Transitioning to rice-shrimp farming in Kien Giang, Vietnam

Determining rural household resilience to changing climatic conditions

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Abstract

The Mekong Delta (MD) is known as Vietnam's so-called 'food-basket' and produces a significant amount of the country's agricultural products. However, it is also considered to be one of the areas in Southeast Asia that is most vulnerable to climate change impacts such as sea-level rise, saline intrusion, and changes in temperature and precipitation. As a response to changing climatic conditions, Vietnam's national and provincial governments have put more emphasis on aquaculture-oriented farming practices, such as shrimp and rice-shrimp farming, as opposed to rice farming. This research explores this agricultural transition that Kien Giang, one of the coastal provinces in the MD, is currently experiencing, by focusing on three different farming models: mono-crop rice farming, rice-shrimp farming, and extensive shrimp farming. Driven by the following research question: *"To what extent has the transition from rice farming towards various shrimp-farming methods in Kien Giang province, Vietnam made local farmers more resilient to changing climatic conditions?"*, this thesis analyses the extent to which rural households in each of these farming models are affected by the impact of changing climatic conditions, and determines the level of household resilience. This research shows that the governmental decision to change Kien Giang's agricultural sector to rice-shrimp farming has been successful: 1) agricultural productivity of rice-shrimp farmers is affected least by changing climatic conditions, 2) rice farmers have a higher level of resilience because even though the impacts of changing climate conditions had a higher effect on them, they were better able to fully recover, and finally 3) shrimp farmers are least resilient to changing climate conditions because they are affected most and are in general lacking ability to adequately cope with and adapt to a changing climate. This research contributes to the fields of resilience thinking, adaptive responses to climate change, and international development.

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List of abbreviations

ADB	Asian Development Bank
CAAE	Centre for Agriculture and Aquaculture Extension
DARD	Department of Agriculture and Rural Development
DS	Dry season
FAO	Food and Agriculture Organization of the United Nations
FSIN	Food Security Information Network
JICA	Japan International Cooperation Agency
KGU	Kien Giang University
MARD	Ministry of Agriculture and Rural Development
MD	Mekong Delta
MPPACC	Model for Private Proactive Adaptation to Climate Change
NGO	Non-governmental organization
PL	Post-larvae
PMT	Protection motivation theory
PPT	Parts per thousand
RIMA	Resilience Index Measurement Analysis
SES	Socio-ecological systems
SLR	Sea-level rise
USAID	United States Agency for International Development
VietGAP	Vietnamese Good Agricultural Practices
VND	Vietnamese Dong
WS	Wet season
WSD	White spot disease

Map 0.1: Mekong Delta in Vietnam

Source: Stewart & Coclanis, 2011

Introduction

During the last two and a half decades, Vietnam has undergone a highly spectacular development process, in which its economy has grown substantially. This has resulted in the transformation of Vietnam from one of the poorest countries globally, towards having a lower middle-income status (Demant & Rupsaert, 2017). This immense growth was made possible by the agricultural productivity within the Mekong Delta (MD), where especially the rice sector was important in creating an economic surplus in Vietnam. By 2015, Vietnam produced twenty-eight million tons of rice, of which seven million tons were exported, making Vietnam one of the biggest rice exporters globally (Demant & Rupsaert, 2017). However, agriculture and more specifically, the production of rice is very sensitive to alterations in the climate (Nguyen & Hoang, 2015). Vietnam is one of the world's countries most vulnerable to the consequences of climate change, and thereby sensitive for changes in the country's climate variability (USAID, 2017). Changes in temperature, precipitation, or soil conditions, are potentially thus very harmful for the Vietnamese rice industry, whose productivity is highly dependent on environmental conditions (Nguyen & Hoang, 2015).

Rice cultivation has always been a dominant agricultural activity within the MD, whereas aquaculture was first only carried out on a relatively small scale. During the early 1990s, aquaculture only accounted up to 5% of the total area that was suitable for it (Nhan et al., 2007). The aquaculture industry has however undergone a massive transformation since then, with an increase of production from 162,000 tons in 1990 to about 3.1 million tons in 2010 (JICA, 2013). Moreover, most of those aquaculture activities take place in floodplains and coastal areas, which have a high exposure and are therefore more vulnerable to climate change impacts. This is not only in terms of impact on climatic parameters such as changes in temperature and precipitation patterns, but also the impact of sea-level rise (SLR), floods, and coastal saline intrusion (Kam, Nhoung, Hoanh & Hien, 2015).

It goes without saying that climate change impacts potentially have huge social and economic costs for those directly and indirectly dependent on either the agriculture or aquaculture sectors for their daily livelihoods. Adaptation is therefore indispensable for the people within these important economic sectors to enhance their ability to cope with these changing climatic conditions (Kam et al., 2015). Future SLR and the consequential saline intrusion further inland could have a significant impact on both the agriculture and aquaculture sector. Adaptation measures to deal with these threats could involve the relocation of farming practices further inland, or by shifting the production towards more saline tolerant species (De Silva & Soto, 2009). The implementation of such changes on a farm level would result in incremental investments and additional operational costs for the individual farmers (Kam et al., 2015).

While the consequences of climate change might force farmers into taking adaptation measures to cope with these climate stresses, changing climatic conditions also bring opportunities. For example, saline intrusion within areas formerly used for agriculture, and in particular traditional mono-culture rice farming, could provide farmers with additional areas for shrimp production. The economic benefits of shrimp farming are much higher than most agricultural products because shrimps are a higher valued commodity, and the shrimp industry has a bigger market potential (De Silva & Soto, 2009).

In 2016, the Vietnamese government announced their plans to expand their shrimp exports from the current US$3 billion, towards US$10 billion over the next years. Which was decided after the devastation drought in 2015 and 2016, and the resulting saline intrusion, which ruined the rice harvest in the MD. Currently the climatic conditions in the MD are more favourable for the production of shrimps and are therefore a decisive factor in the transition from traditional mono-culture rice farming towards shrimp farming practices in coastal provinces in the MD (Voice of Vietnam, 2017).

The choice of farmers for their response to changing climatic conditions, as well as the use or implementation of certain adaptation measures, is however not only determined by economic factors, and favourable government policies (Tran, 2012). Research has shown that the response of farmers to the impact of climate change is determined by a set of socio-economic characteristics, with the knowledge of farmers being one of the most influential factors (Deressa, Hassan, Ringler, Alemu & Yesuf, 2009). Furthermore, combining and integrating new technologies with local farming practices has been identified as the most efficient development pathway (Uddin, Bokelmann & Antsminger, 2014).

The MD is known as Vietnam's so-called 'food-basket' and produces a significant amount of its aqua- and agricultural products (De Silva & Soto, 2009). However, it is also considered to be one of the areas in Southeast Asia most affected by climatic impacts such as SLR, saline intrusion, and changes in temperature and precipitation (Tuan & Chinvanno, 2011). The combination of these impacts threatens livelihoods of thousands of farming households in the MD. Research (Smajgl et al., 2015) has shown that top-down policy implementation is needed to prepare farmers for alternative livelihoods, and thus help farmers to increase their resilience to climate change impacts. Currently, the levels of adaptive capacity in MD communities are low, which amplifies the vulnerability to climate change impacts. It is therefore promising that the Vietnamese government and local authorities have announced plans to take action (Smajgl et al., 2015).

Despite negative impacts, saline intrusion of arable lands and the possible loss of these areas might also present local farmers an instance in which alternative livelihoods could be explored by the application of new aquaculture farming methods (De Silva & Soto, 2009). Recently, Kien Giang province, which is located in the MD, announced plans in accordance with the national plan, to drastically increase their shrimp production. Instead of preventing further saline intrusion from happening, local authorities have decided to accept the upcoming sea water which turns the water brackish and thus becomes more favourable for the production of shrimps (VietnamNet, 2017a). The present state of infrastructure for shrimp production, such as salt control, and fresh water inflow systems, is however below standard, which has a significant negative effect on the efficiency of shrimp farming in Kien Giang province (USAID, 2016).

Until now, the national government, and local authorities of Kien Giang province in particular, have mainly emphasized the potential of adapting to shrimp farming practices, in terms of poverty alleviation, provision of employment opportunities, and rural development (Tran, 2012). These shrimp farming practices do however also come with environmental and economic risks, and could have a negative influence on local ecosystems, and on sustaining the livelihoods of people that are relying on shrimp farming. So far, only little research (Hue & Scott, 2008; Joffre, Prein, Tung, Saha, Hao & Alam, 2010 in Tran, 2012) has been done concerning the diversity of livelihood and decision-making strategies that farmers employ to improve their resilient to climate change impacts. This research is therefore focusing on the different farming practices that local farmers in Kien Giang have adopted towards becoming more resilient, and what socio-economic drivers and barriers local farmers have experienced in adopting new farming practices. The following research question has been formulated to guide this research:

To what extent has the transition from rice farming towards various shrimp-farming methods in Kien Giang province, Vietnam made local farmers more resilient to changing climatic conditions?

This research aims to contribute to the existing body of knowledge on resilience thinking, by applying the concept of resilience thinking to the agricultural transition that is currently happening in Kien Giang. Vietnamese farmers are experiencing the impact of changing climatic conditions on their daily farming routines. By exploring to what extent farmers are affected by these climate variations, and by determining their capacity to cope with and adapt to these changing climate conditions, it is possible to determine how resilient farmers are to a changing climate. The application of the resilience concept helps to create a better understanding of this agricultural transition and provides insights on how farmers are able to improve their household resilience.

In order to accomplish this research aim, this research has the following objectives:

- Gaining a better understanding of the transition, from agriculture towards aquaculture, that is taking place in Kien Giang province.
- Determining what socio-economic drivers and barriers are experienced by local farmers in Kien Giang, during this transition.
- Creating a typology of the various stages of the transition and link these stages to the concept of resilience thinking.
- Determining how farmers in Kien Giang are adapting to changing climatic conditions.

Research questions and research framework

To answer the main research question and give structure to the research, the following four sub-questions are formulated.

To what extent has the transition from rice farming towards various shrimp farming methods in Kien Giang province, Vietnam, made local farmers more resilient to changing climatic conditions?

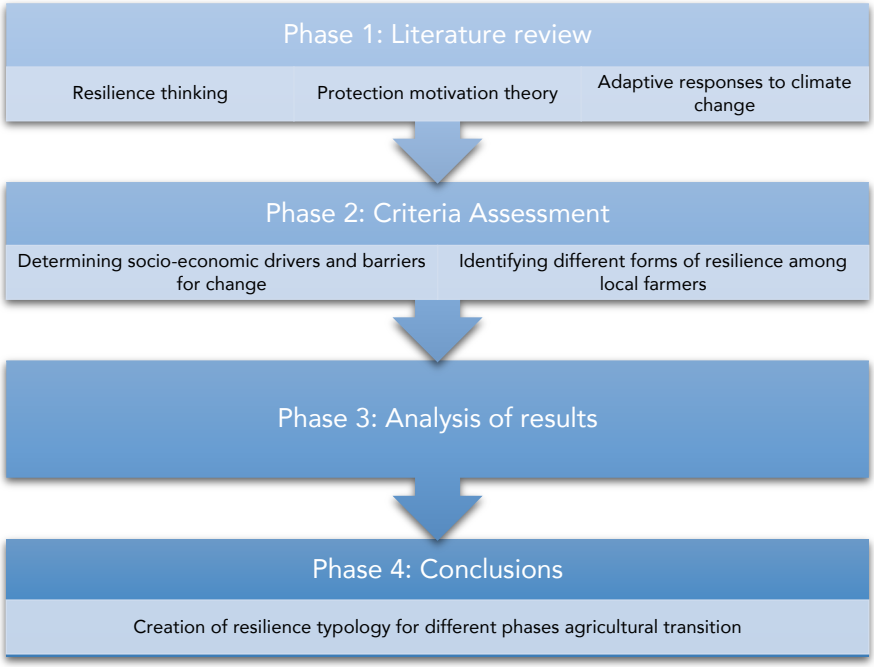
Sub-questions:

- RQ 1.1: How are local farmers in Kien Giang affected by climate change?
- RQ 1.2: What socio-economic factors affect the ability of local farmers in Kien Giang to adapt to changing climatic conditions?
- RQ 1.3: How do local farmers in Kien Giang perceive the risk of climate change impacts?
- RQ 1.4: How do local farmers in Kien Giang adapt to changing climatic conditions?

As this research focuses on the agricultural transition in Kien Giang, a distinction between different farming models used by farmers in Kien Giang is made. This ensures that rural households in the different stages of the transition are included in the research to create a realistic overview of the current agricultural situation in Kien Giang. All three models are assessed to determine whether differences between the farming models can be identified in terms of impact of changing climatic conditions, household resilience, and taken climate adaptation measures. The three models that are assessed for this research are 1) mono-crop rice farming, 2) rice-shrimp farming, and 3) extensive shrimp farming. All of which are elaborated on in chapter 3.

The presented thesis framework (figure 0.1) provides a schematic overview of the different stages of this research, that have been followed in order to fulfil the research objectives and research aim.

Figure 0.1: Research framework



This thesis is divided into six chapters. The first chapter presents the theoretical framework in which various theories and concepts are presented from disciplines such as international development and ecological science. These theories are used to examine the agricultural transition in Vietnam and determine the extent to which the agricultural sector is resilient to changing climatic conditions. Additionally, this chapter contains the conceptual framework of this research. Chapter 2 presents this research's methodology and discusses the case selection and operationalization. The third chapter provides a regional context, which clarifies and elaborates on the current situation in the agricultural industry in Kien Giang province. Chapter 4 presents the results of this research. The fifth chapter discusses the results, and relates them to the existing body of knowledge, after which recommendations are given for the implementation of new policies, and for future research. This thesis concludes with chapter 6 that summarizes this thesis' findings.

1. Theoretical Framework

This chapter presents the theoretical concepts that have been used for this research, and that helped to create a framework by which the collected data has been analysed and structured.

1.1. Resilience

In the sectors of international development or vulnerability reduction, the concept of resilience is becoming more influential, and the term resilience is also increasingly referred to by policy makers, NGOs and international development agencies (Bene, Wood, Newsham & Davies 2012). The 'capacity to recover', and the 'degree of preparedness', both mentioned by Bene et al., (2012: 10) are usually phrases used in the definition of resilience. Which is in line with how Holling (1973) firstly introduced resilience, as a "measure of the persistence of systems and of their ability to absorb changes and disturbance and still maintain the same relationships between populations or state variables" (p.14). The increased use of the term resilience can be explained by several reasons, one of which is that the application of a resilience framework can help to analyse a situation more holistically. With the concept of resilience looking holistically at a situation, it emphasizes the interdependency between the different components within a system. When it appears that individuals are becoming more vulnerable, whilst at the same time they experience more external shocks and stresses, the application of this concept becomes particularly relevant. Especially in sectors that have their focus on social protection, climate change adaptation, and disaster risk reduction (Bené et al, 2012).

Secondly, when analysing rural households, which is the case for this research, the concept of resilience and its holistic nature is also relevant when observing the relation between the use of natural resources, and the environment. Poor people are in general more dependent on natural resources and therefore the resilience of rural households or communes are inextricably linked to the environmental conditions and their use of natural resources (Lee & Neves, 2009). Putting an emphasis on this interdependency can help to adequately define various groups within the system, and how vulnerable each group is (Bené et al, 2012).

The following sub-paragraphs elaborate on the concept of resilience, and especially household resilience to changing climatic conditions, by discussing the concepts of resilience thinking, the five resilience pillars, and subjective household resilience. The five resilience pillars build on the concept of resilience thinking and are part of the Resilience Index Measurement Analysis (RIMA) framework, which assesses the ability of vulnerable households to cope with combined stresses such as climate change, social conditions, and economic forces (FAO, 2016). Subjective household resilience refers to the perception of individuals or households on their ability to cope with and adapt to perturbations and external shocks, such as changing climatic conditions (Jones & Tanner, 2015).

1.1.1. Resilience thinking

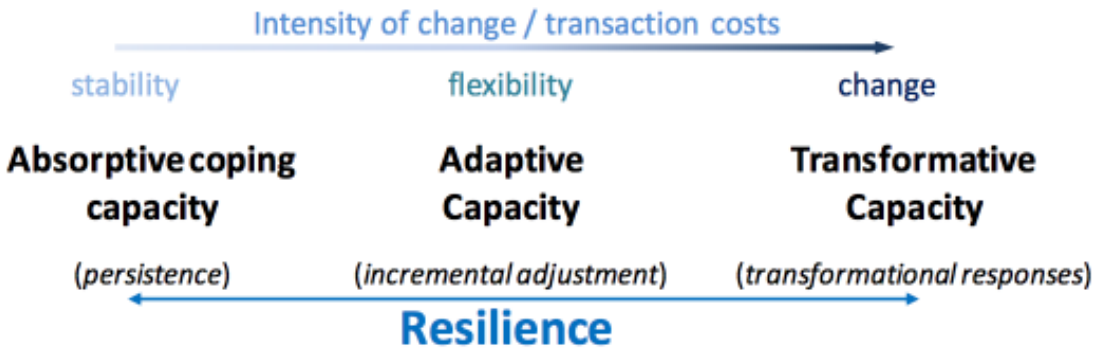
The concept of resilience thinking has originated from ecological science in which it describes change as "an inevitable feature of a system and places emphasis on either maintaining its character by absorbing the disturbance or transforming to a new regime when conditions become untenable" (Hoque, Quinn & Sallu, 2017: 1). Resilience of socio-ecological systems (SES) focuses on the ability to cope with (hazardous) events, and the capacity of actors within the SES to increase their knowledge base by learning from events and creating skills for possible transformations within the system (Cutter et al, 2008). Dynamics within a SES can best be described in the form of a cycle, better known as the adaptive renewal cycle. This heuristic model suggests that all complex systems undergo cyclic changes, and passes through four different phases (exploitation, conservation, release, reorganization) in which the resource use and structure of the SES will slowly change (Walker, Holling, Carpente & Kinzig, 2004). These gradual changes result in the system's structure becoming too rigid, and lead to a chaotic collapse, followed by a new phase of exploitation that is characterized by experimentation and innovation (Hoque et al., 2017; Folke, 2006).

Within resilience thinking three different capacities can be identified, namely absorptive capacity (resilience), adaptive capacity, and transformative capacity (Folke et al., 2010). Absorptive capacity, is the ability of a community to absorb impacts by using certain predetermined coping mechanisms, which prevent the system from exceeding it absorptive capacity or thresholds. By preventing to exceed its threshold, a system is able to maintain its function, identity, structure, and feedbacks (Cutter et al., 2008). Adaptive capacity is best described as "the capacity of actors in a system to influence resilience" (Walker et al., 2004: 5). It focuses on the ability of a system to adjust to change, how it can deal with perturbations, and how actors can minimize the effects of change within the system (Brooks, Adger & Kelly, 2005). The transformative capacity of a system is described as the ability to transform and create a new system when the conditions (economic, ecological, social) in the existing system are becoming unsustainable (Walker et al., 2004).

Resilience in general is about coping with uncertainties in as many ways as possible and does not distinguish parts of the system that might exceed its thresholds. It is important to recognize that efforts to avoid regime shifts within the SES from happening, are not always effective, and thus is the first step to understand the need for transformational change. SESs that have strong cultural beliefs and identities, often require a shock to get through this phase of denial (Folke et al, 2010). The concept of resilience thinking advocates that such shocks offer new "opportunities for re-evaluating the current situation, trigger social mobilization, recombine sources of experience and knowledge for learning, and spark novelty and innovation" (Folke et al., 2010: 5). Eventually, such shocks might even lead to new forms of adaptability or even to transformational change within the system. O'Brien (2011) pointed out that such changes or shifts may include a combination of (technological)

innovation, behavioural change, cultural change, and institutional reforms, which together challenge the prevailing status quo.

Figure 1.1: Resilience framework



(Source: Béné, et al., 2012)

The framework presented above (figure 1.1), illustrates how resilience emerges as the result from not one, but from all three capacities. With each of them leading to a different response, namely persistence, incremental adjustment, and transformational response. The framework furthermore links the intensity of the shock or change, to the different responses. Whenever the intensity of the initial shock is low, farmers are better able to cope with, resist, and absorb these shocks (Béné et al., 2012). When the intensity of the shock increases, and the absorptive capacity is exceeded, a farmer is dependent on its adaptive capacity (Cutter et al., 2008). Adaptive capacity, or adaptive resilience, mainly refers to the adjustments, that people have to make if they want to maintain their function and identity, without any major changes. These adjustments or incremental changes can take various forms, such as adopting new farming techniques, broadening livelihood base, or improving knowledge. It is important to note that these adaptation strategies can be taken individually or collectively, and can occur on different scales, from individual to community or even on regional level. When eventually the required change becomes too large for the adaptive capacity of farmers to cope with, transformation is needed, and changes have become transformative instead of incremental (Béné et al., 2012).

1.1.2. Five resilience pillars

The abovementioned concept uses absorptive, adaptive, and transformative capacity to determine household resilience and is currently one of the most credited descriptions of core components to assess resilience (FAO, 2016). For example, the Food Security Information Network, used these three structuring elements to construct their resilience assessment framework (FSIN, 2014). However, for this study these three structuring elements are slightly adapted to the RIMA-framework. The RIMA-framework divides resilience into five pillars, which together determine the resilience of households to perturbations and external stresses, of which this research focuses on changing climatic conditions. The adaptation to

this framework and using these resilience pillars allows for a more practical assessment and will make it easier to assess the household resilience to changing climatic conditions. These five resilience pillars are:

- Access to basic services
- Assets
- Social safety nets
- Sensitivity
- Adaptive capacity

Access to basic services contributes to household resilience because it affects the household's ability to generate income, which is an important aspect of resilience. If households are constrained from market access or other public institutions, resulting from bad infrastructure, or those facilities being too far away, this could negatively affect a farmer's revenue (Dercon, Bold & Calvo, 2004). A recent study (Khan, 2014) supports the correlation between access to basic services and the rate of recovery after experiencing a disaster. Access to basic services such as electricity and fresh drinking water is furthermore important to determine a household's exposure to risk, for instance related to health issues (Dercon et al, 2004). Household assets, the second resilience pillar, are important for a household's resilience because they can enable a household to cope with climate shocks. For this research financial assets such as income, and savings were regarded as most important because they permit a household to obtain goods and services, and are therefore a determining factor for a household when experiencing climate related shocks (Dercon, 2002)

The third resilience pillar, social safety nets, consists access to informal formal transfers, which refers to the financial insurance households have when being affected by climate-induced events. Formal transfers refer to the possibility for households to receive financial support through official channels, such a bank loans, government subsidies, or government compensation, which are usually more recognizable and easier to identify than access to informal transfers (Morduch, 1999) Such formal transfers are usually intended to provide social protection and poverty alleviation by improving the access to financial resources, and provision of credit (FAO, 2016), Informal transfers consist of money borrowed from friends or family, received remittances from relatives, which helps households to recover from disasters, whilst retaining them from building up massive debts. Both formal and informal transfers complement each other (Devereux & Getu, 2013), and together with income are one of the coping mechanism that come into action first when a household is affected by external stresses (FAO, 2016).

Sensitivity, the fourth resilience pillar, relates the extent a household is exposed to climate stresses. In the light of this research it thus refers to the extent a household is affected by changing climatic conditions. The sensitivity of a household is comparable with one of the resilience capacity, namely the absorptive capacity, which is exemplified by Adger's (2006) definition of sensitivity; "the extent to which a human or natural system can absorb impacts without suffering long-term harm of other significant change" (p.270). Adaptive capacity, the fifth resilience pillar and also one of the resilience capacities, determines the ability of households to adapt to changing climatic conditions. Whereas some of the previous resilience pillars were constructed by only a few factors, adaptive capacity is a multi-dimensional concept, which is constructed by complex relationships between a number of different factors (Vincent, 2007). According to Folke, Colding and Berkes (2003) adaptive capacity in social systems "is strictly connected to the existence of institutions and networks that represent learning and store knowledge and experience, creating flexibility in problem solving and balancing power among interest groups" (cited from FAO, 2016, p15). Such flexibility in problem solving can be achieved by household by applying certain livelihood strategies such as livelihood diversification (Kinsey, Burger & Gunning, 1998), or by acquiring more knowledge. Other indicators for adaptive capacity can relate to the household's demographic structure (dependency ratio, presence of ill household members) (Vincent, 2007), or to the educational level of household members (Abdulai & Eberlin, 2001).

Altogether, these five pillars are used to determine household resilience to changing climate patterns and complement the three core elements for resilience, namely absorptive, adaptive, and transformative capacity. Whereas the resilience pillars have been used to classify the level of resilience, these three resilience capacities will eventually be used to create a typology which describes the level of resilience for each of the farming models.

