Utrecht University

Political Ecology Assessment of Smallholder Farmers' Vulnerabilities Following Agricultural Transition for Climate Adaptation

A Case Study of Kien Giang, Vietnam

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Summary

This thesis aims to analyze the vulnerabilities of farmers in the Mekong Delta from a political ecology perspective due to Vietnam's government-led agricultural transition. The region is a major agricultural area in Vietnam contributing significantly to rice production and exports, yet facing challenges such as salinity, prompting a shift towards rice-shrimp farming. While this transition has led to increased income and improved climate resilience for some farmers, it poses initial investment challenges that may exacerbate vulnerabilities for small-scale farmers. Government policies promoting hybrid agriculture prioritize economic benefits over traditional rice monoculture, yet not all farmers benefit equally, particularly disadvantaging the poor and small-scale farmers. Farmers are expected to take all the business risks associated with this agricultural shift.

Therefore, this thesis focuses on analyzing the structural vulnerabilities from social, economic, and political perspectives, which farmers face due to agricultural transition and top-down climate change adaptation policies implemented by the Vietnamese government. Specifically, this thesis examines changes in vulnerability due to agricultural transition, external influences on farmers' decision-making, and the impacts of agricultural transition on farmers' livelihoods and practices. The conceptual framework integrates the IPCC climate adaptation framework and T. T. Nguyen 's (2017) rural livelihood framework.

Data for this thesis were gathered through semi-structured interviews with 35 farmers in Hung Yen commune of Kien Giang province in Vietnam. Additionally, interviews were conducted with seven experts in agriculture, aquaculture, and rural development. To ensure the reliability of the data, the results from the farmer interviews were triangulated with the expert interviews and relevant literature. The collected data were coded using NVivo and analyzed through a grounded approach.

The analysis reveals that farmers not only face environmental vulnerabilities such as rising temperatures, water pollution, and limited agricultural land, but also complex social, political, and economic vulnerabilities. Social vulnerabilities include disparities in social safety nets within communities and unequal access to agricultural knowledge. Political vulnerabilities encompass the top-down implementation of neoliberal climate change policies, lack of fairness in decision-making processes, and inadequate research funding addressing ramifications of climate change policies. Economic vulnerabilities include widening economic disparities due to agricultural transition and future impacts on food security.

Given that this thesis presents a case study from one commune, further research is needed to explore ramifications arising from climate change adaptation policies. And the improvement in the climate adaptation policies is also required not to leave the marginalized population.

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This thesis would not have been possible without the support and assistance of many individuals. I am grateful for the opportunity to express my gratitude here.

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Upon my return to the Netherlands, I spent many days in the library writing this thesis. I am grateful to my friends who shared this journey with me, as well as my family and Mehrdad, who provided unwavering emotional support.

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1. Introduction

The Mekong Delta is the most productive agricultural region in Vietnam, responsible for half of the country's rice production, 95% of rice exports and a third of Vietnam's agricultural GDP (World Bank, 2022). However, between 2002 and 2012, many farmers have shifted their main means of livelihood, such as rice monoculture, to rice-shrimp hybrid systems (Betcherman et al., 2021)In 2000, the area under rice shrimp farming in the Mekong Delta was about 40,000 ha, but by 2023 the area has exceed 220,000 ha (Brennan et al., 2005; Ngoc et al., 2023). Five provinces in the Mekong Delta have large rice shrimp areas, the largest of which is in Kien Giang (100,000 ha) (Ngoc et al., 2023).

One reason behind this agricultural transition is the increasing salt damage in the rice paddies of the Mekong Delta. Kien Giang experiences the effects of flooding from the Mekong River during the flood season and encounters saltwater intrusion from the sea every year during the dry season (Loc et al., 2017). Between 2019 and 2020, the water level of the Mekong River reached a historic low, a condition not seen in over 60 years (Mekong River Commission, 2022). Thus, the lack of water during the dry season and the intrusion of saltwater into agricultural lands have made it increasingly difficult to grow rice year-round in the Mekong Delta. Therefore, farmers in the Mekong Delta have the potential to limit the impact of climate change to agriculture by switching to rice-shrimp hybrid agriculture (Dang, 2020; Yifan et al., 2023). In Kien Giang Province, farmers engaged in rice and shrimp farming have successfully sustained their agricultural activities, demonstrated resilience to climate change challenges and achieved increased incomes (Poelma et al., 2021).

Furthermore, this transition is in line with the Vietnamese Government's development policies such as the Mekong Delta Programme (MDP) and Resolution 120. Farmers are obliged to follow government zoning plans that specify specific land uses, such as rice cultivation or combined rice and shrimp cultivation (Poelma et al., 2021) Resolution 120 is an initiative of the Vietnamese Government aimed at developing a comprehensive plan for sustainable and climate resilient development in the Mekong Delta (The Socialist Republic of Vietnam, 2017). However, promoting rice-shrimp hybrid system in a top-down approach may further marginalize small-scale and poor farmers who find it economically difficult to make the agricultural transition (Brown et al., 2018; Lan, 2011; Thomas, 2023). It may also degrade soil nutrient status, making future cultivation more difficult (Kruse et al., 2020; Nguyễn et al., 2011; Nguyen Đ. V. et al., 2012). Thus, both social and scientific evidence points to the possibility that current methods of agricultural transition may not be sustainable in the long term.

Therefore, this paper analyzes agricultural transition and the vulnerabilities faced by farmers as a response to climate change from a political ecology perspective. Political ecology is an interdisciplinary field of study that analyzes environmental issues and natural resource management from political, economic and social perspectives(Liverman, 2015; Robbins, 2019; Roberts, 2020; Wescoat, 2015). Political ecology has developed in ways that explore how economic structures and power relations drive environmental change and question the neo liberalization of the 1970s and 1980s (Roberts, 2020). The

field emphasizes the impact of international development and economic modernization programs on local livelihoods and environments in the Global South (Roberts, 2020). The political-ecological approach provides insights into understanding the causes, consequences and responses to climate change from the local to the global scale, while also focusing on the structural factors of vulnerability and individual and organizational agency (Liverman, 2015). Identifying the social, economic and political structures that create the vulnerability faced by farmers is important for identifying what impacts and invisible losses are occurring among households of different farm sizes (Walker et al., 2021).

Furthermore, the government's emphasis on high-tech agriculture and aquaculture in land-use planning, prioritizing them over subsistence agriculture and fisheries, has created new vulnerabilities(Bayrak et al., 2022). The expansion of shrimp farming increases the dependence of aquaculture operators on world markets. Given the instability of the global market, shrimp farming may not always be a stable source of income. For example, a strong dependence on global markets exposes vulnerability during global emergencies such as pandemics. A recent UNDP survey revealed that 71% of 1,335 survey farmers experienced income decreases due to the epidemic, while other research indicated disrupted supply chains and changing demand patterns led to some fields being abandoned because harvesting costs exceeded potential profits (Giang, 2020). The increase in shrimp farming also entails associated risks such as shrimp diseases and price fluctuations (Betcherman et al., 2021). In particular, the risk of crop failure due to disease poses a major threat to small-scale farmers who may not have sufficient capital for recovery (Lebel et al., 2002). Excessive transition to shrimp farming may also lead to an inability to meet domestic demand for rice as a staple food. In Kien Giang Province, rice-shrimp production is still not sustainable, with farmers failing to cultivate approximately 40 000 ha of rice each year(Dao, 2023) .

As a cause of such problems related to agricultural transition, Camargo (2022) points to the confusion between the historical dynamics of agricultural capitalism and adaptation to climate change, and this argument can also be found in the Vietnamese context. Current climate change adaptation policies in Viet Nam are built on the false premise that 'economic growth and climate adaptation can be compatible' and lean towards a neoliberal approach (Thomas, 2023). The Vietnamese Government is promoting a top-down approach to shift from monoculture rice cultivation to rice-shrimp hybrid cultivation, particularly in areas affected by salinity(Thomas, 2023; Tran et al., 2022). As a result, top-down climate change adaptation measures led by the Vietnamese Government may not always match the current situation of vulnerability faced by farmers. Resolution 120 emphasizes the promotion of sustainable and prosperous development by turning challenges into opportunities, with the motto 'living with floods, brackish water and salt water' (Socialist Republic of Viet Nam, 2017). Furthermore, according to Resolution 120, farmers in the Mekong Delta are expected to transform themselves into skilled agricultural workers (Bayrak et al., 2022). Thus, while the Government is promoting a hybrid rice-shrimp model, which has the attractive potential to bring more benefits than monoculture rice cultivation, farmers are expected to take all business risks associated

with its success or failure, regardless of their farming. The Mekong Delta Plan (MDP) and Resolution 120 also outline the Vietnamese Government's Mekong Delta development strategy, but individuals with limited landholdings, particularly poor farmers, are not explicitly mentioned in these plans. Planned adaptation that ignores the deep-rooted inequalities that exist within different groups of society risks further marginalizing affected communities (Griffin et al., 2023; O'BRIEN et al., 2007).

Adaptation measures are determined by considering vulnerability due to climate change, but do not adequately take into account vulnerability due to the social, economic and political structures faced by farmers. In addition, changes in water access and water quality due to newly constructed sluice gates may be hampering farmers' adaptive capacity (Brown et al., 2018). Such measures may result in more marginalization of vulnerable farmers. New research has therefore advocated investigating the structural factors and power structures that exclude certain individuals from the transition (Bayrak et al., 2022; Poelma et al., 2021). Moreover, although the sustainability of hybrid agriculture is often discussed in terms of natural science and economics, there is still little debate on whether hybrid agriculture, which may contribute to disparities among farmers, is really sustainable from a political-ecological perspective and from a Vietnamese rural social perspective(Brown et al., 2018; Lan, 2013; Thomas, 2023).

Therefore, this paper aims to identify from a political ecology perspective which specific conditions expose farmers to further vulnerability due to agricultural transition, and what social, economic and political structures are behind this. More specifically, the process of agricultural transition, i.e. climate change adaptation measures, is divided into three components: farmers' vulnerability before adaptation, the adaptation process and adaptation outcomes, and the social, economic and political structures that contribute to farmers' vulnerability are identified. By shedding light on the conditions under which farmers face more vulnerable positions after agricultural transition and why, this thesis provides insight into the kind of support that will be required to support farmers in more vulnerable positions in the future.

Therefore, the main research question and sub-questions are formulated as follows.

Main research question

From the perspective of political ecology, to what extent did the transition from rice monoculture to rice- shrimp farming lead to new climate vulnerabilities among smallholder farmers in Kien Giang, Vietnam?

Sub-questions

1. What kinds of vulnerabilities have smallholder farmers been facing before and after the agricultural transition?
2. To what extent did farmers conduct the agricultural transition of their own will, and to what extent were their decisions influenced by external forces?
3. To what extent did the agricultural transition mitigate existing vulnerabilities, exacerbate them, or introduce new vulnerabilities?

2. Theoretical framework

This chapter compares theories of political ecology and climate adaptation to identify how and why farmers face vulnerability after climate change adaptation.

First, in the political ecology literature, vulnerability refers to the actual and potential suffering of social groups and individuals marginalized by economic class, gender, age, ethnicity, caste, (disability), etc. (Wescoat, 2015). Vulnerability is then shaped by political, economic and social structures (Adger, 2016; Griffin et al., 2023; Rahman & Hickey, 2020). Vulnerability is attributed to poverty, limited access to technology and other social, economic and cultural factors, while deteriorating environmental conditions are expected among the most marginalized individuals and groups (Preston & Stafford-Smith, 2009; Robbins, 2019; Wescoat, 2015). (Fellmann, 2012) points to the importance of viewing social, economic and political marginalization as the root causes of social problems, rather than attributing them solely to physical stressors such as climate change.

On the other hand, in the context of climate change, vulnerability refers to characteristics and tendencies that make certain entities more susceptible to negative impacts from climate change, including a lack of resilience and adaptation capacities (IPCC, 2022). Furthermore, the IPCC identifies three elements of vulnerability as exposure and sensitivity to climate change impacts, and the adaptation capacity (Wescoat, 2015). Adaptation capacity refers to the prerequisites for adaptation to occur, such as available resources and system attributes (Watts, 2015). Therefore, assessing climate vulnerability solely based on the IPCC definition does not highlight the vulnerabilities stemming from social, economic, and political structures, even though these vulnerabilities arise from climate adaptation measures.

Thus, the IPCC defines the concept of adaptation within the context of climate change, yet it does not necessarily encompass vulnerabilities discussed in the political ecology context. According to the IPCC, adaptation is "the adjustment of human systems to actual or expected climate and its effects, in order to moderate harm or exploit beneficial opportunities' (IPCC, 2022). However, from a political ecology perspective, inconsistencies in the definition of vulnerability have been noted, leading to instances where adaptation measures may not align effectively with the realities which the community face (Camargo, 2022; Paprocki, 2018). For example, adaptation plans that ignore inequalities can further hinder affected communities from improving their resilience (Griffin et al., 2023). Moreover, increased integration in regional and global markets can lead adaptation measures to contribute to overexploitation of natural resources and increased poverty, potentially making previously sustainable community management unsustainable due to external interventions (Wescoat, 2015). Especially, in the Global South, foreign economic interventions can distort adaptation policies to climate change (Camargo, 2020; Paprocki, 2018). Paprocki (2018), in a case study in Bangladesh, defines adaptation to climate change as managing both people and landscapes through imagination, experimentation, and land deprivation. Imagination involves envisioning the future, often depicting dystopian scenarios (Paprocki, 2018). Camargo (2020), in a case study in Colombia, emphasizes changes in imagination that

depict affected individuals not only as farmers but also as entrepreneurs. This imaginative process is reinforced by experimental development interventions tailored to harsh climatic conditions, inadvertently promoting land deprivation (Camargo, 2020).

The adaptation measures to climate change in Vietnam are based on the erroneous premise that growth is essential for adaptation and that growth brings developmental benefits (Thomas, 2023). This theory rests on the assumption that environmental sustainability can coexist with economic growth. However, not only is this theory economically unfeasible, but it also perpetuates imperialistic patterns of exploitation (Hickel & Hallegatte, 2022; Ward et al., 2016). Furthermore, foreign development agencies tend to prioritize investors' economic risks over human security when planning projects, which the Vietnamese government leverages to advance neoliberal policies, effectively attracting foreign capital (Thomas, 2023). Consequently, adaptation strategies in Vietnam are implemented through a neoliberal approach. Specifically, they include both hard policies such as significant investments in large-scale dikes and sluices to manage salinity and soft policies encouraging changes in crop and land use (Hang et al., 2023). The Mekong Delta development projects underpinning these hard policies include the Mekong Delta Plan funded by the Netherlands and the Climate Change Adaptation Master Plan funded by JICA through Vietnam's Ministry of Natural Resources and Environment (Smajgl et al., 2015). However, how these infrastructure interventions (re)shape the dynamics of resource-based livelihoods management in the context of regional-scale agricultural transitions remains poorly understood (Tran, 2022). Moreover, Resolution 120, which underpins soft policies, aims to shift from a singular focus on rice-centered agricultural production to a diversified agricultural economy to meet market needs (VNS, 2023).

As a result of these adaptation measures, farmers in Vietnam face new vulnerabilities(Bayrak et al., 2022; Lan, 2013; Thomas, 2023; Tran et al., 2022). While the vulnerabilities of farmers vary, institutional adaptation projects often overlook the specific vulnerabilities faced by all farmers. Moreover, both these hard and soft policies aim at international market entry for shrimp and economic development, representing a neoliberal approach. Thomas (2023) criticizes the transition of the Mekong Delta into an agricultural export production region, which reconstructs socio-environmental structures to align with national and development planner visions. Such neoliberal approaches promote producer competition, creating winners and losers (Robbins, 2019). Farmers with sufficient adaptive capacity can successfully apply adaptation strategies to improve their livelihoods. On the other hand, farmers lacking adaptive capacity face challenges in implementing adaptation strategies. Rural development projects and adaptation policies emphasize enhancing the competitiveness of vulnerable farmer groups, which can lead to enclosure of common resources and unequal distribution (Lan, 2013). Consequently, the logic of competition propagated through adaptation policies worsen and naturalize inequality (Thomas, 2023). Overall, inconsistencies in the definition of vulnerability leads to the implementation of erroneous premise-based neoliberal adaptation measures. This, in turn, perpetuates inequality and generates new vulnerabilities in a negative cycle.

Conceptual framework

To understand why certain groups are pushed into more vulnerable positions due to agricultural transitions in the Mekong Delta, it is crucial to delve deeper into the negative cycle mentioned above. This requires a detailed examination of the fundamental causes of vulnerability, understanding local knowledge and values, and grasping broader socio-economic and political structures that determine resource allocation (Griffin et al., 2023). Therefore, this thesis references the livelihood framework concept by T. T. Nguyen et al. (2017) (Figure 1) to analyzes the impact of adaptation policies on agriculture from the perspective of farmers and to elucidate which groups among them are being pushed into

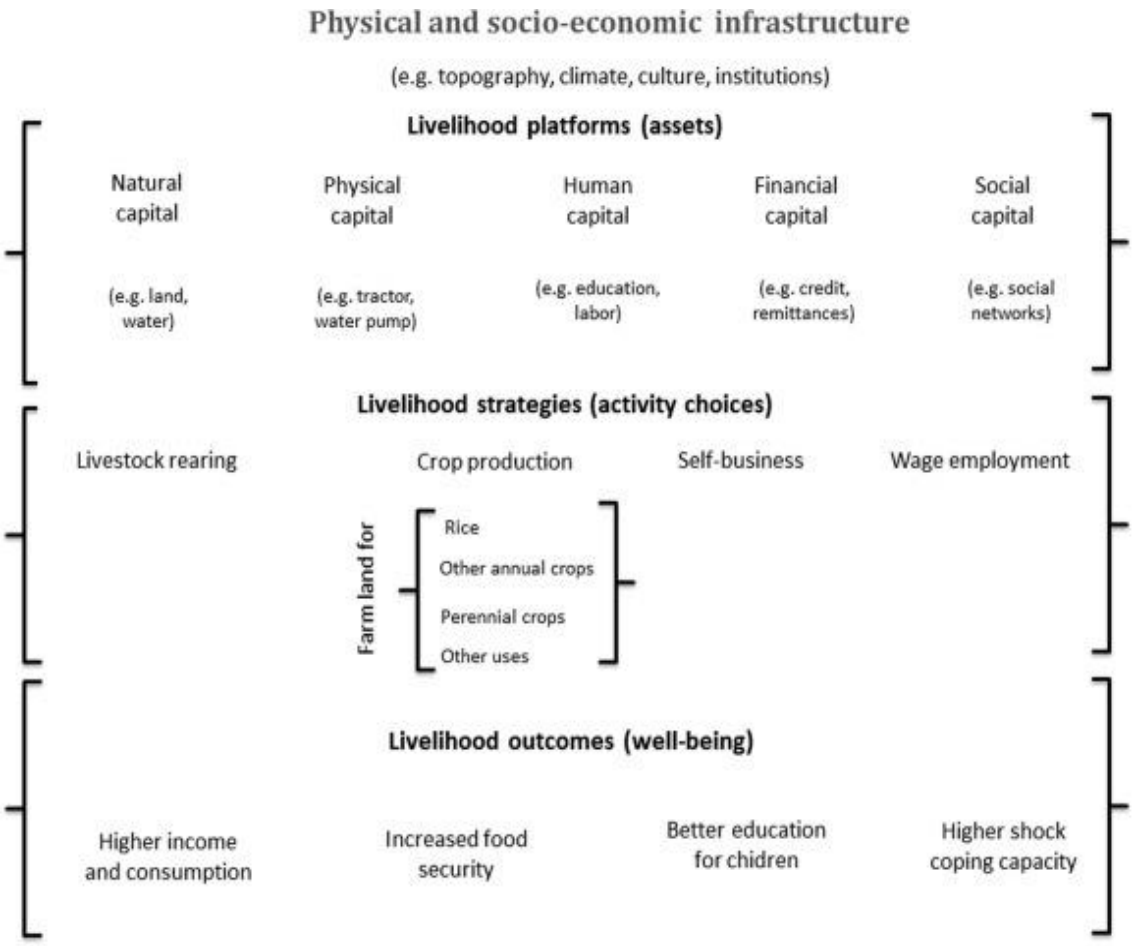

Figure 1 Conceptual livelihoods framework for analyzing farmers´land use decision-making by T. T. Nguyen et al. (2017).

vulnerable situations.

This framework consists of three interrelated components: livelihood platforms (assets), livelihood strategies, and livelihood outcomes. Livelihood platforms comprise five perspectives: natural capital, physical capital, human capital, economic capital, and social capital. By analyzing the assets of farmers, it is possible to measure their adaptive capacity in the face of climate change (Brown et al., 2018). In the case of farmers in Kien Giang province, the primary factor directly affecting their livelihoods is the land use planning as part of Vietnam's government-led climate change adaptation measures,

particularly the transition from rice monoculture to a rice-shrimp hybrid farming system. Therefore, in this paper, "adaptive capacity" refers to the availability of the capital necessary for the transition to hybrid agriculture.

Moreover, the livelihood framework's livelihood strategies represent the options available to farmers in response to climate change (T. T. Nguyen et al., 2017). In other words, livelihood strategies are the processes through which adaptation is undertaken (or the decision is made not to adapt). For farmers in Kien Giang, the adaptation process is heavily influenced by the Vietnamese government's hard and soft policies. Specifically, under soft policies, the process by which the government decides on agricultural transition, and the impact of hard policies on the agricultural environment, are included in this adaptation process. It should be noted that the Vietnamese government's adaptation measures are based on " erroneous premise " and adopt a neoliberal approach, which may not necessarily align with the farmers' intentions.

Lastly, livelihood outcomes refer to the results of adaptation (or the decision not to adapt). In this thesis, livelihood outcomes pertain to the results of the transition to hybrid agriculture or the lack thereof. As indicators for analyzing outcomes, T. T. Nguyen (2017) cites changes in food security, changes in educational expenses, and changes in income. Additionally, the initial capital strength of farmers varies across households, and the degree of well-being post-adaptation measures also varies accordingly. Specifically, while some farmers have capitalized on the adaptation measures to accumulate further wealth, others have become more vulnerable due to various factors resulting from the implementation of these measures.

Thus, by combining the political ecological theoretical framework regarding to vulnerability and climate adaptation, and Conceptual livelihoods framework by T. T. Nguyen (2017), the framework was developed as below (Figure 2). Each element will be explained from the next paragraphs.

