Feeding the Future

Towards a climate resilient rice production in the Mekong Delta of Vietnam

Ke Zhou
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Delft University of Technology, The Netherlands

Faculty of Architecture and the Built Environment
Department of Urbanism

Research group	Planning Complex Cities
Student	Ke Zhou
Student number	5563356
First mentor	Marcin Dabrowski
Second mentor	Inge Bobbink
Date	21/06/2023

Front image source: photo by Suthep Kritsanavarin, google map

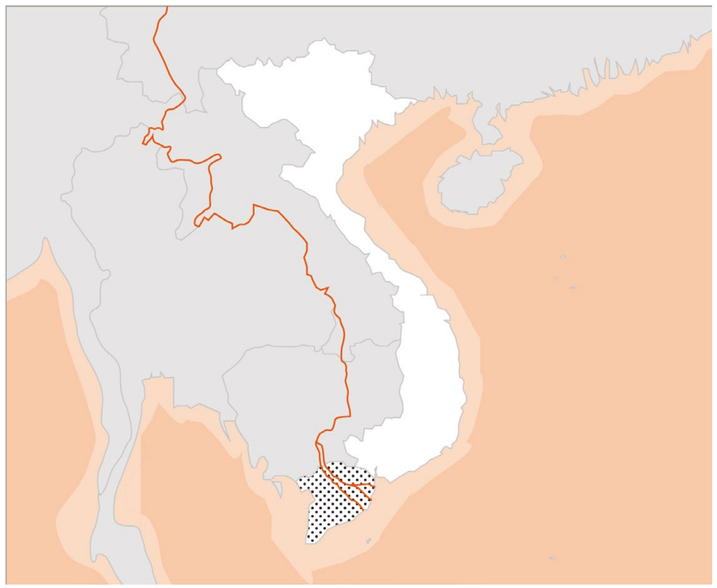

Figure. Location of Mekong Delta

ABTRACT

Delta systems, characterized by their dynamic nature and high population densities, are crucial for food and water security. However, they face significant challenges as they are on the forefront of climate change impacts, including sea level rise, river and coastal flooding, and coastal erosion. Among them is the Mekong Delta in Vietnam, where rice-dependent agricultural production systems and methods are increasingly unable to adapt to the new environment created by climate change. There is therefore an urgent need for climate-resilient agricultural transformation and the accompanying social engagement and cross-border cooperation, taking into account and adapting to local cultures and contexts. The Mekong Delta, spanning nearly 50,000 km2, is a region predominantly composed of fertile alluvial and marine sediments, stretching from Phnom Penh in southeastern Cambodia to southern Vietnam and encompassing the South China Sea and the Gulf of Thailand. Within Vietnam, approximately 39,000 km2 or 78% of the total area is covered by the delta. This graduation project will focus on its main area of rice production, namely the upper delta in the north.

This graduation project, under the Planning Complex Cities studio, will address the development of spatial planning and strategies that include political, cultural, and social contexts of the site, sustainable agricultural rice production adapted to climate change, and pilot spatial design for selected case areas.

Keywords: Delta region, rice production, water management, climate adaptive planning

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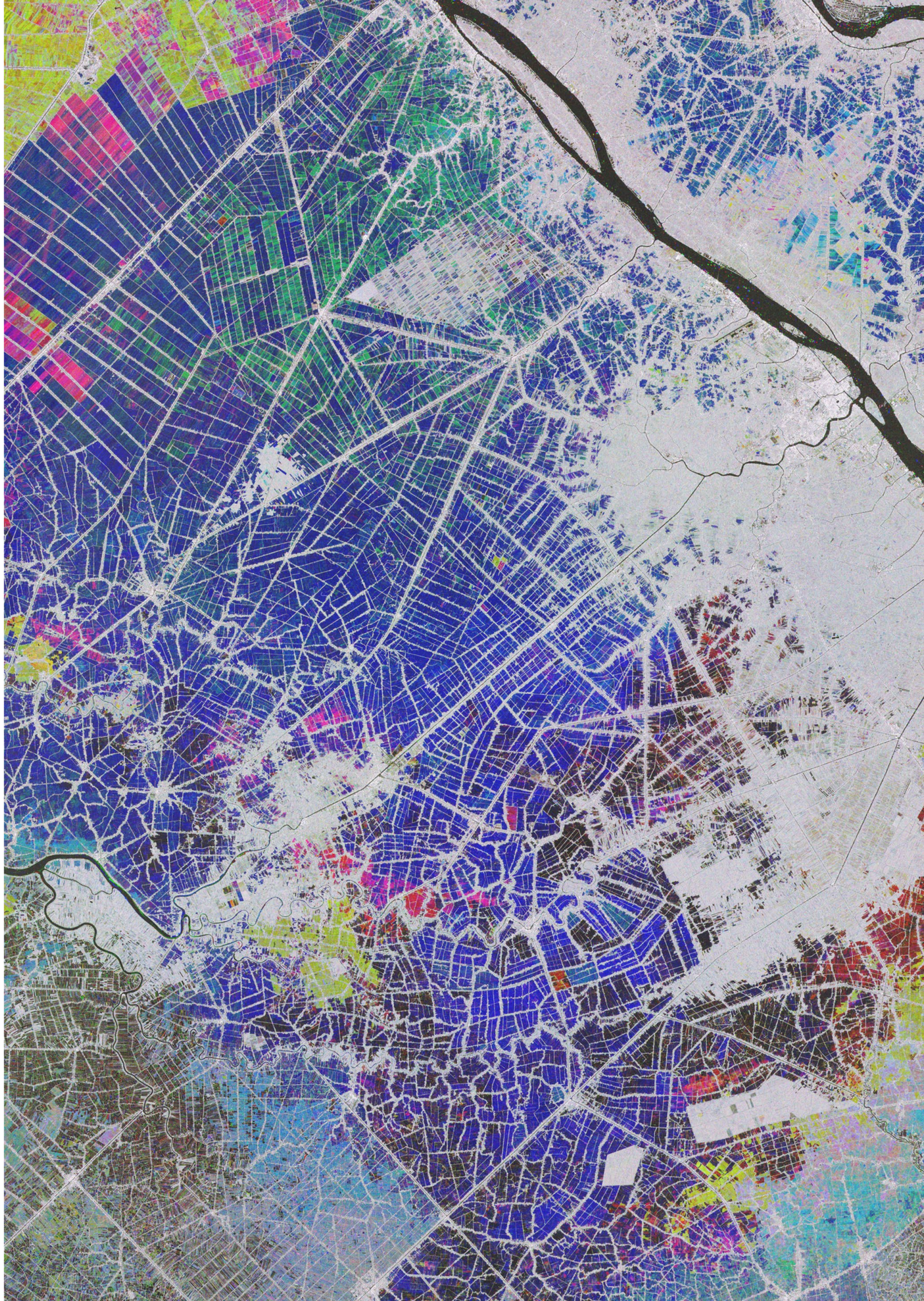
01 INTRODUCTION

Problem field

Problem analysis

Problem statement

Source: www.esa.int/ESA_Multimedia/Images/2020/03/Rice_fields_Vietnam



PROBLEM FIELD

(1) Rice production and dietary traditions

Rice serves as a vital staple food for a significant portion of the global population. Particularly in Asia, it holds paramount importance as the primary staple, contributing an average of 32% to the total caloric intake (FAO, 2020).

Notably, around 75% of global rice production takes place in irrigated lowlands, including the delta basins found in Asia, such as the Mekong River delta (FAO, 2020). Vietnam, since 1992, has held the position of the fifth-largest rice producer globally, with the Mekong Delta playing a pivotal role in sustaining substantial rice production and being one of the most densely populated rice-producing areas worldwide (Arai, 2022). Furthermore, the agricultural sector in Vietnam contributes over 10 percent to the gross domestic product (GDP), employs more than one-third of the workforce, and generates income for approximately 75% of the impoverished population (Zhai and Zhuang, 2012).

(2) Geopolitics of the upper Mekong countries

The Mekong River Basin's cross-border nature has sparked discussions regarding knowledge dissemination in hydropower development. Despite the flow of water, sediment, and migratory fish being oblivious to political boundaries, the basin's governance and knowledge sharing are shaped by geopolitical relationships (Sneddon & Fox, 2006).

The ongoing construction of large hydroelectric dams in the lower reaches and more populated areas of the basin is causing significant socio-ecological transformations (ICEM, 2010). These planned dams pose a threat to the region's highly productive fisheries and the livelihoods of millions of people residing in the basin. Furthermore, the impacts are expected to worsen due to global and regional climate change (Fox & Sneddon, 2019). The northern upper reaches of the Mekong Delta in Vietnam are at the front line of this impact at the national border.

Figure 1.2. Rice production Source: www.freepik.com/premium-photo/aerial-view-fresh-green-yellow-rice-fields-palmyra-trees-mekong-delta-tri-ton-town-giang-province-vietnam-ta-pa-rice-field_27565689.htm

Figure 1.3. Upstream dams source: Guillaume Lacombe/Cirad

(3) Threats from climate change and social adaptation

The Mekong Delta, renowned for its agricultural and aquaculture activities, is facing severe ecosystem degradation. Climate change, specifically sea level rise and saltwater intrusion, poses significant threats to the delta, putting the livelihoods of its residents at risk. It is projected that by 2050, a rise in sea level of 30 cm could affect 10-12% of Vietnam's population. Adaptation becomes crucial for the survival of resilient farmers and communities who rely on the delta's abundant natural resources.

Understanding farmers' perceived risks of climate change and the factors influencing their perceptions is vital for effective adaptation strategies. However, research by Le Dang and colleagues indicates that farmers in the Mekong Delta generally possess limited knowledge regarding these issues. Only a minority of farmers exhibit willingness and capability to modify their practices. The study highlights concerns among farmers regarding the challenges of adopting new agricultural approaches and emphasizes the need for resources, mandates, and the capacity of provincial governments to address these issues collaboratively (Le Dang et al., 2014).

Figure 1.4. Climate change effect in Mekong Delta

PROBLEM ANALYSIS
Agricluture

(1) Rice production

Vietnam is a significant agricultural producer, with a substantial portion of its land, approximately 35%, dedicated to agricultural activities. The majority of the population, around 66%, resides in rural areas, and nearly half, about 47%, are engaged in primary agricultural production. Rice cultivation is the predominant staple crop in Vietnam, encompassing over 77% of the agricultural land. Vietnam's average rice yield stands at approximately 5.5 tons per hectare, surpassing the regional average (Nguyen, 2017).

In Vietnam, the Mekong Delta region plays a pivotal role in rice production, accounting for approximately 56% of the country's total rice output (Maitah, 2020). Specifically, rice production in the Mekong Delta is concentrated in the northern upper region, which benefits from its proximity to the Mekong River. This area possesses abundant water resources and fertile soil, leading to the establishment of extensive triple rice cultivation areas capable of year-round production.

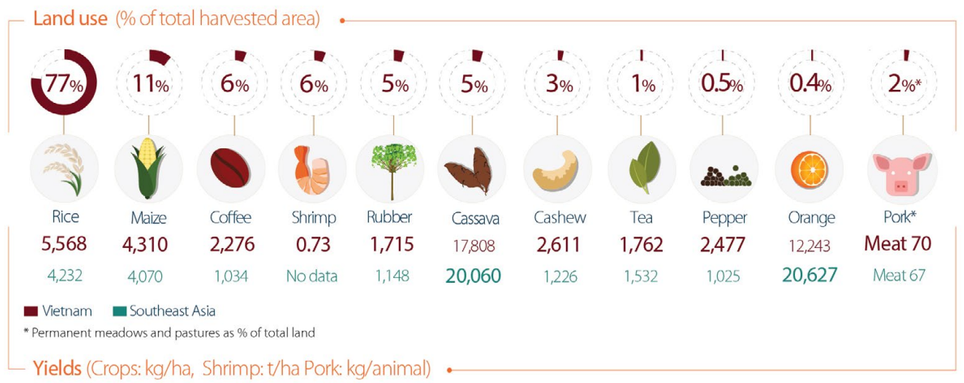


Figure 1.5. Agriculture production in Vietnam
Source: Nguyen, T. N., Roehrig, F., Grosjean, G., Tran, D. N., & Vu, T. M. (2017). Climate smart agriculture in Vietnam. CSA Country Profiles for Asia.

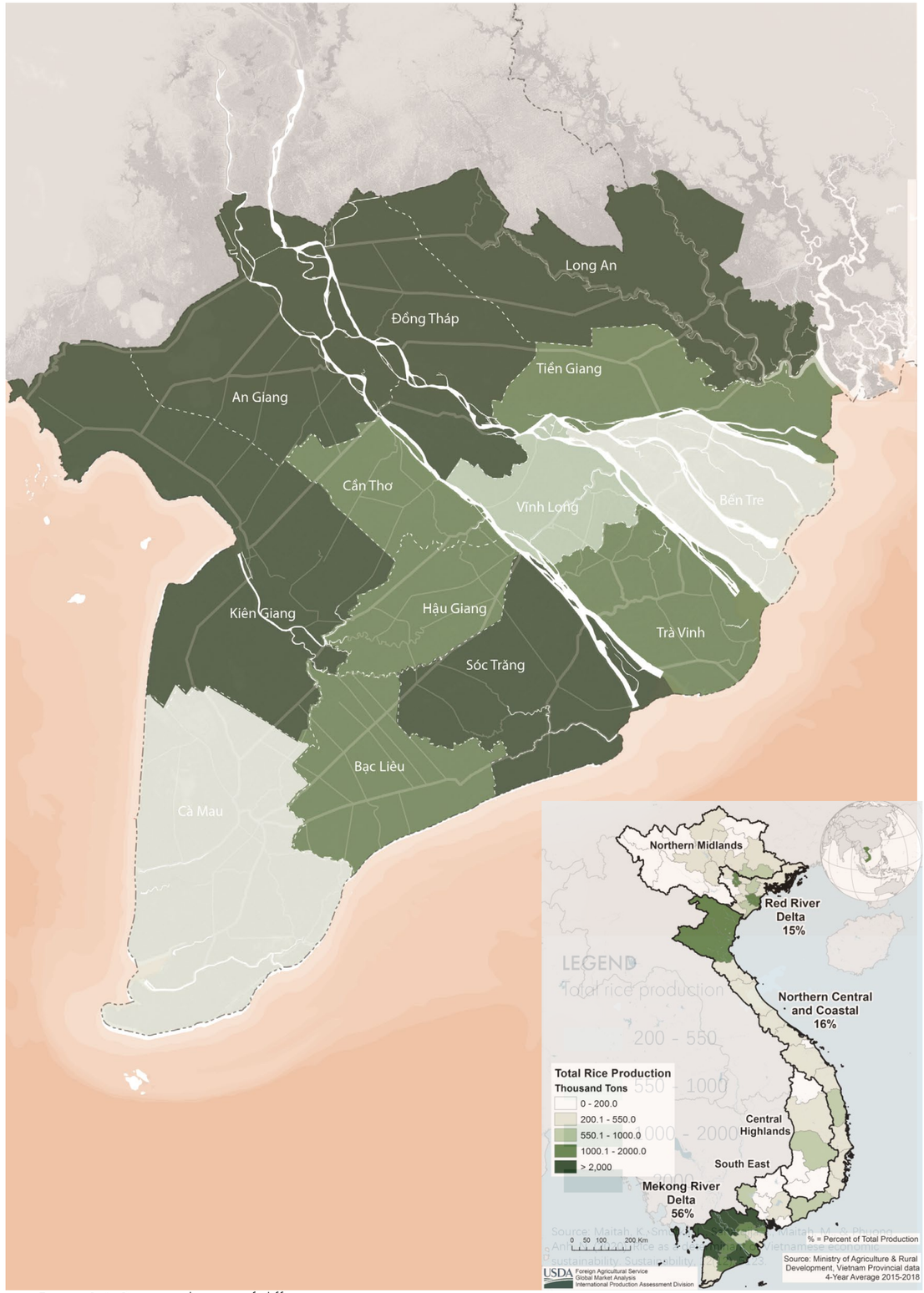


 Figure 1.6. Rice production of different provinces

Agricluture

(2) Rice cropping

Large areas in the upper delta flood in the wet season, double rice crops fit in this flood system. While the growing triple rice in the upper delta requires flood protection taking retention area from the river system. However, due to the higher economic efficiency and developing engineering level more and more triple rice areas are occupying the Mekong Delta plain.

The double rice cropping system in the Mekong Delta follows a specific schedule. The first crop, known as the winter-spring crop, is cultivated from December to the end of February. After a brief interval of approximately 4 weeks, the second crop, referred to as the summer-autumn or spring-summer crop, commences in early April and is harvested in mid-July. To facilitate this system, the fields are enclosed by dikes, with the lower dikes positioned around 2 meters above the ground. This design allows floodwaters to permeate the fields once the second crop is harvested. Consequently, the land remains submerged and fallow for the majority of the flood season.Towards the end of November, when the water level recedes and the lower dikes become visible, farmers utilize water pumps to extract water from their land, preparing it for the upcoming winter and spring crops (IUCN, 2016).

In this farming system, agricultural fields benefit from the nutrient-rich sediments carried by Mekong River floodwaters, which serve as a natural fertilizer. This reduces the reliance on chemical inputs, such as fertilizers and pesticides, and promotes stronger, disease-resistant rice stems. Additionally, the flooded fields during the flood season provide opportunities for fishing, offering socio-economic benefits to the landless and impoverished communities. However, the timing of crop planting requires flexibility due to fluctuations in flooding. Specifically, during the initial stages of the winter and spring crops, farmers must wait for floodwaters to recede before draining the fields. It's important to note that non-elevated roads may experience inundation during this period, hindering transportation activities.

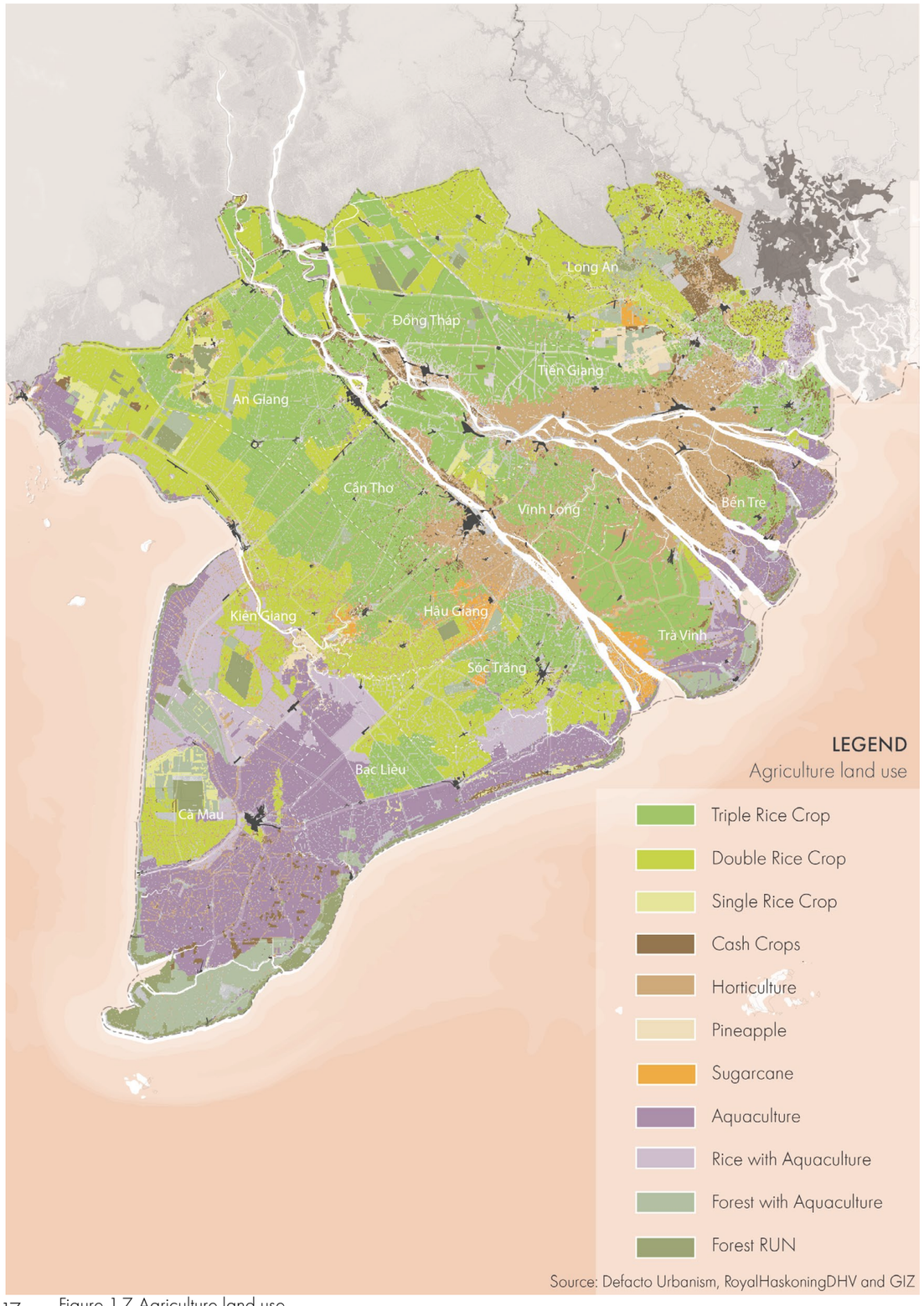


Figure 1.7. Agriculture land use

(2) Rice cropping

In the triple rice system, farmers commence land preparation and planting of the winter and spring crops in the latter part of October, utilizing rainwater from the polders as the water level recedes. Following the harvest of the first crop in January, there is a brief interval of approximately two weeks before the second crop is sown. During the planting phase, water from the surrounding canals must be pumped into the fields. A third crop is sown in mid-June and harvested at the end of September, coinciding with the peak of the annual flood.

The break between the two seasons is quite limited, lasting only two weeks. Since floodwater is prevented from entering the polder, sediment and incidental nutrients do not reach the farmland to replenish the soil. The amount of sediment entering the farmland through pumping is minimal, as water is primarily pumped out from the farmland during the flood season. Pumping occurs during the dry season when the water contains minimal sediment (IUCN, 2016).

In terms of labor, the ownership of land for the triple rice cultivation in the polders significantly reduces the physical labor required for farmers. Most of the heavy tasks such as plowing, pumping, harvesting, dumping, and transportation are carried out by machinery. Only a minimal workforce of one or two individuals per hectare is necessary. However, this reliance on machinery results in limited employment opportunities for local poor laborers throughout the year, as they cannot fulfill the high labor demand. Within each polder, there is a pumping station operated by private investors, both from within and outside the community. These investors, who also serve as the primary managers of the dike, take charge of the pumping station's ownership and operations (IUCN, 2016).

Table 1.1. Double rice cropping

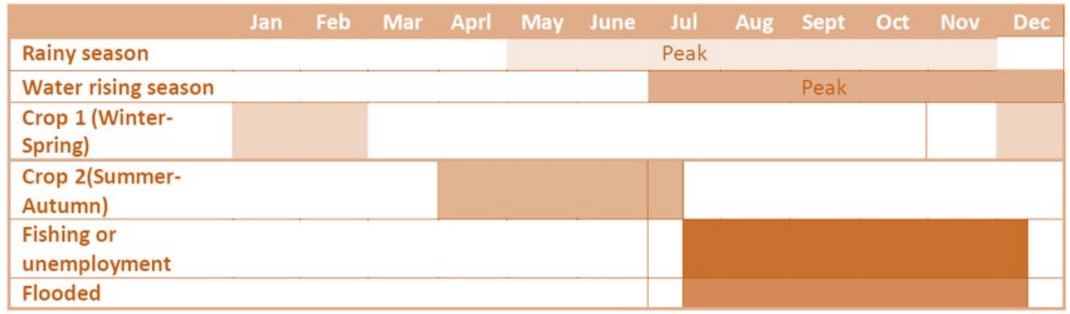
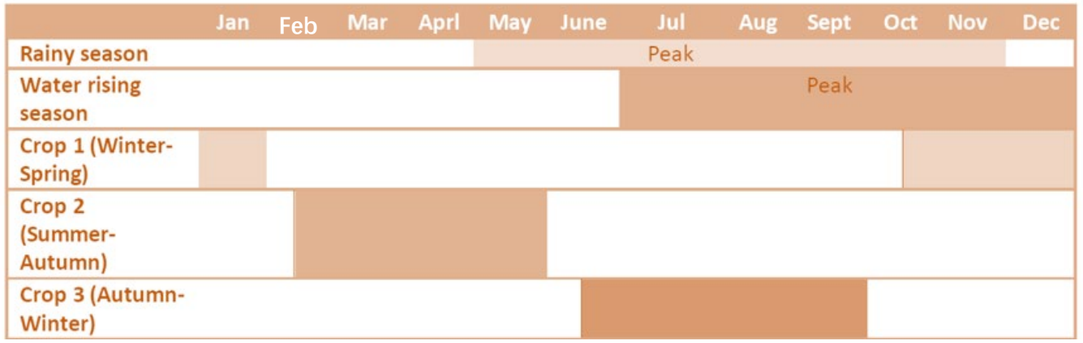


Table 1.2. Tripple rice cropping



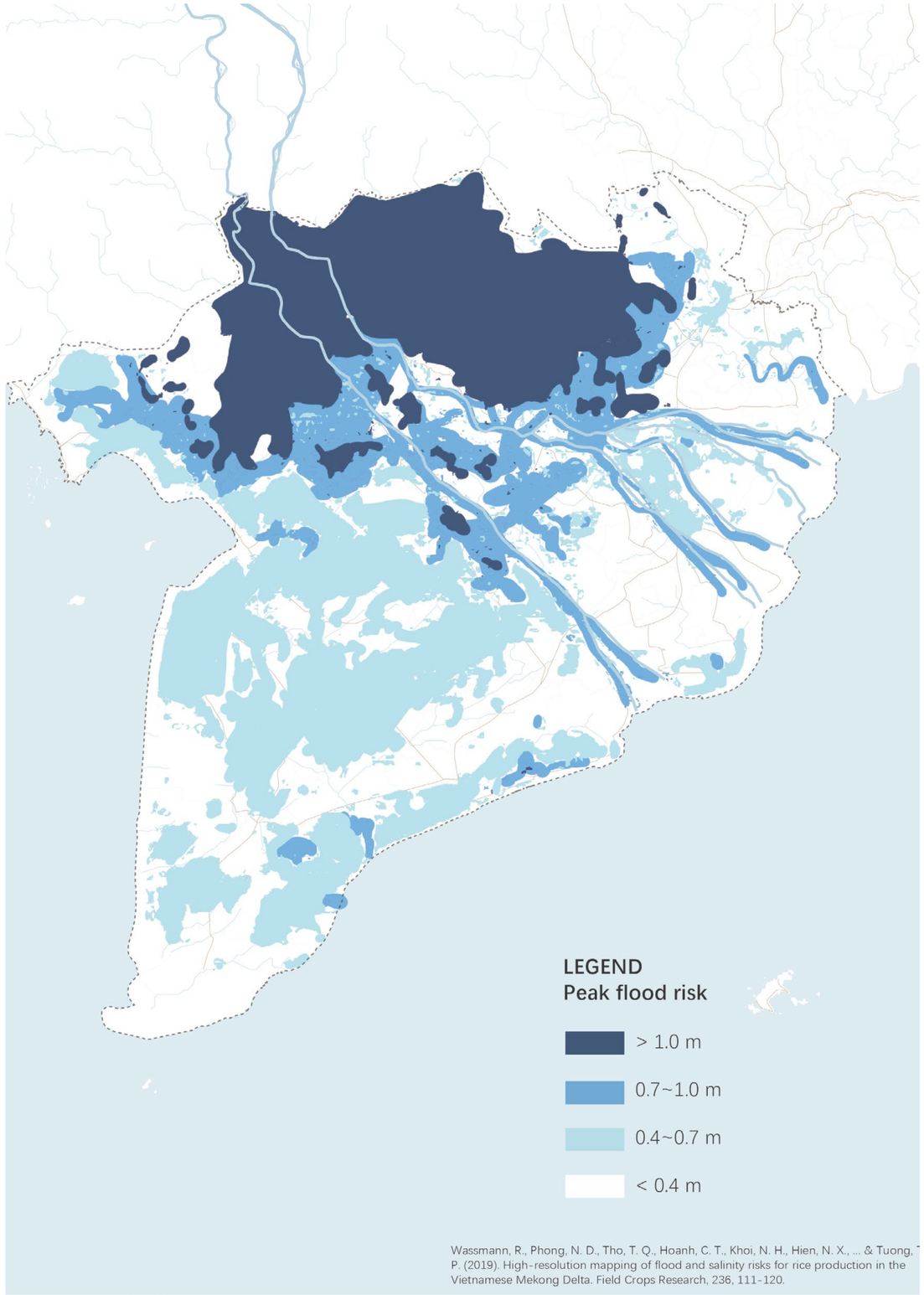
Source: IUCN, 2016

Climate change

(1) Flood risk

The Mekong Delta experiences two distinct seasons: the rainy season spanning from May to November, and the dry season occurring from December to April. Approximately 90% of the annual rainfall is concentrated within the rainy season. Typically, flooding transpires after June, a month characterized by heavy rainfall. The combined effect of frequent precipitation and high water flows from the upper Mekong River into the Mekong River basin leads to rising flood levels, peaking in October and gradually subsiding until the end of the rainy season. In recent years, there has been a notable increase in the water level of the Mekong River channel during this period. Throughout the dry season (January to July), diminished river flows and inadequate rainfall contribute to saline intrusion in coastal areas, necessitating reliance on water pumping for agricultural purposes.

Climate change projections indicate a projected sea level rise of 30 cm by 2050, potentially impacting approximately 1.8 million hectares of land in the Delta. Furthermore, it is anticipated that there will be a 2-5% increase in rainfall during the wet season and a projected 4-8% decrease in rainfall during the dry season by 2050. These alterations in rainfall patterns are expected to intensify wet season inundation and exacerbate dry season salinity levels (Thuc, 2016).



Wassmann, R., Phong, N. D., Tho, T. Q., Hoanh, C. T., Khoi, N. H., Hien, N. X., ... & Tuong, T. P. (2019). High-resolution mapping of flood and salinity risks for rice production in the Vietnamese Mekong Delta. Field Crops Research, 236, 111-120.

Figure 1.8. Flooding in wet season

Climate change

(2) Salt water intrusion

Sea level rise is projected to have a detrimental effect on the salinity levels of the river branches and water networks in the Mekong Delta. With each meter of sea level rise, the area experiencing a salinity level of 4 g/l is estimated to expand by 334,000 hectares or 25% compared to the base year of 2004. The intrusion of deep salinity during the dry season has already caused significant crop losses, and under the influence of climate change, the extent and frequency of such intrusion may further increase, leading to more frequent and severe economic losses (Mekong Delta Plan, 2013).

Approximately 60% of the water availability in Vietnam relies on upstream countries (World Bank, 2010). However, the combination of reduced river flows during the dry season, sea level rise, and increased saltwater intrusion poses challenges to freshwater availability in various regions. Coastal areas, in particular, face limited freshwater surface flow during the dry season. To address this scarcity, there is a growing reliance on groundwater extracted from deep submerged aquifers as an additional freshwater source. Unfortunately, the current utilization of groundwater is already depleting these limited aquifers, and further intensification of groundwater extraction in the future would be unsustainable.

(3) Climate change and rice production

The agricultural sector is confronted with significant challenges due to climate change. The warming climate, increased prevalence of pests and diseases, and more frequent droughts are projected to result in a 4.3% reduction in rice yields between 2016 and 2045, compared to levels that would have been achieved without climate change. Sea level rise and salinity intrusion further compound these impacts, causing a shift in the geographic distribution of rice production. As a result of climate change, rice cultivation may need to relocate to areas more suitable for multiple crops, adapting to the changing conditions (Nguyen, 2017).

In the Mekong Delta, climate change is anticipated to reduce the agricultural land area by approximately 24%. This decline in available land is not the only consequence, as agricultural productivity will also be affected. If sea levels were to rise by 1 meter, rice production in the Mekong Delta could potentially experience a loss of 40.5% in total regional output (World Bank, 2010). These projections highlight the significant risks that climate change poses to rice production and the urgent need for adaptation and mitigation strategies in the agricultural sector.

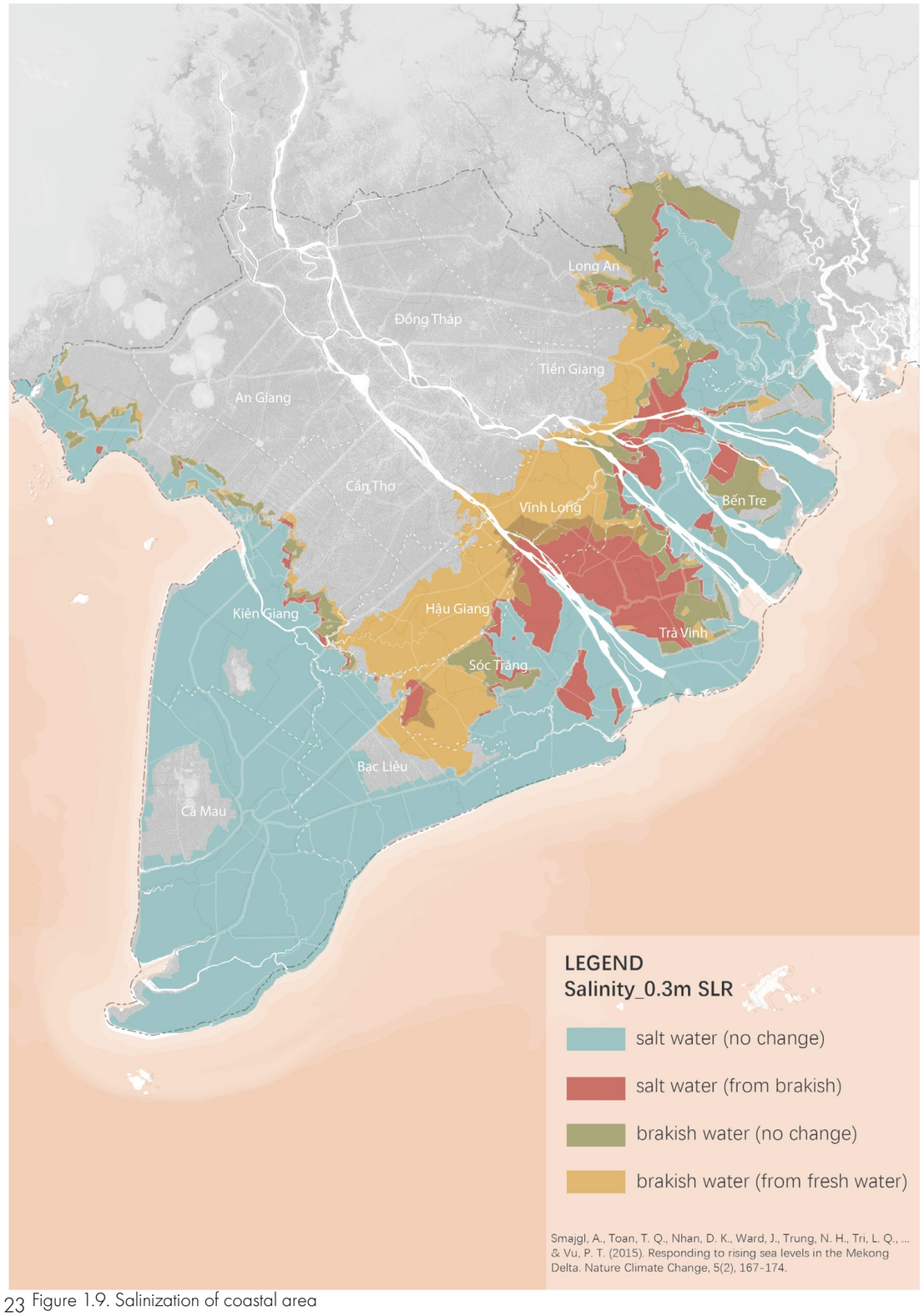


 Figure 1.9. Salinization of coastal area

Vulnerability

According to the Statistical Yearbook of Vietnam 2021, the highest population density in the Mekong Delta region is in the rice-growing provinces and along the Mekong River, and the rural population is higher in the northern upper delta rice-growing provinces. Poverty rates are higher in the coastal provinces affected by climate change sea level rise and salinization, and unemployment rates are higher in the northern and western provinces due to landlessness and poor access to land by ethnic minorities (GSO, 2021).

In the rural areas of the delta, the natural capital comprising land, water, and fishery resources plays a crucial role. However, in the process of rice intensification, landless individuals often bear the brunt of the negative consequences. They do not benefit from the increased income generated by rice cultivation and experience the loss of natural resources such as wild capture fisheries and wild edible plants, which were previously relied upon for subsistence and additional income. The mechanization of rice production has led to a decline in the demand for labor, with machines replacing many manual tasks like harvesting.

Poverty is particularly prevalent among ethnic minorities, despite accounting for only 15% of the population. They constitute half of the poor and three-quarters of the extremely poor. The high poverty rates among ethnic minorities can be attributed to various factors, including geographical isolation, limited access to quality education, and restricted land ownership opportunities. These groups face heightened vulnerability to climate change, natural disasters, economic shocks, and health crises (Nguyen, 2017). Additionally, malnutrition remains a persistent issue due to the heavy reliance on rice as the primary staple food for ensuring food security in the region.

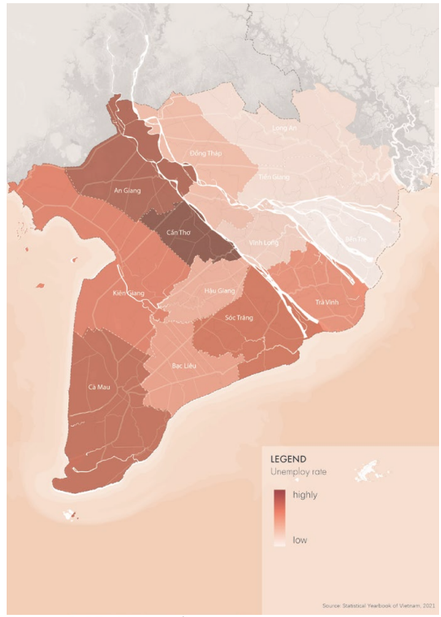


Figure 1.10. Unemployment rate

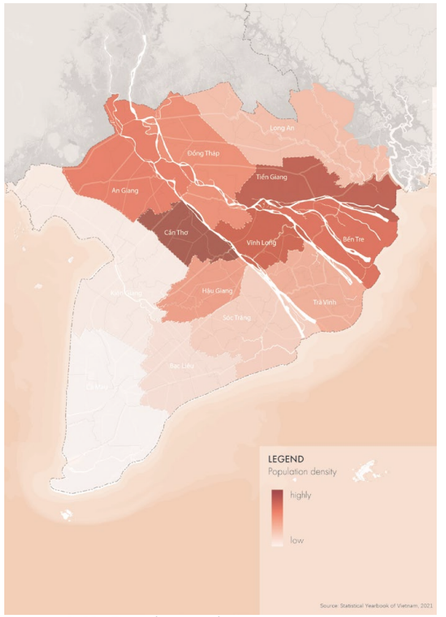


Figure 1.11. Population density

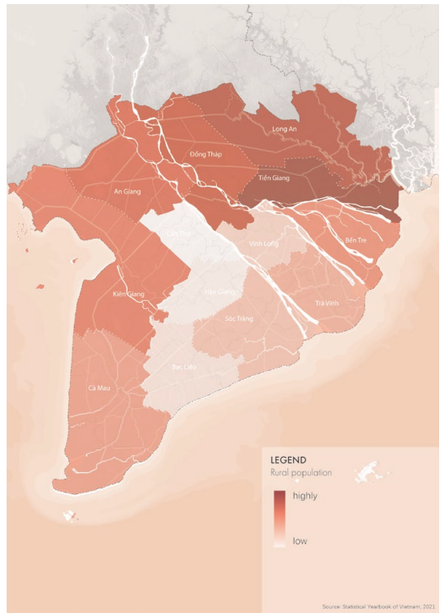


Figure 1.12. Rural population

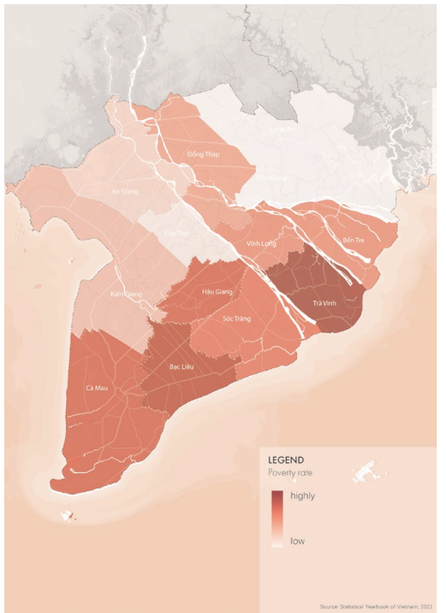


Figure 1.13. Poverty rate

Vulnerability

According to the IPCC Third Assessment Report, vulnerability refers to the extent to which a system is susceptible to and unable to cope with the adverse effects of climate change, including variability and extremes. It is determined by the characteristics, magnitude, and pace of climate change, as well as the system's sensitivity and ability to adapt (IPCC, 2001). The report defines exposure as the level of exposure of a system to significant climate change, sensitivity as the degree to which a system is affected, either negatively or positively, by climate-related factors, and adaptive capacity as the system's ability to adapt, mitigate, exploit opportunities, or cope with climate change consequences.

