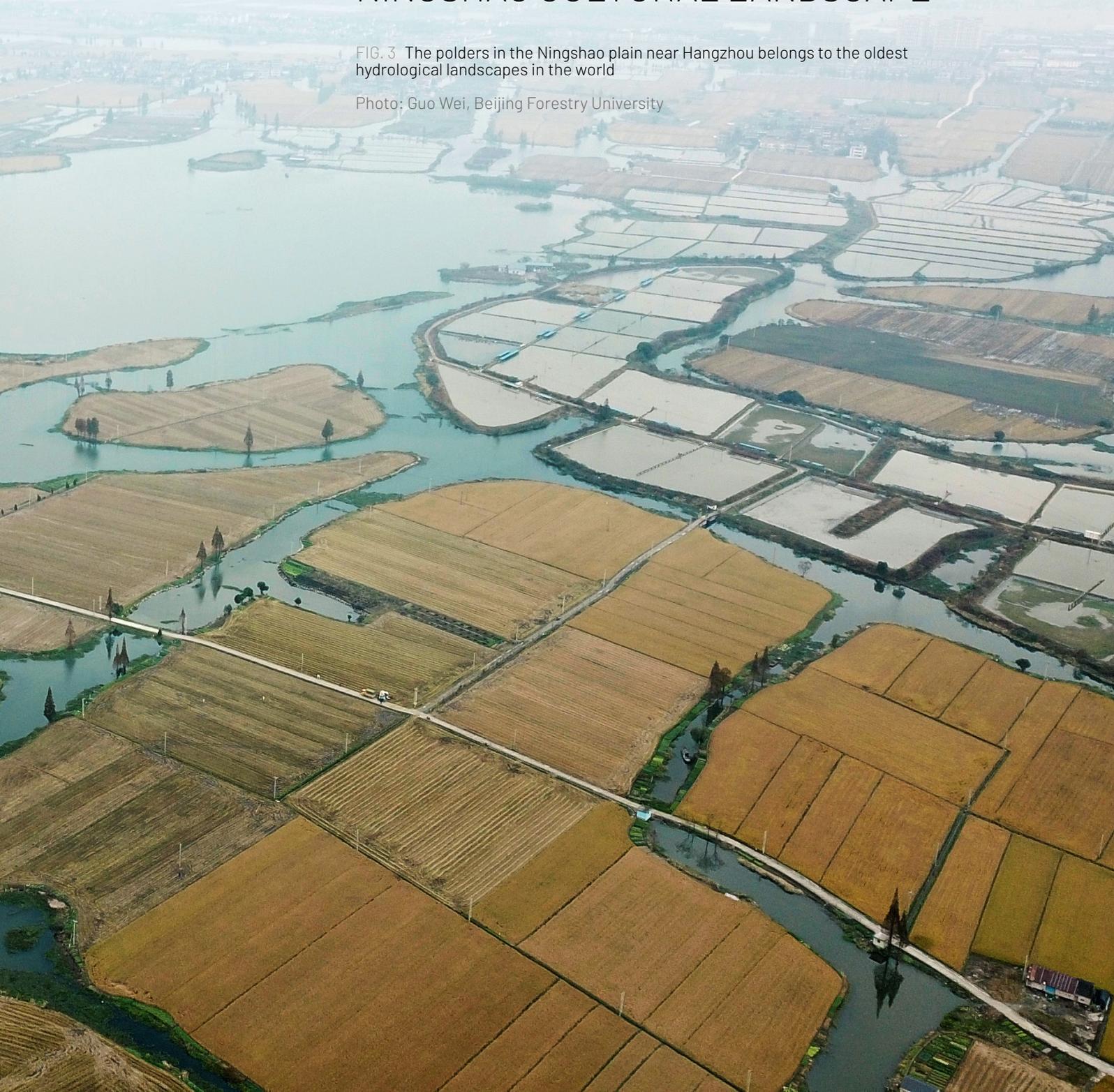
The lab is connected to the research project: NSFC, NWO and EPSRC Joint Research Project: 'Adaptive Urban Transformation (AUT) - Territorial governance, spatial strategy and urban landscape dynamics in the Pearl River Delta' (grant no. ALWSD 2016.013 sustainable delta program) with Delft University of Technology, Department of Urbanism (NL); South China University of Technology, School of Architecture (SCUT) (China); The University of Sheffield, Department of Landscape (UoS) (UK). <https://adaptiveurbantransformation.com>



NINGSHAO CULTURAL LANDSCAPE

FIG. 3 The polders in the Ningshao plain near Hangzhou belongs to the oldest hydrological landscapes in the world

Photo: Guo Wei, Beijing Forestry University







MUMBAI COASTAL HERITAGE

FIG. 4 Aerial view overlooking the Mahim Fort, one of the forts that forms the historic defence structure of the city. This fort sits on the edge of Mahim Island.

Photo: Dinodia Photos / Alamy Stock Photo - Mahim Fort Mumbai





MUMBAI COASTAL ECOLOGY

The remnants of Mangroves at the Mithi Mahim Estuarine zone that are bound by infrastructure. Much of the coastal gradient has been erased because of urban pressure.

Photo: Dinodia Photos / Alamy Stock Photo - Mumbai, India, mangroves in Mithi river at Dharavi Bandra link road





MUMBAI URBAN JUXTAPOSITION

FIG. 5 The tall and short of Mumbai – informal settlements situated in the estuarine zone are putting pressure on mangrove and coastal ecology, and the formal built environment is reaching towards the highland forests causing an erasure of the natural landscape system.

Photo: Srinivas Akella / Alamy Stock Photo - Mumbai, India 2020 Appa Pada Slum



FOSHAN DIKE-POND LANDSCAPE

FIG. 6 The traditional dike-pond is a well-known circular agri-aquacultural landscape in the Pearl River Delta. The organic form and multi-functional land use have fed prosperous silk trade and rural economy. However, regional urbanisation, has transformed this landscape into standardised grids focused on higher aquacultural yields. The mono-functional transition has broken material exchange between dikes and ponds, and the productive landscape is being separated from the local construction. How could we rebuild the interactions between agriculture and aquacultural production, and how could we provide conditions for modern livelihood with this productive landscape and transform the countryside into independent and comprehensive settlement systems for the Great Bay Area?

Photo: Imaginechina Limited / Alamy Stock Photo - Foshan City 2019







LANDSCAPE UNDIVIDED

FIG. 7 The Shenzhen River in the middle of the two cities has been a border river since 1898. Coupled with the green buffer zone on the Hong Kong side that was once a restricted border area, the bay, the estuary, the river, and the land form a uniquely polarized landscape, where urbanization and nature are juxtaposed across the river.

Photo: MEMEME / Alamy Stock Photo - Yeun Long, Hong Kong



BANGKOK'S URBAN SPONGE

FIG. 8 Lumphini Park was established as the first public park in an outskirts location of Bangkok. Today, this 57.6-hectare green space serves as a vital urban sanctuary for the city's central business district. It is widely known for its generous provision for human recreational activities. However, much less is acknowledged for its role in buffering and storing rainwater and alleviating urban runoff. How do we maintain green spaces like this in the face of rapid urbanisation to ensure a flood-resilient city, reinstate people's connection with water, and provide habitats for other living beings?

Photo: Stockbym / Alamy Stock Photo - Lumphini Park and skyscrapers Bangkok city





Projects

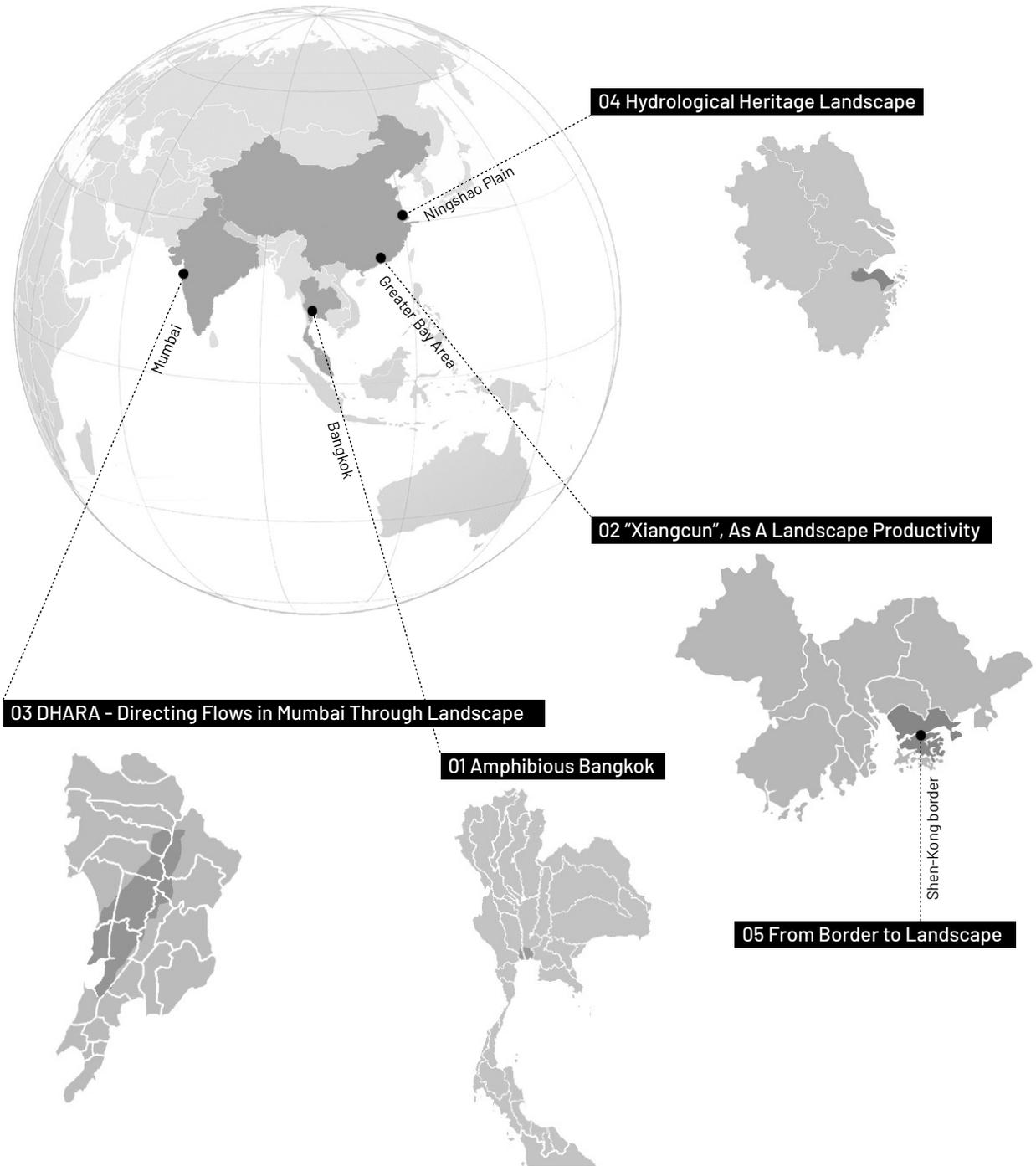


FIG. 9 Project map location

Project Overview

Amphibious Bangkok / **Akarapol Chongwattanaoj**

Water-resilient landscape, Landscape infrastructure, Sponge capacity

“Xiangcun”, As A Landscape Productivity / **Jie Chu**

Sustainable countryside, Urban-rural disparities, Agricultural landscapes

DHARA - Directing Flows in Mumbai Through Landscape / **Ayesha Hussain**

Blue-green infrastructure, Landscape of gradients, Urban permeability

Hydrological Heritage Landscapes / **Wansu Lu**

Cultural landscape, Polder grammar, Resilient landscape framework

From Border to Landscape / **Yuqi Pu**

Resilient landscape infrastructure, Landscape corridor, Border territory

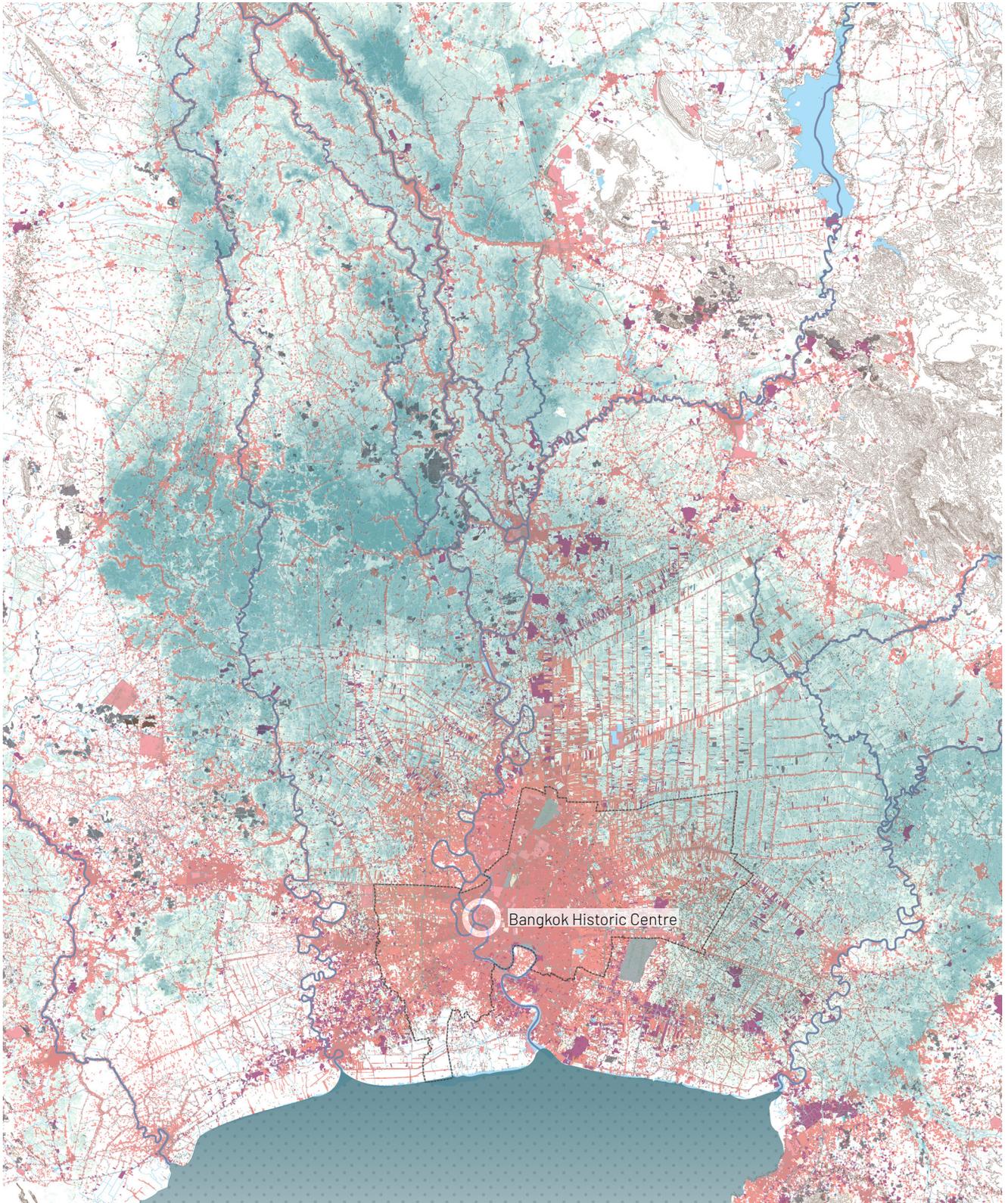


FIG. 10 Bangkok and its conurbation within the Chao Phraya River Delta and the conflict with repeated flooding

Amphibious Bangkok

Creating a resilient landscape framework for amphibious urbanisation and fostering human and water connection

Akarapol Chongwattanaoj

Supervisors

Steffen Nijhuis, Landscape Architecture

Fransje Hooimeijer, Environmental Technology

Introduction

Bangkok is located on the low-lying deltaic soil near the mouth of Chao Phraya River. Like many coastal and delta cities, it has faced many floods and environmental challenges due to human's extensive alteration of the landscape and consumption of natural resources. These cities are threatened by increasingly destructive climate catastrophes which can cause even more tremendous economic loss and deteriorated livelihood.

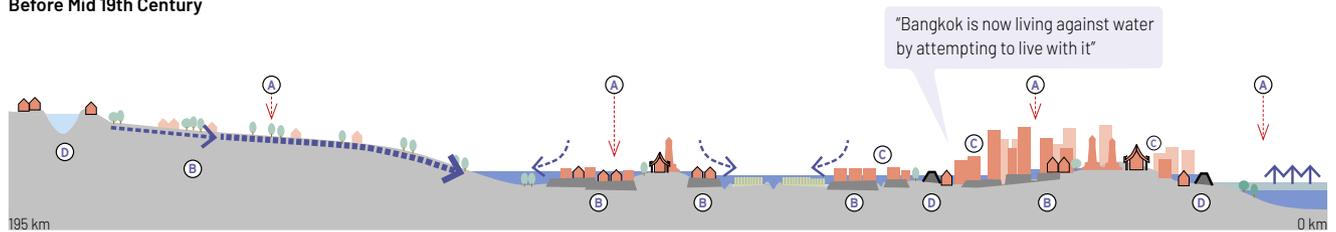
As a response, Bangkok has been prioritising engineering solutions such as high dikes, pumps, and flood tunnels to manage its water network in the low-lying topography. Still, they are mostly inflexible to the increasing climate change pressure and leave less room for water, causing more widespread floods and social conflict. The intensive built-up inner city and the rapid land-based peri-urbanisation into agricultural and open lowland are also exacerbating these issues.

This graduation project "Amphibious Bangkok" aims to tackle these issues by exploring the application of a resilient landscape design framework to increase landscape capacity in coping with current flood problems and future climate uncertainties. By drawing on the wisdom accumulated through the human-water symbiotic relationship and practices, the new landscape design and planning proposals integrate the top-down infrastructural and bottom-up landscape approaches and provide the multi-scalar landscape networks as the basis for a more sustainable urbanisation.

The framework leads to the design exploration and spatial expression of the landscape design approach on the strategic sites as a part of the larger water management scheme. The cyclical research-design iteration allows knowledge production through design explorations, which can serve as an example of more water-resilient urbanisation. Ultimately, the framework can serve as a guideline to understand delta cities in other geographical and climate contexts.



Before Mid 19th Century

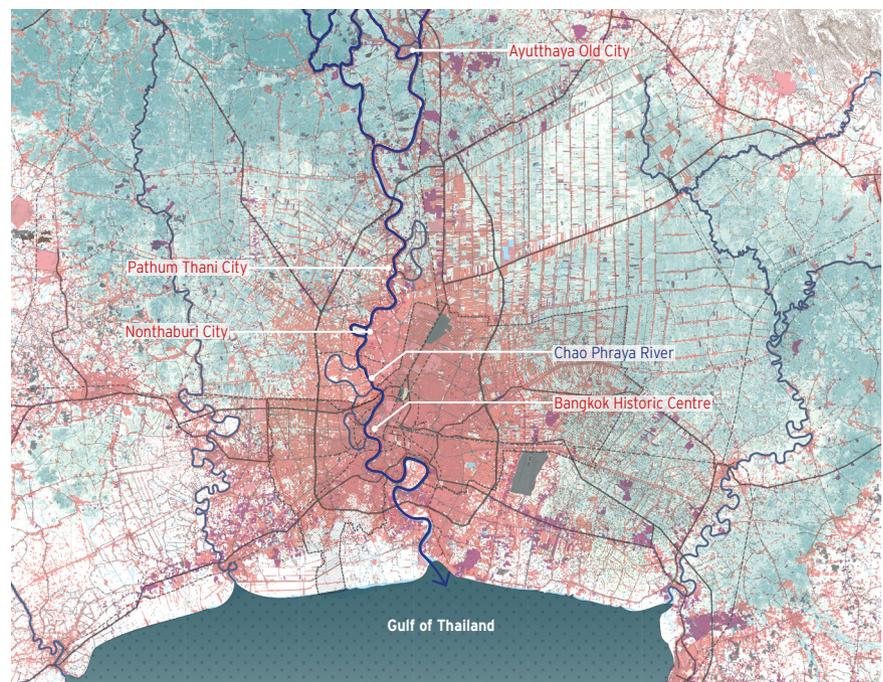


After Mid 19th Century

- Ⓐ Climate change
- Ⓑ Human extensive landscape alteration
- Ⓒ Negligence of water systems
- Ⓓ Rigid & technocratic water management

FIG. 11 (Top) Schematic Lower Chao Phraya Delta long section and the summary of loss water-resilience due to interrelated factors

FIG. 12 (Right) Repeated flood map of the lowest part of Chao Phraya River Delta from 2005-2015 superimposed with developed areas and major road network



Towards a Landscape Resiliency Approach

The current technocratic and engineering infrastructures can control flood spreads but also limit natural water flows while disconnecting land and water. To propose a more inclusive water management approach, this project employs **Landscape Resilience** as the theoretical framework. The concept is inspired by the Planning and Design Approach for Urban Resilience by Thaitakoo (2012) which points out the “liquid perception” embedded in the Thai historical resilience and adaptability to living with water in traditional processes. The practices are based on perceiving water and its dynamics as the basis for social and economic activities, and that the flows should be embraced and not controlled by rigid structures.



FIG. 13 (Top) River floodwall being heightened in Nonthaburi area, segmenting riverfront lives and water

FIG. 14 (Bottom) The components of the adapted Resilient Landscape Design Framework which are applied and as the result of the research-design process

Two research and design approaches are applied. First, the Landscape-based Regional Design approach guides the overall project's research and design process (Nijhuis et al., 2020). The approach promotes iteration of analysis and design through modelling and visualisation. The analysis uses a layers approach as a method to gain an understanding of the landscape structures and processes. In each decomposed landscape layer, landscape challenges are identified, and the key elements of the layer and their opportunities that can contribute to achieving the project objective are acknowledged. These key landscape structures will be made more resilient through research-by-design process guided by the five strategies provided by the second approach - the Safe-to-fail Adaptive Design and Planning approach (Ahern, 2011).

Resilient Landscape Design Framework

To engage further in the research and design, the characteristics of the adapted design framework for Bangkok need to be defined. Firstly, the framework indicates the primary tasks to make Bangkok more water resilient which are 1) increasing discharge capacity of waterways, 2) increasing sponge capacity of the landscape, and 3) improving water quality. Secondly, it proposes the core water-resilience design principles to achieve these tasks. Lastly, it identifies the key resilient landscape components selected through the layers approach, in which the principles can be applied to and work together to achieve the tasks. These landscape components are the substratum layer including soil and water, blue-green networks, and the cultural landscapes. The framework also stresses the importance of multi-scalar design and phasing - designing through and with time - to reinforce the link between the design principles and design outcomes which are site-specific, and showcase high implementability.

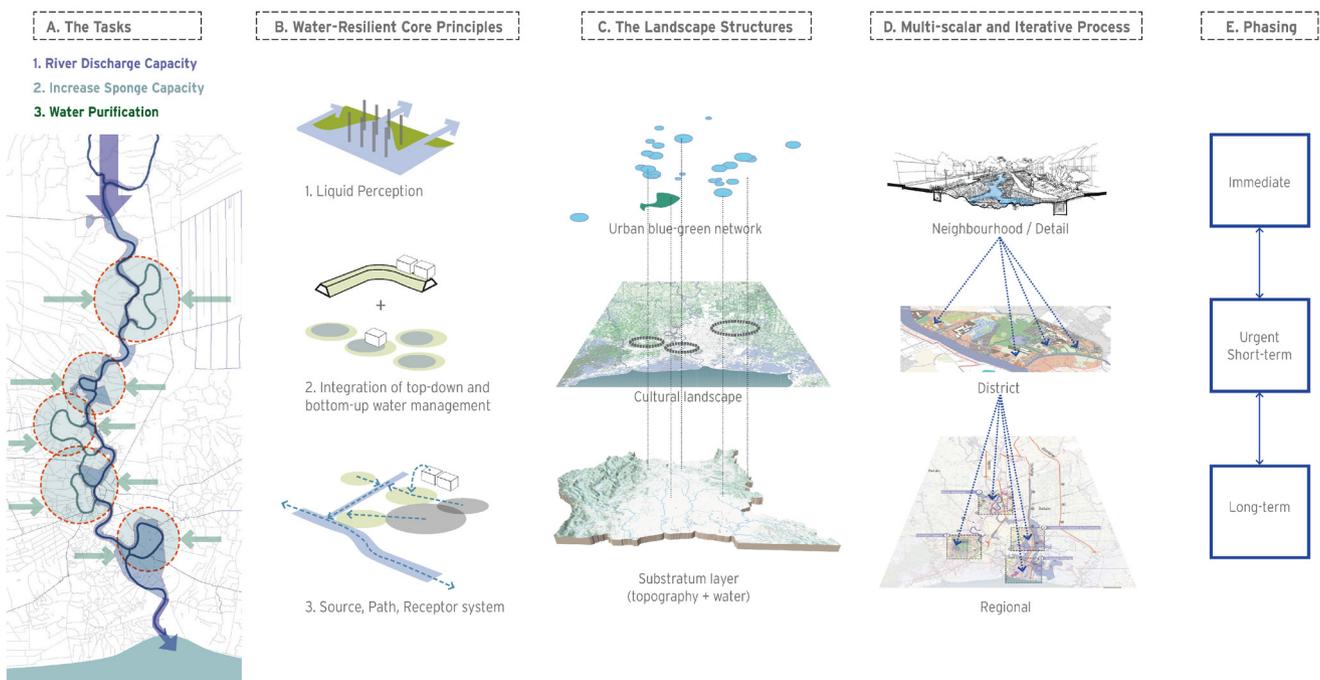




FIG. 15 An example of agricultural settlement on waterways, with canal houses adaptive to water fluctuation and orchard plants in the background
Source: Parichart. (n.d.) - stock.adobe.com

The core water-resilience design principles to realise these improvements are drawn from the precedential international projects and the generally top-down or large-scale adaptive water management schemes. One of them stresses the importance of the integration of top-down and bottom-up (infrastructural-landscape-adaptive) strategies. The existing blue-green-grey networks and the cultural landscapes in both urban and rural areas should be acknowledged as an essential contributor to solving the water issues. Fruit orchards, rice paddies, canal networks, fish ponds, and urban open spaces can be a part of the blue-green network that helps detain, retain, and purify water, and enhance the living environment. Thai traditional water adaptive practices such as urban settlement patterns on levees, forms of architecture that allows water flows, spatial arrangements that embrace seasonal changes, and adaptive crop cycles can guide the new peri-urban planning schemes that are water-resilient and inclusive while safeguarding local practices and ecosystems.

In summary, the resilient landscape framework allows the project to work towards landscape resilience in a systematic way. The research and design results are, therefore, based on the solid understanding obtained from this process.

Results

The iterative process allows the principles to manifest in a set of interconnected and multi-scalar design. The large-scale regional strategies are applied to the strategic district, where multiple neighbourhoods' landscape components can be improved to contribute to the overall discharge and sponge capacity.

The Regional Strategy focuses on Chao Phraya River as the vital artery of the lower part of this Lower Delta. Taking Bangkok as the focus, the river can be divided into the upstream (north of Bangkok), middle stream (inner urban Bangkok within King's Dike), and downstream stretches. Each of these stretches represents distinct cultural landscape characteristics.