1.1.3. Subjective household resilience

Subjective household resilience originates from the idea that people generally have a good understanding of their own capabilities, capacities, and their limits (Nguyen & James, 2013). It can therefore be defined in terms of how an individual perceives the level of household resilience when experiencing certain external shocks and stresses. This perception is related to and influenced by an individual's cognitive valuation of their own capacity to deal with, buffer, and adapt their livelihoods to such external shocks and stresses. Whereas the above-mentioned concept of resilience thinking mainly focusses on objective indicators, this complimentary form of assessing household resilience that is often overlooked, offers significant advantages (Jones & Tanner, 2015). The recent development in which subjectively defined resilience is getting more attention is in line, and shows similarities, with the shifting paradigm that started when the measurement of well-being changed from being an objective approach towards being a subjective approach (Brown & Westaway, 2011)

Individual or household resilience is thus not the result of only objective elements, such as livelihood assets, and various other cultural, psychological, and social factors (Adger, Adams, Evans, O'Neill & Quinn, 2013). Subjective resilience is often comprised of elements relating to an individual's cultural identity, perception of risk, sense of place, social norms, and culture and beliefs (Grothmann & Patt, 2005, Adger et al, 2009, Clayton et al. 2015). However, subjective household resilience is a complex concept to assess because cultural and psychological elements have an effect on how someone rates their own, or their household's ability to deal with external shocks and stresses. When for example two individuals within the same household have very different personalities, one being overly optimistic and the other being more pessimistic, their ratings of their household's resilience can differ quite a bit. Subjective elements of resilience can therefore cause a significant bias when trying to determine a household's level of resilience. However, the same cultural and psychological elements have a significant influence on the level of household resilience (Jones & Tanner, 2015). According to Burton and Cutter (2008), cultural norms such as ethnic marginalization, or social exclusion, affect the ability of some social groups into reacting to, and coping with, external shocks. Lacking the ability to respond to such shocks can be caused by for instance a social group's restricted access to natural resources, or due to economic marginalization. Besides cultural elements having an effect on household resilience, personal subjective elements, like risk taking or risk aversion, also affect the way on how a household responds to disaster risk, or other external shocks, and thereby also affect the overall household resilience (Jones & Tanner, 2015).

Despite the complexity of assessing subjective household resilience, due to the biases created by an individual's psychological traits or because of cultural circumstances, it offers a great possibility in complementing and enhancing existing practices to measure resilience (Jones & Tanner, 2015). It is therefore important that care is taken when designing your research and choosing the right methodologies for data collection, which is elaborated upon in chapter 2, on this research's methodology.

1.2. Protection motivation theory

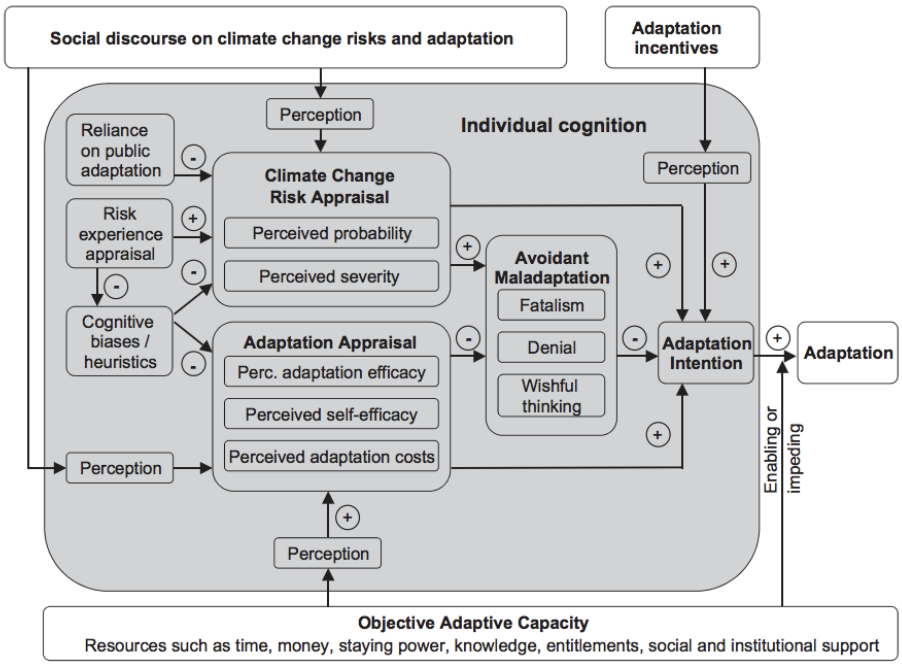
The protection motivation theory (PMT) is mainly used to explain what motives people have to engage, or not to engage, in certain practices, and gives insights in how behavioural change can be accomplished. The PMT and subjective household resilience complement each other in the sense that both assume that an individual's perception is essential when determining a household's livelihood strategy, and the way a household might be able to cope with or adapt to changing climatic conditions. The model was originally designed to gain a better understanding of the cognitive mediating processes that would result in adaptive or maladaptive behaviour of individuals towards health threats (Grothmann & Patt, 2005). However, since PMT's introduction, the use has expanded to a wide range of research

fields such as journalism, the natural science, and technological security (Kuruppu & Liverman, 2011; Woon, Tan & Low, 2005).

Rogers (1975) first introduced this theory, which is used to describe how fear for an upcoming (hazardous) event influences people's behaviour, and to what extent individuals are motivated to protect themselves. The behaviour of people is determined by three factors, namely the harmfulness of the upcoming event; the probability of the event from happening; and the ability from predetermined coping responses to result in a desired result. These cognitive processes are mediating the effects of possible danger and will result in the motivation for an individual to protect himself from danger (Maddux & Rogers, 1983). Rogers (1983) added a fourth factor to the cognitive mediating process, namely how individuals perceive their self-efficacy, which means how individuals perceive their own ability in showing the necessary behaviour. One of the main features of PMT, is that within the cognitive mediating process, two perceptual processes can be identified of which each is influenced by two of the determined factors that were introduced by Rogers (1983). Grothmann and Patt (2005) used the PMT as the basic theory to design a socio-cognitive model aimed to explain why some people show adaptive behaviour when experiencing climate-induced events. This model (see figure 1.2), better known as the Model of Private Proactive Adaptation to Climate Change (MPPACC) and will be elaborated on below.

The first process is known as 'climate change risk appraisal or risk perception' in which an individual assesses the possibility of a threat, known as the perceived probability, and the damage potential of this threat for assets valuable to this person, which is called the perceived severity. In the second process called the 'adaptation appraisal or perceived adaptive capacity' that comes after the risk appraisal, an individual evaluates their ability to prevent harm from being done, and thereby taking into account any possible costs of possible actions (Grothmann & Patt, 2005). The perceived adaptive capacity determines the consists of three subcomponents, namely perceived adaptation efficacy, perceived self-efficacy and perceived adaptation costs. The first refers to the belief that the taken adaptation measures within a household are capable of protecting all household member from being harmed by external stresses. Perceived self-efficacy is related to an individual's perception whether he or she would be able to carry out such adaptation measures. The third component, perceived adaptation costs, are the assumed costs for realizing these adaptive responses (Grothmann and Patt, 2005),

Figure 1.2: Process model of private proactive adaptation to climate change.



Source: Grothmann and Patt, 2005

The process of risk appraisal mainly results in the risk perception of an individual, whereas adaptation appraisal results in how an individual perceives his or her own adaptive capacity. The process of adaptation appraisal comes after the process of risk appraisal and only starts after certain thresholds are exceeded by the threat. Schwarzer (1992) described this process as follows; "A minimum level of threat or concern must exist before people start contemplating the benefits of possible actions and ruminate their competence to actually perform them" (p. 235). The outcome of these risk and coping appraisal processes determines the response of a household or individual to those threats. In general, two types of responses are identified, namely adaptation or maladaptation. An adaptive response threats are aimed to prevent damage from being done, or to increase possible benefits, and ae usually taken when the the perception of adaptive capacity and risk are high (Grothmann & Patt, 2005). Such adaptive responses are discussed in the next paragraph (chapter 1.3). However, when risk perception is high, but the perceived adaptive capacity is low, a household or individual could take maladaptive responses, and not do anything to prevent harm from being done. In cases of maladaptive responses, a household or individual is often unable to take any adaptive responses due to a lack of means or resources (Grothmann & Patt, 2005).

Besides assessing their own capacities, the individual's perception is also dependent on some external factors, as can be seen in the illustrated model (see figure 1.2). The social discourse on climate change is an important external factor that determines the perception of individuals. For example, a farmer's perception of climate change risk is formed and

influenced by what they hear in their direct environment by friends or media (Kasperson et al, 1988). Another external factor which has a big impact on both the ability to carry out adaptive measures, but also influences the perceived adaptive capacity, is the objective adaptive capacity (Grothmann & Patt, 2005). These are resources an individual possesses or owns and are closely linked to some of the resilience pillars.

1.3. Adaptive responses to climate change

Agricultural productivity in the MD is one of the most important sources of income for the majority or rural communities. Taking adaptation measures to protect farmers and their households from being affected by a changing climate is therefore critical (Bryan, Deressa, Gbetibouo & Ringler, 2009). Adapting to climate change can be done on multiple scales, and can be done according to different adaptive responses, including autonomous and conscious responses (Bryant et al., 2000). Autonomous responses mainly indicate the coping mechanism of farmers during farming practises. These could be adaptation strategies such as "irrigation, diversification, changing the growing calendar, using highly heat-tolerant varieties, or buying insurance" (Dang, Li, Nuberg & Bruwer, 2014: 12). Improving or changing land management can be a suitable strategy for farmers to adapt to changing climatic conditions. When experiencing prolonged droughts, altering a farm's water management which requires less water would be an advisable strategy to ensure agricultural yields are still maintained to some extent (Lasco, Habito, Delfino, Pulhin & Concepcion, 2011). Research (Lasco & Boer, 2006) has shown that changing cropping calendars can be an effective method to adapt to climate variability. This method mainly focuses on changing the timing of certain agricultural activities on the farm to ensure they are suitable climatic changes. In some cases, different crops were planted in succession of each other to ensure at least one crop would be able to get harvested. Another adaptive response to changing climatic conditions is to change to another crop variety. Farmers often change to more climate-resilient crop varieties that are better able to cope with climate extremes or changing climatic conditions (Lasco et al, 2011).

Conscious adaptive responses refer mainly to public policies and governmental intervention concerning climate change impacts, which can include research funding, favourable taxing, improving existing infrastructures, and subsidizing (Bryant et al., 2000). Furthermore, a division of responses can be made in terms of adaptation to short-term climate variability, or long-term climate change (Smithers & Smit, 1997). It is argued that short-term responses to climate variability, also have a positive influence on adapting to climate change on the long-term (Burton, 1997). However, several studies (Smithers & Smit, 1997; Ziervogel et al., 2008; Smit & Wandel, 2006) have indicated that short-term adaptive responses to changes in the climate, mostly classified as coping responses, are not able to cope with long-term climate change, and might even increase the system's vulnerability to future climate change. Thus, it

is important that long-term adaptive responses are the result of a learning process and must be based on the anticipation of long term climate change (Bryan et al, 2009).

Whereas a farmer's adaptive response is mainly impacted by, and associated with climate change, other factors are also influential on a farmer's adaptive response. Several studies (Below et al., 2012; Bryan et al., 2009; Deressa et al., 2009) have indicated that socio-economic factors and the availability of resources also have a major influence on a farmer's adaptive capacity. These could be factors such as income level, wealth, availability of climate information, government support, education level, knowledge, and access to fertile land (Bryan et al. ,2009; Deressa, Hassan & Ringler, 2011; Dang et al, 2014).

1.4. Conceptual framework

To construct a schematic overview in which the interconnectedness of the all the discussed theoretical concepts is illustrated (figure 1.3), the MPPACC that is based on the PMT, was used and adjusted to create a framework that could be applied to this research. To create this framework, the concepts of resilience thinking, and resilience pillars are incorporated with the MPPACC, which enables the model to describe the relationship between the motives and capacities of an individual for climate change adaptation, with the actual adaptive response.

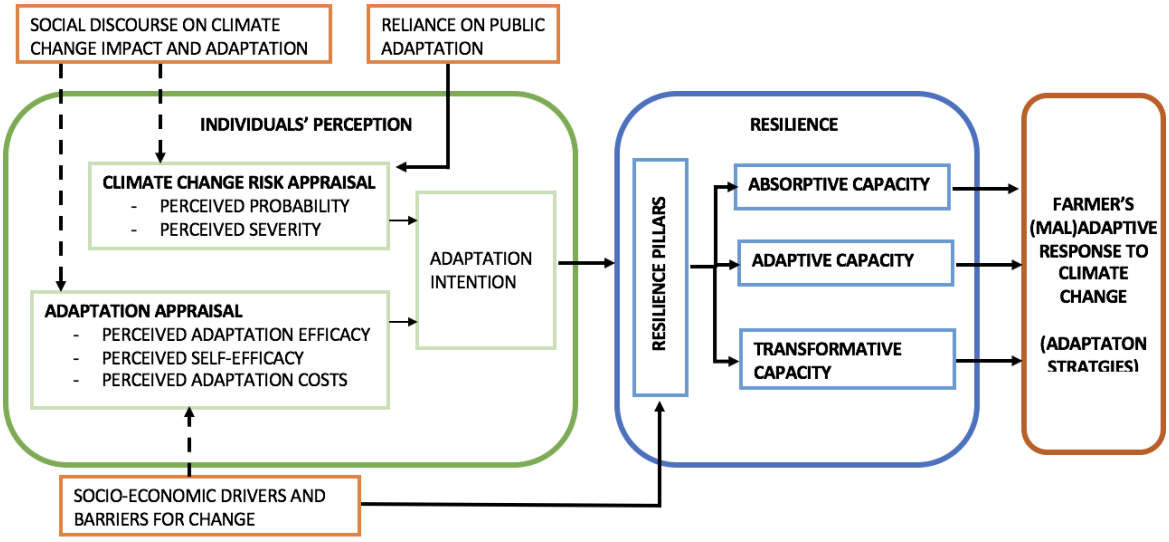
The perception of local farmers on climate change risk, and their perceived adaptive capacity to cope with these risks is influenced by internal factors, but also several external factors. These are external factors such as the social discourse on climate change that is experienced by farmers through the media, or by sharing stories with relatives or friends. Another external factor are the socio-economic drivers experienced by farmers, such as knowledge, income, institutional support. These socio- economic drivers and barriers not only influence the perceived adaptive capacity but are also factors that form the five resilience pillars. Climate change risk appraisal is determined by the perceived probability and perceived severity as was discussed in chapter 1.2. However, and additional determining factor is found in the framework below, namely reliance on public adaptation. Which means that an individual's risk appraisal can be influenced by the presence of public adaptation measures such as dams. For example, if the government has constructed a dam to prevent floods from happening, a farmer would feel more secure and the urge to take their own adaptation measures would be less.

Although the concept of subjective household resilience is not directly shown in the conceptual framework below, the components determining subjective household resilience can already be found in the framework. The concept of subjective household resilience assumes that an individual is well aware of his or her own capabilities of coping with external shocks and stresses. This perception is influenced by an individual's cognitive valuation of

their own capacity to buffer experienced stresses and adapt their livelihoods if needed. Those cognitive valuations that make up subjective household resilience are closely linked to climate change risk appraisal and adaptation appraisal, which is why the decision was made not to additionally mention subjective household resilience in the conceptual framework.

The outcome of a farmer's perception on climate change risk and adaptive capacity lead to the adaptation intention, which means what would be an ideal adaptive response for the farmers to cope with experienced climate stresses. However, the household resilience eventually determines what the actual adaptive or maladaptive response of the farmers is. Household resilience is determined by the five resilience pillars, which are partially formed by the socio-economic conditions experienced by the household or farmers. The five resilience pillars are used to classify the household resilience, which will be translated to the resilience capacities a household possesses. The household resilience will eventually determine whether a household is capable of taking adaptive response to cope with and adapt to changing climatic conditions.

Figure 1.3: Conceptual framework research



Source: Author's own making

2. Methodology

This study was carried out in Kien Giang province, Vietnam, over a period of ten weeks in which both quantitative and qualitative research methods were applied in order to gather all the data. This research was designed to gain a better understanding of the impact of climate change on farmers in Kien Giang in the past and present, and to what extent farmers have been able to cope with, and recover from, the consequences of climate change. As case study research is mainly used to gain a better understanding of the dynamics within a certain setting, such as organizations, projects, or communities (Eisenhardt, 1989). It tries to gain insights on all different actors, processes, and relationships, that are found within the case. With its eventual goal to formulate an in-depth conclusion on the case, that takes all these dynamics into account (Verschuren & Doorewaard, 2010). A case study approach was therefore chosen as most suitable for this research, and two communes, Nam Yén and Nam Thái, were selected as cases.

Despite the fact that this research had its main focus on data collection within the selected cases, other means, such as desk research, and literature reviews, have also been used to gather data. The use of both qualitative and quantitative research methods was needed in order to create a better understanding of the research area and topic. The following paragraphs are discussing into more detail (a) about the research area and what communes were selected, (b) which research methods have been used for this study, (c) explain how the variables have been operationalized, (d) how the gathered data has been analysed, and conclusively discusses (e) some of the methodology's limitations.

2.1. Research area and case selection

Kien Giang province was chosen as research area because the recent developments concerning the agricultural transition showed interesting potential to conduct a research about climate change impact and household resilience. Kien Giang is a coastal province located in the MD, which is globally one of the most vulnerable areas for climate change. Since agriculture and aquaculture are the major drivers of the province's economy (Mackay & Russel, 2011), together with the region's vulnerability to several climate related threats, a research concerning household resilience in terms of climate change was regarded as relevant. In all coastal districts, a diversity of farming systems can be found, which made the case selection quite difficult. However, after discussions with professors from Kien Giang University (KGU) and officials of several districts, Nam Yén and Nam Thái commune, both located in An Bien district, were selected as cases.

As this research focuses on the transition from rice farming to shrimp farming in Kien Giang, the presence of various farming models in the communes including these farming practices, was essential. Nam Yén and Nam Thái were selected due to the presence of three dominant farming models that will be elaborated on later (chapter 3.2). An Bien district, and these

communes especially are furthermore heavily affected by saline intrusion (ADB, 2013), which makes the study more relevant and interesting, and was a determinant factor for the selection of these communes. Other selection criteria such as travel distance, cooperation of district, and receiving permission from the provincial office for foreign affairs were also taken into account. During the research, I was based at KGU, so to conduct household surveys and interviews on a daily basis, the selected communes had to be within travel distance. Before selecting the communes, professors from KGU contacted several district officials to inform whether it was possible to conduct research in their district, and whether they were willing to cooperate. Furthermore, the provincial office for foreign affairs had to give permission and decided whether I was allowed to carry out this research in Nam Yén and Nam Thái.

2.2. Research methods

For this study several research methods (qualitative and quantitative) were used complementing each other, aiming to provide various perspectives that all contribute to answering this study's research question. This research has used key-informant interviews, semi-structured interviews with farmers, and household surveys to gather all the data. Before going into the 'field', interviews with several officials of provincial departments were conducted in order to get on overall view of the farming situation in Kien Giang. After which, in the selected communes, household surveys and semi-structured interviews were conducted with farmers, and furthermore in-depth interviews were done with commune and district officials. A total of 145 farmers (n=145) were interviewed, of which 120 were household surveys, and 25 semi-structured interviews. For both the household surveys and semi-structured interviews, an uneven distribution of the number of interviewed respondents was made. The main reason for this was that the majority of farmers in both communes were rice-shrimp farmers, whilst the number of rice, and shrimp farmers was significantly lower. An overview of the number of respondents can be found below (Table 2.1).

Table 2.1: Overview number of household surveys and semi-structured interviews

	Nam Yén		Nam Thái	
Farming model	Household Survey	Semi-structured Interview	Household Survey	Semi-structured Interviews
Rice	15	3	15	3
Rice-Shrimp	30	7	30	6
Shrimp	15	3	15	3
Total	**60**	**13**	**60**	**12**

A recent study (Hoque et al., 2017), focusing on socio-ecological change and resilience thinking, used a variation of these research methods, which aimed to gain a better understanding of all the involved drivers within the study site and were therefore also deemed as suitable for this research. For this study, three research assistants were used, that helped me in the field conducting interviews and surveys with farmers, as well as for the key-informant interviews. In all cases, research assistants were needed due to the low level of English all the interviewees had.

2.2.1. Key informant interviews

A total of six interviews were conducted with key-informants that are working at various government bodies (see table 2.2). Firstly, three interviews were done with representatives from provincial government bodies, with the aim to gain a better understanding of the farming situation in Kien Giang province. These interviews focused on topics such as recent developments of farming in Kien Giang, currently active policies concerning rural development, the impact of climate change on farmers, and future prospects of farming in Kien Giang. The interview with the district official of the department of agriculture and rural development was mainly aimed to get a better idea of the developments of the farming situation in An Bien district, and to gain insights on An Bien district's demographics. Each of the interviews with the commune officials was done after all the surveys were finished in the communes, so that questions that were raised during the surveys could be asked and accounted for by the commune officials. These interviews were furthermore used to get more specific information about (a) local policies concerning agricultural practices, (b) agricultural development in Nam Yén and Nam Thái, (c) the impact of climate change on farmers, and (d) the ability of farmers to cope with climate change. Both commune officials also assisted as gatekeepers during the first days doing fieldwork and made sure we were properly introduced to the local village heads, so that no problems would arise whilst doing fieldwork due to our presence.

Earlier studies (Ogalleh, Vogl, Eitzinger & Hauser, 2012; Mertz, Mbow, Reenberg & Diouf, 2009; Nelson & Stathers, 2009) on climate resilience, and the farmer's perception on climate change, have also used key informant interviews to gain valuable insights in the dynamics within the research area. Key-informants usually have a wide knowledge concerning the research area and have an understanding of the underlying motivation and attitudes of the research's target population. The use of such interviews for this study was therefore deemed appropriate and ended up being very informative, and useful for the remainder of the study. All the topic lists used for the interviews with key-informants can be found in Appendix A, except for the topic lists with both commune officials. These interviews happened more spontaneously, which resulted in preparing questions on-site, without the use of a topic list.

Table 2.2: List of key informant interviews

Government body – *representative*
Department of Agriculture and Rural Development – *provincial official*
Centre for Agriculture and Aquaculture Extension – *aquaculture expert*
Sub-department of Aquaculture – *provincial official*
District Department of Agriculture and Rural Development (An Bien district) – *district official*
Regional Government Office Nam Yén – *commune official*
Regional Government Office Nam Thái – *commune official*

2.2.2. Structured interviews with farmers: Household Survey

The household survey was designed to get a better understanding of the farmer's perception on climate change, their ability to cope with the consequences of climate change, and developments they had undergone with their farm in recent years. The survey was conducted with household heads (n=95), spouse (n=23), and in a few cases the children within the household (n=2). In the two cases that the children were interviewed, they had taken over most of the farm tasks of their parents and were therefore more knowledgeable on the topic as the actual household head. The selection procedure for the respondents was randomized, by choosing a household every 100-150 meters, and only 4-5 households in the same area. The latter to make sure that the selected respondents were spread out over the communes and would be a realistic representation of the research population.

The questions of the survey were carefully designed using and adapting existing resilience indicator frameworks and articles on subjective resilience (FAO, 2016; Smith et al., 2015; FSIN, 2014; Jones & Tanner, 2015). The resilience indicator frameworks have proven themselves in the past to be successful in assessing household resilience and collecting information on topics such as household assets and socio-economic variables. The entire household survey is shown in Appendix B.

Most of the time in the 'field' was spent on conducting the household surveys, with the help of the research assistants. It was therefore important to explain the survey to all assistants carefully, so they would understand the questions and would be asked in the same way. The survey was furthermore translated to Vietnamese, trying to avoid bias as much as possible. However, whilst conducting the surveys, new questions would sometimes arise amongst the respondents or assistants, upon which I would elaborate further to make sure everything would be clear.

2.2.3. Semi-structured interviews with farmers

After finishing the household surveys in each community, semi-structured interviews with farmers from all three farming models were conducted. The interviews focussed on topics such as the impact of climate change on their farm, their perception on their household's resilience, and whether they were trying to improve their household's resilience. The full topic list for the semi-structured interviews can be found in Appendix C. Although the household surveys already covered most of these topics, the semi-structured interviews provided the opportunity to ask for more insights and further explanation from the farmer's point of view. As most of the questions asked during the interview were open ended, and discussions started, diverging from the topic list, all the interviews were recorded. These were recordings made to make sure nothing that was said during the interviews would be lost or forgotten. These recordings were later analysed to create transcripts and notes, which were used for further data analysis.

2.3. Operationalization variables

As this research is focusing on some complex concepts such as household resilience, climate change adaptation, and the protection motivation theory, operationalization of the variables is important. The conceptual framework introduced in chapter 1.4 has given a schematic overview of all the key concept of this research. The concept of resilience was not specifically operationalized during the research. Instead, variables to form the five resilience pillars were included in either the household survey or semi-structured interviews. The main concepts that needed to be operationalized during the research are:

- Protection motivation theory
- Subjective household resilience
- Resilience pillars

As these concepts are constructed by multiple variables, the household survey was carefully designed to make sure most of the variables were being accounted for in the survey. In several cases, the survey was unable to account for all variables. However, this was solved by conducting additional semi-structured interviews to make sure that the variables not accounted for in the survey, were at least discussed during the interviews. The following sub-paragraphs discuss into more detail on how the above-mentioned theoretical concepts have been operationalized for this research.

2.3.1. Protection motivation theory

The climate change risk appraisal consists of two components, namely the perceived probability and perceived severity. Perceived probability can best be described as the extent to which a person feels exposed to a threat. Perceived severity indicates to what extent an individual expects a threat and its consequences to be harmful to his or her assets, or things that he or she values (Grothmann & Patt, 2005). The variable of perceived probability was included in the survey and made measurable by a Likert-scale (see table 2.3). The component of perceived severity was only asked for during the semi-structured interviews, and thus not operationalized by a single indicator. It is however taken up in the transcripts of all the interviews and comes back in the eventual data analysis.

Table 2.3: Operationalization – Climate change risk appraisal

Variable	Indicator	Question
Perceived probability	*Will my household be affected by climate change threats in the coming 3 years? (1: Strongly agree – 5: Strongly Disagree)*	45

As indicated by Grothmann and Patt (2005) the adaptation appraisal consists of three components, namely perceived adaptation efficacy, perceived self-efficacy, and perceived adaptation costs. The first component, perceived adaptation efficacy, is about the belief that a certain response or adaptation measure is effective in protecting an individual or household against the consequences of a threat. Perceived self-efficacy mainly refers to how an individual perceives his or her own ability to successfully and adequately carry out such adaptive responses. The final component, perceived adaptation costs, is best described as the expected costs when taking these adaptive responses. These could include any type of costs, such as effort, time or money, related to taking these adaptive responses (Kuruppu & Liverman, 2011). The variables of all three components can be found back a question in the household survey, and the use of a Likert-scale made it possible to make the variables measurable (see table 2.4).