Applying these definitions, the mapping assessment reveals that Vietnam's vulnerability is primarily driven by its exposure to climate hazards. Among the most vulnerable areas in Southeast Asia, the top 25% consists of the 10 most vulnerable provinces in Vietnam. Eight of these provinces are situated in the Mekong Delta region, namely Dong Thap, Vinh Long, Can Tho, Tra Vinh, Soc Trang, An Giang, Tien Giang, and Ben Tre. These areas are particularly threatened by sea level rise, with some also experiencing frequent flooding. Additionally, many of these regions have dense populations, further exacerbating their vulnerability to climate impacts (Owaygen, 2010).

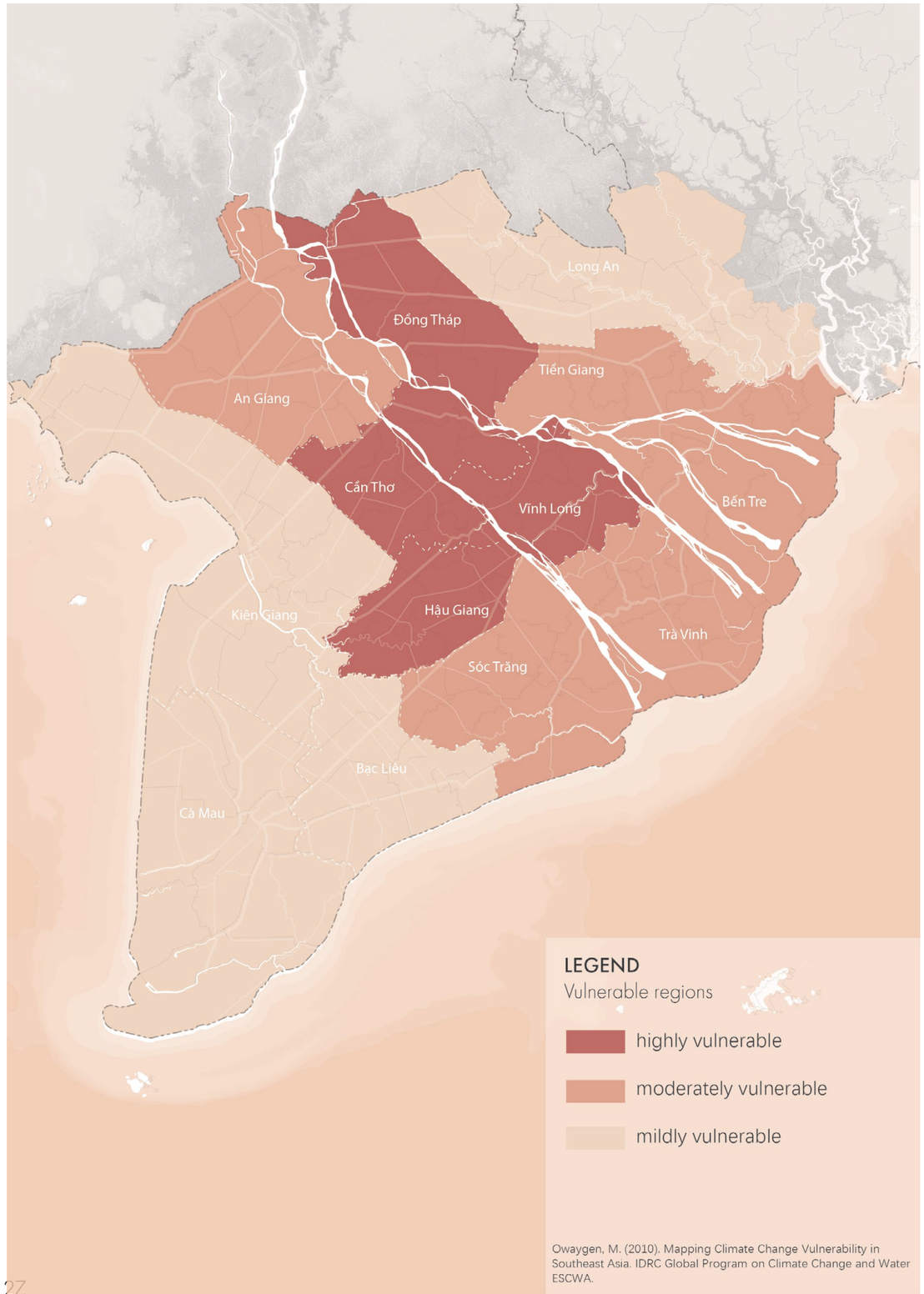


Figure 1.14. Vulnerability assessment
Source: Owaygen, M. (2010). Mapping Climate Change Vulnerability in Southeast Asia. IDRC Global Program on Climate Change and Water ESCWA.

Institutional landscape - Vietnam

The current institutional situation in the Mekong Delta is characterized by complexity, with multiple ministries and agencies involved in planning and implementation. This complexity poses challenges to effective planning and development of the region. The Ministry of Agriculture and Rural Development (MARD) holds the responsibility for providing policy guidance and overseeing agriculture and rural development in Vietnam. In addition, MARD plays a significant role in the development of water resource infrastructure, including irrigation, flood control, and coastal defenses. The Ministry of Natural Resources and Environment (MONRE) takes charge of managing the country's land, air, and water resources, and serves as the lead ministry for climate change policy in Vietnam. The Ministry of Planning and Investment (MPI) has the overarching responsibility for national and regional planning processes and provides guidance for infrastructure investments (World Bank, 2016).

However, these challenges are compounded by the fragmentation of data, information, and analysis among different research institutions, which often fall under specific sectoral ministries. Additionally, there is a lack of data-sharing agreements and limited collaboration among these institutions (World Bank, 2016). This fragmentation and limited collaboration hinder effective decision-making and planning for the Mekong Delta's development and resilience.

INSTITUTIONS	RESPONSIBILITIES
The Ministry of Planning and Investment (MPI)	oversees the overall national, regional, planning processes, and promotes and guides infrastructure investments
The Ministry of Natural Resources and Environment (MONRE)	managing the nation's land, air, and water resources, and is also Vietnam's lead ministry for climate change policy
The Ministry of Agriculture and Rural Development (MARD)	agriculture and rural development, water resource infrastructure including irrigation, flood control, and coastal defenses
The South-West Steering Committee	limited in its mandate from taking a stronger coordination role, especially with regard to the implementation of policies and investments

Figure 1.15. Institutions of Vietnam

Institutional landscape - Mekong River

The Mekong River Commission (MRC) was established in 1995 as an advisory body comprising Cambodia, Laos, Thailand, and Vietnam. Its primary purpose is to conduct research, surveys, and coordination of water-related resource management in the Lower Mekong Basin. While the MRC does not possess the authority to halt the construction of dams on the mainstream of the Mekong, it plays a significant advisory role through the Procedures for Notification, Prior Consultation, and Agreement (PNPCA) process.

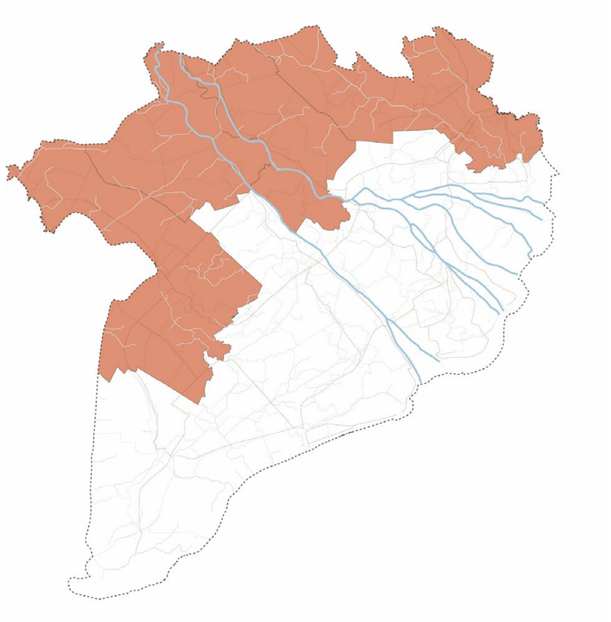
Funded by the member countries and donors, including foreign governments, the MRC's PNPCA process involves a comprehensive review by its members of the potential benefits and risks associated with mainstream Mekong projects. Environmental, safety, development, and other related concerns are taken into account during this months-long process. It is important to note that the decisions made by the MRC are not legally binding, and member countries are not obligated to adhere to its recommendations or decisions. The MRC's role primarily revolves around providing advisory guidance and facilitating cooperation among the member countries in managing the Mekong's resources.

INSTITUTIONS	RESPONSIBILITIES
The Mekong River Commission (MRC)	provides research, surveys and coordination of development on the management of water-related resources in the Lower Mekong Basin. No country is bound to abide by the decisions of the MRC.
The Lancang-Mekong Cooperation (LMC)	acts as China's development arm along the Mekong river, facilitating projects including the Laos-China Railway; has not elevated hydropower generation as a focal point
The Greater Mekong Subregion (GMS)	promotes economic growth and development using economic corridor investment zones that extend along major highways connecting centers of economic activity.

Figure 1.16. Institutions of Mekong River countries

PROBLEM STATEMENT

Climate change has brought major shocks to agricultural livelihoods and ecosystems in the Mekong Delta of Vietnam. The current rice production models are no longer sustainable under the climate threats. The geopolitical relations of the Mekong River countries for basin management also exacerbate the climate problems facing the delta. Therefore, spatial planning for adaptation to climate change in agricultural systems and collaboration in stakeholders and institutions will be necessary.



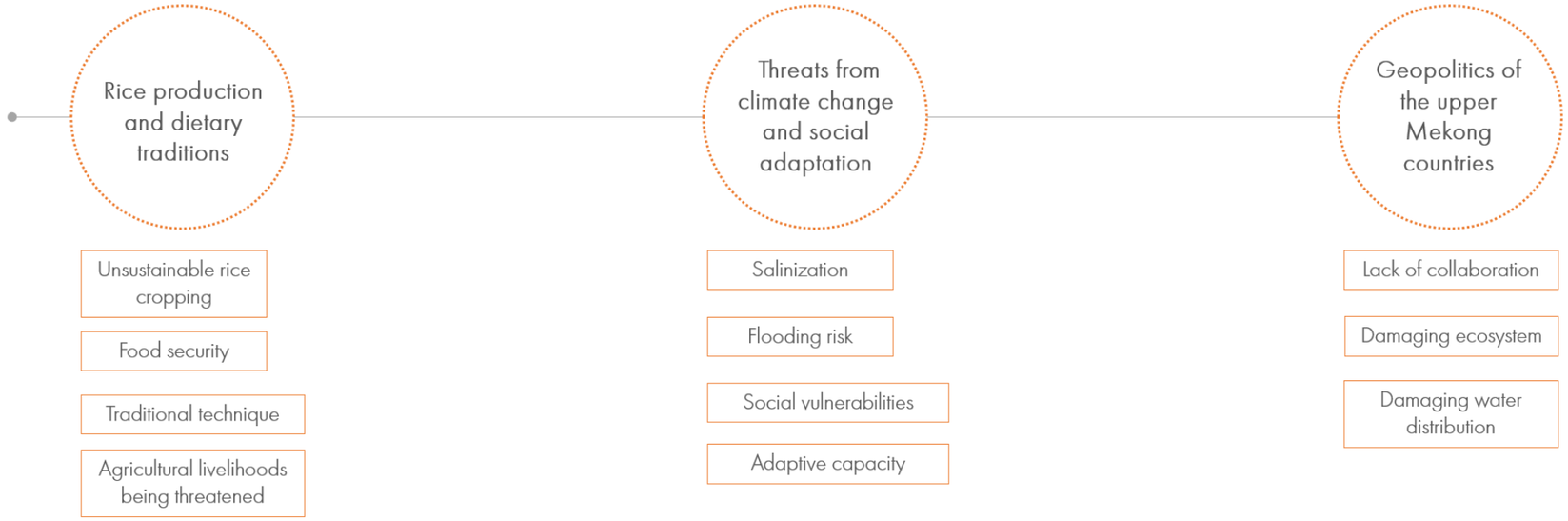


Figure 1.17. Problrm statement

02 METHODOLOGY

Research questions

Theoretical background

Conceptual framework

Methodological framework

Source: https://pixabay.com/zh/photos/inle-lake-myanmar-old-woman-boat-4634117/

RESEARCH AIMS

(1) This thesis aims to increase the climate resilience and sustainability of the Mekong Delta's societies, ecosystems, and natural resources through targeted and climate-resilient spatial planning of food systems, starting with rice-based food production, and to create new economic opportunities for its sustainable development.

(2) At the institutional level, the goal is to integrate leadership, coordination, and funding for the governance of the transition to sustainable agriculture in the Mekong Delta, combining top-down planning with bottom-up action.

(3) To develop a common language for integration and communication with different stakeholders, to address cross-border cooperation in governance, and to mitigate the contradictions between traditional lifestyles and climate adaptation measures.

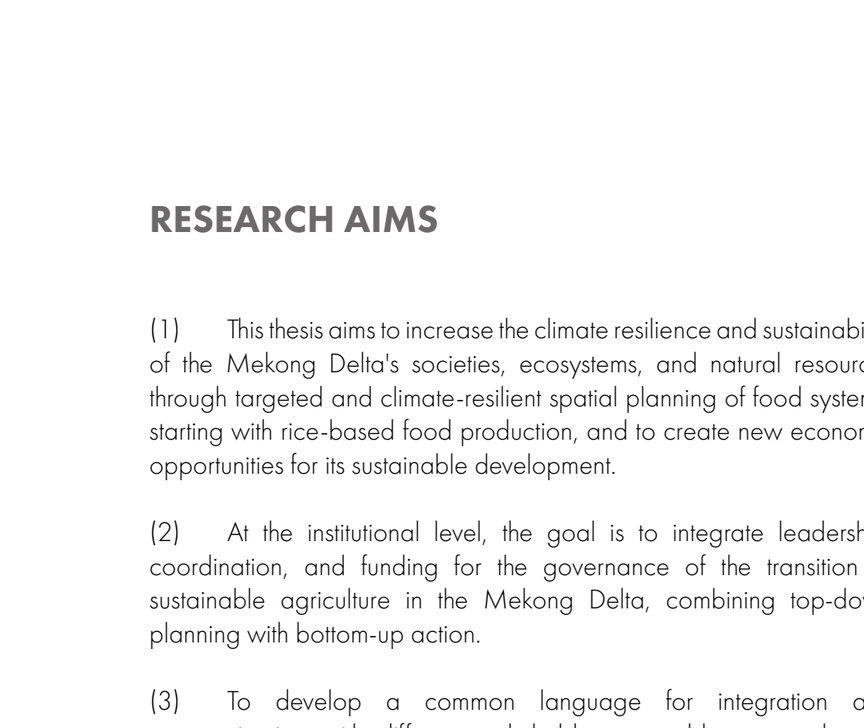


Figure 2.1. Research aims

RESEARCH QUESTIONS

Main research question: How can climate adaptation strategies intervene in the agricultural production chain of rice and social engagement while creating economic opportunities and environmental benefits in the Mekong Delta of Vietnam?

Sub-RQ1: What is the knowledge gap between the current planning policies and research, and the problems in the agriculture system regarding climate change effect?

Sub-RQ2: What are the challenges and opportunities for climate adaptation strategies?

Sub-RQ3: How can farmers and citizens adapt to climate change risk by developing a climate-resilient agriculture system while maintaining the quality of life in urban and rural areas?

Sub-RQ4: How can local experiences guide the change in rice production and water management to improve resilience through agricultural transition toolboxes?

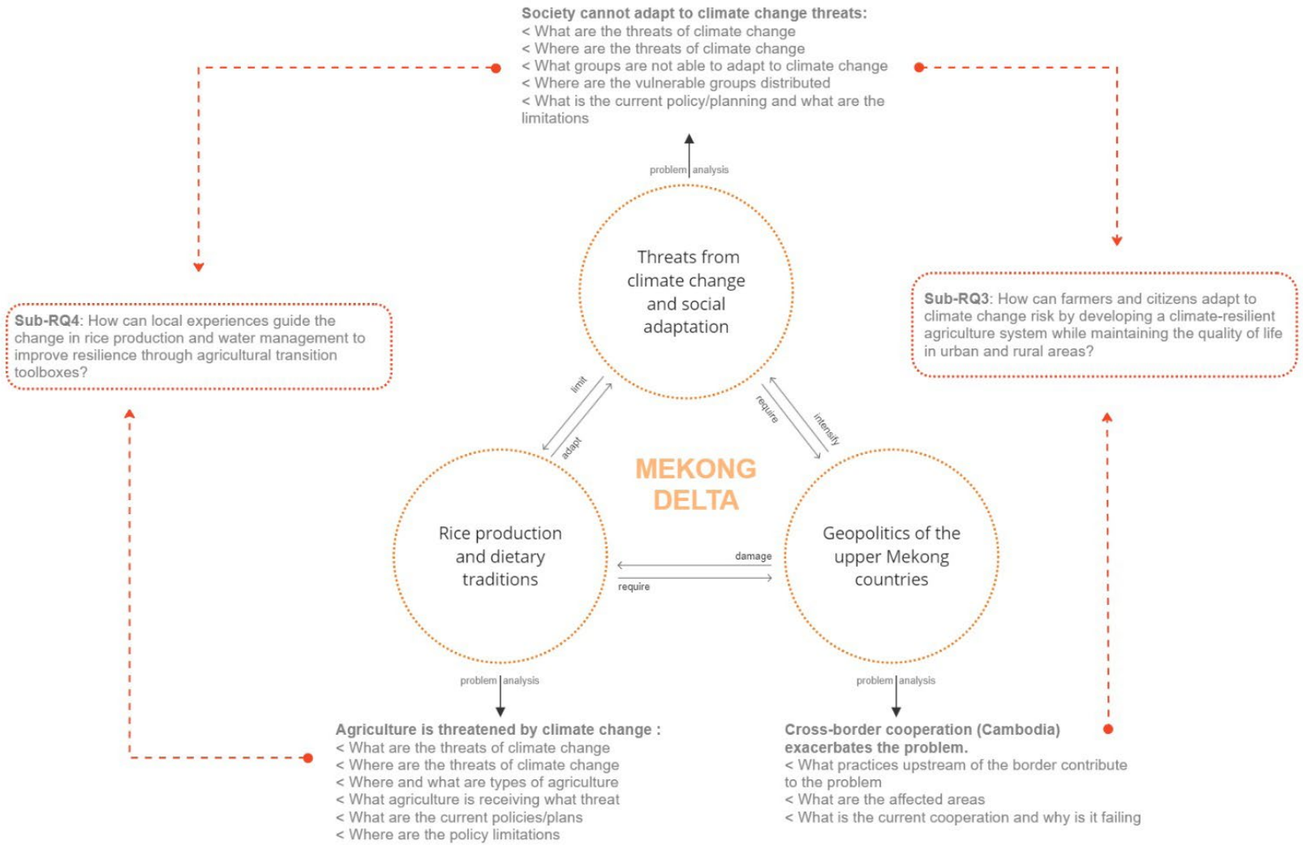


Figure 2.2. Research questions

THEORETICAL BACKGROUND

(1) Adaptive capacity

The IPCC defines adaptive capacity as "the ability or potential of a system to respond successfully to climate variability and change" (Andger, 2007). While the ESPON study aims to provide a comprehensive and consistent mapping of adaptive capacity across the European Union, it focuses on societal-wide assessment. ESPON adopts a systematic approach by utilizing various indicators to assess adaptive capacity in five dimensions: knowledge and awareness, technology, infrastructure, institutions, and economic resources. These dimensions can be further aggregated into three key dimensions: awareness, ability, and action, which collectively influence adaptive capacity (Kruse, 2011).

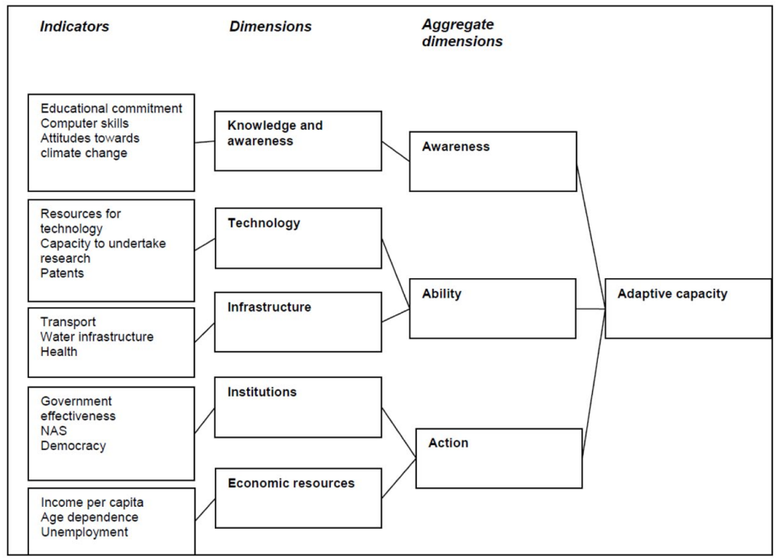


Figure 2.3. Adaptive capacity assessment framework
source: Suk, J. E., Ebi, K. L., Vose, D., Wint, W., Alexander, N., Mintiens, K., & Semenza, J. C. (2014). Indicators for tracking European vulnerabilities to the risks of infectious disease transmission due to climate change. International journal of environmental research and public health, 11(2), 2218-2235.

(2) Transition management

The theory is structured in a modular way, encompassing various elements that contribute to its overall framework. These elements include a depiction of the transition dynamic, delineating the distinct stages of the transition process. Additionally, a three-level analytical hierarchy comprising the 'niche', 'regime', and 'landscape' provides a comprehensive structure

for comprehending transition processes. The theory incorporates a diverse range of future-oriented visioning devices such as goals, visions, pathways, and intermediate objectives. Furthermore, it emphasizes a practical approach to activities through arenas and experiments. Underlying the theory is a broad 'philosophy of governance' that places importance on decision-making amid uncertainty and the gradual adaptation of existing development pathways to align with long-term objectives (Loorbach, 2010).

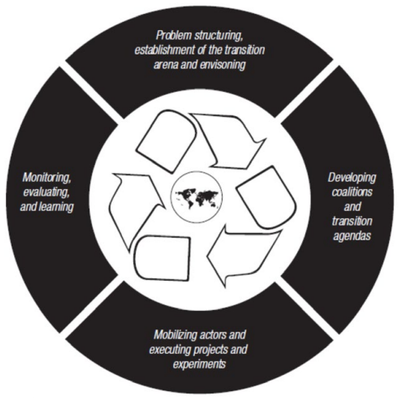


Figure 2.4. Transitional management structure
source: Loorbach, D. (2007). Transition management. New mode of governance for sustainable development. Utrecht: International Books.

(5) Boundary spanning

A boundary object is a shared entity that is interpreted or utilized differently by multiple communities (Star and Griesemer, 1989). The presence of boundary objects, such as infrastructures that traverse administrative and sectoral boundaries, can prompt actors to reevaluate their own boundaries and reassess their judgments. These boundaries arise from decisions or assessments made by decision-makers, analysts, scientists, or practitioners. As decision-making becomes increasingly complex and dynamic, individuals within organizations find themselves operating at the interface between internal and external realms, grappling with the present and future. These boundary spanners, whether individuals or subsystems, occupy the periphery of an organization and engage with the broader issues by exchanging information with the organizational environment. They actively transcend disciplinary, institutional, geographic, temporal, and sense-making boundaries (Warner, 2010).

(6) Traditional ecological technology (Lo-Tek)

Lo-TEK, a concept introduced by Julia Watson, an urban design lecturer at Harvard and Columbia Universities, refers to resilient infrastructure created by indigenous communities based on traditional ecological knowledge (TEK) (Watson, 2021). Lo-TEK embodies principles of sustainability, aligning with contemporary values of low energy consumption, minimal environmental impact, and cost-effectiveness, while fostering intricate nature-based innovations. TEK, a field of study in anthropology, encompasses a wealth of knowledge, practices, and beliefs that have been transmitted across generations through traditional songs, origin stories, and daily life.

Lo-TEK empowers humans to harness ecosystem energy and adapt to environmental challenges by employing soft and symbiotic living systems. By engaging directly with nature, Lo-TEK emphasizes sustainable resource management rather than exploitation. It fosters symbiosis among species and places biodiversity at the core of building sustainable technologies (Watson, 2019).

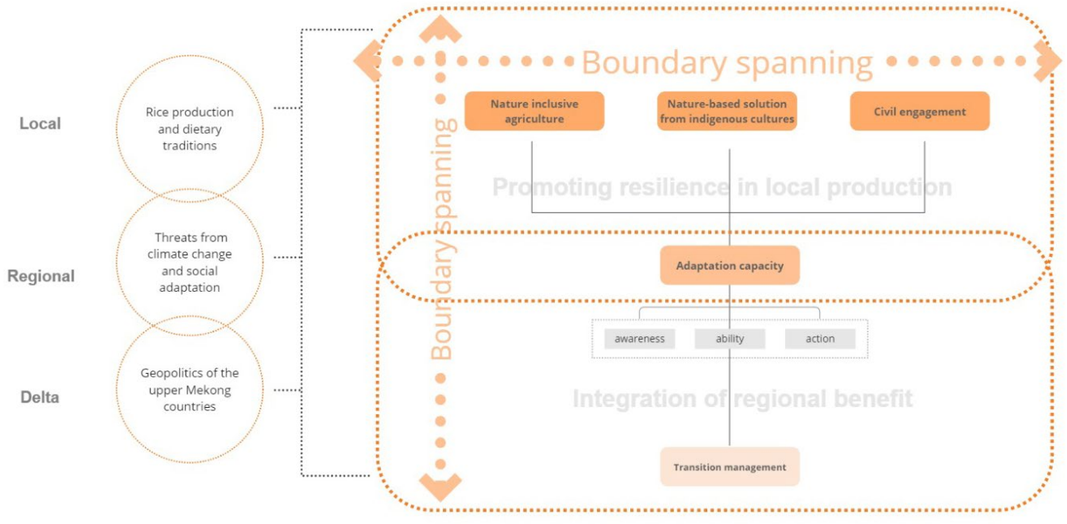
(7) Nature-inclusive agriculture

Nature-inclusive agriculture is a sustainable farming approach that integrates resilient food production with ecosystem preservation. By leveraging natural processes of ecosystem development, this agricultural model reduces the strain on ecosystems and enhances biodiversity recovery (Runhaar, 2016).

The key principles of nature-inclusive agriculture include:
- Emphasizing the use of ecosystem services over external inputs in farming practices.
- Minimizing environmental pressures and maximizing contributions to "non-functional" biodiversity and landscape quality. This involves conserving, improving, and harnessing the services provided by water and soil.
- Adopting measures to minimize and close harmful emissions to water, soil, and air.
- Constructing and preserving landscape elements that enhance the ecological functionality of the agricultural system.

CONCEPTUAL FRAMEWORK

The conceptual framework is based on the problem field and research questions described earlier, defining rice production, climate change, and upstream Mekong issues at different scales of local, regional, and delta. As mentioned earlier, the increasingly unsustainable rice production practices and the threats of climate change are the main problems facing the northern upper Mekong Delta. From a local perspective, the strategy focuses on the transformation of rice production and the adaptation of livelihoods of farmers and other related groups. A nature-based solution based on local indigenous agricultural traditions will be able to establish a relationship between the agricultural transformation process with nature and the farmers' daily life culture and historical customs; and gradually build up the resilience of local agricultural production from the bottom up while respecting the culture of the place. On this basis, adaptation capacity allows to intervene in regional climate change issues on a larger scale, and to build up the adaptation of rice production and other agricultural systems in the Mekong Delta to climate change in the three dimensions of awareness, ability and action, including public awareness, technology, infrastructure, institutions and economic resources. At the delta scale, the concepts of soft planning and transitional management will enable cooperation among the upper Mekong Delta countries.While the boundary spanning can connect the interests of different stakeholders in different areas and time dimensions, and coordinate the strategies and responsibilities of each scale and sector.



40 Figure 2.5. Conceptual framework

INTENDED OUTCOMES

The analysis results of the research and spatial planning will provide an overview and insight for society, government, and agencies across boundaries to build a vision that communicates planning performance and open communication.
This will be conducted through a set of principles, toolboxes, and assessment methods that form a planning framework to develop a common language of communication for civic education, stakeholder integration, and evaluation of planning performances.
A study of local experience, traditions, and history in climate adaptation will help develop spatial planning strategies from the bottom up, enriching the toolbox of agricultural transformation from a site-specific approach, and enhancing the cultural and traditional aspects of design. Several pilot projects will be conducted in specific areas as testing for the methods and intervention.

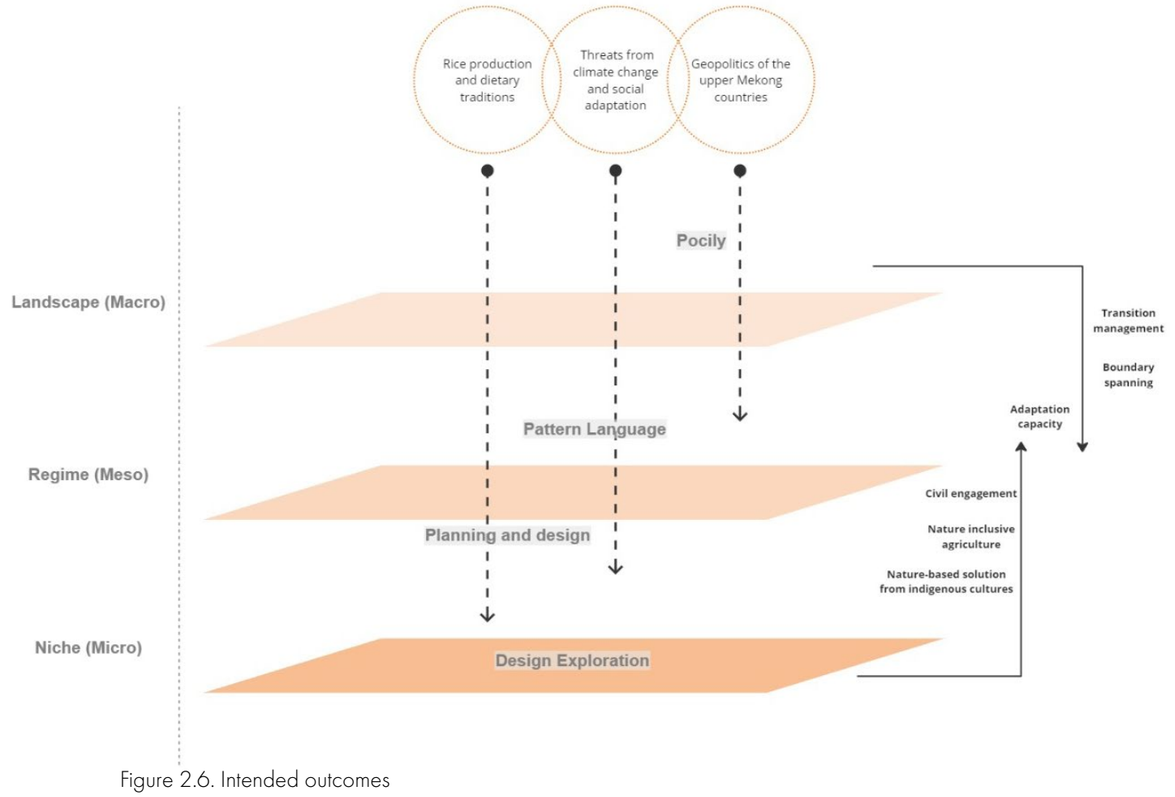


Figure 2.6. Intended outcomes

METHODS

(1) Literature Review

Through literature research and study, the impact of climate change on agriculture and vulnerable populations in the Mekong Delta and its causes, as well as the coping strategies and measures proposed in previous studies, will be compiled; by reading relevant policies and current plans, as well as proposals from different organizations, will inform the background and possible directions of the project; learning from case studies of agricultural transformation and social adaptation in different deltas around the world will help me to synthesize existing tools and propose appropriate strategies for the site. The best practices of agricultural transformation and social adaptation in different deltas around the world will help me to take stock of existing coping tools and propose appropriate strategies for the sites.

(2) Mapping and data analysis

Collecting data and maps on demographics, economics, agricultural production, and climate change such as flooding and saltwater intrusion from various institutions will help me identify narrower areas of concern and populations. The data and analysis will need to be aggregated and summarized to produce a synthetic map that will guide the implied spatial structure and spatial planning.

(3) Pattern language

The pattern language will allow me to summarize spatial tools and local experiences in a systematic way, forming a toolbox and assessment network for the site. The pattern language will also form a common language and tool for communication and co-creation with stakeholders and will play an important role in public participation and civic education of the project.

(4) Research by design

The project will be designed in a series of pioneering areas, designed strategically through solid preliminary research and feedback from design practice. Knowledge and understanding will be generated through research into the effects of positive and systematic changes in design solutions and their context, leading to the further development of larger-scale planning strategies and applicability to other deltaic and rice-producing areas.

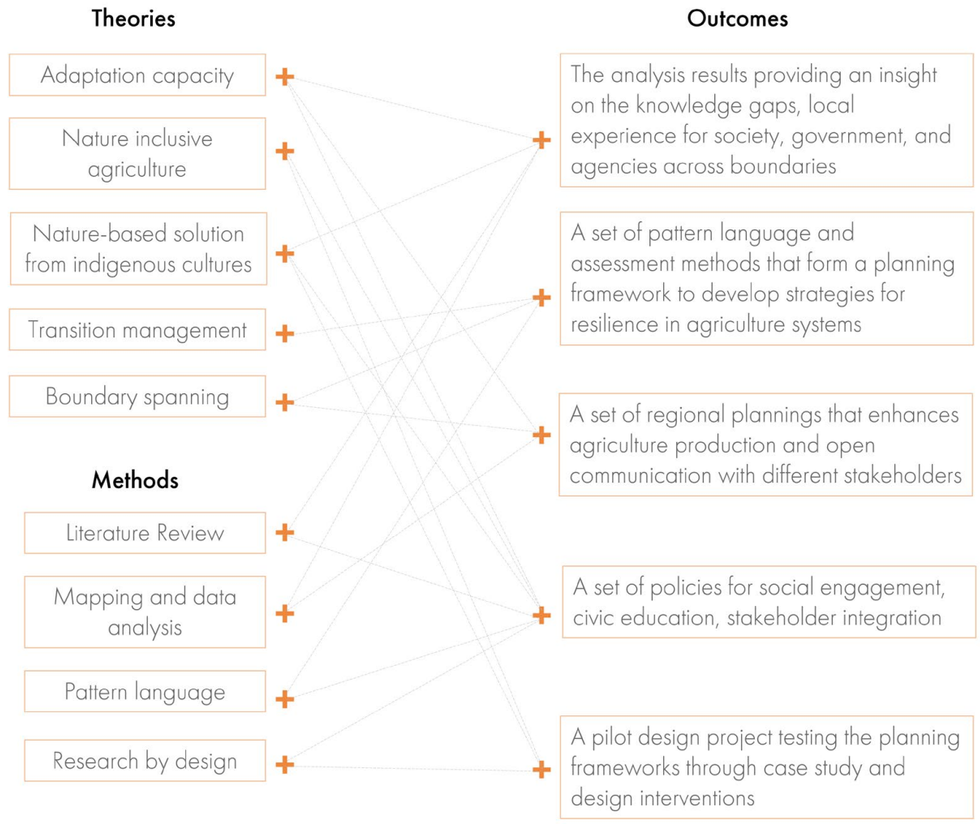


Figure 2.7. Methods and outcomes

METHODOLOGICAL FRAMEWORK

The methodological framework describes the basic path of this thesis. Starting from the problem field as the motivation and based on that, a spatial analysis is conducted to identify the key challenges and core areas of interest in the field. From the problem and the challenge, the purpose of the research and the research questions to achieve that purpose are introduced. In order to answer the questions several analyses will be made to examine the knowledge gap between the current state of rice production and several current planning projects as well as the specific spatial challenges and opportunities for the current state. A series of literature review, data acquisition and spatial analysis will guide the development of the pattern language for the subsequent spatial planning snd design. It will provide a direction for the development of this thesis in the coming period.