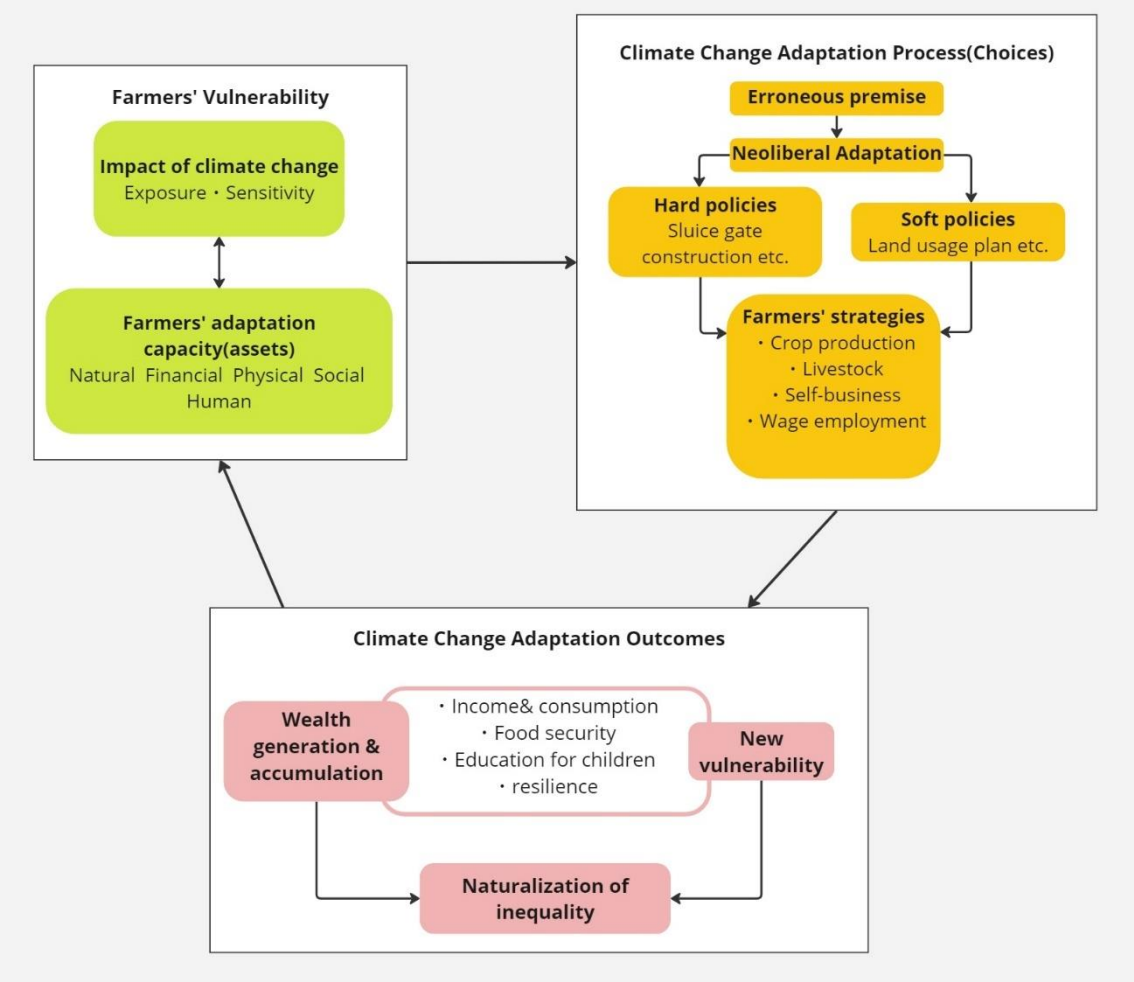

Figure 2 Theoretical framework

Farmers Vulnerability (Impact of climate change and farmers' adaptation capacity)

Vulnerability in this thesis is defined as following three perspectives: Exposure & Sensitivity as defined by the IPCC, and Adaptation Capacity (assets) as defined by T. T. Nguyen (2017). Firstly, Preston and Stafford-Smith (2009) define exposure as various changes in the climate system that stakeholders are concerned about, such as climate variability, and changes in temperature and precipitation patterns (including extremes). In Kien Giang Province, there is a trend towards increased dryness during the dry season and more intense rainfall during the rainy season (Mackay & Russell, 2011). Additionally, sea-level rise increases flood risks during the rainy season, while insufficient water flow from the Mekong River during the dry season leads to extensive salinization of downstream deltas (Mackay & Russell, 2011). Furthermore, anthropogenic activities such as groundwater extraction causing land subsidence, hydropower dams upstream of the Mekong River, and riverbed mining exacerbate saltwater intrusion (Loc et al., 2017). On the other hand, sensitivity is the degree to which a system is affected by climate-related stimuli (Fellman, 2012). In the context of rice farming in Kien Giang, the impact of climate change can be understood as exposure to salt intrusion and drought, as well as the sensitivity of crop yields to water availability.

These climate change impacts deeply affect the natural capital component of adaptation capacity. For rice mono-culture farmers, freshwater is needed throughout the year, making them vulnerable to water shortages during the dry season or intrusion of saline water (Dang, 2020; Loc et al., 2017; Mackay & Russell, 2011). On the other hand, for hybrid rice and shrimp farmers, freshwater is required during the rainy season and brackish water during the dry season. Changes in water access due to the construction of embankments and sluice gates also need to be considered(Hang et al., 2023; Toan, 2014). Moreover, changes in water quality or soil quality due to climate change, infrastructure construction, or shifts in agricultural practices also affect them (Ngoc et al., 2023). Thus, these changes in the natural environment directly impact their crop yields and incomes.

Additionally, land area is an important natural capital when transitioning from mono-cropping rice to hybrid agriculture. Since the Doi Moi policy in the 1980s, there has been an increase in medium-sized farmers owning more than 1 hectare of land, while landless farmers without land have also increased in the Mekong Delta region (Yamazaki, 2004). Yamazaki (2004) reported that medium-sized farmers owning 1.0 to 3.0 hectares of land have higher rice cultivation profitability in the Mekong Delta based on farmer surveys from the 1990s to the early 2000s. Unlike other countries in the Global South where land grabs by corporations or state entities are prevalent, Vietnam has experienced a more gradual and subtle process of land accumulation (Gorman, 2022). The accumulation of land by large to medium-sized farmers was driven by government promotion of shrimp farming, leading small-scale farmers to abandon agriculture and migrate to urban areas as laborers, as well as by speculative trading of land, which stimulated a more active agricultural land market(Yamazaki, 2004; Yamazaki & Kamakawa, 2015). The agricultural land market is influenced by the influx of excess capital from developed countries into the land market and speculative land investment needs (Yamazaki & Kanagawa, 2015). Thus, land area as an adaptive capacity is already dominated by neoliberal capitalist regimes. Furthermore, the Mekong Delta has the highest rate of land loss domestically, but large-scale land use change projects favor landowners with surplus land for rice-to-shrimp production systems (Thomas, 2023). Through the accumulation of land by wealthy farmers, former farmers who lost their land are forced to work as a labor for a living, contributing to the surplus returned to the process of capital accumulation in export-oriented agriculture (Gorman, 2022).

Next, human capital includes the labor necessary to sustain agricultural activities. The Mekong Delta has a high agricultural population and historically low levels of education (UNICEF, 2022). Shrimp farmers are predominantly male, and their educational attainment is generally low (Duy et al., 2022). However, within this group, shrimp farmers with higher levels of education are more efficient compared to those with lower educational levels, and younger farmers tend to be more efficient than older farmers (Duy et al., 2023) . This indicates that younger farmers, who are more eager to adopt new practices, or those with higher education levels, who can acquire and implement new information from various sources, are more likely to flexibly modify their agricultural practices in response to climate change. However, there are instances where poor households with limited savings find it difficult to send their children to school(Duy et

al., 2023; Lan, 2011). This suggests a correlation where the increasing complexity and difficulty of the agricultural environment due to climate change affect the educational level of farmers, which in turn impacts agricultural income, and vice versa.

Physical capital includes access to infrastructure such as canals for shrimp farming, electricity for water pumps, and ownership of agricultural machinery (T. T. Nguyen, 2017). Access to these resources is deeply connected to the financial capital strength of the farmers. One critical aspect of economic capital strength for farmers is their capacity to pay the investment cost required for transitioning from mono-cropping rice to integrated rice-shrimp farming (Brown et al., 2018). Additionally, indicators such as food self-sufficiency, non-agricultural side job, or cash crops after meeting food needs are considered (Williams et al., 2016). It is also important to consider that multiple strategies, such as remittances from migrated family members, are often complementary (Williams et al., 2016).

Lastly, social capital includes the presence of social networks such as cooperative organizations that provide various forms of support related to agriculture. According to Duy et al. (2022), older farmers are more likely to participate in social networks, and the number of years residing in the village tends to positively influence the decision to participate in social organizations. By accessing new technologies or market information through existing village networks or workshops held by companies and agencies, farmers can potentially improve shrimp rearing conditions and enhance their market negotiation capabilities (Duy et al., 2022). Conversely, if training courses on shrimp farming are restricted to members of specific cooperatives, an information gap may arise between cooperative members and non-members in the village (Lan, 2013).

Climate Change Adaptation Process

According to the livelihood framework, the adaptation process for farmers involves selecting adaptation strategies—deciding how to adapt among various options (T. T. Nguyen et al., 2017). However, household-level adaptation in Vietnam has been strongly guided by central government policies (Smajgl et al., 2015). Moreover, neoliberal adaptation policies, based on " erroneous premise " (Thomas, 2023), may limit household-level adaptation capacities. T. T. Nguyen et al. (2017) categorize livelihood strategies for farmers as including livestock raising, changes in cropping or cultivation methods, small-scale businesses, and wage labor. In Kien Giang Province, due to land use planning, the main adaptation mean is changing cropping patterns, driven by the promotion of shrimp-rice hybrid farming. Thus, actions by farmers may be determined by social structures, political structures, or relationships within the community, even if they contradict their own intentions (Preston & Stafford-Smith, 2009).

Rice-shrimp hybrid farming comprises two primary forms: the alternating cultivation model (rotational farming) and the integrated farming model (simultaneous farming). In Hung Yen Commune, Kien Giang Province, where this thesis research was conducted, the predominant system is rotational rice-shrimp farming. In this system, shrimp are farmed in brackish water during the dry season, while salt-tolerant rice integrated with freshwater shrimp is cultivated during the rainy season (Dang, 2020). According to Dang

(2020), the general process of rice-shrimp hybrid farming in the Mekong Delta involves the following steps:

1. Modify the rice fields for shrimp farming by creating ditches and embankments around the fields.

2. After the rice harvest, convert the fields for shrimp farming by flooding them with saltwater and releasing shrimp larvae.

3. At the onset of the rainy season, flush out the salt with fresh water.

4. Before starting rice cultivation, apply lime to the fields to adjust soil acidity.

5. Resume rice cultivation.

The initial investment cost required for transitioning from monoculture rice farming to hybrid farming mainly pertains to the expenses needed to modify the fields by creating ditches and embankments around them. Although this modification reduces the area available for rice production, it provides a refuge trench for the shrimp, which is an advantage for them (Brennan and Preston, 2002). The modified fields have the following structure (see Figure 3). Figure 3 illustrates the state of the fields during the dry season when shrimp farming is being conducted.

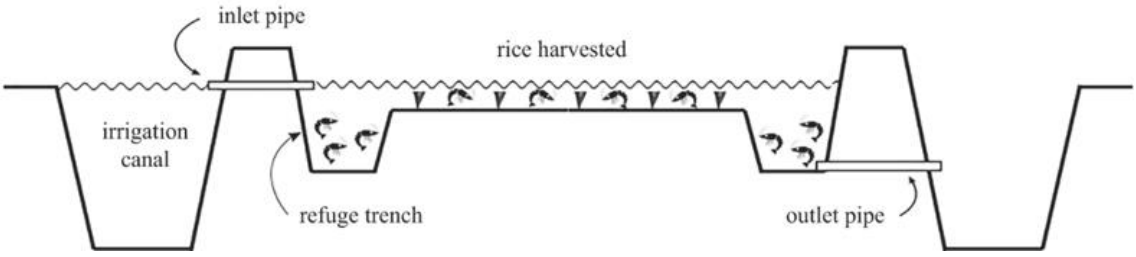

Figure 3 Illustration of shrimp-farming farmland of hybrid farming system (Dang, 2020)

However, at each stage of these processes, farmers without sufficient initial investment capital for field modification costs or shrimp larvae face difficulties. Additionally, it is essential to bear in mind that providing information about shrimp farming to farmers is part of the government's soft policy so that farmers can get the advantages from agricultural transition. Shrimp farming offers opportunities for farmers to generate wealth, yet inexperienced farmers must quickly demonstrate competitiveness, leaving little room for error (Thomas, 2023). Support addressing these challenges faced by farmers is crucial, and comprehensive policies and technical assistance are required for long-term agricultural activities.

Climate Change Adaptation Outcomes

The adaptation outcomes highlight the naturalization of inequalities. This results from the accumulation of wealth among farmers who capitalize on adaptation measures, alongside the displacement of more vulnerable farmers. Shrimp farming has become a significant new livelihood option for coastal communities in the Mekong Delta; however the shrimp industry is not equally accessible to all local residents (Lan, 2013). Development policies suggest the potential for sidelining the livelihoods of agricultural communities supposed

to benefit (Tran et al., 2022). Thusnalyzing these outcomes involves considering elements such as changes in income and consumption, food security, changes in children's educational environments, and changes in resilience (T. T. Nguyen, 2017).

Concerning vulnerabilities related to farmers' livelihoods and the natural environment, unequal pressures on common resources and the expropriation of nature can lead to the overexploitation of natural resources, while hard policy water management projects may destroy biodiverse brackish water areas (Tran et al., 2022). Furthermore, unresolved social issues persist before and after agricultural transitions. Water resources remain a crucial determinant of yield, both during monoculture rice farming and after adapting to hybrid farming. Yet, internal conflicts among farmers over water use arise easily due to contamination through household practices (Lan, 2013). Moreover, environmental pollution from excessive fertilizer use and inadequate water management worsens, impacting the health of local residents and consumers and reducing the competitiveness of Vietnamese agricultural products (Lan & Kien, 2021). Additionally, there is a concern about the long-term sustainability of hybrid agriculture itself. Groundwater extraction for shrimp farming causes land subsidence at rates of 1-2 cm annually, with the Mekong Delta subsiding nearly ten times faster than global sea level rise (Anthony et al., 2015; Minderhoud et al., 2017). This leads to increased seawater intrusion into inland areas, affecting more land and households vulnerable to climate change impacts (Thomas, 2023). Furthermore, the continuation of hybrid agriculture amid freshwater shortages may lead to soil acidification, necessitating proper soil management involving lime applications (Ngoc, 2023; Nguyen, 2011).

The transition to rice-shrimp hybrid farming brings notable changes in household income and consumption patterns, reflecting economic vulnerability shifts. Diversifying income sources enhances farmers' economic stability and resilience against climate variability and market fluctuations (Dang, 2020; Poelma, 2021). Transitioning to shrimp farming shifts households from subsistence to market-oriented production, linking economic activities with the global market (Lan, 2013). Export-oriented agricultural transition may unevenly impact fairness depending on crop nature and capital accumulation methods (Gorman, 2022). While some shrimp is consumed domestically, the majority is exported to markets in China, the European Union, Japan, and the United States (Thomas, 2022). This export-oriented shift commonly involves producers contracting with processors and exporters beforehand, granting local producers a degree of power and resources to large corporations (Thomas, 2022). This potentially secures economic safety for producers but also concentrates capital and power within the agricultural and food chain, potentially reducing farmer-owners to roles akin to wage laborers (Robbins, 2019). Furthermore, Flaherty et al. (1999) emphasize that reversing established shrimp farming in a region is challenging due to structural economic problems and environmental impacts, based on a case study from Thailand. Factors such as low income from rice farming, existing debt, limited employment opportunities outside agriculture, and the potential for high profits from shrimp farming often lead to short-term exploitation benefiting a few individuals rather than long-term resource management (Flaherty et al., 1999).

Farmers often perceive shrimp farming as a "high-risk, high-return" commodity, yielding

approximately 5-7 times more income than rice producers (Lan, 2013; Tran, 2022). However, during crop failures in shrimp or rice farming seasons, farmers actively manage risks by selling rice, borrowing at high interest rates, withdrawing children from school, or seeking non-agricultural employment in urban areas (Brown et al., 2018). The impact of transitioning to rice-shrimp hybrid farming on farmer vulnerability is multifaceted, posing significant challenges particularly for poor farmers. Communities adopting intensive shrimp farming require substantial investment in equipment, potentially excluding local poor farmers from this industry (Lan, 2013). Concentration of productive land in the hands of a few commercial farmers exacerbates income inequality, potentially displacing former farmers into wage labor roles, resulting in income loss and widening disparities (Gorman, 2022).

Furthermore, from a human capital perspective, the lack of economic feasibility in small-scale rice farming worsens with the disappearance of wage labor opportunities in the agricultural sector. Donor-funded projects promoting professionalization among shrimp farmers reduce employment opportunities for landless households compared to traditional rice farming, which required seasonal labor from poor farmers during harvest periods until mechanized combines replaced this income source (Gorman, 2022).

3. Methods

This study was conducted over four months in Kien Giang Province, Vietnam. To address the research questions, a mixed-method approach incorporating desk research (DR) and field research was employed to collect all necessary data. The study was designed from a political ecology perspective to understand the conditions under which farmers become more vulnerable due to agricultural transitions driven by climate change and the social, economic, and political structures underlying these transitions. As Robbins (2019) notes, political ecologists often work based on case studies and frequently use immersive methods to understand both the values and practices of individuals within households, communities, and regions. Thus, this study adopted an immersive qualitative research approach, similar to many other political ecology research efforts.

In addition to semi-structured interviews, desk research, including literature reviews, was conducted to complement data collection. The data collected through desk research were also used for triangulation with the field-collected data, thereby strengthening the overall quality of the data. The following paragraphs describe the study area and selected communes, the research methods employed, the operationalization of variables, data analysis, and, finally, the limitations of the methodology and the researchers' positionality.

3.1 Research Location

Kien Giang Province, located in the southwestern part of the Mekong Delta in Vietnam, has a population of approximately 1.723 million people and consists of two cities, 13 rural districts, and 117 communes (Poelma et al., 2021). After consulting with Dr. Nha at Kien Giang University (KGU), the initial candidate areas for the study were Hung Yen and Dong Thai Communes, located inland, and Tay Yen and Nam Thai A Communes, located along the coastline, within An Bien District. However, the provincial government of Kien Giang only granted survey permission for Hung Yen , prompting a decision to focus the detailed survey on Hung Yen.

Hung Yen is located far from the coastline, and the transition from rice farming to rice-shrimp farming is currently ongoing. Since this study focuses on vulnerabilities associated with agricultural transitions, the ongoing transition in Hung Yen is appropriate for capturing farmers' experiences related to this change. Moreover, Hung Yen faces the Cai Lon River, which features a sluice gate built in 2021 to prevent saltwater intrusion. Therefore, it is an optimal location to gather farmers' narratives regarding the impact of the Vietnamese government's hard policies on agricultural transitions as well. Additionally, during the four-month research period, the author was based at Kien Giang University, making it important that the interview locations were within a commutable distance from the university.

As represented in Figure 4, the blue pins indicate approximate locations of the interview sites. These pins are shown to provide a rough understanding of the geographical spread, such as along rivers, inland areas, and main roads, without specifying the exact locations of the participants' homes. Furthermore, the yellow pin marks the Cai Lon Sluice Gate, constructed in 2021. For reference, the red pin indicates Kien Giang University, the

research base for the author. "Sông Cái Lớn" on the map refers to the Cai Lon River in Vietnamese.

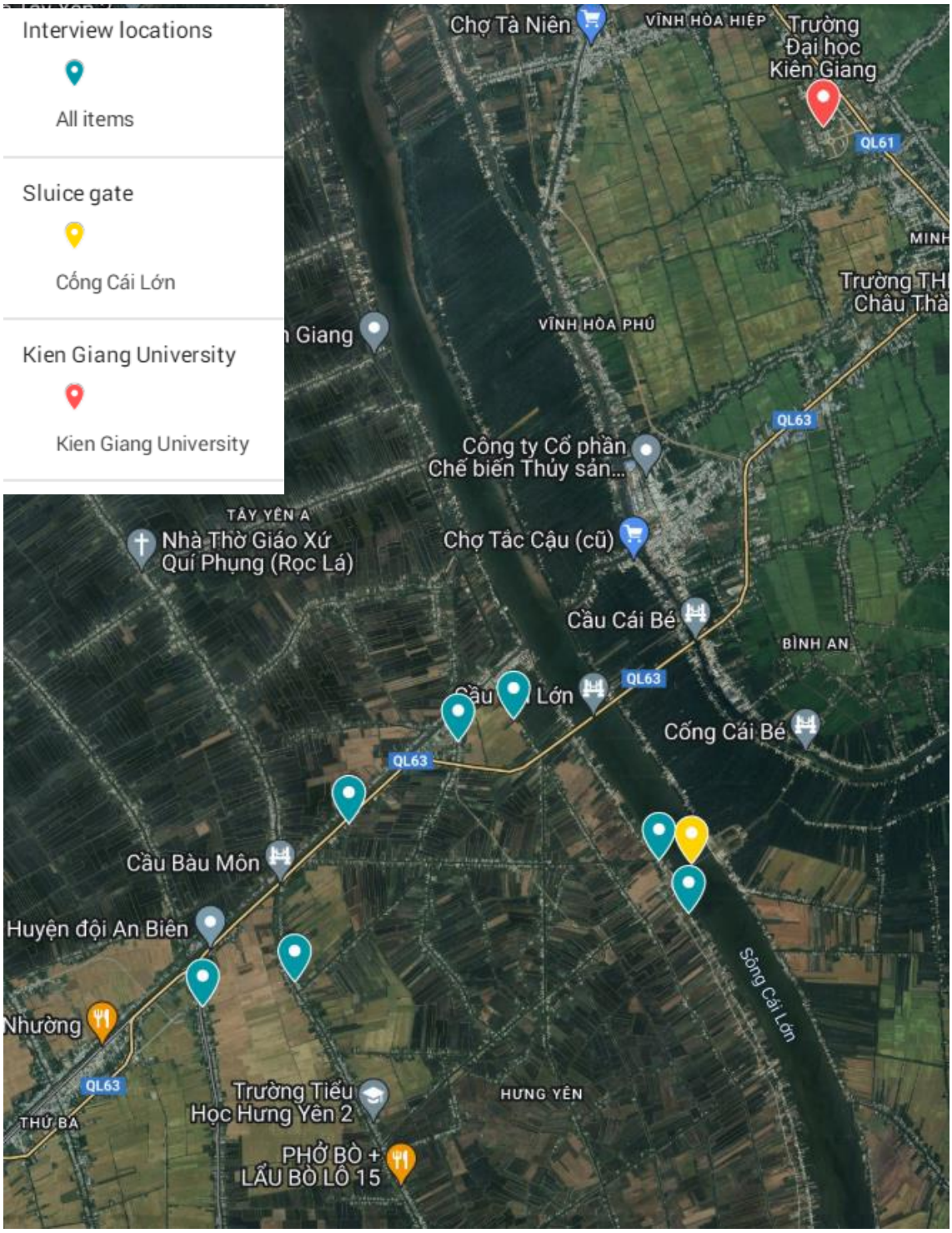

Figure 4 Map of research location

3.2Research Methods

Previous studies on climate change and agricultural transitions in the Mekong Delta have included interviews with both farmers and experts(Brown et al., 2018; Poelma et al., 2021; Thomas, 2023; Tran et al., 2022). Therefore, this study also combined interviews with farmers and experts, deeming it an appropriate approach. The data collection process in this study followed a cyclical approach. Initially, the target population was defined based on a literature review, focusing mainly on small-scale farmers with less than one hectare of farmland. Subsequently, after conducting interviews with some experts and incorporating their advice, the target population was expanded to include farmers who lacked access to social organizations serving as knowledge-sharing hubs. As a result, both deductive and inductive approaches were employed in the sampling process, enhancing the richness, completeness, and rigor of the research data (Hennink et al., 2020).