- ⊕ Purifying function added to all path elements
- Regional bypass channel
- Additional drainage path
- Inundation field to detain peak discharge
- Lowest water detention area before discharging to waterways and water bodies
- Second lowest area for water retention

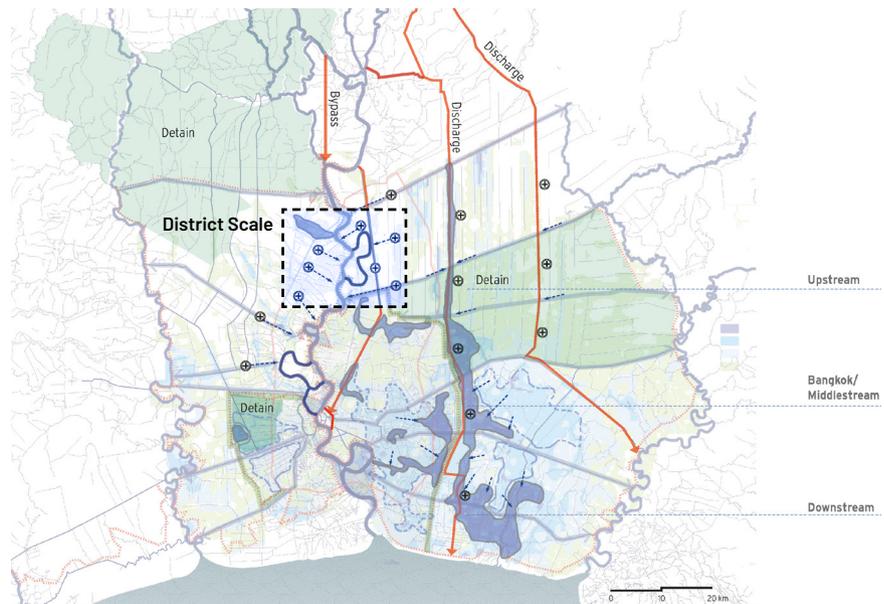


FIG. 16 The Regional Scale Strategy Map indicating key elements and tasks of improving discharge and sponge capacity of the lower delta area, with the district-scale site indicated

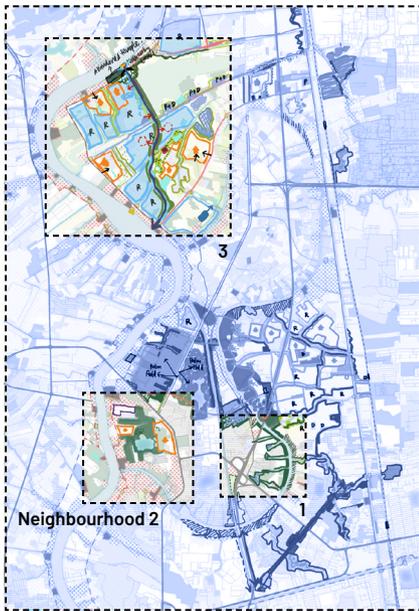
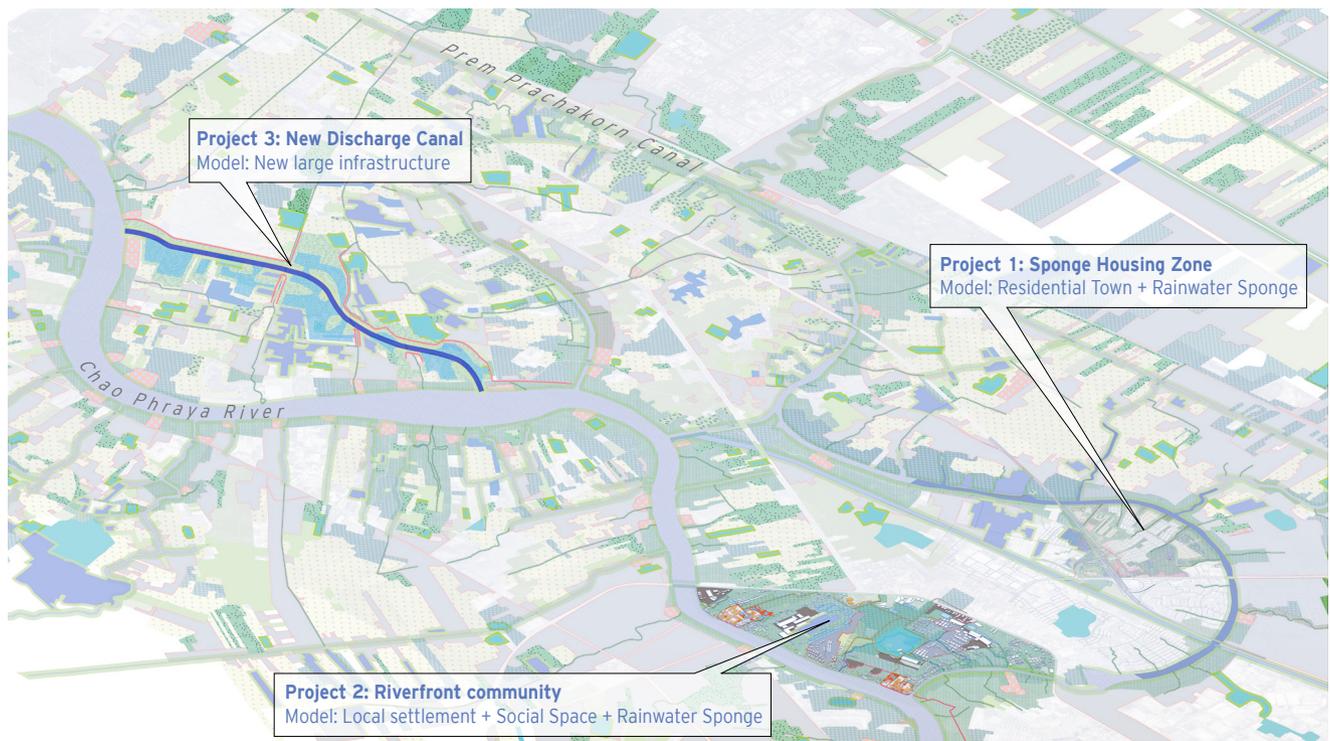


FIG. 17 The District-Scale design exploration of Bang Luang Chiangrak area, upstream fringe of Bangkok, with three Neighbourhood-Scale sites indicated

FIG. 18 Axonometric view of the District-Scale masterplan and three Neighbourhood-Scale projects for further spatial design expression.



The upstream and downstream areas consist of a higher percentage of agricultural land and natural areas which offer better sponge capacity. The upstream areas hold a strategic position for water retention before it reaches Bangkok. In addition, finding spaces in the blue-green adjacent landscape in front and behind the dike for a bigger river corridor is also an important task.

Located on the northern fringe of Bangkok outside King's Dike, Bangluang Chiangrak-Baan Prao canal was the original Chao Phraya River which narrowed down after the completion of river bypass in 1608. **The District-Scale** design explores how this mixture of urban-rural landscape connected to this former river meander can contribute to the increased landscape resilience while creating safer and more adaptive future urbanisation. The masterplan integrates the infrastructural approach (e.g., discharge canal and dike relocation), variety of agricultural landscapes, and local adaptive practices into the sponge system. Non-structural approaches such as opting for aquatic crops to allow more water retention is also introduced. Ultimately, the design generates a well-connected blue-green (and grey) network as the multifunctional backbone of the area that interweaves the fragmented landscape with many urban and rural neighbourhoods. This network also incorporates slow transport paths to connect both land and water mass transit systems.

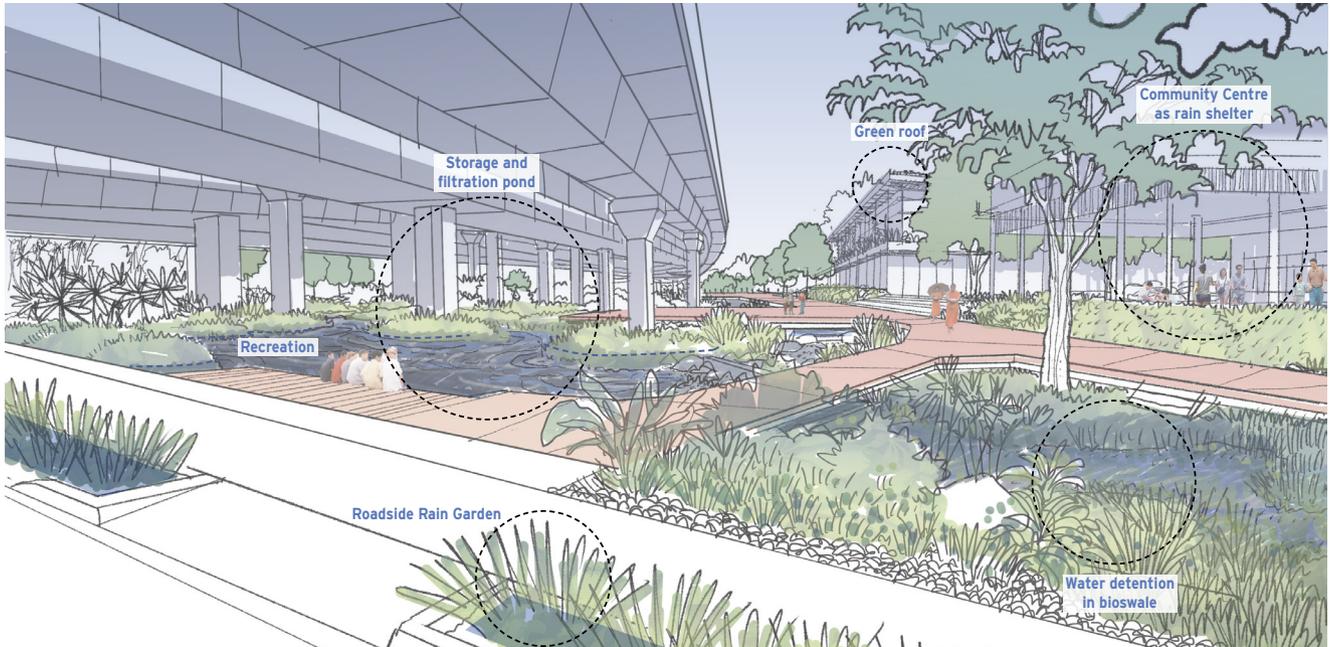
Suitable areas for new urban centres and neighbourhoods are identified to preserve local agricultural landscapes, the structures of ancient towns, and local practices while residential areas can be safe from unprecedented river overflow and waterlogging. Low swamps are also integrated into the blue-green backbone to help naturally clean industrial wastewater from the dense urban centres nearby before discharging into the larger receptors such as canals and the river.

- ① Soft water edge with public access
- ② Proposed commercial & communal buildings
- ③ Residential (Built)
- ④ New adaptive residential
- ⑤ River and canal communities
- ⑥ Wetland park
- ⑦ Water recreation area
- ⑧ Bio-diverse aquaculture

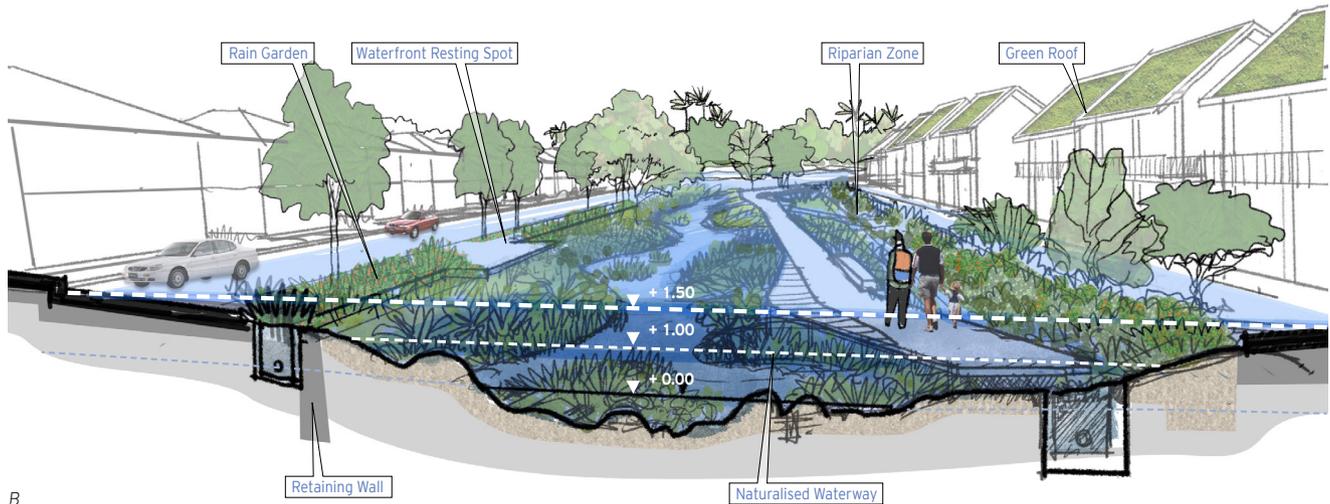


The district comprises diverse urban typologies such as the adaptive riverine community, agricultural and canal community, gated residential area, and modern urban residential. Each of these require an application of various design principles to increase sponge capacity. New programs and upgraded social spaces in the **Neighbourhood-scale design/projects** help to strengthen the district's culture and livelihoods. They can also reconnect people with the blue-green networks through spatial design interventions that allow eco-friendly and accessible water edges.

Scenarios of competing social and economic demands such as housing, recreation, and industrial and urban expansion can be explored on these strategic neighbourhood zones where the landscape backbone has been established to maintain its functions i.e., ecosystem services to both humans and animals. Such design exploration not only leads to the framing of spatial problems and outcomes but also generates multiple possibilities and various solutions (Nijhuis et al., 2020). The project can be seen as a model of amphibious urbanisation that allows for flexibility in planning of the peri-urban Bangkok.



A



B

FIG. 19 (Top left) The proposed master plan of neighbourhood project 1: The Sponge Housing Zone, where gated housing estates are designed with more adaptive gestures to allow the larger water management system to be more resilient and flexible. The blue-green-grey landscape network integrates open spaces, orchards, and swamps into one system which detain, retain, and purify stormwater. This newly established water network acts as the basis for new commercial and communal programs, recreation, and animal habitat restoration. It also acts as the connector that dissolves the hard edges of the fragmented landscape between the old and new residential areas whose waterfront can now be publicly accessed and not neglected.

FIG. 20 (Top right) The impression of the new blue-green-grey network utilising the abandoned space underneath the highway during rainy season. This landscape network increases rainwater buffer capacity while providing shade and cooling

effect for many outdoor activities. New retails and community centre expanding from the existing municipality buildings can benefit from this urban refuge area where slow movement connection is also provided.

FIG. 21 (Bottom right) The interface between the already constructed and newly proposed gated residential areas. Waterways in the zone are often neglected and framed by high fences between these estates. By establishing the well-connected water system, a series of green spaces along these blue arms, and removing barriers, the water network becomes the connector - an extensive linear park - for residents in the zone. The non-isolated landscape also allows more flexible stormwater management and sponge capacity. This is done by integrating roads and garden spaces for water detention for extreme rainfall periods.

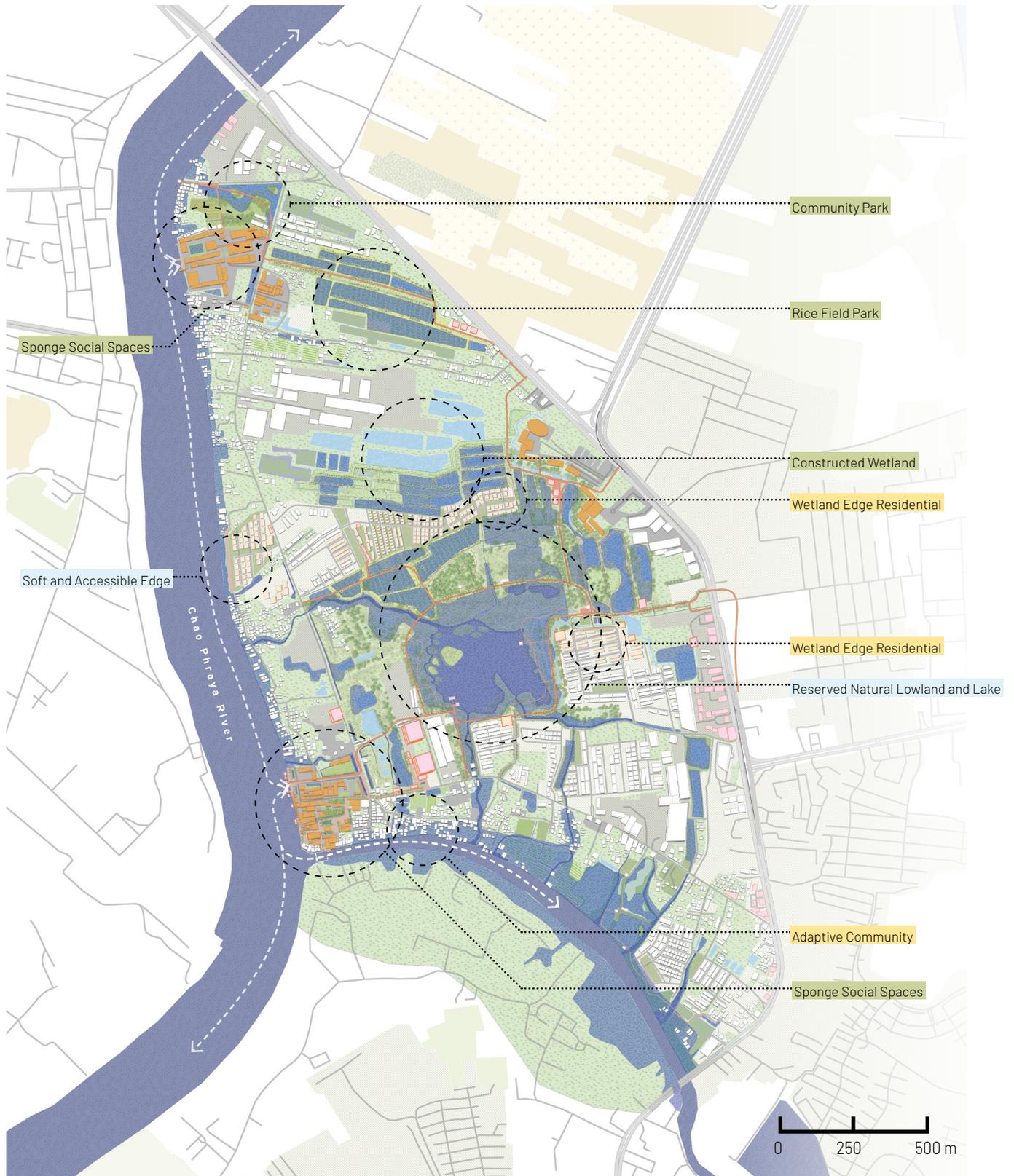




FIG. 22 (Left) Neighbourhood 2 masterplan maximises green spaces in the floodplain area where new housing development can enjoy access to open spaces for recreation and climate adaptation. The existing agricultural land remain intact to provide food and income for nearby communities. The connection from the road-lined border to the green network and social spaces is crucial and is, therefore, improved by the new slow mobility route network. The proposed Green Heart and the network of blue-green allow a generous volume of water retention during wet season. The landscape is transformed throughout seasons depending on the amount of rainwater storage in the area.

FIG. 23 (Top) The temple plaza is pedestrianised and make way for more sponge spaces such as rain gardens, sunken plaza, and open waterways with green edges. More trees provide shade for people while reducing urban heat island effect. The new spatial structure also highlights the importance of each building and creates a better sense of place. The new sunken plazas break up large hardscape and allow more filtration. They allow water to fill up to alleviate the stress on public sewer system and waterways. These sunken plazas are connected to bio-swale network on the temple grounds by sewers underneath pavement, which allows these plazas to dry up when the water levels of the waterways outside recede.

Envisioning extreme rainfall scenario

FIG. 24 During extreme flooding events, such as the Big Flood in 2011, upstream discharge in the landscape area is inevitable. With numerous flexible landscape spaces, infrastructure in-place for water storage and detention, adaptive residential areas, and safe commute routes throughout the design site, the overall neighbourhoods are equipped with the structure and tools to adapt and live during these intense months.

Rice Field Park

- Rice cultivation remains for the adjacent local community but made publicly accessible by providing paths leading to the temple and school.
- Deepwater rice or aquatic crops can be explored / researched within these field plots in wetter years.

Constructed Wetland

- Wetlands follow the pattern of the abandoned rice field to preserve the cultural landscape physical structure.
- Various plants such as typha angustifolia, sedges, water hyacinth, and lotus are used to phyto-remediate high mineral content in industrial wastewater.

Community Park

- The undulating park provides pockets for rainwater detention. Naturalised bio-swales allow water to fluctuate.
- The park provides recreational spaces as well as fruit and vegetables for the existing riverfront community nearby.

Public Waterfront

- New waterfront development needs to be set back to allow for riparian zones and public access of the river.
- Soft edges allow fauna movement and water detention/fluctuation.

Waterworks Canal

Reserved Natural Lowland and Lake (Green Heart)

- The lowland combined with stone weir allows the lake to fluctuate, storing water up to 1.5m higher.
- The area serves as wetland habitat restoration and public connectivity, allowing pedestrians and bicycles to move between neighbourhoods.
- The lake serves as urban refuge and recreation area for residents and tourists.

Pocket Gardens and Blue-green Corridors

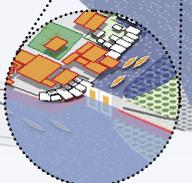
- Grasslands and swamps in small spaces are preserved and connected into the larger water systems.
- Surface runoff are collected and detained.

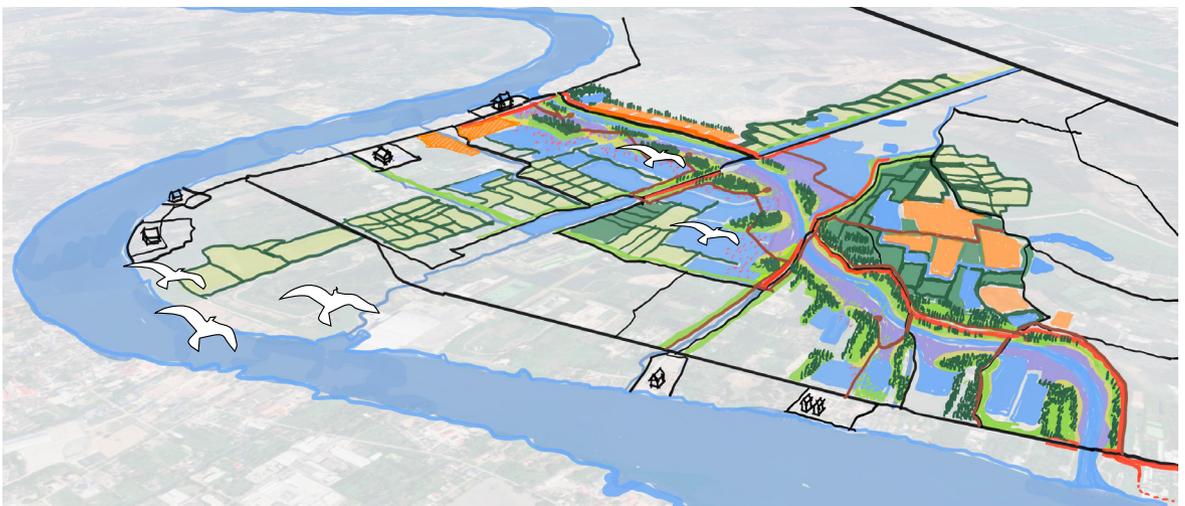
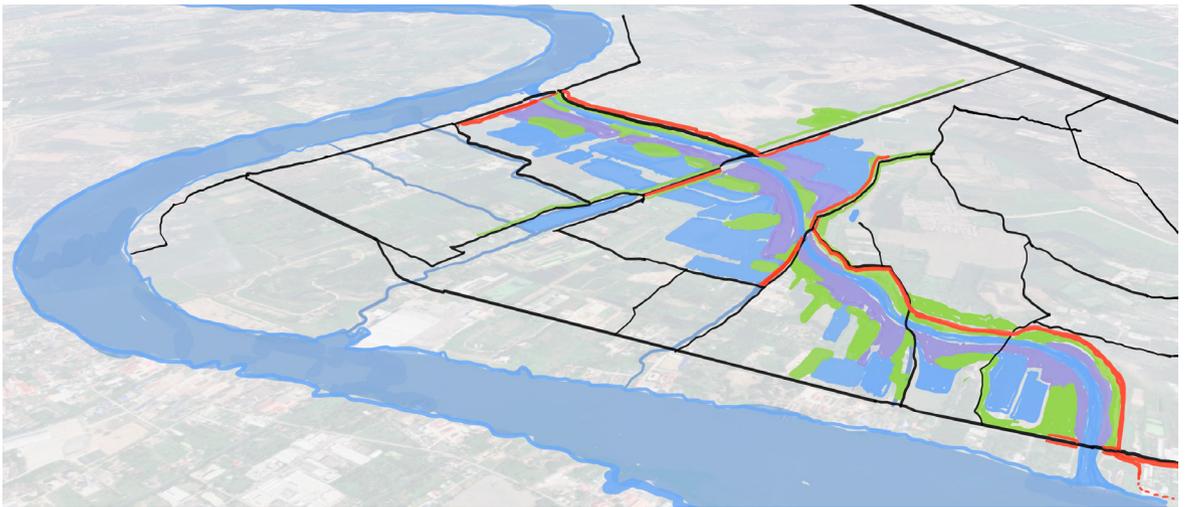
Bang Luang Chiangrak Canal

Sponge Social Space

- Sponge capacity is increased by adding more green spaces and permeable paving.
- Waterfront is greener and more accessible to and from water, both physically and visually. Trees, seating areas, and new piers are added to create pleasant environment.
- Creating greener spatial experience by rearranging traffic, reducing car access to social spaces. New parking buildings are located nearby. Streets are pedestrianised, which helps to promote local businesses and walkable journey towards the temple.

- Floodgate closed during peak river discharge allowing the meanders to work as rainwater buffer





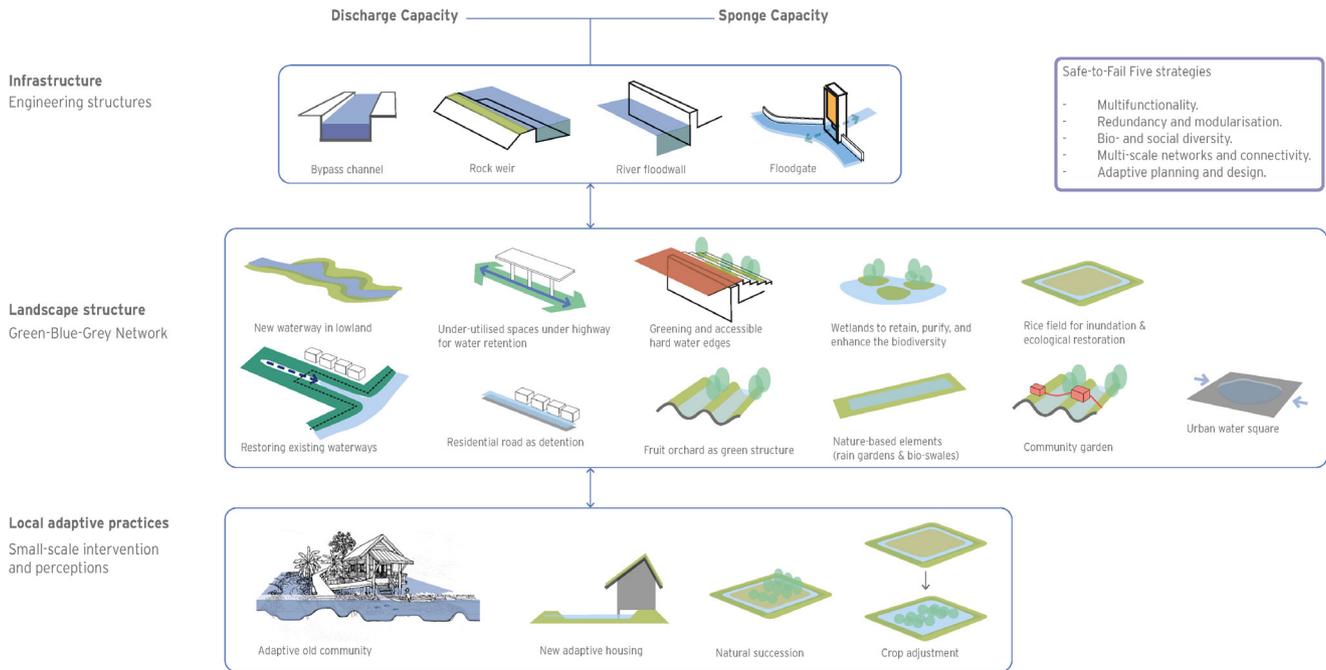


FIG. 28 The summary of the design principles integrating the top-down engineering infrastructure, landscape approach, and the bottom-up local adaptive principles as the result of the research-design process

FIG. 25 (Top left) The design exploration of Neighbourhood Scale Zone 3: New Discharge Canal. The strategy is to propose a new discharge canal to increase the river's discharge capacity while being multifunctional and inclusive. The intervention process starts with engineering with nature and reinforcing the dikes in strategic places.