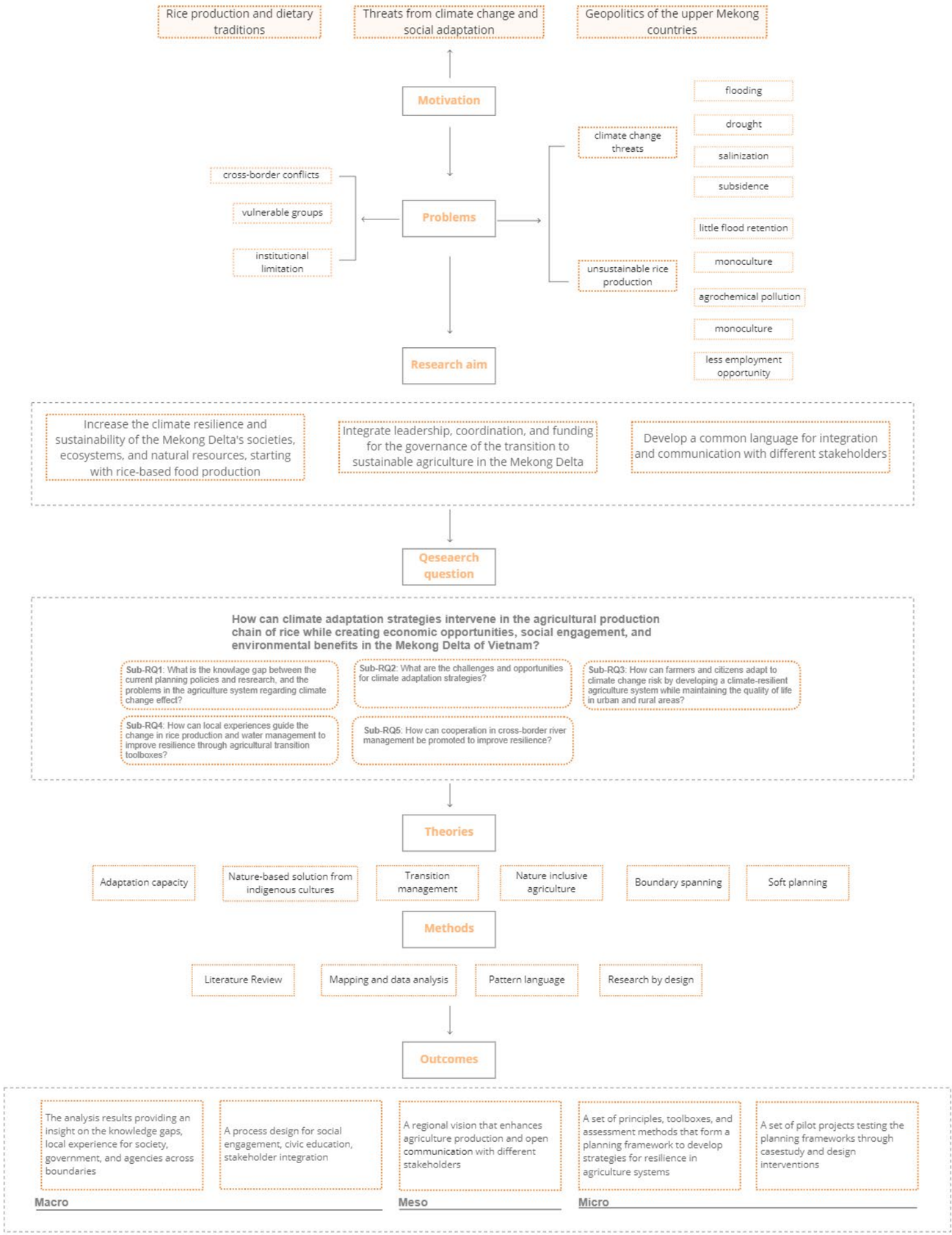


Figure 2.8. Methodological framework

03 ANALYSIS

Previous projects

Indigenous agriculture tradition

SWOT analysis

Study areas

PREVIOUS PROJECTS

There are many organizations in the Mekong Delta region that have ongoing or upcoming activities and projects that address climate change and regional development. A review of these projects and plans can increase synergy between this thesis and other activities and avoid duplication. A comparative analysis can also identify the knowledge gap between previous projects and the problems facing rice production in the delta, in order to further narrow down the scope of this thesis and enhance its focus.

ADB: **The Central Mekong Delta Connectivity Project** will construct the portion of Viet Nam's proposed Second Southern Highway (SSH) that traverses the Mekong Delta region to the west of Ho Chi Minh City. The Project will remove these bottlenecks by completing the missing infrastructure for uninterrupted road access across the Mekong River Delta along the SSH artery.

GIZ: **Integrated Coastal Management Program** supports the Vietnamese authorities in strengthening the coastal areas, as well as piloting new and innovative techniques in climate-resilient measures (for example, bamboo T-fences for coastal erosion) and in alternative sustainable livelihood models (for example, floating rice in upper delta and so on).

DFAT: **Mekong Water Resources Program**, which aims to strengthen water governance across the Mekong region.

IFAD: **Project for Adaptation to Climate Change in the Mekong Delta** (AMD) in Ben Tre and Tra Vinh Provinces. The project will build the capacity of smallholder farmers, communities and local institutions to cope with the impacts of climate change and expand into sustainable, profitable enterprises. AMD will target poor communities, specifically women-headed and ethnic minority households.

JICA: JICA's proposed **investment in sluice gates** in the upper section of Ben Tre Province to maintain freshwater zones complements by focusing on investments to build the brackish zone. The project also builds on the

Table 3.1 Previous projects of Mekong Delta

Project	Organization	Scope	Scale	Location
The Central Mekong Delta Connectivity Project	Asian Development Bank (ADB)	Transportation and connectivity	Delta	An Giang, Kien Giang, Ca Mau
Coastal Management Program	Gesellschaft für Internationale Zusammenarbeit (GIZ)	Coastal climate resilience and livelihood	Province	An Giang, Kien Giang, Soc Trang
Mekong Water Resources Program	Department of Foreign Affairs and Trade (DFAT)	Water governance across the Mekong region	Delta	An Giang, Kien Giang, Soc
Investment in sluice gates	Japan International Cooperation Agency (JICA)	Investment to build the brackish zone and adaptive capacity	Community	Ben Tre, Tra Vinh
Pilot certified organic mangrove-shrimp program	International Union for Conservation of Nature and Natural Resources (IUCN)	support farmer participation and help reverse mangrove losses	Community	Ben Tre, Ca Mau
Mekong Delta Plan 2013	Dutch government	Different development strategies including considerations of climate change	Delta	Mekong Delta
Viet Nam National Adaptation Plan	United Nations Development Programme (UNDP)	Integrate climate change adaptation into the government's administration processes	Nation	Vietnam
Mekong Delta Integrated Climate Resilience and Sustainable Livelihoods Project	World Bank (WB)	Improve climate resilience of land and water management	Province	An Giang, Kien Giang, Ca Mau, Bac Lieu, Tra Vinh, Ben Tre

International Fund for Agricultural Development's Adaptation to Climate Change in the Mekong Delta Project in Ben Tre and Tra Vinh—which strengthens the adaptive capacity of rural communities and invests in salinity monitoring stations.

IUCN: the pilot certified **organic mangrove-shrimp program**, in which the IUCN and SNV Netherlands Development Organization are working with Ca Mau DARD, the Nhung Mien Forest Management Board, and Minh Phu, one of the world's largest seafood exporters, to support farmer participation and help reverse mangrove losses.

Dutch: The government has acknowledged the pressing threats faced by the Mekong Delta and has taken steps towards developing a comprehensive and spatially integrated approach to manage the present and future risks and opportunities in the region. In collaboration with the Netherlands government, a **Mekong Delta Plan** (MDP) was formulated in 2013. This plan assessed various development strategies, taking into account the implications of climate change. Concurrently, ongoing efforts are being made to establish scientific databases specific to the delta and conduct assessments on the impacts of climate change. These initiatives are crucial for informed decision-making and proactive management of the challenges in the Mekong Delta. (World Bank, 2016).

UNDP: **Viet Nam National Adaptation Plan**. This project supports the Government of Viet Nam's vision to strengthen its capability to effectively integrate climate change adaptation into the government's administration processes in priority sectors. These processes encompass policy formulation, development planning, budgeting, implementation, and monitoring and evaluation.

WB: **Mekong Delta Integrated Climate Resilience and Sustainable Livelihoods Project**. The project aims to strengthen the capacity for climate-smart planning and enhance the resilience of land and water management practices in specific provinces. Through this initiative, the goal is to improve the ability to respond to climate change challenges and incorporate climate considerations into decision-making processes (World Bank, 2016).

Policy gap

Most of the projects in the Mekong Delta are focused on building climate resilience along the delta coast, as well as agricultural livelihoods and local development in the region, such as mangrove protection, brackish zone construction, and water management. Most of the projects are located in the coastal provinces directly threatened by sea level rise, and most of the agricultural livelihood strategies are focused on coastal fisheries and aquaculture, while less attention is paid to the extensive rice and horticulture agricultural areas in the upper and middle delta.
In addition, most projects consider climate adaptation development strategies and interventions from a more technical perspective and apply them from a top-down approach. Certain projects remain at the theoretical level and have not yet been fully integrated into the decision making process. Thus, a bottom-up approach to local culture and everyday habits is a missing component.

Therefore, from the perspective of local indigenous agricultural traditions and the landscape typology and life patterns of the area of focus, this thesis analyzes and summarizes the possible strategies and principles for rice production in the middle and upper delta in order to provide direction for the later design and vision building.

INDIGENOUS AGRICULTURE TRADITION

Rice-fish/prawn Aquaculture

Rice-prawn farming is a traditional practice in freshwater areas of the Mekong Delta. It describes a system for raising prawn and rice together. Meantime rice-fish farming alos has a long history in Indonesia. Farmers have developed several systems that fit diffrerent areas (IIRR, 1992):

A. Fish culture (no rice) in wet season followed by dry season rice: appropriate in areas where flooding is deep.

B. Concurrent rice-fish (wet season) followed by dry season rice: done in areas where standing water is not so deep and water is sufficient to support dry season rice crop.

C. Fish culture throughout: done in areas where farmers prefer to raise fish instead of rice in the entire flooding season.

D. Concurrent rice-fish system during wet season: appropriate in areas where inundation and the risk against submergence of rice is low. On the other hand, water is not sufficient to support a dry season rice crop.

Figure 3.1. Rice-fish aquaculture
Source: www.agrifarming.in/rice-fish-farming

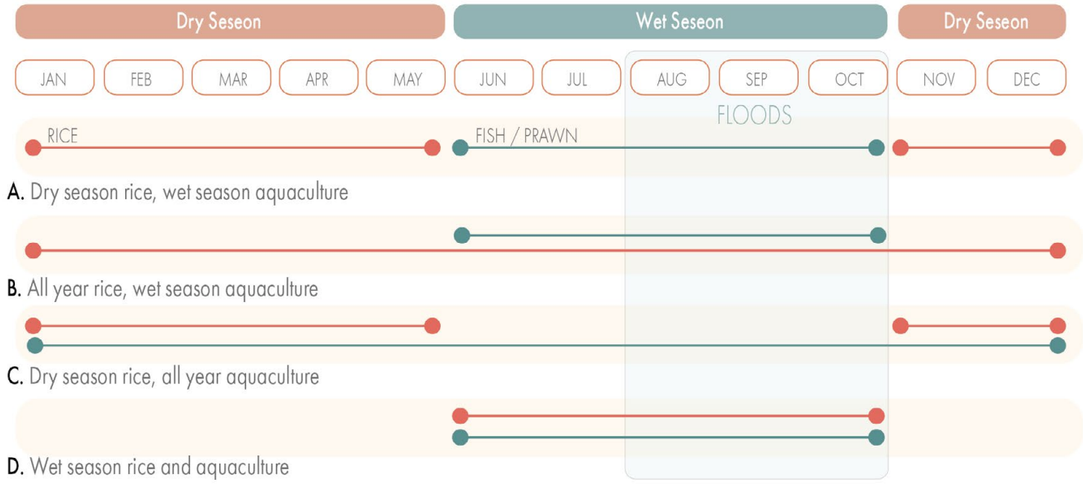


Figure 3.2. Time of rice-fish crops

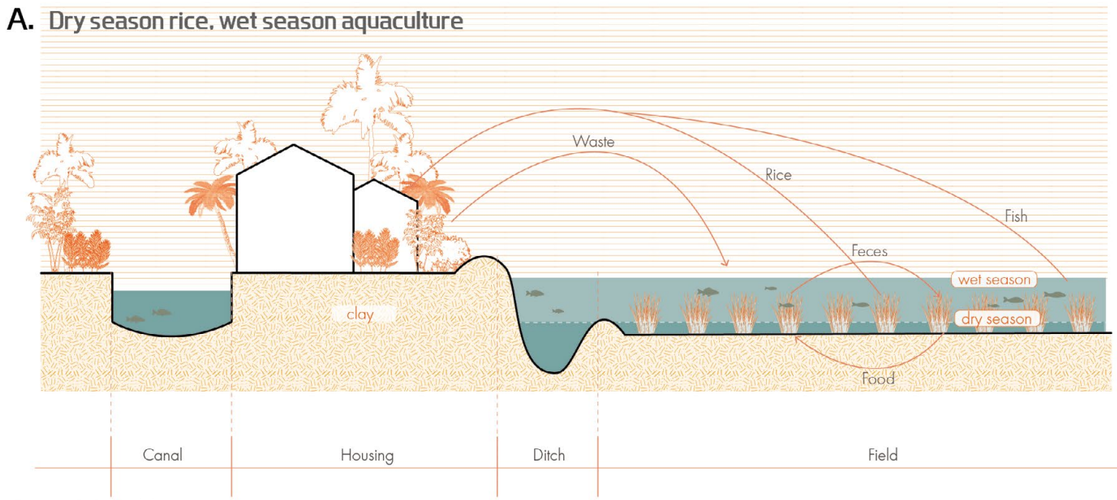


Figure 3.3. Field section type A

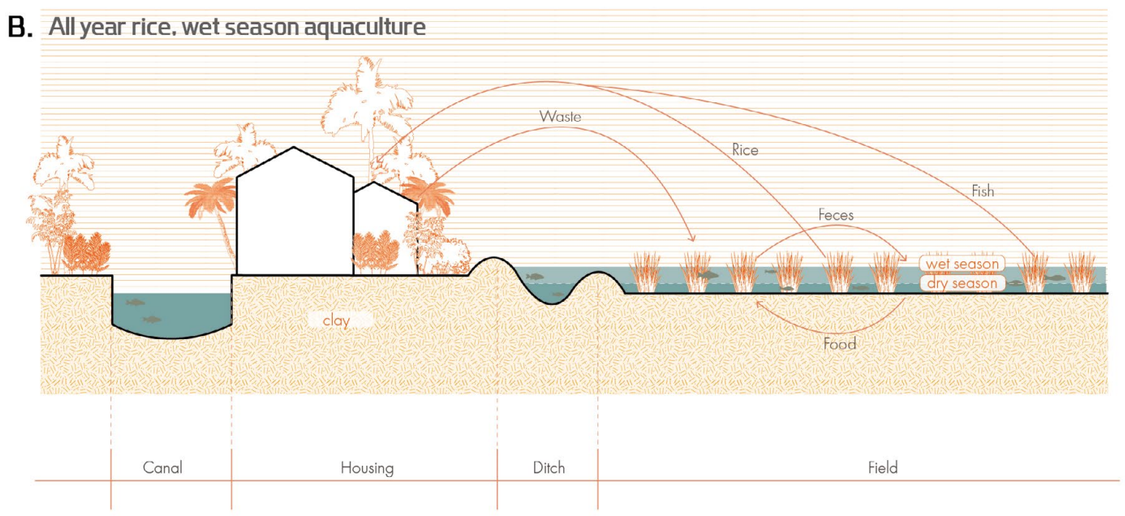


Figure 3.4. Field section type B

Mixed Rice-shrimp Aquaculture

For the past four decades, rice and shrimp farming have been practiced in rotation in the coastal region of the Mekong Delta. Rice cultivation takes place during the wet season when water salinity is low, while shrimp farming is carried out extensively and semi-intensively during the dry season when water salinity becomes too high for rice production to continue (IIRR, 1992).

The tidal flats in the coastal areas experience periodic flooding during high tides. In the dry season, the salinity levels typically exceed 5 ppt (per thousand), leading to fallow periods in most paddy fields. However, during the rainy months, the salinity decreases, allowing for rice cultivation. Farmers in these coastal areas of southern Vietnam generally have lower living standards compared to their counterparts in freshwater regions. To enhance their incomes, integrating freshwater prawn culture with rice cultivation during the rainy season, as well as practicing marine shrimp monoculture in the dry season, has been pursued as a means of economic improvement.

Figure 3.5. Mixed rice-shrimp aquaculture
Source: vietshrimp.net/ca-maus-organic-shrimp-solution-to-climate-change-adaptation/

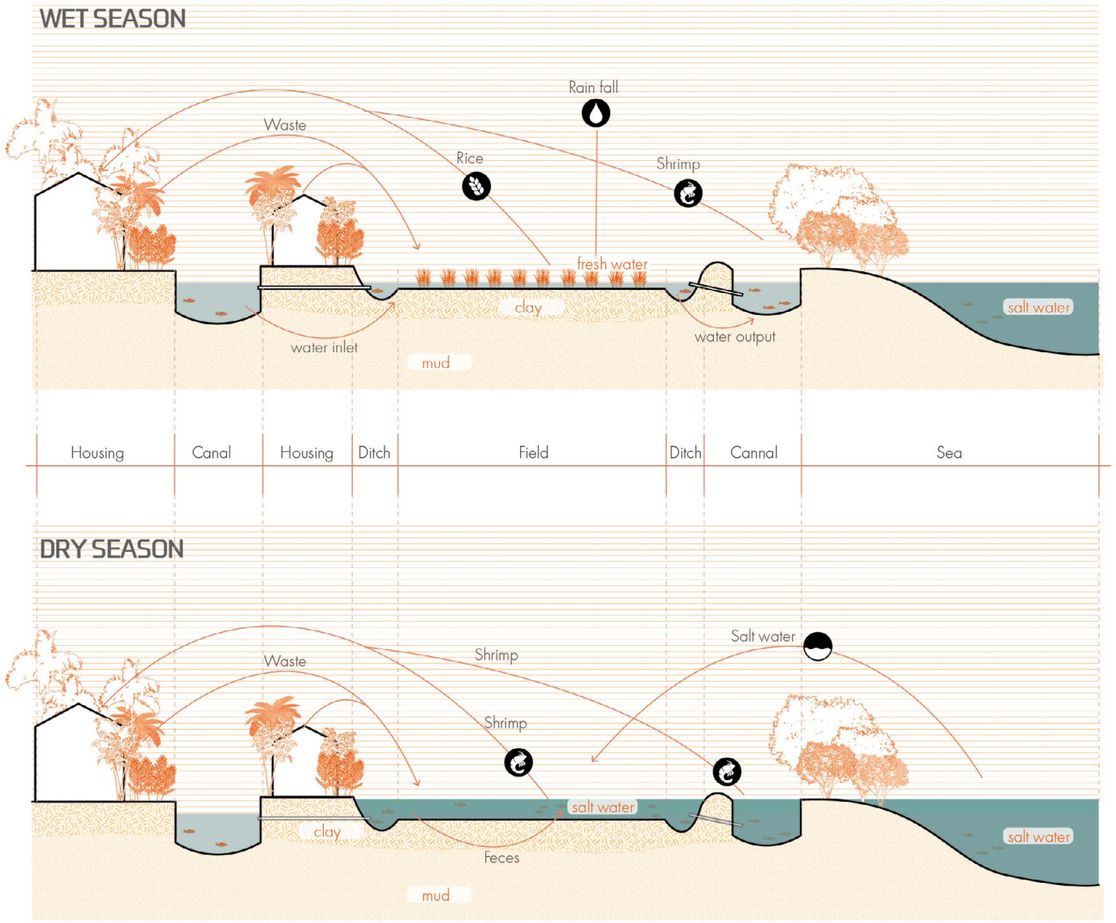


Figure 3.6. Field section

FIELD LAYOUT

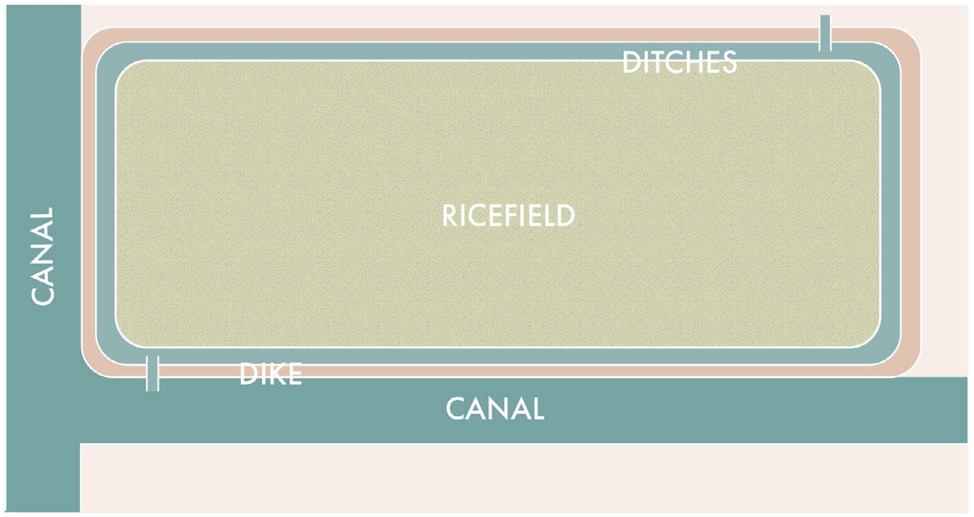


Figure 3.7. Feild layout

Floating Rice

Floating rice cultivation offers an adaptive solution to cope with increased flooding and rising water levels, while providing ecological benefits. In the face of more frequent flooding and climate extremes, floating rice exhibits flexibility in adapting to varying water levels, ensuring a certain level of rice production. The soil in floating rice fields is characterized by its softness and lighter composition, enriched with organic material, which contributes to the field's biodiversity (Van, 2015).

Traditionally, floating rice played a prominent role as the main staple crop in the Plain of Reeds and Long Xuyen Quadrangle. However, after 1975, the expansion and intensification of short-term high-yielding rice led to a rapid decline in floating rice cultivation. The area of floating rice decreased significantly from 500,000 hectares before 1975 to approximately 60 hectares in An Giang Province, with small remaining areas in Dong Thap Province by 2012. Furthermore, the diversity of floating rice varieties has been greatly reduced, dwindling from five to only one variety at present (IUCN, 2016).

Figure 3.8. Floating rice
Source: Le Hoang Vu. https://vietnamagriculture.nongnghiep.vn/floating-rice-the-unique-rice-variety-with-internodes-of-3--5m-long-d300152.html

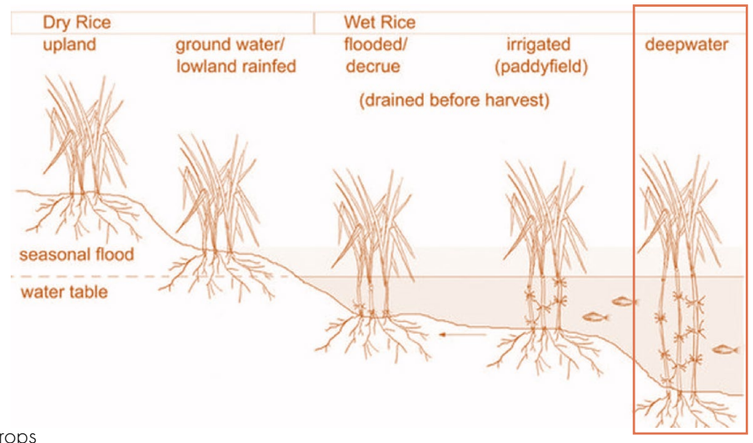
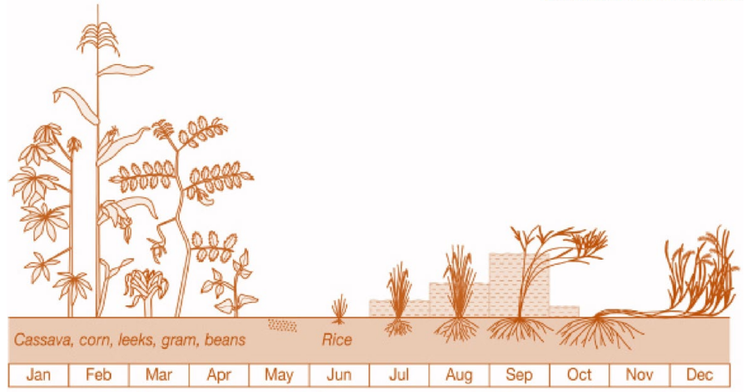


Figure 3.9. Rice crops
Dumaresq, D., van Nguyen, K., Pittock, J., Oo, M., Sok, K., van Hieu, T., & Blessington, L. (2020). The paradoxical values of traditional deep water floating rice systems. Global Food Security, 26, 100391.



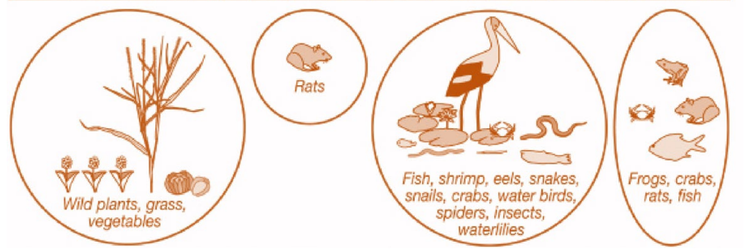


Figure 3.10. Growing process floating rice
Fuller, D. Q., Van Etten, J., Manning, K., Castillo, C., Kingwell-Banham, E., Weisskopf, A., ... & Hijmans, R. J. (2011). The contribution of rice agriculture and livestock pastoralism to prehistoric methane levels: An archaeological assessment. The Holocene, 21(5), 743-759.

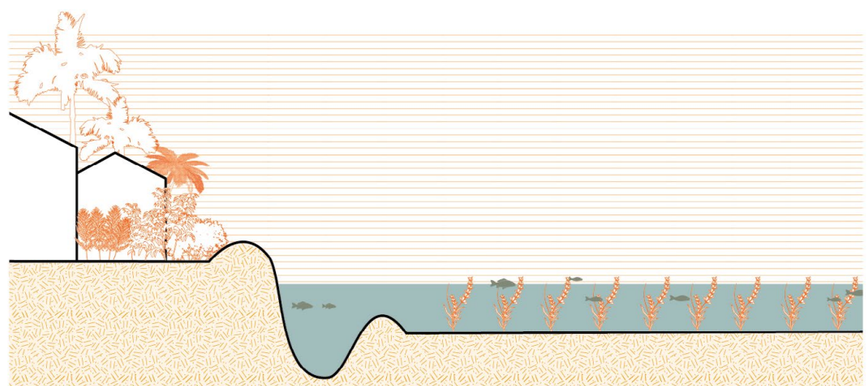


Figure 3.11. Field section

Traditional Uses of The Mangrove Ecosystem

The mangrove forests that line the coast of Vietnam serve multiple crucial functions. Firstly, they act as a natural barrier against erosion and typhoons, thereby reducing the need for extensive dike maintenance and coastal protection expenses. Additionally, mangroves provide valuable goods and services, including wood for fuel and energy, while also functioning as natural filters, improving water quality by trapping and removing pollutants (Orchard et al., 2015).

Moreover, mangrove forests serve as vital habitats for various coastal and marine species, serving as nurseries and foraging grounds. The unique structure and rich biodiversity of these forests create favorable conditions for traditional activities such as coastal village dwellings, traditional forestry practices, and traditional fisheries like fishing and crabbing (Hong & San, 1993).

Figure 3.12 Mangrove forest
Source: Harald Franzen/©GIZ www.bbc.com/travel/article/20170413-the-trees-keeping-vietnam-afloat

Figure 3.13. Mangrove forest
Source: www.bbc.com/travel/article/20170413-the-trees-keeping-vietnam-afloat

Figure 3.14. Traditional housing by mangrove forest
source: W

SWOT Analysis

The spatial analysis of the upper and middle Mekong Delta begins with a SWOT analysis that identifies the challenges and potential of the site and spatially maps out the areas of threat and potential. These areas can provide hints for further scaling analysis and guide the formulation of spatial strategies and principles, and are the spatial basis for the development of vision.

The weaknesses and threats of the Mekong Delta, as mentioned above, are mainly related to the unsustainability of rice production methods, the lack of adaptive capacity, and climate change and upstream hydropower construction. Its strength lies in its long history of rice cultivation and its experience in coping with floods during the rainy season. It is also a low-lying delta with a wide irrigation network and excellent agricultural cultivation conditions. In addition, the system of state ownership of all land will facilitate the implementation of planning and design. The opportunity is that the development of rice cultivation and other agricultural crop technologies offers many possibilities for diversification of agricultural production and ways to cope with climate change. But it also means, in part, that agricultural production will require less labor and fewer jobs for the poor and vulnerable. Rising environmental awareness and high market demand in international markets provide opportunities for improving rice production. At the same time, cross-border economic cooperation and investment and planning project proposals from various international organizations also offer economic and financial possibilities for the transformation of agricultural systems.

Figure 3.15. SWOT analysis

Figure 3.16. Mapping strength

STRENGTH

Vast agriculture land use: The large amount of rice based agricultural land provides a lot of potential for the development of flood retention and nature-inclusive agriculture.

Vast water network: The numerous canals and irrigation channels linking the Mekong River provide access for flooding during the extreme precipitation of the rainy season, and also connect various fields and ditches, allowing the entire system to work together to increase the room for river.

Sustainable double rice production: Some of the double rice systems that still exist in the northern region are more environmentally friendly, can accommodate more flooding and provide compatibility with traditional production methods such as rice-shrimp and rice-fish. Socio-economically, it also provides more employment opportunities for the poor.

Figure 3.17
source: www.worldatlas.com/articles/longest-rivers-in-vietnam.html

Figure 3.18
source: www.traveller.com.au/from-saigon-to-siem-reap-seeing--the-delta-dawn-on-the-mekong-h19hqn

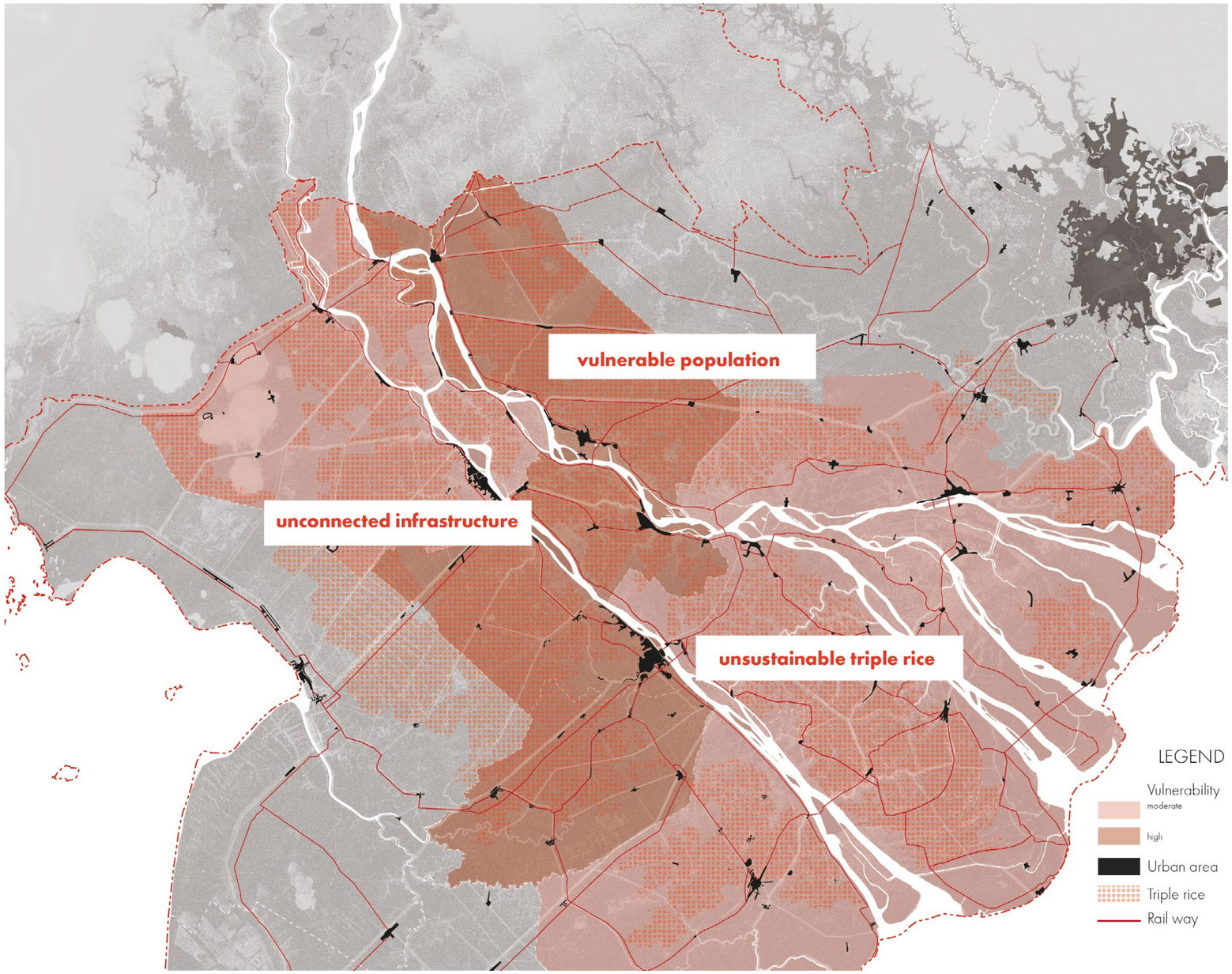


Figure 3.19. Mapping weakness

WEAKNESS

Vulnerable population: The northern and Mekong provinces are home to more poor and unemployed people and ethnic minority groups.

Unconnected infrastructure: The lack of connectivity and accessibility of the large transportation infrastructure in the north gives the region a much lower adaptive capacity.

Unsustainable triple rice production: Triple rice, which relies on hydraulic engineering and mechanization, is widely distributed in the delta plain, occupying a large number of flood retention areas and reducing employment and exacerbating poverty.

Figure 3.20.
source: www.mrcmekong.org/news-and-events/articles-and-stories/living-on-the-edge-of-the-rising-sea/

Figure 3.21.
source: en.vietnamplus.vn/mekong-delta-to-develop-1-million-hectares-of-highquality-rice/231572.vnp

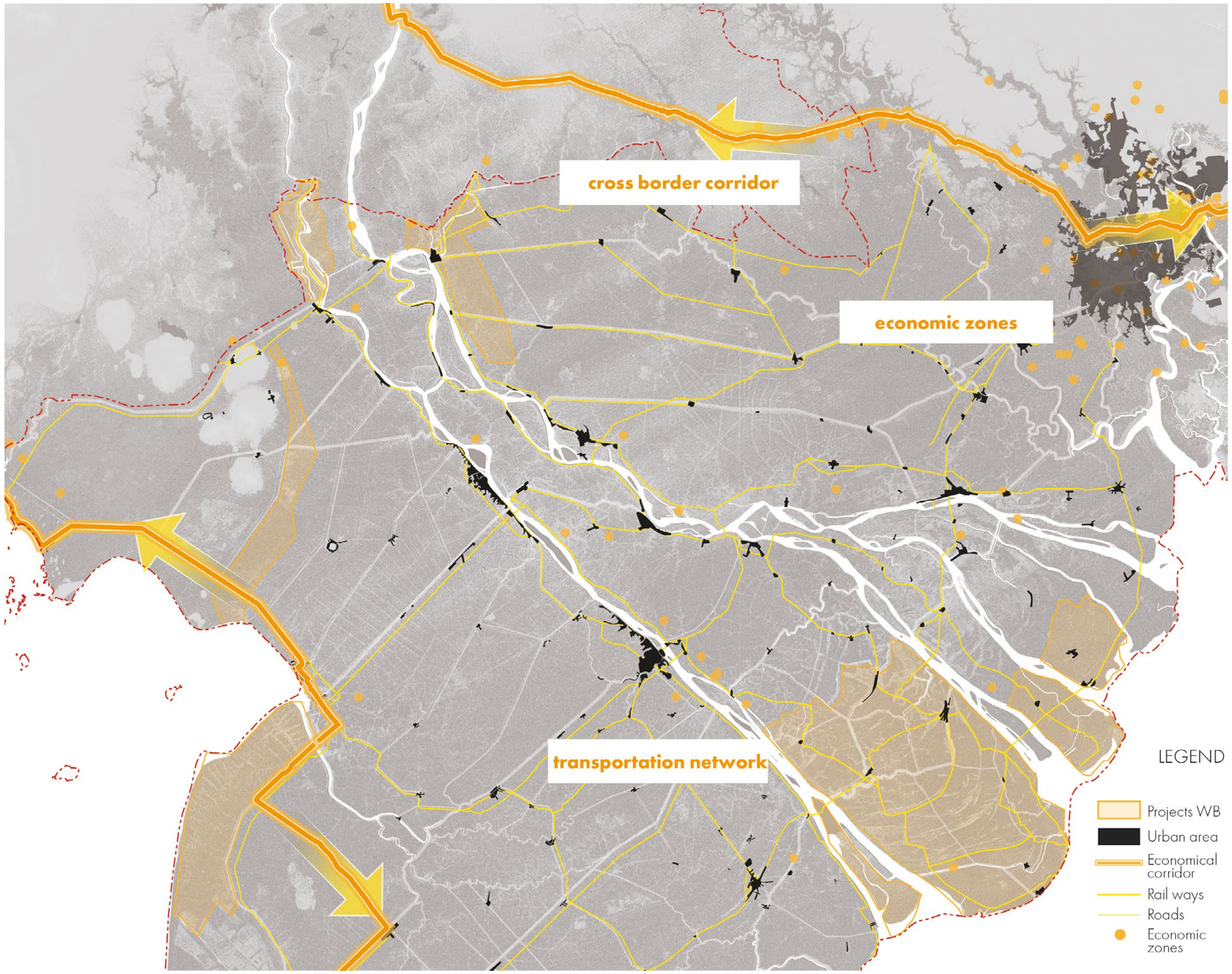


Figure 3.22. Mapping opportunities

OPPORTUNITY

Cross border corridor: The Mekong River Commission's regional development plan to establish an economic transport corridor linking the Mekong River Basin countries contributes to linking agricultural production areas and increasing regional transport connectivity.

Economic zones: A number of economic zones related to border trade and industrial development are located in large numbers in Ho Chi Minh City and some in the central delta such as Can Tho, providing space and economic base for the construction of agricultural production hubs.

Transportation network: The Delta's transportation network connects major cities and agricultural production areas, and also provides connectivity to economic corridors and economic regions, providing a spatial skeleton for regional agricultural development linkages.

Figure 3.23
source: www.bangkokpost.com/business/1596078/isan-economic-corridor-requested-by-private-sector

Figure 3.24
source: www.khmertimeskh.com/50963361/cambodia-to-establish-sihanoukville-multi-purpose-special-economic-zone/

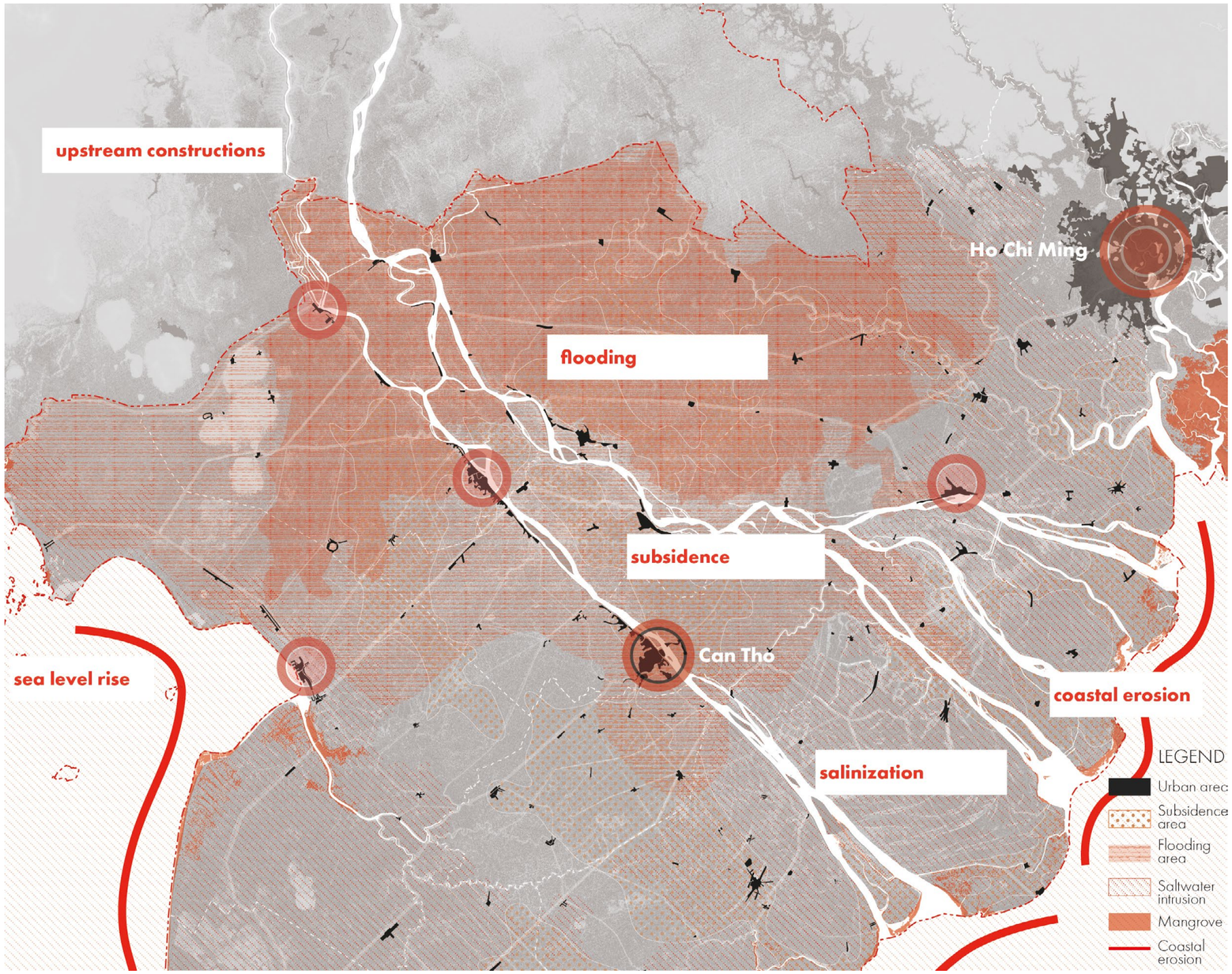


Figure 3.25. Mapping threats

THREAT

Flooding: The northern part of the country, as the front line for upstream river water, faces more flooding pressure during the rainy season as climate change intensifies.