Additionally, the gatekeeper method was primarily used as the sampling process. Dr. Nha, my advisor at Kien Giang University, played a crucial role as the main gatekeeper, liaising with local personnel responsible for communicating with experts and farmers. The sampling process faced challenges in terms of precision, as government permits limited the options for selecting field survey districts. However, by directly explaining the purpose and significance of this study to the local personnel who guided me through the villages, they made every effort to introduce me to farmers suitable for this study. Data saturation was confirmed after analyzing the data from the farmer participants. This indicated redundancy in further data collection, as no new issues arose and no new insights were gained on the identified issues (Hennink et al., 2020).

Initially, focus group discussions were planned in addition to semi-structured interviews. However, due to the confirmed data saturation from the semi-structured interviews and the difficulty in finding facilitators fluent in both Vietnamese and English, the focus group discussions were abandoned in consultation with my advisor.

3.2.1 Expert Interviews

This study conducted a total of seven interviews with experts knowledgeable in agriculture, aquaculture, and rural development (see Table 1). Six of these experts were Vietnamese, and appointments were secured through Dr. Nha's extensive network. The remaining expert was a Japanese NGO staff member who has been active in the Mekong Delta for over 20 years, with whom I arranged an appointment directly.

As previously mentioned, to gain detailed insights into the trends of hybrid rice-shrimp farming in Kien Giang Province, interviews with two university professors and a local government officer were conducted before the farmer interviews. The expert interviews aimed to gather insights on the impact of climate change on farmers' agricultural practices, the effects of the transition to hybrid farming on farmers' livelihoods, rural development policies, and the future outlook of agriculture in Kien Giang Province.

In the interview with the officer from the local government's agricultural development department, discussions focused on the state of the transition to hybrid farming in An Bien District and the narratives and trends among farmers regarding this transition. This

officer was interviewed twice: once before the farmer interviews and once afterward for follow-up questions. The six Vietnamese experts and government officials provided detailed and valuable information. Additionally, the Japanese NGO staff member offered deep insights into the trends in Mekong Delta agriculture from a foreign perspective.

The experts, such as university professors, not only participated in the interviews but also provided relevant literature and advice on the interview questions for the farmer surveys. Moreover, the officer from the agricultural development department coordinated with local officers in the communes to arrange the interviews.

The interview guide used for the expert interviews is included in Appendix A. The interviews conducted before the farmer interviews followed this guide. The supplemental interviews conducted after the farmer interviews involved different topics for each expert, and these questions are also included in Appendix C.

Table 1 The list of expert interviewees

Date	Name	Specialties	Title	online/in person
21 Jan 2024	Dr Da	Aquaculture	Professor at Ton Duc Thang university	Online
22 Jan 2024	Dr Niem	Agriculture	Vice director of science and technology department of KG	In person (Rach Gia, KG)
22 Jan 2024	Dr Van	Rural development	Professor at An Giang University	Online
26 Jan 2024	Mr. Bush	Agriculture	Officer at the agriculture department of the local government in Kien Giang	In person (Rach Gia, KG)
16 Apr 2024	Dr Hieu	Rural development	Professor at Can Tho University	Online
22 Apr 2024	Dr Minh	Rural development and cooperatives	German Cooperative foundation	Online
6 May 2024	Mr. Bush	Agriculture	Officer at the agriculture department of the local government in Kien Giang	In person (Rach Gia, KG)
8 May 2024	Ms. Inou	Rural development	NPO Seed to Table	In person (Ho Chi Minh City)

3.2.2 Semi-Structured Interviews with Farmers

The semi-structured interviews included 35 small-scale farmers, comprising 7 rice monoculture farmers and 28 hybrid rice-shrimp farmers (see Table 2). No interviews were conducted during the first two weeks of February due to the Vietnamese Lunar New Year holidays. Each interview lasted between 30 minutes to one hour per household. Depending on the schedules of the local personnel and the Kien Giang University staff who accompanied as interpreters, interviews were conducted either for half a day or throughout the day. From January to March, during the dry season when hybrid farmers were engaged in shrimp farming, the farmers were relatively available during the day and willingly participated in the interviews. Rice farmers were also available for interviews as they were at home during the hot hours (from 8 AM to around 4 PM) when they refrained from working in the fields. To gather sufficient qualitative data, interviews were conducted over seven days, visiting different villages each day, resulting in interviews conducted in seven villages within Hung Yen .

Table 2 The list of semi-structured interview schedule

Interview date	No. of farmers	Farming practice
31 Jan 2024	3	Rice-shrimp hybrid
23 Feb 2024	7	Rice-shrimp hybrid
27 Feb 2024	4	Rice-shrimp hybrid
28 Feb 2024	6	Rice-shrimp hybrid
6 Mar 2024	6	Rice-shrimp hybrid (3) + Rice monoculture (3)
11 Mar 2024	5	Rice-shrimp hybrid
18 Mar 2024	4	Rice monoculture

The interviews were conducted following an interview guide that included open-ended questions. This guide was structured based on the conceptual framework and comprised three parts: pre-transition vulnerabilities, the adaptation process, and the outcomes of adaptation as climate change measures. The actual interview guide used in the field survey is included in Appendix B. All questions were open-ended. Occasionally, the interpreter translated questions into yes-or-no format, but the author consistently requested them to maintain the open-ended question style. The interviews were recorded to ensure no information was missed, as the interpreter could not translate everything the farmers said on the spot. These recordings were later transcribed and used alongside the handwritten interview notes for data analysis.

3.3 Operationalization

The interview guide used in the field survey was designed based on the Conceptual Framework explained in Chapter 2 to ensure that the research questions were adequately addressed through the interviews. This section explains how each concept illustrated in

Figure 2 of Chapter 2 was operationalized.

3.3.1 Farmers' Vulnerability

In this study, vulnerability is defined by combining the IPCC's definition with the sustainable livelihood framework, as explained in Chapter 2. Vulnerability here refers to the conditions farmers faced before the implementation of climate change adaptation measures, specifically before the transition from rice monoculture to hybrid rice-shrimp farming. This includes not only climate-related factors but also social, political, and economic factors.

According to the IPCC, vulnerability is determined by "Exposure," "Sensitivity," and "Adaptive Capacity" to climate change (IPCC, 2022). Additionally, several prior studies on rural areas in the Mekong Delta have applied the sustainable livelihoods framework to assess adaptive capacity (Brown, Nguyen, 2017). Thus, the operationalization items for vulnerability in this study were defined as follows.

Table 3 Operationalization elements of farmers' vulnerability

Variable	Indicator	Related question
Impact of climate change	Exposure to climate stimuli	SSI 9, 10
	Sensitivity to climate stimuli	SSI 1,8, 9
Adaptation capacity (Farmers' assets)	Natural Capital	SSI 2, 3, 4
	Physical Capital	SSI 2, 3, 6
	Human Capital	SSI 1, 4, 12
	Social Capital	SSI 15
	Financial Capital	SSI 7,13

These items aimed to examine how the situations related to these factors changed before and after adaptation for hybrid farmers or the conditions faced by rice monoculture farmers before adaptation. The goal was to elucidate how the perceptions and impacts of climate change differed across households based on their adaptive capacity.

3.3.2 Adaptation Process

This study focuses on how farmers' livelihood strategies are influenced by external forces during the adaptation process. The items "self-business" and "wage employment" under

livelihood strategies were consolidated into the item "other income sources." Additionally, to clarify how government-led soft policy land use plans align or conflict with farmers' own land use strategies, the item "Land use plan" was added. Therefore, the operationalization items for the adaptation process were created as below.

Table 4 Operationalization elements of adaptation process

Variable	Indicator	Related question
Farmer's strategies	Crop production	SSI 2, 12
	Other income source	SSI 7
	Land use plan	SSI 12, 14, 15, 16
	Livestock	SSI 7

3.3.3 Adaptation Outcomes

The adaptation outcomes of interest in this study concern how inequalities are naturalized as a result of climate change adaptation policies. Implementation of these policies enables some farmers to generate and accumulate wealth, while others face unchanged or new vulnerabilities. The indicators of adaptation outcomes within the livelihood framework, such as income, consumption, and food security explained in Chapter 2, were primarily related to economic capital among farmers' adaptive capacities.

In this study, drawing on the adaptation outcome indicators of the livelihood framework, the items were used again to examine pre- and post-adaptation vulnerabilities by assessing the economic capital and other forms of capital relevant to farmers' adaptive capacities. Thus, the operationalization items for adaptation outcomes were created as follows:

Table 5 Operationalization elements of adaptation outcomes

Variable	Indicator	Related question
Natural environment	Utilization and Management of Water Resources	SSI 29
	Adaptation Methods to Changes in Temperature and Precipitation	SSI 10, 29, 30
Physical Capital	Soil Condition and Management	SSI 16, 22, 23
Economic Capital	Diversification and Stability of Income Sources	SSI 7, 20, 26, 27

	Market Connections	SSI 19
	Agricultural Costs and Profits	SSI 14, 15, 17, 25
	Food Security	SSI 21
	Solutions for Crop Failure	SSI 11
Human Capital	Changes in the Agricultural Work Environment	SSI 24
	Non-Agricultural Employment	SSI 17
	Children's Educational Environment	SSI 20
Social Capital	Cooperation Systems among Farmers	SSI 17, 18

3.4 Data Processing

In this study, to protect the personal information of the interviewed farmers, pseudonyms and labels were used. "RM" denotes Rice Monoculture Farmers, while "RS" denotes Rice Shrimp Farmers, followed by sequential numbers for convenience. These labels were consistently applied to all audio data, handwritten notes, and transcript data. The names and affiliations of interviewed experts were disclosed with their permission.

Before starting the interviews, participants were asked for their consent to record the sessions. The recordings were made using the Voice Record function on the author's iPhone and subsequently labelled and uploaded as MP3 files to Utrecht University's OneDrive. In parallel with the recording, handwritten notes were taken. These interview notes were saved as Word files on the same day as the interviews. Transcripts were then created based on the MP3 files uploaded to OneDrive using the transcription function of the online version of Microsoft Word. To ensure the accuracy of the AI-generated transcripts, the content was cross-checked with the accompanying interpreter. The transcript data were used to supplement the handwritten notes and were primarily used for data analysis.

A limitation of this study is the author's lack of proficiency in Vietnamese and the inability to find a trained English interpreter. According to Hennink (2020), "It is necessary for the accuracy and appropriateness of translation to be checked by someone familiar with the language and culture of the research, aiming to maintain the colloquial style and phrases used by the participants." However, since this study focuses on the narratives of farmers in the context of agricultural transition rather than linguistic analysis, the priority was given to understanding the topics and discourses discussed by farmers. Thus, it was determined that sufficient data could be obtained without verbatim translation to answer the research questions. For quoted statements, the author cited them from the transcript

data, with the nuances confirmed by the accompanying translator.

3.5 Analysis Method and Coding

The analysis method adopted in this study is the Grounded Theory approach. Grounded Theory research outcomes are comprehensive theories derived from data using systematic methods capable of explaining phenomena or processes (Hennink, 2020). Generating theory is a key feature of Grounded Theory, where "theory" is generated based on collected data, explaining the process of social phenomena (Islam & Sayeed Akhter, 2022). Therefore, this method was deemed appropriate for deriving answers to the research questions of this study. Additionally, data validity was triangulated by referring to academic literature and interviewing local scientists.

Before coding, a codebook was developed based on the conceptual framework and operationalization items illustrated in Figure 2 of Chapter 2. The initial codebook included deductive knowledge derived from the literature review. The interview data imported into NVivo were coded based on this codebook. During the coding process, many codes were added inductively. The inductive strategy for developing codes involved reading the data, identifying issues, reflecting on their meanings, and coding accordingly. This procedure is essential to avoid forcibly applying non-existent codes to the data, thus enhancing code validity (Hennink, 2020). Furthermore, a combination of deductive and inductive strategies was used to avoid missing new and unique issues raised by participants (Hennink, 2020). This approach allowed the data to speak for itself.

After completing the coding, the codes were organized. Duplicate codes were consolidated, referencing the operationalization items. An Excel file listing each interview participant's age, gender, type of farming, land size, and costs associated with agricultural transition was created and imported into NVivo as a classification sheet. This classification sheet was used as a criterion for categorizing each interview data and is attached as Appendix D. It was also used to analyzes the concentration of codes by the profile of each interviewee. Core categories deemed crucial for answering the research questions were identified. The next chapter of results is described aligned with those core categories. Based on these core categories, data were integrated to form theoretical explanations. The final codebook is attached as Appendix E, indicating whether each code was created deductively or inductively.

3.6 Ethical issues and Positionality

While this research mainly discussed farmers experiences with farming changes, covering both successes and challenges, some sensitive issues such as conflict among farmers such as water contamination problems between farmers were discussed. Decision making process on transitioning to rice-shrimp farming from rice monoculture farming were also complex, with farmers often struggling to agree. In order to keep farmers privacy, all the private information were deleted from the transcribed data to keep anonymity. Moreover, all the recording is saved on one drive of Utrecht university, which is locked by a password.

How the interviewer presented herself mattered since it could impact what information

the interviewees shared (Hennink et al., 2020). Therefore, throughout the field research, different settings were paid attention, such as what the university staff members wore at the university and what farmers wore in paddy fields and markets. When talking to expats, the author dressed formal while the author was in more casual outfit for farmers interviews to avoid seeming offensive or an outsider. As an Asian, the author's appearance often led people to believe the author was Vietnamese until speaking. Despite being a foreigner, this familiar appearance helped avoid being perceived as an outsider at first glance. Furthermore, learning Vietnamese served as a means to connect with interviewees. While fluency was not achieved quickly, using basic phrases such as "Thank you" helped to break the ice.

When interviewing farmers, the interviewees were allowed to choose the location, such as their homes or community centers, to ensure they could relax during the interview. It was always made clear that the goal was to provide a better understanding of farmers' experiences, offering insights for local governments and organizations. By sharing their real experiences, small-scale farmers could gain useful information for their farming and market strategies.

In interviews with expatriates, an introduction was provided as a master's student researcher, establishing transparency about positionality. The expatriate interviewees generously shared insightful details about the Mekong Delta's social networks and the cultural dynamics underlying the difficulties faced by farmers during agricultural shifts. Their insights, advice, and introductions to other expatriates were invaluable to the field research.

3.7 Limitations of research

This research has certain limitations. First, when considering response measures, the risks posed by climate change are broadly categorized into two aspects: climate change mitigation and climate change adaptation (Füssel & Klein, 2006). Mitigation involves reducing greenhouse gas emissions and strengthening their absorption sources to control global climate change. On the other hand, adaptation primarily aims to alleviate the adverse impacts of climate change through a wide range of actions targeting vulnerable systems (Füssel & Klein, 2006). This thesis primarily focuses on the adaptation measures implemented by the Vietnamese government. While a country should effectively implement both adaptation and mitigation measures, this thesis does not conduct a policy evaluation for mitigation measures.

Moreover, merely supporting agricultural activities may not fundamentally resolve the underlying issues contributing to farmers' vulnerability to climate adaptation measures. For instance, dam construction has significant environmental impacts. The decrease in nutrient input linked to sedimentation caused by dams could weaken the river's food web and, concurrently, escalate the demand for artificial fertilizers to sustain productivity in the Mekong River's agricultural system, thereby posing the risk of ecosystem collapse (Kondolf et al., 2018).

In addition, a language barrier was another research limitation. Communication with local

farmers was slow, potentially leading to misunderstandings, as the author was unable to speak Vietnamese. To mitigate this limitation, the author had a meeting with a translator before entering the field, ensuring that both me and the translator are on the same page for the field research. Due to constraints in time and budget, the research area was limited to one commune, and as a result, the knowledge gained in this research might not be precisely applicable to other locations within Vietnam.

4. Results

In this chapter, the demographics of the participants in the semi-structured interviews will first be presented. Following that, the research results will be described in alignment with the theoretical framework, which include the impact of climate change, as well as the adaptation capacity, adaptation process, and adaptation outcomes. The words of the farmers interviewed are quoted with their permission and are written in italics.

4.1 Participants' demography

Out of the 35 households of farmers interviewed, 29 respondents were men, 4 were women, and 2 households responded as couples. The age distribution is as shown as below.

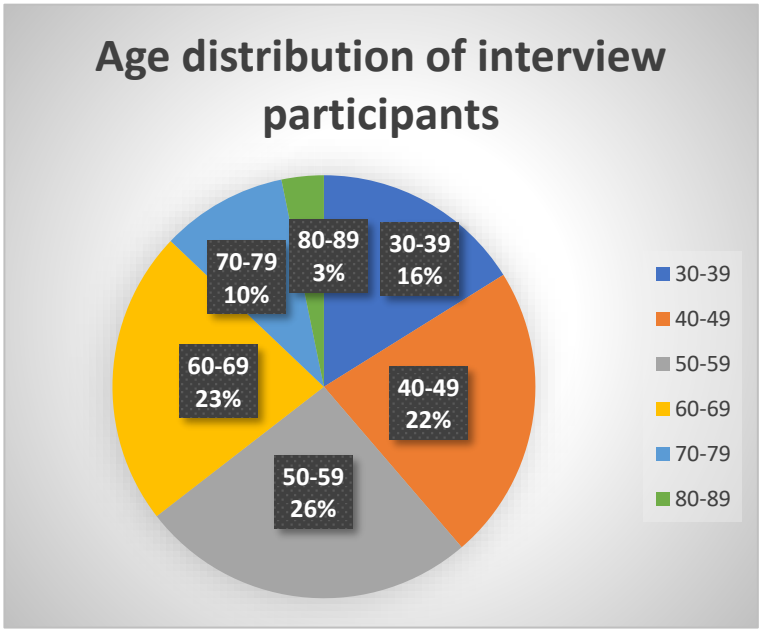

Figure 5 Age distribution of interview participants

The proportions of land ownership among the farmers interviewed in the Hung Yen area are shown in Figure 8. Based on the 2016 census data(General Statics Office, 2018), the size of farmland owned by farmers in the Mekong Delta(Figure 6) and the distribution of land ownership among farmers in Kien Giang Province(Figure) are shown as following. The unit of measurement for each plot of land is hectares (ha). On a Mekong Delta-wide scale, Kien Giang Province has relatively larger farmland per household compared to other provinces (Figure 6). When comparing the data of Hung Yen (Figure 8) and Kien Giang Province (Figure 7), it is evident that Hung Yen has a higher proportion of households with larger farmland within Kien Giang Province. The data is divided into four categories based on area: less than 0.2 ha, 0.2 ha to less than 0.5 ha, 0.5 ha to less than 2 ha, and 2 ha or more, according to the classifications used by the Vietnam General Statistics Office. However, the statistical data did not provide an explanation for these four categories.

Here, following the definition of small-scale farmers used in this thesis, the farmland data

for each household in Hung Yen is re-presented in Figure 9[1]. According to Figure 9, 20% of the 35 households interviewed fall under the small-scale farmer category. In this chapter, farmers owning less than 1 ha of farmland will be referred to as small-scale farmers, while those owning 1 ha or more will be referred to as medium-scale farmers.

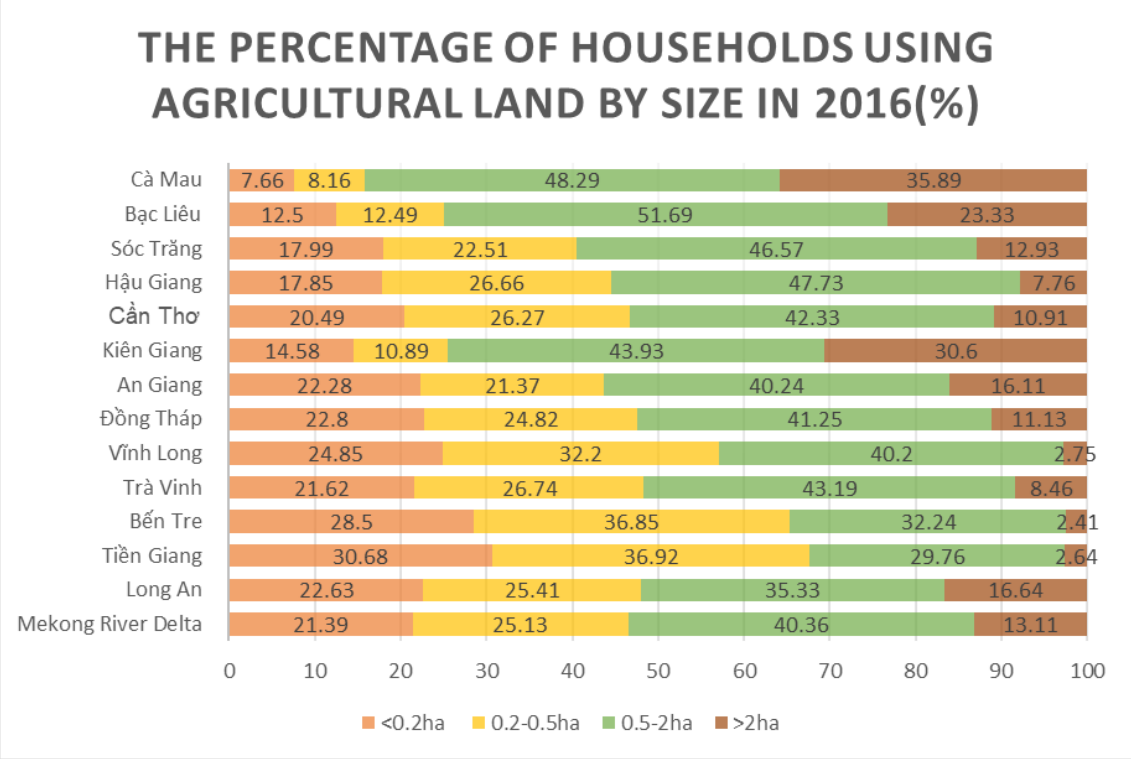

Figure 6 The percentage of households using agricultural land by size in 2016, made by the author based on the data from General Statics Office(2018)

[1] As mentioned at the beginning, this thesis adheres to the FAO's definition of small-scale farmers, which refers to those owning less than 1 ha of farmland. Therefore, the category defined by the Vietnam General Statistics Office as '0.5 ha to less than 2 ha' has been modified to '0.5 ha to less than 1 ha' for Figure 10.