Table 2.4: Operationalization – Adaptation appraisal

Variable	Indicator	Question
Perceived adaptation efficacy	*I think that the adaptation measures taken are able to protect me and my household from future climate change threats. (1: Strongly agree – 5: Strongly disagree)*	47
Perceived self-efficacy	*I think that me and my household will be able to take adaptation measures to protect ourselves from future climate change threats. (1: Strongly agree – 5: Strongly disagree)*	46
Perceived adaptation costs	*I think our household can carry out adaptation measures without external support (money, training, technology) (1: Strongly agree – 5: Strongly disagree)*	48

2.3.2. Subjective household resilience

Whereas the concept of resilience thinking, and the five resilience pillars mainly focus on objective (socio-economic) indicators, a complimentary form of assessing household resilience that is often overlooked, can be used (Jones & Tanner, 2015). When trying to observe such subjective indicators of perceived resilience, which are often based on people's behaviour and their attitudes, it is difficult to capture them by the traditional objective indicators. The survey therefore contains seven questions (see table 2.5) that try to encompass the concept of subjective household resilience, which are based on knowledge from earlier studies (Nguyen & James, 2013; Jones & Tanner, 2015; Jones & Tanner, 2017).

Table 2.5: Operationalization – Subjective household resilience

Variable	Indicator	Question
Farmer's perception on their household's resilience to the impact of future climate change.	*Decreased farm productivity due to climate change (1: Strongly agree – 5: Strongly disagree)*	35
	Loss of farm animals due to climate change (1: Strongly agree – 5: Strongly disagree)	36
	Decreased household income due to climate change (1: Strongly agree – 5: Strongly disagree)	37
	Decreased food accessibility due to climate change (1: Strongly agree – 5: Strongly disagree)	38
	Decreased availability of fresh drinking water due to climate change (1: Strongly agree – 5: Strongly disagree).	39
	Migration of household members due to climate change (1: Strongly agree – 5: Strongly disagree)	40
	Willingness of learning new climate change adaptation measures (1: Strongly agree – 5: Strongly disagree)	41

2.3.3. Resilience pillars

Whereas the concept of subjective household resilience was operationalized by seven different indicators, it is much harder to operationalize all five resilience pillars. The number of indicators needed to fully operationalize the variables and measure the five resilience pillars as in the RIMA-framework, was too high. Instead, a smaller selection of variables was made and put in the survey, that made the assessment of objective indicators more feasible. The variables that were not incorporated in the survey, were discussed extensively during the semi-structured interviews, and are therefore still included in the data analysis. The set of indicators to measure resilience that were incorporated in the survey can be found below, differentiated according to the five resilience pillars. An additional indicator was taken up in the household survey, which aimed to shed light on the coping capacity of households, referring to their ability to recover from changing climatic conditions in the past (see table 2.6).

Table 2.6: Operationalization: Coping capacity

Variable	Indicator	Question
Coping capacity	*Ability to recover from consequences of climate change (1: Did not recover, 2: Did recover but worse off than before, 3: Recovered to same level as before, 4: Recovered and better off, 5: Not affected)*	34

Access to basic services was operationalized in the household survey by two variables, which determined the accessibility to basic services and the quality of those services (see table 2.7). Additional factors such as availability of water and electricity were either discussed with farmers during the interviews or was determined by observations whilst conducting the surveys or interviews.

Table 2.7: Operationalization – Access to basic services

Variable	Indicator	Question
Access to basic services	*Nearest market (in km)*	22b
	Nearest primary school (in km)	
	Nearest secondary school (in km)	
	Nearest high school (in km)	
	Nearest Health clinic (in km)	
Quality of basic services	*Nearest market (1: Very good – 5: Very bad)*	22c
	Nearest primary school (1: Very good – 5: Very bad)	
	Nearest secondary school (1: Very good – 5: Very bad)	
	Nearest high school (1: Very good – 5: Very bad)	
	Nearest Health clinic (1: Very good – 5: Very bad)	

For this research, annual income in Vietnamese Dong (VND) was considered to be the most important indicator to determine the amount of assets a household owns. Although household assets are usually determined by a wide array of factors (FAO, 2016), this survey only contained five indicators in total to assess the assets owned by a household (see table 2.8), which is one of the limitations of this research. Following the advice of my research assistants and KGU staff, a question whether a household had loans or not was left out of the survey due to the sensitivity of the subject.

Table 2.8: Operationalization - Assets

Variable	Indicator	Question
Yearly household income	*Income in million VND / year*	17
Able to take care of household's daily needs	*1: Yes / 2: No*	18
Household's savings	*1: Yes / 2: No*	19
Land ownership	*1: Yes / 2: No, rent / 3: No, other.*	11
Farm size	*Size in hectares*	12

Social safety nets of households are formed by the availability and access to formal and informal transfers (Devereux & Getu, 2013), of which the former was extensively discussed during the key-informant interviews and semi-structured interviews with farmers. The latter was partially operationalized by the survey indicators, which determined whether households received remittances, and whether their social network was capable of supporting them to improve their resilience (see table 2.9).

Table 2.9: Operationalization – Social safety nets

Variable	Indicator	Question
What other source of income	*1: Cultivating crops / 2: Livestock production and sales / 3: Wage labour / 4: Sale of wild products / 5: Other self-employment/own business / 6: Sale of other non-livestock asset/rental of land / 7: Remittances / 8: Gifts/inheritance / 9: Other: ….*	16
Social network for loan	*1: Yes / 2: No*	20
Social network for farm support	*1: Yes / 2: No*	21

Household sensitivity to changing climatic conditions was partially operationalized by one variable that consists of six indicators (see table 2.10). However, several open-ended questions in the survey and during the interviews touched upon the topic of climate sensitivity, which is extensively discussed in the upcoming results chapter on the impact of changing climate patterns on farmers. The sensitivity is therefore to a lesser extent discussed as one of the resilience pillars, and more so in paragraph 4.2.1.

Table 2.10: Operationalization – Sensitivity

Variable	Indicator	Question
Experienced changing climatic conditions	*Rising temperatures* *(1: Strongly agree – 5: Strongly disagree)*	32a
	More droughts *(1: Strongly agree – 5: Strongly disagree)*	32b
	Saline intrusion soils *(1: Strongly agree – 5: Strongly disagree)*	32c
	More frequent floods *(1: Strongly agree – 5: Strongly disagree)*	32d
	Unpredictable rainfall *(1: Strongly agree – 5: Strongly disagree)*	32e
	More storms/typhoons *(1: Strongly agree – 5: Strongly disagree)*	32f

Household adaptive capacity is a complex concept which is not easily grasped by several indicators. Despite this complexity, some indicators were discussed in the survey which were regarded as important to determine the household adaptive capacity (see table 2.11). Income diversification is regarded by several authors (Lasco et al, 2011; Lin, 2011) as a successful livelihood strategy to improve household resilience. The dependency ratio shows the total amount of people in a household whose livelihoods are depending on the number of working household members. Thus, the lower the dependency ratio, the higher the adaptive capacity. Other variables, such as crop diversification, and acquiring knowledge were extensively discussed during the semi-structured interviews and will thus be taken up in the data analysis.

Table 2.11: Operationalization – Adaptive capacity

Variable	Indicator	Question
Main source of income	*Open question*	14
Other sources of income	*1: Yes / 2: No*	15
Income diversification	*1: Cultivating crops / 2:_Livestock production and sales / 3: Wage labour / 4:_Sale of wild products / 5: Other self-employment/own business / 6: Sale of other non-livestock asset/rental of land / 7: Remittances / 8: Gifts/inheritance / 9:_Other: ….*	16
Level of education	*1: None / 2: Primary school /* *3: Middle school / 4: High school / 5: College / 6: University*	4
Dependency ratio	*Number of household members*	8
	Number of people working in household	9

2.4. Data analysis

During the key-informant and semi-structured interviews, extensive notes were taken, and recordings were made. Following the interviews, the recordings were analysed, and the notes were complemented with additional information from the recordings where needed. During this process, the first selection of information took place, in which a distinction between relevant information, and non-relevant information for the research was made. After which the open coding software Nvivo, has been used to code the selected information, and create an overview of all the relevant information attained during the research.

The quantitative data from the household survey has been processed using the SPSS software, which has been used to generate frequency tables and cross tabulations. This data was transferred to the spreadsheet program Microsoft Excel, to create various figures and tables that clearly display the results of this research.

2.5. Limitations

This research was carried out using several research methods, thereby aiming to increase the reliability of the findings of the research. Although a lot of data was collected using these methods, which is in favour of the reliability of the research's findings, it was unfortunate that e the participatory map-making workshop which was planned was not carried out due to the limited amount of time. Such a workshop would have assembled different stakeholders within the communes and create an overview of the farming situation using the shared knowledge of all participating stakeholders. And it would have provided the opportunity, not only to confirm the collected data, but also to translate all the knowledge present during the workshop into a map.

Whilst conducting the interviews and surveys, a couple limitations were identified concerning the used methods, which are discussed in this paragraph. The language barrier, being the first limitation, was experienced during the entire period of the research. As the research was conducted in an area with barely any foreigners, the level of English of all the respondents, and even the key-informants was very low. Due to my lack of knowledge of the Vietnamese language, research assistants were used to overcome this language barrier. However, the use of research assistants created a new limitation, namely that information gets lost in translation.

Another limitation of the research was that despite putting a lot of effort into shortening the survey as much as possible, some respondents still experienced the survey as being too long. In some cases, this resulted in speeding through the survey because the respondent was in a hurry, or in a single case stopping the interview because the respondent had to leave immediately. Shortening the household survey also meant that a selection of objective variables to measure household resilience had to be made. Resulting in a significant number

of variables not being incorporated in the household survey, thereby affecting the eventual ability of the survey to assess household resilience through objective indicators. I tried to overcome this limitation by incorporating as many of the variables into the semi-structured interviews with farmers, so they were at least still discussed with a smaller number of respondents.

Another limitation of the research is that the current sample size of respondents does not allow for extensive statistical analyses. Whilst 120 conducted household surveys ensure that a good representation of the research population is given, and frequency graphs and tables can be constructed, it is not enough to carry out reliable correlation and other statistical tests. More surveys should have been conducted to make this possible, but the time frame in the field did not allow for the collection of additional data from household surveys.

A final limitation that was experienced while being in the field was the presence of the commune official. Even though his presence was quite helpful when showing us around the commune, introducing us to new hamlets, and familiarizing us with the people, his presence also had a significant negative impact. It became clear in the first days that whilst conducting a survey, the commune official would walk away to try and find the next respondent. As these actions would impact the randomization of the selection process, I tried to make clear that the commune official was not needed anymore. Despite some minor resistance from the research assistant at first, we eventually arranged that the commune official was only needed when introducing us to a new village head, instead of being around constantly.

3. The Mekong Delta: Vietnam's food basket

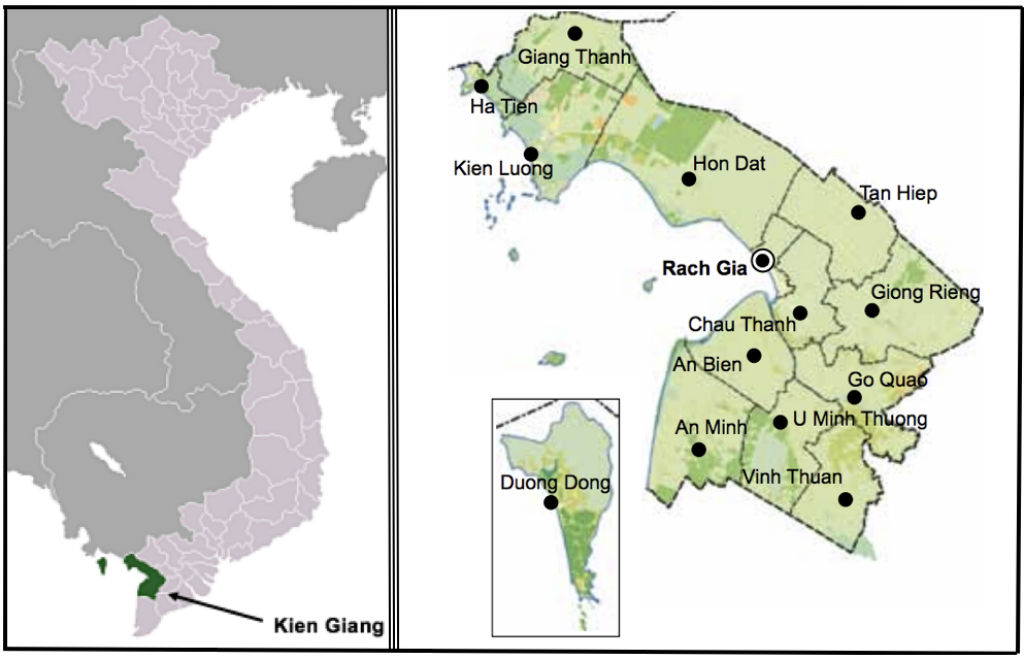
The Mekong Delta (MD) is located in the south of Vietnam, totalling an area of 39.200 km2 with waterways that are present everywhere, and are a part of all aspects of life, including transportation, fishing, trading, and all kinds of domestic uses. Over the years, water has been like a double-edged sword for people living in the delta. On the one hand, the alluvium rich water results in very fertile soils, which increases the agricultural productivity of farmers in the MD. Whilst on the other hand, the presence of water exposes people living in the MD, and the delta itself, to a constant threat of climate stresses, such as floods and excessive rains during the wet season, and water scarcity, saline intrusion, and drought in the dry season (Käkönen, 2008). Currently, the MD is Vietnam's main rice producing belt, which has transformed the country from experiencing enormous rice deficits in the past, towards being an economy with a huge rice surplus (Demont & Rutsaert, 2017). This rapid increase in productivity was made possible by technological development, and investments in the regions' infrastructure. The major improvements in terms of productivity is best illustrated by the rise of the region's rice production from 4,5 million tons of rice in 1976 to 24.6 million tons in 2012 (MARD, 2013**).** However, in 2015 and 2016 the agricultural industry in Vietnam was hit hard by climate-induced disasters and around 700.000 hectares of rice and various other agricultural crops were affected or destroyed. Rice production fell by over 800.000 tons compared to the year before, which forced the Vietnamese government into taking climate change adaptation measures. According to the Ministry of Agriculture and Rural Development (MARD) shrimp farming appears to be the most promising alternative, although still facing some challenges to overcome (Vietnamnet, 2017b). The following paragraphs give some additional information about Kien Giang and discuss Kien Giang's agricultural transition that is currently ongoing. After which the current agricultural situation in An Bien districts is elaborated on.

3.1. Kien Giang: Agriculture, aquaculture and changing climatic conditions

Kien Giang province is located in the south of Vietnam (see map 3.1), totaling a land area of 634,000 hectares, and is one of the 13 provinces that form the MD. The total population of around 1.7 million people is divided amongst 13 districts, and a total of 118 communes. With around 73 percent of the population living in rural areas, the emphasis of Kien Giang's economy lies on the agricultural and aquaculture industry, with a total of 443,000 hectares used for production of agricultural products (Mackay & Russell, 2011; ADB, 2013). The agricultural industry in Kien Giang is mainly dominated by rice cultivation and aquaculture, in which it holds second position in terms of production volume within Vietnam (JICA, 2013; Mackay & Russell, 2011). The north of Kien Giang is since the construction of drainage and irrigation systems mainly characterized by the presence of two crop rice paddy fields. Whereas the south, and the coastal districts of Kien Giang are experiencing seasonal saline intrusion, which makes it much harder to only grow freshwater crops such as rice or fruit. In

these areas the farming systems have adapted to be better able to cope with changing climatic conditions and focus on the production of shrimps during the dry season, whilst cultivating freshwater crops, such as rice, during the wet season. In some coastal areas, fresh water availability is lacking to such an extent that the cultivation of fresh water crops is near to impossible, and farmers are only able to grow shrimps (JICA, 2013). A recent report (ADB, 2013) stated that Kien Giang can be divided into three ecozones; a) Kien Luong and Hon Dat, b) central eastern districts, and c) U Minh Thuong NP, An Bien and An Minh (see map 3.1). The zone of Kien Luong and Hon Dat is bordering Cambodia and An Giang province, and is affected by annual flooding, and the coastal areas are affected by seasonal saline intrusion. The central eastern districts are too far inland to be affected by saline intrusion but are experiencing occasional floods affecting their agricultural productivity. The U Minh Thuong, An Bien and An Minh region is heavily affected by saline intrusion, which has resulted that a significant part of the region applies the rice-shrimp farming model.

Map 3.1: Location of Kien Giang province (left), and map of Kien Giang province (right)



Source: Author's own making, and adapted from ADB, 2013

Originally, Kien Giang, like other coastal provinces in the MD, was mainly focused on subsistence rice farming, but in the late 20th century privatization and commercialization of rice-based farming systems in Kien Giang led to the intensification and diversification of the agricultural industry, and eventually created a food surplus (Nguyen, 2011). Following the policy implementation for land use diversification in late 2000, the aquaculture industry in Kien Giang, and other coastal provinces in the MD, have seen a rapid increase in shrimp production (Nguyen, 2011). In several of Kien Giang's districts, the focus has been on shifting the farming model from double-rice cropping towards a system that alternates between rice and shrimp farming. According to the authorities, this alternating system is believed to be

better able to cope with increasing salinity levels, is more profitable than double-rice cropping and is able to reduce diseases amongst shrimp by interrupting the presence of disease during the dry season (MARD, 2016). Currently, a total of 300,000 hectares of land is used for rice cultivation, and around 80,000 hectares for the rice-shrimp model[1]. However, recent plans to change the land-use of 72,713 hectares of unproductive rice fields to rice-shrimp or rice-fish farming models by 2020 (ViêtNamNews, 2018), confirm the quick transition that Kien Giang's agricultural industry is currently experiencing, and emphasizes the relevance of this research.

3.2. An Bien district: a regional context

An Bien district is one of the coastal districts of Kien Giang province, and has a population of around 129,000 people[2]. It totals an area of 40,029 hectares, of which around 75 percent is used for the production of agricultural products (ADB, 2013). The agricultural sector is, as indicated before, heavily affected by saline intrusion, which has led to the transition from rice cultivation to a mainly rice-shrimp oriented agricultural sector. This transition started in the beginning of the 21st century when farmers in close vicinity of the ocean saw their rice yields. decrease due to increased salinity levels. Over the years, saline intrusion affected more farmers inland, which resulted in the slow transformation of farming models across An Bien district. As saline intrusion continuously reached further inland, and salinity levels increased, more farmers were forced to change their models to rice-shrimp farming[2]. In 2018, rice-shrimp farming covered a total of 21,000 hectares, whilst rice cultivation covered 8,000 hectares. In line with the provincial plans to increase the shrimp production by 2020 (ViêtNamNews, 2018), projections for An Bien district show an increase of rice-shrimp farm area to a total of 25,000 hectares, and a decrease of rice cultivation area to only 2,900 hectares by 2020[2].

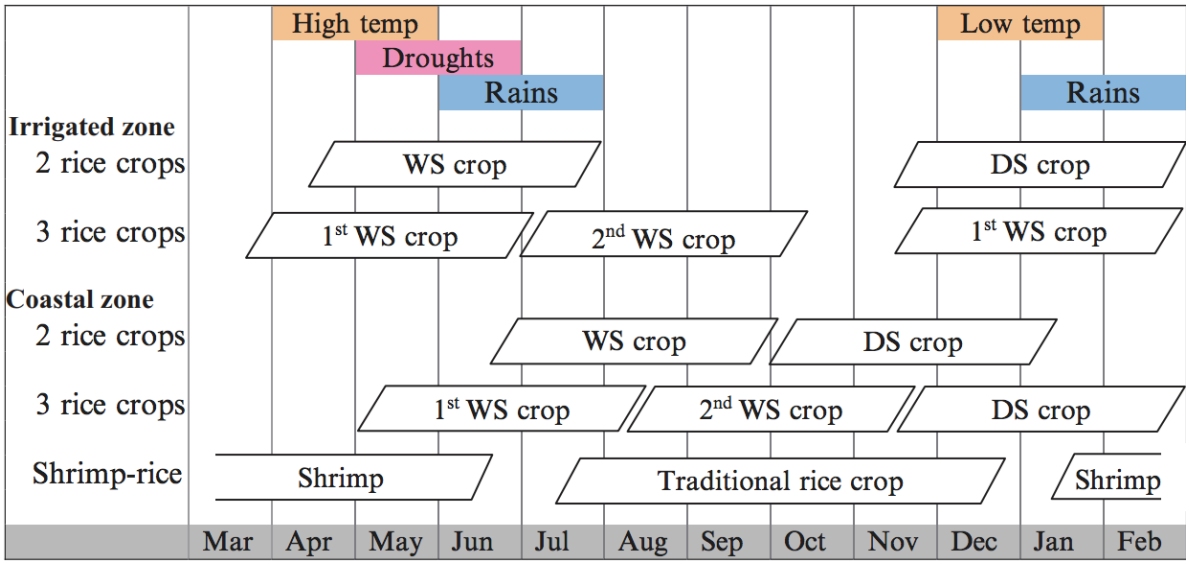
The crop calendar below illustrates the crop seasons of the rice and rice-shrimp farming models for coastal zones in the MD and indicates when certain climate threats could be harmful for the crops (see figure 3.1). Kien Giang, and An Bien district more specifically are coastal zones within the MD, which makes this crop calendar applicable. The rice model in An Bien in characterized by two crop seasons, one in the wet season (WS) and one partially in the dry season (DS). If heavy rainfall occurs at the end of the DS crop, when the rice is in its flowering and ripening stage, it will have a devastating effect and cause significant losses (Nhan, Trung & Sanh, 2011). Usually, rice-shrimp farmers have one rice crop during the wet season and try to have two shrimp crops during the dry season. However, extreme temperatures and unpredictable rainfall in the period from March till May would cause big

[1] Interview with official Department of Agriculture and Rural Development (DARD) (22/03/2018)

[2] Interview with An Bien district official, DARD (29/03/2018)

changes in the water environment of the shrimp ponds, thereby causing shocks for the shrimp population and could potentially result in harvest losses (Tuan & Chinvanno, 2011).

Figure 3.1: Possible climate threats and seasonal calendars for rice and shrimp farming in



irrigated and coastal zones, in Mekong Delta.
(Source: Stewart & Coclanis, 2011)

Additionally, a third farming model is applied by some farmers in An Bien district, namely extensive shrimp farming, and is mainly used in areas in close vicinity of the ocean due to the absence of fresh water. Extensive shrimp farming is usually characterized by low capital investment in the maintenance of the farm, such as the building and preparation of ponds, or shrimp raising techniques. Using this model shrimps are growing naturally without too much human involvement, such as feeding. Post-larvae (PL) are released at a low density, usually only one or two per m², which rely usually only on natural food present in the shrimp ponds. Farmers only interfere slightly during the development of the shrimps, by applying agricultural products such as lime powder ($CaCO^3$), or some fertilizers to increase algae growth, which acts as nutrition for the PL (Lan, 2011).

Altogether, An Bien's agricultural sector is mainly dominated by rice-shrimp farming, and to a much lesser extent by the other two farming models, which is In line with the statement of the MARD that rice-shrimp farming is regarded as the best option. The An Bien district official[3] furthermore mentioned that the transition from rice farming to rice-shrimp farming has shown promising outcomes in terms of livelihood improvement, and increased the ability to cope with experienced climate stresses. However, switching between farming models has not been completely without challenges. These challenges experienced are discussed in the upcoming chapter.

[3] Interview with An Bien district official, DARD (29/03/2018)

4. Results

The results of this research are presented in three paragraphs: the impact of changing climate patterns on farmers, household resilience to changing climate patterns, and adaptive responses to a changing climate. However, some general information about Nam Yén and Nam Thái, and household demographics of the survey sample are presented first, as they provide more background information on the local context and the research findings

4.1. Nam Yén and Nam Thái: Household demographics

Nam Yén and Nam Thái are two coastal communes within An Bien district, and are mainly dependent on agriculture or aquaculture. Livelihoods in areas in close vicinity of the ocean mainly depend on either aquaculture (shrimp farming) or fishing. In some occasions both professions are combined because shrimp farming does not require a farmer to be present on the farm full-time. Rice-shrimp farming practices are found more inland and comprise the biggest land area of all three farming models that are present in the communes (see table 4.1). Rice is still being cultivated in both communes, but due to recent developments the area for rice cultivation is declining[4]. Whilst the main crops are primarily grown for retail, households also use it for own consumption. Besides these main crops, several households across all three farming models kept farm animals such as chicken, or pigs, as a source for food. For (rice-)shrimp farmers, their main crop (shrimps) is considered as farm animal and is also produced for own consumption to sustain the families in rural households.

Table 4.1: Land area per farming model in Nam Yén and Nam Thái (hectares)

	Nam Yén	Nam Thái
Rice	183 ha	196 ha
Rice-shrimp	3,900 ha	3,475 ha
Shrimp	52 ha	300 ha
Total	**4,135 ha**	**3,971 ha**

Source: Interview with An Bien district official (29/03/2018)

As the household is the research unit of this research, the household characteristics of this survey sample are presented in the following paragraph. Characteristics such as age, educational level, gender, household size, and working population within the household, give an indication of the sample's demographics and help with providing more background information of the research area (see table 4.2). The average age from all respondents was 49,37 years, with a slight difference between Nam Yén being 48,87 years, and Nam Thai being 49,87 years. The age distribution of the respondents gives an indication that the population in both communes is becoming older, with only 12% of the respondents being between 26-35 years old. This ageing phenomena might become a problem in the future, as

[4] Personal observation in the field.