Salinization: The rising sea level has caused the salinization area to expand inland, making it more difficult to produce rice along the southern coast, thus increasing the pressure on rice production in the northern region.

Subsidence: Salinization has also led to increased groundwater abstraction, which has put several coastal areas and densely populated cities at risk of subsidence.

Coastal erosion: Coastal areas are facing coastal erosion due to sea level rise and frequent extreme weather, so mangrove protection areas are especially important here.

Figure 3.26
source: www.snexplores.org/article/explainer-why-sea-level-rise-rate-varies-globally

Figure 3.27
source: vietnamnet.vn/en/salinity-intrusion-in-mekong-delta-exceeds-record-level-from-2016-616806.html

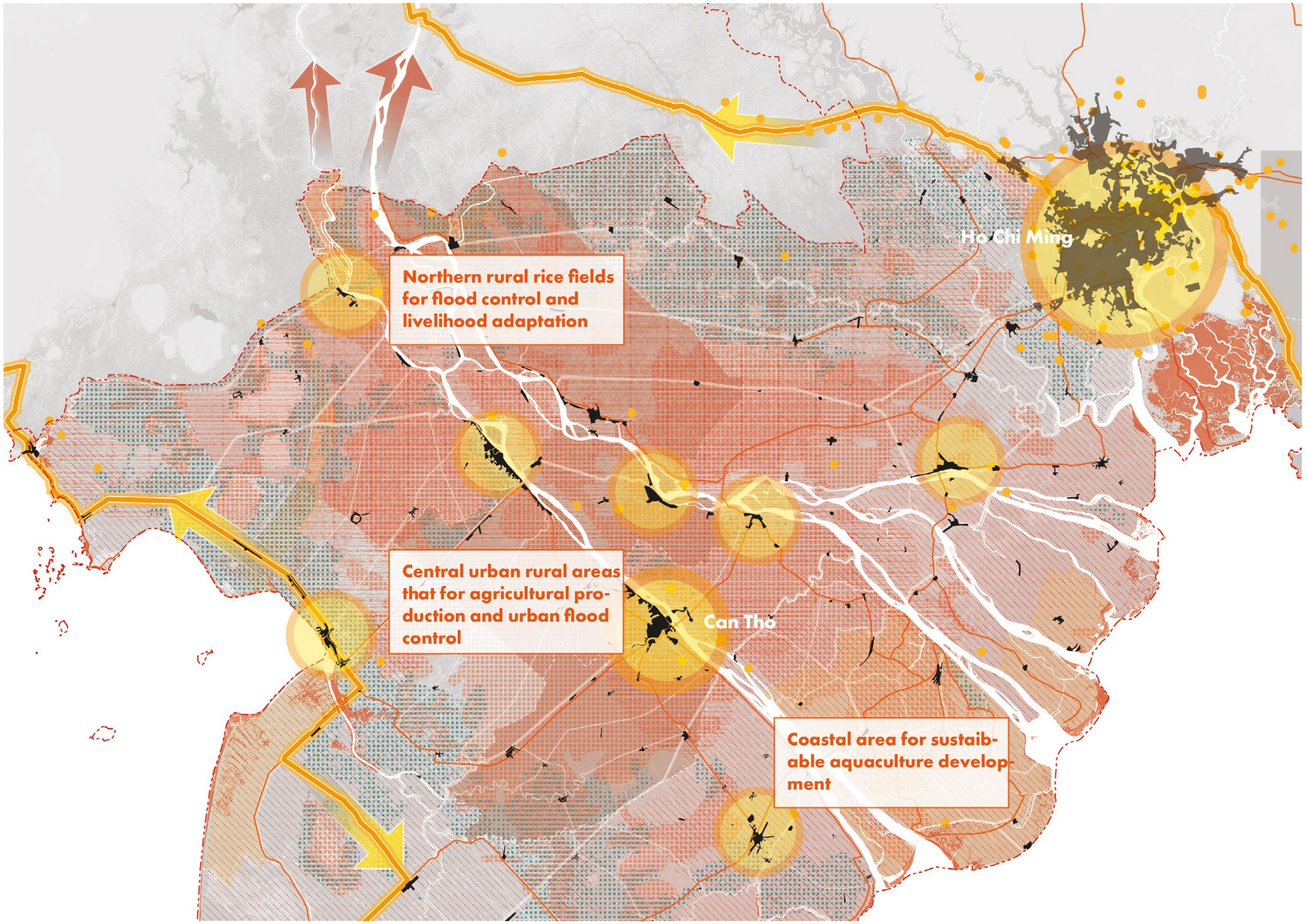


Figure 3.28. Conclusion map

CONCLUSION

The SWOT analysis overlaid with its spatial analysis shows that the northern region is more exposed to flood risk and faces greater poverty and employment pressure on vulnerable populations. The central region has greater potential for agricultural production and transformation, with large rice production areas and fruit forestry areas and the largest city in the delta, Can Tho, while the coastal region is more exposed to the threats of salinization and land subsidence brought about by sea level rise, and its triple rice production is no longer sufficient to meet the actual situation and needs urgent localized agricultural transformation.

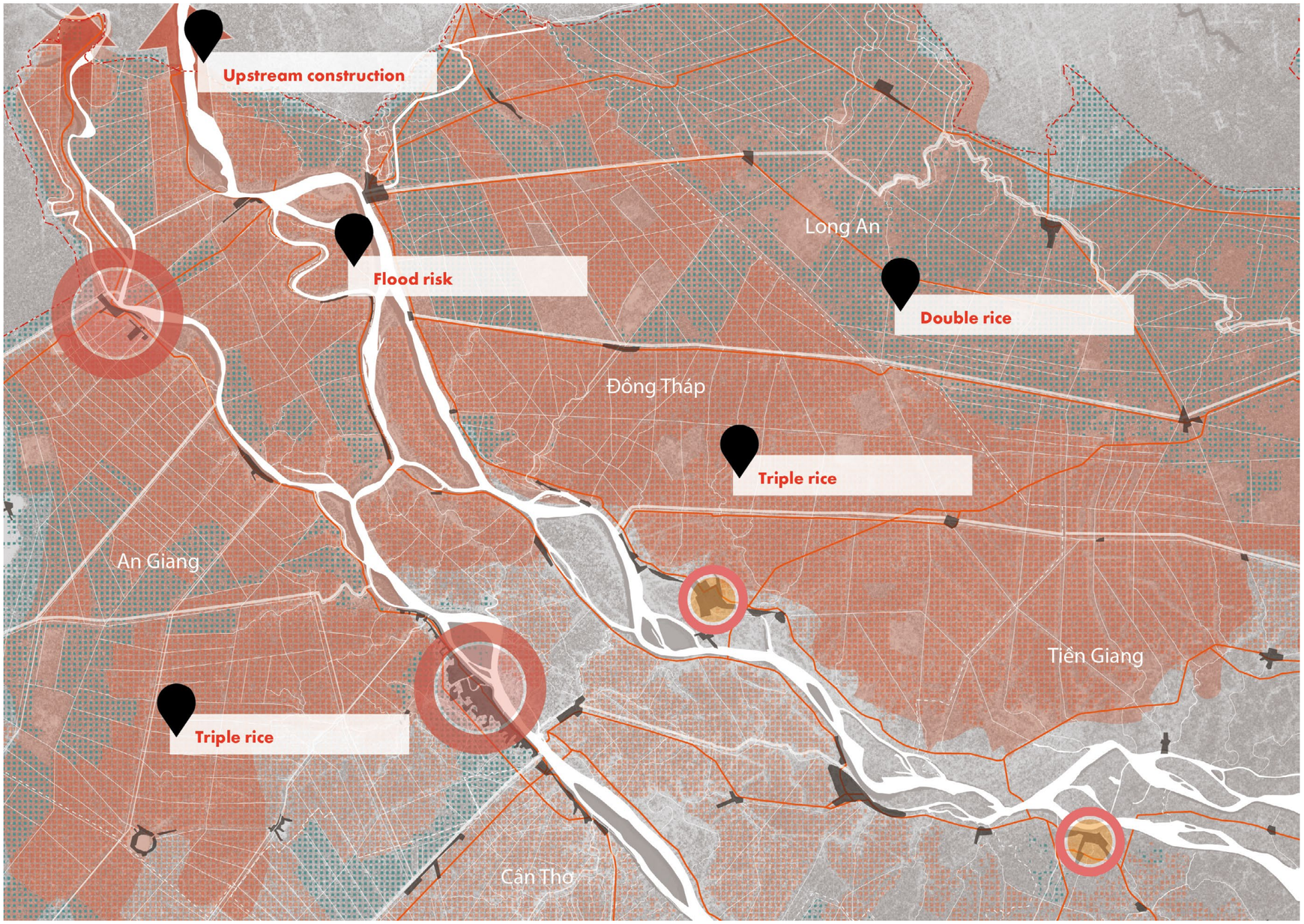
The spatial analysis therefore identifies three types of areas in the middle and upper delta that need to be scaled up to make different strategies:

A. Northern rural rice fields for flood control and livelihood adaptation;

B. Central urban rural areas that focus on agricultural production and urban flood control;

C. Coastal aquaculture areas for improved agricultural production of rice combined with aquatic products.

STUDY AREA



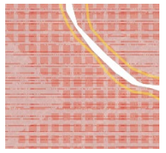
A. Northern rural rice fields for flood control and livelihood adaptation

Flood risk - flood retention, room for river
Triple rice - adapt to more sustainable crop
Upstream construction - cooperation
Vulnerability (ethinic people) - livelihood adaptation, more job opportunities through changing triple rice

LEGEND

- City Grade I
- City Grade II
- City Grade II
- Urban area
- Subsidence area
- Flooding area
- Saltwater intrusion
- Mangrove
- Water body
- Double rice
- Triple rice
- Natinal road
- Economical corridor

Figure 3.29. Study area A



Rural rice field

Charateristics

- The landscape is made up of intersecting river channels, consisting of a combination of mostly moderately open areas to very open areas.

- Characterized by straight river channels and vertically distributed rice fields with them.

- The land use is primarily agricultural, with the triple rice cropping being dominant.

- There is a contrast between the relatively dense spatial support of vegetation (strips, channels) and the predominantly open rice land. Settlement is distributed linearly along the canal structure.

Figure 3.30. Rural rice field map

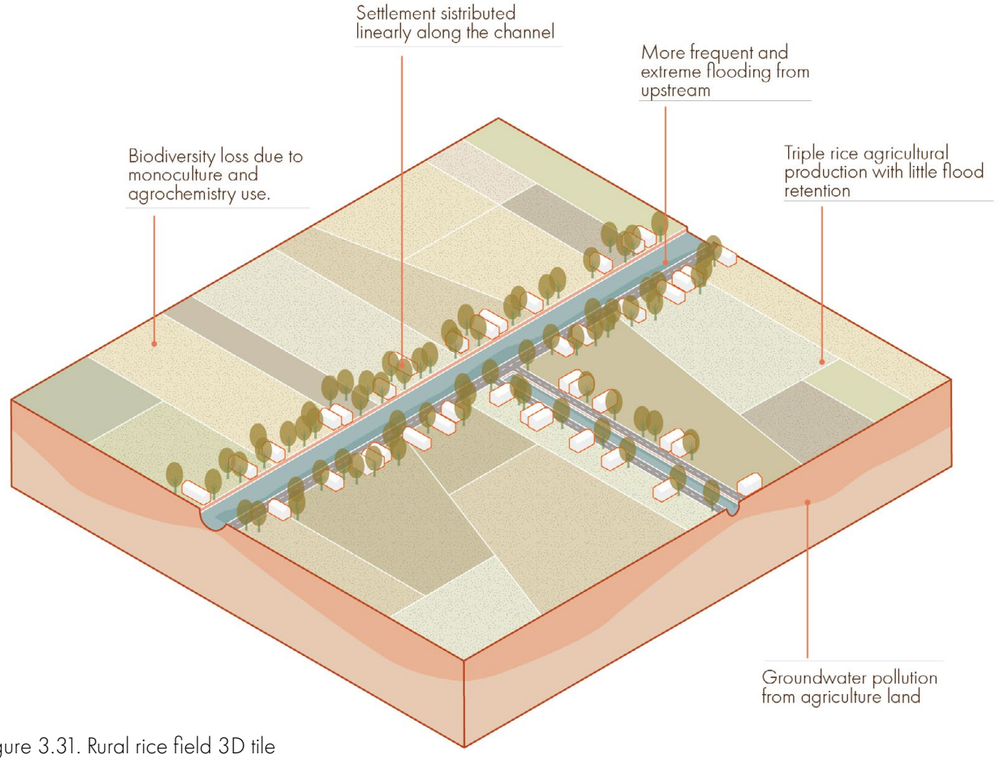


Figure 3.31. Rural rice field 3D tile

Challenges

- More frequent climate extremes such as flooding and droughts due to climate change and unsustainable agriculture production.

- Groundwater is polluted through seepage flow of agriculture. Groundwater-dependent vegetation is also threatened.

- Species disappear due to fertilizer application and pesticide poisoning.

- Vegetation diversity reduced. Species become scarce in agricultural land due to monoculture.

Preliminary Strategies

- **Floating rice**: flood retention, biodiversity
- **Mixed rice-fish aquaculture**: flood retention, biodiversity, pollution control
- **Nature-inclusive agriculture**: biodiversity, pollution control (Functional agrobiodiversity, Landscape diversity, Source areas and connecting zones)

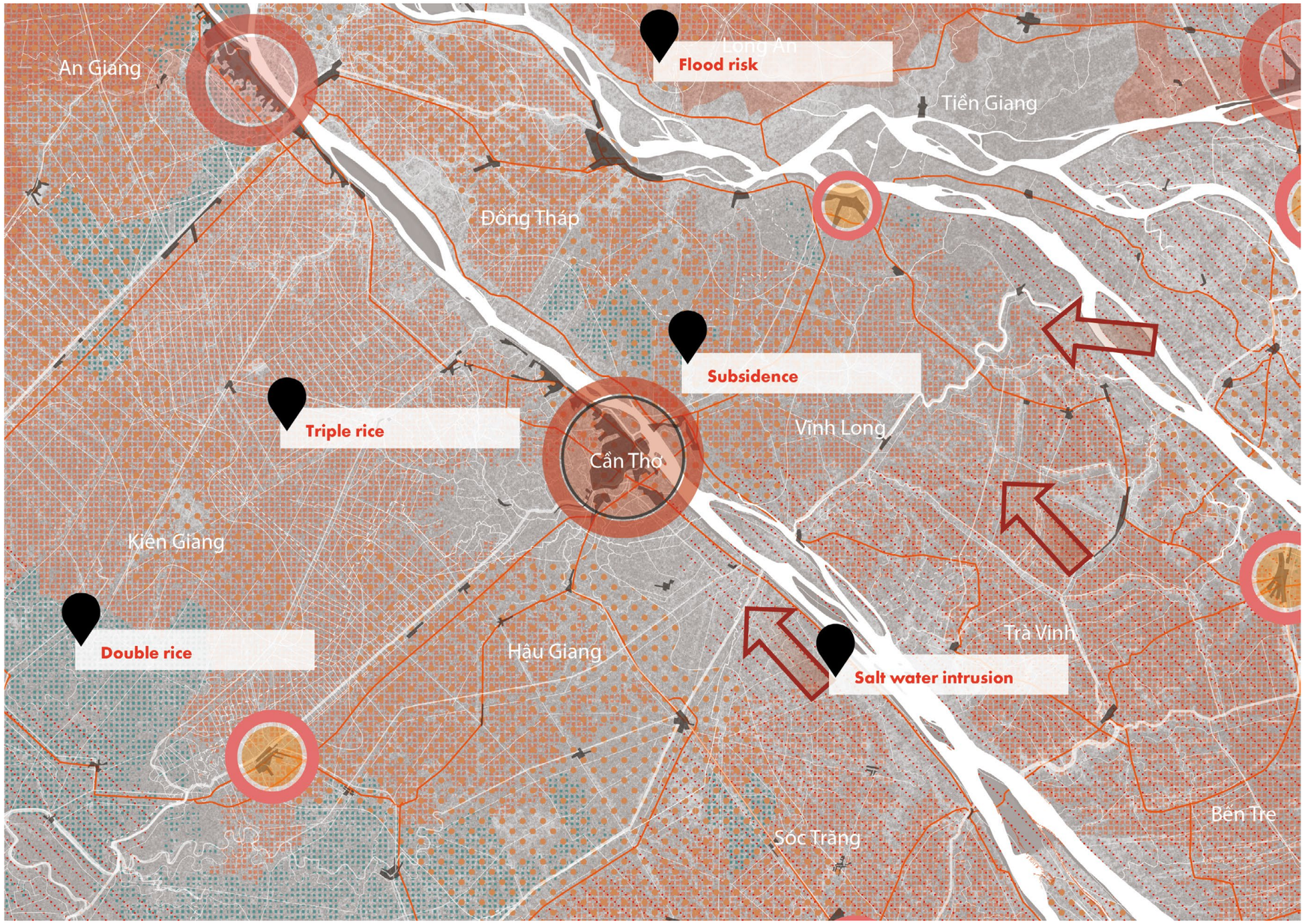


Figure 3.32. Study area B

B. Central urban rural areas that focus on agricultural production and urban flood control

Triple rice - alternative crop
Subsidence - adapted buildings in cities, water retention, alternative crop-less extraction
Salt water intrusion - salinization adaptation, water storage with farmland

Urban-rural area (Can Tho city)

Charateristics

- Dense and highly populated urban landscapes, fruit forests and nurseries, and open three-season rice landscapes alternate here

- The meandering river and the distribution of housing and vertical fields along it are directly connected to the dense urban built-up area, with few transitional zones.

- The land use is mainly urban and agricultural, with mainly fruit trees and a portion of triple rice crop.

- The vegetation is dominated by urban greenery and economic fruit trees.

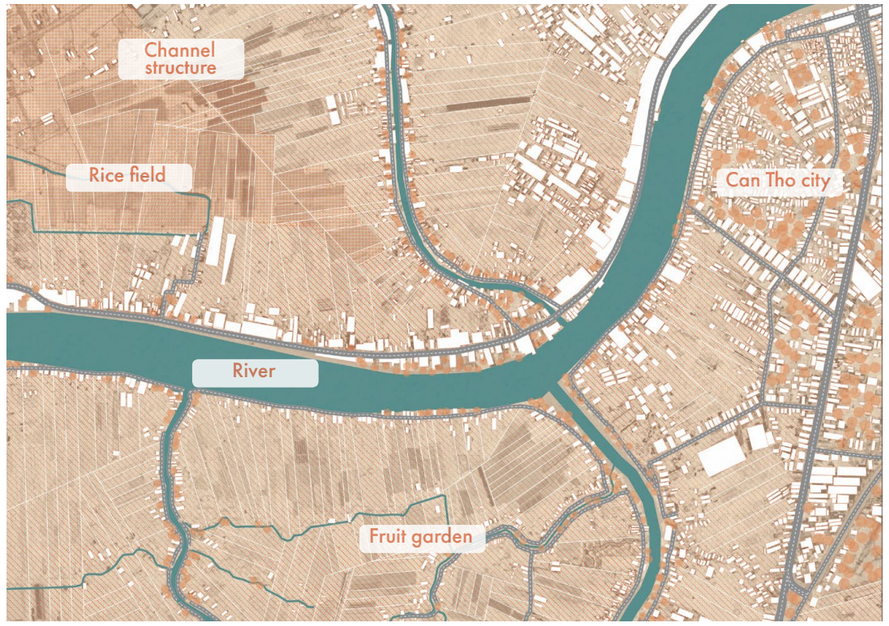


Figure 3.33. Rural-urban area map

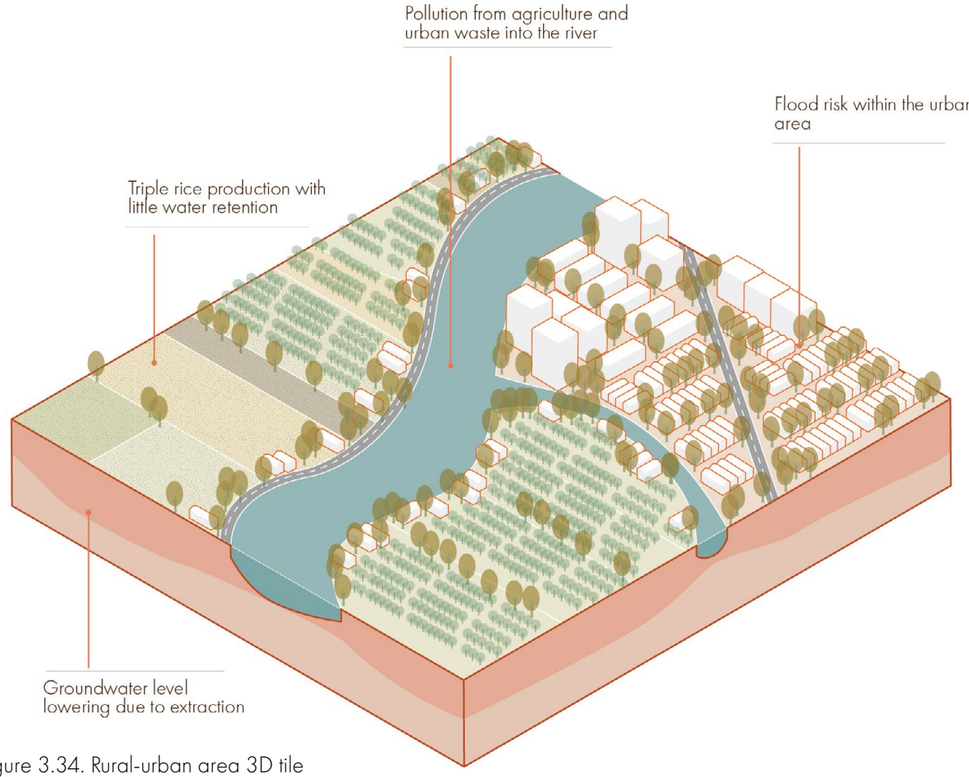


Figure 3.34. Rural-urban area 3D tile

Challenges

- Extreme precipitation and flooding directly affect urban areas forming internal floods

- Subsidence caused by excessive groundwater extraction threatens urban and housing safety.

- Triple rice and fruit forests have less room for flood retention, exacerbating the intensity of flooding.

- Pollution from urban living and farming discharges into rivers and other water bodies.

Preliminary Strategies

- **Water retention within cities**: flood retention, biodiversity
- **Room for river**: flood retention, biodiversity, pollution control
- **Nature-inclusive agriculture**: biodiversity, pollution control
- **Adapted buildings**: urban flood control, subsidence

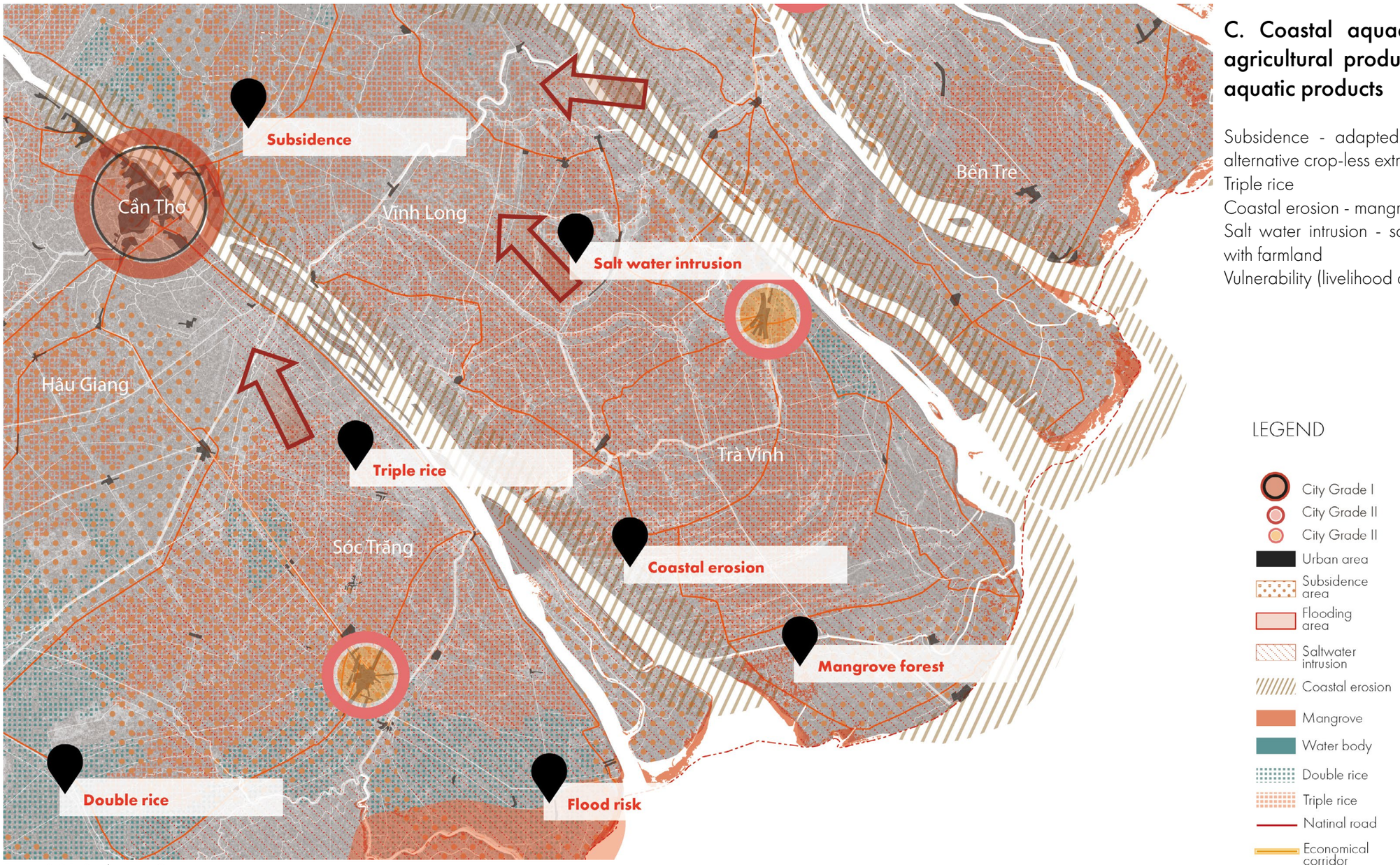
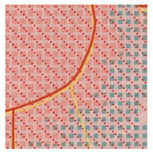


Figure 3.35. Study area C

C. Coastal aquaculture areas for improved agricultural production of rice combined with aquatic products

Subsidence - adapted buildings in cities, water retention, alternative crop-less extraction
Triple rice
Coastal erosion - mangrove restoration
Salt water intrusion - salinization adaptation, water storage with farmland
Vulnerability (livelihood damage)



Coastal rice-aquaculture

Charateristics

- The road is the backbone of the landscape, with housing, vegetation, open rice fields and fish ponds distributed vertically along the road.

- Between the houses and the fields there is often a plot of land for family livestock, fruit trees or a family cemetery.

- The land use is mainly agricultural, with rice and fish farming as the main crops.

- The plots of rice and fish ponds are distributed in a narrow shape.

Figure 3.36. Coastal rice-aquaculture map

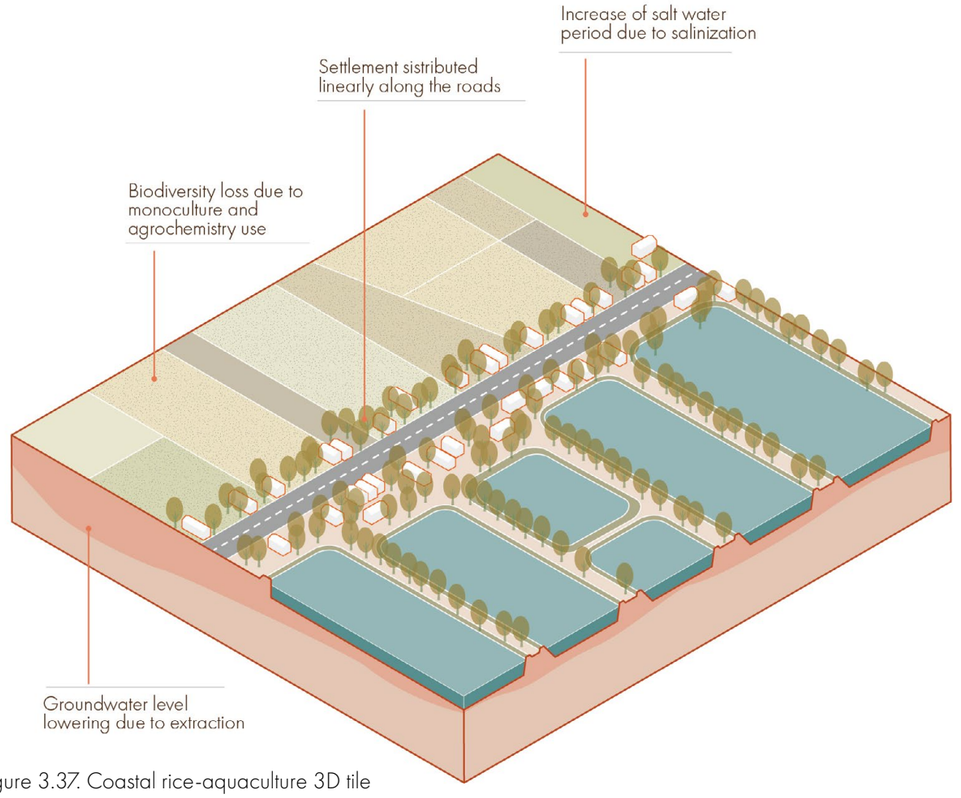


Figure 3.37. Coastal rice-aquaculture 3D tile

Challenges

- Increasing salt water intrusion has increased the salinity of the water and soil, shortening the period of fresh water available for rice cultivation.

- Over-abstraction of groundwater leads to subsidence and reduction of freshwater resources.

- Species disappear due to fertilizer application and pesticide poisoning.

- Vegetation diversity reduced. Species become scarce in agricultural land due to monoculture.

Preliminary Strategies

- **Water retention**: salinization
- **Mixed rice-shrimp aquaculture**: flood retention, biodiversity, pollution control
- **Nature-inclusive agriculture**: biodiversity, pollution control

04 PATTERN LANGUAGE

Pattern system

Pattern field

Pattern assessment

Source: https://www.pexels.com/photo/people-working-in-sa-dec-flower-village-9792169/

PATTERN SYSTEM

The step of generating the pattern language focuses on summarizing conclusions from the analysis of agricultural production and climate challenges in the Delta. These analyses included climate threats such as flood risk, salt intrusion, and subsidence, as well as factors such as land use type, agricultural production, rice production patterns, and the distribution of vulnerable populations. Based on these analyses, a series of different types of patterns were generated and knowledge was gained through case studies and literature analysis. These patterns include adaptation tools for freshwater and saltwater agriculture, as well as related institutional and social support. At the same time, the internal linkages between these patterns are further explored. By analyzing the scale and the extent of concreteness, the location of each pattern and the way they interact with each other are determined. This analysis method helps to understand the association between different patterns.

Based on the above analysis, an assessment framework was developed. The framework includes indicators of basic conditions, climate challenges, and adaptive capacity. Through further analysis of these indicators, the applicable patterns for each site and scale are identified, as well as their location and extent. Such an assessment framework provides a structured approach to understanding and addressing the climate challenges facing Delta agriculture. Through the analysis and application of the generated patterns, adaptation strategies are developed for different sites and scales to ensure the sustainability of agricultural production and protect vulnerable populations.

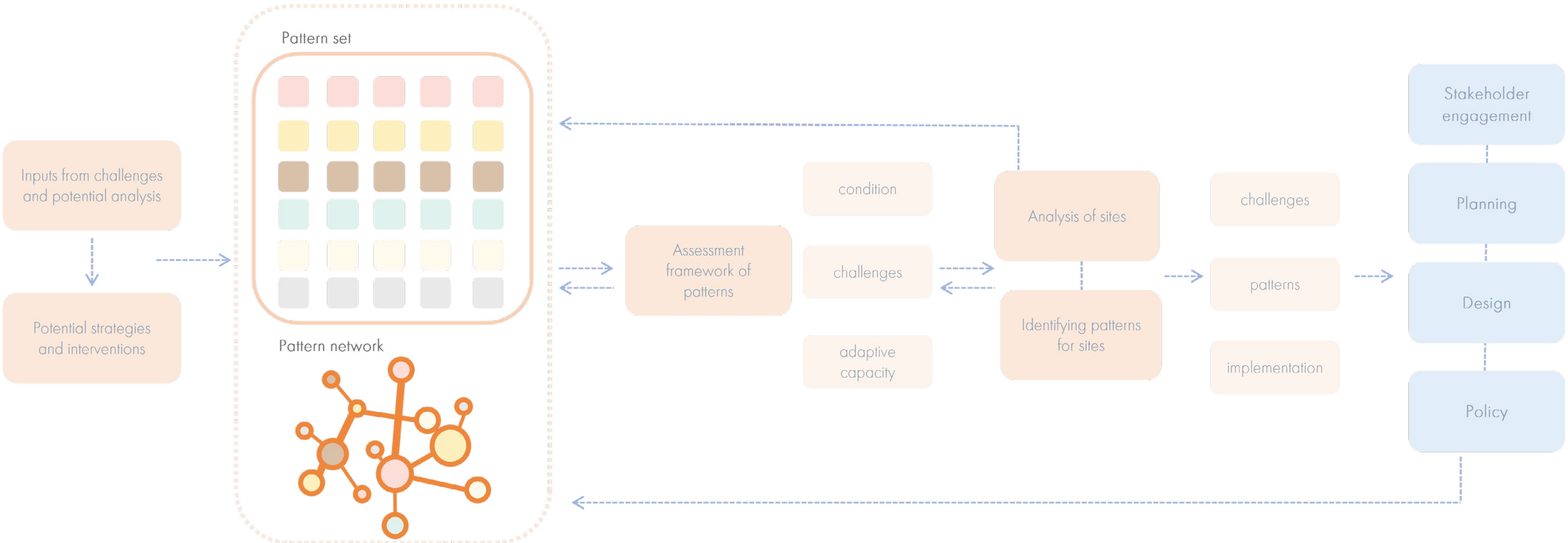


Figure 4.1 Pattern system

ENGAGEMENT PROCESS

Identify Stakeholders: Identify and engage relevant stakeholders who will be involved in the development and implementation of the model language. This can include government agencies, local communities, experts, NGOs, and other relevant organizations.

Conduct a needs assessment: Assess the existing conditions, challenges, and opportunities in the Mekong Delta. Understand the context, including social, economic, environmental, and cultural factors. Identify specific models that can address the identified needs and challenges.

Involve stakeholders in pattern development: Facilitate workshops, meetings, or collaborative sessions with stakeholders to gather their input, insights, and experiences. Encourage their active participation in shaping the language of the model, ensuring that it is based on local knowledge and context.

Test and refine the model: Pilot test the model in a real-world scenario or case study in the Mekong Delta. Assess its effectiveness, feasibility, and adaptability. Collect feedback from stakeholders and make necessary adjustments to the model based on lessons learned.

Integrate the pattern language into the planning process: Work with relevant government agencies and decision makers to integrate the pattern language into planning frameworks, policies, and guidelines. Ensure that the pattern language becomes an integral part of the decision-making process and informs sustainable development practices in the Mekong Delta.

Continuously update and develop the model language. Regularly review and update the model language to incorporate new knowledge, emerging trends, and stakeholder feedback. Foster a culture of continuous learning and improvement to ensure that the model language remains relevant and effective over time.

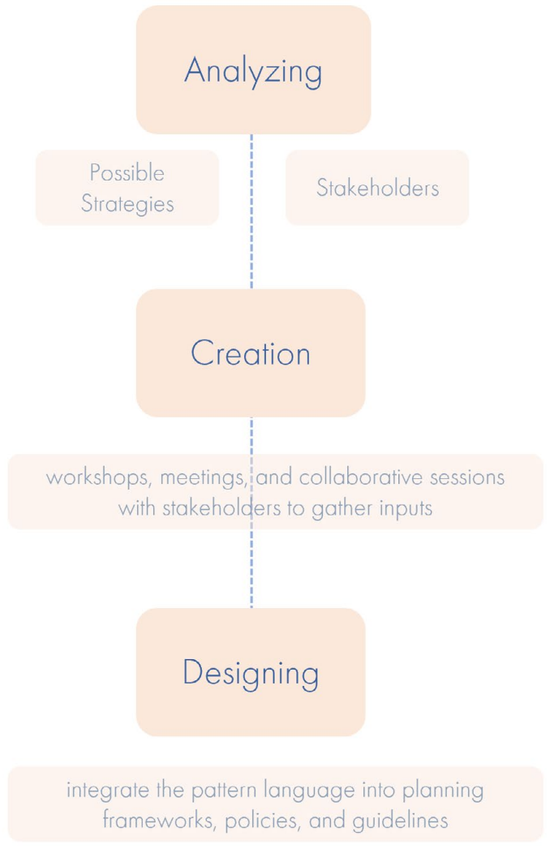


Figure 4.2 Engagement process

PATTERN FIELD

After the previous analysis, the challenges of climate change in different regions can be summarized as follows: firstly, flood risk, subsidence risk, and salt water intrusion in central urban areas and rural rice growing areas; secondly, coastal erosion and coastal flooding in coastal fishing areas.Strategies to address these threats include the development and support of sustainable agricultural livelihoods, water management, and ecological protection. Through the study of several relevant case and literature studies (Collentine, 2018; Tran, 2021; Frankic, 2003; Runhaar, 2016), the following PATTERN SET can be proposed in combination with site-specific situations:

The first is freshwater production, i.e., when faced with flood risk and subsidence risk, the corresponding means of agricultural production are adopted to adapt to these challenges. The second is saltwater production, which focuses on saltwater intrusion. This involves the use of salt-resistant plant species, the adoption of salt-water irrigation techniques, and improved soil salt management to ensure proper crop growth and yield in a saline environment. nature-inclusive agriculture incorporates ecosystem services into agricultural production. Finally, urban adaptation focuses on the challenges of climate change in central urban areas.