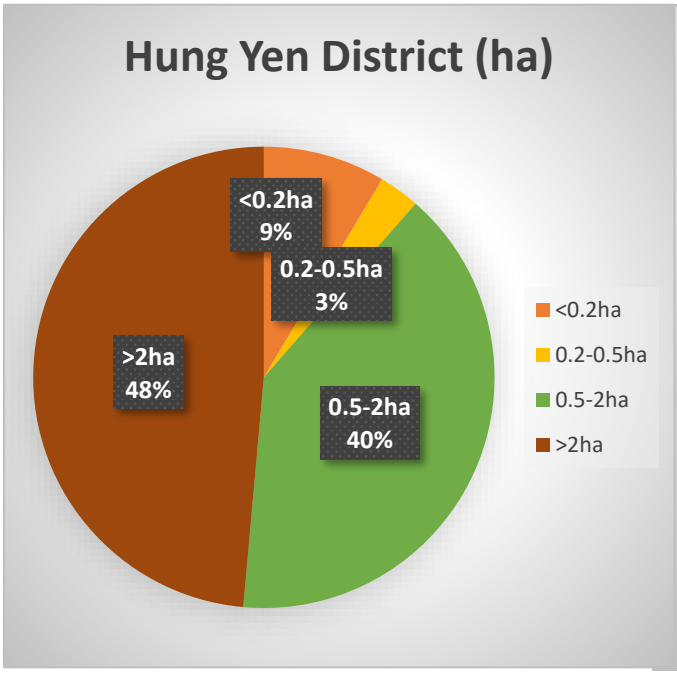

Figure 8 The percentage of households using agricultural land by size in Hung Yen District in 2016, made by the author based on the interviews

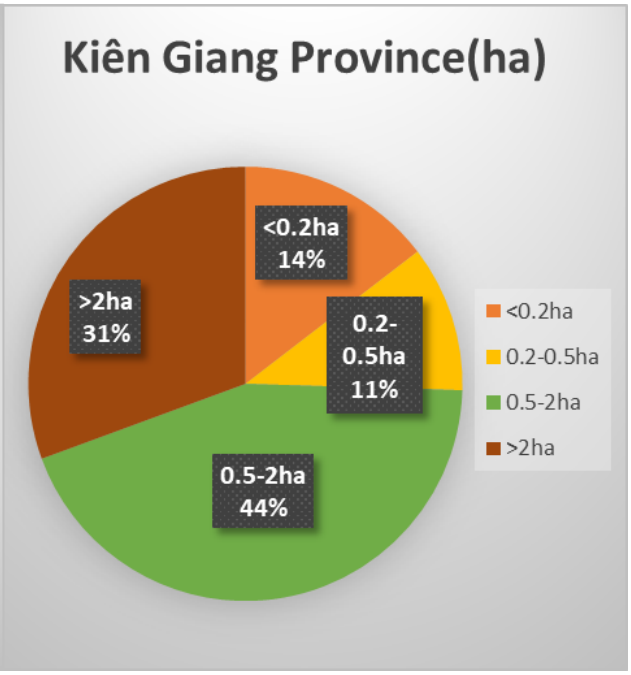

Figure 7 The percentage of households using agricultural land by size in Kien Giang Province in 2016, made by the author based on the data from General Statics Office(2018)

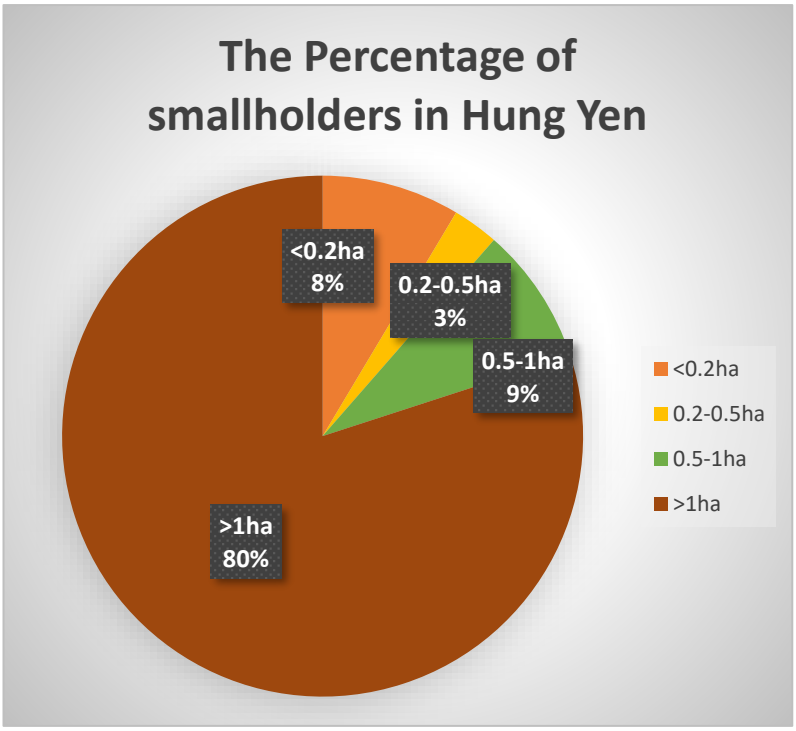

Figure 9 The percentage of smallholder farmers in Hung Yen

4.2 Vulnerabilities Faced by Farmers Before Agricultural Transition

Out of the 35 households interviewed, 7 practiced monoculture rice farming, while the remaining 28 were engaged in hybrid rice-shrimp farming. In Phu Yen, monoculture rice farming follows two growing seasons during the rainy period: from mid-April to mid-August and from mid-August or September to December (Table 2). In the hybrid farming system, shrimp are cultivated from January to mid-August, and rice is grown during the rainy season from mid-August to December (Table 2). The vulnerabilities faced by current hybrid farmers before transitioning to the hybrid system, as well as the vulnerabilities currently faced by monoculture rice farmers, were summarized from the perspectives of the natural environment, economic capital, and social capital. Interview responses related to stimuli and sensitivities due to climate change, and the natural capital aspect of adaptive capacity within the framework, overlapped with each other. Consequently, these were collectively categorized under the item "natural environment."

Table 6 Annual farming calendar

Month	1	2	3	4	5	6	7	8	9	10	11	12
Rice (Twice)												
Rice Shrimp												

4.2.1 Natural Environment (Salt water, Too hot for humans, Farmland size)

According to the farmers, natural disasters such as diseases, storms, rain, and warm weather, the natural environment, which directly affects agricultural yields, is closely related to the vulnerabilities faced by farmers. This section analyzes the vulnerabilities stemming from the natural environment by focusing on the most frequently mentioned and agriculture-transition-related codes from the "Exposure & Sensitivity" code family, namely "Salt water" and "Too hot for humans." Additionally, the code "Farmland size," from the "Natural capital" code family, which is deeply connected to agricultural transition, is also analyzed.

Salt water

From the interview responses coded as "Salt water intrusion," it is evident that saltwater intrusion adversely affects crop quality and yield. Many farmers reported that saltwater intrusion hindered rice growth and deteriorated its quality, which in turn decreased productivity. Farmers who have already transitioned to hybrid farming reflected on their experiences during the two-season rice cultivation period.

"In order to harvest 2 seasons of rice, the weather and water quality don't fit anymore because the production will be low. (RS26)"

Saltwater intrusion not only affects the primary income from rice but also complicates the cultivation of fruits and freshwater fish, which are secondary income sources:

"Other fruit trees and fresh water fish couldn't survive because of the salinity level.

(RS24)"

Monoculture rice farmers face challenges as they lack effective countermeasures against saltwater intrusion. This situation indicates that households relying solely on monoculture rice farming are particularly vulnerable during the dry season, which spans half the year:

"We cannot do anything if the salt water intrusion happens. (RM4)"

Too hot for humans

Responses coded as "heat" indicate that rising temperatures significantly impact farmers' lives and health. The increase in temperature in Vietnam has been notable in recent years, especially during the dry season (Trinh, 2021). Eight out of 35 respondents mentioned that the rising temperatures make agricultural work challenging. Specifically, the daytime heat reduces work efficiency, making it difficult for farmers to continue their tasks. Several farmers reported experiencing fatigue and headaches due to the heat:

"The concern is my health. In dry season I will be tired and have headache easily. (RS9)"

"The afternoon is too hot. (RS8)"

These responses highlight that heat imposes considerable stress and burden on farmers' lives and productivity. As long as temperatures continue to rise, farmers will be compelled to work under harsh conditions, potentially lowering their quality of life.

Farmland size

The size of the land and other available resources can significantly influence a farmer's readiness to adopt new agricultural technologies. There are regional differences in land size in the Mekong Delta (Figure 7). The land sizes of interviewees in Hung Yen are shown in Figures 8 and 10. It is noteworthy that buying and renting land is common in the Mekong Delta. According to the interviews, ambitious farmers are constantly monitoring the market for available land to rent or buy, indicating a competitive environment:

"The farmland is behind my house. I own 11,000 m². I rents the land of 25,000 m², which is 200 m away from my house. (RS20)"

Some farmers also lease their land to others, earning rental income. For instance, one farmer reported an annual rental income of 90 million VND, highlighting the significance of rental income as a secondary source of livelihood:

"I rent my farmland to my brother's family. I can get 90 million VND/year. My house is 10 km away. I am willing to shift that farmland into hybrid. (RS12)"

However, challenges related to land ownership and rental were also mentioned. Some farmers hesitated to expand their operations due to economic constraints, which made acquiring additional land difficult:

"In the future if I have enough money, I'd like to rent other farmland to expand crop production area. (RS24)"

One monoculture rice farmer argued that his land was unsuitable for hybrid farming due to water management issues caused by land elevation differences. His land altitude, being higher than usual, couldn't retain pumped water for more than 2-3 days before drying out again:

"I don't want to change to hybrid farming because it is not effective. Because... The high level of the land. (RM3)"

Lastly, one farmer hesitated to be interviewed due to the small size of his farmland:

"I first said I don't want to take interview because my farmland size is small. (Translator)"

Overall, the size and condition of farmland significantly affect farmers' livelihoods and livelihood strategies. The diverse realities of land ownership and rental provide crucial insights into the economic and geographical challenges faced by farmers.

4.2.2 Financial Capital (Other income sources, Education fee, Health issues)

Variations in crop yields due to weather directly affect farmers' income, which in turn impacts their expenditures. The impact of agricultural income fluctuations on household finances significantly depends on whether the household has sources of income other than agriculture. Additionally, the analysis reveals that in households with non-working children, the largest expenditure is education fees, whereas households with independent children primarily spend on healthcare and agricultural investments such as shrimp feed and juveniles. Therefore, this section analyzes the vulnerabilities faced by farmers from an economic perspective, focusing on the codes classified under the "Financial Capital" code family—"Other income sources" and "Education fee"—as well as "Health issues" from the "Human capital" code family.

Other income sources

Many farmers depend primarily on agriculture for their income (RM5, RS11, 20, 21). While rice and shrimp are farmers' main production, some farmers also grow coconuts and other crops (RM3, RS18). Non-agricultural income sources include fishing (RM1), growing vegetables and fruits (RM2, 6, RS16), and cultivating coconuts or pineapples (RS22). Some farmers run small shops as a side business (RM7, RS27), and others hold government jobs (RM4, RS24, 5), thus diversifying their income and enhancing economic stability.

"The main income is from rice. We also run a small grocery store but we only have a small amount of profit. (RM7)"

Some families diversify income sources through the employment of family members in government offices, factories (RS14, 25), or even overseas labor (RS28). This

diversification mitigates risks associated with fluctuations in crop yields or market prices. Some farmers recognize the instability of their income and the necessity to diversify their income sources (RS12). For example, selling vegetables during the rainy season supplements their income (RS16).

"Income only from farming. In the rainy season I sometimes sell vegetables in front of my house. (RS16)"

Although farmers primarily depend on agriculture, having diverse supplementary income sources contributes to economic stability. Families working together to diversify income sources often offset the instability of agricultural income. Additionally, holding external jobs in government or factories further enhances economic stability.

Education fee

Analysis of interview responses regarding education expenses in rural areas reveals that education holds an extremely high priority in household budgets (RM3, RS10, 12, 14, 15, 16, 19, 25, 28). A common theme among multiple responses is that children's or grandchildren's education fees are one of the most important expenditures, prioritized alongside food expenses (RM3, RS16, 19, 25). This strong commitment to education reflects the farmers' families' willingness to invest sustainably in future generations. However, the financial burden of education also significantly impacts household finances. Some households reported the necessity to reduce other expenditures to cover education costs, highlighting the financial pressure exerted by education expenses:

"We make money for our daughter who studies at Can Tho University. As we get more money, we spend more for our daughter. (RS28)"

"The biggest expense is for food and education fees for my grandson to study. (RM3)"

The Mekong Delta has the highest number of children in secondary and higher education in Vietnam (UNICEF, 2022). According to Mr. Minh, a local authority guiding us through Hung Yen, the general education level in the region is low. Previously, few continued educations beyond high school, but now most students attend high school. The average years of schooling among interviewed farmers were about six years. They prioritized working on the family farm over education before graduating from elementary or secondary school. However, the current generation of parents among the interviewees showed a high interest in education, prioritizing spending on their children's education. Additionally, according to Mr. Minh, farmers with higher education levels were more enthusiastic about hybrid farming and exhibited higher adaptive capacity compared to those with only secondary education. Despite an increase in high school graduates, economically disadvantaged farmers, particularly small-scale farmers, struggle to afford education costs. These insights indicate the necessity of measures to alleviate education expenses and education support policies, which would improve the quality of life and economic stability for farmers.

Health issues

Among the 35 households, one household (RS18) reported that healthcare expenses significantly burden their finances. Both spouses in this household have heart and liver diseases, requiring regular treatment, which severely impacts their monthly budget. They must travel long distances to receive medical care, adding further economic and physical strain. Specifically, they travel to hospitals in Ho Chi Minh City (5-6 hours by bus from Kien Giang) or Rach Gia (less than an hour by motorbike) every month, incurring transportation costs and time. Consequently, healthcare expenses are a priority expenditure alongside food and other living expenses. Adverse weather or market price declines can affect the ability of farmers to afford medical services:

"We have enough money for everything we need. We are trying to save money so we don't travel anywhere else. (RS18)"

4.2.3 Social Capital (Services from a cooperative, Information exchange)

Finally, by focusing on the codes "Information exchange" and "Services from a cooperative" included in the "Social capital" code family, this section elucidates the presence or absence of social safety networks in various regions before agricultural transition and the nature of information exchange among community members. These social environments play a crucial role in mitigating the vulnerabilities faced by farmers. Conversely, the absence of such social capital can increase the susceptibility of some farmers to natural disasters or significant market fluctuations.

Services from a Cooperative

According to Dr. Minh, a rural development expert, agricultural cooperatives are formed by farmers pooling capital and cooperating in both management and business activities. These cooperatives bring together independent producers at the village level to collectively handle the shipment of agricultural products and the purchase of necessary supplies. Cooperatives provide extensive support to farmers, playing a critical role in their operations. Specifically, they regularly hold workshops and offer advice on rice cultivation and shrimp farming techniques (RS1, RS3).

"When some farmers don't have knowledge about shrimp farming, they can call the cooperative members to get advice. (RS1)"

Additionally, cooperatives supply agricultural materials, such as organic fertilizers, particularly during the initial stages of farming. These organic fertilizers are provided free of charge by the cooperatives, reducing the economic burden on farmers (RS2, 3). Furthermore, cooperatives facilitate contracts with wholesale companies. By collectively selling large quantities of rice through the cooperative, farmers can negotiate better terms compared to selling individually (RS2, 3). There are also plans for collective shrimp shipment in the future (RS1). However, the activities of cooperatives are still not widespread in the Mekong Delta (RS1). In the interviews conducted for this study, only three out of 35 households belonged to a cooperative (RS1, 2, 3). Additionally, local government officials who guided us through the villages indicated that cooperatives are uncommon, particularly among small-scale farmers.

"There are no cooperatives because they are small-scale farmers. (Mr. Minh, a local officer from the local government)"

The primary reason cooperatives are not common among small-scale farmers is economic: establishing a cooperative is not profitable. Dr. Minh explains that a certain scale of production is necessary to establish a cooperative, and assuming all members are small-scale farmers with less than 1 hectare of land, at least 100 members are required. Moreover, Dr. Minh highlights the insufficiency of funding from public institutions and emphasizes the need for investment in maintaining and operating agricultural cooperatives. To apply for foreign aid programs, a cooperative typically needs three to four years of activity records, during which it must sustain itself with its own funds. Therefore, Dr. Minh suggests that rather than establishing new agricultural cooperatives, it would be more realistic to create a system allowing small-scale farmers to join existing cooperatives.

In this way, cooperatives provide comprehensive support to farmers, including training, disease prevention measures, and material supply, which contribute to the improvement of farmers' skills and economic stability. However, the prevalence of cooperatives varies by region, and their further dissemination is necessary. For small-scale farmers and impoverished households, who are particularly vulnerable to external factors like climate change and market price fluctuations, the services provided by cooperatives are crucial for reducing their vulnerability. Nonetheless, the issue of profitability has hindered the implementation of such systems among those who need them most. Therefore, the utilization of public funding should be considered to bridge this gap between the social needs and the supply of services.

Information Exchange

The nature of information exchange in rural Vietnam is diverse, varying significantly by region and individual. Some farmers actively engage in information exchange, sharing agricultural knowledge and experiences with neighbors and within the community. For example, some farmers regularly discuss agricultural timing and techniques with their neighbors, while others participate in agricultural organizations and workshops to deepen their knowledge and provide advice to other farmers (RM4, RM7, RS25). Additionally, individuals working in local government often have a professional understanding of agriculture, making it easier for them to obtain and apply agricultural information (RS25).

"I talk a lot with my neighbors to discuss farming, such as when to start growing rice, when to spread pesticide and fertilizer. (RM4)"

"I talk with neighbors. Everyone has some information, and we talk a lot together to find solutions when we have some troubles in farming. (RM7)"

"There is a guy who is professional in agriculture in the government office. So, I ask him about some knowledge or information when I have questions. (RS25)"

However, some farmers avoid information exchange. For instance, a farmer from RM1, who is not originally from the village where my farmland is located but rents land there,

does not know the villagers and claims, "In Vietnam, it is common not to share agricultural techniques with others." However, this is not entirely the case, as other farmers actively engage in information exchange.

"I do everything by myself and don't want to exchange information or knowledge with other people. Usually, farmers in Vietnam don't share knowledge. (RM1)"

The findings reveal that the nature of information exchange in rural Vietnam is influenced by the characteristics of the local community and individual choices. In regions where information exchange is active, agricultural efficiency and productivity tend to improve, potentially enhancing the quality of life for farmers. On the other hand, in regions or households with limited information exchange, farmers are more likely to experience isolation, necessitating external support. These insights underscore the importance of information exchange within communities and serve as crucial guidance for future agricultural support policies. For farmers transitioning to hybrid agriculture, engaging in shrimp farming for the first time, local information exchange among farmers is expected to be an even more critical source of information.

4.3 Top-Down Agricultural Transition Process

This section discusses the Vietnamese government's policies on agriculture and climate change. As outlined in the framework, the government has two policy options: hard policies, which involve significant investments in large-scale dikes and sluice gates to manage salinity levels, and soft policies, which focus on agricultural production strategies and land-use management. While the land-use planning aspect of soft policies directly impacts farmers, interviews revealed that the construction of sluice gates, a hard policy, also affects agriculture. However, as previously mentioned, the capacity for adaptation varies by village and individual, yet the policies are top-down, expecting farmers to comply with government directives (Thomas, 2023). Therefore, this chapter analyzes the agricultural transition process from the perspectives of decision-making processes, cost burdens of transition, access to necessary knowledge for shrimp farming, and the impact of sluice gate construction on agriculture.

4.3.1 Decision-Making Process for Agricultural Transition (Government decision, Majority vote, For more income, Concerns)

The decision-making process for agricultural transition was analyzed based on the codes "Government decision," "Majority vote," "For more income," and "Concerns," classified under the code family "Decision making for shift." The decision to transition to rice-shrimp hybrid farming is made at the community level through a majority vote. Thus, even if there are dissenting voices, the community is compelled to make the transition if more than 50% are in favor (RM1). Consequently, farmers in areas where the government has recommended the shift to hybrid farming can express their opinions, but they do not have complete autonomy over their agricultural practices. This discourse aligns with the argument by Lan (2013) and Tran et al. (2022) that farmers own the land but have lost their decision-making autonomy.

In these decision-making processes, unanimity is not always achieved, and opposing

opinions exist. However, the majority's opinion ultimately becomes the course of action. Farmers who were compelled to express their opinions through majority vote voiced various perspectives. For instance, some residents opposed the transition to hybrid farming, but the decision was made by majority vote (RS1, 3). Additionally, cases were observed where farmers decided to transition due to the influence of neighboring farmers who had changed their farming methods (RS23).

"The government changed the land use plan, so the villagers just had to follow it. 3 out of 10 people disagreed with it. (RS3)"

"My neighbor changed, so I had to follow it. That's why I decided to shift to hybrid farming. (RS23)"

"I heard that, at first, there were also some people who objected. But, after their income increased, they no longer object. (RS1)"

"I shifted 8 years ago because of the government plan. I changed because everyone also had to change it. (RS27)"

Those who opposed the agricultural transition often expressed fears and doubts about the transition (RS16, RS25).

"I was afraid of changing the farming style to rice-shrimp because I didn't know if it would be effective or not. (RS16)"

"At first, I was suspicious about the hybrid farming because I thought the weather was too hot for shrimp and the water was too salty for rice. (RS25)"

Additionally, following the government's plan can affect land use rights. For instance, farmers with less land may need to lease or sell their land to other farmers (RS3).

"Everyone has to shift to rice-shrimp farming. If someone has less land, they have to give it to someone else to rent or sell. The government is planning for all the areas. Every person has to follow the planning. (RS3)"

The decision to transition to hybrid farming is also influenced by economic motivations and regional climate conditions. For example, the necessity to switch to rice-shrimp farming arose from the declining income from rice monoculture and the impact of saltwater intrusion (RS22).

"When I was practicing rice monoculture, rice was not a good income source as the production yield decreased because of saltwater intrusion. So, I had to change to rice-shrimp farming. (RS22)"

There are also cases where individual farmers changed their agricultural practices before the government's plan was implemented. Some farmers voluntarily transitioned to hybrid farming to increase their yields due to reduced rice yields caused by salt damage (RS2, 21). For instance, the farmer, RS2, transitioned to hybrid farming in 2007 to increase income but reverted to rice farming in 2009 upon government instruction, as the area was designated for rice cultivation in the government's land-use plan. However, in 2013, he

switched back to hybrid farming following the government's directive. The construction of sluice gates compelled them to change their farming methods. Additionally, one household switched to hybrid farming before others as a test to see if the government plan was feasible (RS26).