Table 4.2: Household demographics

Variable	
Sex	Male: 78% Female: 22%
Age	26 – 35 years: 12% 36 – 45 years: 27% 46 – 55 years: 31% 56 – 65 years: 23% 66 – 75 years: 6% 76 years and older: 1%
Educational level	No education:4% Primary school: 42% Secondary school: 38% High school: 15% University: 1%
Literacy rate	Literate: 92% Illiterate: 8%
Ethnicity	Vietnamese: 81% Khmer: 19%
Position in household	Household head: 79% Spouse: 19% Child: 2%
Number of household members (average per farming model)	Rice (n=30): 4.8 members Rice-shrimp (n=60): 4.6 members Shrimp (n=30): 4.2 members
Number of household members working (average per farming model)	Rice (n=30): 1.9 members Rice-shrimp (n=60): 2.6 members Shrimp ((n=30): 2.2 members
Farm size in hectares (average per farming model)	Rice (n=30): 1.37 ha Rice-shrimp (n=60): 3,02 ha Shrimp ((n=30): 1,75 ha

there will be a decreasing number of farmers that can take over the daily tasks of the elderly farmers. According to many of the interviewed farmers, their children moved away to bigger surrounding cities to find jobs and provide for their families, which explains the ageing population. However, in some cases, the farmers were confident that their children would return as soon as daily tasks on the farm would become too difficult, as is indicated by the following quote.

"My children had to move to the city to earn money when our crop failed, but they will come back when me and my husband will get too old. To take care of us and the farm" (Interview with rice-shrimp farmer, Nam Thái, 24/04/2018).

The highest level of education for most respondents was either primary or secondary school, whilst only one respondent attended university. Most farmers explained that while they were still attending primary or secondary school, they were already helping their parents on the farm. Common practice was that after children finished secondary school, they would start assisting their parents full time on the farm or find a job to support their household financially. When comparing the household sizes of the different farming models, households of rice farmers have the highest average with 4,8 household members per household. Whereas the households of rice-shrimp farmers (4,6 household members) and shrimp farmers (4,2 household members), have slightly less household members on average. Remarkable is that the average working population of households cultivating rice is the lowest (1,9 household members), while they have the most household members. The average household working population of rice-shrimp farmers with 2,6 members.

The ethnic distribution of the respondents was slightly skewed with respect to a recent Asian Development Bank report (Mackay & Russell, 2011) with 81 percent being Vietnamese (n=97), and 19 percent Khmer (n=23). Interestingly, the number of Khmer people in each farming model differed significantly. Off 23 respondents being Khmer, 20 respondents were rice farmers, while only 3 applied the rice-shrimp model and none were among the respondents doing shrimp farming. These differences are discussed later on in paragraph 4.3.1., which elaborates on the five resilience pillars.

4.2. The impact of changing climate patterns on farmers

Multiple authors (Adger, 1999; Morton, 2007), have discussed the potential impact that climate change can have on the agricultural industry. As the Mekong Delta (MD) is one of the areas in Vietnam most vulnerable to climate change, whilst simultaneously being the area with the country's highest agricultural productivity (Käkönen, 2008). Farmers have already been experiencing the effects of a changing climate, and experienced difficulties in coping with changing climate patterns. According to the DARD[5], the main threats for especially rice and rice-shrimp farmers are rising temperatures, droughts, and increased salinity levels, all of them affecting the water quality used for their farms. Unpredictable rainfall is a major concern for shrimp farmers because excessive rainfall leads to sudden alterations of the water temperature, which affects the quality of shrimps.

[5] Interview with DARD official (23/03/2018)

These changing climatic conditions led to the transition of farm models as a method to provide farmers with an opportunity to still be able to provide for their family. As this transition is ongoing, farmers are still switching their farming models to more appropriate models, which in the case of Nam Thái even resulted in such a decrease of rice farming, that only a small area of the commune remained rice farmers. The total area of rice cultivation in Nam Thái was in reality much smaller than the number provided by the district official of An Bien's department of agriculture and rural development (DARD).

Changing climatic conditions in Kien Giang province have not only resulted in more difficult circumstances for farmers. On the other hand, a changing environment has made it possible for farmers to change from rice farming to rice-shrimp farming, which generates a higher income with the current climatic conditions. The average income of rice-shrimp farmers (n=60) was with 106 million VND, significantly higher than the income of rice farmers (n=30) and shrimp farmers (n=30), respectively having an annual income of 69 million VND and 66,5 million VND. These numbers are in accordance with the district official[6], that claimed that climate change has been positive for most farmers as it provides them the opportunity to increase their annual income. According to him, climate change mainly has a negative effect on rice farmers because they lack flexibility when adapting to changing climate patterns, which is the result of operating a monocrop farming model.

According to provincial and district officials, climate change has thus been both detrimental and beneficial for farmers in affecting their livelihoods. The following paragraphs discuss the results acquired during the research concerning the experiences from farmers related to climate change impacts and give a better understanding of the farmer's perception on the topic. After which the perception of the farmers on whether the farming situation has become easier or not, is elaborated on. Conclusively, the reasons why farmers have or have not changed their farming model in the last ten years, are reviewed.

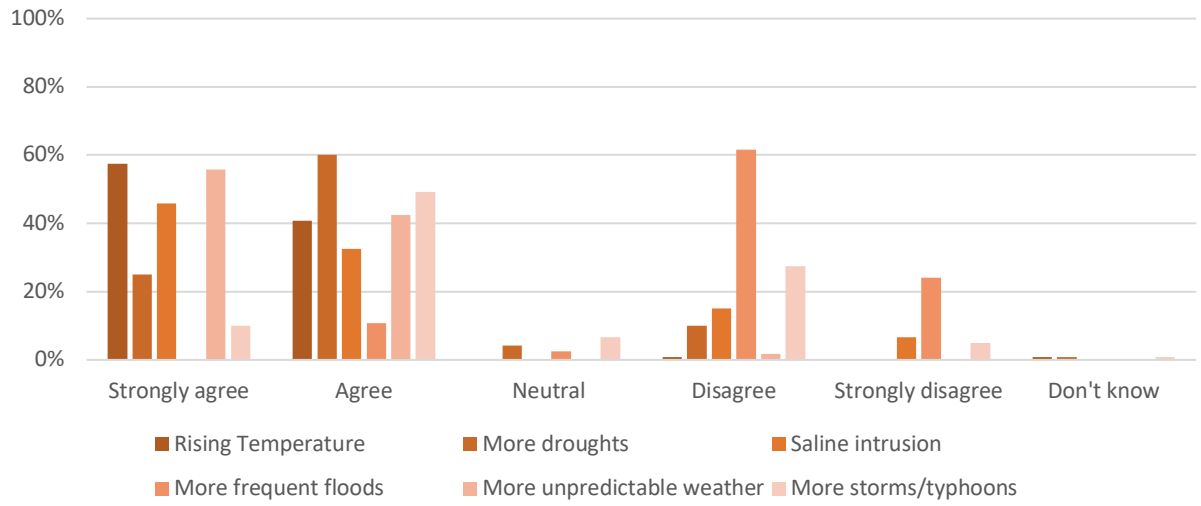
4.2.1. A farmer's experience of changing climate patterns

As farmers experience and deal with the weather every day, they are prone to changes in climate patterns. Agricultural productivity in the coastal areas of the MD is highly reliant on the weather, and the various crops grown there are mainly rain fed (Johnston et al. 2012). This research therefore aimed to find out to what extent farmers experienced changes in the climate patters in the last ten years. The farmers were given six statements concerning changing climate patters for which they had to indicate to what extent they agreed with the statements or not. During the research, it became clear that increased saline intrusion, rising temperatures and more unpredictable weather, were experienced most in the past ten years by farmers (see figure 4.1), which confirms the information provided by the interviewed

[6] Interview with An Bien district official, DARD (29/03/2018)

officials. The farmers also stated that they experienced more droughts in the past ten years, but whereas the other three climate change impacts were mainly strongly agreed with, the increase of droughts was mainly just agreed with by 60 percent. The main outlier though, is that 62 percent of the farmers disagreed, and 24 percent strongly disagreed with the statement whether they had experienced more floods in the past ten years. This is in accordance with the Asian Development Bank (Mackay & Russell, 2011) stated that An Bien is currently only moderately exposed to floods, but projections show that exposure will increase in the future.

Figure 4.1: Changing climate patterns experienced by farmers in An Bien, Kien Giang

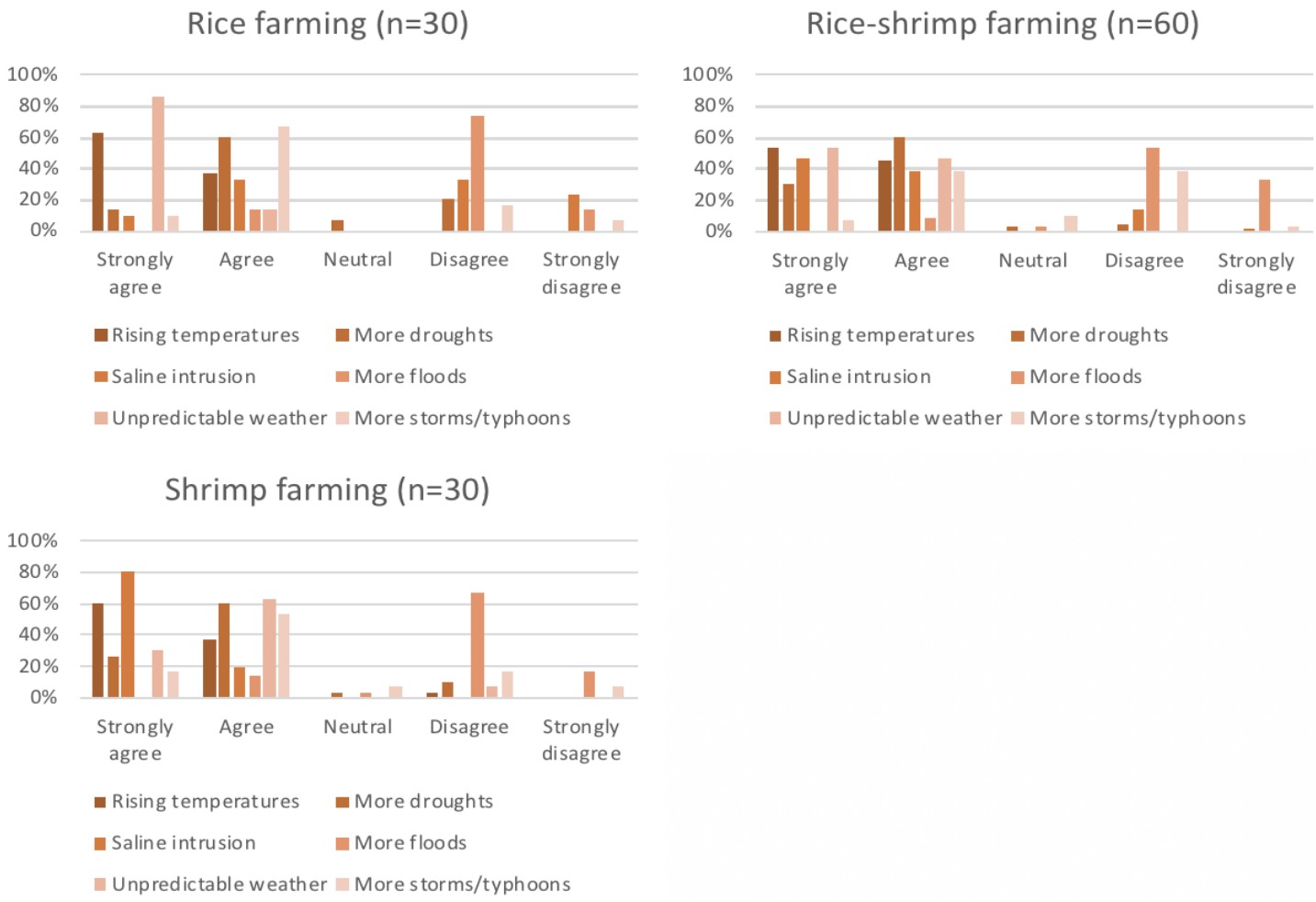


These numbers are however for both communes and all farming models this research focusses on. After analysing the experienced climate change impacts amongst farmers per farming model, something interesting showed up. As the charts below show (see figure 4.2), there are a few outliers which indicate that differences were identified between climate change impacts experienced by farmers using a different farming model. Over 80 percent of the rice farmers strongly experienced increased unpredictable weather, whereas with rice-shrimp and shrimp farmers, this was respectively 53 percent and 30 percent.

When analysing the impact of saline intrusion, it becomes clear that shrimp farmers were experiencing the worst impact from saline intrusion. From all shrimp farmers, 80 percent strongly agreed, and 20 percent agreed, with the statement whether they experienced saline intrusion in the past ten years. In comparison with rice-shrimp and rice farmers this is significantly higher, which clearly is shown in the bar charts below (see figure 4.2). This phenomenon can be explained by the fact that shrimp farms are in general always located closer to the ocean than rice-shrimp and rice farmers. It is however remarkable that the salinity levels of the ponds of shrimp farmers have increased to such an extent that occasionally farmers are facing problems growing shrimps. Several shrimp farmers

experienced salinity levels up to 40 parts per thousand (ppt), whereas 25 ppt is the ideal salinity level to grow shrimps. Salinity levels in which shrimps are able to survive range from 10 to 35 ppt, but when those salinity levels are exceeded, shrimps will become weaker, grow at a slower rate, and are more susceptible to disease (WorldBank, 2010).

Figure 4.2: Changing climate patterns experienced per farming model



An impact experienced mainly by rice farming that is not illustrated by the charts above, is a massive drought that occurred 3-4 years ago. This same drought pressured the government into taking action to prevent an agricultural and economic disaster of this scale from happening again, with increased shrimp production as a result (Vietnamnet, 2017b). Although rice-shrimp and shrimp farmers were also affected, rice farmers mentioned that since the drought occurred, rice cultivation has been impossible, and no profits have been made from rice farming since. In many cases, rice farmers have only been able to produce just enough rice to provide for their families, whilst the major part of their rice paddies is drying out (see figure 4.3). If rice paddies dry out, farmers experienced more difficulties growing rice next season, which often results in a decreasingly worsening situation.

Figure 4.3: Rice fields in Nam Yén during dry season

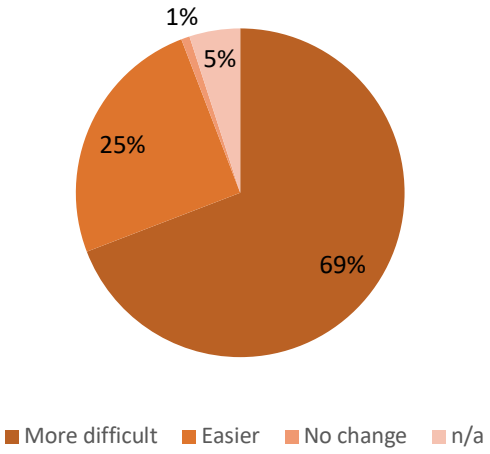
Source: Poelma, 2010

4.2.2. Assessing the current farming situation

As discussed in the previous paragraph, all farmers in An Bien district have been experiencing changing climate patterns, which has affected their livelihoods and farming situation. However, as An Bien's district official[7] mentioned, these changing climate patterns do not necessarily have a negative influence on the livelihoods of farmers. According to him climate change even had a positive effect in terms of increased annual income due to the possibility for farmers to change to more profitable rice-shrimp farming practices. The results of this research (see figure 4.4) indicate however that a majority of farmers (69 percent) assess their current farming situation as being more difficult compared to ten years ago. 25 percent of all farmers stated that their farming situation improved in the last decade, and only 1 farmer experienced no change. A small part of the survey sample is indicated as n/a in the pie chart, which is because those farmers have been farming for a period shorter than ten years. Despite increased difficulties experienced by farmers in the last ten years, simultaneously it was also mentioned that in certain aspects farming has become easier. The following sub-paragraphs first discuss why farming compared to ten years ago, has become more difficult for farmers, after which the results on why farming has become easier are elaborated on.

[7] Interview with An Bien district official, DARD (29/03/2018)

Figure 4.4: Farmer's assessment on current farming situation compared to ten years ago



4.2.2.1. Negative agricultural development

The majority of farmers (n=83) experienced that farming has become more difficult in the past ten years. A wide variety of reasons was given for their worsened farming situation, with the main reasons being climate related. Around 60 percent of the farmers who claimed that farming has become more difficult blamed it either on saline intrusion or unpredictable weather, or unpredictable rainfall more specifically. One of the interviewed farmers stated the following about this:

"Some years ago, the water became too salty and destroyed all my rice. There was nothing I could do about it" (Interview with rice farmer, Nam Thái, 26/04/2018).

The saline intrusion experienced by this farmer was during the massive drought that affected the entire agricultural industry in the MD in 2015 and 2016. Adamson and Bird (2010) state that deficient water flows during the dry season caused by droughts, allow for increased saline intrusion, thereby reducing fresh water availability. Which explains the saline intrusion experienced by this farmer. Another rice farmer even claimed that fresh water was only available for 3 months in 2015, while in the remaining 9 months water in the rivers was saline. The drought affected several other farmers that complained about rising salinity levels after prolonged dry seasons, which had major impacts on their agricultural productivity and yields. The salinity in rivers sometimes reached levels up to 30 ppt, which are salinity levels similar to the open ocean (WorldBank, 2010). For rice-shrimp farmers, saline intrusion affecting their rice seasons indirectly also affects their shrimp production. The roots of the rice crop acts as a natural nutrient for shrimps, which they need to develop and grow. A lack of roots from the rice crop will therefore result in a lack of natural nutrients, which have to be replaced by fertilizers and medicines in order to let the shrimp develop, which is highlighted by:

"My shrimp production is affected by my rice season. When I do not have the roots from the rice plant, the shrimps are missing food. Because my rice crop failed I now have to use medicines to replace the root of my rice plant" Interview with rice-shrimp farmer, Nam Thái (24/04/2018).

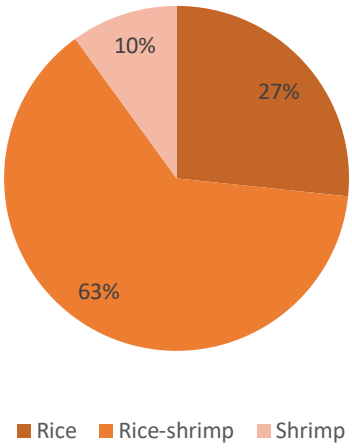
The increased use of fertilizers and medicines automatically leads to increased operational costs for the farmers, which makes it sometimes even more difficult to provide for their families. Furthermore, farmers experienced rising temperatures, which indirectly also contributed to further increase of salinity levels in the shrimp ponds. The resulting evaporation of water in the shrimp ponds caused salinity levels to increase even more, sometimes leading up to levels of 40 ppt. Due to these high salinity levels, several farmers noticed that shrimps either were underdeveloped, or became so weak that they died. During this research, I mainly encountered farmers that experienced high salinity levels which affected their farm. However, in a single case, a farmer experienced the exact opposite, with salinity levels being too low (2-3 ppt) for shrimp production. Salinity levels this low are as harmful for shrimps as high salinity levels, resulting in underdeveloped, weak shrimps with a high mortality rate.

According to many farmers, unpredictable heavy rainfall was another reason why farming has become more difficult in recent years compared to ten years ago. In some cases, heavy rains occurred during shrimp seasons, which led to sudden changes of water temperatures in the shrimp ponds. These sudden changes in temperatures often lead to disease amongst the shrimp, of which White Spot Disease (WSD) is the most common. Xue, Wei, Li, Geng & Sun (2015) confirm that decreased water temperature is an important factor that allows replication of the virus, whilst simultaneously affecting the immune systems of shrimps. As soon as WSD is identified amongst the shrimps, farmers have to harvest all the shrimps immediately, despite the size of the shrimps. Until now, no treatment is available that can cure WSD, which makes it even more devastating for farmers upon discovery of the presence of the disease. The possibility of new disease outbreaks in the future due to the presence of the virus in the soil, necessitates farmers to properly treat their ponds after harvesting the affected shrimp population. Treatment of the soils is furthermore needed to prevent the overall quality from degrading too much, which will affect the productivity off the farm. Several farmers told that farming became more difficult compared to ten years ago because their farm soils degraded due to extensive use over a long period of time. It was mainly shrimp farmers that were affected by this, explaining that shrimp production for a long period causes all the nutrients to be depleted from the soils, making the soils infertile if fertilizers, medicines and pesticides are not used adequately.

4.2.2.2. Positive agricultural development

A total of 30 farmers (n=30), making up 25 percent of the survey sample, shared the opinion that farming has become easier compared to ten years ago. Figure 4.5 shows the division of farmers, per farming model, that claimed that farming has become easier in the past decade. Farmers using the rice-shrimp model were most positive about their farming situation, with 19 farmers declaring farming became easier. Just like with farmers that claimed farming became more difficult, was that a wide array of reasons was provided that explained their assessment of the current farming situation. Remarkable though is that several farmers did mention how the consequences of climate change had a negative impact on their farming activities. Apparently, for those respondents, positive developments in the past ten years outweighed the negative impact of climate change on their livelihoods. Unsurprisingly is the fact that the reasons given to why the farming situation has improved over the last decade are all non-climate related.

Figure 4.5: Positive assessment of agricultural situation (per farming model)



According to 50 percent (n=15) of the farmers who claimed that farming became easier, increased annual income and higher profits were one of the main reasons given for this improvement. Analysis of the results show that the increased income was mainly the result of changing farming models. 12 out of 15 farmers changed their farming model from rice to rice-shrimp farming, which resulted in higher income due to higher shrimp prices. The average annual income of farmers within different farming models confirm this, as rice-shrimp farmers on average (n=60) earned 37 million VND more than rice farmers (n=30). Another reason that explains why farming has become easier is that less labour is needed by farmers to maintain their farm. Several farmers claimed that shrimp farming requires significantly less labour because once the post-larvae (PL) are seeded in the shrimp ponds, only little work remains except for occasionally checking the quality of the water and shrimps. Whereas rice farming required much more tough manual labour such as maintaining the rice paddies and spraying pesticides. The manual labour on rice fields often is time consuming and requires additional help from paid labourers, which results in additional operational costs.

It thus seems that farmers are positive after changing to rice-shrimp farming due to increased income and the requirement of less labour. However, the results furthermore indicate that rice-shrimp farmers that claimed their farming situation improved (n=19), on average changed their farming model 6,6 years ago. Whilst rice-shrimp farmers claiming the opposite (n=39), changed their farming model averagely 10,5 years ago. Unfortunately, the sample size does not allow for further statistical analysis on the matter, but it does suggest a possible correlation between the length of running the rice-shrimp model and the assessment of their farming situation. The results on the other farming models did not suggest any possible correlation and will therefore not be elaborated on.

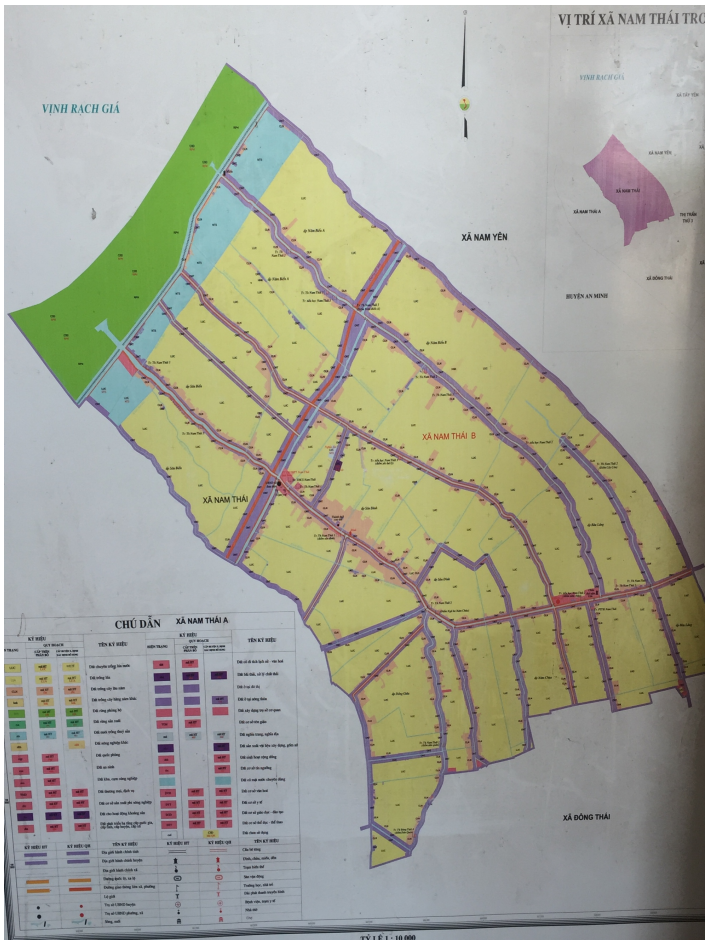
Whereas rice-shrimp farmers mainly mentioned increased income as reason for an improved farming situation, rice farmers were mainly positive about the availability of better equipment. They mentioned that new machinery reduced the manual labour needed to maintain the rice paddies. New pesticides, medicines, and fertilizers was another factor which made rice farming easier and more successful compared to ten years ago. Newly developed rice seeds also had a positive impact on the farming situation of several rice farmers, as they claimed that these new rice seeds were better able to cope with more extreme weather conditions compared to the seeds they used before.