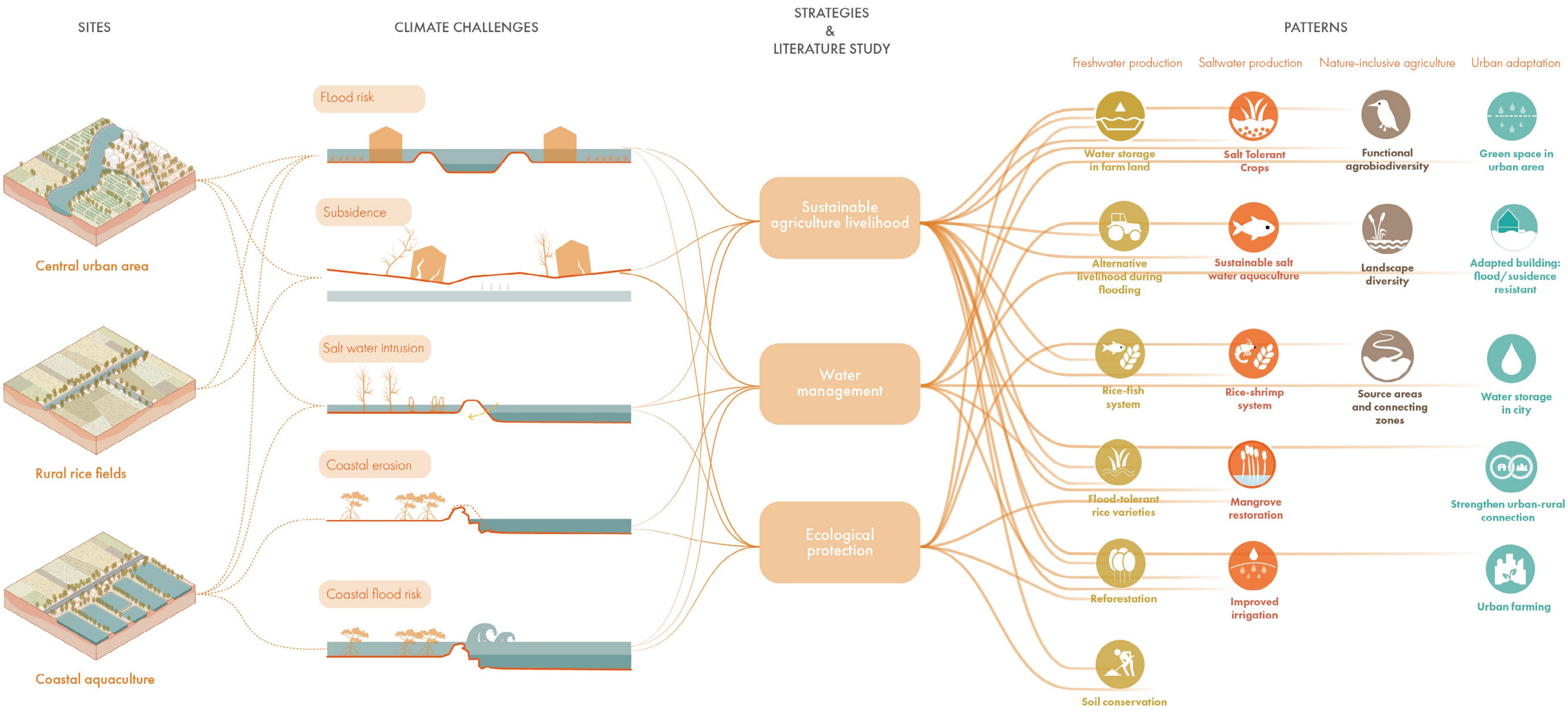


Figure 4.3 Pattern generation

Freshwater production: i.e., adapting agricultural production tools to these challenges in the face of flood risk and subsidence risk. This includes improving drainage systems, selecting flood-resistant crop species, and promoting flood-tolerant farming practices. Examples include Water storage in farmland, alternative livelihood during flooding, rice-fish system, flood tolerant rice varieties, etc((Van, 2015; Tran, 2021).

Saltwater production: It focuses on saltwater intrusion and coastal erosion. This involves the use of salt-resistant plant species and salt-water irrigation techniques to ensure crop growth and production in a saline environment; and the development of sustainable aquaculture, rice-shrimp systems and mangrove restoration to promote coastal ecological restoration and its stabilization to prevent coastal flooding(Frankic & Hershner, 2003).

Nature-inclusive agriculture: This model of agriculture incorporates ecosystem services into agricultural production, such as the use of wetlands and green infrastructure to regulate flood risk, increase the water retention capacity of farmland, and provide functions such as biodiversity conservation and natural resource restoration. Source areas and connecting zones are concerned with the use of ecological corridors such as rivers and forest belts in agricultural production areas to establish linkages between ecological sources to protect biodiversity. (Gies, 2019; Runhaar, 2016)

Urban adaptation: The main focus of urban adaptation is to address the challenges of climate change in urban areas by improving urban infrastructure, increasing flood resilience. It also promotes public awareness through urban farming and strengthening the linkages between urban and rural agricultural production and markets, strengthening urban-rural relationships.

Decision making and networks: In the area of decision making and networks, there is a need to address the shortcomes of spatial patterns, such as reduced production capacity and market changes. This can be achieved by working with stakeholders, strengthening agricultural value chains, building networks between producers and markets, developing incentives, and leveraging international support.

Social adaptation of communities: Social adaptation of communities can be facilitated by conducting research on local experiences, developing diversified food markets, establishing risk mitigation mechanisms, strengthening capacity building and training, supporting alternative sources of income, and conducting research on integrated production(Watson, 2021; Greenville, 2017).

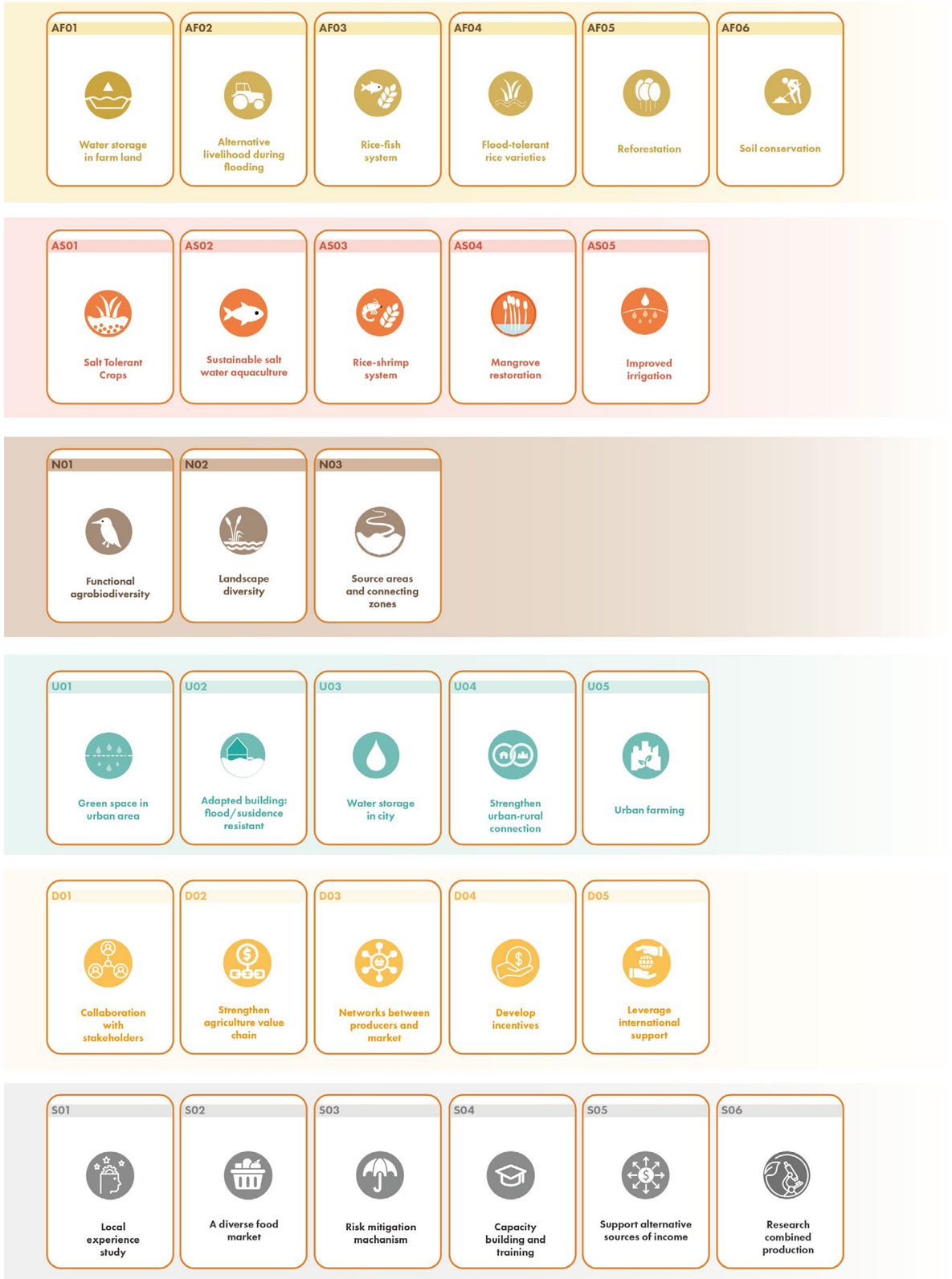


Figure 4.4 Pattern sets

Different patterns differ in scale and specificity in their internal linkages, and their spatial and temporal locations are indicative of their scale and continuity. Specific and small-scale patterns, such as salt tolerant crop, flood tolerant rice varieties, and rice-fish systems, can be implemented first in pilot projects. At the urban and regional scales, alternative livelihoods during flooding, sustainable saltwater aquaculture, and landscape diversity can be implemented.

At the abstract institutional level, patterns from the different perspectives of decision making and networks and social adaptation of communities dominate the upper and lower right corners of the pattern field. They can provide institutional support to promote spatial interventions for agricultural and urban adaptation. This includes building networks between producers and markets, strengthening agricultural value chains, and developing incentives. Through the coordinated operation of these interventions, a diverse food market can be created while protecting biodiversity and resisting the challenges of climate change to achieve the goal of sustainable agricultural livelihoods.

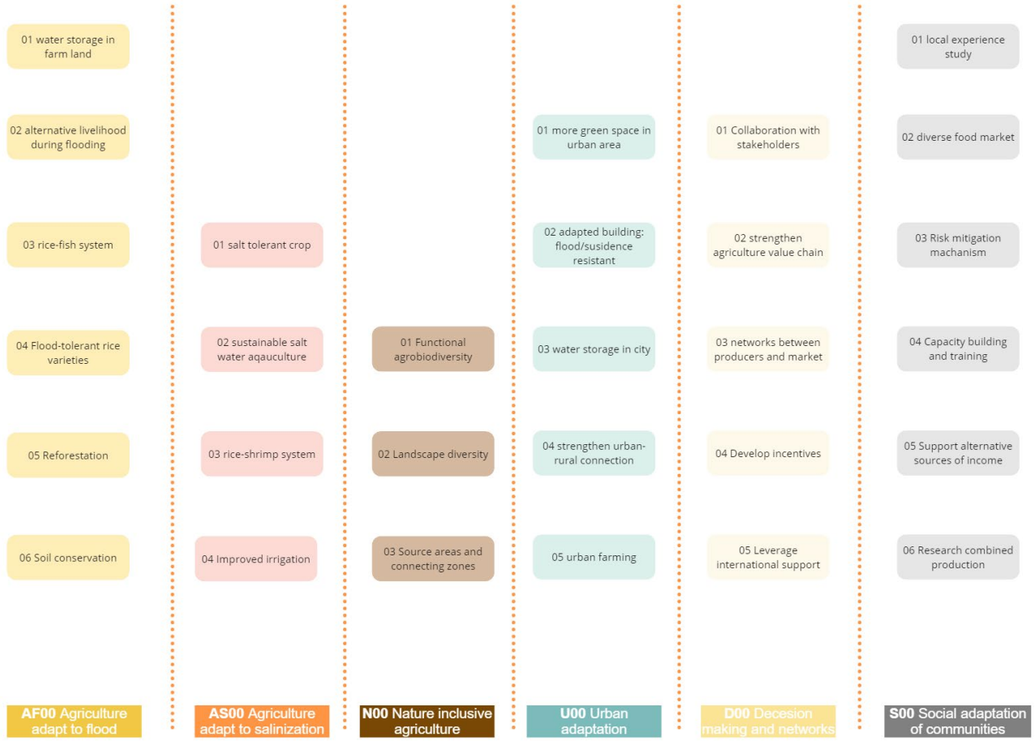


Figure 4.5 Pattern field 1

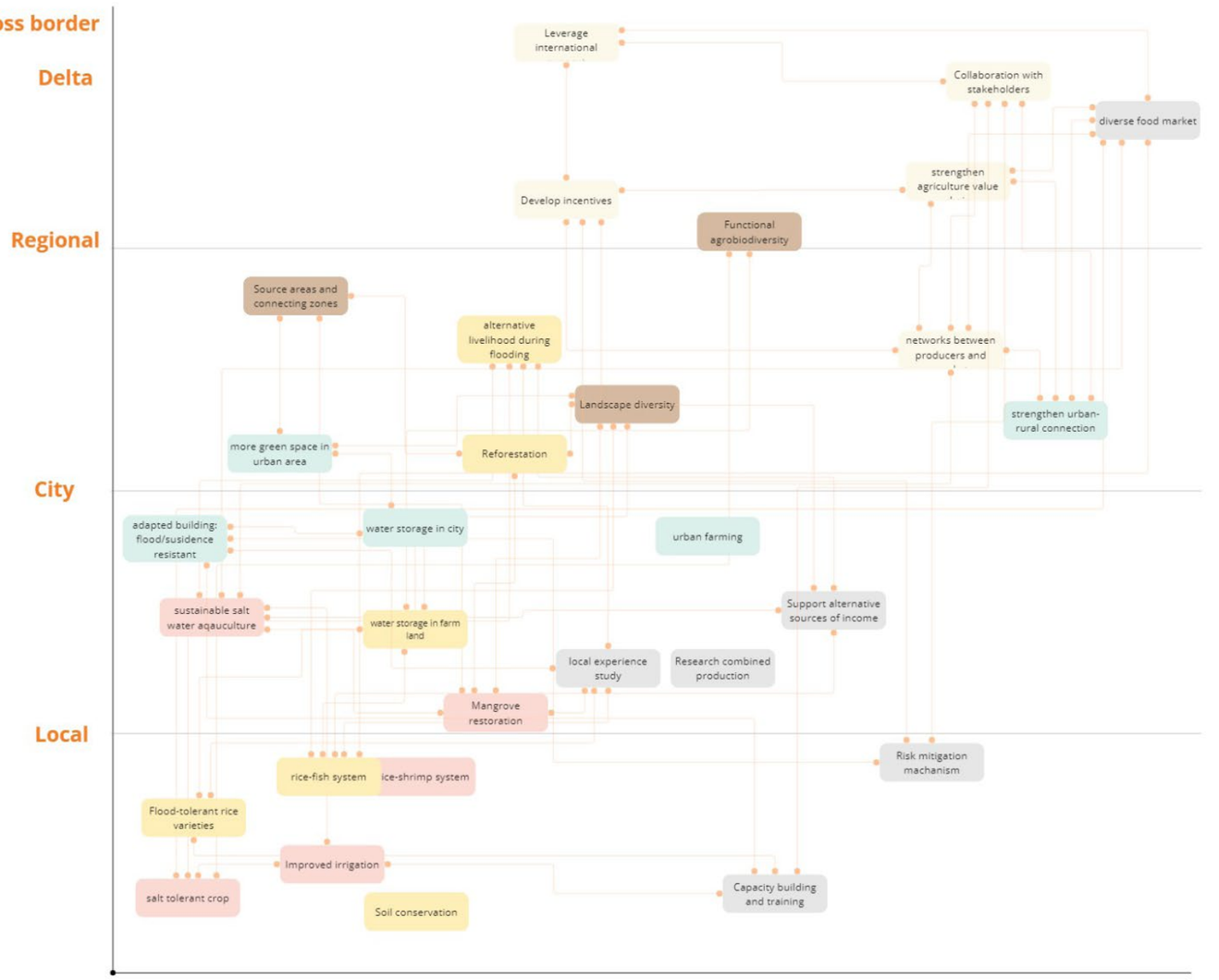


Figure 4.6 Pattern field 2

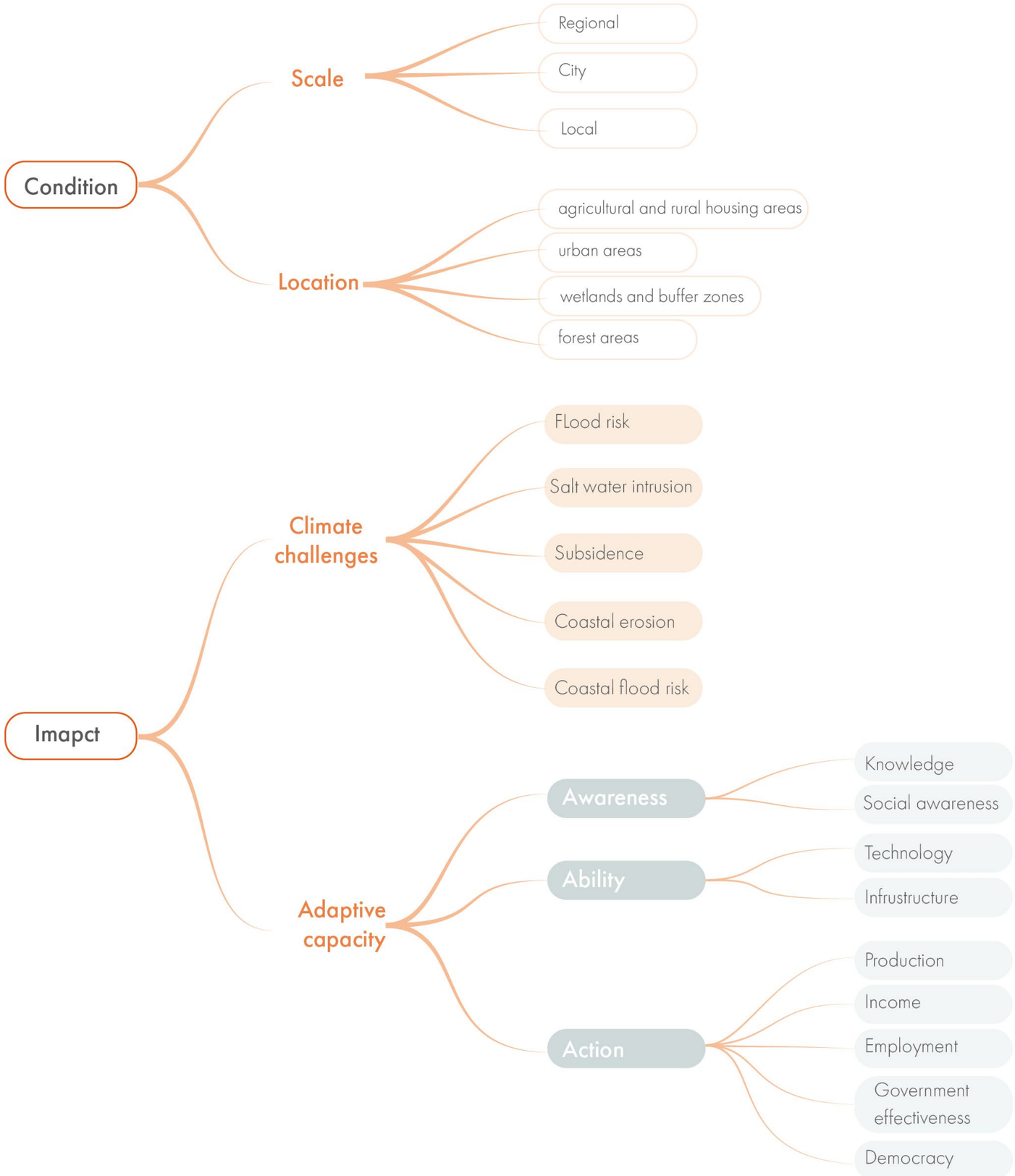


Figure 4.7 Pattern assessment

PATTERN ASSESSMENT

The evaluation of Pattern is composed of two aspects: the basic conditions and their impact utility. The basic conditions include different scales and locations, such as local, city, regional, as well as agricultural and rural housing, urban, forest areas, and wetlands and buffer zones. patterns, and by analyzing the main conflicts faced by each site and at different scales, such as flood risk and coastal erosion, the most appropriate measures to improve the site can be selected. At the same time, a combination of analysis of the adaptive capacity of different areas, including aspects of awareness, capability, and action, as well as their spatial and policy-level subindicators, can be used as a reference for evaluating and deciding the suitability of patterns.

One of the patterns, water storage in the farmland, is used as an example. This model is applicable at multiple scales, including agricultural and rural housing areas and wetlands and buffer zones environments. By using farmland to control flooding, flood peaks can be regulated while water is stored during the dry season. When water is plentiful, plants are better able to absorb nutrients, thereby reducing damage to the environment and improving water quality. At the same time, water is retained longer in the landscape, helping to reduce the height of flood peaks downstream (Collentine, 2018). However, this model may have a negative impact on agricultural yields, so complementary other patterns are needed, such as Alternative livelihood during flooding and Develop incentives.

Impact: positive, neutral, negative
Scale: regional, city, local
Location: agricultural and rural housing areas, urban areas, wetlands and buffer zones, forest areas

	Scale	Location	Flood risk	Salt water intrusion	Subsidence	Coastal erosion	Coastal flood risk	Production	Income	Employment	Government effectiveness	Democracy	Technology	Infrustructure	Knowledge	Social awareness
Water storage in farm land	●	● ●	●	●	●	○	○	●	●	○	○	○	●	●	○	○
Alternative livelihood during flooding	●	●	●	○	○	○	○	●	●	●	○	○	●	○	○	●
Rice-fish system	●	●	●	○	○	○	○	●	●	●	○	○	●	○	○	●
Flood-tolerant rice varieties	●	●	●	●	○	○	●	●	●	●	○	○	●	○	○	○
Reforestation	●	● ● ●	●	○	●	●	●	●	○	●	○	○	○	●	○	○
Soil conservation	●	● ● ●	●	●	●	●	●	●	○	●	○	○	○	○	○	○
Salt Tolerant Crops	●	●	○	●	●	●	●	●	●	●	○	○	●	○	○	○
Sustainable salt water aquaculture	●	● ●	○	●	○	●	●	●	●	●	○	○	●	○	○	○
Rice-shrimp system	●	●	○	●	○	○	●	○	●	●	○	○	●	○	○	○
Mangrove restoration	●	● ● ●	○	●	●	●	●	○	○	○	○	○	○	●	○	○
Improved irrigation	●	●	○	●	●	●	●	●	●	●	○	○	●	●	○	○
Functional agrobiodiversity	●	● ● ●	●	○	○	○	●	●	●	●	○	○	●	●	○	○
Landscape diversity	●	● ● ●	●	○	○	●	●	○	○	○	○	○	●	○	○	○
Source areas and connecting zones	●	● ● ●	●	○	○	●	●	○	○	○	○	○	○	●	○	○
Green space in urban area	●	● ●	●	○	●	○	○	○	○	○	○	○	○	○	○	○
Adapted building	●	● ●	●	○	●	○	○	○	○	○	○	○	○	●	○	○
Water storage in city	●	●	●	○	●	○	○	○	○	○	○	○	○	○	○	○
Strengthen urban-rural connection	●	● ●	○	○	○	○	○	●	●	●	●	●	○	●	○	●
Urban farming	●	● ●	○	○	○	○	○	●	●	●	○	○	●	●	○	●
Collaboration with stakeholders	●	● ●	○	○	●	●	●	○	●	○	●	●	●	○	●	●
Strengthen agriculture value chain	●	● ●	○	○	○	○	○	○	●	●	●	○	●	●	○	○
Networks between producers and market	●	● ●	○	○	○	○	○	○	●	●	●	●	○	●	○	●
Develop incentives	●	●	●	●	●	●	●	●	●	●	○	●	●	●	●	○
Leverage international support	●	● ●	●	●	●	●	●	○	●	○	○	○	●	●	●	●
Local experience study	●	●	●	●	●	●	●	●	●	●	●	○	●	○	●	●
A diverse food market	●	● ●	○	○	○	○	○	●	●	●	●	○	○	●	○	●
Risk mitigation machanism	●	●	●	●	●	●	●	○	●	●	●	●	○	●	○	●
Capacity building and training	●	●	●	●	○	●	●	●	●	●	●	●	●	○	●	●
Support alternative sources of income	●	●	●	●	○	○	○	○	●	●	○	●	●	○	○	●
Research combined production	●	● ●	●	●	●	●	●	●	○	○	○	○	●	●	●	●

Figure 4.8 Assessment framework

05 IMPLEMENTATION

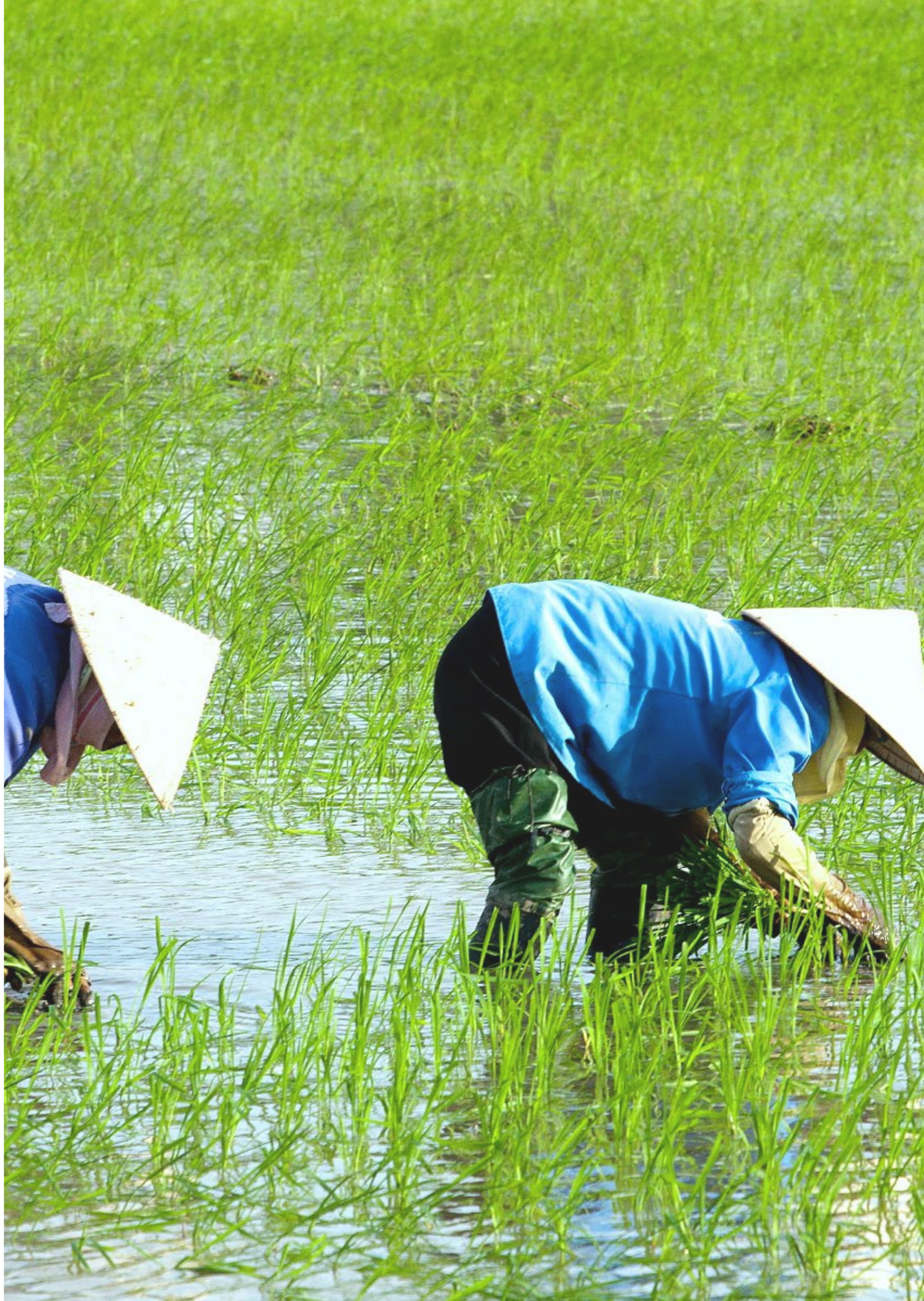
Central urban area

Northern rural rice fields

Coastal aquaculture

Phasing

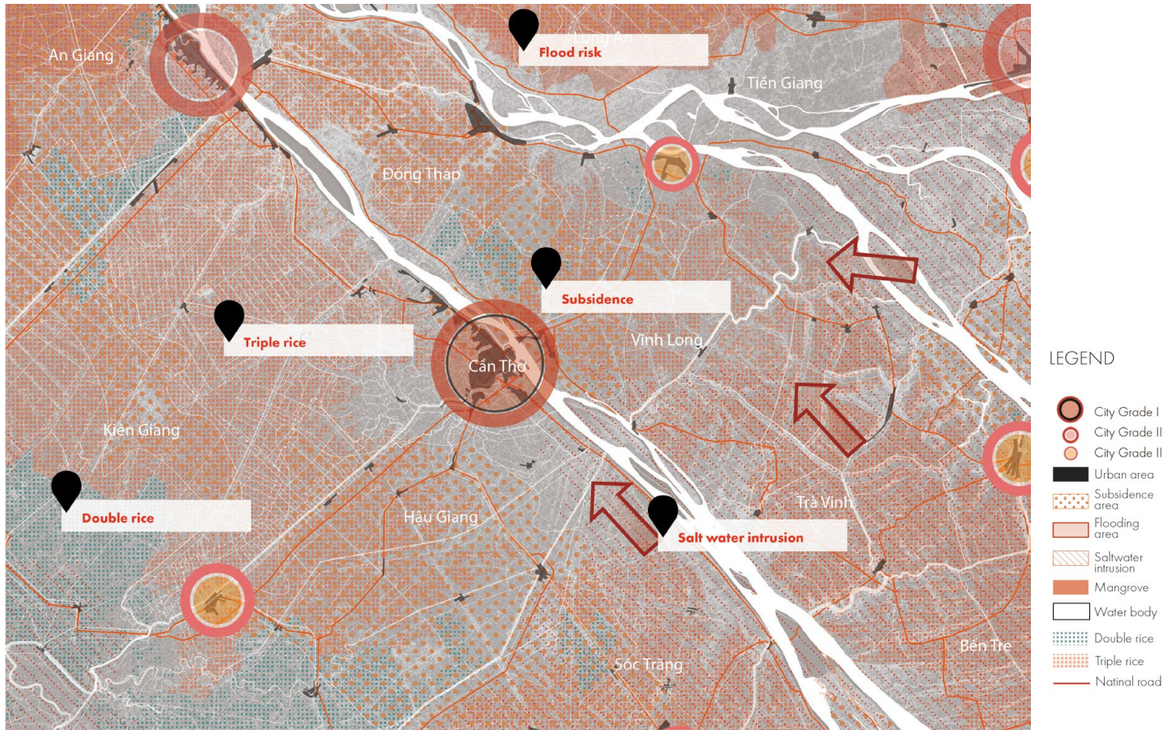
Source: www.bortonoverseas.com/tour/the-mekong-delta-vietnam/



CENTRAL URBAN AREA

Regional scale: Pattern assessment

At the regional scale, the Central urban area is located in the heart of the Mekong Delta. The area covers the city of Can Tho, an important city in Vietnam. Can Tho and its surrounding areas have diverse land use characteristics and ecological environment. Agricultural land is widely distributed and is one of the important agricultural production bases in the region. The area also includes important ecosystems such as urban areas, wetlands and forests. These diverse environments contribute to its complex land use structure and critical geographic location. It faces a variety of climate challenges, including flooding, subsidence and saltwater intrusion. These climate challenges require adaptation measures in terms of agricultural productivity, social awareness, and technology.



Regional | agricultural and rural housing areas | urban areas | wetlands and buffer zones

FLood risk | Subsidence | Salt water intrusion

Production | Social awareness | Technology

Figure 5.1 Central urban area-regional

According to the site conditions and the pattern assessment framework, 11 patterns such as water srorage in the farmland were obtained, among which spatial pattern such as water srorage in the farmland can be firstly implemented in the area of the site after further analysis. Policy-related patterns such as collaboration with stakeholders provide stakeholder engagement strategies and policy directions for the implementation of spatial intervention. These patterns will address climate challenges while ensuring sustainable agricultural productivity and social development.

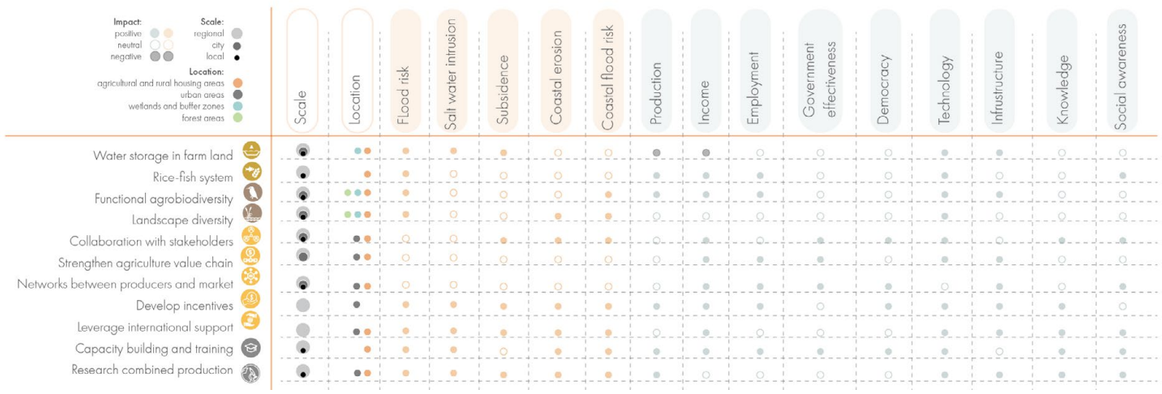
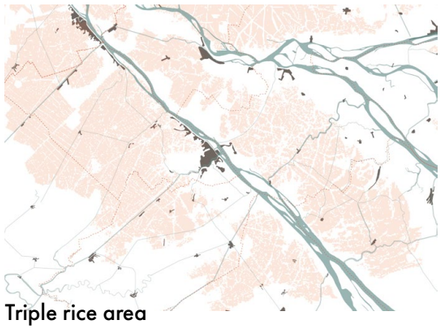


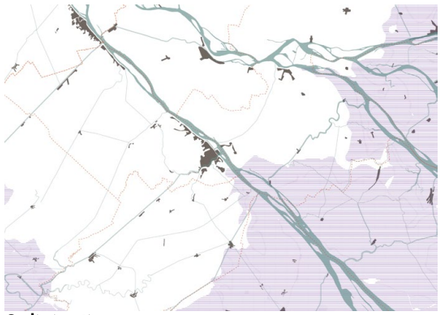
Figure 5.2 Central urban area pattern assessment



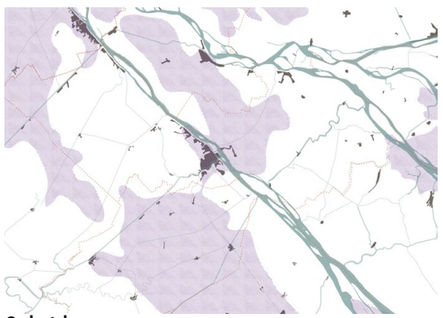
Triple rice area

Double rice area

Horticulture area



Salinization



Subsidence

The analysis of the site's agricultural land use and climatic threats shows that the area has a large area of triple rice cultivation, while the southern and central double rice areas near the city have potential for experimental transformation measures. The horticulture areas are mainly fruit gardens, producing pineapples, mangoes, durian and other tropical fruits, which also play a role in the delta ecosystem as part of the agroforestry, connecting ecological sources, forming habitats and food sources. The riverine hydrological system, mainly the Mekong and Hau rivers, which connects many rivers and canals, serves as a reservoir and discharge for floods during the wet season when rainfall is intense. Therefore, the overlapping areas of agricultural and forestry land around the river system, the double rice area with potential for rehabilitation, and the area threatened by salinization and subsidence are areas that need to be adapted for agriculture.

Figure 5.3 Central urban area-regional analysis

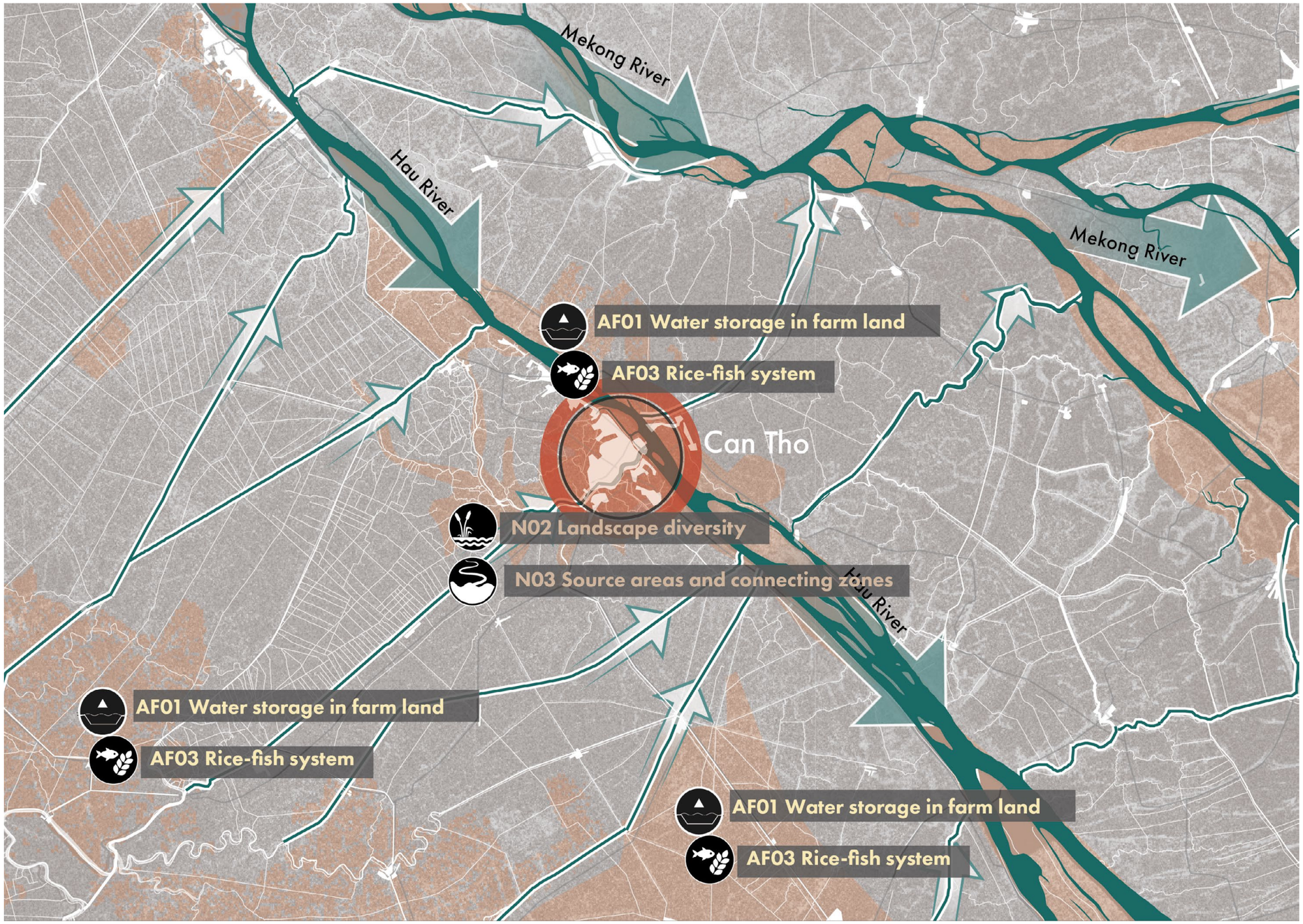


Figure 5.4 River discharge and agriculture adaptation

Regional scale: River discharge and agriculture adaptation

In response to the increasing threat of seasonal flooding, emphasis needs to be placed on expanding the storage function of the river and canal hydrological systems to slow down flood speeds and reduce damage to downstream areas by retaining water locally. In the planning, pattern source areas and connecting zones can be used to modify waterways to provide both flood control and ecological corridor functions. By redesigning waterways and establishing hydrological linkages to redirect water from source areas to downstream areas, not only can flood flow be slowed down, but ecological resources can also be provided to promote biodiversity conservation and restoration. In agricultural adaptation areas, patterns such as water storage in farmland can be used to allow more water to be retained in farmland. This pattern can store water during the wet season, maintain irrigation, and reduce crop damage from flooding. In addition, the rice-fish system is an effective agricultural adaptation pattern that ensures that farmers can continue to produce and profit from environmental resources during the wet season.