"I decided to shift because of the low income from rice monoculture farming. I also learned about rice-shrimp farming from my neighbors. (RS21)"

"I shifted to rice-shrimp farming in 2007, went back to rice farming in 2009, and changed to shrimp farming again in 2013. (RS2)"

"I changed to hybrid farming in 2008 before the government plan. I could freely change my farming style, and it was like an experiment to see if the government plan was feasible and effective. (RS26)"

However, some rice monoculture farmers, despite being interested in agricultural transition, were unable to switch to hybrid farming due to government policies or constraints from neighboring farmers. For instance, a rice monoculture farmer had considered transitioning to hybrid farming for about 15 years but could not implement it due to the lack of a specific government plan. He mentioned that transitioning to a new agricultural model without government support would be too risky. A medium-scale farmer also mentioned that it would be difficult to get consent from surrounding small-scale farmers to transition to hybrid farming (RM7).

"Though I've been willing to change to hybrid farming, other farmers' farmlands are not large enough. So other farmers will not agree with hybrid farming. (RM7)"

"For about 15 years, I have been thinking about shifting to the hybrid farming model. I believe in and trusts the government. I want to change my farming practice, but the government doesn't have any plan to change, so I can't change it. Without any support from the government, I don't want to change to hybrid farming. (RM6)"

As illustrated, the decision-making process for agricultural transition is complexly influenced by government guidance and plans, economic factors, and community reactions, with different decisions being made based on each farmer's situation and perceptions. These cases highlight that while farmers are encouraged to act as "entrepreneurs" as required by Resolution 120, various constraints from the government and community limit their ability to make autonomous decisions. This situation reveals that an environment where farmers can make independent decisions is not yet established.

4.3.2 Transition Cost (Expensive Investment vs. Reasonable Investment)

The discourse on the cost burden of transitioning was analyzed based on interview responses coded under the code family "Transition cost," specifically the codes "Expensive investment" and "Reasonable investment."

Transitioning to a rice-shrimp farming system involves an initial investment to convert paddy fields into aquaculture ponds. The perceived affordability of this investment varies according to the household's economic status. Factors such as land conditions, distance,

and terrain also influence the costs (RS19, 20). In the early stages of agricultural transition, in addition to construction costs, the initial investment in items such as shrimp fry is higher than that for rice cultivation, further increasing the financial burden on farmers (RS7, 9). While increased income post-transition can recoup these initial investments (RS5), the high upfront costs and the risk of initial shrimp farming failures are major deterrents for farmers considering the transition.

The average initial investment reported by hybrid farmers interviewed was 20,772,727 VND (approximately 761 euros) per hectare. Eleven households described the investment as high (RS15, 17, 19, 20, 4, 5, 7, 8, 9), with individual costs ranging significantly from about 3,333,333 VND (approximately 122 euros) to 37,222,222 VND (approximately 1,364 euros) per hectare. The household with the highest initial investment, RS17, had to spend 67,000,000 VND (approximately 2,456 euros) for 1.8 hectares. RS19 attributed the high cost to the specific terrain of their paddy field.

"The money we have to move from rice to shrimp rice is expensive. (RS17)"

"It's pretty expensive but not much. It's about 20 million VND. (RS4)"

"I have a little bit difficult because I have to spend money to rebuild the land. (RS7)"

"In the beginning I had to spend money to change the field for the rice-shrimp model, but income increased and it paid off. (RS5)"

Conversely, nine households described the initial investment for agricultural transition as "reasonable" or "cheap" (RS1, 11, 15, 16, 21, 22, 24), with their initial costs ranging from about 2,500,000 VND (approximately 92 euros) to 10,000,000 VND (approximately 367 euros) per hectare. These farmers stated that the affordability of the initial investment made the transition easier. For these households, low investment costs contributed to a positive attitude towards agricultural transition (RS1, RS24). Furthermore, in cases where support was provided by the government or related organizations, the financial burden of the initial investment was further reduced (RS15).

"In order to shift their farmland, I will have to spend 7-8 million VND and the amount was affordable for me. (RS1)"

"To shift, I had to pay 7-8 million VND and it wasn't that expensive for me. (RS22)"

"I had to spend 10 million VND to dig a pond for shrimp farming. My farmland is 10,000 m². The government helped me to rent money to dig the canal, so it didn't cost that much. (RS15)"

The cost burden of initial investments for agricultural transition varies according to household financial capacity, but factors such as terrain can drive up construction costs. Whether these initial investments can be quickly recouped depends on market prices, climatic conditions, and the farmer's expertise, among other factors. Thus, there is no guarantee that the costs incurred for agricultural transition will be recovered immediately. This uncertainty poses a significant burden, particularly for economically vulnerable or small-scale farmers.

4.3.3 Changes in Agricultural Practices (The Process of Acquiring New Knowledge)

The discourse on the process of acquiring the necessary knowledge for shrimp farming, in the context of changing agricultural practices, was analyzed based on interview responses coded under the "Transition process" code family, specifically the code "Getting new knowledge." Interview responses highlight that government-organized workshops and training sessions play a crucial role in disseminating new agricultural techniques. Many farmers have acquired the knowledge required to transition to hybrid farming through these workshops and training sessions (RS1, RS4). These knowledge dissemination activities are part of the government's agricultural policies and serve as vital mechanisms to enhance the productivity of local communities.

"Every year, the government will send experts to provide training. Thanks to the local government's training, we learned how to do shrimp farming. We now know how to do it and do not feel any difficulties. (RS1)"

"We have workshops organized by the government and they invite specialists. (RS4)"

However, there are disparities in access to this knowledge. Some farmers are unable to participate in the workshops because they are already fully booked (RS8). This imbalance in access can exacerbate information gaps among farmers and create inequalities in the agricultural transition process.

"I didn't join any workshop or organization. There were two workshop courses, but they were already fully booked, so I couldn't join. (RS8)"

Overall, the interview responses reveal that knowledge dissemination activities led by the government and agricultural companies are critical to supporting the agricultural transition in local communities. Farmers who lack access to these opportunities to acquire new techniques and knowledge are placed at a disadvantage in the agricultural transition process. Therefore, there is a need for institutional improvements to ensure the sustainability of these activities and to guarantee equal access for all farmers.

4.3.4 The Impact of Sluice Gate Construction on Agriculture

This section is primarily analyzed under the code "Sluice gate." One of the government's hard policy measures for salt mitigation involves the construction of sluice gates. This initiative was part of the Water Resources Master Plan in the Context of Climate Change 2011, with the involvement of the Dutch government (JICA, 2013). The Dutch government's long-term goal was to build several flood barriers(Smajgl et al., 2015). One of these, the Large Sluices at Cai Lon & Cai Be, was constructed in 2021 in an area adjacent to Hung Yen district. The farmers' opinions about this sluice gate were mixed.

Interview results reveal that while some farmers benefit from the construction of the sluice gates, others suffer adverse effects. The government's decision to construct and operate the sluice gates forces local farmers to adapt to the post-construction environmental changes (RS2). This decision directly impacts regional production activities, compelling farmers to comply with the plan (RS2, 23).

The construction of the sluice gates may have redistributed environmental risks within the region, potentially causing certain areas or farmers to bear an excessive share of these risks. The impacts of sluice gate construction and operation on agriculture are significant, with neighboring farmers claiming direct effects from their management. For instance, unpredictable opening and closing times of the sluice gates have led to reports of flooding and drought, damaging crops (RM2, RS22). Specifically, excessive water supply during the rainy season and water scarcity during the dry season have negatively affected rice yields, leading to farmer dissatisfaction (RS22). While this thesis cannot conclusively attribute all environmental changes mentioned by the farmers to the sluice gate construction, their consistent reports of such changes highlight the need for rigorous scientific investigation.

"It depends on the sluice gate. It closes in August, causing floods in their area, which damage the rice. I don't know about the timing of when the gate is closed and opened. (RM2)"

"Before the cooperative was created, many people just had to follow the government plan because the sluice gate was constructed as well. The sluice gate construction changed everything in their farming. (RS2)"

"My production is not influenced by salt water or drought but by the sluice gate. The government closes the sluice gate for a long time. I have enough salt water for shrimp, but in the rainy season, the water is too much. The sluice gate opens too late. Too much water decreases the rice yield, so I am not happy about the growing condition for rice. (RS22)"

Distrust towards sluice gates is not limited to Hung Yen. In Thanh Phuoc Commune, located near the Ba Lai sluice gate in the Mekong Delta, farmers also expressed their distrust towards the sluice gate (Tran et al., 2022). However, according to Mr. Bush, a local government official, the timing for opening and closing the sluice gate is determined based on scientific data and observations of farmers' agricultural conditions. Additionally, the schedule for when the gate will open and close, and for how long, is communicated to nearby residents through newspapers, television broadcasts, apps, and letters.

On the other hand, some farmers feel that the construction of the sluice gates has stabilized water supply, improving water availability and thus agricultural production (RM6, RS17, 20, 24). The management of saltwater intrusion is particularly crucial, with the sluice gates helping to maintain water quality by preventing saltwater incursion (RS17).

"Water security is not their concern because the big sluice gate controls salt water. (RS17)"

"For the past few years, I haven't worried about water availability thanks to the sluice gate. (RS24)"

Thus, the construction and operation of sluice gates have significant impacts on agricultural sustainability and productivity. It is necessary to communicate the basis for

determining sluice gate opening and closing times to local residents and ensure transparent management practices. Additionally, rigorous scientific investigations into the long-term environmental impacts of sluice gate construction are required, especially concerning the ecosystems upon which fishing households depend. While this thesis does not focus on fishermen as they are outside the scope of this study, future research on the ecological impacts of sluice gates is essential.

4.4Naturalization of Inequality

Thus far, it has become evident that despite varying vulnerabilities among farming households, the transition to hybrid agriculture is predominantly carried out in a top-down manner by the government. This chapter analyzes how the naturalization of inequality occurs as a result of agricultural transition, focusing on perspectives such as agricultural transition and the natural environment, changes in household finances, and future prospects. This section is primarily analyzed under the code "3.1 Natural environment." First, the analysis will examine agricultural transition and the natural environment, considering aspects such as climate change and income instability, the impact of water pollution on yields, strategies during yield declines, and shrimp theft issues.

4.4.1 Agricultural environment and natural environment (impact of climate change on income instability, effects of water pollution on yield, strategies during yield decline, shrimp theft)

Impact of Climate Change on Income Instability

This section primarily analyzes under the codes "Too hot for shrimps" and "Vulnerable to weather". Some farmers have been able to mitigate vulnerability to salinization during the dry season by switching from rice cultivation to shrimp farming. However, the income of agricultural practitioners still heavily depends on climatic conditions (RS12, 13, 24, 25, 27, etc.). Particularly, unexpected rainfall or high temperatures significantly affect shrimp and rice production, leading to reduced yields. Consequently, farmers' incomes are annually unstable, increasing their economic vulnerability. For example, responses such as RS13 and RS28 clearly indicate the economic impact of climate change on agricultural production. Yield reductions directly translate to income decreases, jeopardizing the stability of farmers' livelihoods. Thus, farmers unable to adapt to weather variations often face severe economic challenges.

Responses from interviews underscore the severe impact of rising temperatures on shrimp farming. Interviews (RS1, 10, 11, 12, 16, 17, 20, 24, 25, 26, 5, 6, 7, 8) reveal that high temperatures directly harm shrimp growth. Particularly, excessive water temperature increases the risk of shrimp mortality. These phenomena highlight that climate-induced heat stress poses a significant challenge to shrimp farming.

High temperatures causing shrimp mortality and poor growth result in decreased production levels, reducing shrimp farmers' incomes and exacerbating economic instability. This suggests that climate change's effects could permeate throughout economic activities.

"Impact a lot from the climate change. Because in the dry season, they are still hot, but suddenly rain, it will become less production. (...) If we have 1 ton of shrimp, we will have only 700 kg. It's 0.7 ton. (RS10)"

"Hot weather affect to shrimp farming. (RS26)"

Water management plays a crucial role in hybrid agriculture, as emphasized by many hybrid farmers (RS11, 13, 20, 22, 24, 25, 26, 27, 28, 3, 4, 5, 8). Farmers maintain productivity and mitigate the impacts of climate change and saltwater intrusion through water quality and quantity management. For instance, the difficulty in water quality management for shrimp farming is evident from RS25, indicating the necessity for proper treatment to maintain suitable water conditions for shrimp. Effective water management is essential to address fluctuations in water temperature and salinity due to climate change. Responses like RS24 and RS5 describe strategies against temperature and salinity fluctuations, involving water circulation and temperature regulation. These measures are crucial for shrimp farmers to adapt to climate change.

"The hardest thing is to treat the water. (...) To treat the water, appropriate water for the shrimp to live. (RS25)"

"For the shrimp, when it's hot, we will pump water. So that the water is cool again. When it suddenly rains, (...) the temperature is important. It changes the temperature suddenly. (RS24)"

"I check the water quality before I grow something. (...) I check once in 5-10 days. (RS5)"

Thus, water management in shrimp farming is crucial for maintaining productivity and supporting the livelihoods of local communities. Technical support is essential to enable farmers who transitioned to hybrid agriculture to effectively manage water resources.

Water Pollution Issues and Their Impacts

This section primarily analyzes discourse coded under "Water pollution". Water pollution poses a serious problem for both agriculture and shrimp farming, with diverse implications. As revealed by interview responses, water pollution causes reduced crop yields and deterioration of soil quality, directly impacting productivity (RM3, RS12). The wastewater discharge contains harmful substances that adversely affect the growth of shrimp and rice. Consequently, water pollution poses a significant threat to the sustainability of agriculture and aquaculture.

"Yeah, the impact has been significant. The field was damaged when the water became contaminated. The soil quality has deteriorated, affecting crop cultivation. It's not as productive as it used to be. (RM3)"

According to farmers, water quality worsens during the dry season when canal flows decrease due to household wastewater. This poses a challenge to shrimp farming, which thrives under dry season conditions. While severe water pollution can reduce shrimp harvest, farmers note some adaptation among shrimp to polluted conditions (RS12).

Farmers have implemented strategies such as creating water reservoirs to filter irrigation water and prevent direct contamination of rice paddies (RS12). However, concerns about potential health effects on humans from shrimp adapted to polluted water remain unaddressed.

"Water pollution is a problem because the yield decreases. But the shrimp is getting used to the polluted water. (RS12)"

In villages along the Cai Ron River, concerns about water pollution from neighboring seafood companies have been raised (RM2, RS23). Farmers fear the impact of wastewater discharge from these companies on shrimp production. Similar concerns have been echoed in Ca Mau Province within the Mekong Delta, where seafood companies receive local government support despite conflicting land use practices. Industrial wastewater directly enters farms along the Cai Ron River, increasing the risk of agricultural failure in these areas. Despite these concerns, scientific research on the effects of industrial wastewater on crop growth and safety remains insufficient.

"Both drought and saltwater are not an issue for him. But I concern the water pollution from the seafood company. (RS23)"

Continuous discharge of household and industrial wastewater without environmental consideration can severely impact agricultural production. Authorities urgently need to develop sewage infrastructure to prevent polluted water from entering rice paddies and fields. Otherwise, despite advances in agricultural technology, current practices may become unsustainable economically and ecologically. Lan (2013) previously highlighted the threat of water pollution to agricultural sustainability, which remains a pressing issue a decade later.

Thus, the severity of water pollution varies depending on river and canal flow patterns and the location of agricultural land. Mapping vulnerable areas affected by water pollution on a geographical scale remains challenging. Further investigation is needed to determine the extent of water pollution, its impact on crop yields, and potential health implications for humans.

Strategies for Mitigating Yield Variability

This section focuses on discourse coded under "Water management", "Water pollution", "Solutions for yield decrease", and "Fertilizer". The issue of yield reduction in agriculture and shrimp farming is multifaceted, influenced by factors such as diseases, natural disasters, and environmental pollution. In addition to effective water management, farmers and shrimp breeders implement strategies through land management and chemical usage to mitigate yield decreases. For instance, immediate application of pesticides is crucial when diseases occur to minimize damage (RM2, RS24). While these diseases don't occur frequently, failing to treat them promptly could lead to a significant decrease in production (Desrina et al., 2022). Common diseases in shrimp farming include White Spot Syndrome (WSS), Yellow Head Disease (YHD), Taura Syndrome (TS), Early Mortality Syndrome (EMS), among others. To prevent the spread of diseases,

water containing infected shrimp needs to be properly treated before being released (Desrina et al., 2022).

Furthermore, preventive measures such as harvesting crops before impending natural disasters like typhoons are taken based on weather forecasts (RS24). However, identifying precise causes of reduced harvest compared to previous years remains challenging due to the ecological complexities arising from climate change and hybrid farming practices integrating shrimp and rice. Farmers often rely on hopes for better outcomes in subsequent seasons without clear improvement measures in place.

"I think the solution is to improve in the next season. When it's already damaged, I can't cure it. The solution is to use medicines to reduce the damage. (RM2)"

"In order to grow rice, weather forecasting is important. For example, we decide to harvest rice before a storm comes. (RS24)"

For farmers newly transitioning to hybrid farming, limited experience in shrimp farming necessitates knowledge to make informed decisions and apply appropriate treatments when shrimp diseases occur. Access disparities to knowledge on shrimp farming could lead to varying abilities in responding to diseases. Therefore, establishing mechanisms for continuous training and networking with specialists is crucial for hybrid farmers, particularly for impoverished or small-scale farmers, to ensure ongoing access to information and knowledge on shrimp farming practices.

Shrimp thief

Furthermore, an issue arose with shrimp theft associated with the change in land use to shrimp farming. This topic is discussed based on discourse coded under "Shrimp thief".

According to respondents (RS15), theft of shrimp from aquaculture ponds occurs frequently during nighttime. This problem is not confined to rural areas like Hung Yen; similar incidents have been reported in aquaculture ponds in urban areas of Kien Giang as well. A homeowner near Kien Giang University, who maintained fish ponds on their property, experienced theft while away on a trip. Despite efforts to secure the ponds with wire mesh, the perpetrators managed to breach the security and steal the fish. The affected individuals expressed frustration over the lack of effective measures to address theft, despite authorities being aware of the issue.

"We want cameras because other people steal their shrimp. We need more security. The police don't do anything about it. (RS15)"

4.4.2 Changes in household economics (food security, securing education expenses, variations in agricultural investment, changes in income levels, market price instability)

Changes in Household Income

This section is analyzed based on discourse coded under "High rice yield after

transition," "Difficult only in the beginning," "Less workload," "Stable or higher income and consumption." The main income sources in agriculture are rice and shrimp, with shrimp farming particularly noted for its stable income generation according to several respondents (RS14, 21). Shrimp farming provides daily income, which is highlighted as more stable compared to rice cultivation (RS1, 14). The increase in income has been associated with shifts in consumption patterns, including higher expenditures on education, healthcare, home improvements, and entertainment (RS9, 5, 24). Moreover, surplus savings contribute to increased economic stability (RS6, 7). Improved income has also enhanced quality of life, reported through better health conditions and improved living environments, leading to increased happiness among farmers (RS14, 27). With rising income, there has been a concurrent advancement in agricultural technology and infrastructure investment, promising further productivity gains and income growth (RS9, 21).

"Hybrid farming is good for health and I got more free time to do another work. I can get more profit and stable income. (RS27)"

"I am happy with my situation. Their income is enough and I can save money. (RS9)"

"I got more income and spent more. Rebuilt our house and spend more money for entertainment. (RS14)"

"When I switched to shrimp farming, the rice yield became very high in the first 2 years. But it decreased after that but the income is still higher than rice monoculture. (RS21)"

"Income changed, we have more money for entertainment such as a speaker and microphone for karaoke, good Honda motorbike. It must be benefits for Japanese companies. (RS5)"

However, income stability remains a concern, particularly vulnerable to weather and market price fluctuations (RS13, 8).

"Our income depends on the weather every year. Shrimp is a big income source so when its yield decreases due to the weather, it is a big problem for us. (RS13)"

"I got more income but it's not stable. (...) It depends on the years. If I earn more profit, I will live happily. But if I don't have a lot of profit, I will live more difficultly (RS8)"

Overall, interviews clearly demonstrate diversification and improvement in agricultural income. The introduction of shrimp farming notably contributes to income stability and enhancement, thereby improving the livelihoods of farmers. Furthermore, income growth stimulates changes in consumption patterns and technological investments, contributing to sustainable agricultural management. Nonetheless, concerns regarding income stability persist, necessitating further strategies for sustained income growth.

Market price volatility

Fluctuations in market prices significantly impact income. This topic was analyzed based on codes such as "Unstable shrimp price" and "Shrimp selling system". Both rice

and shrimp market prices vary annually. Rice prices, for instance, may decline 2-3 times a year (RM5). Similarly, the instability in shrimp prices has been highlighted as a factor leading to income instability (RS16). Price drops directly affect the income of farmers, becoming a major economic instability factor.

"The price has decreased a little this year. The other year, the price has dropped 2-3 times." (RM5)

"It's not stable. It changes, the price changes." (RS16)

The fluctuation in shrimp market prices results in varying revenues annually (RS8, 21). Years with high income provide stability and satisfaction in livelihoods, while years with lower income led to financial difficulties. Therefore, market price stability is crucial for improving quality of life. Furthermore, there are calls for stronger shrimp species resistant to diseases and environmental changes, appropriate fertilizers, and financial support (RS7).

"Our income also depends on the market price." (RS21)

"I want stronger species, better fertilizer, and financial support for shrimp. I also wish for stable shrimp prices in the market." (RS7)

The instability in shrimp market prices significantly impacts the economic stability of shrimp farmers. Income instability due to frequent price fluctuations directly affects their quality of life. Shrimp farmers strongly advocate for market price stabilization to achieve more stable incomes.

Food security

Many households secure their food through a combination of self-production and market purchases. This topic was analyzed based on the "Food security" code. For example, households cultivate vegetables and rice for self-consumption, while purchasing protein sources such as meat from the market (RM1, 4, RS10, 12, 20). Some households are entirely self-sufficient, rarely visiting the market (RS15, 16, 17).

"Mostly our food is from self-production but sometimes we also buy from a market." (RS20)

The degree of self-sufficiency varies by household. Some households produce 80% of their food and purchase the remaining 20% from the market (RM6), while others source 70% from the market and produce 30% themselves (RS22). Dependency on the market varies, with some households heavily reliant on market purchases and others emphasizing minimal reliance (RS19, 27). Market purchases are common when self-production falls short or for dietary variety (RS6, 28). Some respondents mention earning income specifically for purchasing food from the market (RM3). However, households emphasize minimal market purchases, prioritizing self-production (RS6, 17). Food produced is often consumed within the household, with surplus sold in the market. For instance, rice and vegetables are used both for self-consumption and market sale (RM1, 14). Notably, farmers mostly sell shrimp without keeping any for personal

consumption (RS10, 12).

"80% of the food is self-production, and other protein sources such as pork, beef are from the market." (RM6)

"So we keep some to eat, we don't want to buy other food." (RS3)

"We mostly buy food from the market and save some rice for ourselves to eat. I don't want to eat shrimp, so I don't keep shrimp and sell them all." (RS10)

"I need money to grow children because they eat a lot. And I would like to grow more rice because I want sell more to make more money (RS6)"

These results indicate that food supply in the local community is ensured through diverse methods, highlighting varying balances between self-sufficiency and market dependency among households. While individual procurement strategies exist, vulnerabilities due to the transition to hybrid farming were not observed. Instead, salinity damage poses a significant impact on self-sufficiency, preventing the cultivation of vegetables and fruits during dry seasons. Furthermore, while sufficient quantities of food may be secured through self-production, ensuring adequate nutritional balance remains uncertain.