4.2.3. Changing farming models

The previous paragraph indicated that changing farming models in some cases had a positive impact on the livelihoods of farmers. Changing farming models thus seems like an appropriate manner to cope with and adapt to changing climate patterns. However, according to Kien Giang's official[8], farmers are obliged to follow the governmental zonation plan, in which all areas in the district are designated to a certain land use. Farmers located in an area that is designated for rice production are obliged to cultivate rice, and the same applies to the other farming models. This explains that among farmers, following the zonation plan, was the most common reason to change their farming model. The map (see map 4.1) below shows the zonation plan for Nam Thái commune, in which, amongst others, the agricultural zones are indicated until 2020. The light red areas in the map indicate the presence of farms, whereas the bright yellow areas are for agricultural purpose. All over the map letter combinations indicate what the land use of that particular zone is, which is determined by the provincial government.

[8] Interview with official sub-department aquaculture, DARD (23/03/2018)

Map 4.1: Communal zonation plan Nam Thái commune, An Bien district



Source: Poelma, 2010

Although farmers are officially obliged to follow the provincial zonation plan, slight discrepancies between the plan's designated land use zones, and actual land use in both communes, have been found in the past. Several farmers mentioned that after zonation plans were updated, not all farmers switched directly to new farming models. Unwillingness due to a lack of knowledge among farmers, which is needed to run daily operations with the new farming model, was often the main reason for farmers to refuse cooperating into switching models. However, being reluctant at first due to lacking knowledge of new farming techniques, many farmers were eventually satisfied changing farm models because of increased income, as was described in the previous sub-paragraph. Saline intrusion from neighbouring farms was another reason that forced rice farmers into adopting new farming methods. The saline water needed for shrimp production will seep through adjacent areas, thereby affecting the groundwater of neighbouring farms. Illustrative for this is that several rice farmers explained that affecting their neighbours with saline water is the main reason that keeps them from changing their farming model, which is made clear by the following quote.

"I will not just change to rice-shrimp farming because I can get problems with my neighbours because of the salty water that is needed to grow shrimps. I will only change my model when the government changes their plan" (Structured interview with rice farmer, Nam Yén, 09/04/2018).

Whereas farmers located more inland were often following the zonation plans, farmers in coastal areas were affected by climate induced threats to such an extent that forced them into adopting new farming methods. Several farmers explained that officially their farms were located in a zone destined for rice-shrimp farming, but salinity levels were so high that rice cultivation was impossible. Therefore, they changed to extensive shrimp farmers in order to cope with the changing climatic conditions. Two farmers stated that the rice-shrimp model was a good and sustainable farming system, but saline intrusion forced them unwillingly into changing their farming model to extensive shrimp farming. Now, their shrimp yields are decreasing annually due to degrading soils and increasing salinity levels.

Most farmers eventually changed their farming model to adapt to changing climatic conditions, saline intrusion from neighbouring farms, or in some cases to increase their annual income. However, a major part of remaining rice farmers in both communes remain unwilling to change their farming model to rice-shrimp farming. As became clear during an interview with Kien Giang's provincial official [9], 70 percent of farmers in a certain area have to agree with the new provincial zonation plan when it is updated. If not, the land use for that area will not be changed. Rice farmers in both communes unwilling to cooperate often had small-sized farms, which makes changing to rice-shrimp farming not profitable. However, some rice farmers in Nam Thái suggested that in 2020 the last rice farming zone will be converted to rice-shrimp farming, which was later confirmed by a Nam Thái commune official[10].

4.2.4. Conclusion

Analysis of the data has shown that all respondents (n=120) were to some extent affected by changing climate conditions in the past ten years. Shrimp farmers were affected mainly by saline intrusion and unpredictable rainfall. Whereas, rice farmers mainly experienced rising temperatures, and were affected massively by the drought in 2015 and 2016, that brought most of the rice production to a halt since then. These climate change impacts were for a majority of all respondents (69 percent) reason to assess their current farming situation as being more difficult compared to ten years ago. In some cases, the impact of changing climate conditions caused farmers to change or adapt their farming model. However, following updates of the government zonation plan, was the main reason for the majority of farmers to change their farming model in the past ten years.

[9] Interview with official sub-department aquaculture, DARD (23/03/2018)

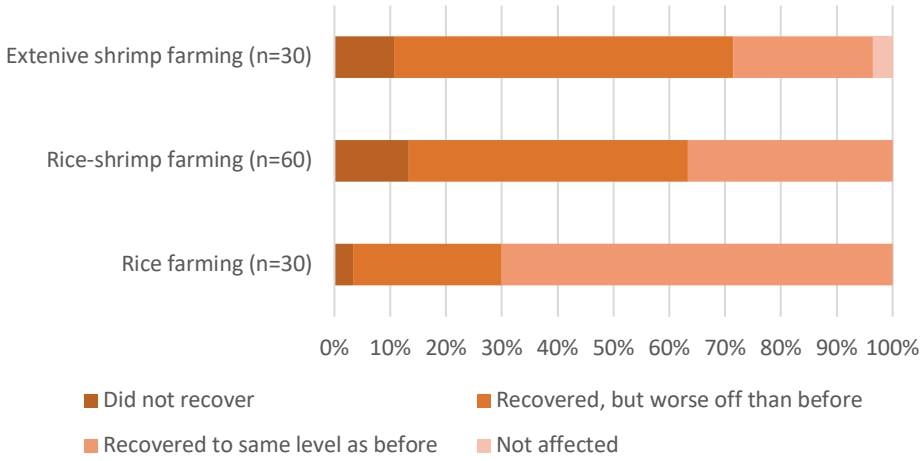
[10] Interview with Nam Thái commune official (25/04/2018)

4.3. Household resilience to changing climate patterns

Recent developments in Kien Giang have shifted the focus from agriculture towards a more aquaculture-oriented economy in coastal districts and communes. The national and provincial governments are convinced that farming models that alternate rice cultivation, with shrimp production, in between wet and dry season, will be better able to cope with a changing climate (Vietnamnet, 2017b). This research has shown that farmers using various farming models in the research area have experienced, and were affected by, changing climate patterns in the past ten years. Whereas the previous paragraph focussed on what impact changing climate patterns have had on farmers in Nam Yén and Nam Thái communes, this paragraphsr's focus will be on the capacity of households to cope with, and recover from, these changing climate patters. Climate is however only one of many factors that influence a household's coping and adaptation strategy (Adger, 1999). The focus will therefore not only be on climate, but furthermore on several other non-climatic factors such as income level, access to basic services, and social safety nets.

The bar chart below (see figure 4.6) indicates to what extent farmers were able to recover after their household was affected by a climate-induced event. Although no distinction was made between what climate events the farmers were affected by and recovered from, the results still show an interesting outcome. Whereas the level of recovery by shrimp and rice-shrimp farmers show similarities, with a majority of them being worse off than before the event. Rice farmers claimed that in 70 percent of the cases, the climate induced event did not affect their household and farm. The following paragraph gives an explanation for these differences in terms of level of recovery, between the farming models, by elaborating on the different objective factors that influence the household's resilience. These factors combined will determine the objective household resilience, whilst in the second paragraph, subjective household resilience will be elaborated on.

Figure 4.6: Level of recovery after climate induce events (per farming model)



4.3.1. Objective household resilience

As was discussed previously, household resilience is determined, not only by climate, but several other factors that affect a household's capacity to cope with external stresses. Those factors can be divided amongst five pillars, which were introduced in the Resilience Index Measurement Analysis (RIMA) framework (FAO, 2016). The collected data concerning objective household resilience, will be discussed in the coming sub-paragraphs by following these five pillars, starting with the access to basic services households have in Nam Yén and Nam Thái.

4.3.1.1. Access to basic services

In line with Aguero, Carter and May (2007), basic services such as access to electricity, drinking water, schools, health clinics, and markets were considered to be important for this research. During the research, a distinction was made between services asked upon during the survey and interviews, such as schools, health clinics and markets, and services (e.g. electricity and water) that were assessed by observation. After analysis of the results, no clear differences were identified between the various farming models in terms of accessibility to services such as schools, marketplaces, or health clinics. Although the travel distance for some households was slightly further, or direct access to the road network was lacking, resulting in using a boat as transport, all respondents were able to access those services without putting in too much effort. An overall rating considering the quality of the services was given, making use of a Likert scale (1 being very good and 5 being very bad), which is shown below (see table 4.3). The ratings given by the respondent do not show significant differences between the different farming models. The quality of health clinics, or healthcare in general, was regarded the lowest, which was exemplified by complaints about the lack of properly trained staff and proper equipment at the local health clinics. Instead of going to the local clinics, some farmers admitted going to the district hospital, which is located much further away. However, several farmers shared the opinion that in recent years the quality of the services increased, which was confirmed by the An Bien district official[11] who stated that the overall quality of An Bien's infrastructure and educational systems has substantially improved over the past ten years.

Table 4.3: Average rating of public services in Nam Yén and Nam Thái

	Rice (n=30)	Rice-shrimp (n=60)	Shrimp (n=30)
Market	2,00	1,97	2,20
Primary school	2,12	2,15	2,22
Secondary school	2,20	2,19	2,24
High school	2,38	2,16	2,42
Health clinic	2,30	2,29	2,71

[11] Interview with An Bien district official, DARD (29/03/2018)

All households were in possession of a television and a mobile telephone, which indicates that they had electricity at their disposal. Whereas all household were connected to the electricity grid, the majority of households did not have tap water. The Mekong River Commission (MRC) stated that in the MD three sources are used for drinking, namely rain water, surface water and ground water (Tuan, 2005). Households in Nam Yén and Nam Thái mainly used rain water as a source for drinking water, which they collected and stored in big storage jars (see figure 4.7). Furthermore, water wells and water pumps are used to extract ground water that is used to irrigate their farms, and if needed as a source for drinking water. Overall, no major differences were found between the different farming models in terms of the access to those basic amenities.

Figure 4.7: Water storage jars, and water pump in Mekong Delta[12]

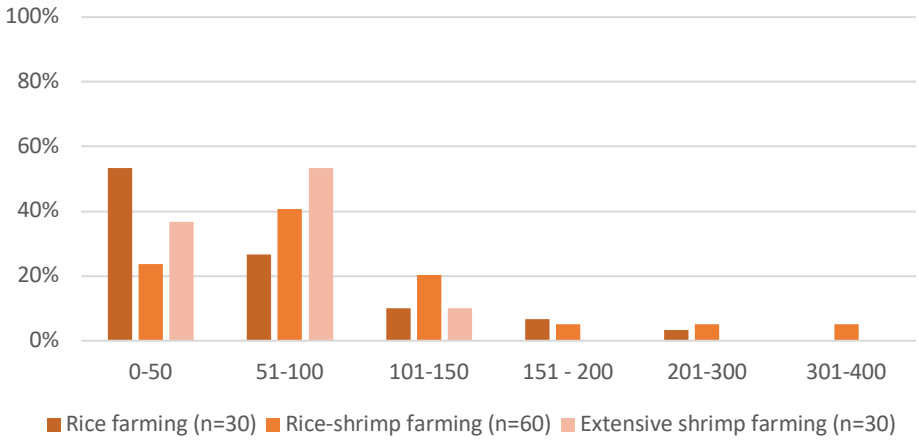
4.3.1.2. Assets

The second pillar of objective household resilience is constructed by assets characterizing households, such as income, presence of consumer durables, and farm size. Income is often regarded as a determining factor when assessing the coping capacity of household after having experienced external shocks (Dercon, 2002). Related to income is whether a household has loans or savings, which both can be an influential factor in the recovery phase after a shock by which the household was affected. As was discussed before, the income amongst rice-shrimp farmers is the highest off the three different farming models, with an average annual income of 106 million VND. Rice farmers and shrimp farmers respectively have an annual income of 69 million VND and 66,5 million VND, which is significantly lower. The bar chart below (see figure 4.8) gives a more exact image of the differences between income levels amongst farmers, with a distinction made between the different farming

[12] Retrieved from https://ewbchallenge.org/habitat-humanity-vietnam/design-area-2-wash

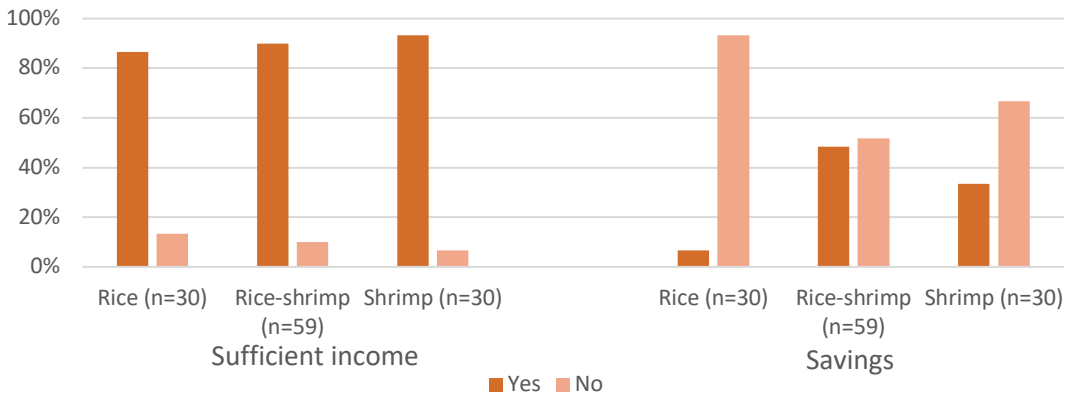
models. It becomes clear that the annual income of rice-shrimp is slightly more divided over all income classes, whereas the average annual income of rice, and especially shrimp farmers is more concentrated in the two lower income classes.

Figure 4.8: Annual income farmers (per farming model)



The analysis of the data concerning whether households were able to take care of their family's needs, and have savings, with their current annual income, showed an interesting finding (see figure 4.9). Amongst all three farming models around 90 percent of the respondents claimed that the household's annual income was sufficient to sustain their family. However, major differences were identified upon analysing whether these households had any form of savings. Only 7 percent of all rice farmers explained that their household had savings, whilst 48 percent of all rice-shrimp farmers and 33 percent of the shrimp farmers claimed they had savings. The difference between rice and shrimp farmers concerning household savings is remarkable because the income level of both farming models is relatively similar. However, the average household size of rice farms (4.8 members) is bigger than the average household size of shrimp farms (4.23 members), and thus have more people to sustain whilst the income level of both models is quite similar.

Figure 4.9: Sufficient income amongst farmers, and household savings (per farming model)



Although no direct linkage was found between the farm size and the ability the cope with and recover from changing climate conditions. Several farmers did claim that in recent years many farmers with a limited amount of farm land were affected by a changing climate and eventually had to move away. The farm size of those households who migrated were usually below one hectares, which hampered them to adequately respond to changing climatic conditions.

4.3.1.3. Social safety nets

This resilience pillar consists of formal and informal networks that both can provide farmers with a better access to financial resources in the case of dealing with external shocks. Such access to resources is an important source of poverty alleviation, especially in developing countries (FAO, 2016).

Access to formal transfers

According to An Bien's district official[13], disaster support plans are developed in the case farmers are affected by climate-induced events, such as the drought in 2015 and 2016. However, before farmers will be compensated a certain procedure takes place, which goes through several bureaucratic layers. After a disaster takes place, farmers first report to the commune office, after which the case is taken to the district office, which then is taken to the provincial department. At the provincial department, the case is evaluated and assessed by provincial officials that determine how, and if the affected farmers will be compensated. Compensation for farmers can either by in the form of rice seedlings or post-larvae, or as financial support[14]. The extent to which farmers are financially compensated is determined by what stage the crop is at the moment the disaster occurred. If the crop is seeded in the first stage, which means within 45 days of the disaster, the farmer invested a relatively small amount of money and time, and can therefore expect a small financial compensation. However, when the crop was planted more than 45 days before disaster struck, the compensation is significantly higher. In some cases, financial compensation reaches levels up to 5 million VND per hectare in the second stage. In both stages, a compensation will be given of 30 to 70 percent of the initial investment. This percentage is determined by the observation of experts who determine how much of the crop is exactly destroyed or affected by the disaster. A remarkable statement from An Bien's district official was that the provincial government only compensated rice farmers after the drought in 2015 and 2016. According to him, rice-shrimp and shrimp farmers were not affected to such an extent they needed external support.

[13] Interview with An Bien district official, DARD (29/03/2018)

[14] Interview with official sub-department aquaculture, DARD (23/03/2018)

In recent years, the government only compensated farmers after the drought in 2015 and 2016, whilst several farmers mentioned their crop was affected in other years too, due to changing climate patterns. If farmers are in need of financial support to sustain their family but government support is lacking, getting a loan at the bank is relatively easy. When applying for a loan, banks usually require farmers to show a proof of ownership of their farm land, which acts as a deposit. Of all respondents, 87 percent owned their own land, and was thus able to apply for a loan at a bank. When farmers are struck by disaster, whilst already having a loan, banks usually allow farmer to postpone their loan's repayment up to one year. However, some farmers explained they were unwilling to get a loan from the bank because the notion of being in debt repulsed them. A single farmer admitted the following:

"I do not want to go through all the legal stuff in order to get a loan. I want to focus on earning money for my family" (Interview with rice-shrimp farmers, Nam Yén, 04/04/2018).

Access to informal transfers

Access to informal transfers can act as an insurance policy in the case farmers are not able, or willing to receive support through formal transfers, which were discussed previously. Remittances are an important factor which provides households with an increased livelihood stability. This financial flow often originates from household members migrated to urban zones to earn money to either support their former household members, or to start a new life with their families. Remittances received by farmers in Nam Yén and Nam Thái were, as Adger (1999) mentioned, in general not dependent on local environmental conditions, and were usually earned by paid employment. In total, 20 farmers stated they received remittances regularly, whilst several others explained during their interviews, they were able to receive money from their children if their crop failed. This confirmed the finding that over 75 percent of all respondents (n=120) would be able to receive money from their social network if their household was affected by climate related events. After analysing the results, no differences between the different farming models were identified in terms of receiving financial support or remittances.

Besides remittances, several other ways of receiving informal transfers were identified during this research. So-called 'hot loans' are another solution for farmers to receive financial assistance through their informal social safety nets when this is needed. Hot loans are characterized by high interest rates and are usually distributed by resourceful commune members. Farmers getting such loans are usually unable to get bank loans because they are not in possession of the certificate of ownership for their land or need additional money besides the bank loan they already have. Several farmers were furthermore satisfied about recent developments that enabled them to acquire agricultural products such as pesticides, medicines and fertilizers, whilst paying for those products at a later moment. Local shops are providing farmers with a service that allows them to pay for their products later when they

are lacking financial resources due to failed crops. Even though all purchased goods are registered by the shops, this service is built mostly on trust between both parties. Conclusively, almost 80 percent of all respondents admitted that if their household was needing help due to experienced problems such as injuries among household member or caused by changing climate patterns, that their social safety nets, consisting of friends and family, would be willing and able to provide support.

4.3.1.4. Sensitivity and adaptive capacity

Sensitivity to external stresses or perturbations, is the fourth resilience pillar which will be discussed, and can best be defined as the "extent to which a human or natural system can absorb impacts without suffering long-term harm or other significant change" (FAO, 2016: 14). Chapter 4.2, on the impact of changing climate patterns on farmers, discussed that the drought in 2015 and 2016 hugely impacted rice farmers. In some cases, farmers have been unable to generate any profits from farming since, and farmers have been forced into finding different ways to sustain their families. This was confirmed by Nam Thái commune official[15] that claimed that rice farmers were affected most by the 2015 – 2016 drought, whilst the rice-shrimp farmers were affected least. Despite being affected, rice-shrimp and shrimp farmers were generally still able to harvest some of their shrimp, which generated enough income for those farmers to provide for their families.

The final resilience pillar is constructed by a household's adaptive capacity, which is determined by the ability of households to adapt to changing conditions of the system in which it operates (FAO, 2016). The results indicated that access to knowledge was one of the most important factors for farmers to be able to successfully adapt to changing climatic conditions. Especially after changing farming models, farmers experienced problems using new farming methods, which were partially solved by following specialized training courses. Usually, a training course is organized by the Centre for Agriculture and Aquaculture Extension (CAAE) for farmers upon changing their farming models, during which they learn how to run their new farming model. Furthermore, the CAAE organizes a training at the start of the season about new farming techniques and gives an explanation on the updated crop calendar. Halfway through the season, a second training is organized in which farmers are educated about how to treat disease and handle insects by using the right medicines, fertilizers and pesticides. When extreme weather events take place, the CAAE usually organizes additional training courses where farmers are taught methods which enables them to cope with such weather conditions in the best possible way[16]. According to the Nam Thái official[15], all household are notified by the hamlet leaders, for upcoming training courses that they can attend free of charge.

[15] Interview with Nam Thái commune official (26/04/2018)
[16] Interview with Nam Yén commune official (10/04/2018)

After analysing the data, a discrepancy with the official's statement was found, as the several farmers mentioned they were rarely notified about upcoming training courses. Farmers furthermore claimed that the training courses often focussed on new farming methods unsuitable for their farming model and were therefore rarely helpful. However, in two cases farmers claimed that knowledge learned during training enabled them to adapt to changing environmental conditions, which eventually increased their agricultural productivity. This is in line with Gallopin (2006) who claimed that "the capacity of adapting to perturbations and shocks is strictly connected with being able to learn from technological process" (p.300). Which is furthermore exemplified by the following statement from a shrimp farmer:

"Farming has become easier because I followed a lot of training courses to adapt to climate change. The training course are very helpful because they give me a lot of knowledge about what medicines to use for different diseases, and what the best way is to change the crop calendar" (Interview with shrimp farmer, Nam Thái, 17/04/2018).

Acquiring knowledge can thus be of vital importance to improve a household's adaptive capacity. But, whereas only several farmers claimed that training courses were successful in providing them with knowledge applicable on their farm, the majority of farmers emphasized the importance of sharing knowledge amongst farmers. Most farmers explained that social gatherings with fellow farmers such as drinking coffee at the local café, or visiting other farms to discover new farming techniques, provided farmers with the needed knowledge for their farms. Social networks are thus not only important for (financial) support when farmers are in need, but also take on a different role into sharing knowledge. Besides social networks, companies that distribute agricultural products such as pesticides, medicines and fertilizers, also provide farmers with information and knowledge on how to apply their products properly. Whilst sometimes helpful, several farmers shared the opinion that this was mainly a strategy from the companies to increase their sales.

Analysis of the data showed that major differences in terms of ethnicity were found between the different farming models. More than 66 percent of all rice farmers indicated they were Khmer, while only five percent of rice-shrimp farmers were Khmer, and none among shrimp farmers. Ethnicity has been proven to be a determinant factor for adaptive capacity (Adger, et al., 2007), and is therefore taken up in analysis. In Nam Yén, the communal government had a meeting with all Khmer rice farmers about whether they were willing to change their farming model. They were unwilling to change to rice-shrimp because they had no knowledge about using the right techniques for rice-shrimp farming[17]. Of the researched Khmer people, over 78 percent indicated primary school as their highest level of education, compared to 38 percent among the Vietnamese people. This was confirmed by the Nam Yén

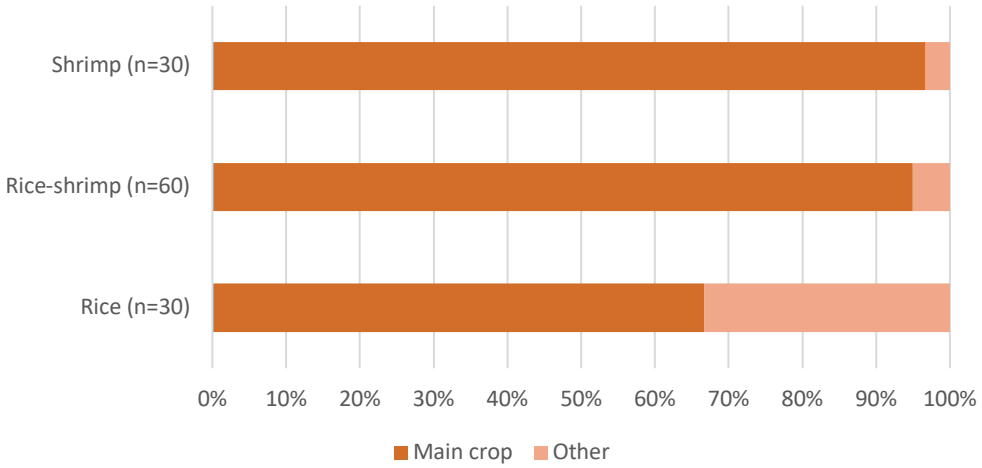
[17] Interview with Nam Yén commune official (10/04/2018)

official who stated that they had no knowledge about farming techniques because they have a lower education. Although the sample size did not allow for extensive statistical analysis, it does show a major difference in terms of educational level between both ethnic groups.

Crop diversification is deemed as another strategy to reduce risks for households when facing hazardous situations (Turner, 2003). Generally, rice farmers were better able to produce a variety of crops, such as leafy vegetables, fruits, and sugarcane, either for own consumption of to sell on the local market. Whilst rice-shrimp and especially shrimp farmers had more difficulties growing different crops. After switching farming model form rice to rice-shrimp, farmers usually experienced higher salinity levels of groundwater which resulted in decreased soil quality, which does not allow for the cultivation of a variety of crops. However, the majority of shrimp farmers is able to grow crab, usually for own consumption. Although rice cultivation generally allows for the cultivation of other crops, the main crop of rice remains more vulnerable in the case of climate related events or changing climate patterns. Whereas the rice-shrimp model is better able to cope with external stresses because it can alternate between rice and shrimp crops. Shrimp famers are this respect least able to cope with external stresses due to a lack of crop diversification.