FIG. 26 (Middle left) The next step is widening adjacent floodplain to allow water retention/fluctuation and preserving fruit orchards and trees in higher places which will allow more opportunities for more biodiverse agriculture and natural habitats. The new discharge canal, therefore, works as the green-blue landscape backbone for the neighbourhood.

FIG. 27 (Bottom left) The established green-blue backbone guides the urban development. Adaptive practices such as wet cropping and aquatic plants are proposed. New movement paths connect the landscape structure and adjacent neighbourhoods.

Conclusion

Through studying the project, landscape resilience is understood as a relatively new concept that has not been widely implemented in the modern Thai water management plans. The negligence of historical resilience, which is embedded in the cultural landscape, and large-scale technocratic approach have become a norm. Therefore, it is crucial to approach the project from the perspective of landscape resilience to create a more flexible "liquid" thinking and water-resilient landscape design solutions. Restoring and increasing Bangkok's amphibiousness through this project showcases new ways of urbanisation that is multi-functional and inclusive while contributing to the delta water management schemes.

Design acts as a powerful tool for research. By applying the design principles on the strategic sites through the pre-defined three to four working scales, new sets of site-specific design principles, which help strengthen the core water-resilience principles, are also generated. This emphasises that the research does not end in the analysis phase or at one particular scale but more of an abduction and cyclical process where new knowledge can be the outcome of the design. The use of layers approach in understanding the landscape systems also allowed for the selection of the crucial landscape components (in this case, the cultural landscape) that can be improved for the better urban stormwater management.

Finally, the resilient landscape design framework established from this research-design process can also act as the guideline for the future tackling of the water issues in the other parts of Bangkok and geographical areas.



FIG. 29 The vision of the future countryside in the GBA: The countryside will become an optional and modern settlement with eco-friendly production, diverse work opportunities and quality environment for dwelling.

“Xiangcun”, As A Landscape Productivity

Sustainable Countryside Development for Urban-rural integration in the Greater Bay Area

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Supervisors

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Introduction

The countryside is standing at the cross of its destiny due to rapid urbanization. Influenced by the historical dual urban-rural relationship, the countryside in China was regarded as the sacrifice of regional modernization. Since the reform and opening up, a miraculous expansion of cities could be seen within the Great Bay Area (GBA). However, the price of this great leap is the broken countryside losing independence: City-oriented planning has led to increasing urban-rural disparities, which is replacing the agriculture landscape with mono-functional land use and transforming rural area into satellite areas within the poly-centric regional structure. Therefore, how to redefine the countryside and propose development patterns jumping out of the urbanization path has become an urgent problem, yet effective spatial strategies and theory-based practices are currently limited (Magel, 2019).

The thesis aims to explore the potential of the modern countryside, which called “Xiangcun” in Chinese, as a sustainable settlement in the GBA. Through comprehensive methodology taking the layers approach as a critical method, the project retrospects the transition from perspectives of form, function and governance in the countryside, and critiques the functional zoning planning approach which reinforces the unbalanced local development. It proposes a vision of the hybrid and productive rural system based on agricultural innovation, a flexible spatial framework that considers production, environment and livability comprehensively, and a series of possible strategies related to existing patterns. In the future, the countryside could become a development option complementary to cities and contribute to the formation of a diverse and urban-rural integrated network of this international mega-metropolitan region.

THE COUNTRYSIDE

An International Agenda



FIG. 30 Development of the countryside has become an international agenda which contribute to the Sustainable Development Goals (SDG)s

Declining Countryside in the GBA

Edward Glaeser described the city as the “greatest invention” of the human in *Triumph of the City* (2012). However, the high-speed urbanization around the world is causing a series of problems: including losing eco-resilience of the land, shrinking agricultural fields, and increasing disparities between settlements. The condition of people’s life is related to the place they live, and the unfairness is continued as the result of urbanization running out of control. Considering the growing environmental and social crisis, urbanists start to reflect on the methods people developed settlements in the past centuries. Today, countryside, the traditional but ignored settlements, is retracting a number of attentions with its landscape-based organization. And the development of the countryside is becoming an international agenda related to the Sustainable Development Goals (SDG).

China is one of the most important agricultural countries in the world, and the continue increasing urbanization rate shows that Chinese countryside still contains enormous potential to explore a more sustainable development pattern and contribute to the global rural agenda. However, influenced by linear urbanization as the result of the historical dual urban-rural segregation and the period of “Feeding the Industries by Agriculture”(R. Liu et al., 2020), the agricultural labours are escaping to the cities for well-paid employment and quality life, meanwhile, the competition is regarded as a phase of the urbanization process (Liu Jinghua, 2018). The countryside is suffering from its weak position in unbalanced rural-urban relationship.

Well-known for the most dramatic urbanization in Chinese history, the price of the “Great Leap Forward”(AMO, 2001) in the GBA is to become the front-line of this urban-rural conflict. Since the reform and opening-up policy, countryside in this mega-region provides blood for urbanization while competing with cities under the market economy. Consequentially, the urban-oriented pattern has left shrinking agriculture land facing flooding risk, decreasing labours for low-rewards agricultural production and increasing disparity between rural and urban areas. In order to maximize the economic value of the limit agricultural land after failing in the land competition with urban construction, the traditional multifunctional agri-aquaculture fields were reformed to reinforce specific functions to stimulate the short-term profits by satisfying the needs of higher-class cities. However, in the long term, the existing mono-functional strategy is insufficient to deal with issues caused by unbalanced urban-rural relationship and leads to the loss of rural independence. Essentially, the development pattern which highly depends on regional cities is another form of the linear urbanization.

The Conceptual Framework built on Integration Theory

The integrated model by Karl Marx provides a theoretical solution to the dilemma from the socio-economic perspective. The dualistic economic theory considers the decline of the countryside as a natural result of the process which equilibrates the marginal productivity gap between urban industries and rural agriculture(LEWIS, 1954). However, Marx pointed out that the weak position of the villages is avoidable in development, and the ideal urban-rural relationship should be complementary and integrated. The model contains two principles: improving rural productivity through

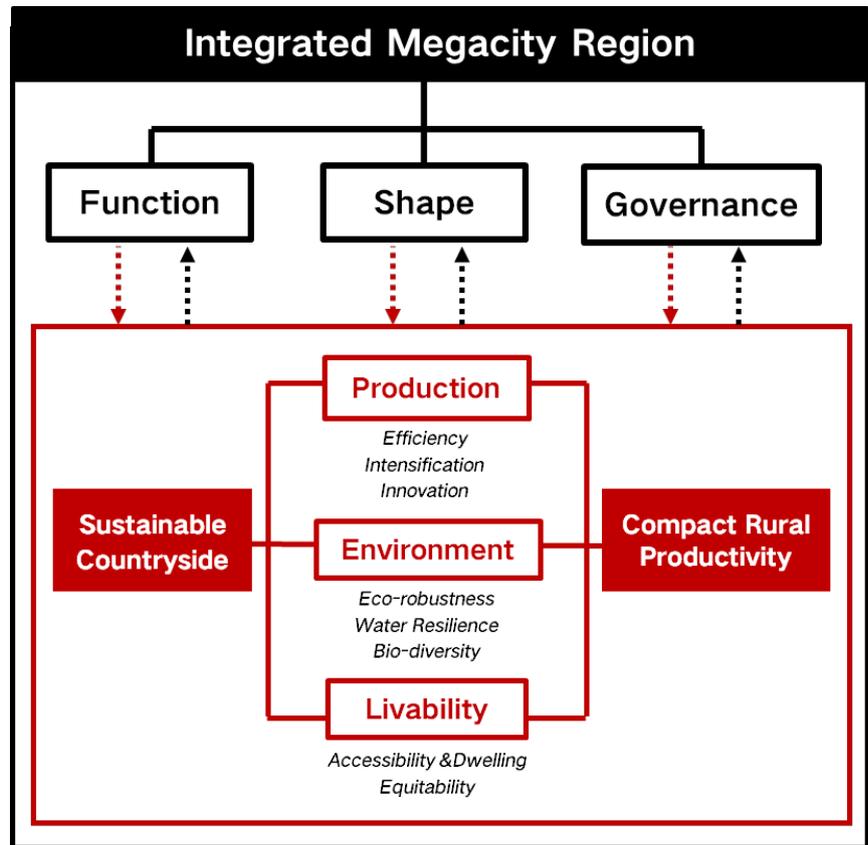


FIG. 31 Labour losing since 1985: after cancel of the dual policy, people in the countryside start to migrant to the magacity regions due to the wealth disparities under the linear urbanization



FIG. 32 (Left) The GBA is now the front-line of the conflicts between urban and countryside. The price of the miraculous urbanization including shrinking agricultural field, increasing disparities and mono-functional rural land use due to the city-oriented development.

FIG. 33 (Right) The conceptual framework build on the integration theory presents the relationship between notions and provides a critique approach guiding analysis and design



extension of the agricultural industry, and optimizing production structure through redistribution intervention (R. Liu et al., 2020).

The conceptual framework of the project is structured on this integration theory. Combining two key principles, the framework presents the relationship between notions across scales. Firstly, at the regional scale, the spatial-social mechanisms of the mega-city region are researched from three aspects: function, shape and governance (Cowell, 2010). Then at the local scale, it discusses how the countryside works as independent sustainable system and reflects on the integrated spatial structure. At the same time, the framework supplies a systematic method for guiding analysis and design.

Broken Interactions in Mono-functional Rural Satellite-areas

The gene of the countryside in the GBA was a culture of the landscape built upon the circular production. Since the 16th century, the typical agri-aquacultural landscape was created within the Pearl River Delta for planting mulberry upon pond dikes under the prosperous silk trade (Sun et al., 2019). The waste from agriculture and aquaculture could complement the needs of each other and form an organic circulation within the system. Organized through clan cooperation, the dike-pond landscape formed a

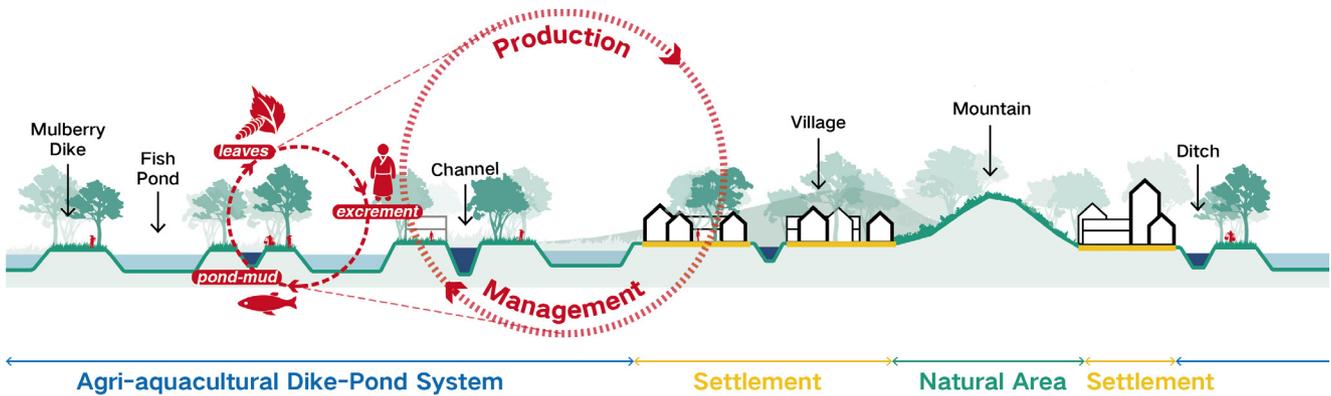


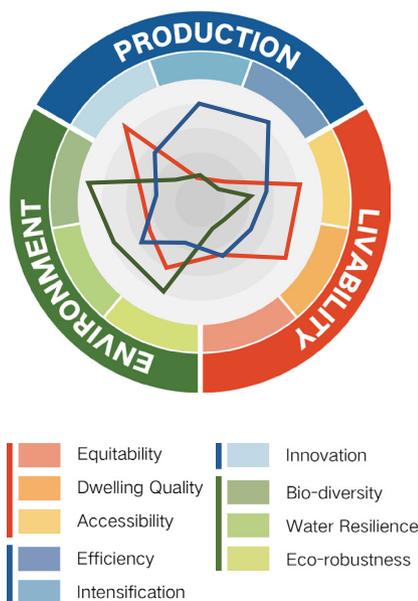
FIG. 36 (Top) The traditional dike-pond system presents a harmonious human-land relationship in traditional Chinese philosophy. It has been inscribed into the genes of the countryside in the GBA.

hybrid system containing multiple functions including production, water management, dwelling and local culture (TIAN, 2019). It echoed the traditional human-land philosophy of “The crop is seeded by human, grown by land, and fed by weather”, and is regarded as a classical model of the sustainable development.

FIG. 34 (Left) Evaluation of the existing patterns in the GBA. The mono-functional models present unbalanced development

However, the self-sufficient mechanism is no longer adequate for the open market in modern economy due to limitations of traditional agricultural productivity (Y. Liu, 2018). During the past decades, the instruments of modernism planning played a significant role in the transition of the rural areas in the GBA and emphasized specific positions of the countryside in city clusters through top-down interventions. Series of stimulating strategies have created new landscape textures of orderly efficiency, functional zoning and homogeneous construction. As a result, separation, isolation and opposition correspondingly appeared in the traditional hybrid system, the interaction between the material layers was broken and the mechanism formed by people and land together in rural areas is degenerating.

FIG. 35 (Right) An abstract collage for Existing Agri-aquacultural Landscape in the GBA. The countryside is separated into de-constructed mono-functional components today.



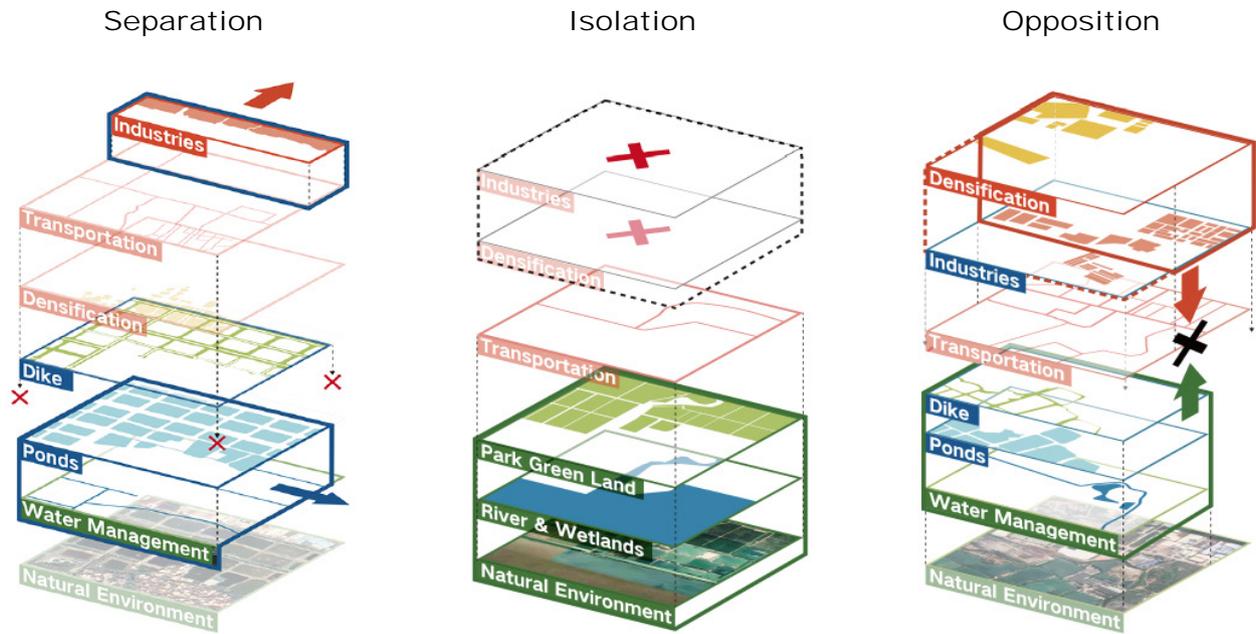


FIG. 38 The mono-functional planning has led to the broken interactions between element layers, which has transformed the countryside into in-complete system with intensified functions.

On regional scale, the incomplete systems are transforming the countryside into carriers of city functions, and satellite areas highly depend on central cities. The losing independence of the countryside exacerbated the fragmentation of the rural area during the urban agglomeration, reinforced the city-centric poly-centric structure in the GBA. In other words, the fact exposes the external continuation of the linear urbanization.

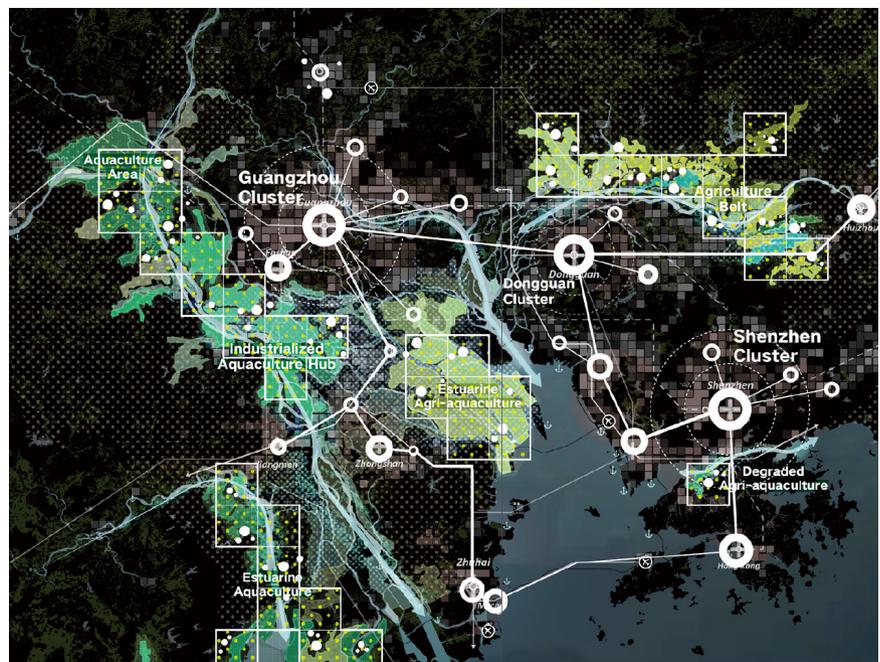


FIG. 37 The current GBA structure is more like a poly-centric metropolitan area rather than an integrated urban-rural network. The countryside are satellite areas highly dependent on the central cities instead of acting as independent nodes within the regional development.

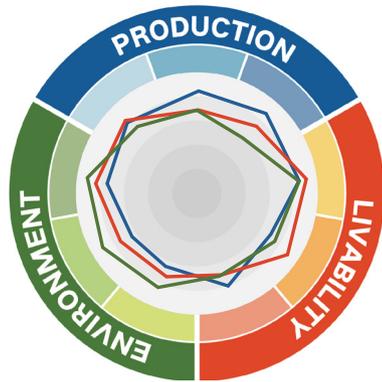


FIG. 41 Evaluation of the three proposed patterns. Enhanced models present sustainable and balanced development with diverse priorities in rural areas.

The Proposal and Exploring Design

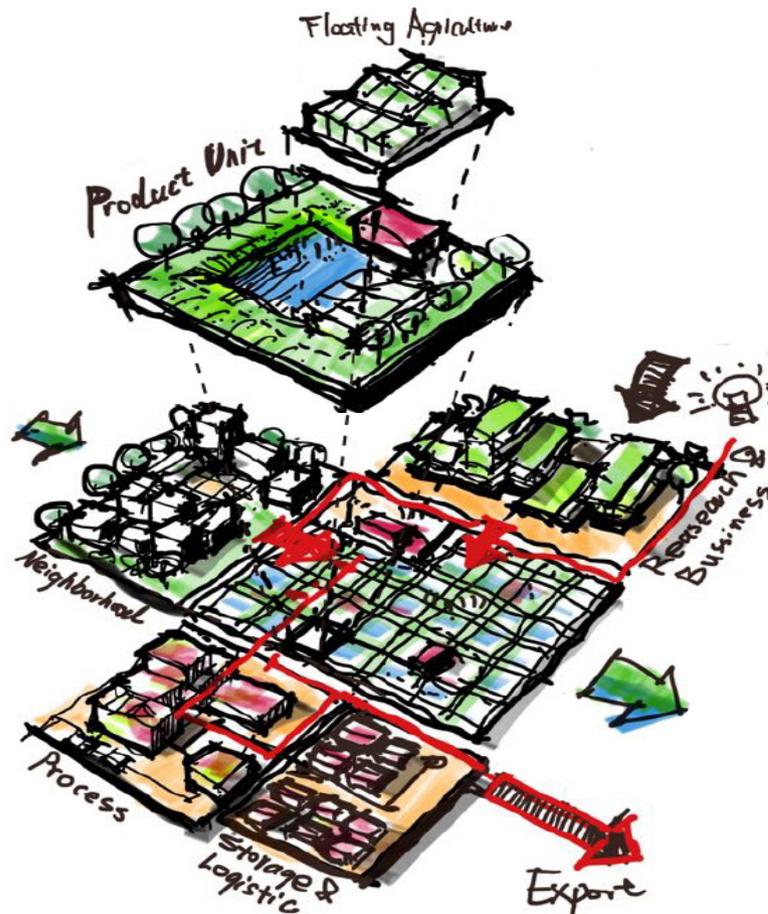
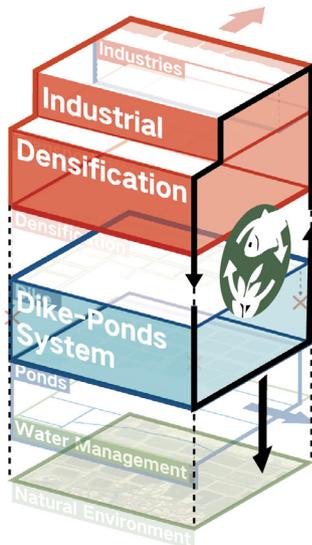
The analysis shows that the key to alleviating conflicts in rural development lies in encouraging local industries grow on the agricultural landscape, and the sustainable value of composite productivity. Thus, enhancing the independence of the countryside as a hybrid human-land system, reducing urban-rural disparities and facilitating the transition of the regional structure from poly-centric to cooperative network.

For this purpose, the project proposes a spatial concept called “A Resilient Aquaponics Belt” to encourage both local agricultural innovation and cooperative production within the entire region. Under this vision, the specific agendas are constructed on taking the three existing mono-functionalization as local characters and restoring connections among broken layers. Three conceptual patterns were developed: “The Innovation Grid”, “The Eco-friendly Neighbourhood”, and “The Hybrid Habitats”.

Taking the first pattern as an example, the design rehearses the implementation mechanism of the project proposal in the GBA. The priority is promoting an industrial regeneration based on aquaponics production and the existing landscape. Related assignments include rebuilding the integrated dike-pond system, regenerating

FIG. 39 (Left) The first conceptual pattern “The Innovation Grids” proposes an independent rural development model. The priorities include rebuilding the multi-functional dike-ponds system and encouraging local economy based on the modern aquaponics production.

FIG. 40 (Right) “The Innovation Grids” proposes a modern production mechanism based on the dike-pond landscape, together with vertical and eco-based interventions of the smart aquaponics units.