Securing Educational Expenses

For many households, educational expenses constitute a significant portion of their financial burden and are a primary expenditure item. This study focused its analysis primarily on the "Education fee" code. Numerous reports indicate that the educational expenses for grandchildren or children often dominate a substantial part of household budgets (RM3, 7, RS1, 24, 26, 27, 28). As household economic conditions improve due to agricultural transition, there is a tendency for expenditures on educational fees to increase. For example, higher incomes enable greater allocation of funds towards educational expenses (RS28). On the other hand, households facing economic difficulties may find it challenging to secure educational expenses (RS16). For instance, some must cut other living expenses to meet educational costs, and in cases where payment becomes unfeasible, interruptions in academic pursuits are observed (RS16).

"My daughter, currently in grade 9 (15 years old), had to stop attending school due to financial constraints. I plan to resume her studies next year. (RS16)"

Respondent RS16, 57 years old single mother, who cares for her 17-year-old daughter alone following her husband's recent passing. Her daughter, currently in 10th grade (first year of high school), had to take a hiatus from school this year due to last year's poor shrimp harvest, attending high school for only a week before stopping. Her school operates on a two-semester system, requiring 2-3 million VND per semester. She plans to resume attending school next year. Their region converted to hybrid farming seven years ago in accordance with government policy. Her agricultural land area is 1.6 hectares. Although income improved post-agricultural transition, shrimp yields remain unstable.

"Income has increased compared to before, but shrimp yields are unstable. I believe that my farming techniques or methods are wrong. (RS16)"

Additionally, as children grow up and complete their education, the burden of educational expenses decreases, although it remains a expenditure item until then (RM7, RS26).

"The primary expenditures include daily living costs and tuition fees for children. However, now that the children have grown up, only two people live together. (RM7)"

"I previously focused on the education fees for my grandchildren, but we have now grown up. (RS26)"

These findings underscore the importance of educational expenses as a critical economic factor for households, where the burden varies with household economic conditions and children's developmental stages. Expenditure on education tends to be prioritized within family budgets as an investment aimed at future improvement in living standards. However, it is noted that despite the profitability reported by moderately capitalized medium-scale farmers post-agricultural transition, those whose livelihoods did not change significantly before and after transition indicated that their expenditure habits remained unchanged. Thus, the widening economic disparities resulting from agricultural transition also contribute to the growing educational gap. Furthermore, it is crucial to note that an increase in income post-hybrid farming transition does not necessarily resolve the vulnerability and poverty issues faced by farmers. The instability in shrimp yields can also impact children's educational expenses. Additionally, social safety nets may be necessary to support remaining family members when a household member passes away and affects household finances.

Change in Agricultural Investment Amounts

This item was analyzed based on the "Hybrid farming cost" code. Hybrid farming (e.g., combining shrimp with other crops) requires higher investments but reportedly yields higher incomes (RS21). Moreover, the transition from double-crop to single-crop rice farming has significantly reduced overall agricultural costs due to reduced fertilizer usage (RS24, 26).

"Hybrid farming requires more investment in farming, but the income is much higher. (RS21)"

"The farming costs decreased because of reduced fertilizer usage. (RS24)"

Primary expenses in shrimp farming include initial investments for field modifications and the purchase of shrimp larvae and feed (RS21, 24). Particularly, shrimp larvae constitute the most expensive investment after starting shrimp farming. Given the risks of failure due to lack of technical knowledge or improper farming practices, inadequate farming techniques may lead to anticipated income not being realized (RS16).

"We spend the most on food and various items. We also allocate considerable funds to purchase shrimp larvae. (RS21)"

Investment in shrimp farming varies significantly due to diverse factors compared to other agricultural activities. Operational costs predominantly involve purchasing shrimp larvae and feed, necessitating substantial investments. Given the significant impact of technical knowledge and expertise on profitability, appropriate technical support and education are crucial.

4.4.3 Future Perspectives

This section was analyzed based on the "Future plan" code family, including codes such as "Dystopia image," "Don't want to change," "Investment for farming," and "No idea."

Dystopia

Farmers who have struggled to adapt to shrimp farming are increasingly losing hope in agriculture's potential. Despite transitioning to hybrid agriculture, vulnerabilities persist among farmers, particularly affecting those on small-scale operations. For instance, some farmers foresee the impossibility of harvesting rice on the same land in ten years (RM5). Factors contributing to this perception include land degradation and climate change. Such uncertainties about the future significantly amplify anxiety among farmers.

"I think that after 10 years later, it is impossible to harvest rice in the same farmland. The disadvantage is that income doesn't come every day like shrimp. (RM5)"

Moreover, among the 35 households interviewed, two mentioned the possibility of working as migrant laborers in urban areas if agriculture becomes unsustainable in the future. However, transitioning to migrant labor does not necessarily lead to an improved living environment compared to their previous life as farmers. The harshness of post-migration life for small-scale farmers has already been documented in several studies (Gorman, 2022; Thomas, 2023). Over the past few decades, the transition from rice cultivation to shrimp farming due to salt damage has already driven many small-scale farmers to abandon agriculture and migrate to urban areas. However, considering the expanding areas affected by salt damage and the effects of climate change such as rising temperatures and changes in the duration of dry and rainy seasons, it's essential to recognize that small-scale farmers are exposed to even greater vulnerabilities.

"In the future I would like to borrow the land so that they can get enough amount of income from farming. If it is not enough, I can go to the city to work at a factory. (RS5)"

Future Prospects for Agricultural Investment

Centered around farmers who have successfully integrated into hybrid agriculture, many farmers are contemplating expanding their land holdings in the future, planning to lease or purchase additional land (RS11, 23, 24, 28). Furthermore, there is a strong emphasis on the importance of technical support, with significant interest in learning about organic farming and new agricultural technologies (RS2, 14). Simultaneously, there are instances where economic reasons prompt hesitation towards land expansion (RS7, 9).

"Some farmers plan to expand their farmland size by buying land from others in the

future (RS23)."

"I am interested in support like techniques (RS14)."

"I want to expand my farming land but I am hesitant due to financial reasons (RS7)."

Certain farmers aspire to achieve self-sufficiency even without government support, yet they hold high expectations for infrastructure development such as roads (RS19). To increase shrimp exports and sell them at higher prices, a larger-scale transportation system and road construction are deemed necessary (RS1). Farmers acknowledge the lengthy timeframe required for road improvements and are aware of the current limitations in infrastructure development.

"If the government plans other initiatives to increase income, we'll follow, but we don't require any support from the government. we simply hope for better roads. However, it's challenging because it takes 10 or 20 years to change the roads (RS19)."

"We need a larger-scale transportation system for shrimp. We also need road construction to export more shrimp at once and sell them at a higher price (RS1)."

There is a growing interest in organic farming, with preparations underway to obtain certification. However, the high costs associated with certification pose a significant burden on investment (RS2, 21, 3). While organic farming promises higher returns, the initial investment required for certification remains a major obstacle.

"I am interested in organic farming, but the cost of certification is high (RS2)."

Farmers, particularly those who have successfully transitioned into hybrid agriculture, recognize the need for various investments such as infrastructure development, land expansion, technical support, and government assistance to enhance competitiveness in the shrimp and other agricultural markets. The transition to organic farming and the improvement of transportation infrastructure are highlighted as critical challenges. Moreover, there is a noticeable trend towards expanding business operations beyond agriculture to diversify revenue streams.

Conversely, among farmers who have not significantly increased their income through hybrid agriculture, there was no mention of self-funding agricultural investments (RS4, 8, 12, 16, 18, 19).

Unwillingness to change.

Many farmers engaged in hybrid agriculture express a desire to maintain their current rice and shrimp production systems in the future (RS17, 19, 15). This reflects their preference to avoid significant changes that involve risks, given the current production systems that provide sufficient income.

"In the future, we will continue with rice-shrimp farming. If the government shares a better way, we will follow it (RS15)."

Additionally, despite the onset of salinity damage during the dry season for single-crop

rice farmers, many expressed anxieties about the risks associated with starting shrimp farming and therefore resist agricultural transition (RM1, 2, 3, 7).

"I don't want to change anything and just want to continue doing everything the same (RM2)."

Several farmers lack specific plans for the future (RM1, 26, 7), suggesting either contentment with the status quo or difficulty in planning due to high uncertainty about the future. Furthermore, a female farmer in RS8 mentioned uncertainty about future prospects, stating, "My husband decides, so I don't know."

Overall, farmers exhibit a strong inclination towards maintaining the status quo and resistance to change. The absence of concrete future plans among some farmers suggests a reliance on family roles and decision-making processes. Such tendencies towards maintaining the current situation and lack of planning likely stem from a desire for stability and anxiety about future uncertainties. In this regard, Mr. Ino's perspective aligns with the view that Vietnam being a communist country, particularly in South Vietnam, tends to limit individual decision-making. Mr. Ino further points out, "Many of them desire a stable life but dislike being instructed by others. They want to choose from options themselves, but the options are limited, often resulting in failure."

5. Discussion

This chapter integrates the findings from the result with insights derived from the literature review to address the research questions of this thesis. Additionally, it discusses the research limitations and suggests future research.

5.1 Vulnerabilities Faced by Farmers

The first sub-question of this study was "What kinds of vulnerabilities have smallholder farmers been facing before and after the agricultural transition?" Some studies suggest a discrepancy between vulnerabilities defined from a political-ecological perspective and those contextualized within the climate change discourse, contributing to the ramifications of climate adaptation policies (Camargo, 2022; Paprocki, 2018). The Vietnamese government-led transition from traditional rice monoculture to hybrid agriculture is positioned as part of climate change adaptation means. However, hybrid agriculture primarily addresses salinity issues in rice farming, representing just one of the various vulnerabilities that farmers in the Mekong Delta actually face. Resolution 120 emphasizes transforming challenges into opportunities to foster sustainable and prosperous development (The Socialist Republic of Vietnam, 2017). Yet, agricultural transition alone mitigates vulnerability only to salinity, leaving farmers susceptible to other external factors that continue to jeopardize their livelihoods. Therefore, this discussion addresses the impacts revealed in this thesis on farmers, focusing on natural environmental changes affecting agriculture, economic vulnerabilities related to land, and social vulnerabilities associated with cooperative systems.

Natural Environmental Changes and Impacts on Agriculture

Increasing temperatures are linked to water shortages and droughts, adversely affecting crop quality and yield. The interplay between heat and water scarcity compounds the agricultural production challenges. Particularly when overlapped with saline water issues, the impact on agriculture intensifies further. A critical concern is the lack of coping mechanisms for rice monoculture farmers during dry season when salinization happens. For farmers whose sole income source is agriculture, salinization during dry seasons significantly undermines their crop yields.

Furthermore, shrimp aquaculture is vulnerable to rising temperatures and sudden rainfall. Excessive heat increases water temperatures, leading to shrimp mortality, while rapid temperature changes shock the shrimp, further elevating mortality rates. Effective management of water temperature through continuous water replenishment in aquaculture ponds is essential. However, ensuring that all farmers possess the necessary knowledge for such delicate temperature management is crucial. Therefore, establishing information systems and training programs accessible to all farmers regarding water management is imperative.

Moreover, climate change profoundly impacts farmers' health and agricultural productivity. Rising temperatures increase physical fatigue among farmers, contributing to increased cases of headaches and physical discomfort. These health issues are particularly pronounced during the dry season, where prolonged exposure to heat

deteriorates health and reduces labor productivity, significantly affecting farmers' daily life styles.

Land and Economic Vulnerability

The adoption readiness of new agricultural technologies is significantly influenced by the scale of farmland and other available resources. Particularly, farmers with large-scale land holdings tend to embrace the introduction of new technologies and hybrid agriculture, whereas those with smaller farmland tend to approach technology adoption more cautiously. Moreover, in the Mekong Delta, it is evident that land transactions through sale or lease are common, intensifying competition for land acquisition. While financially capable farmers expand their cultivation areas, others constrained by economic limitations struggle to enlarge their land holdings. The dynamics of the land market impact farmers' livelihood strategies. Additionally, this research result reveals that households benefiting economically from shrimp aquaculture show eagerness to expand their land, while those financially stressed due to small land holdings face challenges not only from narrow land area but also from various socio-economic aspects, hindering their prospects for agricultural development. These findings align with Thomas(2023)'s assertion that land-use change projects favor landowners who can afford to engage in production systems shifting from rice to shrimp (Thomas, 2023).

On the other hand, livelihoods of farmers are influenced by factors beyond land size, such as non-farm income, community relationships, number of school-aged children, health status of farmers, and food security. These multifaceted factors directly impact income fluctuations post-agricultural transition, indicating the limitations of using a singular criterion for evaluation. For instance, land size alone does not define post-transition life satisfaction. Satisfaction varies among farmers owning less than one hectare compared to those owning more, with some expressing concerns about their future. Hence, it is clear that numerous factors beyond land size significantly influence farmers' livelihoods. Therefore, small-scale farmers and impoverished households are not synonymous. It is crucial to delineate how to determine the recipients when devising strategies for impoverished households in the future. Considering factors such as land size, regular cash expenditures such as food, education, and healthcare costs, and non-agricultural income sources, due to their complex interplay, a singular definition of "poverty" is impractical. All these conditions must be taken into account.

Furthermore, geographical conditions such as differences in land elevation and challenges in water management may influence the suitability of land for hybrid agriculture. It may be necessary to investigate whether agricultural land targeted for agricultural transition is suitable for shrimp farming. If farmers, most knowledgeable about a particular field, argue that it is unsuitable for shrimp farming, it might be prudent to conduct investigations into the feasibility of hybrid agriculture before making decisions via majority vote. Disregarding farmers' claims and proceeding with agricultural transition in a top-down manner may lead to ramifications.

Cooperatives and Social Vulnerability

Membership in social networks also affects vulnerability among farmers. Disparities are observed in access to information about hybrid agriculture across households and villages. For instance, farmers who moved from other villages to rent land may not engage in information exchange within their community where the land is located. Such farmers may face exclusion from local information networks and be disadvantaged in agricultural transition and acquiring new technologies. Conversely, farmers who exchange agricultural information through community networks or gain practical knowledge from agricultural experts through government-related work can effectively address agricultural challenges.

Moreover, the presence of cooperatives influences vulnerability. The multifaceted support functions of cooperatives contribute to enhancing farmers' technological capabilities and economic stability. Comprehensive support including training, disease management, provision of materials, and medical services are crucial elements supporting sustainable development among farmers. Furthermore, the existence of cooperatives enhances bargaining power in price negotiations. Particularly in situations where shrimp market prices are higher and more volatile than rice, improved bargaining power through cooperatives contributes to economic stability among farmers.

Thus, cooperatives may potentially mitigate vulnerability among small-scale farmers through mutual assistance relationships. However, cooperatives remain relatively uncommon in Vietnam's rural areas and have not been widely adopted. Establishing cooperatives is challenging in villages where a minimum production threshold is required, making it difficult for small-scale farmers to aggregate. Therefore, while cooperatives have the potential to serve as a social safety net for vulnerable farmers, their establishment and sustainability face various economic constraints. Further research is necessary to explore the mechanisms and establishment of cooperatives as a means to rescue vulnerable farmers.

In addition, joining agricultural cooperatives may bring drawbacks for farmers. While there is potential for producers to ensure a certain level of economic security, concentration of capital and power in the agricultural and food chain may lead to farmers who own and manage land becoming similar to wage laborers (Robbins, 2019). Integration into such capitalist frameworks may result in farmers becoming dependent on agricultural and food chains, potentially compromising their autonomy over land use decisions in the long term.

However, interviews conducted for this study with farmers belonging to agricultural cooperatives (RS1, 2, 3) did not reveal negative discourse regarding engagements with large corporations. Instead, they expressed satisfaction with the stability of income and the ability to negotiate prices. Nevertheless, due to the limited sample size of farmers belonging to cooperatives who were interviewed, this study's research limitations prevent definitive conclusions regarding whether agricultural cooperatives represent the most effective solution for addressing economic and social vulnerabilities faced by farmers.

Therefore, while cooperatives' mechanisms can potentially contribute to mitigating socio-economic vulnerabilities among vulnerable farmers as seen from a social safety net

perspective, it is evident that their establishment and maintenance face various economic constraints. Thus, further investigation is necessary concerning the mechanisms and establishment of cooperatives as a means to address the vulnerabilities faced by farmers in vulnerable positions.

5.2 The neoliberal paradigm exposed by agricultural transition

Next, the second sub-question is discussed, "To what extent did farmers conduct the agricultural transition of their own will, and to what extent were their decisions influenced by external forces?" This thesis reveals that agricultural transition in Vietnam is largely conducted in a top-down manner driven by government initiatives. Field survey results indicate that farmers' autonomy is significantly constrained by external forces, particularly governmental policies. Interviews suggest that farmers are influenced by both hard and soft climate adaptation policies imposed by the government, impacting their decisions regarding agricultural transition. Thus, the decision-making process of agricultural transition is influenced not only by farmers' own will but also by external policies, corroborating findings from Lan (2013) and Tran et al. (2022). Drawing on insights from this study and other literature, this thesis claims that the political structure of Vietnam's government adaptation strategies is based on erroneous premises and neoliberal approaches, which do not necessarily align with farmers' intentions.

Reflections on agricultural transition under capitalist premise

When agricultural policies promote hybrid farming of shrimp and rice, it becomes evident that those policies favor farmers who possess larger land holdings. Continued implementation of these policies without support for the impoverished will perpetuate inequality and poverty. In capitalist societies, the generation of winners and losers is a fundamental premise, demonstrating that agricultural transition does not inherently address poverty among vulnerable populations. Climate change measures positioned as salinity control strategies are misunderstood as economic measures that benefit the impoverished. Consequently, this confusion exacerbates socioeconomic disparities. Specifically, while some farmers, primarily medium-scale ones, successfully adapt to salinity through shrimp farming, others constrained by land size and economic limitations find themselves in precarious situations, unable to profit from shrimp farming, thus reinforcing their vulnerability.

Transition from single-crop rice farming to hybrid agriculture is categorized under Resolution 120 as both a climate adaptation and economic measure. However, the primary objective of agricultural transition remains salinity control. The theoretical assertion that agricultural transition to shrimp farming ensures higher incomes and resolves poverty is not substantiated in reality. In capitalist societies, economic growth often benefits privileged classes, marginalizing many households and communities. In the Mekong Delta, land accumulation by corporations and medium to large-scale farmers contributes to widening wealth gaps. Furthermore, fluctuating agricultural market prices destabilize incomes, posing significant risks for small-scale farmers. Difficult market access and dependence on intermediaries exacerbate income disparities and expenditure breakdowns. Globalization of this market has brought wealth to some Vietnamese, yet it is crucial not

to overlook those trapped in poverty spirals due to globalization and climate change impacts.

Fairness in the agricultural transition process

This thesis highlights issues of fairness in the agricultural transition process. Firstly, it suggests that the principle of majority rule may not always be a fair decision-making method. In cases where large-scale farmers are surrounded by small-scale farmers content with current practices, the majority opinion of these small-scale farmers may hinder transition to shrimp farming even if desired. Conversely, small-scale farmers in areas dominated by medium or large-scale farms may be compelled to transition to shrimp farming against their preferences due to majority decisions. These situations imply that decisions based on majority rule may not be equitable for all farmers and could potentially lead to conflicts among farmers who disagree with the majority.

Furthermore, it becomes evident that several farmers are maneuvered by government policies, illustrating how challenging it is for farmers to act based on their own voluntary will. Even if farmers are deemed capable of adapting to climate change, their adaptive capacity is constrained by those political structures. This suggests an environment where farmers may not have the autonomy to make decisions and take actions independently.

Additionally, through interviews with farmers regarding sluice construction, it is apparent that some regions were forced into rice-shrimp hybrid agriculture due to sluice construction. On the other hand, farmers living upstream near sluices oppose hybrid agriculture, citing increased flooding due to sluice construction. This underscores the significant impact of government hard policies on farmers' agricultural activities, necessitating attention to how these policies affect different communities and lifestyles. Moreover, the potential ecological impacts of blocking water flow for a certain period must be considered, particularly given its substantial implications for those reliant on fisheries for their livelihoods.

Overall, it has been revealed that reflecting individual opinions of farmers, regardless of their economic scale or land size, in decision-making regarding land use is challenging. It is essential to remember that the government's perceived best methods may not necessarily be the best for all farmers. Furthermore, achieving the goals of Resolution 120, where Mekong Delta farmers are expected to transform into skilled agricultural laborers (Bayrak et al., 2022), appears nearly impossible due to constraints imposed by political and social structures on farmers' decisions and actions.

Bias in research funding

Due to the government's prioritization of innovative agricultural technologies, research funding is predominantly allocated to this area. Consequently, experts have pointed out insufficient research on social issues related to water pollution and agriculture. Research funding provided by donors or governments tends to favor research aligned with their intentions, reflecting the top-down decision-making structure of academic societies and making it challenging to condct bottom-up research demanded at the grassroots level.

Thus, as long as funders support neoliberal regimes, research funding will prioritize fields necessary for maintaining or promoting neoliberal structures. However, this tendency risks ignoring various social issues arising under neoliberal regimes and failing to address them adequately.

Interviews with farmers have highlighted the need for further research on pollution from aquaculture factories and the ecological impacts of sluice construction. Yet, insufficient funding impedes these studies, preventing research that responds to actual needs on the ground. Besides innovative agricultural technology research, studies are also needed on the societal problems faced by adopters of these technologies, environmental impacts of technology adoption, and unexpected environmental pollution post-salinity management. Thus, skewed research funding may delay responses to social and environmental issues, highlighting the crucial role of researchers in political ecology to amplify the voices of vulnerable individuals weakened by power and authority.

Understanding the existence of issues like pollution from aquaculture requires detailed investigations to consider appropriate responses. Therefore, building a donor system reflecting local needs is crucial to ensure research advancing beyond innovative agricultural technology, including reforms in funding systems to enable researchers to conduct studies in fields other than innovative agricultural technology.

5.3 Inequalities and Vulnerabilities Introduced by Transition

Next, the third sub-question is discussed: "To what extent did the agricultural transition mitigate existing vulnerabilities, exacerbate them, or introduce new vulnerabilities?"

Expanding Economic Disparities

Field surveys reveal that irrespective of farm size, several farmers initially resisted shrimp farming, an unfamiliar practice, thereby opposing agricultural transition. However, ultimately, it was observed that agricultural transition contributed to mitigating natural conditions and economic vulnerabilities stemming from climate change for medium-scale farmers owning approximately 1 hectare or more of land. Increased income often goes towards children's education expenses, aligning adaptation policies with the needs of education-focused parent generations of farmers, thereby contributing to livelihood improvement. Moreover, reduced labor burden due to less outdoor work time compared to rice cultivation was mentioned by many farmers, a common benefit regardless of family household composition or land size.