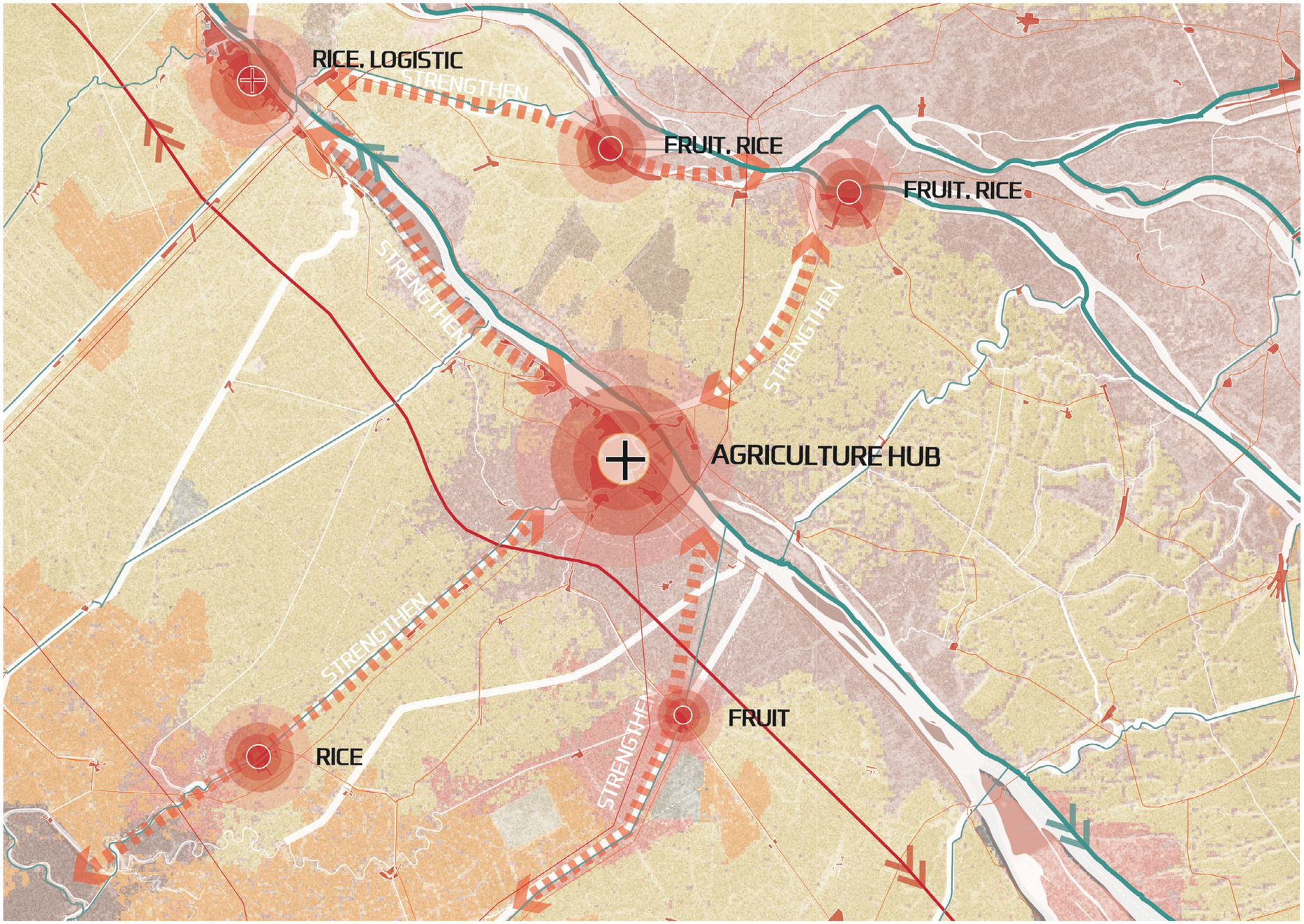
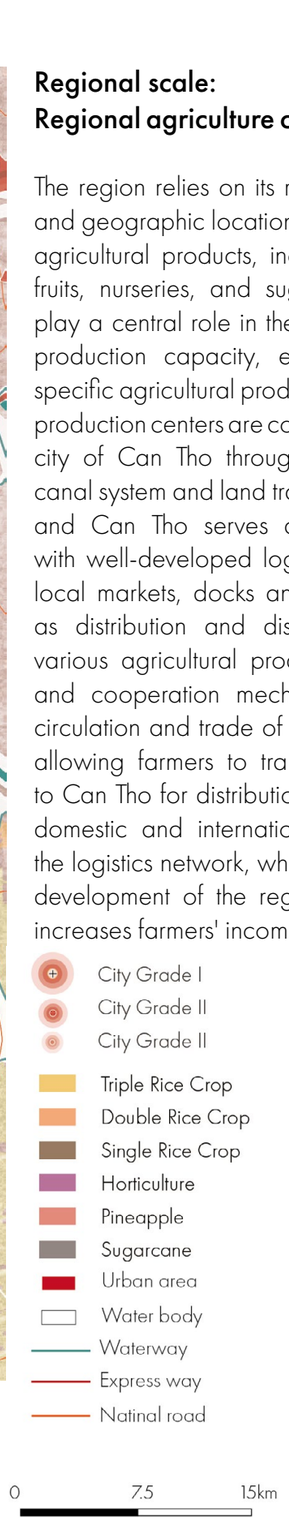


Figure 5.5 Regional agriculture connection strategy

Regional scale:
Regional agriculture connection strategy

The region relies on its rich natural resources and geographic location for a rich diversity of agricultural products, including rice, tropical fruits, nurseries, and sugar cane. Sub-cities play a central role in the region's agricultural production capacity, each focusing on a specific agricultural product. These agricultural production centers are connected to the central city of Can Tho through a well-developed canal system and land transportation network, and Can Tho serves as the regional hub with well-developed logistics nodes such as local markets, docks and airports that serve as distribution and distribution centers for various agricultural products.This connection and cooperation mechanism facilitates the circulation and trade of agricultural products, allowing farmers to transport their products to Can Tho for distribution, and then to reach domestic and international markets through the logistics network, which also promotes the development of the regional economy and increases farmers' income.



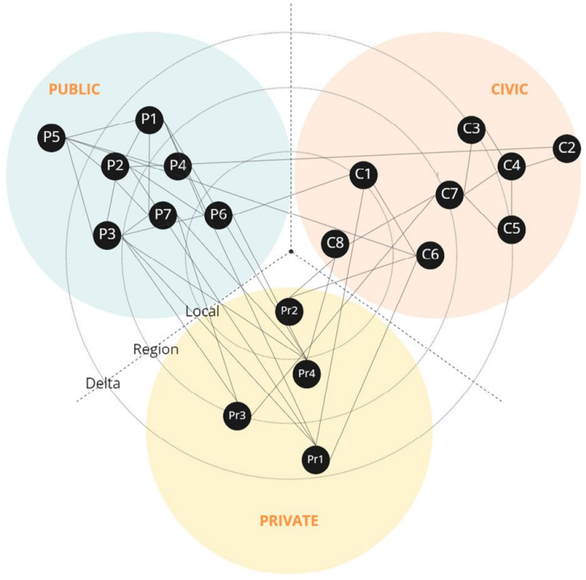
Regional scale: Stakeholder engagement

An analysis of stakeholder from a regional perspective shows that the number and connectivity of stakeholders in the public sector is superior to that of citizens and the private sector. This indicates that the government has more power and influence in the region. However, at a given moment of decision making, the connection between stakeholders such as citizens, businesses, farmers, and markets is not ideal.

By analyzing the power and interests of these stakeholders, it can be concluded that government agencies need to decentralize their power to increase the participation and involvement of stakeholders such as citizens, businesses, and farmers. This means that the government should encourage and support the participation of these stakeholders in the decision-making process to ensure that their voices are heard and fully considered. Relevant development partners and international organizations also need to raise their interest and concern for the region. This can be achieved through increased cooperation and resource sharing to leverage international support for the sustainable regional development and advance the interests of stakeholders. For market actors such as farmers and businesses, they need to increase their power and influence to ensure that their interests are fully protected and respected. This can be achieved by strengthening the networks between producers and markets, capacity building and training, and participation in stakeholder discussions.

At the same time, the relevant plans and interventions in the previous discussion also require corresponding policies and measures to establish a strong logistics and supply chain system, enhance cooperation and coordination, ensure the quality and safety of agricultural products, improve logistics and transportation efficiency, and facilitate market communication and information exchange.

- **PUBLIC**
  - 1 Ministry of Natural Resources and Environment
  - 2 Ministry of Planning and Investment
  - 3 Ministry of Agriculture and Rural Development
  - 4 South-West Steering Committee
  - 5 People's Committee
  - 6 Can Tho City administration
  - 7 Mekong delta provinces
- **CIVIC**
  - 1 Can Tho University
  - 2 Development partners and NGOs
  - 3 Mekong River Commission
  - 4 Lancang-Mekong Cooperation
  - 5 Greater Mekong Subregion
  - 6 Institute of Water Resources Planning
  - 7 Media
  - 8 Consumers
- **PRIVATE**
  - 1 Irrigation Works Management and Exploitation Company
  - 2 Farmers
  - 3 Food retailers
  - 4 Land owners (usage rights)



- Conclusion: public sector taking too much power, private and civic sectors are not fully connected

Figure 5.6 Stakeholder analysis

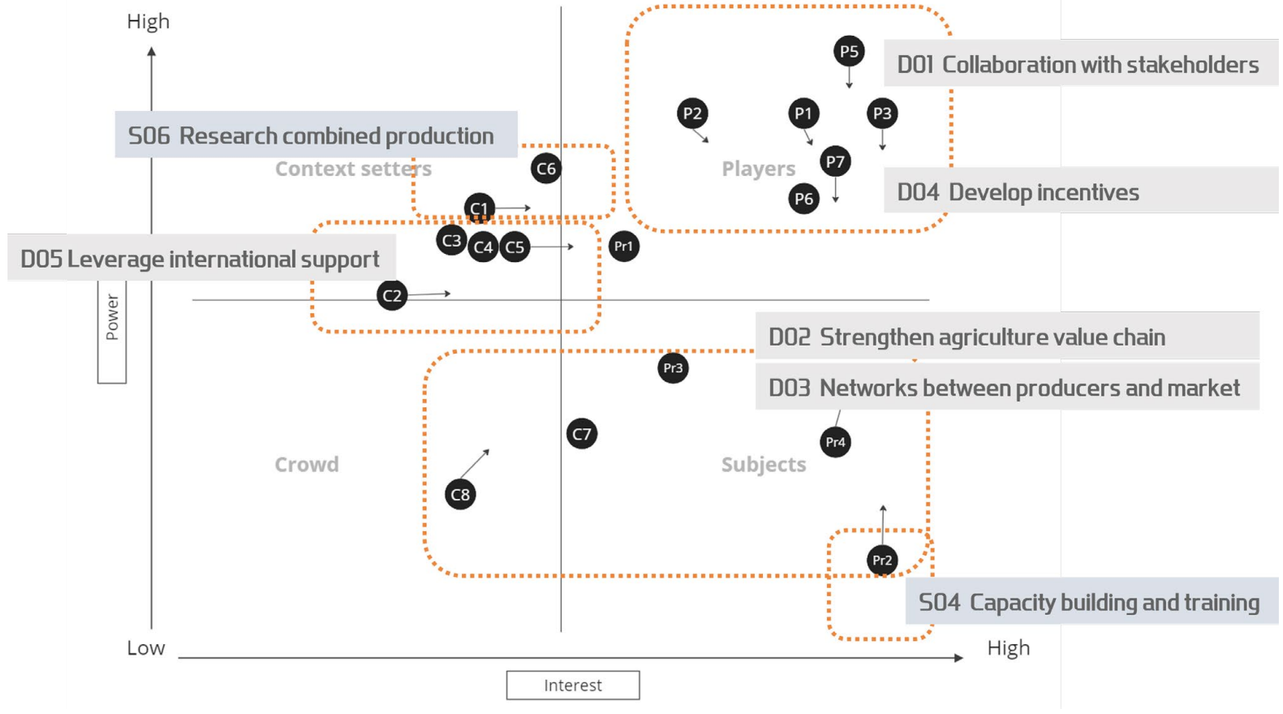
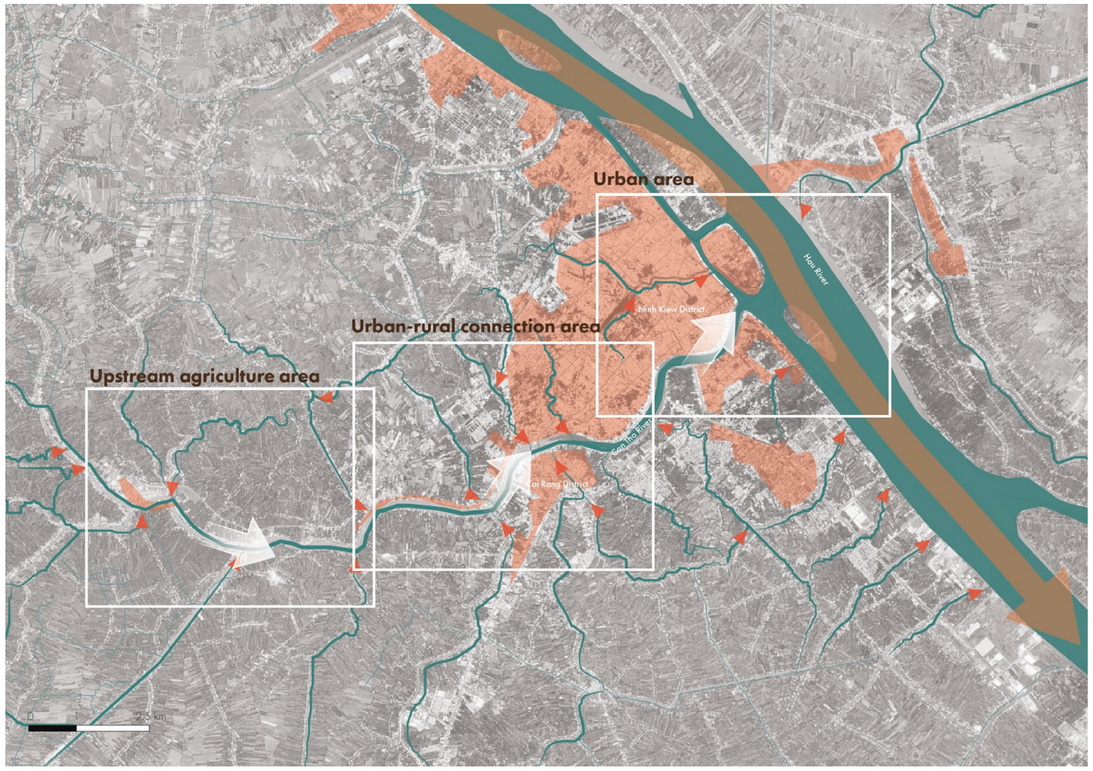


Figure 5.7 Power-interest index and patterns

CENTRAL URBAN AREA

City scale: Pattern assessment

Further study and flood risk analysis of the Cantho urban area reveals its unique geographic and hydrological characteristics; it is located in a bottleneck area where the Cantho River flows into the Hau River, which means that during floods, a large amount of water flows through this narrow section of the river, increasing the risk of flooding to the urban area. In addition, there are several canals and drains in the area that feed into the Cantho River, and these waterways play an important role in drainage during floods. Such flood pressure poses a significant risk and damage to urban facilities, residents and farmland in the area.



City

agricultural and rural housing areas

urban areas

wetlands and buffer zones

FLood risk

Subsidence

Production

Social awareness

Technology

Figure 5.8 Central urban area-city

To cope with this challenge, measures need to be taken upstream to mitigate the effects of flooding and to integrate agricultural production. This involves combining the concepts of agriculture and river modifications to increase flood storage capacity and improve the flood resilience of the city. By using a pattern assessment framework, the best pattern for the area can be identified and policies can be developed to support the implementation of these retrofitting measures. For example, the design of rivers and canals can be improved to increase their flooding capacity to deal with more frequent and severe flooding events.

In terms of policy, the government should develop measures to support these retrofitting and flood storage programs. This includes providing financial and technical support, working with farmers and other stakeholders, and facilitating policy coordination and implementation. In addition, the government should encourage and facilitate public participation to increase awareness of flood risks and sustainable development, thereby improving the flood resilience of the entire community.

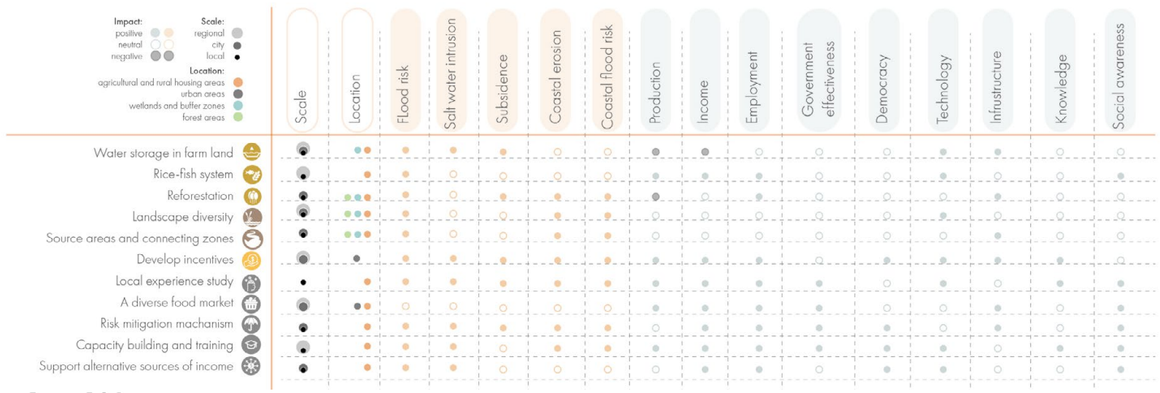


Figure 5.9 Pattern assessment

Before

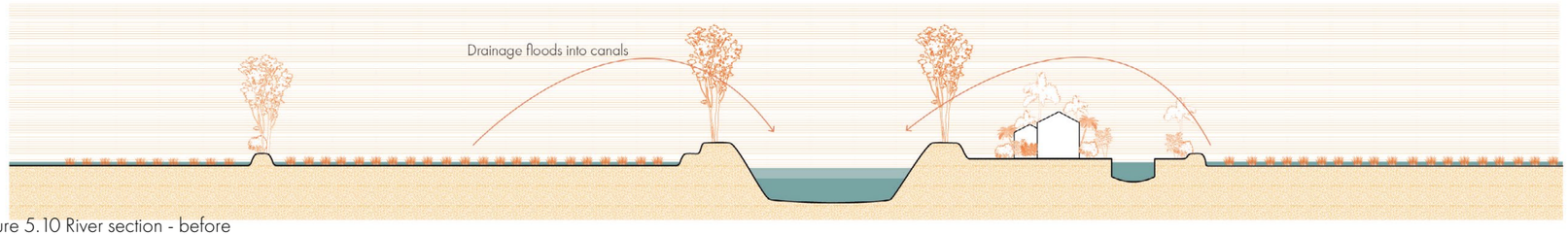


Figure 5.10 River section - before

After

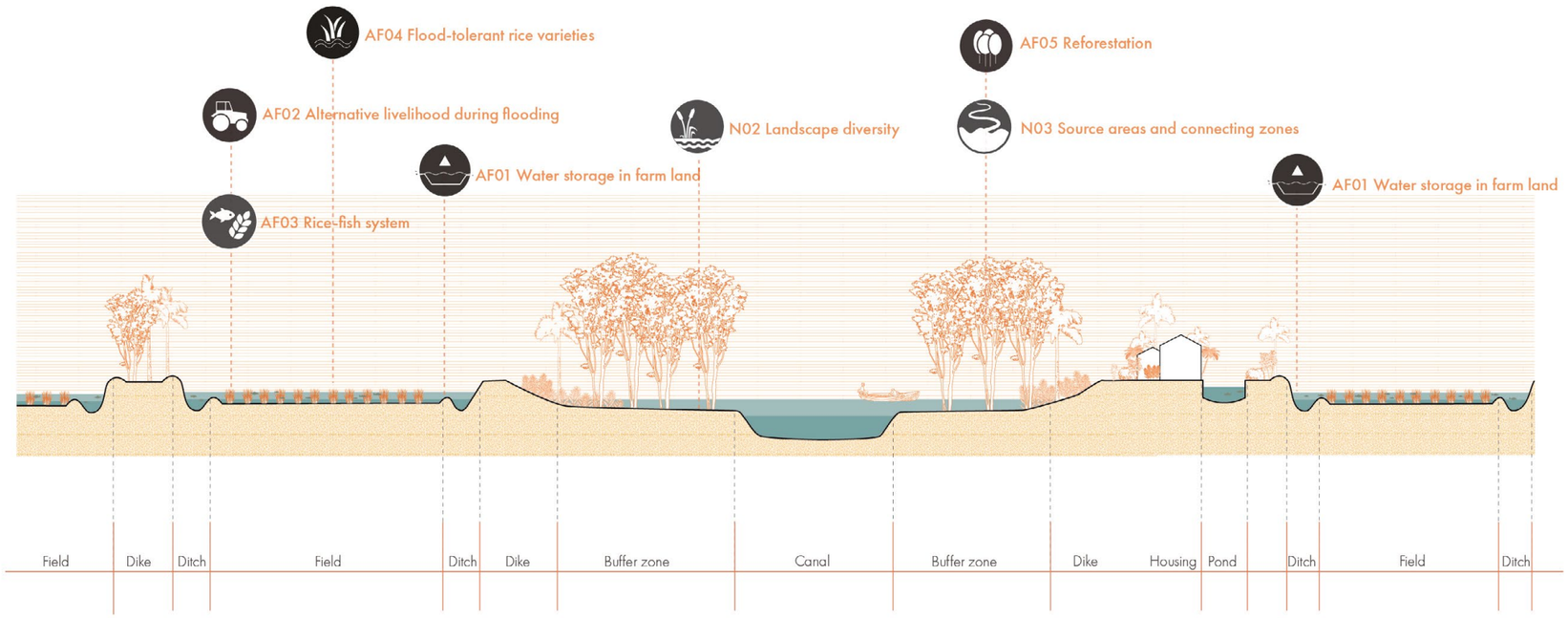


Figure 5.11 River section - after

City scale: River profile

In the current situation, the canals in Can Tho are generally hardened and narrow, which limits the storage capacity of the canals and floods quickly pass through the city and into the downstream areas. Therefore, the renovation of the rivers and canals became an important task, mainly in terms of extending the channels at the profile scale to increase their water storage capacity. At the same time, this also requires the transformation of the surrounding agricultural land to create a synergistic flood storage and retention system.

In addition to expanding the channel profile, it is also necessary to consider the naturalization of the river banks to make them ecological barges. Such transformation not only increases biodiversity and enriches the ecosystem, but also improves the resilience and adaptability to floods. Naturalized riverbanks can absorb and mitigate the impact of floods, reducing the damage to the city and surrounding areas. In addition, the modification of watercourses and riverbanks needs to incorporate scientific flood management principles and methods, as well as socio-economic considerations.

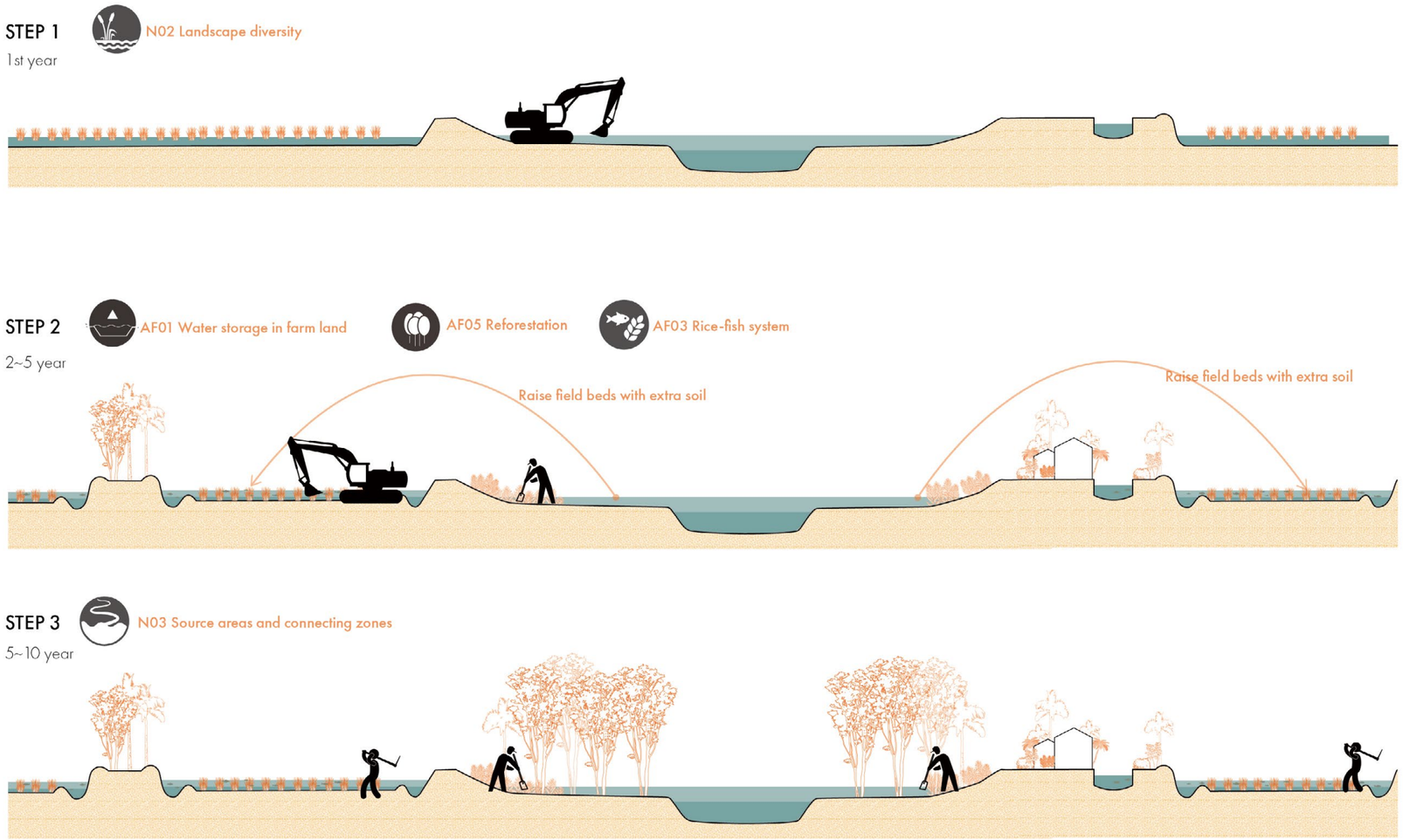


Figure 5.12 River section - phasing

Considering the temporal dimension, the renovation of the river can be divided into several phases. First, the construction phase will involve the expansion of the river and the resettlement of residents. The goal of this phase is to widen the river and increase its water storage capacity, while providing a good housing environment for the residents.

The second phase will involve the use of excess soil generated during the construction process to rehabilitate farmland. In the case of rice planting, the earth will be used to raise the planting bed and create a rice-fish working method. At the same time, trees will be planted along the riverbank to increase the function of the ecological berm. This will not only improve the farming environment, but also provide a suitable water area for fish to survive, and promote the restoration of the ecosystem and increase diversity.

In the third stage, 5 to 10 years after the completion of the renovation, the production and living order will gradually return to normal. The tree belt along the river will become the backbone of the landscape, connecting the various canals, forming an ecological network and contributing to the increase of biodiversity. Such a landscape transformation will bring beautiful scenery to the region, while providing services to the natural environment, such as flood regulation and ecological protection.

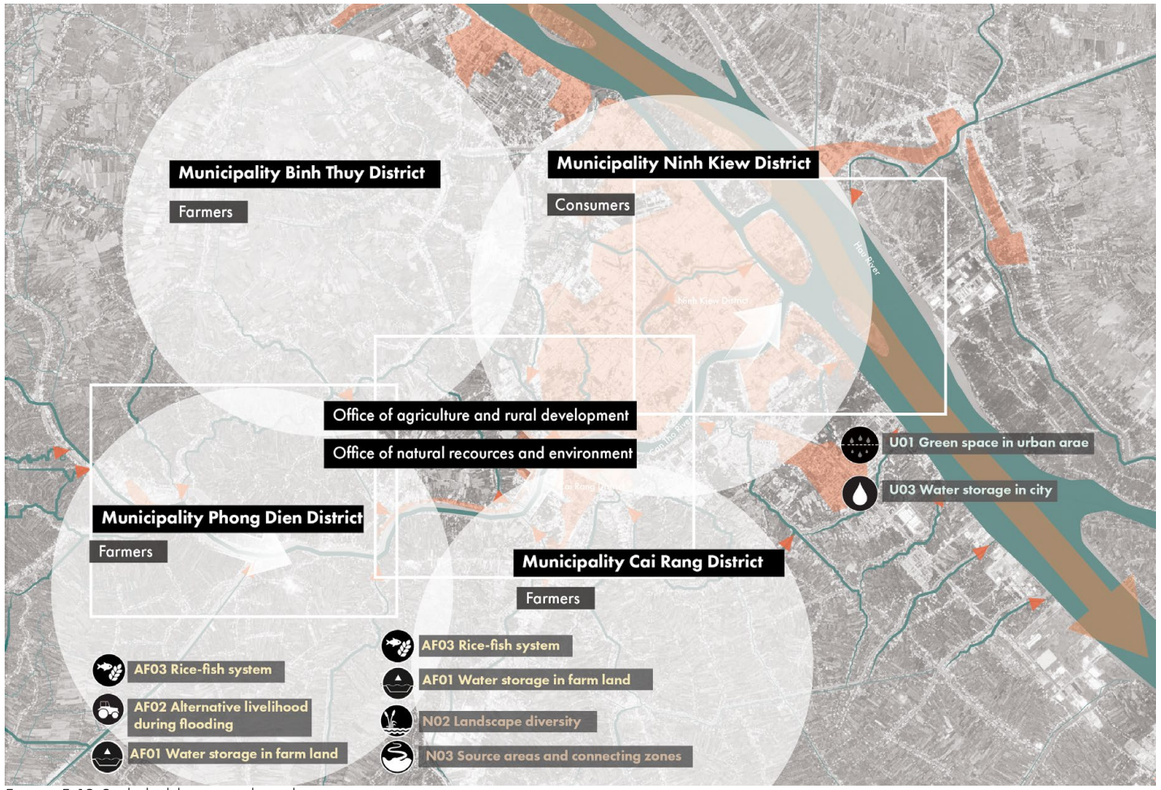


Figure 5.13 Stakeholder spatial analysis

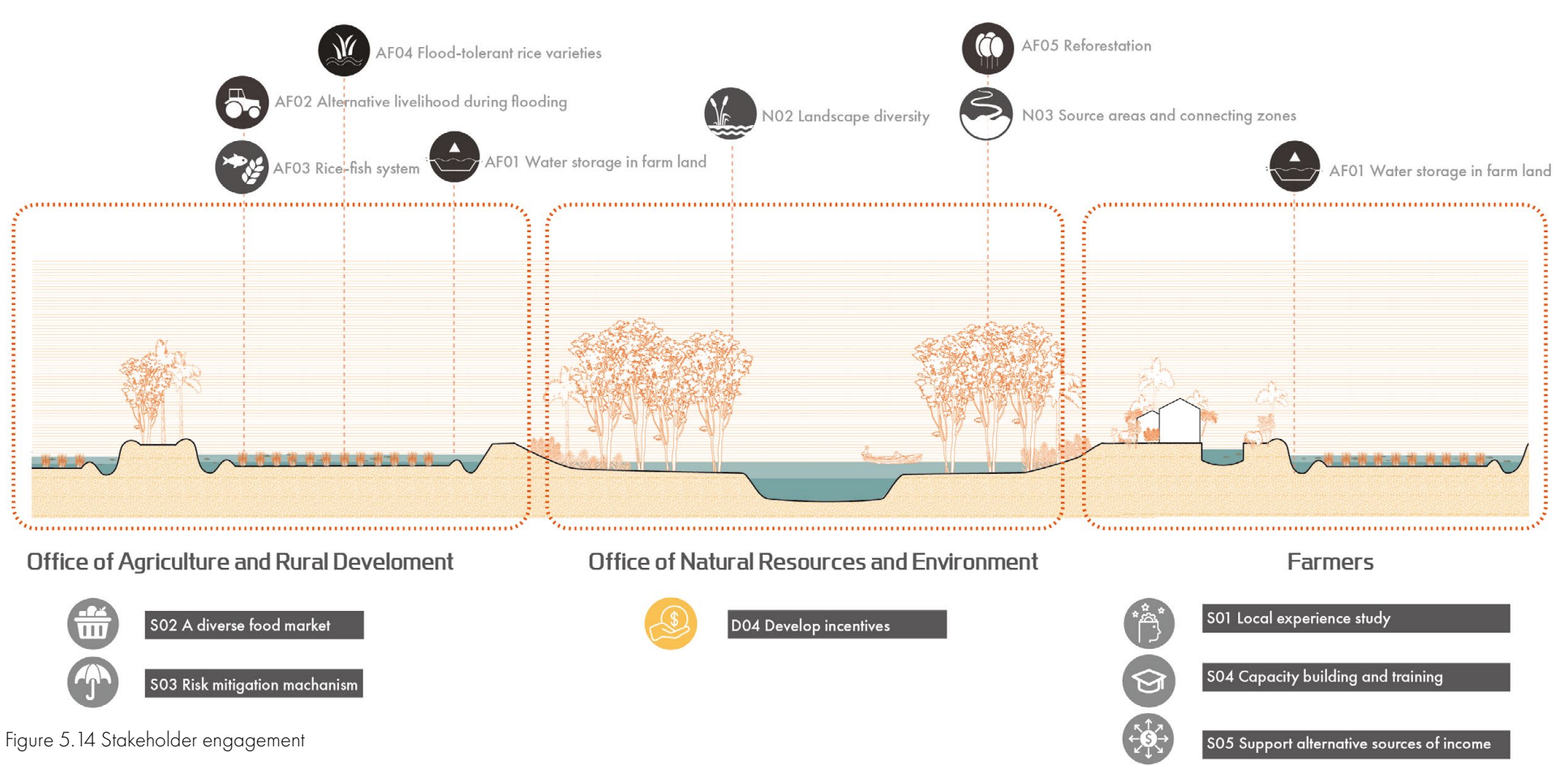


Figure 5.14 Stakeholder engagement

City scale: Stakeholder engagement

Flood management should be a comprehensive process that requires the cooperation and participation of government departments, professional organizations, stakeholders and community residents, and the formulation of appropriate policies and regulations to guide and regulate the renovation work. The area involves the jurisdiction of several municipalities and the interests and power relationships between the office of agriculture and rural development and the office of natural resources and environment and the farmers. In order to balance these relationships and facilitate the sound implementation of the transformation model, a series of policies are needed. These policies are designed to provide financial support for development, technical support, risk management, and livelihoods measures, while facilitating market development.

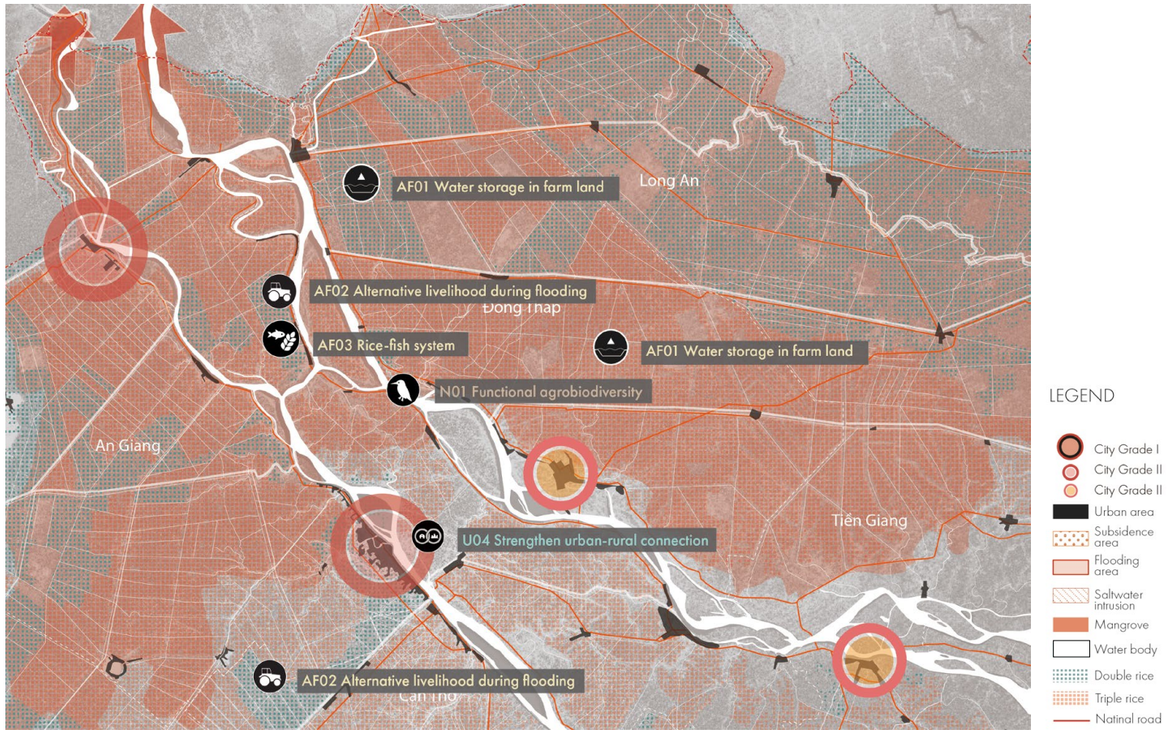
Financial support is an important component of the implementation of retrofit models. The government can provide funds to support the construction and operation of retrofit projects to ensure that they are carried out smoothly. Technical support is critical to the successful implementation of the retrofit model. Farmers and relevant authorities need technical guidance and training to ensure that they are equipped for retrofitting. Technical support can include construction of irrigation systems, water quality monitoring and management, and upgrading of agricultural production techniques. Risk mitigation measures need to be planned and implemented for uncertainties such as floods, climate change, and ecological changes, and can include establishing early warning systems, developing contingency plans, and promoting insurance mechanisms. In addition, the development of markets is essential for the sustainability and successful implementation of various patterns, and the government can create a favorable market environment by promoting the sale and marketing of agricultural products.