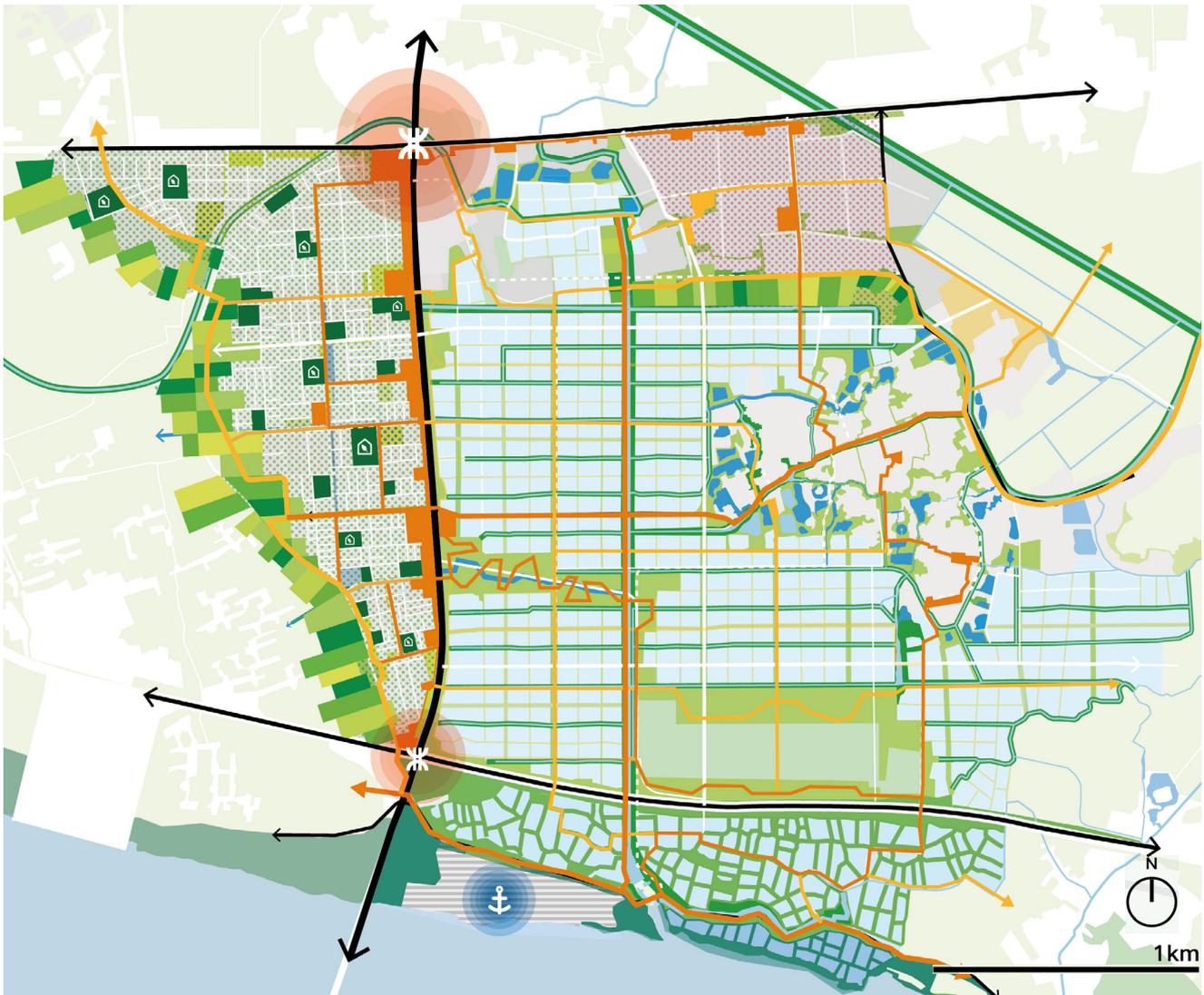
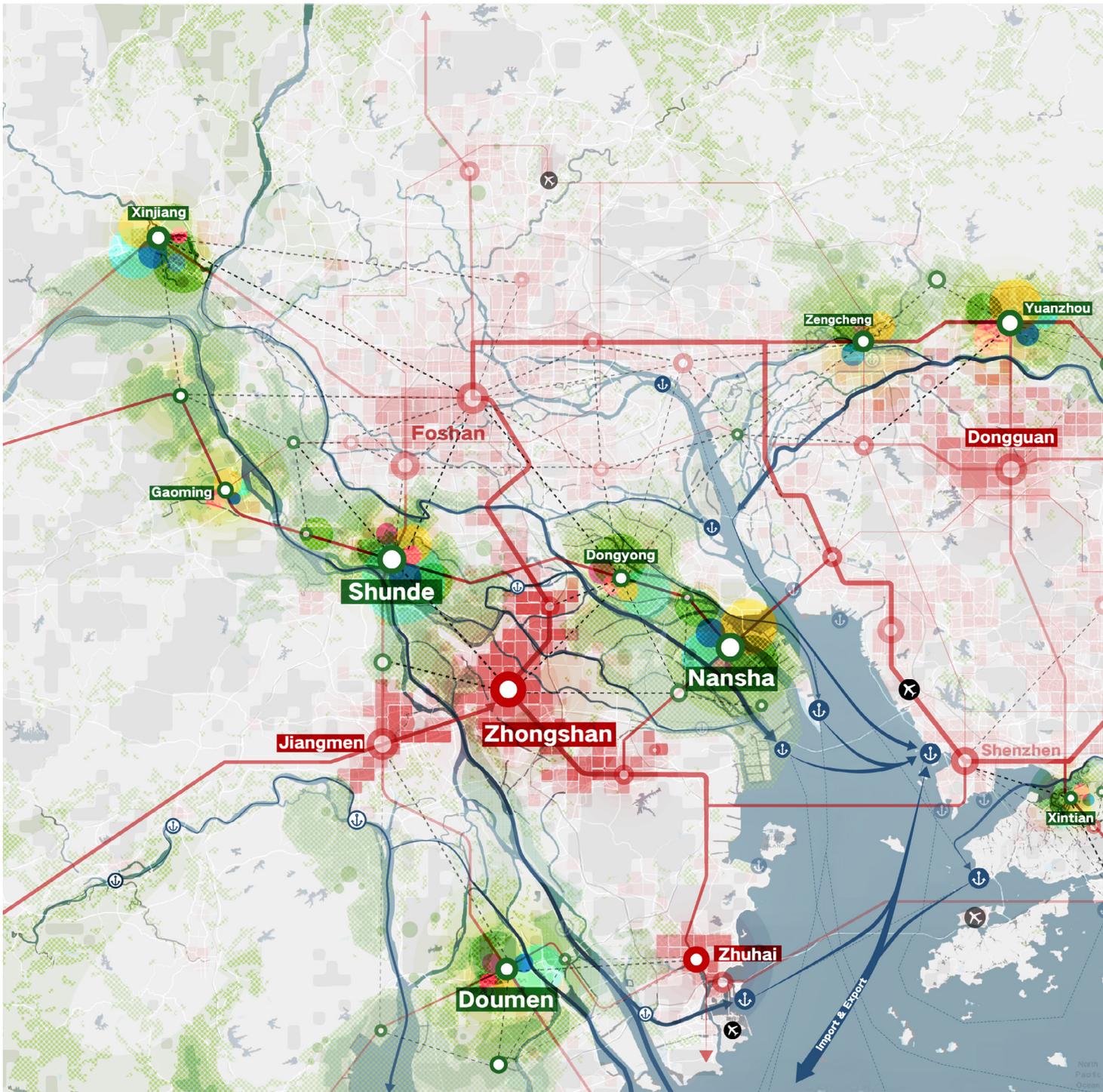


FIG. 42 Design case for "The Innovation Grid" in Xingtian, Foshan. The design proposes a guidance spatial framework with highlight priorities instead of a control plan.

industrial constructions for landscape-oriented productions and organizing a cooperative platform for agricultural sector. Distinguished from urban design projects, the design in the project focuses on structural organisation of the target layers and interaction of elements within the system. It aims to provide a spatial foundation for the proposed mechanism based on aquaponics landscape, rather than a controlling detailed design. Thereby allowing flexibility for engaging and bottom-up development while implement guidance interventions.

As a reflecting conclusion on the regional scale, the transition would construct a coherent cooperation among cities and rural areas through the integrated production process, further, contribute to an inclusive decentralization in the GBA. In the long term, the metropolitan region could be transformed into an urban-rural network with international agricultural trade



Conclusion: A Manifesto for the Future Countryside in the GBA

The glorious history created by the countryside reveals that urbanization is not the only choice for the settlement development. The agricultural landscape basis with natural conditions offers a highly recognizable potential for sustainable development. Distinguished from the traditional villages with smallholder economy as the main production method, the future rural areas within the GBA can be multifunctional independent systems based on efficient and ecological modern agriculture as the production basis, integrating multiple industries and providing an ecology-based environment for production and living. The countryside has potential to emphasize cooperation through multiple scales, become an optional settlement complementary with cities rather than a rough phase in the linear urbanization. The transition would contribute to urban-rural integration in this international mega-metropolitan area.

“Sous Les Pavés La Plage”, the radical slogan from the last century, could adequately summarise my understanding of urbanism: the discipline is more than the science for cities. It is an imagination of future possibilities based on research and understanding of the complex social-spatial mechanism. This is the broad but root motivation of my graduation thesis. The experience of the exploration is tough but fascinating. I learned to balance the macro ambitions with concrete practices in addressing complex spatial problems, and the tools to deal with the complexity of this system. Furthermore, I began to understand the dynamic process of transformation of settlement systems as a hybrid system. The condition of people’s life is related to the place they live, and I will continue observing the world from the perspective of an urbanist in my future practice and exploration.

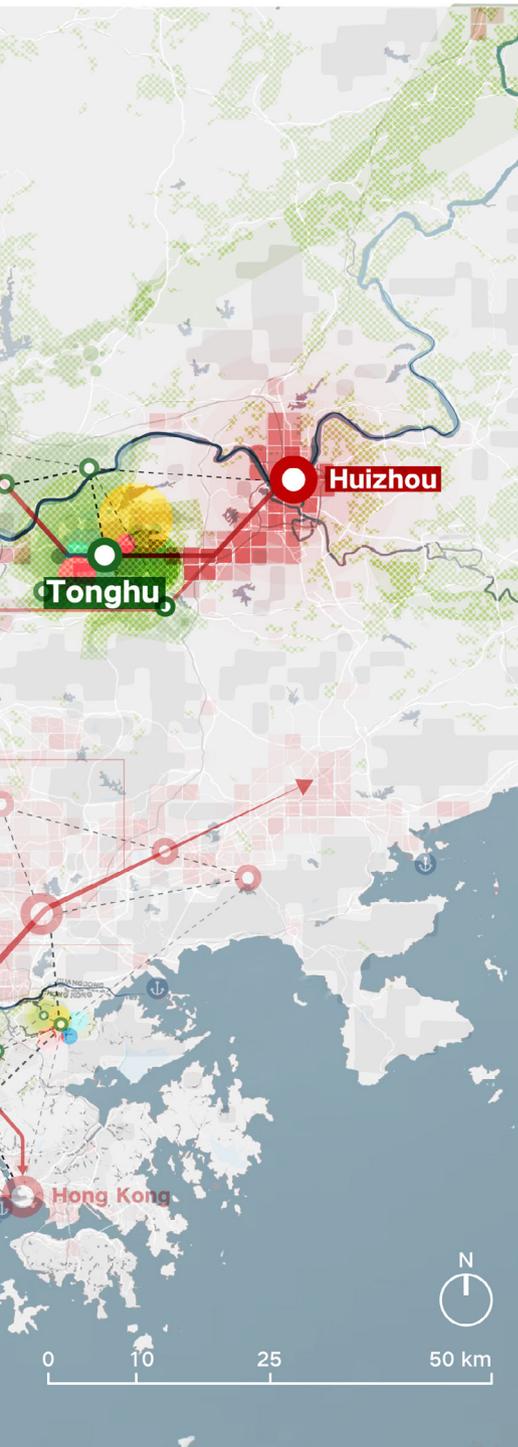


FIG. 43 The vision map presents an integrated urban-rural network founded on modern agri-aquaculture production in the GBA. The rural areas will be transformed into comprehensive and diverse rural clusters which cooperate with the cities through infrastructures and production relationship.

DHARA

"A steady, continuous, flowing movement"

(English Translation of "DHARA" | Collins Hindi-English Dictionary, 2020)



FIG. 44 Mumbai's juxtapositions - The intervention of urban development in the natural landscape system. Source - Climate Group Flickr

DHARA - Directing Flows in Mumbai Through Landscape

A blue-green landscape framework towards hydrological, ecological and communal re-institution of the Mumbai Estuarine Urbanscape

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Daniele Cannatella - Urbanism

Mumbai - The Urbanized Estuary

Mumbai, the financial capital of India and the most populous metropolis in the country, is built on a tropical estuarine landscape. Over time the natural system was modified through a series of reclamation projects, where landfills, sea walls, causeways and other such construction projects were implemented to manage water and accommodate the influx of population that wanted to maximize the economic potential of this prime trade location. Consequently, a high density urban metropolis emerged, gravely restructuring the underlying natural system and also impacting the original inhabitants of this region - the fisherman communities (kolis) - who relied on the water system for their livelihood. There is strong correlation between the two flows, of people and landscape, that has been disturbed by urbanization, resulting in a vulnerable living environment. Due to a lack of options, the marginalized communities established informal settlements in the low lying and hence most vulnerable parts of the city - the areas that are also critical for the gradients and flows of water and coastal ecology to mitigate flooding and manage future climate risk.

This research, Dhara, aims to redirect water, ecology and community flows in Mumbai through a landscape first approach, taking the natural landscape as a basis for urban development. In this context, such an approach is critical because it relies on strong structures (the blue and green networks) and re-looks at grey infrastructure as carriers of landscape. This results in the re-establishment of critical gradients essential to the resiliency and healthy functioning of a city. Hence, this research identifies and explores the potentials of blue-green landscape structures in Mumbai that will provide conditions for hydro-morphological recovery, ecological restoration and communal re-qualification in the city in order to reduce flood risk, restore a healthy ecosystem and improve the living conditions of the marginalized communities - contributing to long term resiliency and liveability.

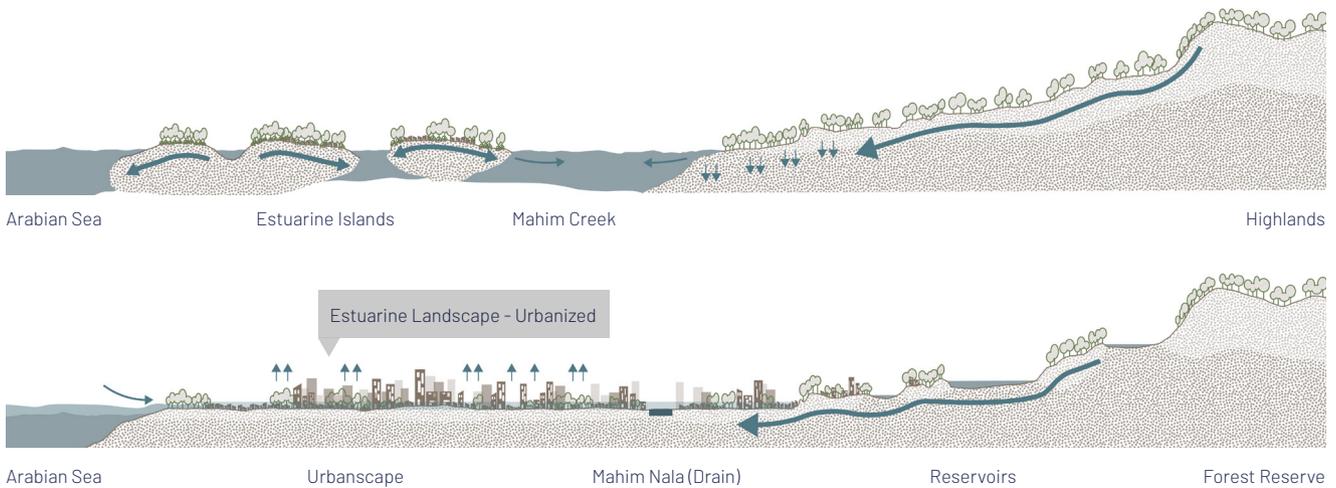
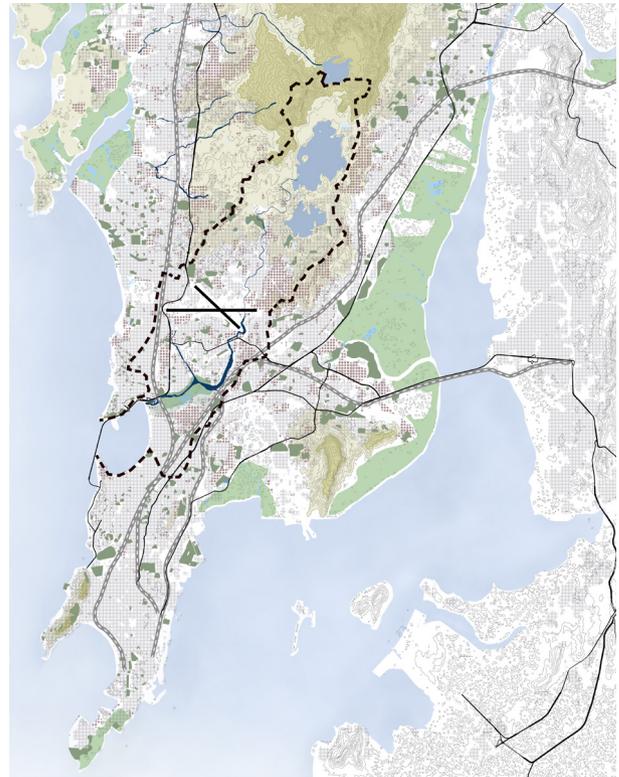
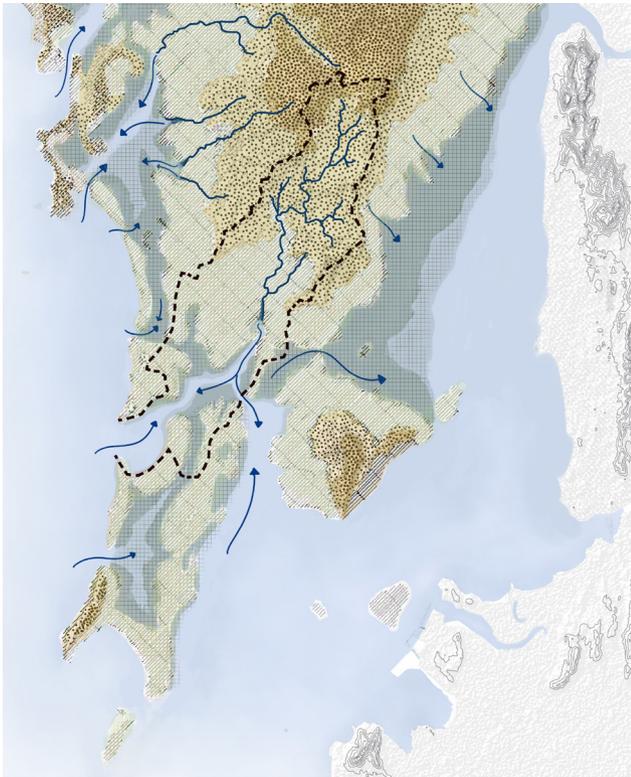
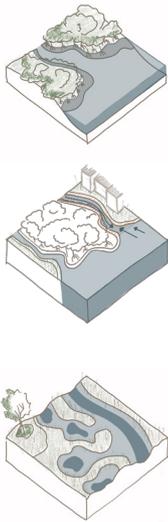


FIG. 45 (Above) Maps showing the historic natural landscape (left) and the present urban situation (right) highlighting the transformation of the Mithi Watershed.

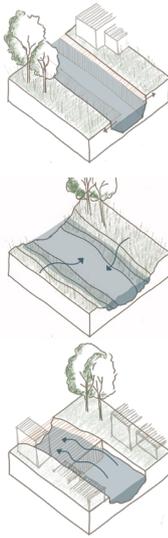
FIG. 46 (Below) Transformation of the Mithi watershed via reclamation of the sea, represented in section.

To work within Mumbai's context, it is important to understand the city's transformation from natural to urban systems. The reclamation projects resulted in narrow and curtailed waterways; the natural coastal defence provided by the mangroves is greatly compromised, bound by webs of infrastructure; and the built environment lacks permeability. The greatest potential is identified in the area with the most apparent transformation - the Mithi watershed, Here restoring natural systems in a context sensitive way would provide coastal protection, a restoration of flows and community safety.

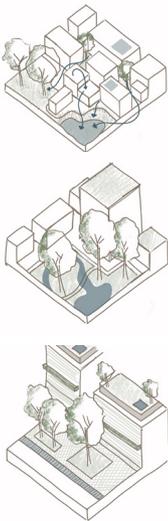
COASTAL



COURSE



PUBLIC SPACE



MOBILITY

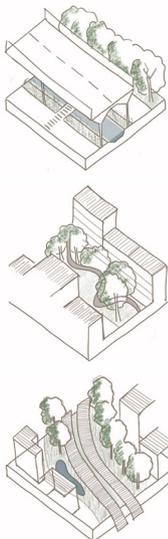
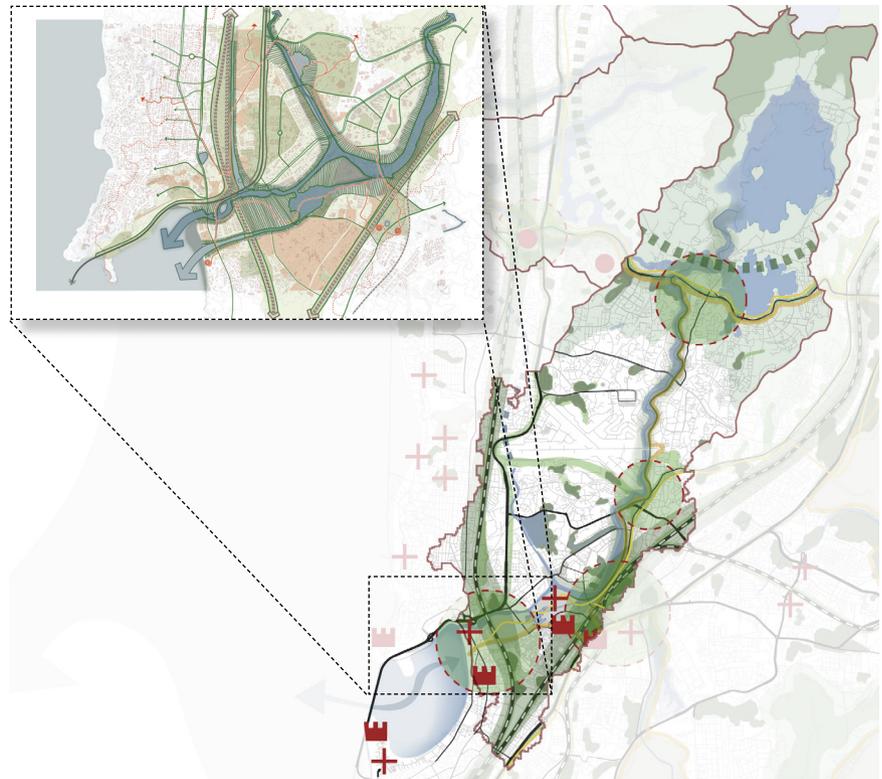


FIG. 47 Design principles for coastal interface, water course, public space and mobility.

FIG. 48 Application of principles at the scale of the Mithi watershed and the scale of the Mithi coastal interface showing the scalability of the principles.



The Blue-Green Landscape Framework and its Principles

The blue green landscape framework is a tool that makes the nature based approach operational. Under the guidelines of this framework, Mumbai's structuring elements can work together as one system in which landscape is viewed as infrastructure as landscape. This framework is translated into spatial design principles that can be applied through scales from Mumbai as a whole, to the Mithi watershed, down to the coastal interface and further. The adaptability of this approach allows the design principles to be contextualized within Mumbai's particular urban structure - its high density and informal urban environment. Through an understanding of the structure of the city and via case studies, principles are extracted and categorized by region - coastal interface, water courses, public space and mobility.

Coastal interface - Mangrove regeneration, restoring tidal dynamics, and wetlands construction for filtration and retention can contribute to a reintroduction of gradients.

Water Courses - Restructuring the water system by naturalizing banks, extending courses, and widening waterways where possible can contribute to restoration of flows.

Public Space - In the dense urban environment, the creation of permeable surfaces, water storage zones, and climate adaptive building can contribute to increased sponge capacity.

Mobility - Infrastructure lines can become connective tissue in the form of ecological corridors and physical connections for the community, improving liveability.

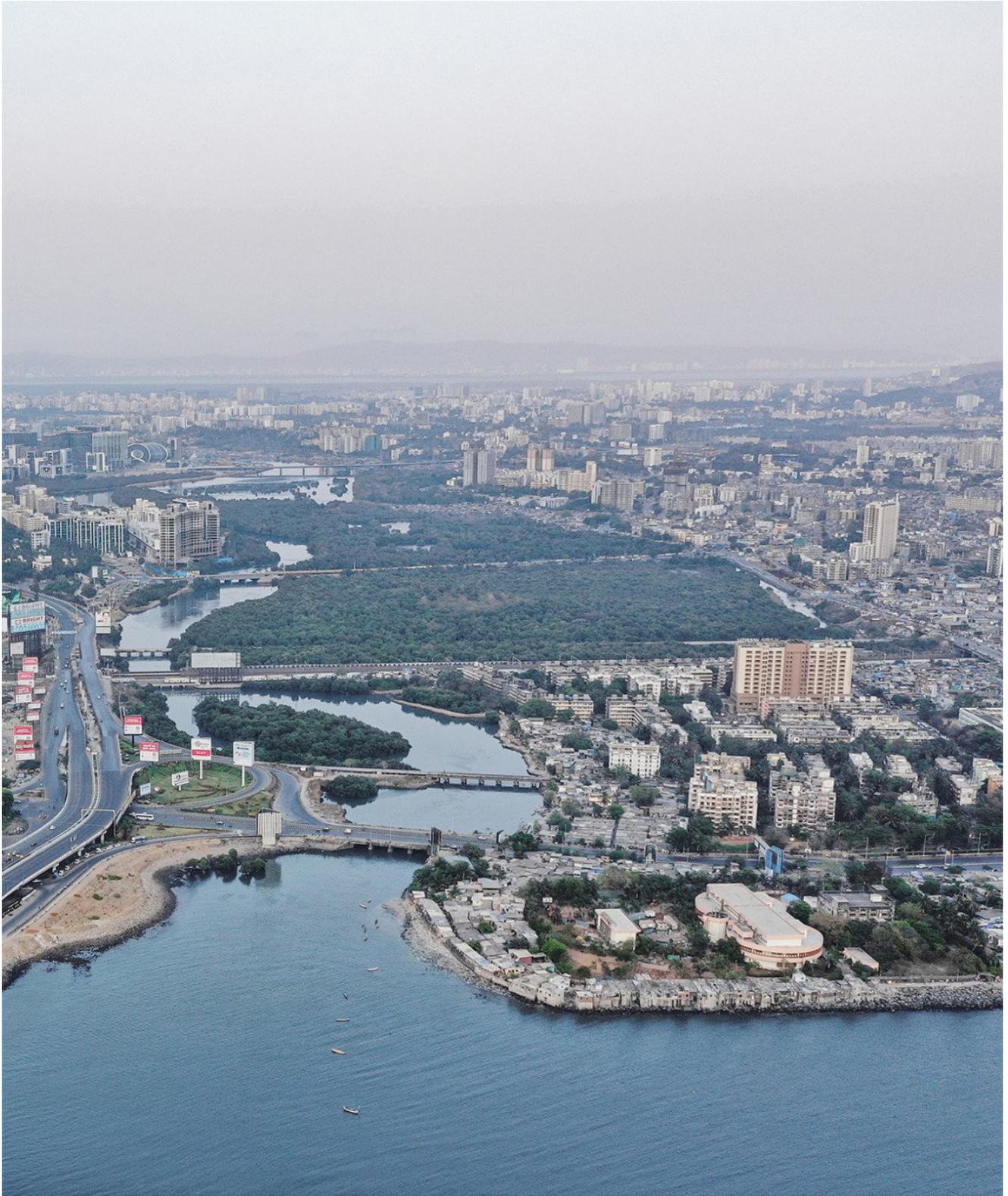


FIG. 49 Existing situation at the Mithi Coastal Interface. Source - Mumbai Live, 2021

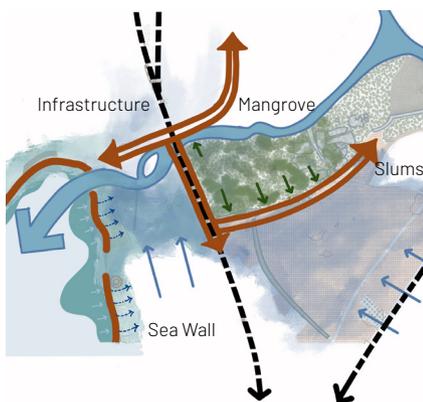


FIG. 50 (Above) Masterplan of the coastal interface of the Mithi Estuary with possible projects. Two areas of intervention are highlighted.

FIG. 51 (Below) Challenges and opportunities in the region.

Reinstating the Dynamic at the Mithi Coastal Interface

An application of a combination of principles at the scale of the Mithi coastal interface shows the potential of the blue green landscape framework for the region. Here new connections are introduced that allow for increased discharge capacity and more room for the tide. Wetlands are created to store and filter water, the canals and river courses are extended and widened where possible, permeability within the informal settlement is increased, and slow mobility networks are created. This is the overall regional strategy for the coastal interface and many smaller projects at the local scale can contribute to the larger regional vision.

This research zooms in further to the coastal edge where the sea wall, the mangroves, multiple infrastructure crossings, and informal settlements come together. The challenge for this region is to restore flows in a way that enables the landscape and community to coexist in order to lay emphasis on the importance of the landscape via community based projects. The masterplan introduces new connections for a braided river system that increases discharge but also allows the tide inland. Gradients are created to ensure water retention and detention during peak monsoons. Lastly, within the community fabric permeability is introduced in the form of smaller localized gestures. Two local projects are highlighted.



FIG. 52 (Above) Developing wet zones as pockets within the informal settlements for increased sponge capacity.



FIG. 53 (Below) Removing some mangroves and narrowing infrastructure to create wetlands for water retention and filtration. This impacts sedimentation improving the health of mangroves.



FIG. 54 (Above) Naturalization of waterways to allow for increased discharge capacity and activities for the community along the edges.



FIG. 55 (Below) Creating an experiential routing within the mangroves that becomes an educative medium to understand the flora fauna and habitat of the mangrove system.