Just as crop diversification, the diversification of income sources enables households to increase their ability to cope with external stresses (Kinsey et al., 1998). Analysis of data concerning income diversification showed slight differences, with 83 percent of the rice farmers having other sources of income, whilst 73 percent of shrimp farmers and 67 percent of rice-shrimp farmers had other sources of income besides their main source of income. A more noteworthy find however, is depicted in the chart below (see figure 4.10), which indicates that rice cultivation for only 67 percent of rice farmers was their main income source. Instead, rice farmers indicated to generate income through wage labour, own businesses, or fishing. Although differences with the other farming models are significant, they can be explained through the fact rice farmers have been affected by changing climate patterns and climate induced events to such an extent, they were forced in seeking new ways to sustain their families. Which is in line with a recent research conducted by Dixon, Stringer and Challinor (2014) who explain that off-farm income generating activities are part of coping strategies to withstand external shocks and stresses.

Figure 4.10: Main source of income (per farming model



4.3.2. Subjective household resilience

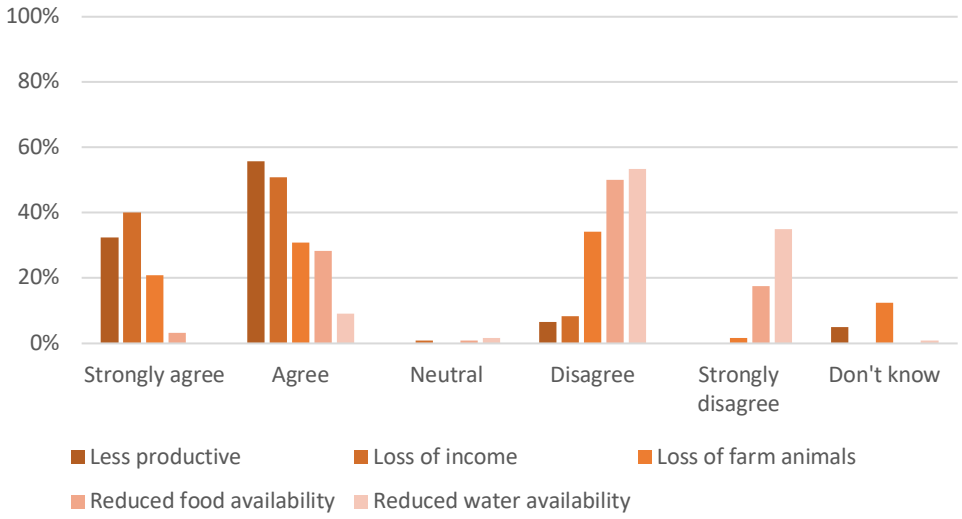
Besides measuring objective household's resilience, the assessment of a household's subjective resilience was also deemed important because it provides a better insight in how farmers experience their household's vulnerability, and furthermore to what extent they deem their household able to cope with and adapt to changing climate patterns. The perception of farmers on their household's vulnerability in the case of experiencing external stresses will be discussed first. After which the perception of farmer on household's ability to adapt to such external stresses will be elaborated on.

4.3.2.1. Farmer's perception on household vulnerability

One of the factors which determines the farmers' perception of their household vulnerability is whether he or she expects their household to be affected by climate related events. The perceived probability of exposure to external stressors was very similar amongst farmers in the different farming models. In all three models, 80 percent of the farmers expected their household to be affected by changing climate patterns in the coming three years. Perceived household vulnerability is furthermore determined the farmer's perception to what extent his household will be affected when experiencing external stresses.

Five household aspects that could possibly be affected by climate related events, were assessed for this research. The assessed household aspects were agricultural productivity, farm animals, household income, food availability, and fresh drinking water availability. Analysis of the data showed no major differences between the different farming models in terms of the perception amongst farmers to what extent their household will be affected by changing climate patterns. The chart below (see figure 4.11) indicates that the majority of farmers expected that their farm's agricultural productivity and household income would decrease when experiencing climate induced events.

Figure 4.11: Farmer's perception on impact of a changing climate on household aspects

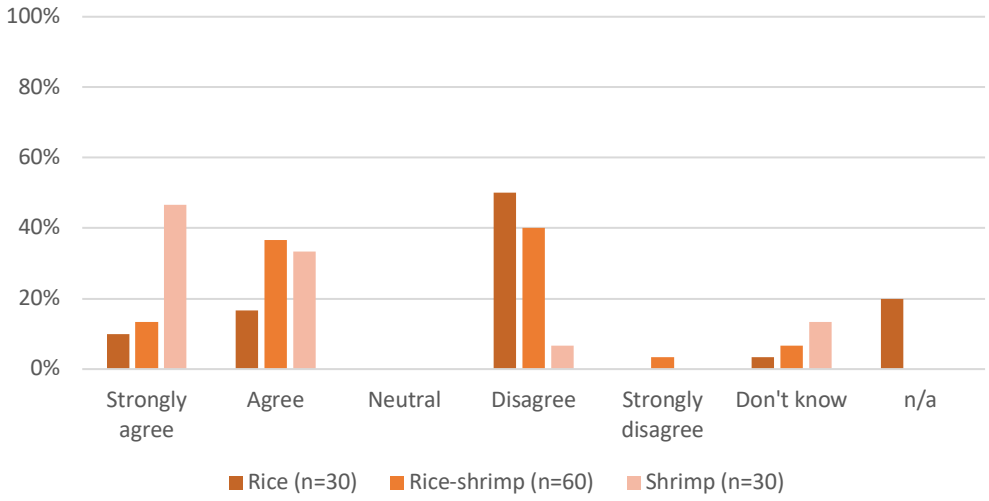


Whilst on the other hand, the majority of farmers believed that changing climate patterns would have a relatively small impact on their household's food security and fresh water availability. Several farmers claimed that whilst experiencing major drought or other climate related events, their household was still able to provide their family with enough food. Farmers were therefore confident that in the case of future climate stresses, their household would be able to secure enough for the meet the dietary needs for all household members. Similar to the household's food security, several farmers explained that while experiencing climate stresses in the past, their household remained able to provide their household member with enough drinking water. Which is best described by the following quote:

"When we run out of rain water we can still go to the shop to buy water" (Structured interview with rice-shrimp farmer, Nam Yén, 09/04/2018).

The extent to which the previously discussed household aspects would be affected by future climate stresses was assessed relatively similar by farmers in all three farming models. However, differences were identified after analysing the data concerning the extent to which farm animals would be affected when experiencing climate stresses (see figure 4.12). The results show that the majority of shrimp farmers expects to lose farm animals when experiencing changing climate patterns, whilst only 27 percent of rice farmers expected to lose farm animals. For this research, shrimps were also regarded as farm animals. Chapter 4.2 discussed that the shrimp's well-being is sensitive for changing climatic conditions such as temperature changes, or exceeding salinity levels. Which makes it relatively easy to explain why shrimp farmers were concerned most about losing their farm animals.

Figure 4.12: Climate change impact on loss of farm animals (per farming model)



4.3.2.2. Farmer's perception on household adaptive capacity

The second factor which determines household subjective resilience is the extent to which farmers perceive their own ability to cope with and adapt to external stresses. Upon determining the farmer's perceived adaptive capacity, several components were assessed by farmers during this research. Firstly, the majority of farmers in all three farming models (strongly) disagreed with the statement that the adaptation measures they had taken were sufficient in protecting their household from future climate stresses. This indicates that the perceived adaptation efficacy amongst most farmers is low. Although the confidence in their household's adaptation measures was relatively low, the prospects of the government completing the dam that is currently being build increased the confidence of several farmers about their ability to cope with future climate stresses. The completion date of the dams is however uncertain because decisions are taken on higher organizational levels, whilst local governments are not updated about the process frequently[18]. The lack of confidence in their adaptation measures is also exemplified by the fact that around 75 percent of the respondents stated that future climate threats might result in household member migrating.

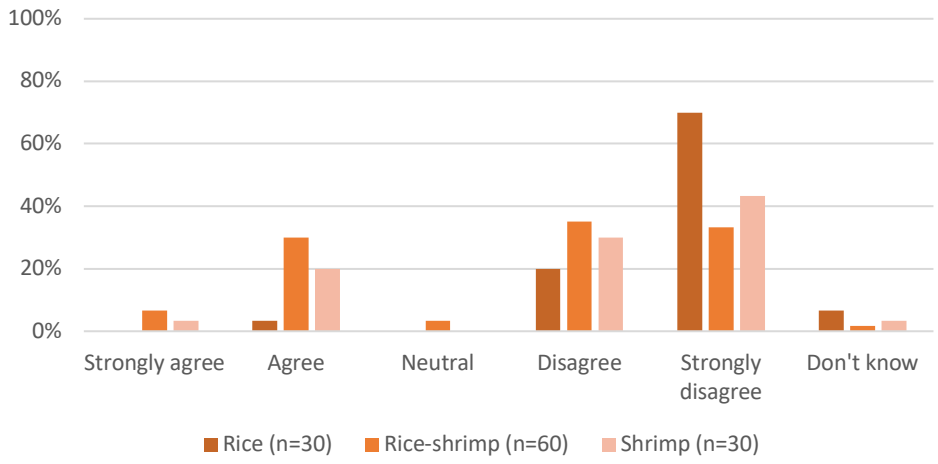
Secondly, the majority of farmers responded relatively reserved to the statement whether farmers were confident if they would be able to take adaptation measures to protect their household from future climate shocks. Most of the respondents stated that they were unable to take adaptation measures themselves and needed more knowledge to undertake such steps. The willingness to increase their knowledge base was confirmed by the overall response to the statement whether farmers wanted to learn new farming techniques that increased their ability to cope with future climate threats. Among all three farming models, more than 80 percent of farmers wanted to expand their knowledge base, which is exemplified by the quote below. The main reason for farmers being reluctant to learn new farming methods was that respondents deemed themselves being too old.

[18] Interview with Nam Thái commune official (26/04/2018)

"I think learning new farming methods is most important to deal with climate change" (Interview with rice farmer, Nam Yén, 11/04/2018).

Whereas the perception among farmers off all three farming models was relatively similar for the previously discussed components, minor differences between the different farming models were identified concerning the final component (see figure 4.13). Over 95 percent of the rice farmers admitted they were under the impression their household was unable to carry out adaptation measures without external support, such as money, training or additional technologies. Rice-shrimp farmers were most confident their household did not need external support to carry out adaptation measures.

Figure 4.13: Perceived adaptation costs (per farming model)



4.3.3. Conclusion

Of all three farming models, the percentage of farmers that stated they had been able to fully recover after being affected by changing climate conditions was highest among rice farmers. Household resilience of the three farming models was determined according to the five resilience pillars introduced in the RIMA-framework (FAO, 2016), which assesses variables such as household assets, access to financial transfers, and adaptive capacity. Analysis of the data showed that among of all three farming models, rice-shrimp farmers possessed most assets in terms of annual income and savings. All three farming models proved to have good access to formal and informal transfers, which is a determinant factor when recovering from climate induced events. However, An Bien's district official stated that only rice farmers received a financial compensation after the drought in 2015 and 2016[19], which was confirmed by the interviewed respondents. Some major differences were identified between the three farming models in terms of adaptive capacity, which is a somewhat more complex concept, constructed by various variables, such as knowledge and livelihood diversification. The results showed that rice farmers had the most diversified livelihoods, both in terms of income and crop diversification. Whereas, shrimp farmers had the least diversified livelihood, which was

[19] Interview with An Bien district official, DARD (29/03/2018)

caused because of their inability to grow different crops besides shrimps. Analysis of the data furthermore showed that knowledge about applying the right farming methods or adaption measures, is an important determinant factor for household resilience amongst all three farming models.

In terms of the individual's perception in terms of household vulnerability and adaptive capacity, no significant differences between the different farming models were identified. Most of the farmers expected that their household and some of their household aspects would be affected by changing climatic conditions. The majority of farmers was furthermore not confident about their own ability to take adaptation measures in the future to cope with changing climatic conditions. Most farmers stated they needed more knowledge or external help.

4.4. Responding to a changing climate

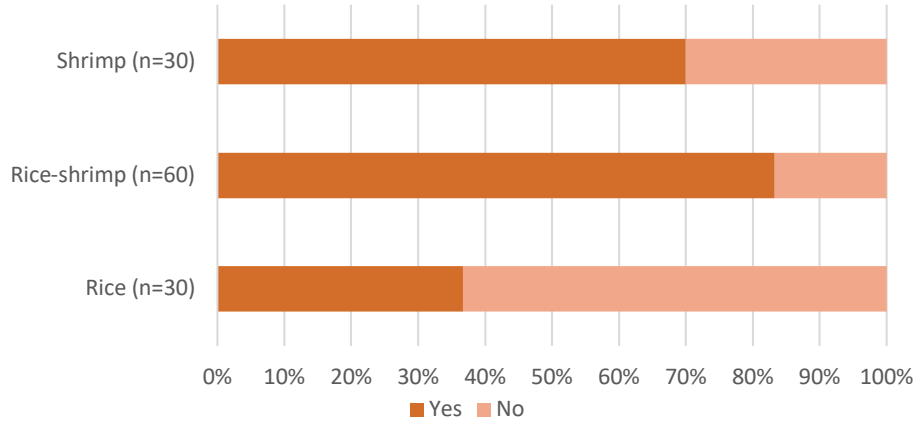
This research has shown that farmers in Nam Yén and Nam Thái have been experiencing changing climate patterns that have affected their livelihoods and agricultural activity. Adapting to changing environmental conditions is therefore important for farmers to cope with and recover from those changing conditions. The previous paragraph discussed that the ability of farmers to cope with external stresses is determined by several factors, such as social safety nets, assets, and adaptive capacity. But as Adger, Arnell and Tompkins (2005) stated, adaptation involves both building adaptive capacity, which was previously discussed, and the actual implementation of adaptation measures, thereby transforming adaptive capacity into action.

The following sub-paragraph will elaborate on what adaptation measures were taken by farmers and will explain why farmers did not take any adaptation measures as a response to changing climate patterns. A topic that kept returning whilst being in the field and which is discussed heavily in literature (Adger, 1999; Tacoli, 2009), namely climate-induced migration, will be discussed in the second, and final sub-paragraph.

4.4.1. Adaptation measures

The different farming models show major differences when comparing whether adaptation measures were taken in the last decade to cope with a changing climate (see figure 4.14). Whereas more than 80 percent of rice-shrimp farmers indicated they had undertaken action to cope with climate stresses, less than 40 percent of rice farmers took adaptation measures.

Figure 4.14: Adaptation measures taken in last ten years (per farming model)



The farmers that undertook action used a wide variety of adaptation measures which they regarded as suitable to increase their household's ability to cope with a changing climate. Shrimp farming and rice cultivation are however very different from each other, which resulted in major differences between the adaptation measures used per farming model. The adaptation measures used for shrimp farming will first be discussed, after which the adaptation measures popular amongst rice farmers are reviewed.

4.4.1.1. Shrimp farming

In terms of climate related event, shrimp farmers were most affected by sudden temperatures changes of water in the shrimp ponds. These sudden changes are mainly caused by unpredictable heavy rainfall, thus affecting the temperature but also other water characteristics such as pH-level, salinity level or oxygen level. Amongst shrimp farmers, the use of calcium carbonate ($CaCO^3$) and zeolite was the favourite option when they were experiencing sudden changes in water characteristics. Remarkable though, is that farmers used zeolite and especially $CaCO^3$ after all types of climate related event such as droughts, heavy rainfall, increase temperatures or too high salinity levels. No distinction was made between when to use what agricultural product, and most farmers claimed using these products usually was not very effective. My research assistant[20] noticed that whilst most farmers did apply products such as zeolite and $CaCO^3$, they were often lacking knowledge in terms of what product to use, dosage, and frequency of dosing.

Excessive rainfall furthermore causes sudden decreases of the pond's salinity level, especially in the top layer because salt water outweighs fresh water. To solve this problem, some farmers pumped away excess fresh water, to adjust the water's salinity to an acceptable level. Another solution of farmers was to exchange water between the top and bottom layer of their shrimp ponds, thereby modifying the water to acceptable salinity levels. Shrimp farmers

[20]Personal communication with Mr. Tú, during fieldwork. Mr. Tú is a staff member of faculty for agriculture and rural development, specialized in aquaculture.

try to maintain the right water characteristics by using agricultural products to prevent disease among shrimps to begin and spread. Furthermore, farmers tried to decrease the shrimp density of the ponds, so the remaining shrimp would have more nutrients and space, thereby reducing the risk of beginning or spreading of disease. However, some farmers explained that as soon as white leg disease was identified in their pond, all shrimps had to be harvested as quick as possible, hoping to harvest enough shrimps with acceptable quality levels and size for retail. Some farmers also referred to the poor quality of post-larvae being the main cause of occurring diseases. Alternating between shrimp hatcheries whilst trying to find stronger post-larvae was another measure several farmers took, trying to prevent a disease from occurring again. The poor quality of post larvae is a big problem, as there is little regulation concerning quality control. The following quote explains how farmer experience this situation:

"*The shrimp larvae are not good. Government does not check those companies, so there are big differences of quality between companies" (Structured interview with rice-shrimp farmer, Nam Yén, 04/04/2018).*

Another problem experienced by shrimp farmers can be both the presence or a lack of particular species of marine algae in their ponds. The presence of certain marine algae causes the oxygen levels in the pond to decrease which hampers the development of the shrimp. Farmers indicated that certain chemicals were used to exterminate the algae in the pond and creating a more suitable environment for the shrimps. However, the presence of another type of marine algae is wanted by the farmers, because young shrimp larvae use these algae as nutrients for their diet, which supports the development of shrimps. A specific fertilizer was used to create a suitable environment in which the marine algae will grow.

4.4.1.2. Rice farming

In the case of rice farming, farmers significantly affected by droughts, of which the last severe drought occurred in 2015 and 2016. Water is essential for the development of the rice crop, so a lack thereof can have devastating results. Adaptation measures to deal with droughts always involve ways to find alternative water sources to irrigate the rice paddies. The farmers explained that several methods were tried such as pumping up ground water, or the use of river water if salinity levels are low enough. The former method is usually not effective because of the limited quantity of water that can be pumped up. Whereas the chance for a situation, that when river water is needed and the salinity levels in the river are low enough for the irrigation of rice paddies, is relatively low. Another method used by rice farmers to deal with a limited quantity of water, is by planting rice seeds on a small part of farmland, which made the chance of survival higher. The use of this method required less labour, and when the crop failed, the financial loss was lower. Unfortunately, similar to the other two methods, the success rate of this method proved to be relatively low.

Although rice crops need water, unpredictable heavy rain can be harmful for the development of rice. When water is abundant, the excess water is usually pumped away by farmers to prevent the crop from drowning. However, in some cases it turned out to be impossible to pump away the excess water because there are no physical barriers between neighbouring rice paddies, which was experienced by a rice farmer in Nam Yén.

"There are no dykes in between my land and the land of my neighbour. When there is a lot of rain, I cannot pump away all the water on my land and on the land of my neighbour. This normally destroys most of my rice" (Interview with rice farmer, Nam Yén, 11/04/2018).

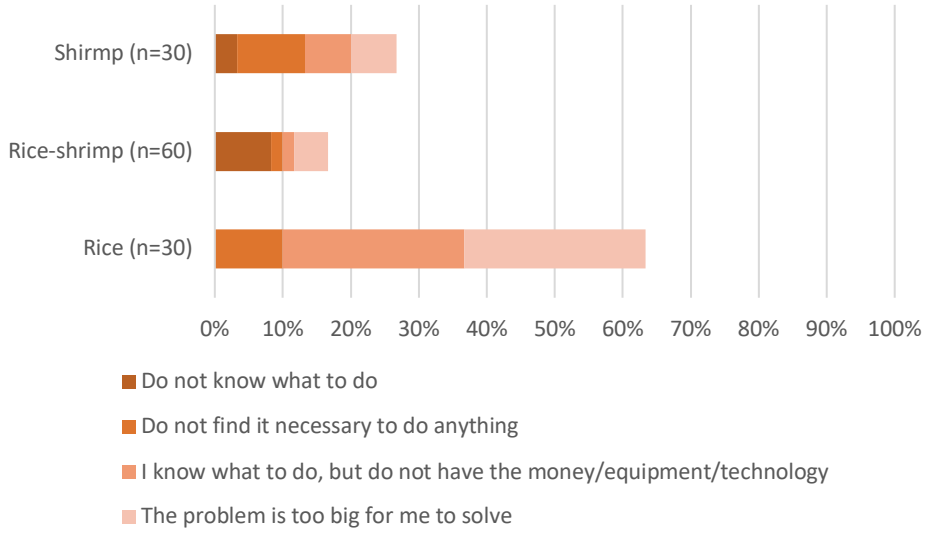
The application of fertilizers to increase the strength of the rice crop was another method used by farmers to deal with changing climate patterns. Several farmers furthermore mentioned that in recent years stronger rice seeds were used, that proved to be more resilient to extreme climatic conditions such as high salinity levels, or prolonged droughts. However, the most remarkable response of many farmers upon asking them what adaptation measure they used during rice season when experiencing climate-induced events, was wait for the weather to change. This illustrates the impotence farmers are experiencing and their attitude towards coping with changing climatic conditions quite clearly.

4.4.1.3. Maladaptive responses to changing climatic conditions

Taking climate change adaptation measures to prevent harm from being done to your household by changing climatic conditions has been done by most farmers. However, the previous two sub-paragraphs explained that farmers are experiencing difficulties when trying to cope with and adapt to changing climatic conditions. Results indicated that around 37 percent of all households did not take any adaptation measures in the past ten years to prevent harm from being done. The chart below (see figure 4.15) elaborates on what motives farmers had, to keep themselves and their household from undertaking action to adapt to experienced climate stresses.

The main difference between the different farming models is the percentage of farmers who did not take any adaptation measures. The difference of shrimp farmers (27 percent) and rice-shrimp farmers (17 percent), compared to rice farmers (63 percent), in terms responding to changing climatic conditions in a maladaptive manner is significant. Rice farmers explained that no climate adaptation measures were taken because the climate stresses they experienced were so vigorous, that they regarded their chances of being successful in coping with and adapting to those stresses as too small. Instead they chose to do nothing and hoped for the weather to change. A lack resources was another major contributor for rice farmers not undertaking action, which is in line with the finding that 95 percent of all rice farmers is

Figure 4.15: Reasons for maladaptive responses to changing climatic conditions (per farming model)



under the impression that their household would be unable to take adaptation measures in the coming years due to lacking resources. Interestingly, none of the rice farmers stated that a lack of knowledge kept them from undertaking action, whilst amongst rice-shrimp farmers this was the main reason. However, several rice-shrimp farmers were confident that despite their lack of knowledge, they would improve their ability to cope with climate stresses in the future by learning from other farmers and attend training courses. Among shrimp farmers, the main reason that keeps them from carrying out adaptation measures is because they are under the impression it is not necessary. Whilst being in the field, it seemed like those shrimp farmers had accepted the difficult situation they were in and were waiting for things to improve. The following quote is from a shrimp farmer who indicated not to take action because it was not regarded necessary. The quote highlights the importance of reliance on public adaptation to determine your climate change risk appraisal, and whether to respond in an adaptive or maladaptive manner.

"We just harvest what we have. We do not really do anything about climate change, but the situation is getting worse. We are now waiting for the dams from the government, so we can switch back to rice-shrimp farming" (Interview with shrimp farmers, Nam Thái, 24/04/2018).

4.4.2. Migration

The previous paragraphs discussed that all farmers (n=120), have been affected by changing climate patterns. Whilst some farmers did not take any adaptation measures, or had more difficulties coping with climate stresses, others were able to cope with and adapt to a changing climate. However, during this research it became clear that either permanent or temporal migration was another climate adaptation measure widely used in both communes.

Several farmers explained that if their crop failed and were unable to find a job in relative close distance to their home, they would move to the city for a couple months to earn money. An increasing number of farmers has been moving to the city because it has become more difficult to find jobs around their homes. Due to the transition to rice-shrimp farming less labourers are needed because shrimp farmers need less labourers for maintaining their farm, and for harvesting. Often working as a wage labourer, farmers have a stable income, which enables them to frequently send remittances to their family that remained on their farm. Usually, after a period of three to six months, temporary migrant workers would return to their farms with enough money to sustain their family and to invest in the new farming season.

Permanent migration is another adaptation measure that was mentioned by many farmers. According to them, the main reason for permanent migration amongst farmers was that small-sized farms were unable to cope with continuously failed crop seasons. In many cases those small-sized farms were able to cope with one failed crop season, but when their crop failed a second time, they were forced into migrating to the city to find jobs. The farm size matters because farmers with bigger farms who are experiencing climate stresses are still able to produce some of their crops for own consumption. However, farmers with small farms, are experiencing much more difficulties to produce enough food to sustain their families.

4.4.3. Conclusion

The results of this research show that the majority of shrimp and rice-shrimp farmers has taken climate adaptation measures in the past ten years, compared to only 37 percent of rice farmers. A wide variety of adaptation measures was taken by farmers to increase their household's ability to cope with changing climatic conditions. Adaptation measures taken by shrimp farmers mainly consisted of the appliance of agricultural products such as fertilizers, chemicals, and medicines, pumping away excess rain water, or decreasing the shrimp density in the ponds. Whereas rice farmers took adaptation measures such as applying fertilizers to strengthen the rice crop or by seeding a more climate resistant rice strain. In some cases, farmers responded in a maladaptive manner, and thus not taking any adaptation measure to improve their ability to cope with and adapt to changing climatic conditions. Major differences were found between the three farming models, with 63 percent of the researched rice farmers responding in a maladaptive way, compared to only 30 percent of the shrimp farmers and 17 percent of the rice-shrimp farmers. Many farmers also mentioned that that impacts of climate change resulted in the temporary or permanent migration of farmers, which can also be seen as a way to adapt to changing climatic conditions.