Due to pre-existing economic capital differences, agricultural transition has led to widening economic disparities. This is because most of medium-scale farmers tend to directly benefit from starting shrimp farming, leading to income growth. However, the agricultural transition process involving majority decision-making has involved small-scale farmers initially resistant to starting hybrid agriculture. Consequently, due to various vulnerabilities such as land size, transitioning to hybrid agriculture did not promise benefits for farmers who opposed agricultural transition, resulting in susceptibility to fluctuations in shrimp market prices rather than economic gains. Negotiations with retailers tend to vary by region or individual discretion. For small-scale farmers,

opportunities to learn not only technical knowledge for shrimp farming but also the market dynamics and negotiation methods for shrimp prices are crucial.

Additionally, households heavily reliant on agriculture as their sole or primary income source face vulnerabilities where adverse weather or market price fluctuations directly impact their livelihoods. Cash income is influenced by fluctuating harvest yields due to extreme weather and market price changes, directly impacting cash expenditures such as education and healthcare costs. While parent generations are highly interested in education, economically constrained farmers struggle to finance educational expenses. Moreover, for farmers facing health issues, regular treatment costs pose a burden. Diversification of income sources in rural areas highlights the limitations of agriculture-dependent households and underscores the importance of strategies to complement agricultural income. These strategies significantly hinge on household human capital factors such as the ability to work and the health of laborers. Small-scale farming households in mother-child or nuclear family setups often reliant entirely on agricultural income frequently lack savings. These households require economic support to ensure compulsory education for their children.

Differences in capital capacity for agricultural land expansion further exacerbate disparities. Households without the economic power to lease or purchase land for rice cultivation alone find economic flexibility for land expansion due to high incomes from shrimp farming. Therefore, in at least Hung Yen, medium-scale farmers transitioning to shrimp-rice hybrid agriculture may potentially consolidate land in the future. However, small-scale farmers experiencing no significant income change may not foresee possibilities for future agricultural land expansion. Thus, a discrepancy in agricultural livelihood prospects arises between farmers who increased income and those who did not.

Food Security

Concerning food security, households experiencing increased income post-agricultural transition noted increased food expenses, whereas some households observed no change in expenditures. Previous studies have indicated that rice farmers transitioning to shrimp farming tend to cultivate export crops, leading to the loss of self-sufficiency lifestyles (Betcherman et al., 2021; Lan, 2011). However, in Hung Yen, where rice-shrimp hybrid agriculture is practiced, all households self-consume staple rice. Nevertheless, saltwater intrusion has rendered vegetable and fruit cultivation challenging. Regions where salinity persists post-sluice construction face difficulty cultivating vegetables and fruits during dry season, whereas regions benefiting from reduced salinity post-sluice construction can engage in year-round rice and vegetable cultivation. Resolution 120 advocates coexistence with floods, brackish water, and saltwater as a means to adapt livelihood styles to climate change, forcing farmers transitioning to hybrid agriculture to rely on crops grown in brackish water. This implies an inability to self-sustain vegetables and fruits that cannot grow in brackish water. Theoretically, income from shrimp farming during dry periods exceeds income from rice farming, suggesting that farmers can purchase crops from the market despite the inability to self-sustain crops in brackish water. Therefore, coexistence with brackish water signifies a transition from self-sufficient

lifestyles to dependency on export-oriented agriculture within a monetary economy.

Environmental Pollution and Vicious Cycle

Farmers are exposed to various environmental vulnerabilities such as salinity, rising temperatures, rainfall patterns, and water pollution from household and industrial wastewater. Despite already experiencing the impact of contaminated water on crop yields, comprehensive infrastructure improvements for water and sanitation have yet to be implemented. Issues regarding water quality remain unresolved as a social problem both during monoculture rice farming and after transitioning to hybrid agriculture. Particularly during dry periods when river and agricultural canal flows decrease, the influence of polluted water is more pronounced compared to the rainy season. Farmers are observed to depend on pesticides and chemicals as measures to address these challenges. Specifically within shrimp aquaculture, water quality degradation is implicated as a contributing factor to decreased yields, suggesting that discharge from rivers may be harmful to shrimp (Iber & Kasan, 2021). Concurrently, a feedback loop exists wherein shrimp aquaculture itself contributes to water pollution (Iber & Kasan, 2021) , prompting several studies to question the long-term sustainability of current shrimp farming practices (Ngoc, 2023; Nguyen, 2011).

Income improvements for affected farmers are limited unless water quality issues are addressed before and after agricultural transitions. Mitigating measures such as sewerage system upgrades and industrial wastewater discharge regulations to prevent household and industrial wastewater from directly flowing into rivers and canals are essential. Governments and international organizations should invest subsidies to protect public goods such as water resources. Furthermore, literature on the sustainability of hybrid agriculture in the Mekong Delta still remains limited. Specifically, scientific investigations into the impact of effluent from aquaculture facilities in Hung Yen on crops are insufficient, and the extent of its effects remains unclear. Therefore, detailed studies are still required. Reassessing approaches to natural resources beyond short-term economic benefits is also essential.

Furthermore, the construction and operation of sluice gates significantly impact the sustainability and productivity of agriculture. Residents near sluice gates have mentioned changes in water environments following their construction. This parallels previous cases where access to water has been altered due to embankments and sluice gates (Hang et al., 2023; Toan, 2014). Transparent communication and neighborhood engagement are necessary to determine the timing and operation of sluice gates. Given the varied impacts of sluice gate construction on farmers, further investigation is needed.

Vulnerabilities of Becoming Migrant Laborers

Farmers continue to face the vulnerabilities mentioned above even after transitioning to hybrid agriculture. These vulnerabilities are particularly pronounced among small-scale farmers. Among the 35 households interviewed, two households mentioned the possibility of working as migrant laborers in urban areas if agriculture becomes unsustainable in the future. The structural migration of farmers to urban areas as wage

laborers due to land loss is a lingering consequence of accumulated land ownership by wealthy farmers (Gorman, 2022). The shift to shrimp aquaculture requires less labor compared to rice farming, thereby reducing employment opportunities for landless households (Thomas, 2023).

However, transitioning to migrant labor does not necessarily improve living conditions compared to their previous agricultural lifestyles. Conducting interviews with former farmers now working as wage laborers in urban areas was unfeasible due to resource constraints. Nonetheless, the harsh living conditions of small-scale farmer households post-migration to wage labor have been documented in multiple studies (Gorman, 2022; Thomas, 2023). It is challenging for household members lacking educational qualifications to secure favorable conditions in non-agricultural labor. Non-agricultural labor entails inherent risks such as job instability without notice, absence of social insurance, long and irregular working hours, and lack of medical benefits (Yamazaki & Kamagawa, 2015). Thus, farmers who abandoned agriculture due to worsened vulnerabilities from climate change and opted for wage labor may face new socio-economic vulnerabilities in their new environments. There exists a negative cycle that needs to be addressed regarding climate-change exacerbated vulnerabilities of farmers who turned to wage labor to mitigate those vulnerabilities, necessitating a discussion on where this cycle must be broken. Social and economic support for former small-scale farmers or impoverished farming families considering becoming migrant laborers is crucial. Simultaneously, establishing employment structures and social insurance systems for migrant laborers is equally important.

5.4 Policy Recommendations

Based on the findings of this study, there is room for improvement in Vietnam's climate change policies and the approach of international donor agencies.

1. Reassessment of Neoliberal Climate Change Policies

Neoliberal economic policies premised on creating winners and losers do not directly address poverty alleviation issues. Instead, they often exacerbate disparities. Therefore, it is crucial to avoid conflating economic policies, climate change strategies, and poverty alleviation efforts. Understanding vulnerabilities faced by hybrid farmers as a result of agricultural transitions is essential, necessitating exploration of methods to mitigate these vulnerabilities.

Moreover, thorough implementation of water quality management as a public good is important. Measures to address environmental issues such as salinity and water pollution should be strengthened. Specifically, strict enforcement of environmental protection laws and promoting environmentally conscientious activities among farmers and enterprises through awareness campaigns are recommended. Furthermore, introducing support measures and technological developments for environmental improvement will facilitate sustainable coexistence of agriculture and environmental preservation.

2. Diversification of Research Funding

Diversifying the allocation of research funds to include studies not only on innovative agricultural technologies but also on social and environmental issues related to agriculture is essential. This will advance research on societal and environmental challenges associated with agriculture, such as water pollution and salinity, ultimately contributing to the development of sustainable agriculture. Reforming the donor system to create an environment where bottom-up research proposals are more readily adopted is necessary.

3. Improvement of Information Access

It is important to enhance information infrastructure so that farmers can access the latest agricultural technologies and market information. This includes expanding internet connectivity in rural areas and developing and disseminating information services using smartphones. It is also critical to provide online consultation services by agricultural experts, ensuring that farmers can receive technical advice whenever needed.

While there is a wealth of natural science-based case studies on agriculture in the Mekong Delta, case studies on issues such as environmental pollution and support for the impoverished are still limited. Local farmers possess valuable experiences and knowledge regarding changes in the natural environment. Future researchers should share insights from the field with the academic community to bridge this gap in scholarly knowledge. This will contribute to encouraging overseas financial stakeholders to donate funds to the most critical areas.

5.5 Constraints and Limitations

Firstly, due to only obtaining opinions on cooperatives from three out of 35 respondents, sufficient data on cooperatives was not obtained in this study. This is because the thesis did not focus on cooperatives as its main theme. Further research is necessary to investigate the impact of cooperatives on mitigating farmer vulnerabilities.

Additionally, Lan (2013) pointed out vulnerabilities among Khmer farmers due to language barriers preventing them from accessing government support systems. However, this study did not include Khmer farmers as subjects, thus data on Khmer farmers are not included. Vulnerabilities due to language barriers among Khmer people have been mentioned in multiple literature sources, underscoring the need for further investigation into this issue in future studies.

Furthermore, rigorous investigation into the long-term environmental impacts of sluice gate construction is essential. Particularly concerning households dependent on fisheries, the impact of water flow obstruction on ecosystems is a significant concern. Although this study did not investigate fishermen as primary income earners, detailed research on the ecological impacts of sluice gates is essential moving forward.

Lastly, attention should be paid to the fact that the living environment after transitioning to migrant labor may not necessarily improve compared to when individuals were engaged in agriculture. Conducting interviews with former farmers now working as wage laborers in urban areas was impractical due to resource limitations. Comprehensive surveys comparing the living environments and vulnerabilities before and after becoming

migrant laborers are necessary for future research.

5.6 Future Research

This study investigated the vulnerabilities among farmers caused by Vietnam's government-led agricultural transition. Monitoring surveys are critically important to assess whether ramifications are occurring due to the top-down implementation of hard and soft policies against climate change. This thesis has only addressed the unexpected adverse effects resulting from one climate change policy—agricultural transition. Therefore, analysis of other hard and soft policies is necessary.

For instance, the construction of sluice gates presents a significant challenge regarding the ecological impacts of temporarily blocking water flow. Given the potential serious implications for communities dependent on fisheries, comprehensive ecological studies are needed to elucidate these impacts. Specifically, research is required on the effects of wastewater discharge from aquaculture facilities, the ecological repercussions of sluice gate construction, and the impacts of these activities on agriculture and fisheries.

Furthermore, comprehensive studies are needed on a wide range of topics, including not only innovative agricultural technologies but also the societal issues faced by adopting farmers, environmental impacts of technology adoption, and unforeseen environmental contamination post-salinity mitigation. Literature on the sustainability of hybrid agriculture in the Mekong Delta remains limited, particularly scientific investigations into the effects of wastewater from aquaculture facilities in Hung Yen . Considering varying impacts of sluice gate construction on different farmers, further research is necessary to evaluate regional-specific conditions and impacts. Therefore, detailed investigations into these issues are still required.

Moreover, while the cooperative mechanism has been suggested to mitigate socio-economic vulnerabilities among vulnerable farmers, it has become evident that various economic constraints exist in establishing and maintaining cooperatives. Hence, further detailed research is necessary on the mechanism and establishment methods of cooperatives. In particular, research is needed on how cooperatives can contribute to sustainable livelihoods for farmers, as well as studies on the factors contributing to their success and barriers.

Additionally, although some news media and literature have highlighted the social issues faced by former Mekong Delta farmers who have moved to urban areas as migrant laborers, scholarly references on this topic are still limited. Research comparing the living conditions and vulnerabilities of former farmers now working as wage laborers in urban areas versus those who continue in agriculture is essential. Comprehensive surveys are needed on their living conditions, working conditions, income stability, and the availability of social support.

6. Conclusion

The Mekong Delta is a key agricultural region in Vietnam, contributing significantly to rice production and exports. However, due to issues like salinity, there has been a shift towards rice-shrimp farming. While this transition has led to increased income and improved adaptive capacity to climate change among farmers, it poses challenges, particularly for small-scale farmers due to the initial investment required. Furthermore, not all farmers benefit equally from government policies promoting hybrid agriculture, disadvantaging particularly impoverished and small-scale farmers. This thesis aimed to analyzes the agricultural transition and farmers' vulnerabilities from a political ecology perspective, aiming to elucidate the structural socio-economic and political vulnerabilities faced by farmers. Specifically, it sought to clarify changes in vulnerability due to agricultural transition, external influences on farmers' decision-making, and the impact of agricultural transition on farmers' livelihoods and agricultural practices. Thus, the following research question was formulated:

“From a political ecology perspective, to what extent did the transition from rice monoculture to rice-shrimp farming lead to new climate vulnerabilities among smallholder farmers in Kien Giang, Vietnam?”

To answer this research question, prior cases were first examined, focusing on the mismatch between vulnerabilities defined from a political ecology perspective and those arising from the context of climate change. This scrutiny highlighted a negative cycle where misguided neoliberal adaptation measures, premised on erroneous premise, institutionalize inequalities and generate new vulnerabilities (Thomas, 2023). Through a political ecology lens, theoretical concepts regarding the vulnerabilities of farmers in the Mekong Delta and the impacts of climate adaptation strategies, as defined by the IPCC, were developed. These were integrated with T. T. Nguyen 's (2017) livelihood framework for farmers to construct the conceptual framework for this thesis.

As a result, this thesis investigation in Hung Yen, revealed a perpetuation of inequalities and the emergence of new vulnerabilities due to the mismatched vulnerabilities defined politically and in the context of climate change. Post-transition to hybrid agriculture, farmers face vulnerabilities classified under social, economic, and political structural factors as below.

1. Social Structural Vulnerability

Whether farmers belong to social networks significantly influences their vulnerability. Disparities in access to information about hybrid agriculture exist between households and villages. For instance, migrant farmers from other villages may not engage in information exchange within their new community, resulting in a disadvantage in acquiring new technologies and transitioning their agriculture practices. Furthermore, while cooperative mechanisms have the potential to mitigate farmers' socio-economic vulnerabilities, their establishment and maintenance are constrained by economic factors. Therefore, further investigation is necessary to assess the effectiveness of cooperatives as a means to support vulnerable farmers.

Moreover, following the transition to hybrid agriculture, small-scale farmers continue to face various vulnerabilities. Particularly, there is an indication that some farmers may consider migrating to urban areas as migrant laborers if agriculture becomes unsustainable in the future. Shrimp farming, unlike rice cultivation, requires less labor, thereby reducing employment opportunities for landless households. However, migrant labor in urban areas does not necessarily improve living conditions. Given the relatively low educational attainment among farmers in the Mekong Delta, accessing favorable working conditions is challenging, leading to issues such as sudden unemployment without notice, irregular working hours, lack of social insurance, and absence of sickness benefits. Thus, climate-induced agricultural challenges and the option of migrating for labor work potentially introduce new socio-economic vulnerabilities.

2. Economic Structural Vulnerability

Initially met with resistance by some farmers, the transition to shrimp aquaculture ultimately alleviated climate-induced vulnerabilities and led to increased income for medium-scale farmers. This income boost has been utilized for children's education expenses, reducing labor burdens. However, this transition has also widened economic disparities. While medium-scale farmers directly benefited from increased income through shrimp farming, small-scale farmers now face new vulnerabilities. Agricultural transition, enforced even upon small-scale farmers without promising returns, has subjected them to fluctuations in market prices. Moreover, for farmers reliant on agriculture as their primary income source, livelihoods are directly affected by crop failures or market price declines. Challenges in financing education and healthcare expenses necessitate income diversification, often relying on family human capital. Economic support is particularly crucial for single-parent households or families with health issues. Furthermore, medium-scale farmers who have expanded their land holdings due to high shrimp incomes may continue to consolidate land, whereas small-scale farmers, lacking economic flexibility, find land expansion difficult. Thus, income disparities impact the future viability of agricultural livelihoods, contributing to widening economic gaps.

Following agricultural transition, some households experienced increased food expenditures due to higher incomes, while others observed unchanged expenditure patterns. In Hung Yen, hybrid agriculture of rice and shrimp is practiced, with all households self-sufficient in staple rice production. However, saline intrusion complicates vegetable and fruit cultivation. In some areas, construction of sluice gates has mitigated saline intrusion, enabling year-round cultivation of vegetables and rice. Yet, in other regions, cultivation of vegetables and fruits remains challenging during dry seasons. Resolution 120, advocating for "living with floods, brackish water, and salt water," offers livelihood choices for climate adaptation. However, households transitioning to shrimp aquaculture are increasingly reliant on crops grown in brackish water, making self-sufficiency in vegetables and fruits impractical. Theoretically, higher incomes from shrimp than rice imply that households can sustain themselves by purchasing crops during dry seasons. Nonetheless, coexistence with brackish water signifies a shift from self-sufficiency to a monetary economy reliant on export-oriented

agriculture. Consequently, if market prices for shrimp, a major export crop, remain volatile, it may adversely affect food security.

3. Political Structural Vulnerabilities:

When agricultural policies promote hybrid farming of shrimp and rice, they favor farmers with extensive land holdings, exacerbating inequality and the ongoing insufficiency of support for the impoverished. In capitalist societies, the existence of winners and losers is assumed, rendering agricultural transition ineffective as a poverty alleviation strategy for those in vulnerable positions. The conflation of climate change and economic policies in Resolution 120 increases the risk of further marginalizing the impoverished. Particularly in the Mekong Delta, wealth accumulation concentrates among large-scale and middle-scale farmers, widening the gap between rich and poor. Fluctuations in market prices and constraints on market access pose significant economic risks, especially for small-scale farmers. Therefore, under the influence of globalization and climate change, comprehensive policies contributing to poverty reduction are necessary to support individuals trapped in the spiral of poverty. However, addressing these challenges requires a multifaceted approach, balancing social equity and sustainable economic growth without solely depending on market principles.

Furthermore, this thesis discussed issues of fairness in the agricultural transition process. Firstly, the principle of majority rule does not necessarily equate to a fair decision-making mechanism. When large-scale farmers dominate, the preferences of small-scale farmers may not be reflected, potentially resulting in decisions imposed by larger farmers, which undermines a fair decision-making process. Moreover, when governmental agricultural policies do not align with the circumstances of regions or farmers, some farmers may not benefit and find themselves in vulnerable positions. Due to the uniformity and lack of flexibility in policies, support is inadequate, particularly for small-scale farmers, thereby hindering the success of agricultural transition. Additionally, the government's hard policies (e.g., construction of sluice gates) significantly impact agricultural activities, with varying effects depending on regions and lifestyles, including implications for ecosystems and substantial impacts on regional livelihoods. Overall, it is evident that decision-making in agricultural transition restricts farmers' autonomy and fails to ensure fairness.

Furthermore, concerns have been raised about research funding primarily focusing on innovative agricultural technologies from governments and donors. This overlooks research on water pollution and social issues related to agriculture. Research topics are often determined top-down by the intentions of providers, neglecting bottom-up research demanded by local contexts. To address these issues, reforming the funding system is crucial, establishing an environment where local researchers in Vietnam can address a diverse range of challenges effectively.

The farmers also face natural vulnerabilities. Firstly, the association of high temperatures with water shortages and droughts has been emphasized, adversely affecting crop quality and yield. This results in compounded difficulties in agricultural production. Additionally, shrimp farming is noted for its vulnerability to rising temperatures and abrupt changes in

water temperature. Consequently, farmers must attend to water temperature management and environmental control in shrimp farming, although this is not considered entirely feasible for all farmers. Furthermore, climate change impacts farmers' health, particularly exacerbating health issues during the dry season.

This thesis investigated the vulnerabilities of farmers resulting from Vietnam's government-led agricultural transition. Both hard and soft policies addressing climate change are implemented top-down, potentially leading to unforeseen adverse effects. Moreover, while this thesis focuses on the unforeseen adverse effects of agricultural transition, it is essential to analyzes other hard and soft policies. Detailed research is further required to ensure that Mekong Delta farmers continue to benefit from natural resources and to develop this region sustainably as a reliable source of food supply.

Appendix A

Interview guide for experts

Introduction

"I am conducting research for my master thesis at Utrecht University in the Netherlands, with the aim of understanding how shrimp farming transition from rice monoculture impact farmers. As part of this research, I am interviewing other smallholder farmers and expats in Kien Giang. I am particularly interested in hearing about your professional perspectives and would like to ask you some questions about your views about climate change impact on farming, changes in livelihood and fairness of support for those changes. I want to assure you that everything you tell me will only be used for this research project. I might use your answers as quotes in my thesis. If you don't mind, is it ok to mention your name in my thesis? Last thing before we start, I'd like to focus on listening you, is it ok to record the interview?"

"Thus, if you agree, I will start the recording by asking for your consent. Do you agree to take part in the study considering that you have been informed about its purpose and how your personal data will be managed?"

(Start recording)

"Now we are going to delve in the interview. I will first ask you general question about climate change and agriculture. After that, I will ask you some questions about agricultural transition from rice to shrimp, fairness of the transition, and changes in farmers' livelihood. We will end the interview by summarizing the main findings together. Do you have any questions so far?"

1. Could you tell me about yourself? Such as your latest project?

   Probe: Professor, researcher, lots of experience in field

2. For farmers, what is the challenge or difficulties to introduce rice shrimp system?

   Prob. lack of knowledge and technology, space, conflict

3. How do smallholder farmers experience the transition compared to wealthy farmers?

Prob. Bigger inequality, difference in affordability, access to knowledge and technology

4. How did the market structure change before and after the transition? Are there any difficulties for farmers in joining the new shrimp market?
   Prob. lack of knowledge and experience, depending on the global market

5. How can rice farmers get financial and technical support for shrimp farming?
   Prob. organization among farmers, group capacity, collective adaptation

6. For small scale farmers, to what extent are the farming cluster and agriculture group helpful?
   Prob. organization among farmers, group capacity, collective adaptation

7. How do farmers livelihood change before and after the transition? Such as income and the amount of rice for self-consumption
   Prob. reduce in production for their own family, rice as main dish for everyone, shrimp as commodity

8. How did famers income change before and after the transition?
   Prob. stable/ unstable, increase/ decrease, long/ short term

9. What do you think is the best way to support smallholder farmers to adopt the climate change? And what kind of support do they need?
   Prob. hybrid? Appropriate land use?