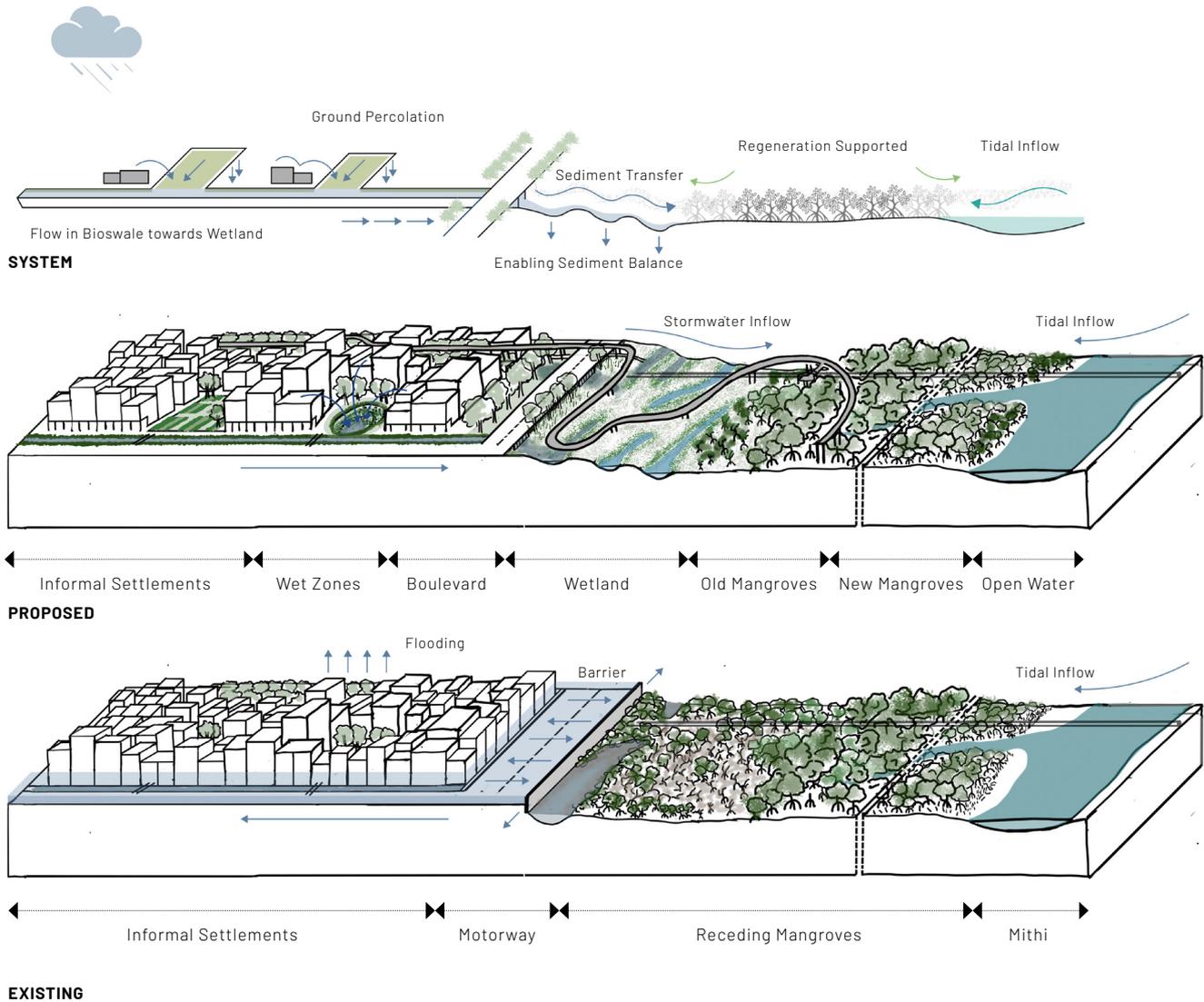


FIG. 56 Change in system from barriers to gradients by introducing the wetland park between the dense informal settlement and the mangroves.

LANDSCAPE AS INFRASTRUCTURE Gradients between Mangroves and Informal Settlements

In this region, presently, the desired outcome of a layered and graded landscape system is interrupted by infrastructure and urban density, however subtle spatial changes can provide the needed conditions for flood safety. The overall strategy is to develop a system of flows that can help improve the mangrove landscape, while also providing community upliftment. The main design intervention is the creation of a wetland that can retain and filter water coming from the informal settlements. This is an important transition zone that provides the necessary sedimentation conditions for the mangroves. To aid this, within the urban fabric smaller permeability and retention areas are created that hold water before it is channelled into the new naturalized canal system and further into the wetland. These also act as a public space structure for the community.

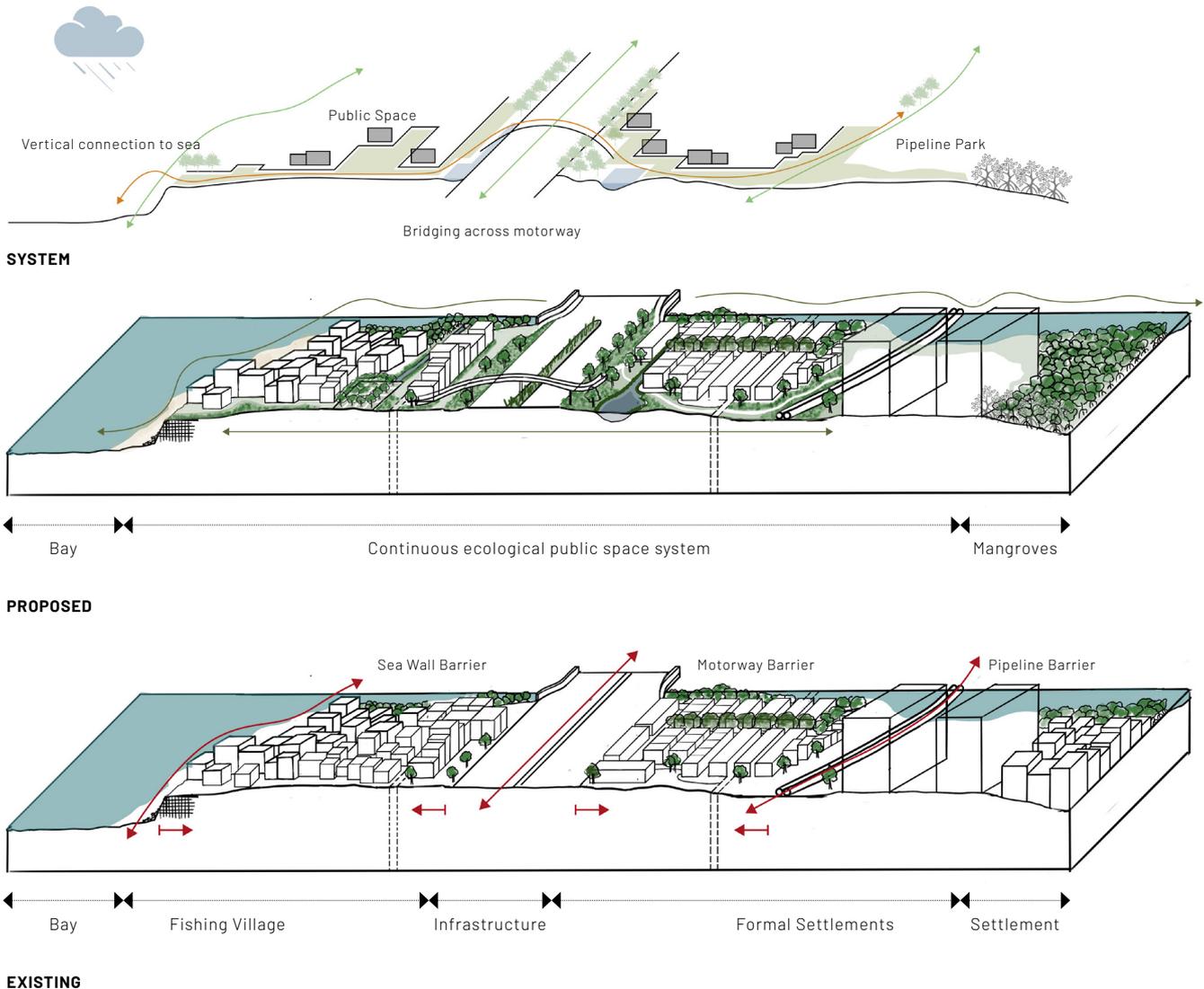


FIG. 57 Change in system from barriers to continuity by introducing a public space structure that transcends the three barriers of the sea wall, the motorway and the pipeline.

INFRASTRUCTURE AS LANDSCAPE

Continuity by breaking infrastructural barriers within the informal settlements

Starting from the sea towards the mangroves there are three prominent infrastructure barriers – the sea wall, the motorway and the fresh water supply pipeline. These three lines form interruptions within the landscape system as well as the community. The overall strategy is to develop a continuous public space structure that traverses the three barriers and provides communal upliftment while also increasing the sponge capacity of the area. At the sea wall, this public space structure manifests itself as vertical connections towards the sea in the form of steps coming down from the sea wall, aiding the fishermen. At the motorway, permeability is created by increasing green surface area by introducing rain gardens and more trees. At the pipeline a park is created that draws the visitor making them understand the water system. This pipeline also leads towards the mangroves. Hence a continuity is created from the sea to the mangroves.



FIG. 58 (Above) The pipeline park as a public space to meet where there is a potential to create community functions along the park.

FIG. 59 (Below) Left - Transforming the motorway into a boulevard by generating space for nature as well as for community by adding slow mobility and places for street vendors.

FIG. 60 (Below) Right - Subtle intervention in the form of a light staircase to connect the fishing community with the sea improving accessibility.



FIG. 61 Bird's eye view of the Mithi Estuarine region showing the potential of the blue-green landscape framework in the form of a braided river system that reasserts the importance of flows in the city to create conditions for hydro-morphological recovery, ecological restoration, and communal requalification.





Conclusion

These two projects are a reflection of how the blue-green landscape framework can be activated via spatial design principles applied in combination with each other, to provide the necessary conditions for the landscape and community to thrive symbiotically. These design principles can be adapted and applied in other locations and through the scales. This scalability of principles is the uniqueness of this approach and what makes it so powerful enabling a nature based system in such a dense urban context, where one would find landscape strategies difficult to implement. Through this approach barriers are converted to corridors, hard edges are modified into gradients and density is converted into permeability. This improves water flows, increases sponge capacity, and impacts the quality of life of residents.

In the introduction it was highlighted that there is a strong relation between the landscape and people flows, and one of the important factors of this relationship is that the community needs to be directed towards respecting the landscape they inhabit. Hence each of these projects pays particular attention to how the community can benefit from the landscape and vice versa. This approach has the potential to contribute towards other urban challenges such as sanitation, waste management etc. that are beyond the scope of this research but if combined with this research could contribute to the restoration of a harmony between people and landscape in this region and also contribute to research in other regions that have similar challenges.

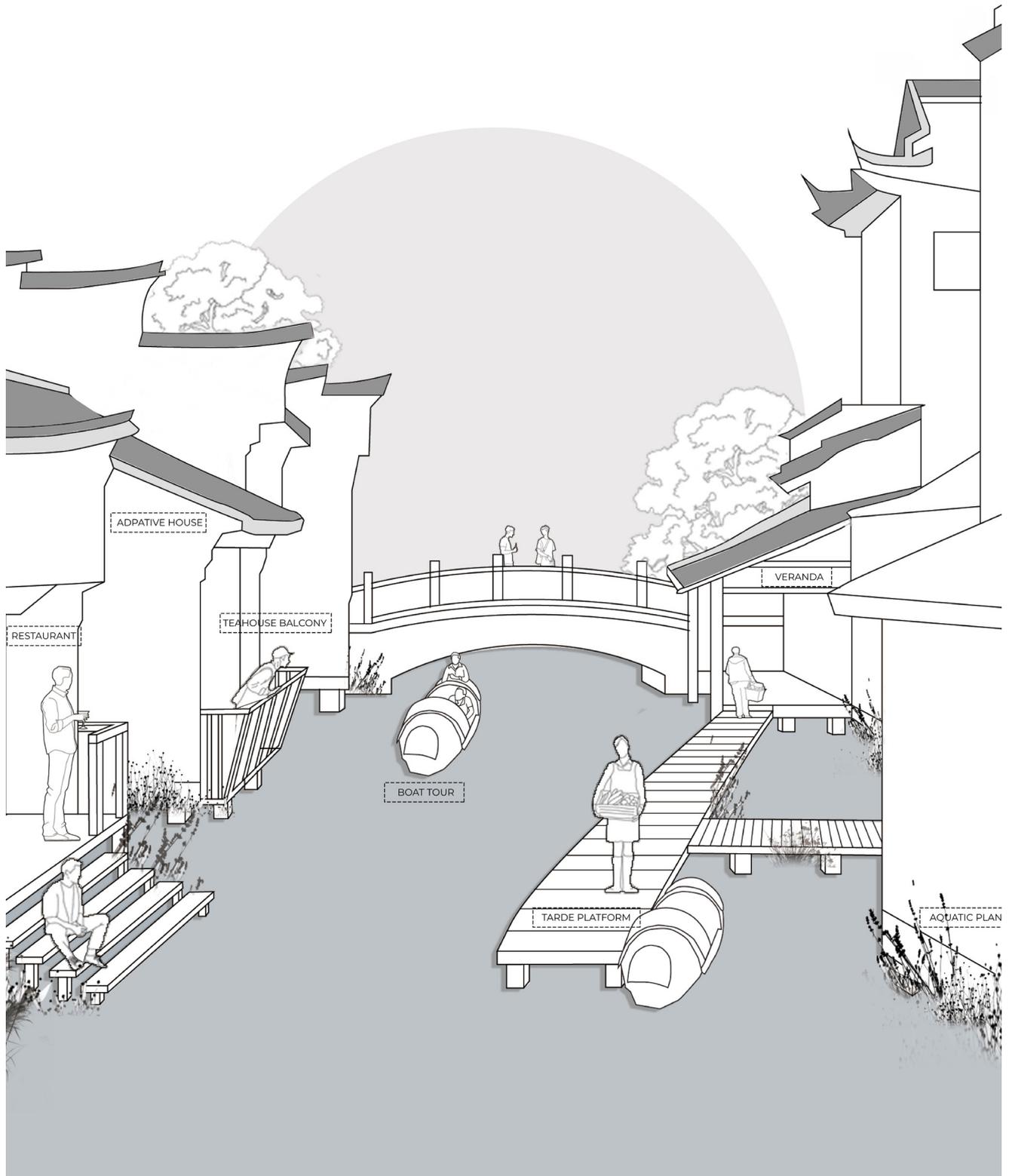


FIG. 62 Design visualization of traditional village and canal development to commercial district

Hydrological Heritage Landscapes

Designing a resilient landscape framework to ensure preservation of the cultural history and sustainable development of Ningshao Plain

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Supervisors

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Introduction

The Ningshao Plain is an east-west narrow coastal plain on the south bank of the Qiantang River, in middle- Eastern of China. It is one of the oldest polder areas in China, about 4800km², formed by the dynamics of water and land, and human intervention over thousands of years. A great variety of polder forms also cause rich water conservancy cultures, diverse settlement systems, splendid hydrological heritage, etc., which are the core source of the cultural identity of this place.

However, with the influence of climate change and human activities, the unique polder landscape has been severely challenged in recent years. Although the water system can quickly discharge water from the canal into the sea when extreme weather such as typhoon comes every summer, cities are still often threatened by floods due to their poor surface discharge capacity; The rapid development of urbanization and the deterioration of the ecological environment also further damaged the morphology of the polder landscape, A large amount of agricultural field was replaced by building blocks so some traditional hydrological system has gradually lost its original function and be abandoned. The large potentials of the polder as cultural landscape was neglect.

Therefore, the design objective is to build a resilient framework taking hydrological heritage landscape as the basis to ensure the preservation of cultural history and sustainable development of Ningshao plain. This project will take the polder landscape of the Ningshao Plain as an example to research how the design can protect the cultural landscape and be adaptive to development at the same time.

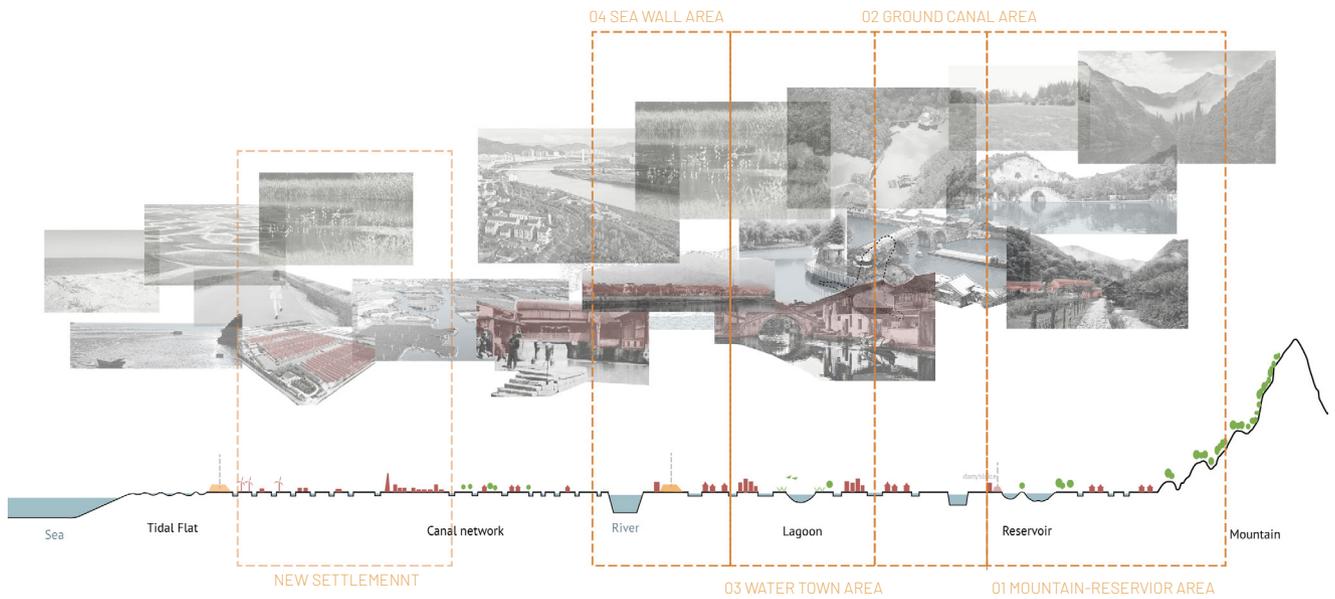


FIG. 63 Landscape structure section of Ningshao Plain

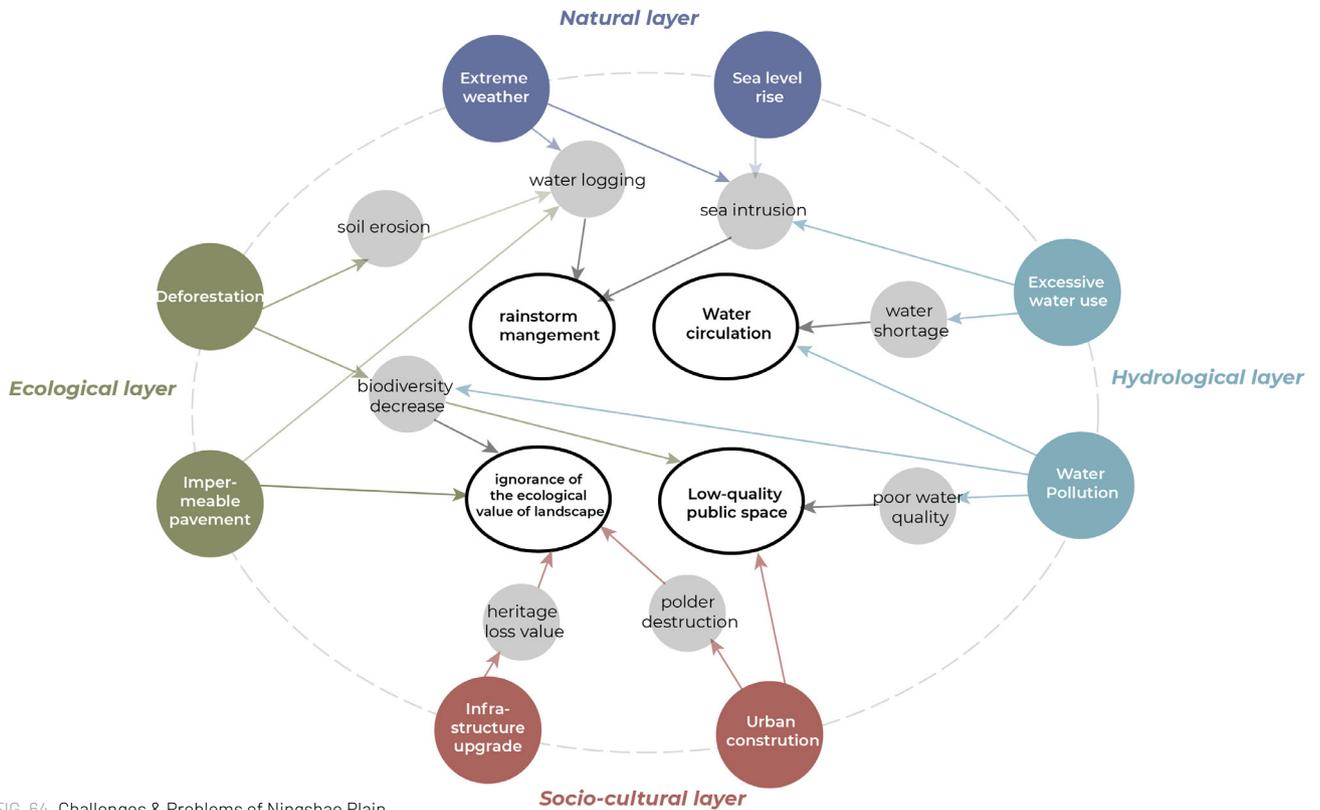


FIG. 64 Challenges & Problems of Ningshao Plain

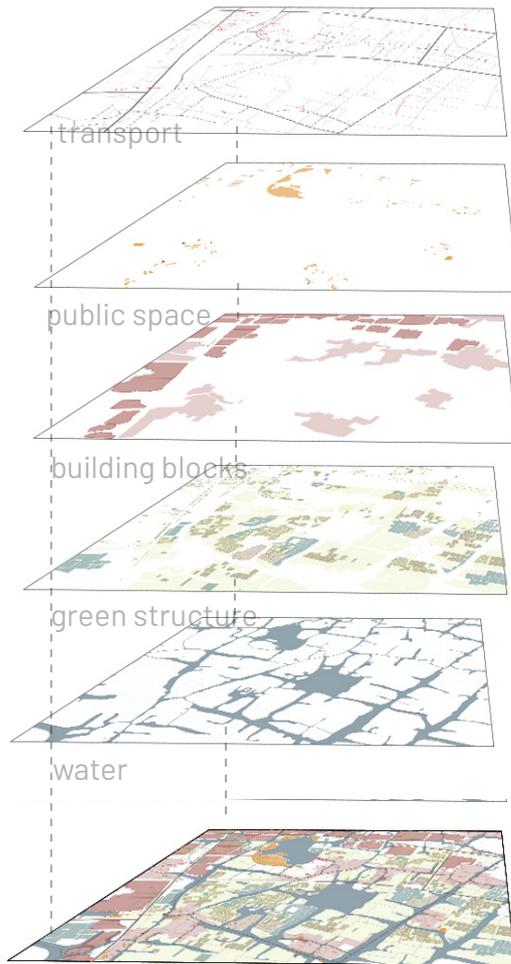


FIG. 65 Polder grammar analysis layers

Principles

The ‘protection by planning’ shows an approach to protect and develop polders as a cultural heritage landscape, it takes landscape development with historical landscape structure as basis (Nijhuis, 2020). The interaction between cultural history and spatial planning, and the recognition of stakeholders, can create the conditions for discovering a new balance between retaining cultural heritage and developing it (Belvedere, 1999).

Polder Grammar In the Ningshao Plain, development means adapting the polders to the needs of urbanization, such as housing, new infrastructure, water safety issues, etc. The ‘protection through planning’ theory proposes a planning tool that can guide design and landscape changes, the polder grammar. The ‘polder grammar’ is the set of structural rules and principles that determines the characteristic composition of the landscape: the complexity of the pattern, the morphology, the visual qualities—and with that, the cultural identity of the polder while providing clues for spatial development in the form of design principles (Nijhuis 2020).

In the design research part, Shaoxing strip area was further researched as it has representative landscape structure, and as Shaoxing area is the oldest polder type in Ningshao Plain. Among the four-type areas of this strip, the water town area still keep the most traditional polder landscape, and is just beginning to be encroached by the city, so it can be better used to further research the structure of the polder landscape, this area is more in line with the research objective.

From the water system, green structure, building blocks, public space and transport analysis in Shaoxing strip area, to study the key elements and their formal characteristics that constitute the polder landscape, learn resilient strategies which adapt to the development from the local history and summarize them into five categories of principles to guide the design, supplemented with resilience theory and related case studies, complement strategies for building resilience frameworks.