5. Discussion

The main objective of this chapter is to relate the findings of this research with the broader discussion on household resilience and climate change. This is done by drawing conclusions on the level of resilience to changing climatic conditions for each of the researched farming models[21]. This chapter furthermore discusses recommendations based on this research for policy makers, and opportunities for future research. Finally, some of this research's limitations are reviewed.

5.1. Determining resilience

The aim of this study was to contribute to the existing body of knowledge on resilience thinking, by applying the concept of resilience thinking to the Vietnamese aquaculture industry. By interlacing the findings presented in the previous chapter with the concepts of resilience thinking and subjective household resilience, an opportunity arises to explore the extent to which farmers in the MD are resilient to changing climatic conditions. Resilience was firstly introduced by Holling (1973) as "the propensity of a system to retain its organizational structure and productivity following a perturbation" (p. 183). Following Holling's definition of resilience, the results of this research have shown that out of the three farming models, rice-shrimp farmers proved to be most resilient in terms of retaining their agricultural productivity, followed by rice farmers who proved to be best able to recover after experienced climate stresses, and finally shrimp farmers who were the least resilient.

This research has shown that among the three farming models, shrimp farmers had most difficulties recovering from experienced climate stresses and were often worse off than before. Whereas the majority of rice farmers were able to fully recover from climate-induced events, regardless of being affected by climate stresses to a similar extent as shrimp farmers. This indicates that household resilience is thus not only dependent on the magnitude of perturbations, but is also the result of various other factors, which is in line with Smith, Anderson and Moore (2012), who state that household resilience not only depends on the impact of changing climatic conditions, but also greatly depends on other factors such the social context in which a household finds itself. Which is furthermore confirmed by Adger (2003), who describes household resilience as "a social process that involves the interdependence of agents through their relationships with each other, with the institutions in which they reside, and with the resource base on which they depend" (p. 388). The crucial thing about the concept of resilience is thus that it aims to capture all factors that enables households to keep functioning under disadvantageous conditions (Speranza, Wiesmann & Rist, 2014). The findings of this research have indicated that a wide variety of factors have

[21] 1. Mono-crop rice farming: two crops per year.
2. Rice-shrimp farming: rice cultivated in wet season, and shrimp cultivated in dry season.
3. Shrimp farming: extensive shrimp farming model (only shrimp production)

influenced the ability of farming households to cope with and adapt to changing climatic conditions. The analysis showed some major differences between the three farming models in terms of the resilience pillars, subjective household resilience, and adaptive responses. These main differences will be discussed in term of their contribution to the level of household resilience for each farming model in the following sub-paragraphs.

5.1.1. Household resilience of rice farmers

The researched rice farmers had a lower average annual income than rice-shrimp farmers, they had the lowest percentage of farmers with savings, they had highest dependency ratio, and rice farmers were the smallest number of farmers with adaptation measures taken, which are all important factors for determining household resilience (FAO, 2016). However, 70 percent of all rice farmers were able to fully recover from changing climatic conditions. The results show that the following determining factors enabled farmers to cope with and recover from these changing climatic conditions: 1) crop diversification, 2) governmental support, and 3) income diversification.

Rice farmers indicated that whilst being affected by changing climate variables, they were to a small extent still able to produce a variety of crops, to sustain their families. Lin (2011) argues that crop diversification leads to improved resilience because it enables farmers to buffer the impact of increased climate variability and extreme weather events. Crop diversification furthermore leads to an increased biodiversity, which provides an insurance against environmental variation because different crops species will respond differently to such variation (Yachi & Loreau, 1999).

Governmental support was only given to rice farmers after the 2015 – 2016 drought, which assisted them in recovering from that event. However, when considering that rice farmers were granted a maximum of 5 million VND per hectare and the average farm size among rice farmers was around 1.4 hectares, the total compensation was maximal on average around 7 million VND. This financial support can be considered as access to formal transfers, which are regarded as a determinant for household resilience according to the FAO's RIMA-framework (FAO, 2016). However, when the additional financial resources originating from these formal transfers, are added up to owned assets in terms of average annual income of rice farmers the total amount of assets owned by rice-shrimp farmers on average is still considerably higher compared to rice farmers. Despite the importance of household assets into constructing household resilience (Perez et al, 2015), the governmental compensation was not the main determinant factor improving household resilience among rice farmers.

Of the researched rice farmers, 33 percent claimed that their main source of income was earned by off-farm activities, such as wage labour, self-employment or fishing. The diversification of income sources is another livelihood strategy which improves the adaptive

capacity of household because it is aimed at mitigating risks and increasing opportunities when facing climate stresses (Turner et al. 2003). Earlier research (Darnhofer, 2009) has shown that farmers are in favour of diversified income sources despite challenges involved to coordinate participating in off-farm generating activities, such as temporary migration, which has been confirmed by this research[22]. Besides working as a buffer in the case of experiencing unexpected climate variability, different sources of income also connect farmers to various social networks (Darnhofer, 2009).

5.1.2. Household resilience of rice-shrimp farmers

Off all three farming models, the researched rice-shrimp farmers have proven to be most resilient in retaining their agricultural productivity and were least sensitive to changing climatic conditions. Additionally, the researched rice-shrimp farmers had the highest average annual income, the lowest dependency ratio, and the highest percentage of savings, off all three farming models. All of which are positive determinant factor that improve a household's resilience (FAO, 2016). Furthermore, the rotating nature of this farming model provides farmers the opportunity, to produce a higher valued commodity, namely shrimps, whilst using the rice crop to reduce the pollution and possibly disease resulting from the waste generated by shrimps. This outcome has been confirmed by earlier research by Krupinsky, Bailey, McMullen, Gossen and Turkington (2002), who stated that disease cycles can be interrupted through crop rotation. The rice-shrimp farming systems is therefore considered to be more efficient and sustainable than either rice of shrimp monoculture farming systems (Lan, 2011) The results of this research confirm this. Two neighbouring farmers who were interviewed claimed that before they were forced by high salinity levels to switch to shrimp farming, the rice-shrimp farming model has been a very sustainable system that was able to withstand climate stresses, whilst remaining productive[23].

Despite all the determining socio-economic factors that proved rice-shrimp farmers to be most resilient to changing climatic conditions, only 37 percent stated they had been able to recover after experiencing climate stresses, compared to a recovery rate of 70 percent among the researched rice farmers.

The reasons given for showing maladaptive behaviour by farmers[24], are used to explain this difference. The majority of rice-shrimp farmers that did not take adaptation measures, stated that they did not know what to do. Whereas none of the rice farmers who showed maladaptive behaviour claimed that a lack of knowledge was the reason for showing this behaviour. Knowledge concerning farming practices and how to respond to changing climatic conditions enables farmers to respond adequately and is an important determinant

[22] See chapter 4.2
[23] Structured interview with two shrimp farmers, Nam Yén (04/04/2018)
[24] See paragraph 4.4.1

for household resilience (Speranza et al., 2014). Knowledge is acquired over years of farming experience and is usually site-specific, or in this case farming systems specific (Boillat & Berkes, 2013), which explains that amongst some rice-shrimp farmers who recently switched farming models, knowledge for that specific farming model was lacking. Especially, compared to the researched rice farmers who usually have been cultivating rice for decades and have acquired a huge amount of knowledge. This was furthermore confirmed by An Bien's district official, who stated that farmers who recently changed their farming model experienced difficulties retaining normal agricultural productivity[25].

5.1.3. Household resilience of shrimp farmers

Among the researched shrimp farmers, the level of recovery after experiencing a climate-induced event was lowest with only 29 percent admitting they were able to fully recover[26]. This low level of recovery can partially be explained by the extent to which farmers were affected by saline intrusion and unpredictable rainfall. Saline intrusion and unpredictable rainfall have had a negative effect on the agricultural productivity of most shrimp farmers, hampering the development of shrimp or causing shrimp disease. Saline intrusion is furthermore making it impossible for shrimp farmers to grow a variety of crops which is problematic because crop diversification can be used as a livelihood strategy to increase household resilience (Lin, 2011). Finally, the level of resilience amongst shrimp farmers is not only determined by the impact of experienced climate stresses, but also the result of the following other factors: 1) prolonged exhaustion of soils, 2) household income, and 3) acquiring knowledge.

The prolonged exhaustion of soils by shrimp farmers has had a negative impact on their agricultural productivity. Which was explained by Gunderson and Pritchard (2002) in the sense that long-term disturbances of an ecosystem can shift its state into a less desirable one that has adverse effects on the development of livelihoods. A less desirable state refers to the farmer's capacity to sustain the natural resources and the ability of their farm to keep providing ecosystem services for societal development (Daily, 1997). The transition to this less desirable state is thus exemplified by the fact that prolonged shrimp farming often has resulted in reduced soil quality and had a negative effect on the farm's agricultural productivity. These negative developments of agricultural productivity have seeped through to the household income and resulted in shrimp farmers having the lowest average annual income of all three farming models, which is another important factor for determining a household's resilience (FAO, 2016).

[25] Interview with An Bien district official, DARD (29/03/2018)

[26] See paragraph 4.3

Several authors (Speranza et al, 2014; Smith et al. 2012; Adger, 1999) have stated that knowledge is an important factor for farmers to be resilient to changing climatic conditions. In the field, the Vietnamese research assistant[27] acknowledged the difficult conditions some of the shrimp farmers were experiencing. However, he furthermore mentioned that if farmers would have been more knowledgeable about suitable farming techniques, the impact of climate stresses would have been less significant as was observed in Nam Yén and Nam Thái. The importance of site-specific knowledge of farmers was previously discusses in paragraph 5.1.2. and is once more confirmed by an interviewed rice farmer who claimed having no difficulties farming, after having attended several training courses that pointed out how to maintain his farm and adapt to changing climatic conditions[28].

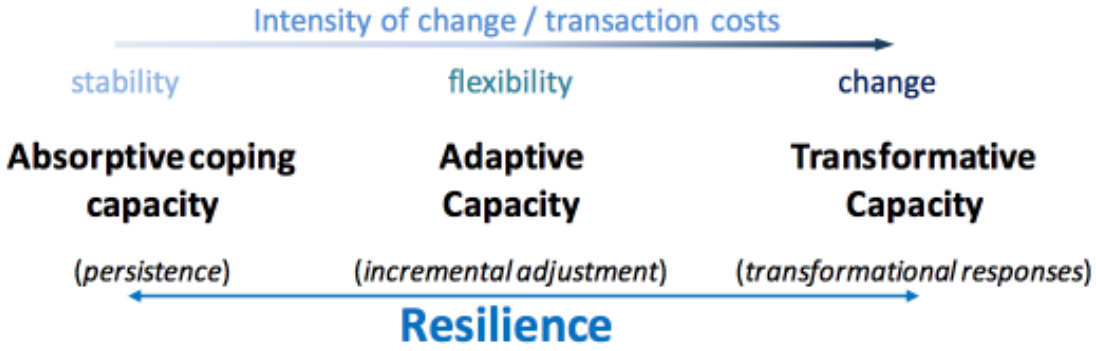
5.1.4. Farming in An Bien district: absorptive, adaptive, or transformative?

By analysing the differences that were identified between the three farming models, the following factors emerged as key determinants for household resilience: 1) income diversification, 2) crop diversification, and 3) knowledge. Linking all the findings concerning household resilience and the resilience pillars back to the resilience capacities (absorptive, adaptive and transformative), as discussed in paragraph 1.1, ties this research together. Béné et al. (2012) described how resilience emerged as a result from not one, but all three of these capacities (see figure 5.1). The researched rice farmers have shown both flexibility, but also in several cases, a transformational response to changing climatic conditions. The change required to cope with the climate stresses in order to retain their household's agricultural productivity was for 37 percent of the rice farmers too large[29], which resulted in changing their household's main source of income. Their households transformed from being dependent on agriculture towards being dependent on wage labour or started their own business.

Overall, rice-shrimp farmers showed their ability to make adjustments in order for their household to continue functioning without being affected to such an extent that their household's functionality suffered from it. This flexibility was mainly derived from the rotating farming system, in which the shrimp crop was alternated with the rice crop. Unfortunately, shrimp farmers proved to be least flexible of all three farming models, which was mainly due to their high climate sensitivity, being affected a lot by saline intrusion, and their inability to diversify their crops.

[27] Personal communication with Mr. Tú, during fieldwork. Mr. Tú is a staff member of faculty for agriculture and rural development, specialized in aquaculture.
[28] Interview with shrimp farmer, Nam Thái (17/04/2018)
[29] See paragraph 4.3.1.

Figure 5.1: Resilience framework



(Source: Béné, et al., 2012)

5.2. Recommendations for policy makers and future research

Based on the findings of this research, several recommendations are given for the implementation of new policies, and for future research possibilities.

5.2.1. Policy recommendations

It has become clear that despite having experienced and endured several climate-induced events, rice farmers have shown most resilience, having been best able to recover from those events, whilst other farmers have had more difficulty. Future policy recommendations are therefore aimed at encouraging both farmers and government, to continue building resilience amongst all farmers. In order to do so, a set of policy recommendations is given below.

1. *More suitable training courses and clear communication about training*

Findings have pointed out that training courses organized by the CAAE[30] have the potential of being successful in making farmers more resilient to changing climate patterns. However, two things need to change in order for the training courses to meet its potential. Firstly, in many cases farmers claimed that training courses were not suitable for their farming model[31]. Farmers complained that courses were too theoretical and were not useful for their farm. Training courses should therefore be adapted to what farmers need, and not solely be about what new farming methods have been developed by the CAAE. Secondly, it happened too often that farmers were not notified about upcoming training courses and did not attend those training courses[32]. Officials claimed that according to current policies[3334], hamlet leaders notify all household in their hamlet about upcoming training courses, but the findings indicate otherwise[3235]. Therefore, stricter enforcement of current policies is needed for

[30] Centre for Agriculture and Aquaculture Extension
[31] Interview with rice-shrimp farmer, Nam Thái, (24/04/2018)
[32] Interview with rice-shrimp farmer, Nam Yén (11/04/2018)
[33] Interview with An Bien district official, DARD (29/03/2018)
[34] Interview with Nam Yén commune official (10/04/2018)
[35] Interview with rice farmer, Nam Yén, (11/04/2018)

training courses, to ensure all households are notified. Upon notification, farmers should also get informed about the nature of the training, so they can determine whether or not such a training could be helpful for them.

2. *Ensure quality of post-larvae (PL)*

Although not discussed extensively in this thesis, the problem of inconsistent quality of PL was mentioned several times by farmers [3236]. The lack of good quality PL is harmful for farmers because these PL are more likely to catch diseases or die. It is therefore important that more regulations concerning quality consistency are implemented. Currently, the certification standard VietGAP is already employed by several shrimp hatcheries and farms, to ensure the quality of PL and shrimps is up to standard. Getting certified is however not attractive for farmers due to the certification costs, and because the retail price for certified shrimps is not much higher than non-certified shrimps[37]. Profits of shrimp hatcheries and farms would not increase a lot whilst they have to out in effort to meet all certification criteria. It is therefore recommendable that national, provincial and local government start encouraging both shrimp farmers and shrimp hatcheries to ensure overall quality of shrimp and prevent bad quality shrimp and PL from being distributed.

3. *Disaster compensation for all farming models*

The remarkable statement that only rice farmers were compensated after the 2015 – 2016 drought[38], while shrimp farmers were also affected and, in some cases, unable to recover, indicates that regulations concerning governmental compensation might have to be adjusted. Although crops were lost among most farmers, the compensation successfully supported rice farmers into recovering from those losses. A policy change concerning governmental support when the agricultural industry in a particular area is struck by a severe climate-induced event is necessary.

4. *Encouraging income diversification*

Income diversification is a very successful strategy for farmers to mitigate the impact of changing climate patterns on their agricultural productivity. The findings have shown that rice farmers have become less dependent of their on-farm generated income which is dependent on environmental conditions. Instead, their off-farm income generating activities have increasingly become more important and has contributed to the overall resilience of rice farmers to changing climatic conditions. It is therefore recommendable that the government takes an active role in encouraging farmers to engage in additional income generating activities that are less dependent on environmental conditions.

[36] Structured interview with rice-shrimp farmer (04/04/2018)
[37] Interview with official CAAE (23/3/2018)
[38] Interview with An Bien district official DARD (29/03/2018)

5.2.2. Future research

Whereas this research has come across many aspects of the ongoing agricultural transition in Kien Giang and several other coastal provinces in the MD, only several aspects have been discussed extensively in this thesis, whilst many other aspects remain to be researched more extensively. Some of these topics are shortly elaborated on below.

1. *Impact of non-climatic factors on agriculture*

Besides the impact of changing climate variables, there were also several non-climatic factors identified that had an impact on farmers in the research area. Factors such as the quality of PL, water pollution from industries and other farmers, and price fluctuation, were all mentioned by farmers as contributors to an increasingly difficult farming situation. As this thesis has mainly focused on climate related factors, further research concerning the impact of non-climatic factors on farming systems in Kien Giang is recommendable.

2. *Ethnicity and household resilience*

This research pointed out that a majority of rice farmers was Khmer, compared to only a very small part among the remaining farmers. Rice farmers furthermore proved to be resilient and were able to a large extent able to fully recover from the impact of changing climate patterns[39]. Unfortunately, this research did not allow to elaborate too much on a single factor that helps to determine household resilience. Future research concerning the determining role of ethnicity in the assessment of household resilience would therefore be interesting and recommended,

3. *Sustainability of shrimp farming*

As the findings have pointed out, farmers in Nam Yén and Nam Thái have been experiencing several changing climatic conditions, which affected their livelihoods. However, what has sparsely been discussed is not how the climate affects farmers, but what impact farmers have on the environment and the ecosystem. Prolonged extensive use of the ecosystem by farmers has a substantial impact on the soil quality, and affects not only the farmer's agricultural productivity, but also the ecosystem services. Another impact is water pollution by farmers who release water contaminated with pesticides, chemicals or disease from their farms into the river system, which also has a major impact on both the environment as well as other farmers. Future research on strategies how to make shrimp farmers more sustainable is therefore necessary to sustain the ecosystems.

[39] See paragraph 4.3.

4. *The importance of social networks*

Whilst being in the field it became clear that the role of social networks is not to be underestimated. Simple daily routines such as drinking coffee at the local café with other farmers or visiting neighbouring farms are important occasions for farmers to share and acquire knowledge. As these social networks are often based on yearlong friendships or acquaintances, there is a huge amount of trust between them, which makes the knowledge being shared more trustworthy. Farmers genuinely want to help each other to ensure that in their communal futures all of them are enabled to cope with and adapt to changing climatic conditions. The support of social networks is often not limited to sharing knowledge but extends also to support on the farm or financial support. Further research concerning the role of social networks is therefore regarded as important to find out to what extent social networks contribute to household resilience. This will give further insights into what strategies can be applied to effectively build household resilience in agricultural areas in the MD.

5.3. Limitations of research

The importance of social networks for household resilience has been highlighted by several authors (Adger, 2003; Smith et al., 2012), and was furthermore confirmed whilst being in the field. Unfortunately, this research was unable to fully grasp the extent to which the presence of social networks or social cohesion influences household resilience. It is therefore not as incorporated in this thesis as would have been desirable, which is also why it is recommended that further research concerning this topic is needed, in which knowledge concerning the importance of social networks is better applied in resilience studies.

The assessment of subjective household resilience, proved to be more difficult than expected and is therefore to a lesser extent incorporated in the findings of this research. The limited body of existing knowledge and the novelty of the concept (Jones & Tanner, 2015; Nguyen & James, 2013), made it difficult to operationalize the concept to such an extent that it would have been a helpful tool in assessing household resilience. This has resulted in the fact that within this research, objective household resilience as an assessment tool, outweighs the assessment of subjective household resilience.

6. Conclusion

After the drought in 2015 and 2016, the Vietnamese government decided for the agricultural industry in coastal provinces in the MD, such as Kien Giang, to put more emphasis on aquaculture, and more specifically on shrimp production. The rice-shrimp model was regarded as the most suitable option because it would enable farmers to cope with changing climatic conditions, whilst retaining agricultural productivity. This research aimed to determine to what extent farmers have become more resilient by changing their farming model to rice-shrimp farming. A distinction was made between three different farming models, that all have been assessed in terms of climate change impact, their ability to cope with and recover from changing climatic conditions, and their adaptive responses to such changing conditions. The following research question was formulated to guide the research:

To what extent has the transition from rice farming towards various shrimp farming methods in Kien Giang province, Vietnam, made local farmers more resilient to changing climatic conditions?

Whilst in recent years the Vietnamese government has emphasized the importance of transitioning the agricultural section towards more aquaculture-oriented farming practices. The agricultural industry in Kien Giang, or more specifically in An Bien district, has been characterized by this transition since the beginning of the 21st century. The agricultural sector has been affected by saline intrusion, which seems to increasingly reach further inland, thereby causing problems amongst most farmers due to increased salinity levels. Especially shrimp farmers, who are usually located close to the ocean, have been experiencing salinity levels to such an extent their shrimp production has suffered from it. Changing precipitation patterns has furthermore affected shrimp farmers because the resulting temperature changes in the shrimp ponds after unpredictable rainfall, negatively influence the development of shrimps. The remaining rice farmers in Nam Yén and Nam Thái were mainly affected by prolonged droughts in recent years, which has made rice cultivation very difficult, and only marginal profits have been made by rice farming households. These changing climatic conditions have caused a majority of farmers (69 percent) to assess their current farming as being more difficult compared to ten years ago, as most have difficulties to cope with, and adapt to those changing conditions.

Resilience of the three farming models was determined according to the five resilience pillars introduced in the RIMA-framework (FAO, 2016), which looked at variables such as household assets, access to financial transfers, and adaptive capacity. This research has shown that among the three farming models, rice-shrimp farmers have been most resilient in terms of retaining their agricultural productivity whilst being affected by climate change. The researched rice-shrimp farmers were best able to continue farming despite being affected by changing climatic conditions. However, 70 percent of rice farmers told they had been able

to fully recover after being affected by changing climatic conditions, compared to only 37 percent of the rice-shrimp farmers. The ability of the researched rice farmers to fully recover from experienced climate change impacts is the result of their household's adaptive and transformative resilience capacities. Whereas, rice-shrimp farmers proved to possess similar adaptive resilience capacity but were missing transformative resilience capacities. Shrimp farmers were affected most by changing climate change because their location in close vicinity of the ocean resulted in a high climate sensitivity. Saline intrusion has made it impossible for shrimp farmers to diversify crops on their farms, thereby negatively affecting their adaptive capacity. Altogether, shrimp farmers have proven to be least resilient to the consequences of climate changes.

Conclusively, the governmental decision to change to rice-shrimp farming has proven to be successful because the agricultural productivity of rice-shrimp farmers was affected least by changing climatic conditions. However, rice farmers have shown a higher level of resilience to changing climatic conditions because their agricultural productivity was affected more by these climatic stresses but were still able to recover, due to livelihood diversification. Shrimp farmers were least resilient to the impacts of changing climate conditions and it is therefore recommended that future policies will focus on improving their resilience. As saline intrusion is increasingly reaching further inland, it is important for these policies to focus on both shrimp and rice-shrimp farmers to ensure the agricultural productivity is retained, and rural households are enabled to sustain their families.

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Appendix A: Topic lists key-informant interviews

Interview with official Department of Agriculture and Rural Development

(22/03/2018)

Structure and topics of interview:

- Current farming situation in An Bien district
    - Could you elaborate on the current farming situation in An Bien district?

- Transition from rice farming towards shrimp farming
    - How have they been experiencing this?
    - Since when have farmers been changing their farming models from rice to shrimp farming?
    - What are the main drivers for farmers to change farming model?
    - What are the main barriers experienced by farmers to stay with the same farming model?
    - Do governmental and provincial departments assist farmers in this transition, in terms of training, providing knowledge?

- Climate change threats for farmers in An Bien district
    - What are the main climate threats experienced by farmers in An Bien district?
    - Have farmers experienced any extreme climate related shocks in the past 5 years?
    - How has climate change impacted the lives and agricultural productivity of farmers in An Bien district?
    - Do farmers feel threatened by changing climatic conditions?
    - How do they react?
    - What adaptation measures do they take to cope with climate change impact/threats?

- Increased resilience of farmers for climate change impact
    - To what extent does changing the farming model, make farmers more resilient to impacts of climate change?
    - Is the distance from water source important for the resilience of farmer?
    - Have farmers in An Bien have become more able to cope with the consequences of climate change (droughts, saline intrusion, rising temperatures), compared to 10 or 5 years ago?

- Sustainability of farming in An Bien
    - How sustainable is rice farming compared to shrimp farming (economically/environmentally)?
    - Which farming model is in general the most sustainable (economically/environmentally)?

- Future prospects of (shrimp) farming in An Bien district
    - What are the most serious threats to farmers in terms of climate change impact?
    - Are there any other non-climate related threats?
    - Are there any projects (schooling/education/knowledge) planned to increase the climate resilience of farmers in An Bien district?

- Scenario in cases of climate related shocks
    - In the case of a climate related shock, is there an action plan available?
    - Are experiences from the past used as lessons?
    - Does the government have support plans for farmers in the case of a climate change related shock?

- Explain them my research and ask for advice in general

Interview with official sub-department aquaculture, DARD

(23/03/2018)

Structure and topics of interview:

- Transition from rice farming towards shrimp farming
    - How have they (officials) been experiencing this?
    - Since when have farmers been changing their farming models from rice to shrimp farming?
    - What are the main drivers for farmers to change farming model?
    - What are the main barriers experienced by farmers to stay with the same farming model?
    - What is the role of the government in this transition?