RURAL RICE FIELD

Regional scale: Pattern assessment

This region is located in the northern part of the delta and its population consists mainly of rural people, mainly engaged in rice farming, with a low urbanization rate. The region's nutrient-rich soil, nourished by the Mekong and Hau rivers, creates a triple rice production area. However, the area is also under constant threat of flooding during the wet season. This, coupled with the ongoing engineering of agricultural activities, has further exacerbated the decline in local income and employment. Therefore, the main goal of planning for the region is to develop sustainable agriculture that benefits local farmers and strengthens regional ties to withstand the damage of floods. Achieving this goal requires a pattern assessment to identify a range of specific spatial measures and policies.

First, sustainable agricultural development will be one of the key measures to reduce negative impacts on soil and water resources. Strengthening regional linkages is also key to counteracting flood damage. This can be done by improving cooperation and organization among farmers, facilitating knowledge sharing and technology exchange. In addition, promoting the processing and marketing of agricultural products and developing agricultural cooperatives and market networks can also increase farmers' incomes and improve their ability to cope with flood risks. The development and implementation of policies will play an important role. These policies should cover capital investment, technical support, risk management, and market development.



Regional

agricultural and rural housing areas

wetlands and buffer zones

FLood risk

Production

Income

Employment

Infrustructure

Figure 5.15 Rural rice fields - regional

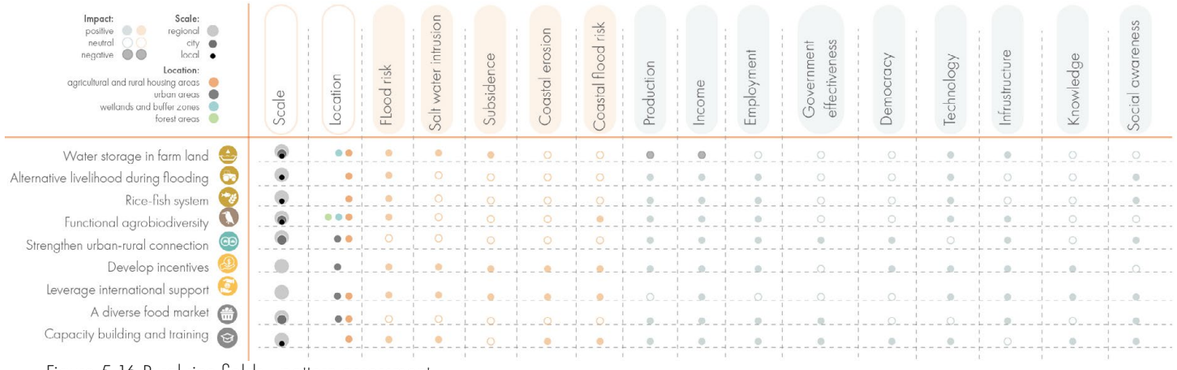
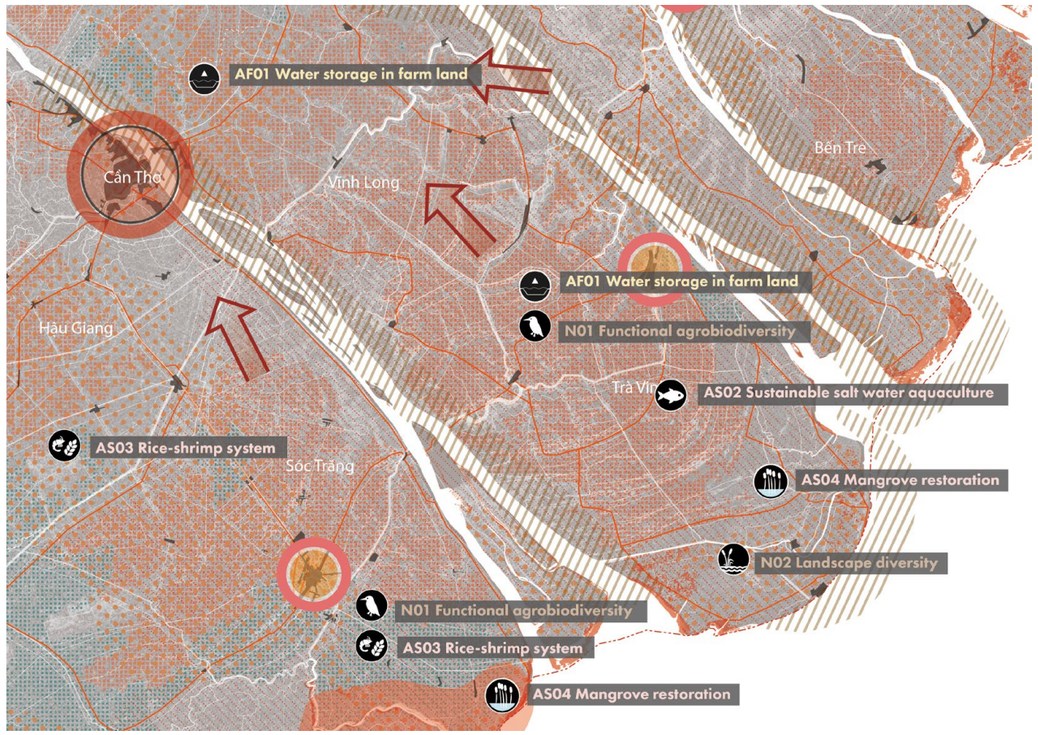


Figure 5.16 Rural rice fields - pattern assessment

COASTAL AQUACULTURE

Regional scale: Pattern assessment

The coastal fisheries region is located in the southern part of the Delta and is directly threatened by sea level rise. This area faces coastal erosion and saltwater intrusion, which are increasing salinization levels throughout the region and negatively impacting agricultural production. In addition, the continued demand for fresh water is forcing the extraction of groundwater, accelerating the rate of ground subsidence. Meanwhile, the continuous degradation of mangrove ecosystems threatens the ecological security of the coastal area.



Regional | agricultural and rural housing areas | wetlands and buffer zones

Salt water intrusion | Coastal erosion | Coastal flood risk | Subsidence

Production | Production | Income | Employment | Technology

Figure 5.17 Coastal aquaculture - regional

Through pattern assessment, it can be concluded that restoring the ecology and strengthening the coast is the primary task for the survival and development of the region. In order to achieve this goal, a series of measures are needed. First, mangrove protection and restoration is needed to enhance the protective function of the coastal zone and slow down the rate of coastal erosion. Secondly, the transformation of the coastal agricultural system to more sustainable production methods is needed to reduce the dependence on freshwater. This can be achieved by promoting the cultivation of salt-tolerant crops, promoting water-saving irrigation techniques, and providing farmer training. At the same time, the implementation of these measures requires policy support from the government and various stakeholders. The government should develop appropriate regulations and policies, provide financial and technical support, and establish a multi-stakeholder collaboration mechanism. In addition, a focus on community engagement, public awareness and education will help to build consensus and promote sustainable development.

Figure 5.18 Coastal aquaculture - pattern assessment

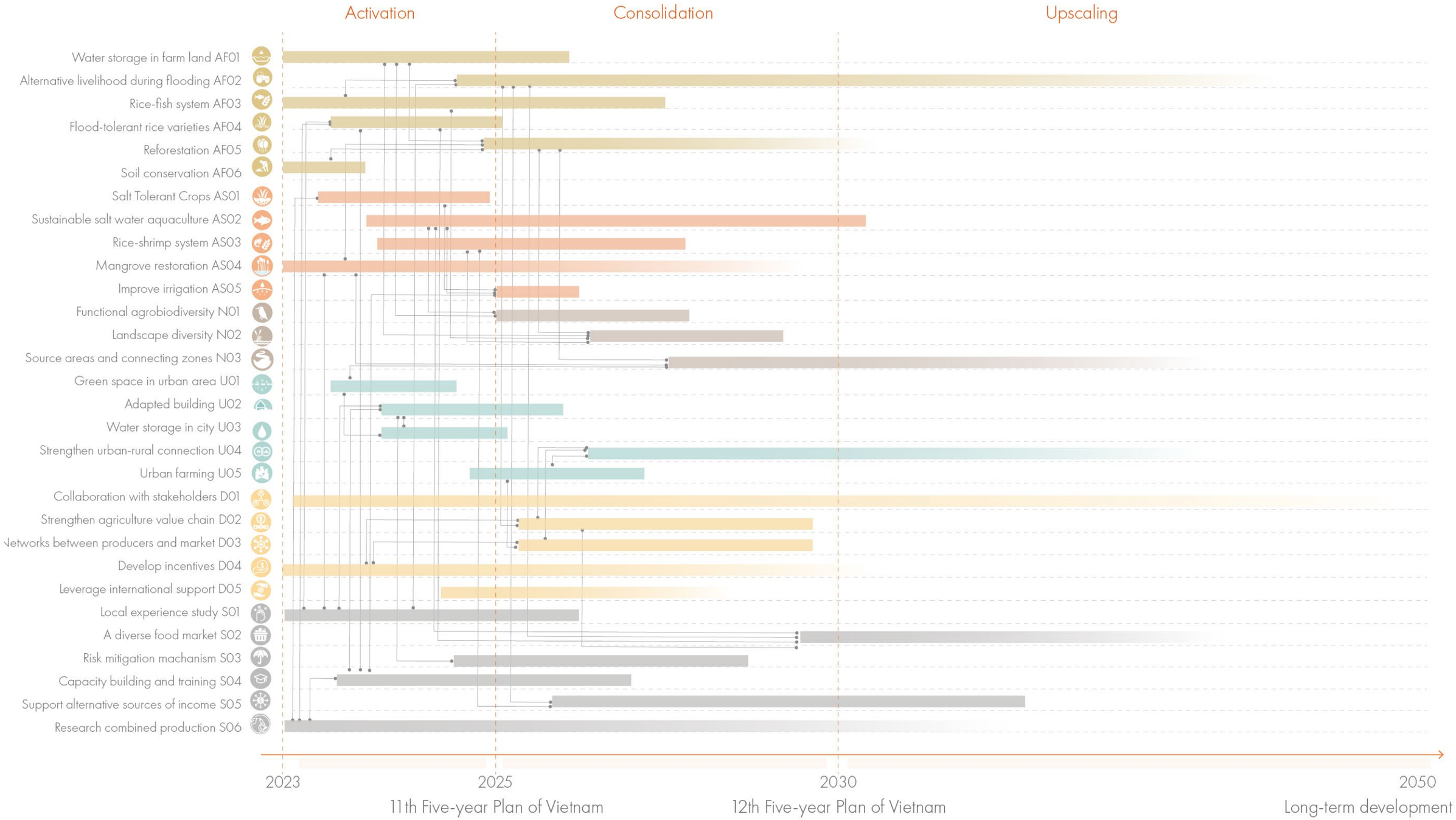


Figure 5.19 Phasing

PHASING

Among the identified patterns that need to be implemented, small-scale agricultural and urban transformation measures require less time and can therefore be implemented immediately; ecology-related measures will need to be coordinated with agricultural measures and wait for ecological restoration to occur and are therefore a bit later; and policy-based patterns have a longer time horizon.

06 DESIGN EXPLORATION
Can Tho suburban

Site analysis

Room for floods

Adaptive agriculture

Adaptive housing

Research & production

Agro-tourism

Policy

phasing

Source: https://pixabay.com/zh/photos/agriculture-irrigation-rice-fields-6560523/

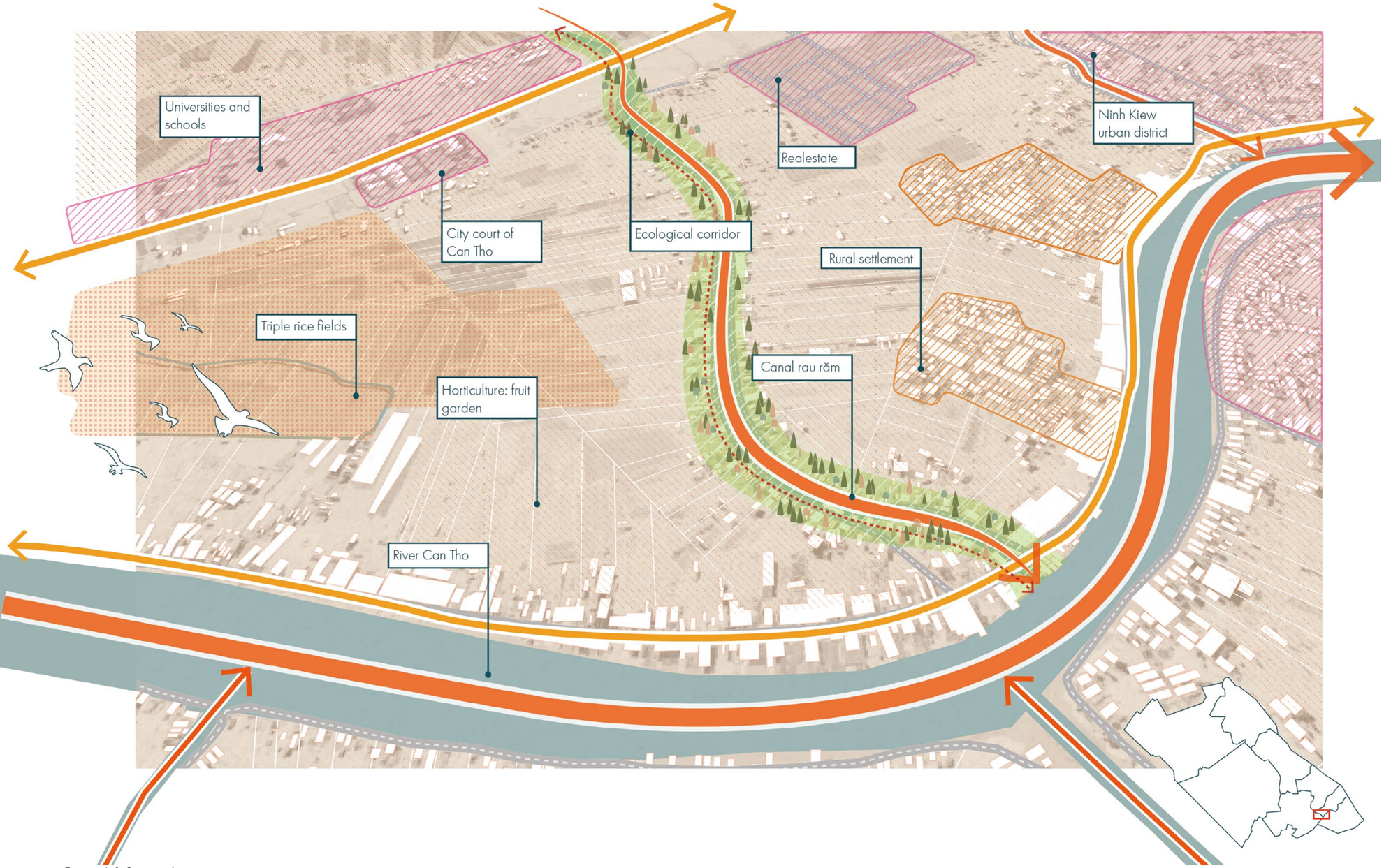


Figure 6.1 Site analysis

SITE ANALYSIS:

The site of the design exploration is located on the suburb of the city of Can Tho, a key location where the Can Tho River flows through the countryside into the city. As mentioned above, this area is a bottleneck of the river, which is essential for storing flood water and thus reducing its loss into the city. Also, as an agricultural area immediately adjacent to the city, the first design explorations in this area have the potential to strengthen urban-rural linkages and introduce sustainable agriculture to the public, thereby opening up markets.

The Can Tho river flows in the south and joins the hau river in the east; the Rau Ram canal in the site joins the Can Tho river from the north to the south. This canal not only serves as a spatial axis for local farmers to live in, but also as a green belt with rich vegetation, linking to more rivers in the north. On both sides of the river, horticulture production, such as tropical fruits, is the main focus, and rice fields are located in the western part. The southern part of the site also has a number of rural settlements along the river, with higher density as it approaches the city. In the north, South Can Tho University, Political Academy, FPT University Can Tho and other universities and their supporting facilities are located. The College of Agriculture and Mekong Delta Rice Research Institute are located in the eastern central city and Binh Thuy district in the north.

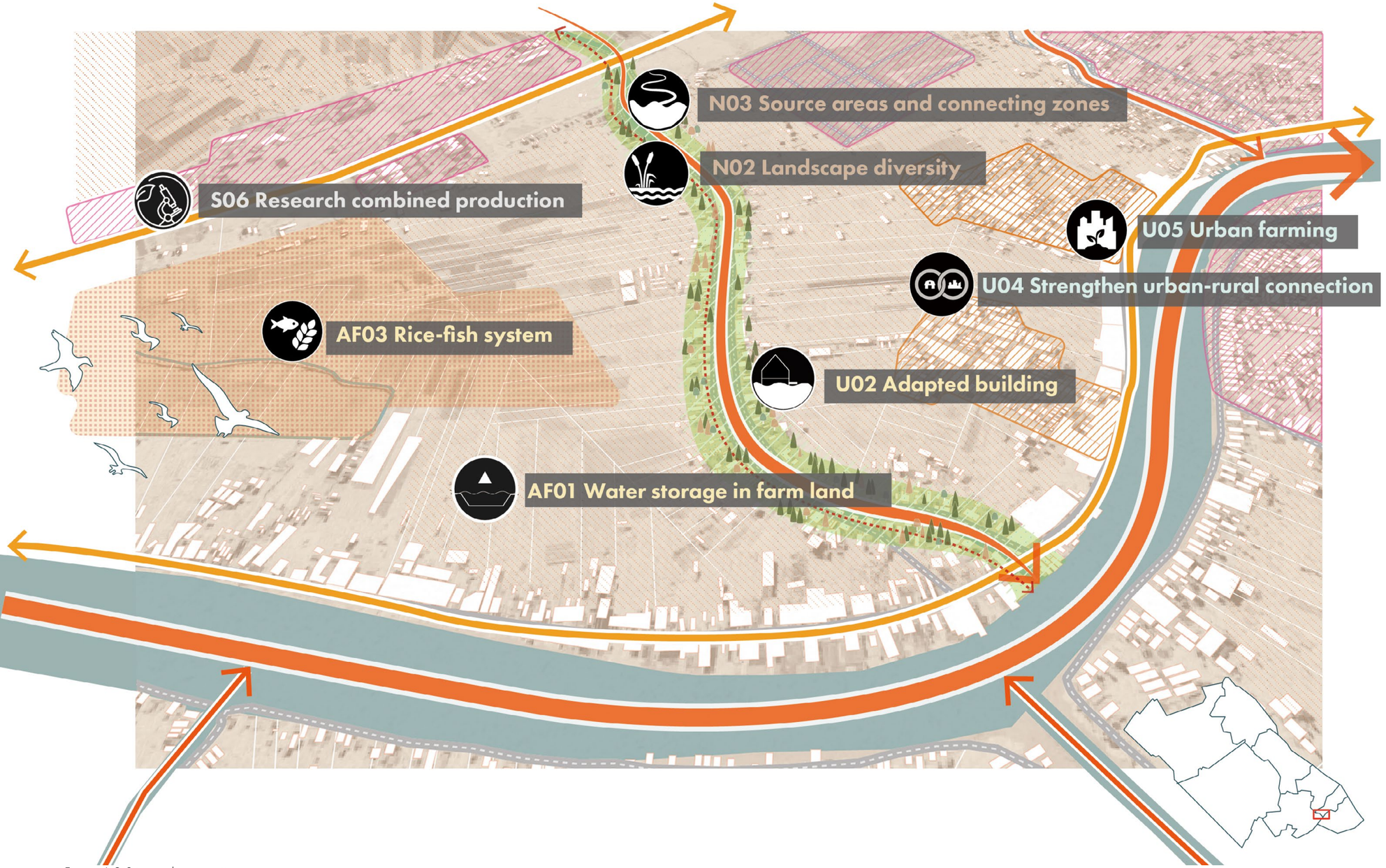


Figure 6.2 Site analysis - patterns

SITE ANALYSIS:

After the analysis of the basic situation of the site, and combined with the previous pattern assessment, we can basically determine the patterns needed in the design as the main design strategy. Along the river Rau Ram is mainly combined with the original structure to form a natural area that provides space for the river. The original housing was transformed into adaptive housing to cope with flooding, and the vast agricultural production area was transformed into a sustainable adaptive agriculture, and at the same time with the function of agricultural tourism. The northern part of the site combines the educational and research resources of several universities with the rice world, forming an area where research and development are combined with production, researching advanced agricultural production techniques and serving as an educational base for farmers.

Figure 6.3 Site analysis - strategies

1 Enlarged river bed
2 Waterfront route
3 Flood retention pond
4 Adaptive housing
5 Wetlands buffer
6 Waterfront platform
7 Fruit garden
8 Adaptive rice field
9 Experimental field
10 Community food garden
11 Public service function

0 50 250 500 m

Figure 6.4 Master plan

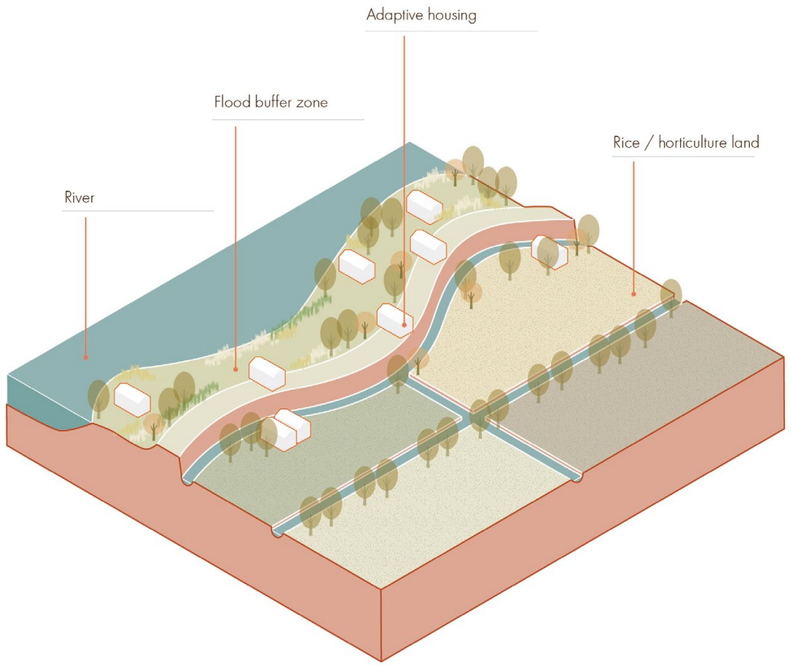


Figure 6.5 Riverbank renovation

A. ROOM FOR RIVER

As mentioned above, the main purpose of river reconstruction is to enlarge the river to enhance its flood storage capacity and to increase the natural and ecological elements to create a habitat to increase the natural resilience. In the specific design and implementation, we pay more attention to the preservation and utilization of the original elements of the site. For example, the housing along the river on the site is preserved to reduce the disturbance to the original residents by the renovation measures, and the original dike structure is used to prevent the housing from flooding.

In addition, the original trees are preserved to respect the ecological structure, and the land associated with them will evolve into ecological islands in the buffer zone of the canal over time, helping the riverbank to become more natural and increase the habitat while also acting as a barrier to slow down the flow and mitigate the flood.

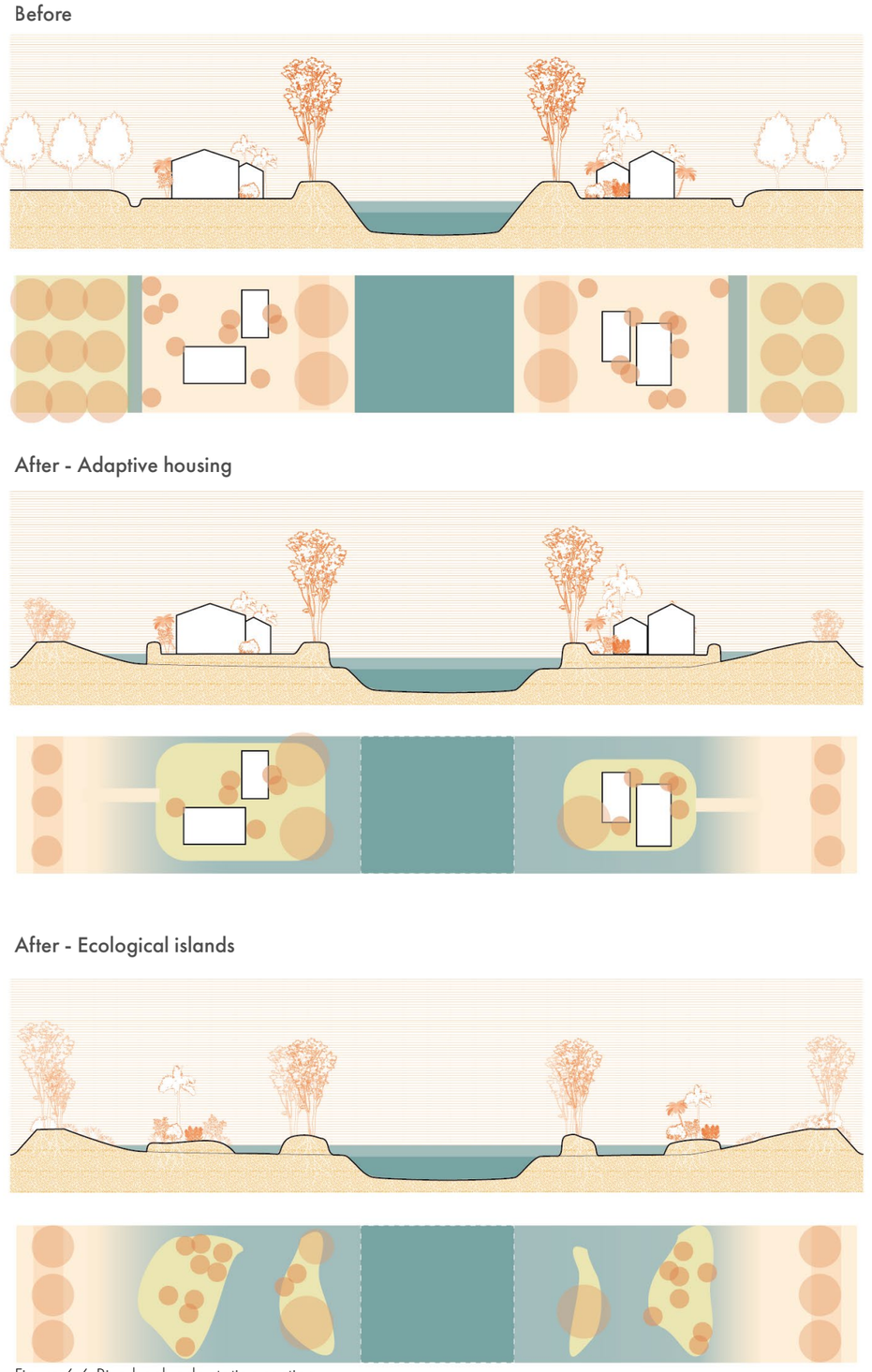


Figure 6.6 Riverbank adaptation section

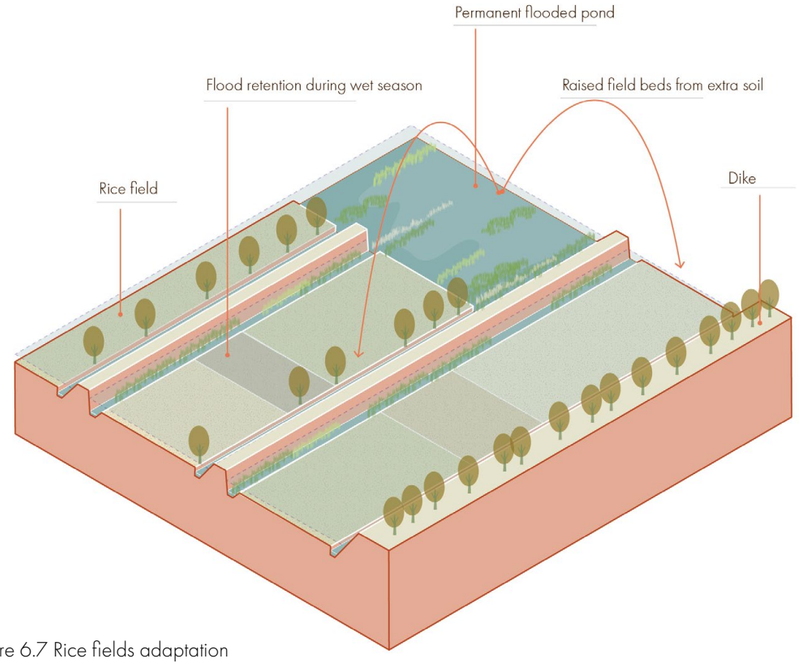


Figure 6.7 Rice fields adaptation

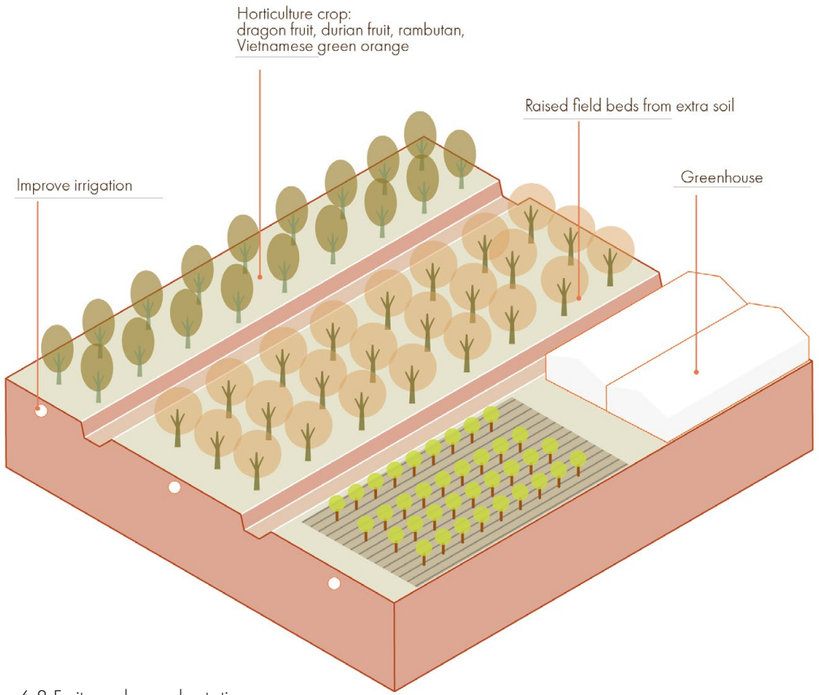


Figure 6.8 Fruit gardens adaptation

B. ADPTIVE AGRICULTURE

Agriculture on the site is divided into rice and fruit gardens, with the adaptive transformation of rice focusing on double rice and rice-fish systems that rely on varying dike systems to grow rice in the dry season and store rainwater in the wet season and develop aquaculture. Depending on the field texture, some areas will become permanently flooded ponds to increase flood resilience and provide a continuous source of water for dry season irrigation. The fruit garden area will also require additional water storage and improved irrigation techniques to reduce the need for groundwater extraction. Excess soil from the construction of the ponds and the modification of the river channel will be used to build dikes and raise the planting beds.

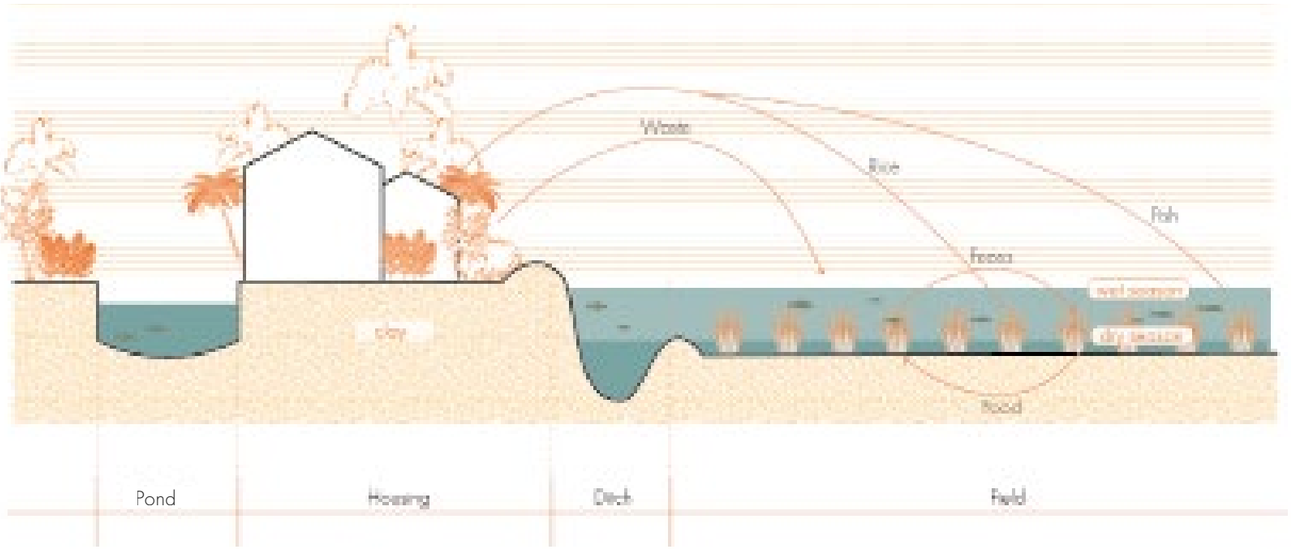


Figure 6.9 Rice-fish system

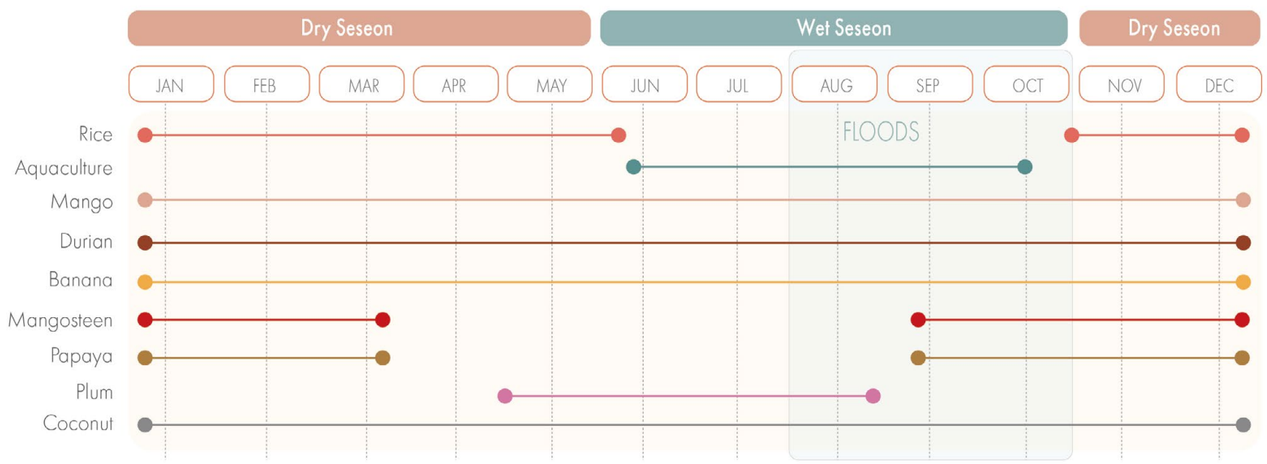


Figure 6.10 Harvesting seasons allocation

C. ADAPTIVE HOUSING

In this design, adaptive housing refers to the adaptation of housing in situ to the threat of inundation due to flood risk, with minimal disruption to the lives of indigenous people and without relocation of housing. The design is based on the indigenous culture, the traditional waterfront housing structures of some deltaic areas, and the integration of new materials and technologies to develop a number of housing typologies that are suitable for different conditions.

Two main strategies are used in the distribution of houses within the river to cope with flood threats. First, one floor of the house is elevated by a system of supports that keeps it away from flooding for most of the time. This design protects the house from flood damage. Secondly, floating housing is used so that the house can float on the water surface to cope with inundation during flooding. This floating housing design allows residents to stay relatively safe and convenient during floods.

For the houses located on the island, the design uses two strategies to cope with flooding. First, the water resistance of the walls was increased to reduce the intrusion of flood water into the houses. At the same time, access to the houses was ensured during floods by building second floor landings and walkways. Secondly, flood control dikes were built around the houses to increase the effect of flood water containment.

For the houses located on the dike, the design takes into consideration the variation of interior height difference and column system to avoid flooding. By adjusting the interior height, the main living area of the house is located above the flood level to reduce the impact of flooding. At the same time, the application of strut system can improve the stability and flood resistance of the house.

For the houses in the buffer zone, the design reinforces the waterproofing and flood protection measures around the house. In case of wet season flooding, the house may be slightly flooded, so it is necessary to take corresponding waterproofing measures, such as raising the height of the ground and strengthening the waterproofing capacity of the building materials. Such measures can reduce flood damage to the house while ensuring the safety and comfort of the residents.