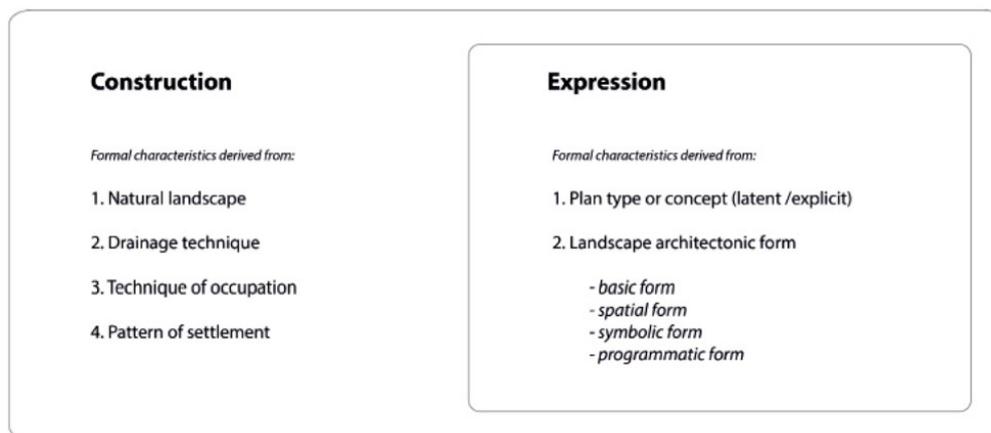
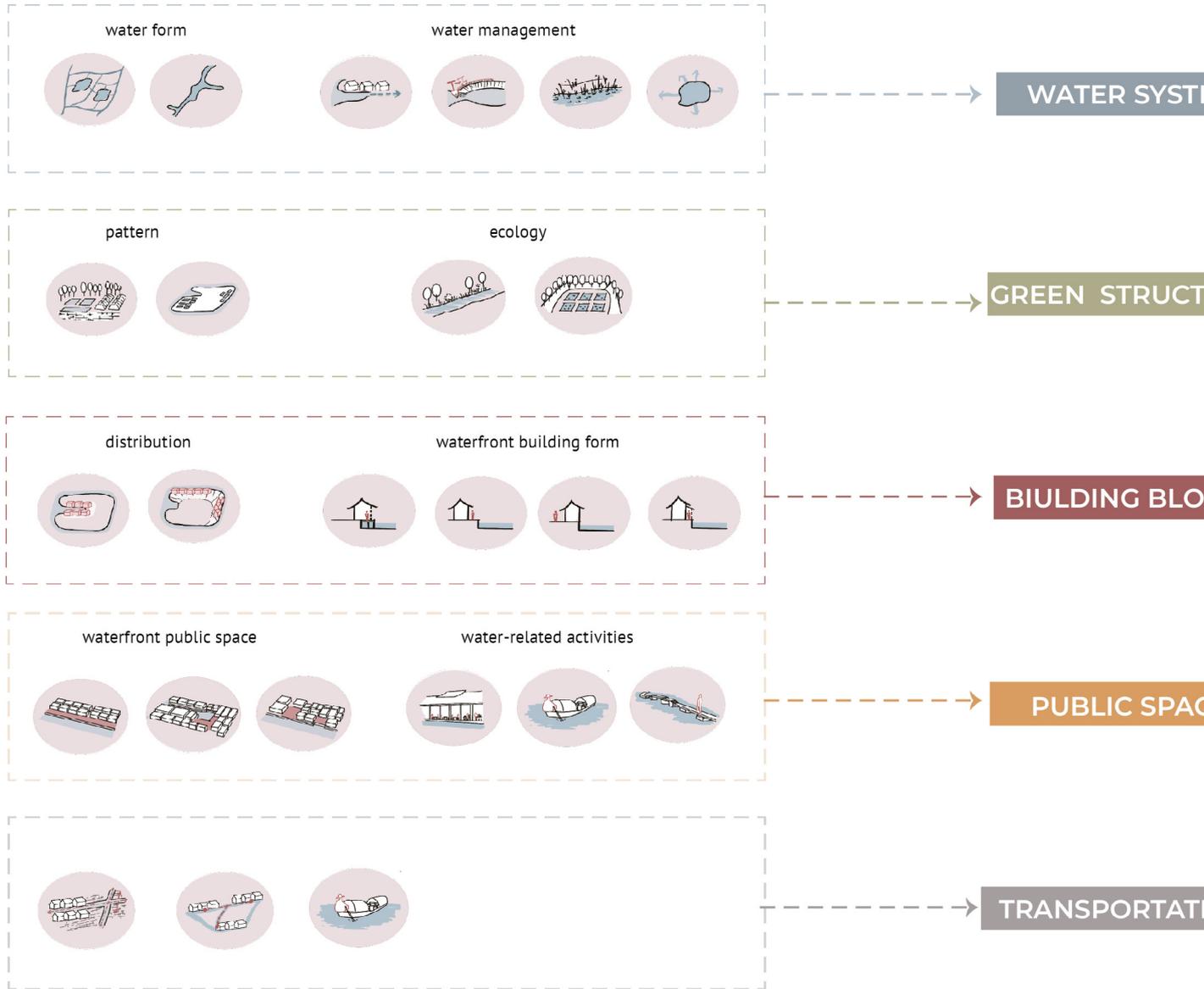


FIG. 66 Analytical framework for the identification of the polder grammar (S. Nijhuis, Delft University of Technology)

POLDER GRAMMAR



CASE STUDY

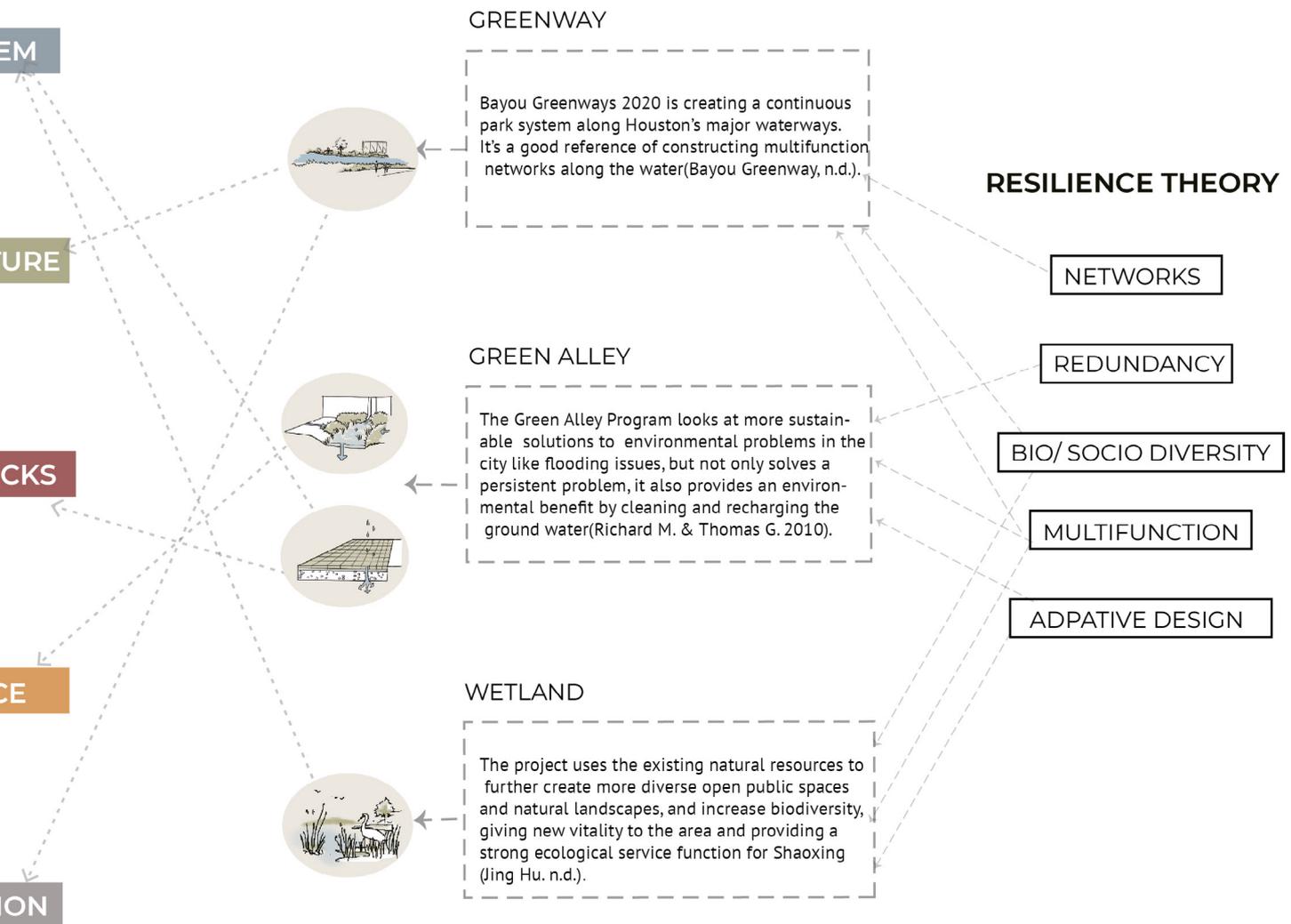
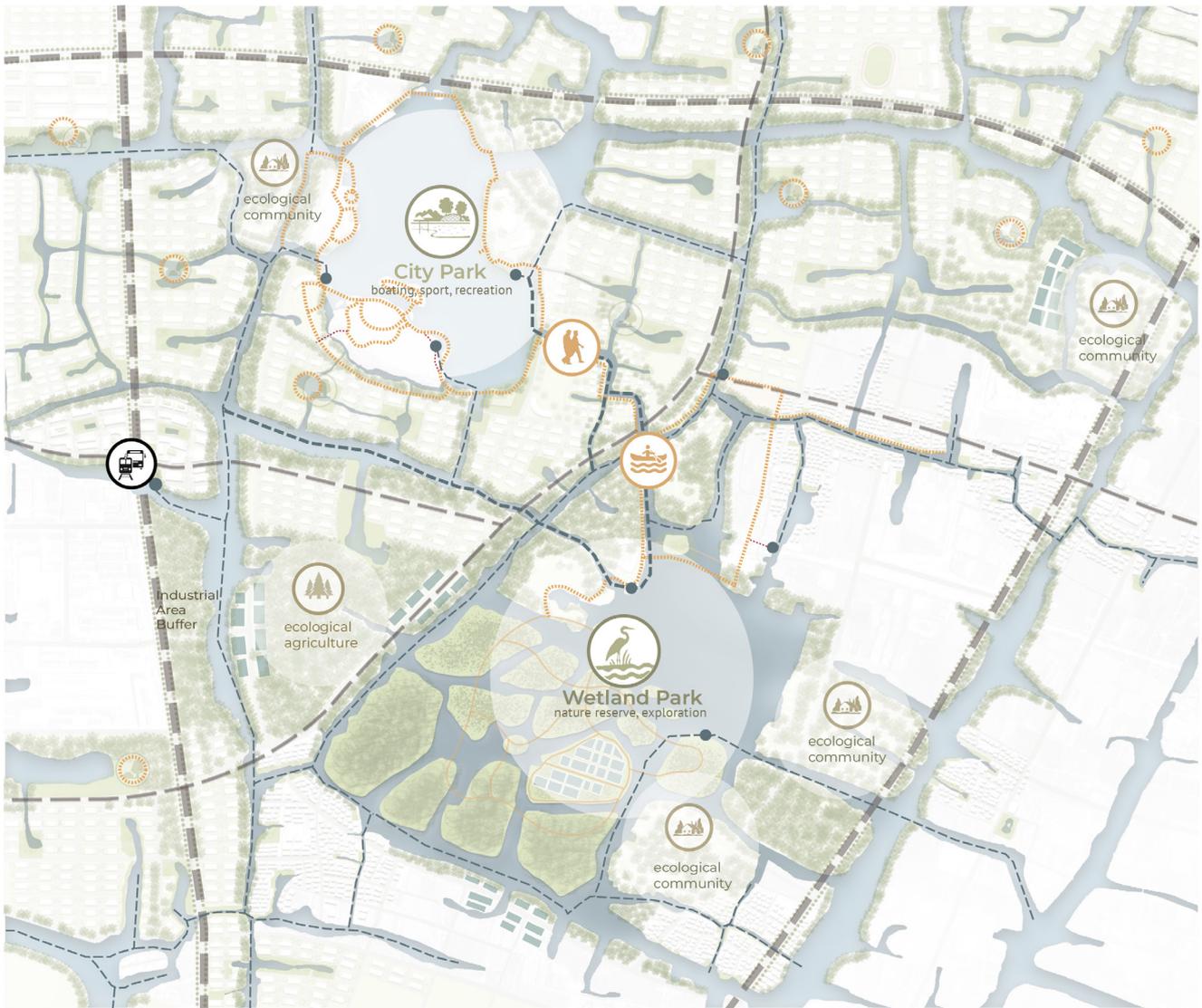


FIG. 67 Design principles research methodology



Results

Resilient landscape framework Combined with the specific diagnosis of the five layers, the more specific design assignments are obtained. Compared with the previous general design assignments, the landscape framework on the design exploration scale can be concluded to three layers, which are the combination of water and green to create a robust green-blue network, building blocks and public space combine to create livable density, and multiple accessibility.

A robust green-blue system A robust green-blue system means a ecological system which is more resilient to environmental challenges like water safety issues. It is established on the basis of the existing water system to increase the space for water storage, support water circulation, biodiversity, pedestrian routes and connecting public space. The strategies related to water system and green structure in the polder grammar guide the planning of this layer.

FIG. 68 Resilient landscape framework

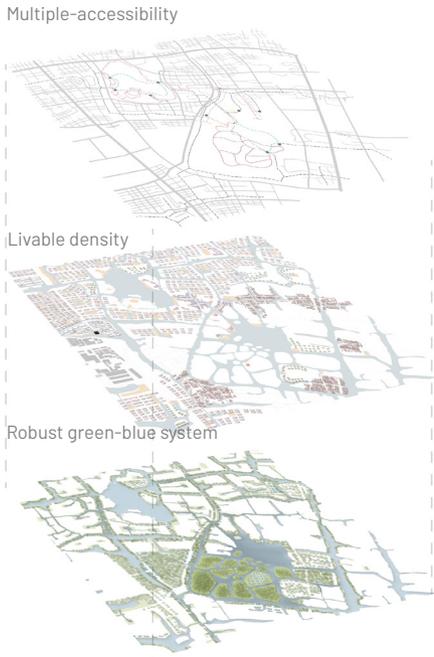


FIG. 69 Three layers of resilient landscape framework

Livable density Livable density means with a appropriate building blocks density with high quality living environment. The main idea is to move the industrial area to an area with convenient transportation but far from the water, plan diverse types of waterfront buildings with vibrant waterfront public spaces by building blocks and public space strategies from the polder grammar.

Multiple accessibility Multiple accessibility means there are both high-speed route and high-quality slow travel routes to meet economic development and recreation needs. The main idea is on the basis of transportation strategies from polder grammar, to rearrange the road system to make it accessible without too much disruption to the continuity of the landscape while adding high-quality slow-travel networks such as boating routes and high-quality pedestrian routes for the area.

Example of traditional villages development

Based on the regional strategy, the design task of the local implementation is determined, and the appropriate design principles are selected to explore its possibility on the local and eye-level and its adaptive application in different sites.



FIG. 70 Diverse livable housing typologies

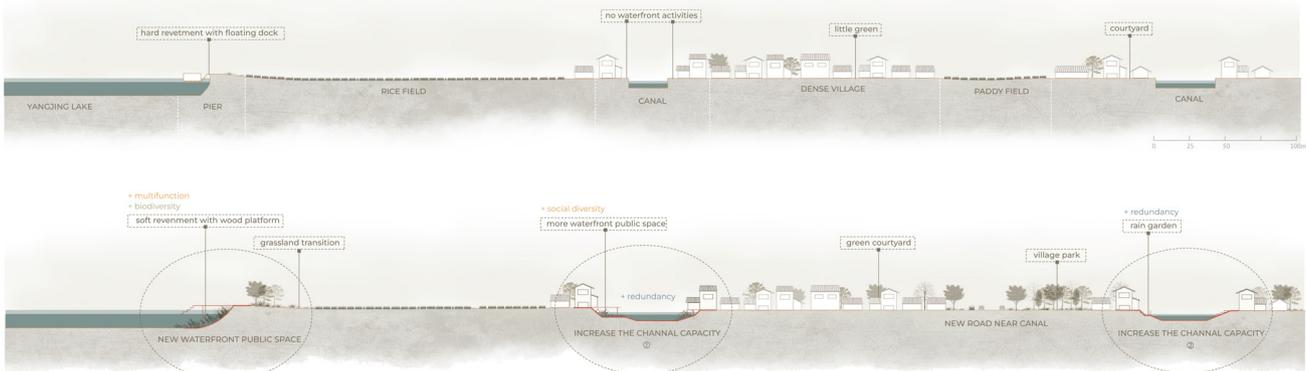


FIG. 71 Section: Villages transformed to commercial district

CURRENT SITUATION

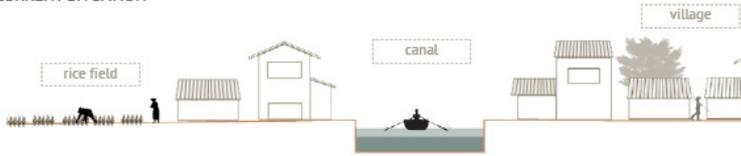


FIG. 72 Section detail: experiment of widening the canal 1

Example of city development

This local implementation in the city mainly experiment how to apply the principles regarding to water management, transportation, and public space in the polder grammar, to decrease the negative effect of city road, form a high-quality waterway and walking routes along water, and create a resilient way of rainwater management and high-quality public space for the community.

Example of a wetland development

This local implementation will experiment how to apply polder grammar, especially in water system and green structure aspects, to transform the lake surroundings to wetland and transform step interface between fish ponds and woods area to a more ecologically-friendly interface with gradient.

Then a smaller scale shows the technical detail of the design experiment. Widening the canal increase the its capacity, the waterfront building is more adaptive to the water level fluctuation, which make the villages more resilient to the water safety issues. And the public space above water will facilitate more water-related traditional activities, which increases the social value for the villge.

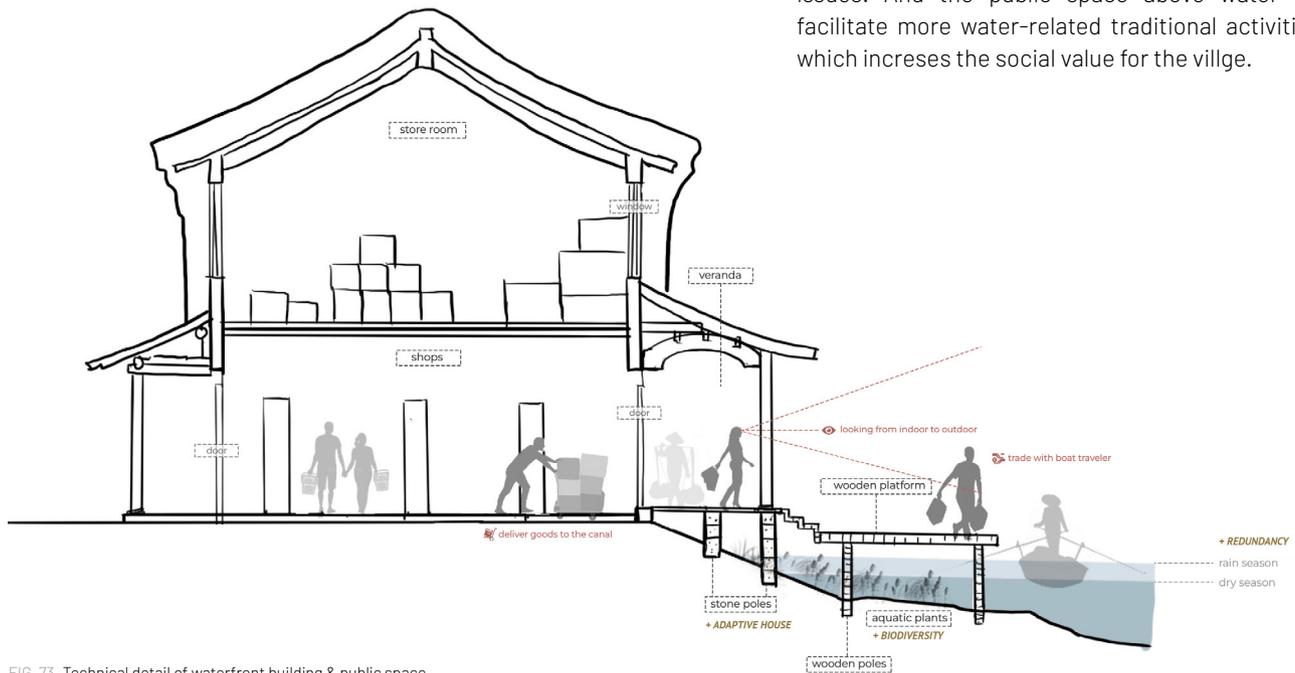


FIG. 73 Technical detail of waterfront building & public space

FIG. 74 Section : Wetland transformation

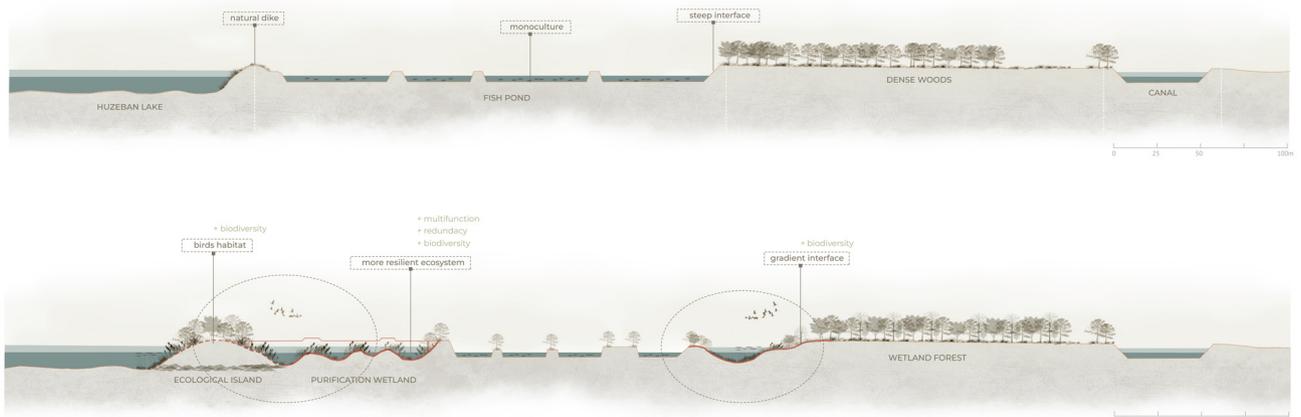


FIG. 75 Section of wetland transformation exploration

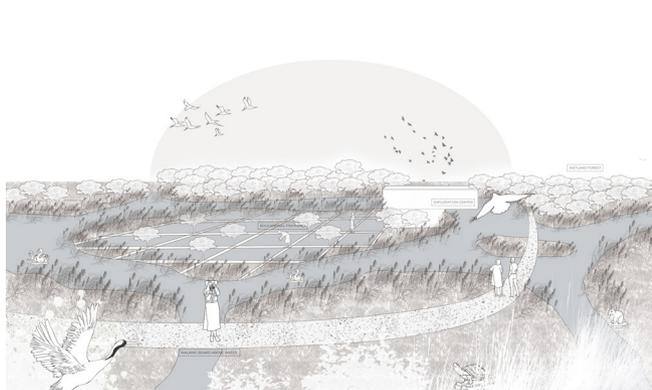


FIG. 76 Wetland in dry seasons



FIG. 77 Wetland in rain seasons

Conclusion

The pilot project played a role as a demonstration. First, the pilot project was developed on the important nodes of the landscape structure to establish the basic backbone of the structure, and then a large-scale landscape framework was developed on this basis. This framework not only retained the Shaoxing strip landscape features and cultural history also add value to ecological and social aspects for sustainable development.

Returning to the scale of the entire Ningshao Plain, as the basis for urban development, the landscape framework taking polder landscape as basis not only retains the characteristics and cultural identity of the Ningshao polder landscape, but also provides space and a high-quality ecological environment for the needs of urban land use, and can respond adaptive to challenges such as environmental problems and climate change. From a long-term perspective, it is more cost-effective and sustainable planning, and the prosperity of the culture and the improvement of the recreation system can also bring more tourism economy to the region, which is worthwhile planning that the government and planners can consider.

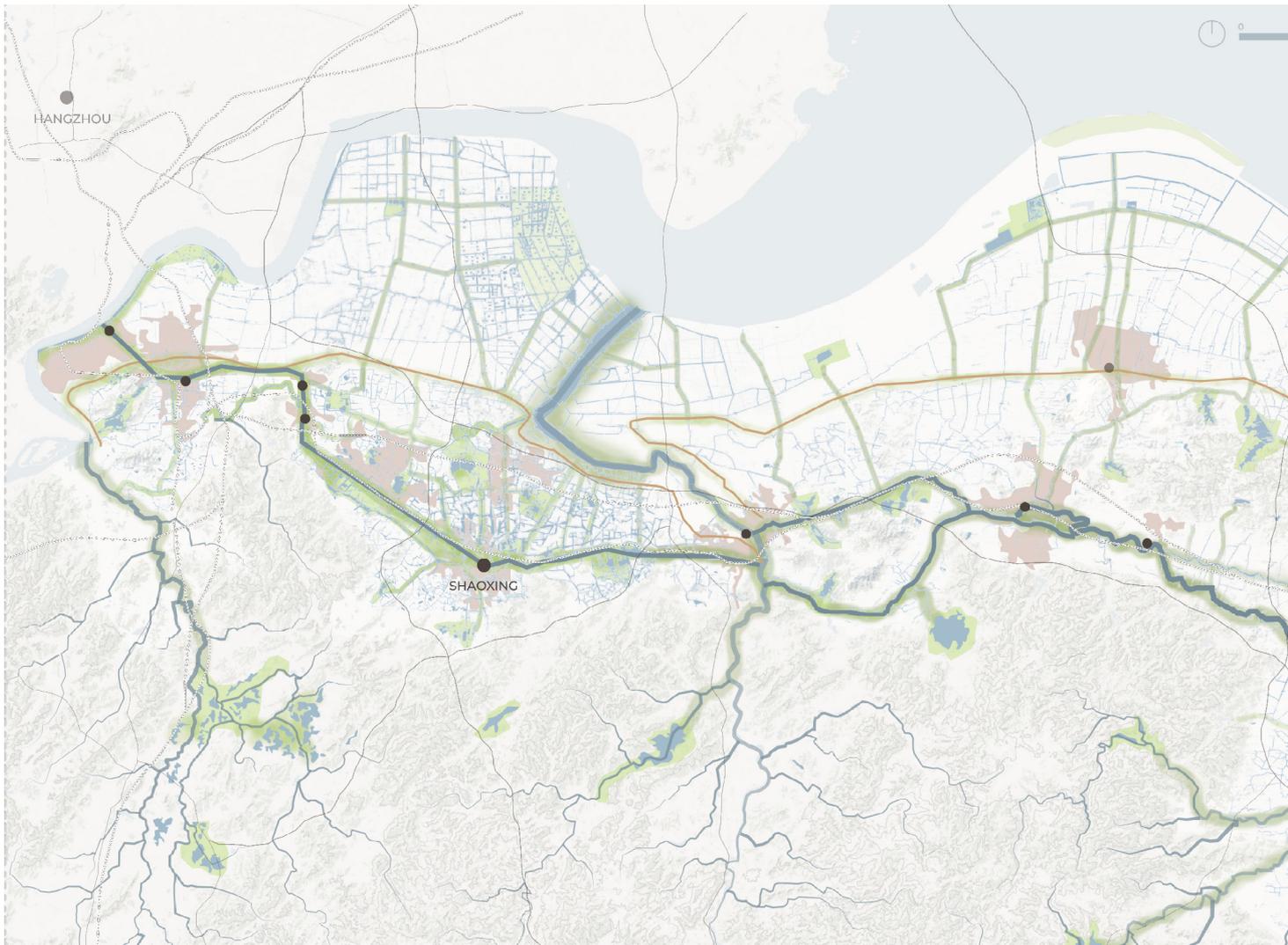


FIG. 78 Vision of Ningshao plain development with resilient landscape framework

This project provides a new thinking way to protect the hydrological cultural landscape and proves that considering the development of the landscape makes the urban spatial design more resilient and strong. So the analysis methods used in this project, Polder grammar, provide a reference of a landscape-based approach, for interpreting polder or other hydrological heritage landscapes from the perspective of landscape architecture and is a practice to test this kind of landscape-based design method.

For society, government planners, or real estate developers, this project is new possible planning that is landscape-based but does not lose urban development or economic development needs. Because it shows the large potential value of the polder landscape related to environmental issues, culture, tourism, social aspect, etc. If a landscape-based design can be taken into account by them, is of great significance to the protection of the polder landscape and urban sustainable development.

FIG. 79 Vision of Shaoxing strip development with resilient landscape framework

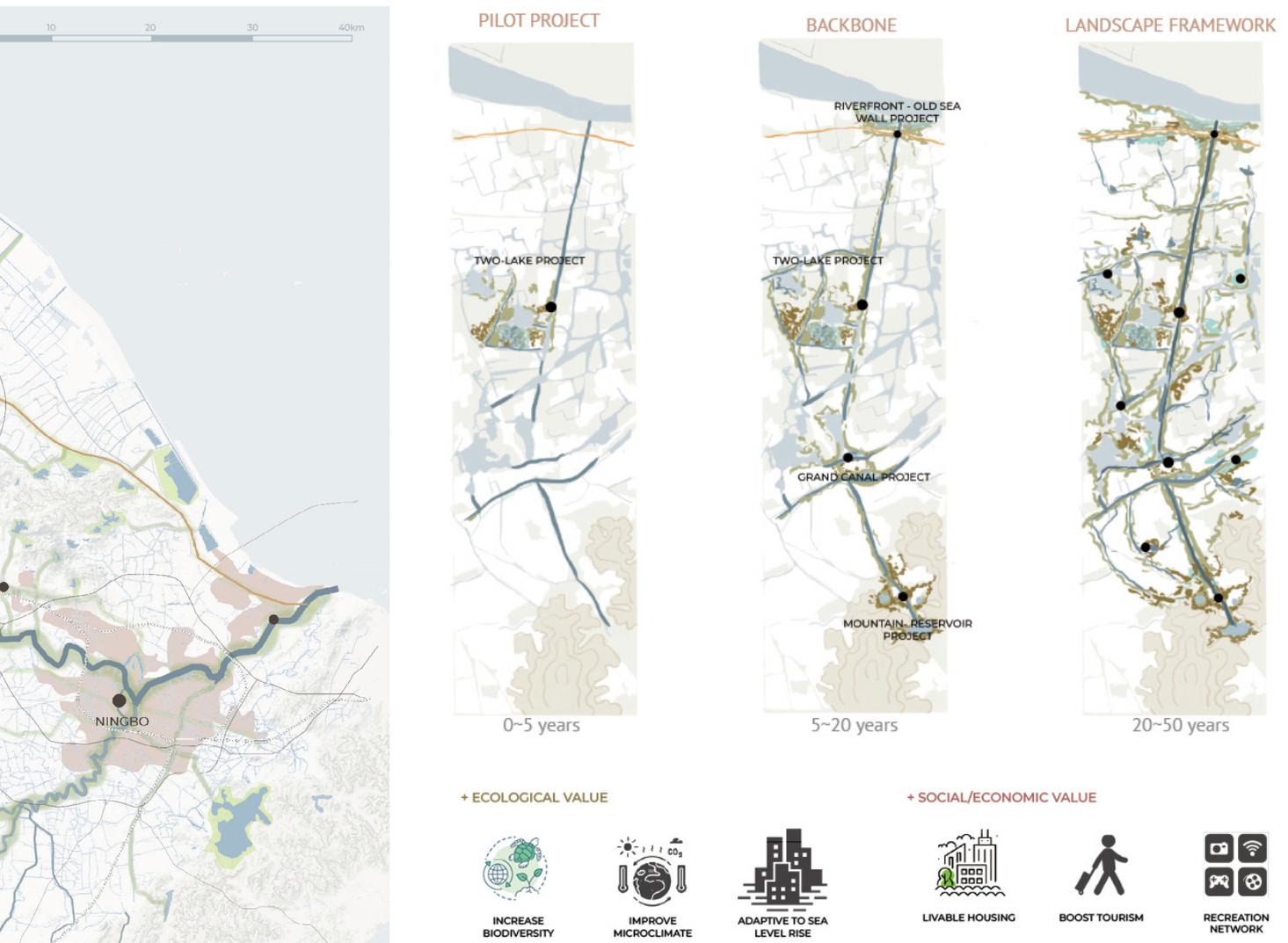




FIG. 80 Different landscapes across the Shenzhen River (Photo: Weibin Lin, 2019)

From Border to Landscape

Designing a resilient landscape corridor in
Shenzhen-Hong Kong border area

Yuqi Pu

Supervisors

Steffen Nijhuis, Landscape Architecture

Lei Qu, Spatial Planning and Strategy

Introduction

The estuarine river landscape between Shenzhen and Hong Kong is a typical case where the landscape lost its value and characteristics due to the border policy. The two megacities Shenzhen (a city in mainland China) and Hong Kong (a special administrative region), are located in the southeast of the Pearl River Delta, one of the world's largest and rapidly developing delta regions.