10. What kind of support do farmers need from the government or international organizations?
    Prob. all kinds of support for farmers (knowledge, technology, finance…), market safety system from volatile global capitalism market

Closing

Thank you so much for your time! It was very valuable to hear your story. If you would like to receive the final thesis with the results of the interviews, I will contact you in mid-July to share the findings with you. If you have any

questions or concerns about the interview, feel free to contact me in the meantime. Thanks again for your time!

Appendix B

Interview guide for farmers

Hiroka Takahashi (Utrecht university)

Introduction

"I am conducting research for my master thesis at Utrecht University in the Netherlands, with the aim of understanding how shrimp farming transition from rice monoculture impact farmers. As part of this research, I am interviewing other smallholder farmers in Kien Giang. I am particularly interested in hearing about your personal experiences and would like to ask you some questions about your experience of climate change impact on farming, changes in livelihood and fairness of support for those changes. I want to assure you that everything you tell me will only be used for this research project and will be kept confidential. I might use your answers as quotes in my report but your name will not be used, and they will not be shared with anyone outside the course. And also, I'd like to record the interview because I'd like to focus on listening your experience. Is it ok for you?"

"Thus, if you agree, I will start the recording by asking for your consent. Do you agree to take part in the study considering that you have been informed about its purpose and how your personal data will be managed?"

(Start recording)

“Now we are going to delve in the interview. I will first ask you some background information about yourself and your experience about climate change and agriculture. After that, I will ask you some general questions about your experience in agriculture and livelihood. We will end the interview by summarizing the main findings together. Do you have any questions so far?”

Background information and opening questions

1. Could you tell me about yourself? Such as your age, education, occupation, family members and place of residence?

   Probe: live alone or with family

2. What type of agriculture do you do and what is the land size? Other crops and animals?

   Probe: rice mono culture, rice- shrimp hybrid, livestock, vegetables

3. What is the distance from your house to your farmland and how is the water availability?

   Prob. easy to take care of crops, any security issue

4. Who does the farming work?

   Probe: family member, other employees

5. What is your farming schedule in a year?

   Probe: rice between this month and this month…

6. What is the hardest work in farming? What kind of machines do you use for farming?

   Prob. costs for using machines, fuel fee, tiring job

7. What type of income source do you have other than farming?

   Probe: livestock, handcraft, remittance from other family members

8. For what do you spend your income the most?

    Probe: food, education

Climate impact and adaptation

9. How have the drought and salt water intrusion influenced the farming yield?
    Prob. Less production, 2019 and 2020 drought

10. What else do you think influence the yield of your product (rice, shrimp, crab, fish) ?
    Prob. land size, water pollution, fertilizer, salt water level

11. If the yield decreases, what kind of solution do you have to improve the production yield?
    Prob. water management

12. How long have you done farming job and when and why did you decide (or not) to shift to hybrid farming?

    Probe: experiences in both mono culture and hybrid farming

13. How much money did you spend or will you expect to spend to change your farming practice from rice mono culture to hybrid farming? Is it reasonable for you?
    Prob. any financial support from some organizations

★Only for hybrid farmers----------

14. How long did the construction work take to change the farmland?
    Prob. canal construction

15. How long did it take until the hybrid farming make profit?
    Prob. any supports from those organizations

16. How did your cultivation area size change after the agricultural shift?
    Prob. land lease, land size

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17. How often do you exchange knowledge or information about farming with your neighbours?

    Probe: when they have any issues and they don't know the solution

18. What kind of agricultural organizations do you join? Why did you decide to join them? What advantages do they have?
    Prob. any supports from those organizations, work shop

Adaptation outcomes

19. What is the process of selling your products to the market (including rice, shrimp, crab, fish or anything)?
    Prob. price negotiation, new marketing

20. What are the advantage and disadvantage for your house economy from hybrid farming (if you shift to rice-shrimp farming)?
    Prob. more income, stable production

21. How is the food expenditure influenced by the income?
    Prob. self-efficiency, purchase from market, influence of weather and market price

22. How often do you use pesticide or chemical fertilizer? How do you get those?
    Prob. interested in organic rice? Buy them by yourself?

★Only for hybrid farmers----------

23. How did the amount of pesticide and fertilizer usage change after shifting to shrimp rice model? How was it before?
    Prob. organic rice certification

24. In terms of workload, what is the biggest difference between hybrid farming and rice mono culture?
    Prob. any supports from those organizations

25. In terms of cost, what is the biggest difference between hybrid farming and rice mono culture?
    Prob. any supports from those organizations

26. In terms of production yield, what is the biggest difference between hybrid farming and rice mono culture?
    Prob. any supports from those organizations

27. How did your income and consumption changed before and after introducing rice-shrimp farming?
    Prob. more investment to education

Closing questions

28. To what extent are you happy with your livelihood and farming situation? And why?
    Prob. any other benefits from rice-shrimp farming

29. To what extent do you feel secured about water availability and other disaster in the future?
    Prob. water access for farming

30. What is your future plan for farming?
    Prob. expand the farming, livestock, other production

Closing

Thank you so much for your time! It was very valuable to hear your story. If you have any questions or concerns about the interview, feel free to contact me in the meantime. Thanks again for your time!

Appendix C

Further Questions

<Water management>

1. **What are the advantages and disadvantages of sluice gate? How is the schedule for opening and closing determined?**
   Farmers from villages distant from the dam were pleased with the reduction in salinity. However, villagers along the river where the dam is located expressed concerns about the irregular timing of opening and closing gates, affecting agriculture. They also mentioned the occurrence of floods. Are there any long-term impacts on the ecosystem?

2. **What is the current status of damage caused by seafood production factories along Cái Lớn river?**
   There are various factors contributing to the decrease in rice and shrimp production. I would like to know about studies regarding the adverse effects on crops due to wastewater discharge from seafood production factories.

<Agriculture>

1. **What are the conditions for establishing agricultural cooperatives?**
   Villages with agricultural cooperatives provided more support to farmers.
2. **What are the solutions for small-scale farmers to address salinity damage**?

3. **How much health damage do commonly used pesticides for rice cultivation cause**? Some interviewees reported a reduction in pesticide usage and improvement in health after starting shrimp farming.

4. **Considering the impacts of rising temperatures, water pollution, and salinity damage, how sustainable is rice cultivation in the future? Also, how sustainable is the use of chemical fertilizers and soil nutrients in the long term**?

<Working environment>

1. Shrimp farming demands less labour than rice production. However, there are concerns about the fate of seasonal workers who are traditionally employed by farmers during rice harvesting, as they may face job loss due to the transition to shrimp farming.
   How do these hired farmers sustain their livelihoods in such circumstances?

2. **Is the standard of living expected to improve by transitioning from agriculture to urban migration as a labourer? Is there a correlation with educational attainment**?

Appendix D: Classification sheet

Interviewer label	Other income source	Land size	Land size after transition	Shift cost(VND)	Shift cost(VND/ha)	Income change	Happy or not	Age	Gender	Agriculture type
RS1	no	>1ha	<0.2ha			up	happy	50	M	Hybrid
RS10	Yes	>1ha	>1ha	20,000,000	10,000,000	up	happy	73	M	Hybrid
RS11	Yes	>1ha	>1ha	9,000,000	3,333,333	up	happy	65	M	Hybrid
RS12	Yes	<0.2ha	<0.2ha		#DIV/0!	up	not happy	39	M	Hybrid
RS13	No	>1ha	>1ha	4,000,000	1,333,333	up	happy	59	M	Hybrid
RS14	Yes	>1ha	0.5-1ha	10,000,000	7,692,308	up	happy	61	M	Hybrid
RS15	No	>1ha	0.5-1ha	10,000,000	10,000,000	up	happy	65	MF	Hybrid
RS16	No	>1ha	<0.2ha	4,000,000	2,500,000	same	happy	57	F	Hybrid
RS17	No	>1ha	<0.2ha	100,000,000	58,823,529	up	happy	75	M	Hybrid
RS18	Yes	>1ha	0.5-1ha	30,000,000	27,272,727	same	happy	68	M	Hybrid
RS19	Yes	>1ha	>1ha	67,000,000	37,222,222	same	happy	46	M	Hybrid
RS2	no	>1ha	<0.2ha			up	happy	53	M	Hybrid
RS20	No	<0.2ha	>1ha			up	happy	51	M	Hybrid
RS21	No	>1ha		15,000,000	7,500,000	up	happy	49	M	Hybrid
RS22	Yes	>1ha	<0.2ha	8,000,000	8,000,000	up	happy	72	M	Hybrid

RS23	No	>1ha	<0.2ha	12,000,000	5,217,391	up	happy	85	M	Hybrid
RS24	Yes	>1ha	>1ha	10,000,000	3,846,154	up	happy	41	M	Hybrid
RS25	Yes	>1ha	>1ha	20,000,000	9,090,909	up	happy	39	M	Hybrid
RS26	Yes	>1ha	>1ha	15,000,000	3,000,000	up	happy	56	M	Hybrid
RS27	Yes	0.5-1ha	0.5-1ha	6,000,000	6,666,667	up	happy	45	M	Hybrid
RS28	Yes	>1ha	>1ha	37,000,000	12,333,333	up	happy	45	M	Hybrid
RS3	No	>1ha	<0.2ha			up	happy	52	M	Hybrid
RS4	no	>1ha	>1ha	10,000,000	3,333,333	up	not happy	56	M	Hybrid
RS5	Yes	>1ha	>1ha	10,000,000	5,000,000	up	happy	51	M	Hybrid
RS6	Yes	>1ha	>1ha		-	up(twice or triple)	happy	30	F	Hybrid
RS7	Yes	>1ha	>1ha	10,000,000	5,000,000	up	happy	37	M	Hybrid
RS8	Yes	0.5-1ha	0.5-1ha	10,000,000	11,111,111	same	not happy	54	F	Hybrid
RS9	Yes	>1ha	>1ha	40,000,000	10,000,000	up	happy	48	M	Hybrid
RM1	Yes	0.2-0.5ha	0.2-0.5ha					57	M	Rice
RM2	No	0.5-2ha	0.5-1ha					60	M	Rice
RM3	Yes	0.5-2ha	>1ha					63	M	Rice
RM4	Yes	>2ha	>1ha					45	F	Rice
RM5	No	<0.2ha	<0.2ha					30	M	Rice
RM6	Yes	0.5-2ha	>1ha					67	M	Rice
RM7	Yes	>2ha	>1ha					59	M	Rice

Appendix E: Codebook

	Name	Inductive/Deductive	Description	Example
1. Vulnerability	**1.1 Exposure & Sensitivity**			
	Damage for fruits and vegetables	Inductive	The code includes mention on the impact of natural disasters such as droughts on agricultural crops that generate secondary income, such as vegetables and fruits. It does not include the impact on rice cultivation or shrimp farming.	"Drought affected coconuts tree and the yield decreased. (RS18)"
	Drought	Deductive	This code includes the impact of drought on rice crops, but does not include the impact on fruit and vegetable crops.	"If the yield decreases, they don't have anything to do and keep rice to survive. The government didn't support them in 2015 and 2016. (RM7)"
	Salt water	Deductive	This code includes the impact of salt damage on rice crops, but does not include the impact on fruits and vegetables.	"If the water is too salty, the soil and rice will be affected and rice will die (RS24)."
	Too hot for humans	Inductive	This code includes references to the health hazards posed to farmers by rising temperatures, including the impact of temperature on agricultural work and feeling unwell after outdoor farm work.	"The concern is my health. In dry season, I will be tired and have headache easily. (RS9)"
	1.2 Natural capital			
	Farm land size	Deductive	The code includes discourse on the size of farmland owned by farmers.	"Their land size is 36,000 m2 and cultivation space is 21,000 m2. The farmland is behind their house. I owns 11,000 m2. I rent the land of 25,000 m2, which is 200m away from their house. (RS20)"
	Farming schedule	Deductive	The code contains statements about a farmer's basic cultivation schedule throughout the year.	"Rice 9-12, Shrimp 1-9(RS1)"
	Farmland location	Deductive	The code includes statements such as how far the farmland is from home and whether it is within easy commuting distance.	"I rent the land of 2,500 m2 and it's behind my house and near the canal. (RM1)"
	Land rental	Inductive	The code includes reference to the size of land that farmers own as well as that they rent from others.	"1 ha is 25 million VND per year for renting (RS6)"
	1.3 Physical capital			

	Machine usage	Inductive	This code includes statements about agricultural machinery such as tractors, and the use of drones to spray pesticides, etc. It includes statements about not using machinery as well as statements about using machinery.	"I do farm by himself. When spreading pesticides, I hire drones and also other employees. (RM5)"
	1.4 Human capital			
	Experience and Human capital	Deductive	The code includes statements about who in the interviewee's household is involved in agriculture, as well as information about how many people are involved in the farming process.	"I do farming with my family members (RM2)"
	Family members	Deductive	The codes include references to the interviewee's family structure.	"Age 63, grade 5, 8 people with 4 grandchildren, with son's wife and my son (RM3)"
	Health issues	Inductive	The code includes health issues faced by farmers, but does not include any reference to heat-related illnesses such as heatstroke.	"Their priority is food and treatment of their disease. (RS18)"
	Hiring someone	Deductive	The code includes reference to whether farm workers hire additional people during busy periods.	"I do farming by himself. When spreading pesticides, I hire drones and also other employees.(RM5)"
	1.5 Social capital			
	Information exchange	Inductive	The code includes references to how agricultural information is exchanged with neighbors.	"I talk about agriculture with my neighbors every day(RM2)"
	Services from an cooperative	Deductive	This describes the various services which cooperative members can get.	"When some farmers don't have knowledge about shrimp farming, they can call the cooperative members to get advice.(RS1)"
	1.6 Financial capital			
	For farming	Deductive	The code includes references to agricultural expenses. However, this does not refer to future agricultural expenditures, but rather to the ordinary agricultural expenses that they have to pay in carrying out their agricultural activities.	"His priority is food and rental fee (RS20)"
	For food	Deductive	The code includes references to food expenses.	"They use income for food and party they do with their friends, neighbors and etc. (RM1)"

	For kids	Deductive	This code includes the cost of raising children in a farm household budget.	"The biggest expense is for food and education fee for my grandson to study (RM3)"
	For saving	Deductive	The code contains discourse on farmers' savings.	"She is happy with her livelihood because she has money to do anything and enough amount to save for the future. (RM4)"
	Other income source	Deductive	This code includes information about sources of income other than on the farm, for example, if another family member has an off-farm job.	"Income only from farming (RS17)"
2. Adaptation process	**2.1 Decision making for shift**			
	For more income	Deductive	This item includes a line about people voluntarily switching to hybrid farming to increase their income.	"I decide to shift because of the low income from rice mono culture farming. I also learned about rice-shrimp farming from my neighbors. (RS21)"
	Government decision	Inductive	The code includes statements such as simply following government policy as the reason for switching to agriculture.	"They just followed the government plan. (RS19)"
	Majority vote	Inductive	The code states that agricultural transition is decided by community majority vote and includes statements both in favour and against transition.	"His neighbor changed so I had to follow it. That's why I decided to shift to hybrid farming. (RS23)"
	Concerns	Inductive	The code includes fears and doubts about whether agricultural transition will really be effective, as well as claims that agricultural land itself is not suitable for hybrid farming.	"She was afraid of changing her farming style to rice shrimp because she didn't know if it's effective or not. (RS16)"
	2.2 Transition cost			
	Expensive investment	Inductive	The code includes references to the high cost of converting rice fields into shrimp ponds.	"The difficulty from changing is the money (RS15)"
	Reasonable investment	Inductive	The code includes a mention that the construction costs for the transition were affordable.	"It's cheap, 3-4 million VND(RS16)"
	2.3 Agricultural practice change			
	Getting new knowledge	Deductive	The code includes how they learned about the knowledge and skills needed for agricultural	"I had difficulties in techniques but I learned it by himself. I

			transition and references to training sessions provided by the government or farmer associations.	joined the workshop but it is held once or twice a year.(RS20)"
	2.4 Sluice gate			
	Because of sluice gate	Inductive	The code includes statements that the construction of the floodgates is having a negative impact on agriculture.	"It depends on the dam. It closes in August so flood happens in their area, which damage rice. They don't know about the timing of when the gate is close and open.(RM2)"
	Thanks to sluice gate	Inductive	The code includes statements about how agriculture has benefited from the construction of the floodgates.	"It depends on the dam. It closes in August so flood happens in their area, which damage rice. They don't know about the timing of when the gate is close and open.(RS20)"
3. Adaptation outcome	**3.1 Natural environment**			
	No worry for drought or salinization	Inductive	This code includes statements that include relief that, as a result of the shift to agriculture or the construction of sluice gates, there is no longer any need to worry about drought or salt damage.	"I don't worry about the water availability(RM3)"
	Salt water availability	Inductive	The code includes references to concerns about whether there will be a stable supply of saline water for shrimp farming as a result of agricultural transition or the construction of floodgates.	"They are worried about salt water availability.(RS21)"
	Too hot for shrimps	Inductive	The code includes vulnerabilities of shrimp farming, including the fact that shrimp have been converted to hybrid agriculture but are dying off due to rising temperatures during the dry season.	"The higher temperatures affect to shrimp production. In the rainy season there're no major problem.(RS1)"
	Vulnerable against weather	Deductive	The code includes reference to the impact of rising temperatures and poor precipitation in recent years on rice yields, regardless of agricultural transition.	"The cause of yield decrease is disease and natural disaster. Not affected by salt water anymore.(RM3)"
	Water management	Inductive	The code includes a reference to how farmers should manage water, as water management is important for both shrimp farming and rice cultivation.	"I do farming job every day in the morning and afternoon as well. In the evening, I check the water

				level and it's not enough I pump in the water(RS13)"
	Water pollution	Inductive	The code includes reference to the impacts on crop yields caused by domestic and industrial wastewater, regardless of agricultural transition.	"Water pollution is a problem because the yield decreases. But the shrimp is getting used to the polluted water(RS11)"
	3.2 Changes in agricultural practice			
	Decrease in rice cultivation area	Deductive	The Code allows for shrimp farming by digging deeper inner edges of rice fields, as shown in Figure X. However, this procedure reduces the area available for rice cultivation.	"It was 2 ha farmland before but now it's 1.6 ha.(RS10)"
	Solutions for yield decrease	Deductive	The code includes provisions on what measures should be taken when crop yields are affected by abnormal weather, disease or other factors.	"There is no solution for him when the yield decreases(RS23)"
	Fertilizer	Deductive	The code includes statements about changes in fertilizer use after switching to hybrid farming.	"The usage of the fertilizer and pesticide decreased because the nutrition in the land improved then before thanks to the shrimp farming.(RS24)"
	High rice yield after transition	Deductive	The code includes statements about increased rice yields following agricultural transition.	"After shifting, the rice yield is higher than mono culture. By growing shrimp, the soil gets more nutrients. (RS22)"
	Less pesticide	Deductive	The code includes statements about the reduction in pesticide use following agricultural transition.	"Use less pesticide, which is suitable for shrimp.(RS16)"
	Less workload	Inductive	The code includes statements about the decline in fertilizer use following agricultural transition.	"Shrimp farming is cot less and less labors.(RS17)"
	Shrimp selling system	Deductive	The code contains discourse on the shrimp wholesale system after switching from rice monoculture to hybrid agriculture, including how farmers sell shrimp, whether they negotiate prices, and how they find current retailers.	"I don't eat shrimp for himself. Retailers come every day and I am depending on shrimp.(RS12)"
	Shrimp thief	Inductive	The code includes a reference to shrimp thieves who steal shrimp from the paddy field in the middle of the night.	"They want cameras because other people steal their shrimp. They need more security. The police

				doesn't do anything about it.(RS15)"
	Easy	Inductive	This code includes the statement that agricultural transition was easy.	"No difficulties for the shift(RS18)"
	Difficult only in the beginning	Inductive	This code includes statements that indicate that there was resistance or difficulty in the agricultural transition at first, but that people became accustomed to it as they continued.	"In the beginning, it was difficult for them to shift their agricultural practice but now I got used to it. The shift was good to increase the income.(RS15)"
	3.3 House economy			
	Food security	Deductive	This code includes discourses about food security among farmers after agricultural transition, including changes in subsistence living, increases and decreases in food costs, and so on.	"I don't have any livestock. I rely on self-production but I also buy from the market more frequently. I grow vegetable too. But only shrimp and rice are for selling.(RS7)"
	Education fee	Deductive	The code includes discourse on the cost of education after the transition to agriculture, mainly regarding the tuition fees of daughters, sons, or grandchildren.	"The biggest expense is for food and education fee for my grandson to study .(RS1)"
	Hybrid farming cost	Deductive	The code includes references to the operational costs of running a hybrid farm, including comparisons with rice monoculture.	"They had to spend 10000 million VND to dig a pond for shrimp farming. Their farmland is 10,000 m2. (RS15)"
	Stable or higher income and consumption	Deductive	The code includes reference to changes in income and expenses after transition to hybrid farming.	"They are happy with their livelihood because their income became higher and stable.(RS1)"
	Unstable shrimp price	Deductive	The code includes statements about the volatile market prices of shrimp farming.	"The profit depends on year, they are happy with more profit but with less profit they feel difficulty.(RS8)"
	3.4 Future plan			
	Dystopia image	Deductive	The code contains statements that farmers have a dystopian image of the future for agriculture, regardless shrimp farming or rice cultivation.	"I think that after 10 years later, it is impossible to harvest rice in the same farmland. The disadvantage

				is that income doesn’t come every day like shrimp.(RM5)”
	Don't want to change	Deductive	The code includes statements by farmers that they do not want to change their current farming style.	“In the future they don’t want to change anything (RS18)”
	Inherit land for children	Deductive	The code includes statements about farmers' planning to retire from farming and pass the farmland on to their sons or grandsons.	“I don’t have expansion plan. The land will be inherited to my grandchild.(RS10)”
	Insurance	Inductive	The code mentions future hopes for improvements to the health care system.	“ But there is no health insurance for him. So they have to pay everything by themselves so they wish the government improve the health care system.(RS18)”
	Investment for farming	Deductive	The code includes references to future agricultural investments - not based on the money needed for day-to-day farming practices, but on the future desire to expand the area of farmland by buying or renting land.	“They can access enough amount of water and plan to expand their farming business by renting land but no one let him rent.(RS14)”
	No idea	Deductive	The code includes the statement "no idea" about future prospects regarding farming.	“In the future I doesn’t have any plan.(RS26)”
	3.5 Happiness			
	Happy with rice mono culture	Inductive	This code contains the discourse that rice monoculture is sufficient for satisfaction. This discourse also contains the connotation that there is no need to switch to hybrid agriculture as rice monoculture is sufficient for satisfaction.	“I have enough money and very happy because I can get enough food and doesn’t have any trouble for paying.(RM3)”
	Happy with rice-shrimp	Inductive	This code includes statements about being satisfied with their current lifestyle after switching to hybrid farming.	“Happy with their livelihood. They feel more comfortable with shrimp rice farming(RS15)”
	Unhappy with rice-shrimp	Inductive	This code includes statements about not being satisfied with their current lifestyle after switching to hybrid farming.	“She accepted the shift but not very happy because the profit is not that much.(RS8)”

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