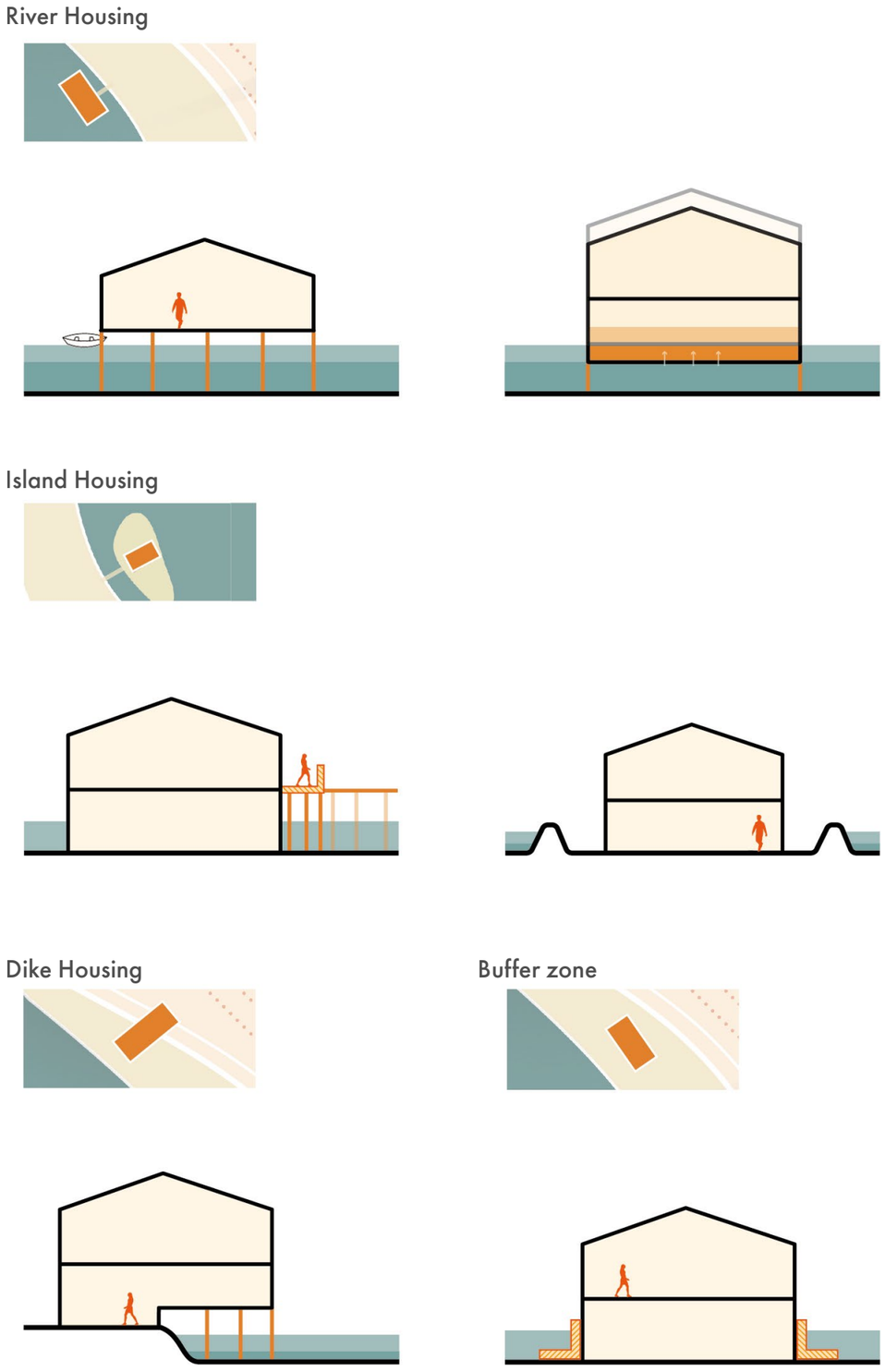


Figure 6.11 Sections of adaptive housing

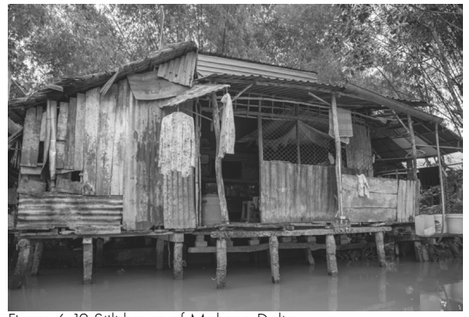


Figure 6.12 Stilt house of Mekong Delta
source:www.singulart.com/zh/artworks/serge-horta-stilt-houses-of-the-mekong-delta-1-648943

Figure 6.13 Floating villages
source: chinadialogue.net/zh/4/44143/

Figure 6.14 Housing by the riverbank
source: www.theroadtoanywhere.com/riverside-houses-in-the-mekong-delta-vietnam-travel-photo/

Figure 6.15 Housing with protections
source: www.freepik.com/premium-photo/village-mekong-river-champassak-laos_28449493.htm

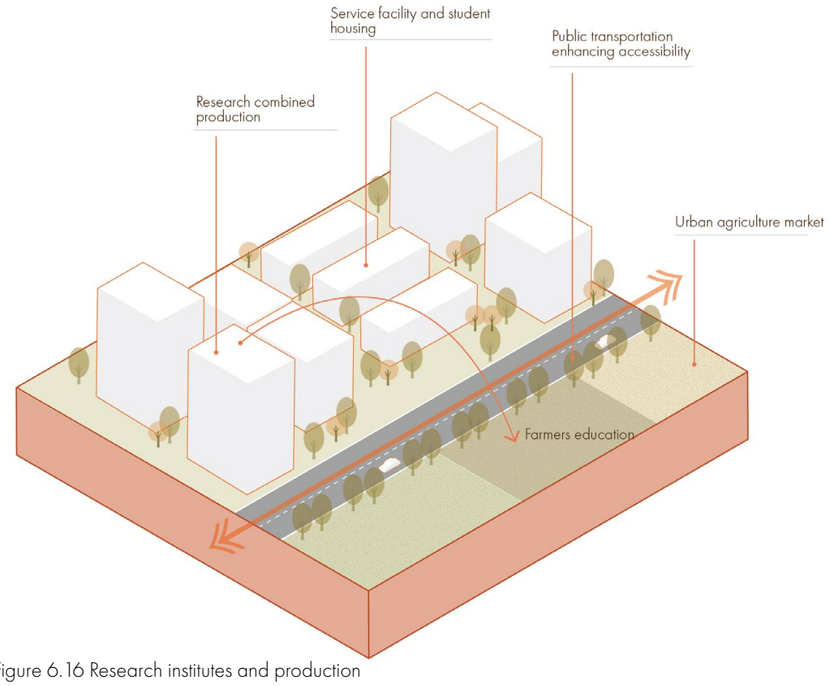


Figure 6.16 Research institutes and production

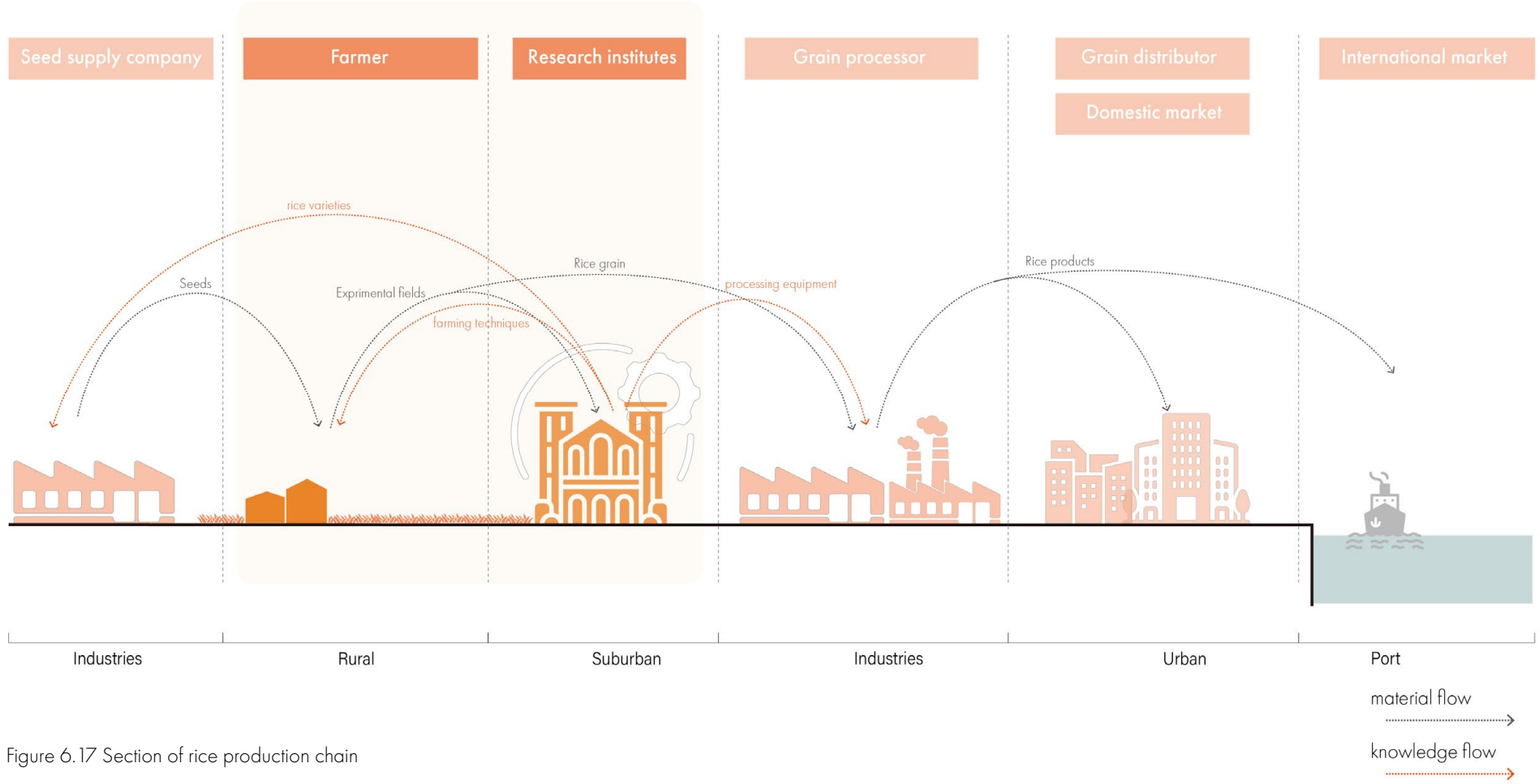


Figure 6.17 Section of rice production chain

D. Research Embedded in Rice Production Area

In combination with the universities in the north and the surrounding College of Agriculture and Mekong Delta Rice Research Institute, a pilot field is designed to integrate research and production in the northern part of the site. The area is based on university-related research facilities with additional support services and student housing, and enhanced public transportation to increase accessibility to the area.

As shown in the diagram, this pilot field area plays an important role in the production chain of rice in the Mekong Delta. The pilot field is able to provide new farming techniques, offering innovative methods and techniques for rice production. This will help to improve the yield and quality of rice. The area may also be able to provide quality rice varieties for seed supply to improve seed selection in the planting process. In addition, for the rice processing sector, the initiative may also investigate and provide modern rice processing equipment to improve the efficiency and quality of rice processing.

Through such an operational approach, the research institutes will provide technical support and innovation while positively contributing to the different aspects of rice production in the Mekong Delta. This will help to improve the efficiency and productivity of agricultural production, while promoting the upgrading and development of the rice industry.

Figure 6.18 Plan of agro-tourism

AGRO-TOURISM

The area is well suited for agro-tourism with agro-tourism, boat trips and harvesting experiences, based on its proximity to the city and its rich tourism resources, such as the Can Tho River and the Cai Rang floating market.

The waterway will be the main tourist route, allowing visitors to enter the interior of the site along the Can Tho River and enjoy the natural landscape of the riverbank, including the bypass area, flood resilient homes and orchards reached through the water retention pond. In addition, visitors can also visit the site's temples and other attractions. The walking route also follows the riverbank, incorporating nodes such as riverbank plazas and platforms, and connecting various public transportation stations and villages to facilitate the movement of visitors.

Supporting services, such as information centers and restaurants, will be located in each village settlement to provide visitors with the information and resting places they need. These facilities will help to provide a better tourism experience while also promoting the development of the local rural economy.

Through the development of agro-tourism, the region can take full advantage of its geographical and cultural resources to attract more tourists to the area, enhance its visibility and economic vitality, and promote the concept of sustainable agriculture and ecological conservation.

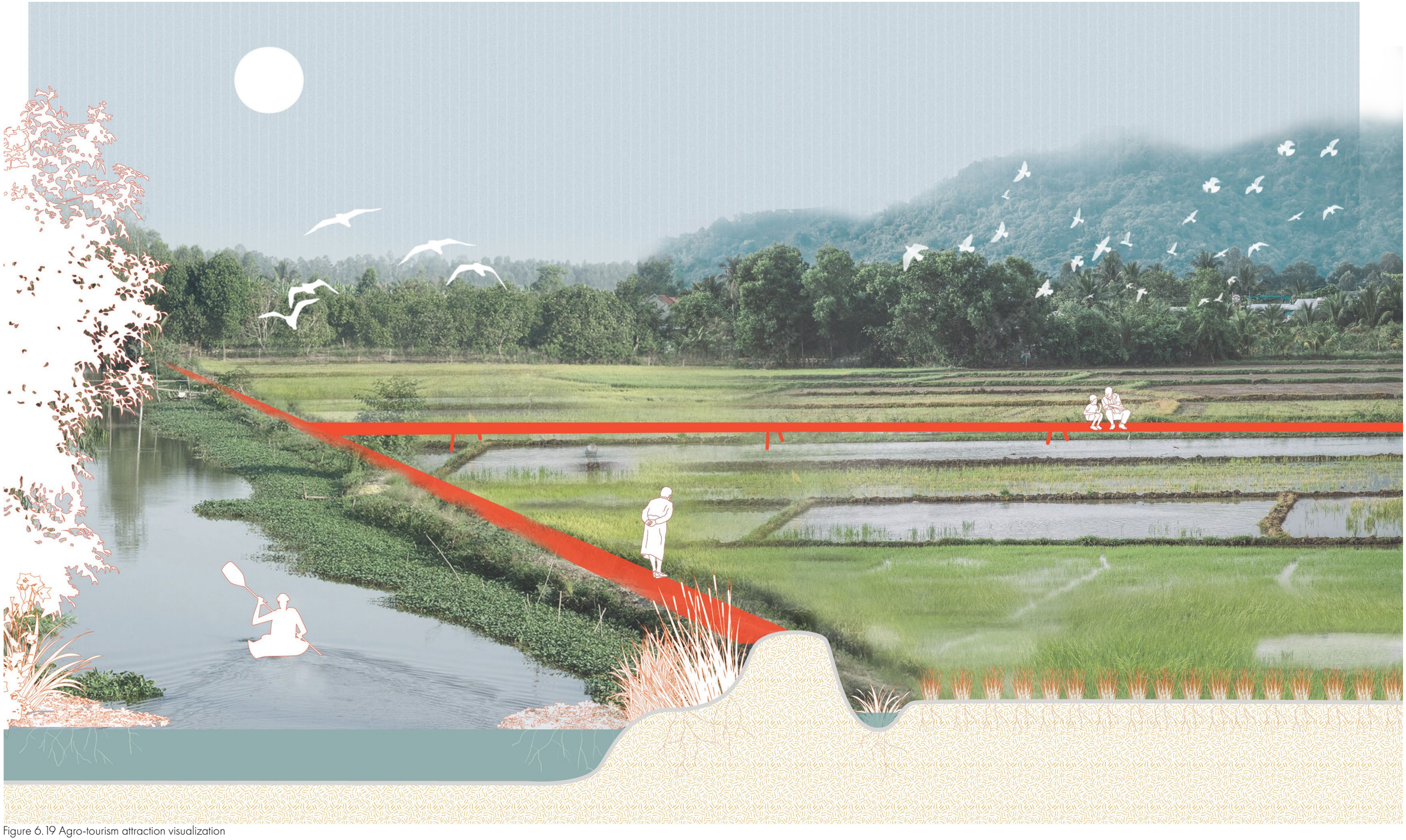


Figure 6.19 Agro-tourism attraction visualization

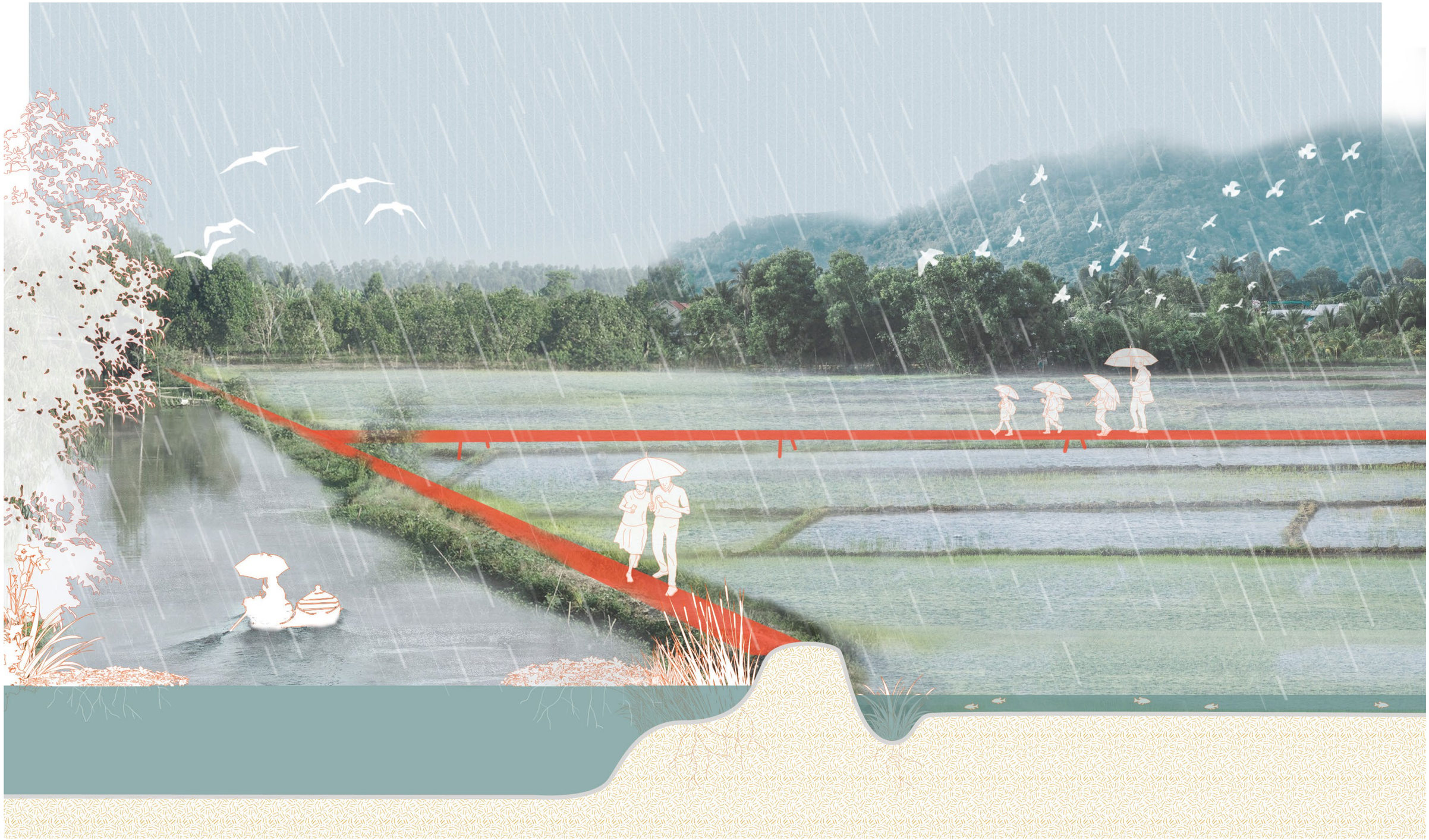


Figure 6.20 Agro-tourism attraction visualization

Figure 6.21 Agro-tourism attraction visualization

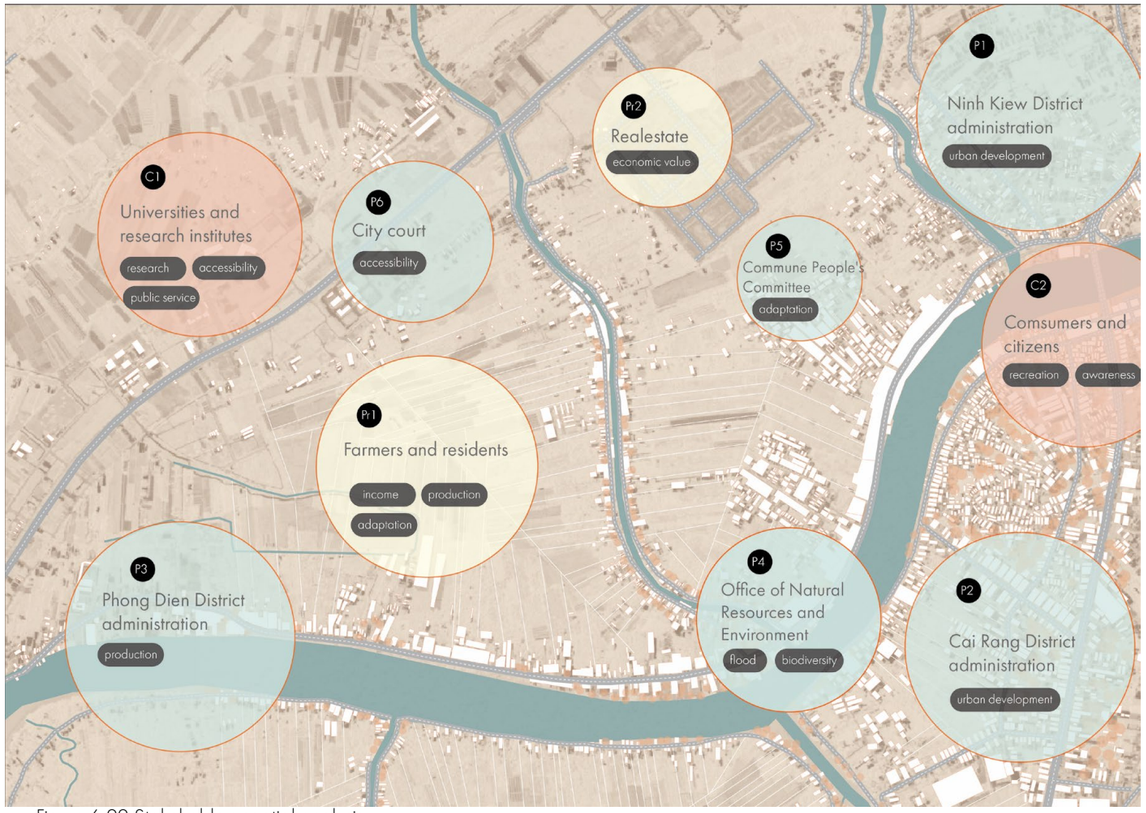


Figure 6.22 Stakeholders spatial analysis

POLICY

Since most of the land is government owned and government structures and management are involved in every aspect of the site and its inhabitants, it is particularly important to develop appropriate policies to promote stakeholder engagement to facilitate the implementation of the project. Similar to the analysis at the regional level, relevant government agencies such as the Ninh Kiew District Municipality need to work within a decentralized framework to provide support and assistance to stakeholders in the renovation and development process. They can facilitate the implementation of programs through regulations and provide financial and technical support for agricultural transformation, tourism facilities, and research development and production. As one of the main stakeholders, farmers can be supported by the government through the provision of agricultural training, financial support, seed supply and market connectivity. The public can be engaged and understood through public participation, promotion of the agritourism program, and marketing of more sustainable and diversified agricultural products.

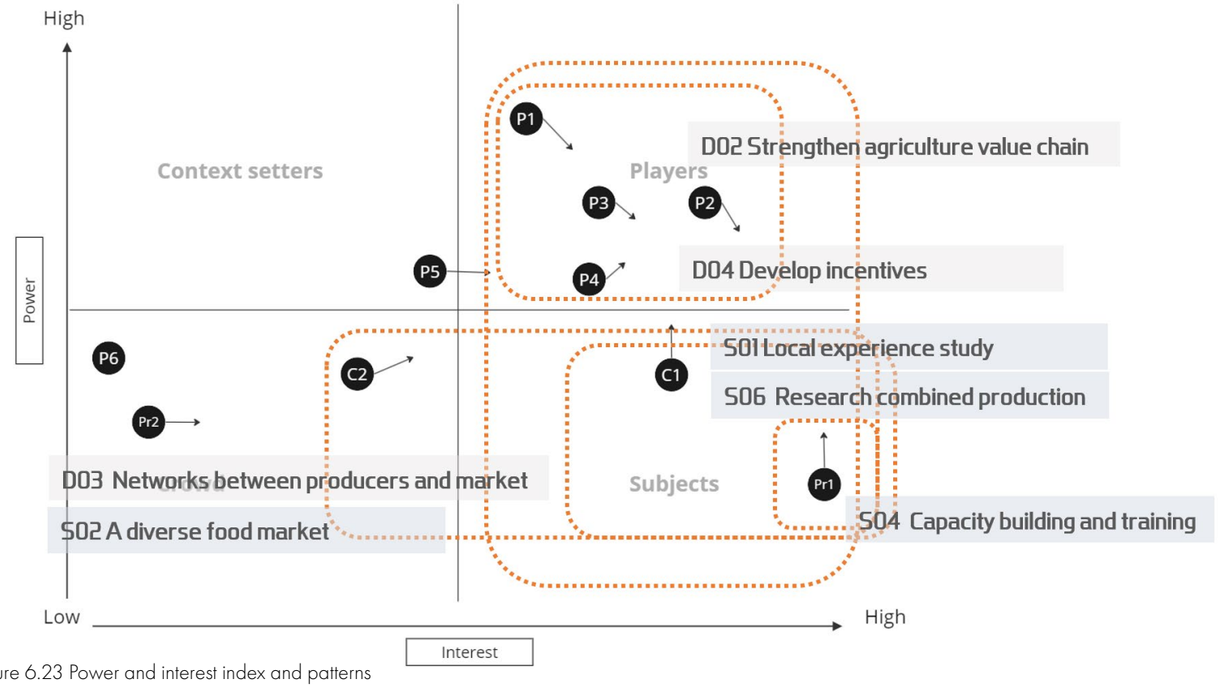


Figure 6.23 Power and interest index and patterns

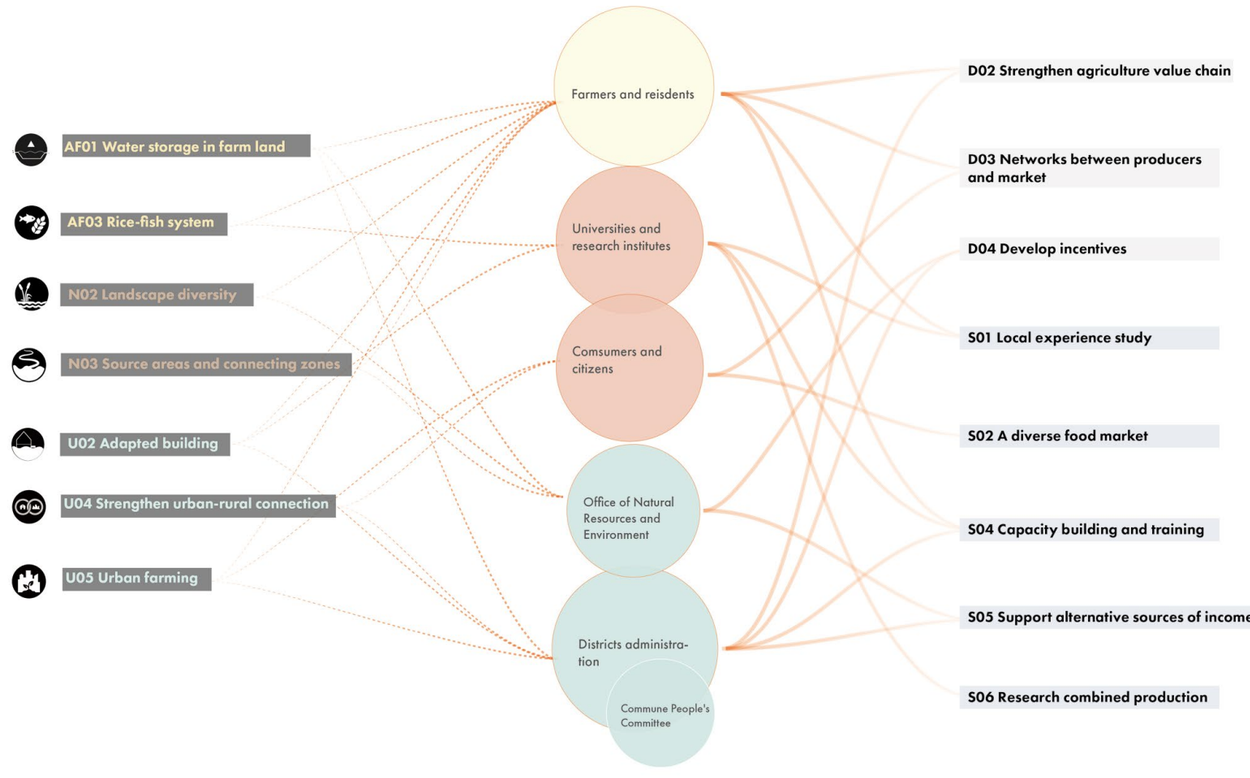


Figure 6.24 Stakeholders engagement for design intervention

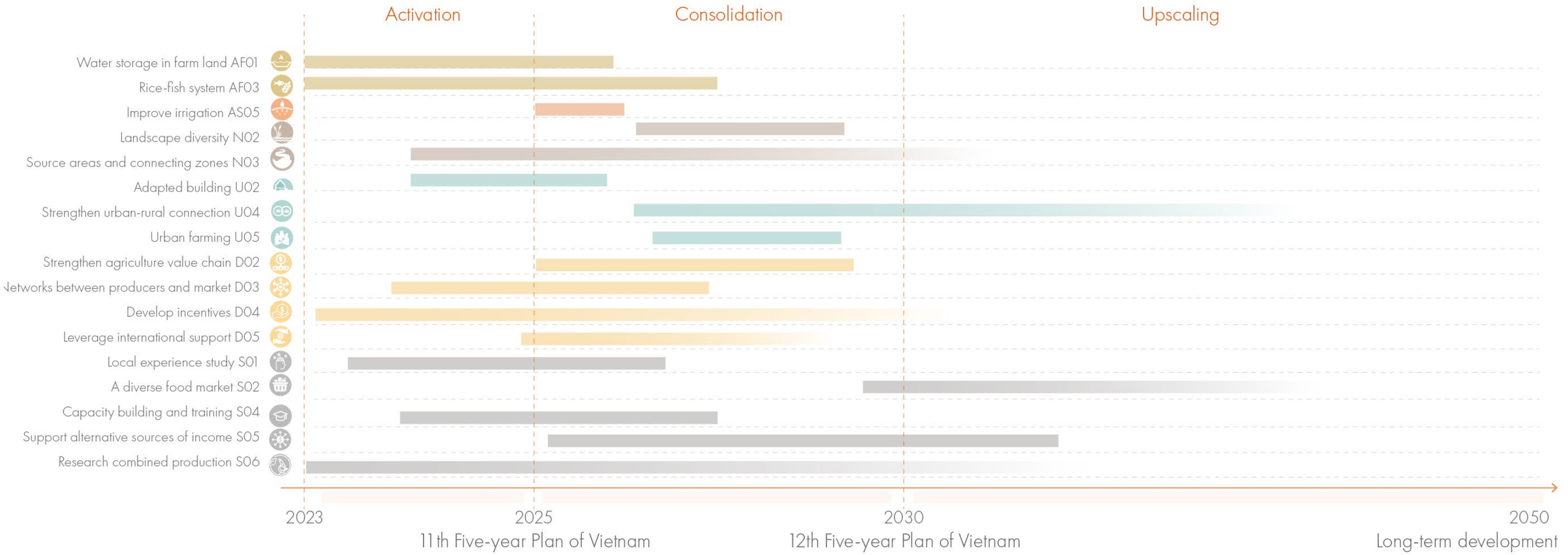


Figure 6.23 Phasing

PHASING

Among the identified patterns that need to be implemented, small-scale agricultural and urban transformation measures require less time and can therefore be implemented immediately; ecology-related measures will need to be coordinated with agricultural measures and wait for ecological restoration to occur and are therefore a bit later; and policy-based patterns have a longer time horizon.

07 CONCLUSION AND REFLECTION

Conclusion

Reflection

Source: https://pixabay.com/zh/photos/vietnam-rivers-fruit-women-trade-5132034/

CONCLUSION

After research and design, the four research questions can be answered:

What is the knowlage gap between the current planning policies and resreach, and the problems in the agriculture system regarding climate change effect?

Most projects in the Mekong Delta focus on coastal climate resilience building, agricultural livelihoods, and local development, such as mangrove conservation, brackish water zone construction, and water resource management. These projects have focused on coastal provinces threatened by sea level rise, on coastal fisheries and aquaculture, and less on rice and horticultural agricultural areas in the middle and upper delta. These projects consider climate adaptation development strategies and interventions at a technical level and are usually implemented in a top-down manner. However, some projects are limited to a theoretical level and are not integrated into the actual planning process, lacking consideration of local culture and daily habits.

What are the challenges and opportunities for climate adaptation strategies?

The Mekong Delta faces a number of challenges and opportunities for climate adaptation strategies. The northern region, which carries water from the upper river, faces increased flooding pressure during the rainy season as climate change intensifies. At the same time, rising sea levels are causing salinization areas to expand inland, making agricultural production of rice more difficult in the southern coastal areas, which in turn increases pressure on rice production in the north. The salinization problem has also triggered over-extraction of groundwater, putting coastal areas and densely populated cities at risk of subsidence. The northern region and the provinces along the Mekong River are distributed with more poor and unemployed people, as well as ethnic minority groups.

However, many opportunities also exist in this region. For example, the large amount of agricultural land, mainly rice, offers a wide scope for flood retention and natural integrated agriculture. In addition, the northern region still retains part of an environmentally friendly two-season rice agricultural system that can accommodate more flood water while being suitable for traditional production methods such as rice, shrimp, and rice and fish, providing more socio-economic employment opportunities for the poor. Economic transportation corridors connecting the Mekong Basin countries will also contribute to the connectivity of agricultural production areas and increased regional transportation connectivity. The transportation network of the delta, which connects major cities and agricultural production areas, also provides connectivity to economic corridors and economic regions, providing a spatial skeleton for regional agricultural development.

How can farmers and citizens adapt to climate change risk by developing a climate-resilient agriculture system while maintaining the quality of life?

In order to maintain the quality of life in the development of climate-resilient agriculture system, it is necessary to analyze the possible damage to the quality of life caused by the intervention and take corresponding measures or policies to compensate for it. In this project, a pattern language is used as a means to intervene and improve agricultural livelihoods and is evaluated in three dimensions: awareness, action, and capability, in order to consider its positive or negative impact on adaptive capacity. Measures with negative impacts are combined with corresponding patterns to reduce the impact of agricultural transformation on daily life.

How can local experiences guide the change in rice production and water management to improve its resilience?

The integration of local experiences can lead to changes in rice production and water management that can improve resilience and promote sustainable agricultural development in the Mekong Delta region. This is embodied in this project by the adoption of traditional agricultural knowledge and farming practices, including climate- and environment-adapted cultivation techniques, irrigation management, and rice variety selection, which can be used to optimize rice production systems and improve resilience. Following the ecological environment in which agriculture is located, coordination with the natural environment is emphasized, including rational use of water resources and increasing biodiversity, in order to improve the resilience and stability of the rice production system and mitigate the effects of various types of climate and its secondary hazards on crops. At the same time, we will build adaptive housing for threatened settlements by taking into account traditional lifestyles and building structures and materials to reduce the negative impact on the quality of life of the residents.

REFLECTION

Relation between graduation project topic, master track (Urbanism), and master programme (MSc AUBS)

The Urbanism track and the studio theme of planning complex cities enables this graduation project to understand the complex spatial and institutional realities of the Mekong Delta in the political, cultural and social context of the site; and to respond to them at the regional scale and planning level in order to address spatial planning in complex urban and rural contexts in terms of climate adaptation, water management and ecology and Strategic development issues. Also at a smaller scale, the study area is concerned with the composition of site structures and spaces, landscapes, networks and systems, time and transformation, and relationships between scales and enabling connections between agricultural rice production and socio-cultural, historical, and economic sustainability.

Relation between research and design

Research and design are the primary means of understanding and intervening in the site during this project. The research phase provides the necessary information and understanding for the design. An in-depth study of the characteristics of the Mekong Delta region, climate trends, natural resources and socio-economic conditions allowed for a better understanding of the challenges and opportunities for more sustainable agricultural transformation in different regions of the Delta. At the same time, the study reveals the experiences and wisdom of local traditional farming and people's lives to provide valuable references for planning and design.

The structure and framework of the pattern language provides a concrete basis for the research. The use of the pattern language for design practice also puts more detailed requirements on the understanding and interpretation of the site from the research level. By further analyzing the site, hydrology, and climatic challenges of the site, it provides a specific direction for planning and design. The design exploration chapter of this project is an integrated manifestation of design and research, and as a pilot project to test and implement the design methodology framework, the design itself is a means to conduct research. Through the design practice, we can know the applicability of the pattern language method in various scales and different venues and adjust it accordingly.

Methodology and approach

Various methods such as mapping and data analysis, research by design, and pattern language are used in this project as tools for understanding and creation. Among them, pattern language is an important approach that is used throughout the project from analysis, synthesis, planning, and design. pattern language will enable to summarize spatial tools and local experiences in a systematic way, forming a toolbox and evaluation network for the site. The pattern language will also form a common language and tool for communication and co-creation with stakeholders and will play an important role in public engagement and civic education for the project.

Pattern language is also a good tool for organizing knowledge in the research and design process. Its ability to summarize information on the site in a systematic and concise manner, and the ability to obtain an overview of the site, enriches the vocabulary of project planning and design, and provides the impetus and direction for further analysis and case studies.

Scientific relevance

This project explores the potential of traditional culture to adapt to the growing impacts of climate change in the context of indigenous agricultural practices in the Mekong Delta of Vietnam, and translates this into design and planning principles by integrating it with the different landscape types and regional characteristics of the region. This can, to some extent, complement the knowledge network of Vietnamese or Southeast Asian indigenous cultures and provide another direction for the expansion and revitalization of this knowledge in today's new context. At the same time, the project provides a new perspective for adaptive capacity theory to intervene through a pattern language that can be applied to design patterns in different contexts and systems. By incorporating patterns that promote resilience, innovation and learning, the pattern language can enhance the adaptive capacity of individuals, communities and organizations in the face of environmental, social or economic disruptions. For boundary spanning theory, the design approach of this project can also facilitate boundary crossing by facilitating collaboration and communication between different stakeholders (Warner, 2010). patterns can serve as a common language and shared reference point for farmers, researchers, policy makers, and others involved in agriculture.

Societal relevance

At the societal level, the project aims to improve the climate resilience and sustainability of the Mekong Delta's societies, ecosystems, and natural resources through targeted, climate-resilient spatial planning of food systems, starting with rice-based food production, and to create new economic opportunities for its sustainable development. Integrate leadership, coordination, and funding to manage the transition to sustainable agriculture in the Mekong Delta, combining top-down planning with bottom-up action. Develop a common language to integrate and communicate with diverse stakeholders, address cross-border cooperation in governance, and mitigate tensions between traditional lifestyles and climate adaptation measures. This attempt to develop a planning and design framework will be informative for a wide range of agricultural regions threatened by climate change, especially for other delta regions in Asia engaged in agricultural production.

Ethical reflections

This project pays special attention to the protection of the rights and interests of vulnerable groups, including farmers and ethnic minorities. The needs and interests of these groups are taken into account in the design and implementation of the project to ensure that they can participate in and benefit from the project. For example, in the study of agricultural adaptation strategies, attention was paid to the agricultural livelihoods and sustainable development of smallholder farmers and migrant workers, and to increasing the employment and income of farmers who are landless or have little land. This project is also closely related to the Sustainable Development Goals, specifically: zero hunger, no poverty, good health and well-being, and quality education. By conducting research and implementing agricultural adaptation strategies, the project works to achieve food security, reduce poverty, provide health and well-being, and promote educational opportunities. These goals contribute to improving the quality of life and social equity of local communities. In addition, the project also values environmental sustainability and resource management at an ethical level, promoting ecosystem conservation and restoration. sdg11 urban

However, among the vulnerable groups the project has paid less attention to women's and children's rights, and has not considered enhancing women's participation and status advancement, promoting gender equality and social inclusion. The project may also be affected by resource constraints and political and economic conditions, resulting in slow progress in achieving its objectives. Despite the project's emphasis on protecting the rights and interests of vulnerable groups, there may be difficult issues to resolve in practice, such as disputes over land rights and social inequality.

Limitations

In addition to the inadequate consideration of vulnerable groups, this project has the following limitations: First, the lack of field research prevents the project from obtaining more first-hand data and hands-on experience with the site, which may lead to a less than comprehensive understanding of the reality of the situation. Secondly, the project's deficiencies in stakeholder contact and engagement led to limited real stakeholder participation and therefore are limited in authenticity and validity.

The design exploration is limited in the number and depth of design methods tested at small scales, and lacks sufficient sample data for comprehensive summaries and conclusions. In addition, the currently developed Pattern Language approach can provide direction at larger scales but cannot go deeper into small-scale design, and there is still potential for further development and refinement of individual Patterns. Therefore, there is still room for improvement and deepening in the above aspects of the project.

Figure 7.1 Major deltas in Asia

Transferability

This project is transferable to some extent and has potential in other rice producing regions in Asian deltas facing the threat of climate change. Many Asian regions have similar traditions of agricultural practices, such as the sangji fish pond system in southeastern China, the dike polder technique, and the low-input rice-fish farming system in Malaysia. The conceptual logic of this project and some of the content of the pattern language are of some reference value to these regions. With the experience and methods of this project, these regions can adapt and apply them accordingly to enhance the adaptability and sustainability of their agricultural production. At the same time, it should also be noted that the applicability of the project may be affected by differences in other regions. The implementation of the project requires the cooperation and support of local stakeholders and government agencies, and the participation and support of local stakeholders needs to be taken into account when replicating and scaling up in other regions. Therefore the project needs to be appropriately adapted and evaluated when scaling up its application in other regions to ensure its transferability and sustainability.

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