The Shenzhen River in the middle of the two cities has been a border river since 1898. Coupled with the green buffer zone on the HK side that was once a restricted border area, the bay, the estuary, the river, and the land form a uniquely polarized landscape, with urbanization and nature across the river. Whether to protect the natural environment or develop the land; and whether to preserve the ecological value or restore the aquaculture productivity become urgent arguments regarding future development in this border area.

This project aims to explore the development of a resilient landscape corridor across the Shen-Kong border to achieve the co-development of the environment and society. Viewing the landscape as a multifunctional and operative field with its own spatial, ecological and socio-cultural qualities (Nijhuis & Jauslin, 2015) can be a way to respond to the aforementioned phenomenon.

This thesis focuses on applying the theory of landscape infrastructure as a method in research and design to generate a resilient landscape framework that is considered armature for urban and rural development to facilitate interactions between natural and human systems (Nijhuis & Jauslin, 2015), projecting natural processes and performing multiple functions. Moreover, a methodology for designing towards a landscape framework is given in this thesis. Examples are provided to show the application of landscape infrastructure services and the assessment.

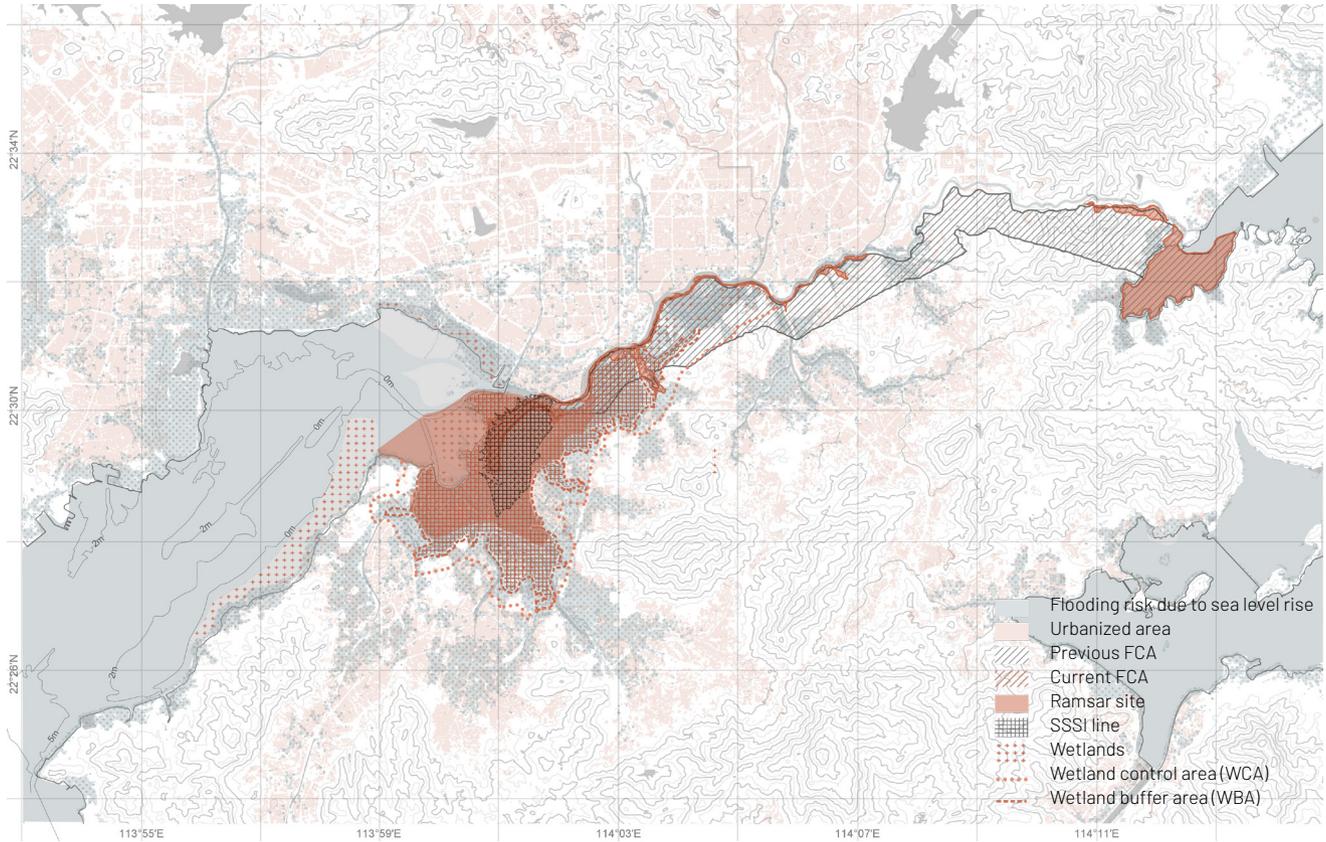
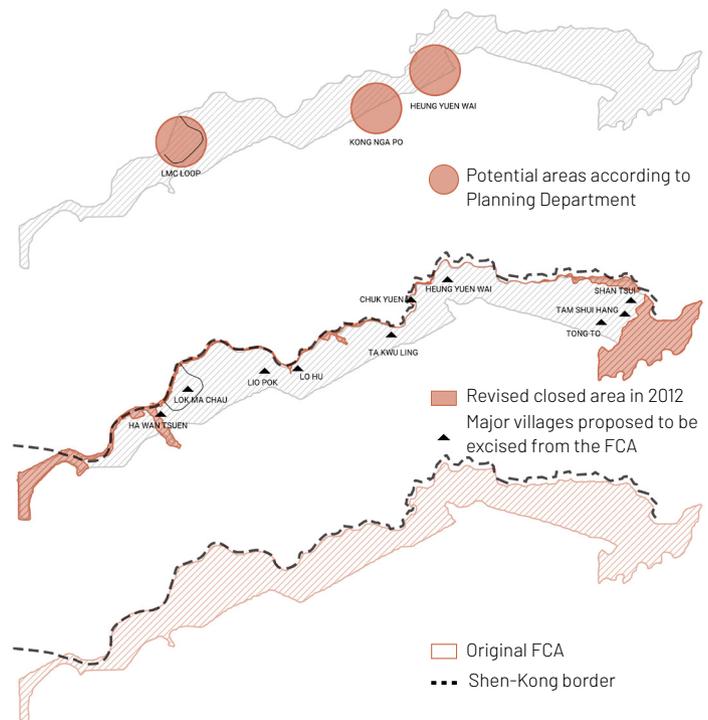


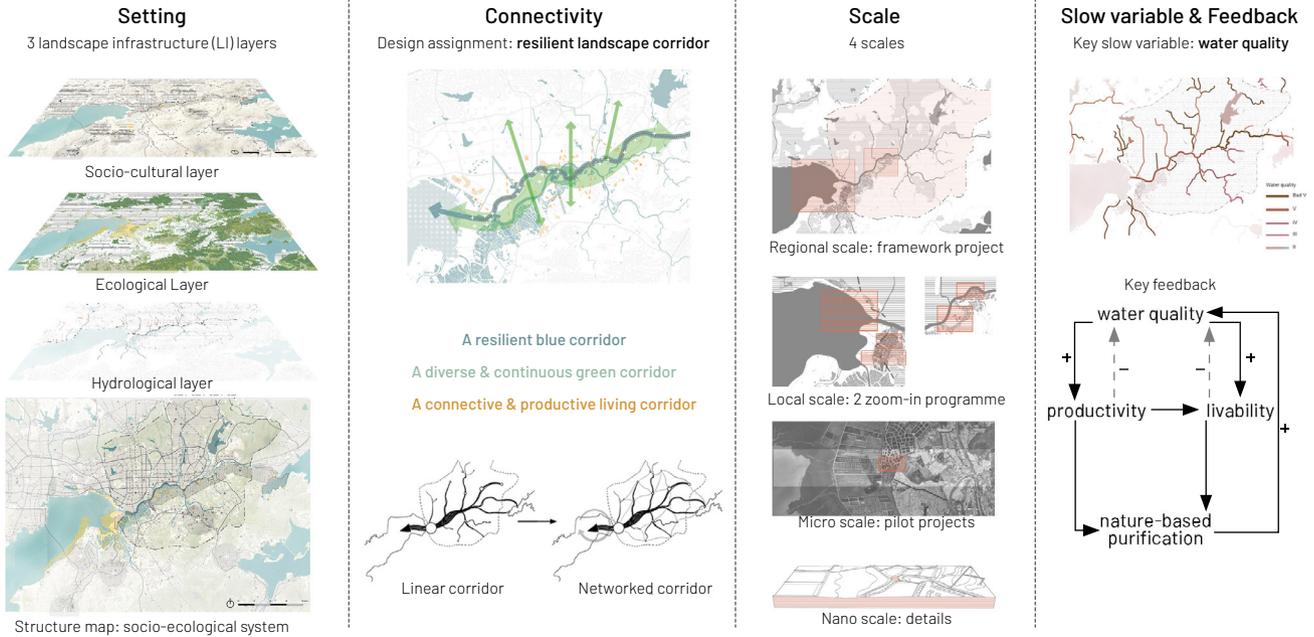
FIG. 81 Problem statement: conflicts between urban development and natural system protection

FIG. 82 The change of Frontier Closed Area (FCA)



Resilience landscape infrastructure thinking

The landscape system is decomposed into three landscape infrastructure layers to help understand the values and functions and further contribute to planning and design hierarchically: (1) hydrological landscape infrastructure, (2) ecological landscape infrastructure, and (3) socio-cultural landscape infrastructure. Furthermore, referenced from the “landscape resilience theory” (Beller, Robinson, Grossinger, Grenier L. 2015), six general principles are identified in this project to guide the research and design progress throughout the project: setting, process, scale, connectivity, diversity & redundancy, slow variables & feedbacks. The design assignment



Process

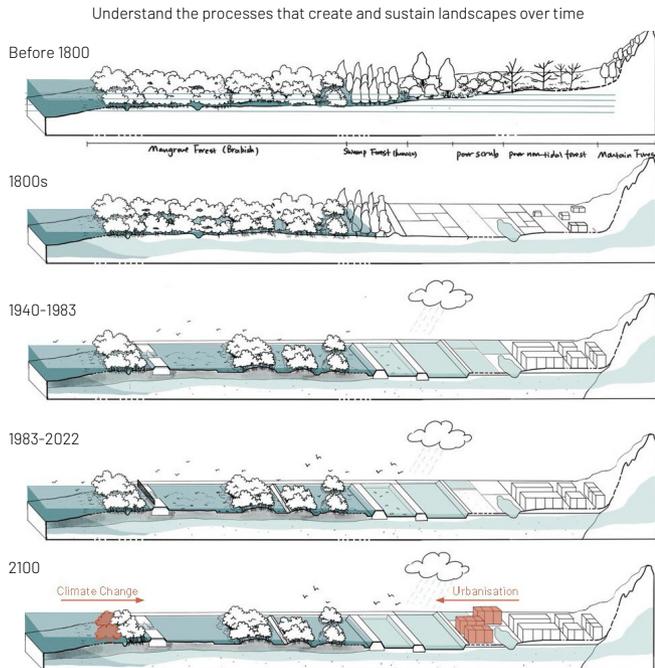


FIG. 83 Applying 5/6 resilience landscape infrastructure principles from understanding to designing throughout the project. The sixth principle of diversity & redundancy is mainly reflected via design exploration.

of developing a resilient landscape corridor is assigned to the three layers to create a resilient blue corridor, a diverse and continuous green corridor, and a connective and productive living corridor with cultural identities.

The interrelationship between layers is essential to interpreting landscapes as a social-ecological system. The interaction between humans and nature is constantly changing when looking into the historical periods. The period with traditional shrimp and fish aquaculture showed a most intimate relationship when people most collaborated with natural processes. With urbanization and development, people gradually tend to control nature with more artificial interventions and management, like wave walls, sluice gates and pipes. However, are these artificial systems adaptive enough to equip the city with the capability to deal with the uncertain disturbances when facing future binary challenges from sea and land? The missing links across layers suggest the vulnerabilities within the system. Moreover, through a holistic understanding, the water quality is the key variable that maintains the social-ecological regime. Together with the water level, the variables form the critical threshold that influences the interactions between layers, and its vibration can lead to the reconfiguration of the system.

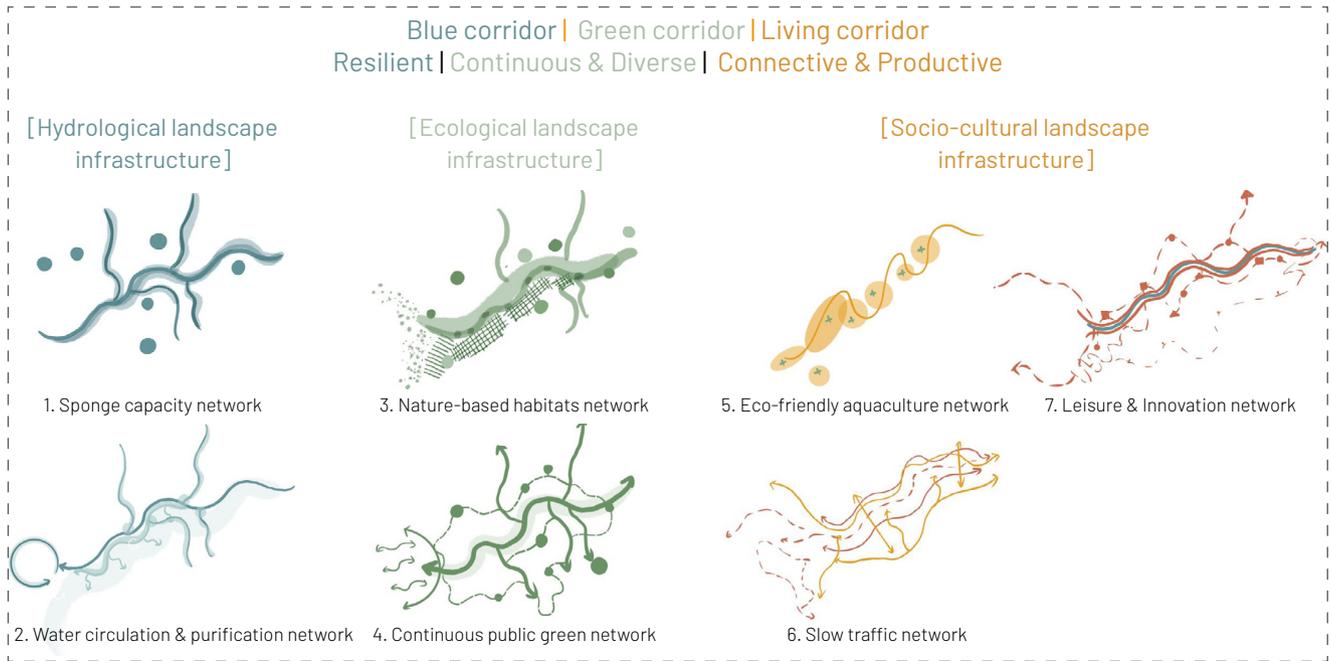


FIG. 84 Regional principles



FIG. 85 Hydrological landscape infrastructure network



FIG. 86 Ecological landscape infrastructure network

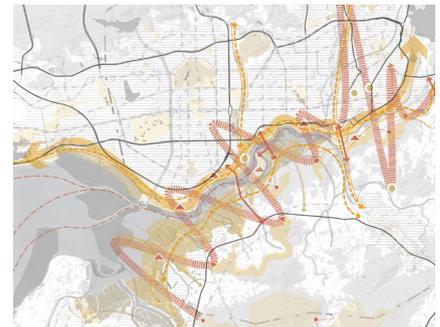


FIG. 87 Socio-cultural landscape infrastructure network

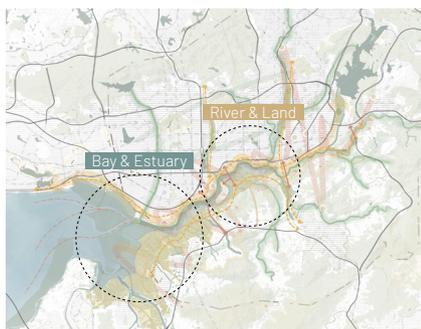


FIG. 88 Integration of three network layers and two zoom-in programmes

Regional Network Principles

Following the same layered structure, seven network principles applied in 3 layers together compose a regional landscape framework project, contributing to the future vision of a resilient green-blue-cultural corridor.

Guided by the regional principles, the decomposed landscape infrastructure networks are created to show the possible spatial connectivity. However, there are common conflicts when overlapping the three layers. Conflicts, particularly between the culture and green-blue layers, can be noticed when the layers intertwine to compose an integrated landscape network. Then how to deal with the relation between the three layers? Next, design exploration is conducted through scales to show several site-specific cases to deal with the complexity when combining the three layers.

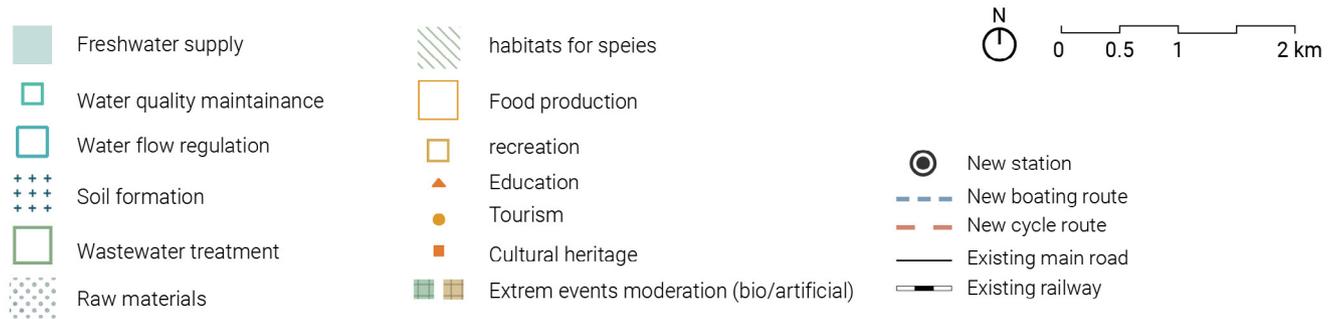
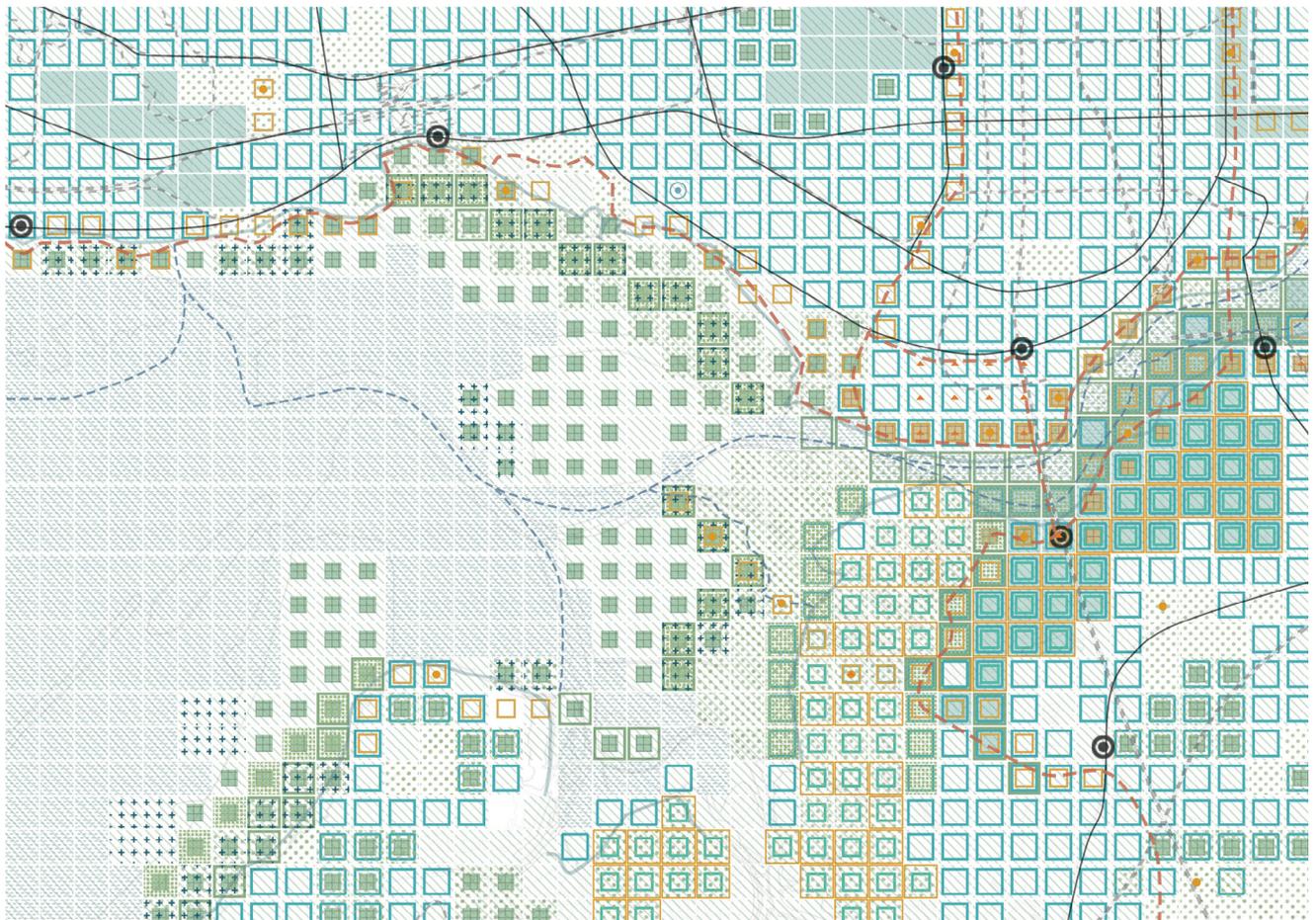


FIG. 91 Networked service map (Bay& Estuary): The overlappings of potential services work as factors to be involved in local strategies.

FIG. 92 (Top left) Stakeholder analysis and priority services: the major stakeholders of each type of land use are shown on the map. Based on the stakeholders, the priority functions (ecological habitats, recreation, production) of the landscape are determined, and the combination and transition between functions is also indicated.

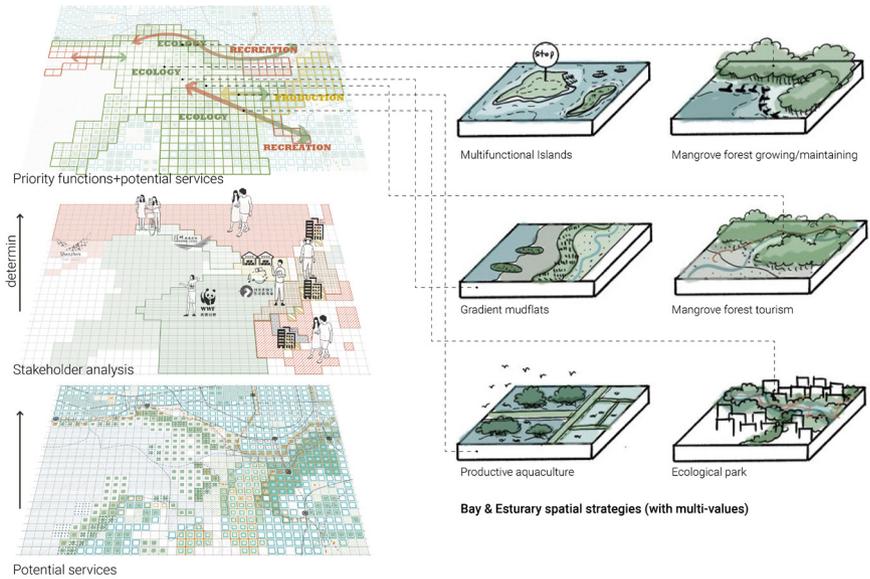
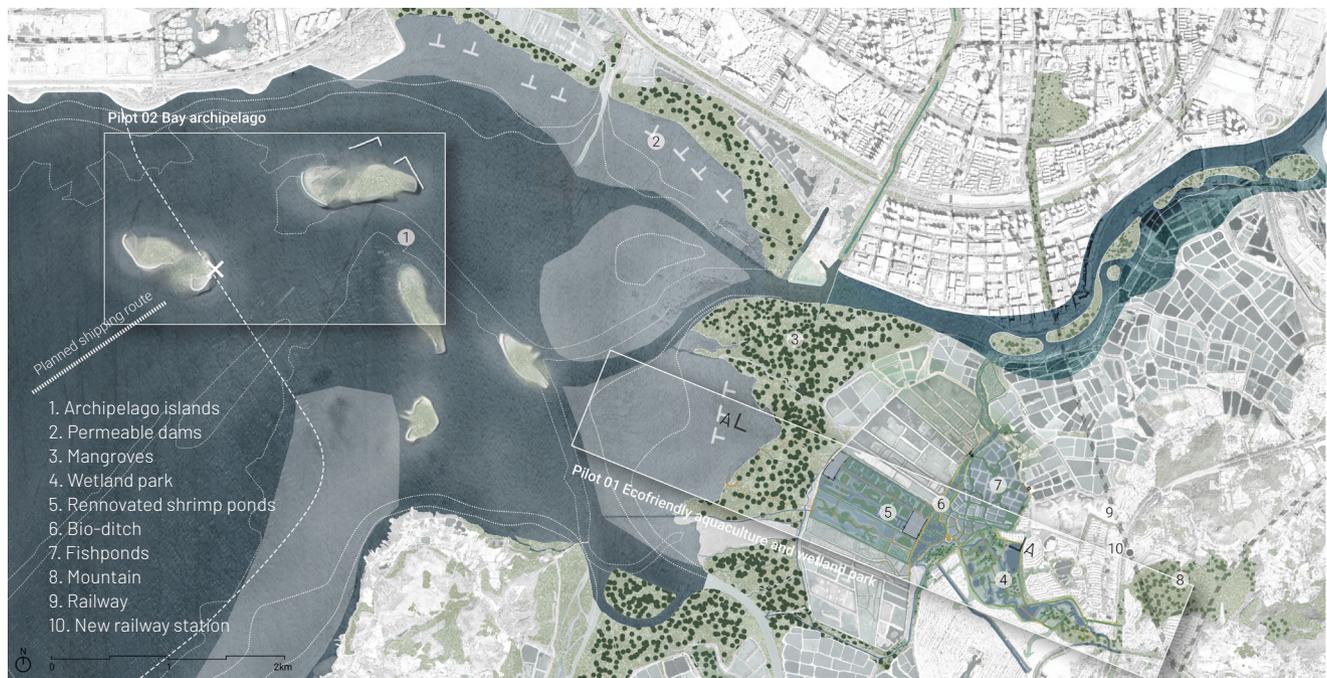


FIG. 93 (Top right) Spatial strategies: combined with the priority functions and potential services, different site-specific strategies can be generated and applied on different land use.

FIG. 94 (Bottom) Master plan: zoom-in 1 Bay & Estuary: the first programme includes three pilot projects—1. Eco-friendly aquaculture; 2. Wetland park; 3. Bay archipelago.

generate landscape structures that support those values (Termorshuizen & Opdam, 2009). Fourthly, several site-specific spatial strategies with multiple values could be given, and as a result, translated into spatial design locally. Lastly, the proposed plan can be assessed again to compare.

Zoom-in 01: sustainable bay & estuary



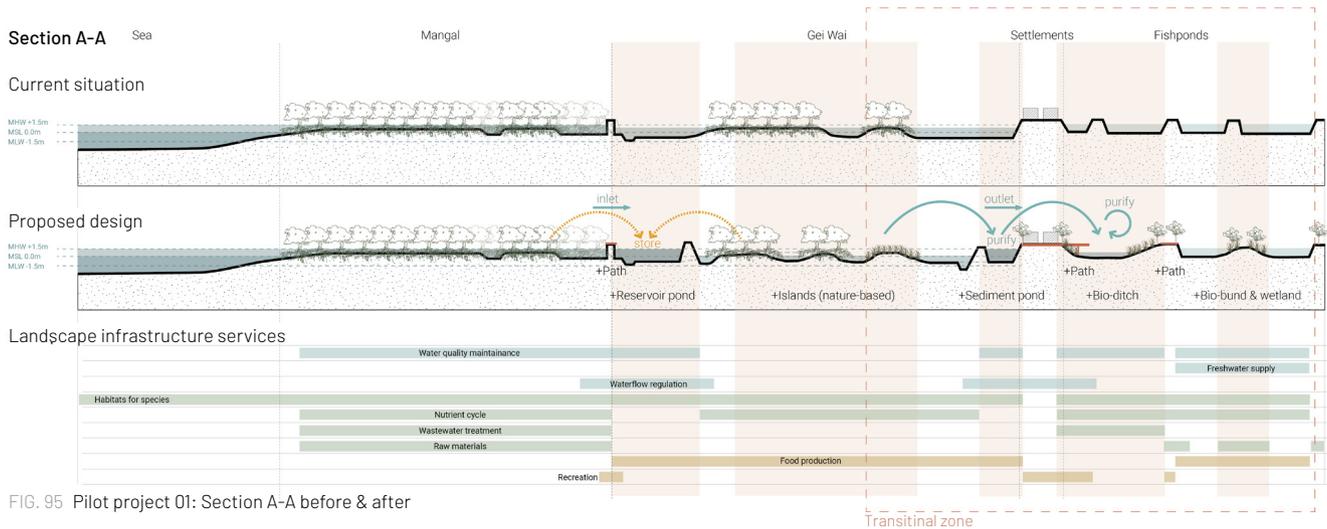


FIG. 95 Pilot project 01: Section A-A before & after

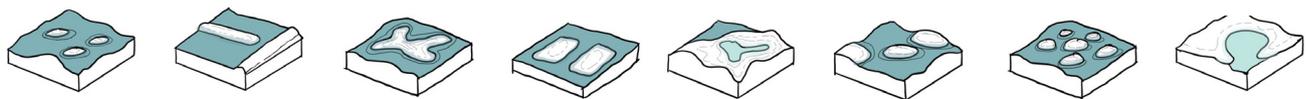


FIG. 96 Tool kit for nature-based habitats morphology

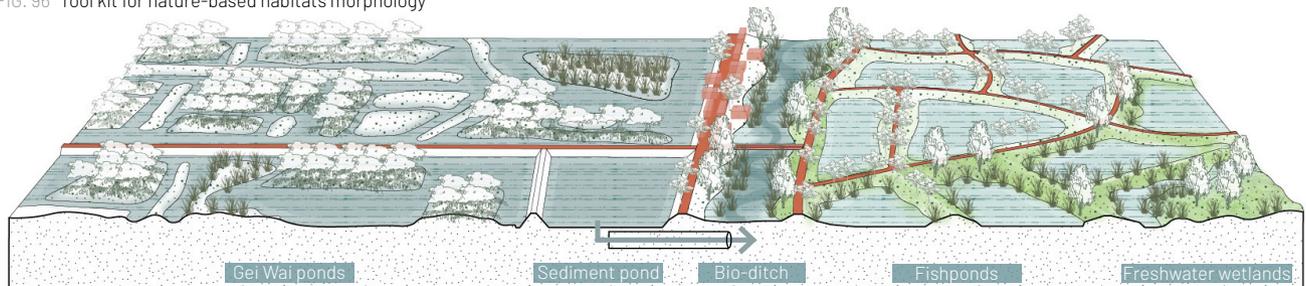
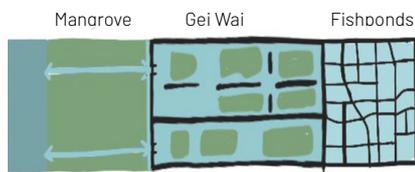


FIG. 97 Transitional zone detail design

Current aquaculture system



Proposed aquaculture system

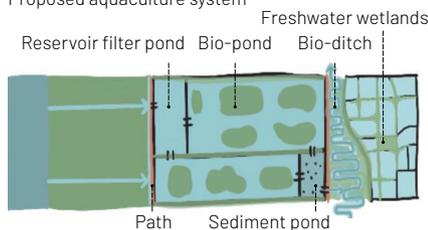


FIG. 98 Proposed eco-friendly aquaculture water network: separate inlet and outlet; two extra ponds in Gei Wai; Bio-ditch for aquaculture wastewater purification.

This first design exploration aims to deal with the commons and conflicts between the landscape's ecological, productive, and recreational functions while adapting to the natural tidal processes. A complete coastal ecological corridor should contain the sea, tidal flats, wetlands, ponds, and woods. However, when looking at the Shenzhen Bay coastal ecosystem, there is no other green link except the wetlands and sea. The green connection is broken by artificial surface construction that also blocks the cycle of the water system.

As a result, a new landscape proposal that links the sea, mudflats, mangrove forests, Gei Wai, and fishponds together, serving balanced hydrological, ecological, and socio-cultural services, is given in this design exploration.

The first pilot project, Eco-friendly Aquaculture and Wetland Park, shows the transformation of the current mangrove-Gei Wai-fishponds system to a new system with productive value while maintaining the current ecological value. Five major implementations are conducted on the site, including the transformation of Gei Wai, fishpond bunds, and the transitional zone. Potential LIS, as suggested, are added to the site as a result.



FIG. 99 Aquaculture and wetland park: with the transformation of the ponds and added wetland park, the whole becomes a multifunctional culture park heritage with production, recreation, and ecology values, benefiting both human and ecological entities.

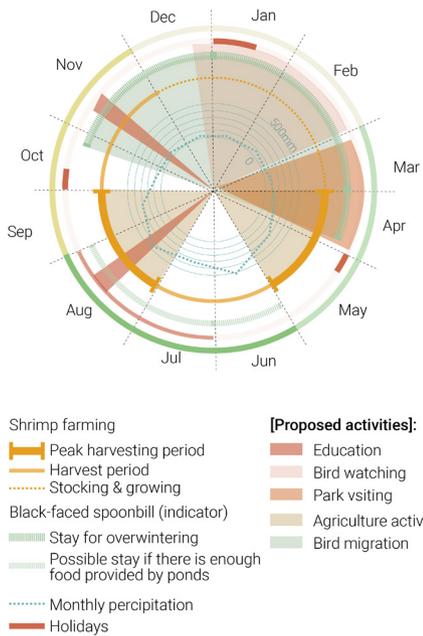


FIG. 100 Aquaculture, bird migration, recreation events calendar

The proposed water network achieves nature-based purification and water circulation. To make the system less rely on current artificial control, a tool kit for nature-based habitats morphology combined with tidal movement is given to create the condition for biodiversity in the ponds area. Moreover, some less productive fishponds are transformed into freshwater wetlands to connect ponds and other green patches.

Zoom-in 02: livable river & land

The second zoom-in programme aims to advance the design principle of sponge capacity and explore its ecological and socio-cultural potentials to enhance a liveable waterfront environment. Due to the restriction of the border policy, the Shenzhen river waterfront is currently not accessible. Wave protection walls on both sides fully walled the bank. The hard revetment cuts off the horizontal waterway and decreases the ecological-based flow from water to the bank. The defending system is becoming more and more vulnerable after each extreme event.

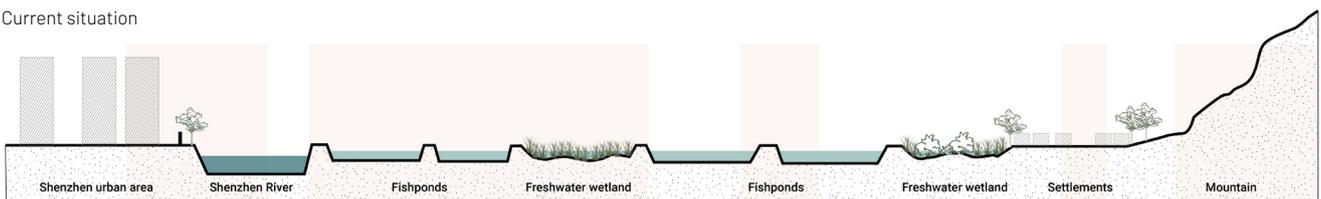
According the regional framework, the Shenzhen river is expanded on HK side to leave more room for floodplains. A secondary bypass waterway with sluice gate is proposed besides the original Shenzhen river to separate the collected rainwater and the polluted domestic water from Shenzhen river, providing freshwater to the fishponds.



FIG. 101 (Top) Master plan of Livable River & Land

Section B-B

Current situation



Proposed design & Local implementations

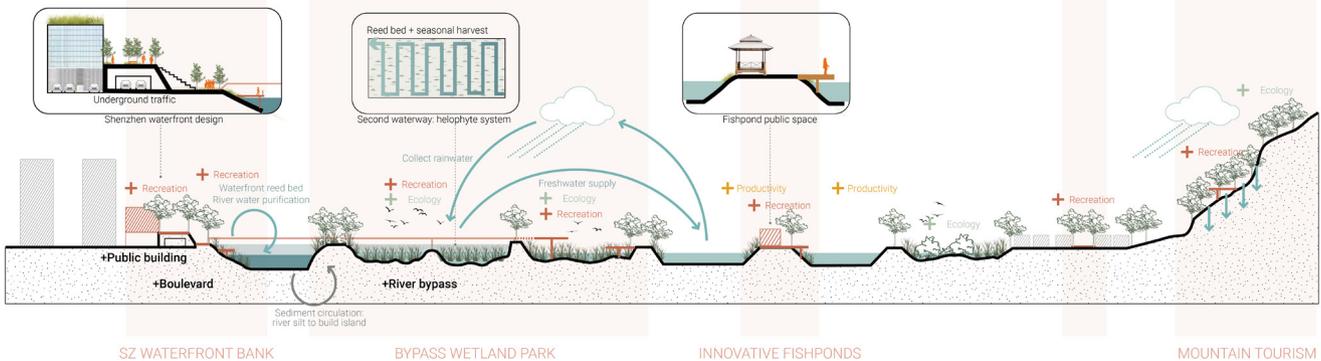


FIG. 102 (Bottom) Section B-B: local implementation



FIG. 103 Perspective of river bypass ponds and wetlands: the cultural and ecological values are extended from the estuary nature reserve to the middle stream of SZ River to create a continuous corridor. Diverse habitats provide birds and other animals with feeding, resting, hiding, and nesting areas. The added walking and biking path make the area accessible for visitors from both sides. Moreover, a mosaic landscape is generated here with different plant harvesting management, providing a diverse and unique aesthetic value.

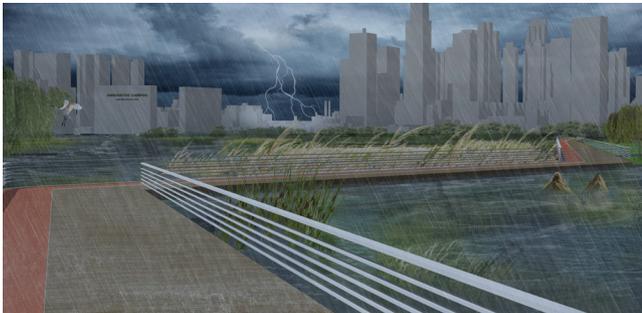


FIG. 104 Perspective of river bypass ponds and wetlands when facing storm: the area become a buffer zone when facing extreme rain and storm.



FIG. 105 Perspective of Shenzhen River waterfront on Shenzhen side: The main way is designed to be a pedestrian-friendly boulevard and biking path. The traffic road is buried underground.

The third pilot project explains the relationship between the Shenzhen river, the river bypass, and fishponds in the urban and rural contexts on the two sides. New nature-based services like water purification and circulation, freshwater supply, and extreme events moderation are emphasized in this pilot project, showing the resilience of the new proposed landscape infrastructure system when facing the future climate challenge.

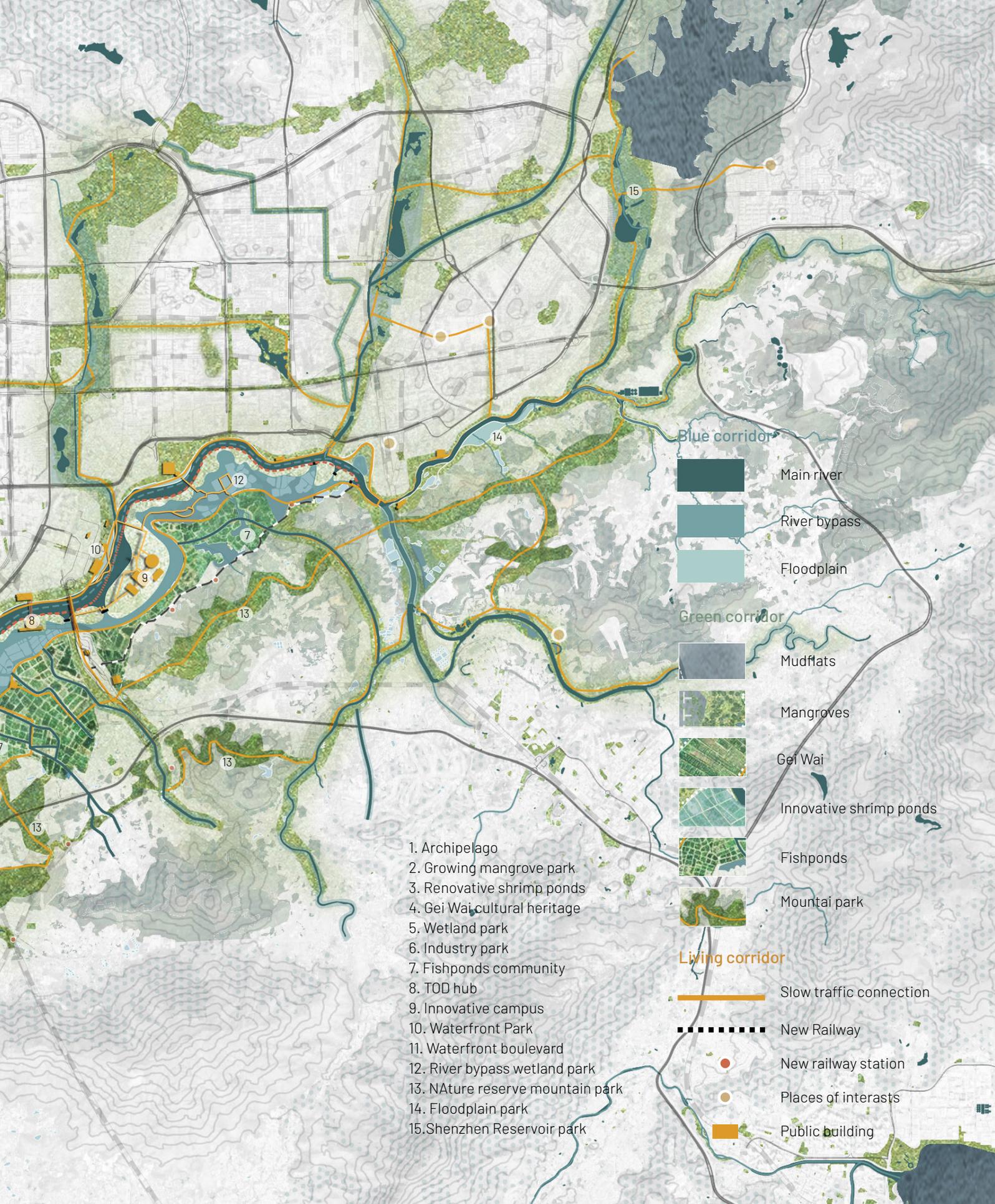
The renovation of the Shenzhen River waterfront continues the aquaculture heritage of the site, transforming the area of the current fishponds into a more multifunctional public space with production, recreation, and ecological values. There are multiple types of aquaculture production, including energy fishponds, educational fishponds, and traditional fishponds. Public spaces are added in the area of the fishponds to connect the settlements. The previous fishponds located in the bypass channel are transformed into helophyte ponds, and a particular harvesting strategy of the reeds is given to create a mosaic view.

In the new proposal, the waterfront becomes a lively public space where people can walk, bike, camp, do sports, visit museums and parks, hold festivals and events, etc.

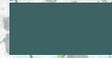
REGIONAL LANDSCAPE FRAMEWORK

FIG. 106 Proposed regional landscape framework of Shenzhen-Hong Kong border area





Blue corridor

-  Main river
-  River bypass
-  Floodplain

Green corridor

-  Mudflats
-  Mangroves
-  Gei Wai
-  Innovative shrimp ponds
-  Fishponds
-  Mountain park

Living corridor

-  Slow traffic connection
-  New Railway
-  New railway station
-  Places of interests
-  Public building

1. Archipelago
2. Growing mangrove park
3. Renovative shrimp ponds
4. Gei Wai cultural heritage
5. Wetland park
6. Industry park
7. Fishponds community
8. TOD hub
9. Innovative campus
10. Waterfront Park
11. Waterfront boulevard
12. River bypass wetland park
13. NATure reserve mountain park
14. Floodplain park
15. Shenzhen Reservoir park



FIG. 107 Public projects & Land development principles

+Land development strategic restriction line

I. Outside the strategic restriction line:

1. Transit-oriented land development (TOD).
2. Connect to the slow traffic system.

II. Inside the strategic restriction line:

[Hydrological]

1. Separate the sewer system and maintain and purify the water within the neighbourhood.
2. Use the main river and the bypass channel differently.
3. Apply green roof and permeable materials to increase sponge capacity.

[Ecological]

4. Preserve the current wetlands, and develop public green to connect the green infrastructure within the framework.

[Socio-cultural]

5. Protect the value of innovative aquaculture, and leave marketing space when developing the land.
6. Connect to the public transportation and slow traffic system.

- 01 Public park project
- 02 Village community project
- 03 Urban renovation project
- 04 TOD land development projects
- Potential land development area
- Key station
- Land development strategic restriction line
- Inner bay tourism development restriction line

Regional landscape framework

The knowledge gained from the local scale design exploration help to refine the overview of the regional landscape framework. The proposed landscape framework provides a robust backbone for future land development with the resiliency to cope with uncertainties. It reflects the spatial application of integrated seven regional principles.

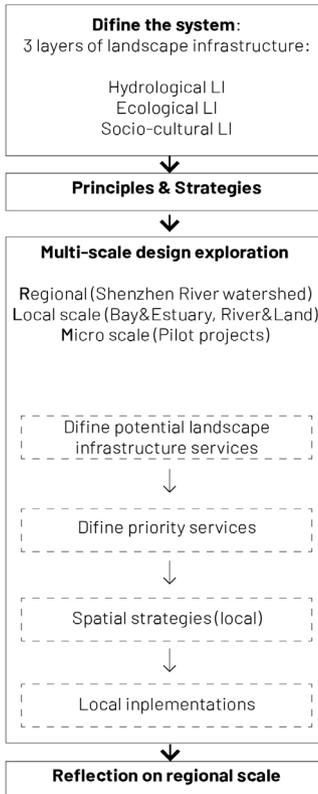
The border area is transformed from a barrier to a resilient and inclusive landscape corridor where nature and culture both prosper here. It becomes a resilient blue corridor, a continuous and diverse green corridor, and a connective and productive culture corridor. The two cities begin to face the river to develop. And this corridor provides opportunities for cross-border cooperation in business, culture, education, production, etc. The unique cultural identity of traditional aquaculture and bird paradise has been maintained and extended along the river.

The proposed landscape frameworks suggest four types of local public projects during different time periods: the public park project, the village community project, the urban renovation project, and the TOD land development project. Meanwhile, land development principles and strategies are suggested based on the landscape framework.



FIG. 108 Bird view of Shenzhen River middle stream area

METHOD & APPROACH



Conclusion

The project gives an insight into the generation and application process of the landscape framework. The landscape framework guides the local design explorations. Meanwhile, the pilot projects contribute back to the exploration of the framework project. They show the application of the landscape infrastructure theory into practical planning and design and apply assessments. Referenced from the ecosystem services, the landscape infrastructure services are linked to the idea of landscape infrastructure, becoming a valuable tool for guiding and evaluating the design.

The outcome provides potential principles and strategies in the coastal context to develop a resilient living environment under the idea of resilient landscape infrastructure. This research helps deepen the understanding of the traditional aquaculture system and inspires natural processes in this area, providing insights into understanding a sustainable social-ecological system. Moreover, applying the landscape-based approach and the nature-based tool provides a perspective that landscape works initially as the armature to guarantee a resilient future with further social-economic development. Through the lens of this project, the landscape architecture field is emphasised in both urban planning and local design.



FIG. 109 Illustration of the Resilient Coastal Landscapes graduation (Chongwattanaoj, 2022)

Reflections

Through the analysis and design explorations of the graduation projects, the "Landscape first" approach is employed as a tool to understand the complex landscape systems and give the direction to the design where the landscape is the basis of sustainable urbanisation. The idea of resilient landscape as infrastructure suggests that landscapes can provide various services to sustain long-term development while being resilient to adapt and cope with uncertainties such as climate change. These landscape-based approaches and nature-based design principles offer a perspective that landscape works as an essential armature to guarantee a sustainable future of social-economic development.

The approach has guided the students' iterative research and design process and allowed them to expand their knowledge of the site and relevant design principles, thus generating design outcomes that are endearing, flexible, and inclusive.

For instance, the project **"From Border to Landscape"** by **Yuqi Pu**, located in the Pearl River Delta, gives an insight into the "bottom-up" development of a coastal estuary river landscape. In this project, the landscape has been healing the land and mediating contradictions. The border area is re-given a landscape identity beyond political stereotypes by transforming from an inaccessible boundary to an inclusive and coherent landscape interface with multiple values and potentials. The landscape-based approach inspires the establishment of a landscape framework that reflects the reconnection of natural elements and public spaces as a basic frame for regional development, providing opportunities for cross-discipline cooperation.

In the project **"Amphibious Bangkok"** by **Akarapol Chongwattanaoj**, a Layers Approach based on the dynamic of change is used to decompose the complex landscape into three layers: the substratum, infrastructure network, and occupation. The method enables a deeper understanding of each of these landscape layers and guides the process of landscape-based regional design in finding the opportunities for the design to improve landscape resiliency in the embedded landscape elements. It allows the cultural landscape of Bangkok to be recognised as a vital multi-functional and multi-dynamic layer to achieve this task. In addition, it also leads to the establishment of the integration of infrastructural and landscape-based water management which guides urbanisation while preserving local adaptive community, practices, and cultural landscapes.

Through his project **"'Xiangcun', As A Productive Landscape"**, **Jie Chu** has also resonated with the acknowledgement of the approach's effectiveness, stating that "The mono-functional zoning in modernism planning reinforces the existing conflicts between metropolitan and rural areas under the trend of the rapid urbanisation, and the Layers Approach offers a tool to deal with this complexity. The method focuses not only on the layout of elements (structure) but also on the interactions (process),

thus considering the countryside and the agricultural landscape as a comprehensive socio-spatial mechanism: the agri-aquacultural landscape will not only be the place where agricultural production takes place but also a shared blue-green infrastructure; similarly, the natural landscape could be a hybrid habitat rather than a green utopia. This multi-functionality is the meaning of the landscape productivity and a prosperous vision for the rural area as ecological settlements. The process has inspired my position as an urbanist on how the landscape could be regarded as a continuous basis that provides spatial conditions for sustainable developments. A strategic framework combining macro goals with specific practices involving collaborations between urbanism, landscape, and architecture is necessary for this transition."

The project **"Hydrological Heritage Landscape"** makes **Wansu Lu** rethink what role landscape architects can play in urban planning. As the oldest polder area in China, the identity of Ningshao Plain has not been excavated or even gradually eliminated. As a cultural landscape, it is far less famous than Hangzhou, a nearby city. This is related to the fact that the urban planner of this region gives priority to economic development when planning the city, but landscape-approach proposes the planning idea of landscape first and deeply excavates the fundamental logic of the formation of the polder landscape in this area. The landscape framework established on this basis not only provides a high-quality space for economic and social development, and maximizes the potential of the landscape, enabling Ningshao Plain to achieve sustainable development on the basis of inheriting and promoting cultural history.

In the project **"Dhara – Directing Flows In Mumbai Through Landscape"** by **Ayesha Hussain**, the city of Mumbai is analyzed via its transformation from natural to urban systems. The complexities of the landscape are unraveled through this understanding, and methodologies for future resilience are derived. The blue-green and grey structures of the city are viewed as opportunities for future resilience through the development of a blue-green landscape framework. This framework reestablishes the importance of natural processes in the design, laying emphasis on the landscape as infrastructure and infrastructure as landscape. This integration of natural and urban systems provides new opportunities in the dense urban environment. By maintaining an informal approach to design and concentrating on the processes and conditions required, a network of interventions that allow for community and landscape to coexist is created. This results not only in hydro-morphological recovery and ecological restoration but also communal reinstation for the city and people of Mumbai.

To summarise, the landscape-based approach not only equips landscape and urban designers with a tool to systematically understand the landscape and its complex issues but also guides the adaptive design and planning for landscape resilience.

Conclusion

-by Steffen Nijhuis

Sustainable urbanization, climate adaptation and biodiversity require a design approach that takes the landscape as the basis. The existing landscape logic offers starting points for planning and designing a socially and ecologically inclusive spatial environment across scales; from city to street profile. The landscape provides structure, ecological coherence and variation, but is also flexible and multifunctional. Landscape also represents spatial-aesthetic values such as beauty and orientation in space and time. After all, the landscape is the result of many years of interaction between man and his natural environment. But how can we design and plan in a landscape-conscious way?

The graduation work presented by the students illustrate how a landscape-based approach can provide possibilities for the development of more resilient urban coastal landscapes. By reading landscape in layers and understanding it as a system, students understood the logic of the project sites from natural, social, and cultural perspectives. The design explorations addressed the potential of long-term regional frameworks and implementation through short-term local projects, while engaging in co-creative processes with multiple disciplines and stakeholders. The projects display the operational power of spatial design as an integrative, creative activity and recognized the regional urban landscape as a significant field of inquiry that is context-driven, solution-focused, and transdisciplinary.

The students displayed a steep learning curve, growing into their role of future professionals. From identifying problems, to defining research directions, exploring alternatives, applying principles adaptively to the site, and finally summarizing and reflecting on them. They are all worthy ambassadors of the TU Delft landscape approach.

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