- Shrimp farming in An Bien district (different models)
    - What different shrimp farming models can be found in An Bien district?
    - Is there one farming model which is applied most in An Bien district?
    - What are the pros and cons of shrimp farming compared to rice farming?

- Sustainability of shrimp farming in An Bien
    - How sustainable is shrimp farming (economically/environmentally)?
    - Which farming model is in general the most sustainable (economically/environmentally)?
    - Which model is the most polluting?
    - Is there any form of external control that monitors farms in their daily practices, and check the conditions (disease, pesticide/chemical use) of the farm?
    - To what extent is environmental sustainability important for farmers in An Bien district? Has this changed in the last 5/10 years?

- Quality of water infrastructure
    - What is the quality of water infrastructure in An Bien district?
    - Are there plans to develop/improve the water infrastructure in An Bien district?
    - How important is good water quality for shrimp farming?
    - What techniques are mainly applied by shrimp farmers to improve water quality of their farms/ponds?

- Climate change threats for farmers in An Bien district
    - What are the main climate threats experienced by shrimp farmers in An Bien district?

    - Have shrimp farmers experienced any extreme climate related shocks in the past 5 years?
    - How has climate change impacted the lives and productivity of shrimp farmers in An Bien district?
    - Do farmers feel threatened by changing climatic conditions?
    - How do they react?
    - What adaptation measures do they take to cope with climate change impact/threats?

- Increased resilience of shrimp farmers for climate change impact
    - To what extent does changing the farming model, make farmers more resilient to impacts of climate change?
    - Is the distance from water source important for the resilience of farmers>
    - Have shrimp farmers in An Bien have become more able to cope with the consequences of climate change (droughts, saline intrusion, rising temperatures), compared to 10 or 5 years ago?
    - Are some shrimp farming models better able to cope with climate change threats, than other models?

- Sustainability of shrimp farming in An Bien
    - How sustainable is shrimp farming (economically/environmentally)?
    - Which farming model is in general the most sustainable (economically/environmentally)?
    - To what extent is sustainability for the environment important for farmers in An Bien district?

- Future prospects of (shrimp) farming in An Bien district
    - What are the most serious threats to farmers in terms of climate change impact?
    - Are there any other non-climate related threats?
    - Are there any projects (schooling/education/knowledge) planned to increase the climate resilience of farmers in An Bien district?

- Scenario in cases of climate related shocks
    - In the case of a climate related shock, is there an action plan available?
    - Are experiences from the past used as lessons?
    - Does the government have support plans for farmers in the case of a climate related shock?

Interview with official Centre for Agriculture and Aquaculture Extension

(23/03/2018)

Structure and topics of interview

- Practical information of various farming models
    - What different (shrimp) farming models are applied in An Bien district?
    - Which farming model generally generates the highest yields?
    - How do farmers usually control outbreaks of diseases?
    - Which model is the most vulnerable for disease?
    - Do farmers usually monitor the amount of used pesticides and chemicals?
    - Are the current farming models able to cope with threats of a changing climate, such as rising temperatures, saline intrusion, unpredictable weather (rain/drought)?
    - What are the pros and cons of shrimp farming compared to rice farming?
    - Which of the farming models is more sustainable (environmental/economic)?

- Innovation and development farming techniques
    - What are the newest farming techniques for rice and shrimp farmers?
    - Are these techniques better able to cope with threats of a changing climate, such as rising temperatures, saline intrusion, unpredictable weather?
    - Is there an ideal (shrimp) farming model according to you, in terms of economic and environmental sustainability, for An Bien district??

- Water quality and environment
    - How important is the quality of water with shrimp and rice farming?
    - Which farming models create the least polluted water?
    - Can climate resilience of shrimp farmers be improved by the availability of better water infrastructure, and better water quality?

- Technology and knowledge transfer
    - Are farmers in An Bien district assisted or given training when they adopt new farming techniques, or a new farming model?
    - Is there any external control that monitors the farming practices after adopting new farming techniques, or a new farming model?

- Resilience and adaptive capacity
    - What adaptation measures can farmers undertake to be able to better cope with the threats of changing climatic conditions?
    - How can such adaptation measure be integrated in new farming techniques?

Interview with An Bien district official

(29/03/2018)

Structure and topics of interview:

- General characteristics An Bien, and Nam Yen and Nam Thai
    - Size area, population, general education level, ethnic groups etc.

- Farming in An Bien, and Nam Yen and Nam Thai
    - % farmers in district and commune, which farming model applied most
    - Do most farmers own their land?
    - How has the transition towards shrimp farming been experienced by official, and by farmers?
    - Are the farmers happy/satisfied with this transition?
    - Are they doing better than 10 years ago?

- Climate Change in An Bien
    - Which climate change related threat has the biggest impact on farmers in An Bien, and Nam Yen and Nam Thai?
    - How do farmers cope with climate change related events, such as temperature rise, unpredictable rainfall, droughts?
    - During the drought in 2015, were a lot of farmers affected? How much did they lose?
    - When farmers are affected by these threats, how difficult is it to recover?
    - Do they get help from relatives, other farmers in commune, government?

- Resilience farmers in An Bien
    - Do most farmers also have other sources of income?
    - Is it easy for farmers to get a loan or subsidy for their farming activities?
    - Has it become easier for farmers to provide for their household's needs compared to 10 years ago?
    - In case of a climate disaster (drought, excessive rainfall) is there a disaster plan available that helps the communes and farmers to recover quicker?
    - Do farmers receive information and are aware of things such as:
        - techniques how to cope with climate change on their farm
        - rainfall prospects
        - methods to prevent disease
        - opportunities to get loans/subsidies

- Future of farming in An Bien
    - What will the biggest threats in the future be for farmers in the communes?
    - Will they be able to cope with these threats?

Appendix B: Household survey

Household survey An Bien district (Khảo sát nông hộ tại huyện An Biên)

Introduction (Gi?i thiệu)	
Dear respondent, My name is Thijs Poelma, and this research is part of my thesis for the MSc Sustainable Development of Utrecht University, in the Netherlands. Thank you for your interest and cooperation to participate in this study. The topic of this research is on the impact of climate change on local farmers in An Bien district, and will focus on farmer households in Nam Yên and Nam Thái communes. This research is carried out with assistance of the Kien Giang University. The objective of this research is to determine to what extent farmers are able to cope with threats caused by climate change and changing weather phenomena. Please be assured that the responses you provide are for academic purposes only and are completely anonymous and confidential. Your participation in this research does not attract any financial incentive, and participation is completely voluntary. Thanks for your understanding, and cooperation. Kính gửi người tham gia, Tôi là Thijs Poelma, phiếu khảo sát này là một phần luận văn tốt nghiệp thạc sĩ chuyên ngành Phát triển Bền vững của tôi tại Đại học Utrecht University, Hà Lan. Xin cảm ơn sự hợp tác của Ông/ Bà trong việc cung cấp thông tin cho bảng khảo sát. Chủ đề nghiên cứu là "Những tác động của biến đổi khí hậu đến nông hộ tại huyện, và tập trung ở hai xã Nam Yên và Nam Thái. Nghiên cứu được thực hiện dưới sự hỗ trợ của Trường Đại học Kiên Giang. Mục tiêu của nghiên cứu là xác định mức độ khả năng ứng phó với mối nguy và những hiện tượng thời tiết cực đoan gây ra bởi biến đổi khí hậu. Vui lòng cung cấp thông tin thật chính xác và đầy đủ và không cần cung cấp danh tánh, vì câu trả lời chỉ nhằm mục đích phục vụ nghiên cứu khoa học. Nghiên cứu này không có bất kì động cơ tài chính nào và người tham gia vào nghiên cứu là hoàn toàn trên tinh thần tự nguyện. Xin chân thành cảm ơn sự cảm thông của Ông/ Bà.	
Date (Ngày/Tháng/năm):	**Respondent nr** (Ng??i trả l?i):

A. General and Household Information (Thông tin chung về nông hộ)	
1. Commune (Xã)	2. Sex (giới tính)
a. Nam Yên b. Nam Thái	a. Male (Nam) b. Female (Nữ)
3. Age (Tuổi) _____ years (Năm)	
4. Education level (Trình độ học vấn)	
a. None (Không đi học) b. Primary education (Cấp 1) c. Middle school (Cấp 2)	d. High school (Cấp 3) e. College (Cao đẳng) f. University (Đại học)
5. Marital Status (Tình trạng hôn nhân)	6. Ethnicity (Dân tộc)
a. Married (Kết hôn) b. Single (Độc thân) c. Divorced (Đã li dị) d. Widowed (Hóa chồng/ vợ) e. Other (Khác)	a. Vietnamese (Kinh) b. Khmer (Khơ me) c. Chinese (Hoa) d. Other (Khác)
7. Literate (Biết chữ)	a. Yes (Có) b. No (Không)

8. Household size (How many people are living in your household?) (Gia đình có bao nhiêu thành viên?)

_____ people (Người)

9. How many people of your household are working? (Có bao nhiêu người trong đang tham gia lao động kiếm tiền?)

_____ people (Người)

10. How long have you been living here? (Ông/ Bà sống ở đây được bao lâu rồi?)

_____ years (Năm)

B. Household Assets (Tài sản nông hộ)

11. Do you own the land of your farm? (Ông/ Bà có sở hữu đất đai không?)

a. Yes (Có)
b. No, rent (Không, thuê đất)
c. No, other,_____ (Không, khác)

12. How large is your farm/shrimp ponds? (Ao của Ông/ Bà có diện tích bao nhiêu?)

_____ hectares (ha)

13. Does your household own? (Gia đình Ông/ Bà có những vật dụng sau đây:…..)
OBSERVATION!!!

a. Television (TV)
b. Radio (Đài)
c. Telephone (Điện thoại)
d. Sewing machine (Máy may)
e. Washing machine (Máy giặt)
f. Stereo (Dàn máy hát nhạc)
g. Computer (Máy tính)
h. Bicycle (Xe đạp)
i. Motorbike (Xe máy)
j. Ploughing machine (Máy cày)
k. Car (Xe hơi)
l. Boat (Ghe/ Tàu)
m. Fridge (Tủ lạnh)

C. Financial Assets (Tài chính nông hộ)

14. What is your main source of income? (Nguồn thu nhập chính của gia đình mình là gì?)

15. Do you or your household members have any other source of income? (Gia đình mình còn có nguồn thu nhập phụ nào khác không?)

a. Yes, (Có)
b. No, go to question 17. (Không, đi tới câu 17)

16. What other sources of income do you or your household member have? *More answers possible* (Nguồn thu nhập phụ khác là gì? Có thể chọn nhiều lựa chọn)

a. Cultivating crops (Trồng trọt)
b. Livestock production and sales (Chăn nuôi và Buôn bán rau cải thịt cá)
c. Wage labour (Làm thuê)
d. Sale of wild products (Bán sản phẩm thu từ tự nhiên)
e. Other self-employment/own business (Những công việc/ hoạt động kinh doanh khác)
f. Fishing (Đánh cá)
g. Sale of other non-livestock asset/rental of land (Buôn bán khác ngoài rau cải thịt cá/ tiền cho thuê đất)
h. Remittances (Tiền từ người khác gửi về cho)
i. Other (Khác): ….

17. What is your household's/farm's monthly income? (Thu nhập hằng tháng của hộ mình là bao nhiêu?)

_____ VND (Đồng)

18. Is your income enough to take csare of your household's daily needs?

a. Yes (Có)
b. No (Không)

19. Does your household have any savings? (Gia đình mình có để dành dụm tiền tích lũy không?)

a. Yes (Có)
b. No (Không)

20. If your household had a problem and needed money urgently, would you be able to get it from relatives or friends? (Nếu gia đình Ông/ Bà gặp biến cố và cần tiền trong trường hợp khẩn cấp, Ông/ Bà có thể nhận giúp đỡ từ người thân và bạn bè không?)

a. Yes (Có)
b. No (Không)

21. If someone in your household had a problem (illness, injury etc.) and your household needed help with work (support on farm), would you be able to get it from relatives or friends? (Nếu như người trong gia đình Ông/ Bà gặp sự cố (đau ốm, chấn thương....) và gia đình rất cần giúp đỡ trong công việc (công việc đồng án hoặc trong vuông tôm), thì Ông/ Bà có thể nhờ họ hàng hoặc bạn bè giúp không?)

a. Yes (Có)
b. No (Không)

D. Access to public services and information (Tiếp cận với các dịch vụ công cộng và thông tin)

22.	How to go? (Ông/ Bà di chuyển bằng phương tiện gì?) (Foot, bicycle, motorbike, car, other) (Đi bộ, xe đạp, xe máy, xe hơi, khác)	How long to get there? (km) (Bao xa cách nhà mình?) (Phút)	Quality of facilities (Chất lượng các dịch vụ này như thế nào)				
			Very good (Rất tệ)	**Good** (Tệ)	**Neutral** (Không ý kiến)	**Bad** (Tốt)	**Very bad** (Rất tốt)
Nearest market (Chợ gần nhất)							
Nearest primary school (Trường cấp 1 gần nhất)							
Nearest secondary school (Trường cấp 2 gần nhất)							
Nearest high school (Trường cấp 3 gần nhất)							
Nearest health clinic (Phòng khám gần nhất)							

23. How often do you receive information about changing weather conditions? (Ông/ Bà có thường nhận được tin tức liên quan đến các chủ đề sau trong năm rồi?)

a. Never (Chưa bao giờ)
b. Every day
c. 1x per week (Một tuần một lần)
d. 1x per month (Một tháng một lần)
e. 1x per 3 months (Ba tháng 1 lần)
f. 1x per year (Một năm một lần)

24. How often do you receive information techniques to improve your ability to cope with changing weather conditions (Ông/ Bà có thường nhận được tin tức liên quan đến các chủ đề sau trong năm rồi?)

g. Never (Chưa bao giờ)
h. Every day
i. 1x per week (Một tuần một lần)
j. 1x per month (Một tháng một lần)
k. 1x per 3 months (Ba tháng 1 lần)
l. 1x per year (Một năm một lần)

E. Farming Activities (Hoạt động canh tác)

25. How many years have you already been a farmer? (Ông/ Bà làm nghề nông được bao lâu rồi?
_____ years (Năm)

26. Which farming model is applied at your farm? (Ông/ Bà hiện có những mô hình nào?)

a. Monoculture rice farming (Trồng lúa)
b. Shrimp-rice farming (Lúa- Tôm)
c. Extensive shrimp farming (Tôm quảng canh)
d. Improved extensive shrimp farming (Tôm quảng canh cải tiến)

27. Are you also growing others crops, besides your main crop? (Ông/ Bà có trồng trọt hoặc chăn nuôi gì khác không?)

a. Yes, which (Có, cụ thể là)

_____
_____
_____
_____

b. No (Không)

28. Have you changed your farming activities in the last 10 years? (Trong 10 năm qua Ông/ Bà có thay đổi hoạt động canh tác nông nghiệp của nhà mình không?)

a. Yes (Có)
b. No, go to question 30. (Không, đi tới câu 32)

29. What were the main reasons for changing your farming model? (Lý do chính mà Ông/ Bà thay đổi hoạt động canh tác là gì?)

30. Have you experienced that farming now is more difficult than 10 years ago? Why? (Ông/ Bà có thấy hoạt động canh tác nông nghiệp bây giờ khó khăn hơn 10 năm trước không? Tại sao?)

31. *Only for shrimp farmers* (Chỉ dành cho nông hộ nuôi tôm) The following techniques are about pond management and environmental protection. Please indicate if you apply these techniques on your farm. (Những kỹ thuật về bảo vệ môi trường và quản lí chất lượng nước. Vui lòng chỉ rõ là Ông/ Bà có sử dụng những kỹ thuật bên dưới trong mô hình của mình không?	
Technique (Kỹ thuật)	**Yes/No** (Có/ Không)
a. Depositing sediment, filtering and treating water before going into the pond. (Xử lý trầm tích, lọc và xử lí nước trước khi cấp nước vào ao)	
b. Treating water before discharge to the river (Xử lí nước trước khi xả vào kênh)	
c. Having place for keeping discharge soil when cleaning the ponds (Có nơi chứa đất bùn đáy khi nạo vét ao)	
d. Having a clean water source for ponds (Có nguồn nước sạch cho hệ thống ao nuôi)	
e. Having large enough sluices, canals, rivers for discharge. (Có hệ thống đê, cống, đập, kênh, sông đủ lớn để phục vụ nhu cầu thay nước)	
f. Having good feed and seed (Có thức ăn và con giống chất lượng)	
g. Having a good ratio of shrimp density in ponds (Mật độ nuôi tối ưu)	
h. Identifying and treating diseases by chemicals (Phát hiện bệnh và trị bệnh cho đối tượng nuôi trồng bằng hóa chất)	
i. Monitoring how much chemicals and pesticides are used. (Quản lí được lượng hóa chất và thuốc diệt côn trùng mà mô hình sử dụng)	
j. Getting advice from extension workers (Nhận được tư vấn từ cán bộ khuyến nông)	

F. Perceptions on Climate Change and Adaptive Capacity (Nhận thức về biến đổi khí hậu và Khả năng thích ứng)						
32. Could you indicate to what extent you agree with the following statements. "In the past 10 years, I have experienced:" (Ông/ Bà vui lòng chỉ ra mức độ đồng ý của mình cho những phát biểu bên dưới "Trong mười năm nay, bản thân tôi đã chứng kiến ...."	**Strongly agree** (Hoàn toàn đồng ý)	**Agree** (Đồng ý)	**Neutral** (Không ý kiến)	**Disagree** (Không đồng ý)	**Strongly disagree** (Hoàn toàn không	**Don' t know** (Không biết)
a. Rising temperatures (Nhiệt độ tăng)						
b. More droughts (Hạn hán nhiều hơn)						
c. Saline intrusion soils (salty groundwater) (Đất bị nhiễm mặn (Nước ngầm nhiễm mặn))						
d. More frequent floods (Lũ lụt diễn ra thường xuyên hơn)						
e. Unpredictable rainfall (Lượng mưa khó đoán được)						
f. More storms/typhoons (Nhiều bão/ Bão lớn diễn ra hơn)						

33. Which of the following events had the biggest influence on your household and its agricultural productivity in the past year? *More answers possible.* (Dạng thiên tài nào sau đây có ảnh hưởng lớn nhất đến gia đình Ông/ Bà cũng như hoạt động canh tác nông nghiệp của gia đình mình trong năm rồi.) (Có thể chọn nhiều đáp án)

a. Rising temperatures (Nhiệt độ gia tăng)
b. More droughts (Hạn hán nhiều hơn)
c. Saline intrusion soils (salty groundwater) (Đất bị nhiễm mặn (Nước ngầm bị nhiễm mặn))
d. More frequent floods (Lũ lụt thường xuyên hơn)
e. Unpredictable rainfall (Lượng mưa khó đoán được)
f. More storms/typhoons (Nhiều bão/ Bão lớn diễn ra hơn)

34. To what extent were you and your household able to recover from these events? (Khả năng phục hồi sau những thiên tai gặp phải đã chọn ở câu 33 như thế nào?)

a. Did not recover (Không phục hồi)
b. Did recover, but worse off than before event (Phục hồi, nhưng tệ hơn so với trước khi thiên tai xảy ra)
c. Recovered to the same level as before (Phục hồi lại được trạng thái trước khi thiên tai xảy ra)
d. Recovered and better off (Phục hồi và phát triển tốt hơn trước thiên tai)
e. Not affected by event (Không bị ảnh hưởng bởi các thiên tai)

The following statements relate to the effect these events can have on your household. Please indicate to what extent you agree with these statements (Những phát biểu bên dưới có liên quan đến những tác động của thiên tai đến gia đình Ông/ Bà. Vui lòng chỉ ra mức độ đồng ý của Ông/ Bà).	**Strongly agree** (Hoàn toàn đồng ý)	**Agree** (Đồng ý)	**Neutral** (Không ý kiến)	**Disagree** (Không đồng ý)	**Strongly disagree** (Hoàn toàn không đồng ý)	**Don' t know** (Không biết)
35. I think our farm will become less productive because of the impact of climate change. (Tôi nghĩ mô hình canh tác của mình sẽ thất bát hơn bởi tác động của biến đổi khí hậu.)						
36. I think our household will lose farm animals because of the impact of climate change. (Tôi nghĩ gia đình mình sẽ bị mất đi các mô hình nuôi cũng như các vật nuôi khác bởi tác động của biến đổi khí hậu)						
37. I think our household income will decrease because of the impact climate change. (Tôi nghĩ thu nhập của gia đình mình sẽ giảm đi bởi tác động của biến đổi khí hậu)						
38. I think that food availability will become worse because of the impact of climate change. (Tôi nghĩ sự sẵn có về lương thực ngày càng trở nên tệ hơn dưới tác động của biến đổi khí hậu)						
39. I think the availability of fresh drinking water will become worse because of the impact of climate change. (Tôi nghĩ sự sẵn có về nước uống ngày càng trở nên tệ hơn dưới tác động của biến đổi khí hậu)						

40. I think that the impact of climate change will result in household members migrating. (Tôi nghĩ tác động của biến đổi khí hậu sẽ làm cho người dân di cư đến nơi khác)						
41. I want to learn new farming techniques/practices to cope with future climate change threats. (Tôi muốn được học những kỹ thuật canh nông mới/ thực tế để ứng phó với những hiện tượng thời tiết cực đoan sắp xảy ra)						

42. In the last 10 years, did you take action to be more able to cope with and adapt to climate change threats, such as drought, increased temperatures, and unpredictable rainfall? (Trong 10 năm qua, Ông/ Bà đã có những động thái gì để ứng phó và thích ứng với những mối nguy từ những hiện tượng thời tiết cực đoan của biến đổi khí hậu, như là hạn hán, nhiệt độ tăng, lượng mưa khó đoán?)

a. Yes, go to next question (Có, đi tới câu hỏi kế)
b. No, go to question 43 (Không có, đi tới câu 48)

43. What adaptation measures and techniques did you use to deal with climate change threats? (Những biện pháp và kỹ thuật nào mà Ông/ Bà đã sử dụng để ứng phó với những sự kiện thời tiết cực đoan đã xảy ra?)
Skip next question (Bỏ qua , đi tới câu hỏi kế)

44. What was the main reason for not doing anything to adapt to climate change? (Lý do vì sao mà Ông/ Bà không có bất kì động thái gì để thích ứng với biến đổi khí hậu?)

a. Don't know what to do (Không biết phải làm gì)
b. Don't find it necessary to do anything (Thấy không cần thiết phải làm gì)
c. I know what to do, but don't have the money/equipment/technology (Biết cần phải làm gì, nhưng không đủ tiền/ trang thiết bị/ kỹ thuật)
d. The problem is too big for me to solve (Vấn đề này vượt quá khả năng của bản thân)

The following statements will be about your perception on climate change, and your ability to cope with its impact on your household. Please indicate to what extent you agree with these statements. (Những phát biểu sau đây sẽ nói về nhận thức về biến đổi khí hậu, và khả năng ứng phó với những tác động mà nó gây ra cho gia đình Ông/ Bà. Vui lòng chỉ rõ mức độ hài lòng của Ông/ Bà)	**Strongly agree** (Hoàn toàn đồng ý)	**Agree** (Đồng ý)	**Neutral** (Không ý kiến)	**Disagree** (Không đồng ý)	**Strongly disagree** (Hoàn toàn không đồng ý)	**Don' t know** (Không biết)
45. I think that me and my household will be affected by climate change threats in the coming 3 years. (Trong 3 năm tới, tôi nghĩ gia đình mình sẽ bị ảnh hưởng bởi biến đổi khí hậu)						
46. I think that me and my household will be able to take adaptation measures to protect ourselves from future climate change threats. (Tôi nghĩ gia đình mình có thể tìm ra giải pháp thích ứng với biến đổi khí hậu và tự bảo vệ mình trước những mối nguy thiên tai có thể xảy ra)						

47. I think that the adaptation measures taken are able to protect me and my household from future climate change threats. (Tôi nghĩ những giải pháp thích ứng đang áp dụng đã đủ sức bảo vệ chúng tôi trước những mối nguy thiên tai có thể xảy ra)						
48. I think our household can carry out adaptation measures, without external support (money, training, additional technology). (Tôi nghĩ chúng tôi có thể tự tìm ra giải pháp thích ứng với biến đổi khí hậu, mà không cần bất kì sự hỗ trợ nào từ bên ngoài (Tiền,Tập huấn, kỹ thuật bổ trợ)						

Thank you for filling out this survey! In the case you have any suggestions or remarks regarding the questions in this survey, is there something you would like to mention? (Xin chân thành cảm ơn Ông/ Bà đã hoàn thành phần khảo sát. Nếu Ông/ Bà có bất kì ý kiến gì hoặc có bất kì đóng góp nào cho các câu hỏi trong phần khảo sát, hoặc có những ý kiến khác mà Ông/ Bà muốn đề cập tới, vui lòng chỉ ra bên dưới.)

XIN CẢM ƠN

Appendix C: Topic list semi-structured interview with farmers

Structure and topics of interview:

- Introduction
    - What farming model, how many years?
    - Are they satisfied about current farming situation?
    - Has farming become easier, or more difficult compared to 10 years ago?

- Climate change impact
    - Do you know what climate change is, and how it affects your household?
    - **If no, shortly explain about droughts, saline intrusion, unpredictable rainfall.**
    - How has your household been affected by climate change (droughts, saline intrusion (salty groundwater), unpredictable rainfall) in the past 5 years?
    - How did you try to prevent your household from being affected by climate change? (Adaptation strategies)

- Resilience
    - To what extent was your household able to recover from these events?
    - Did you need external support (help from friends, loans, government etc.) to recover from these events?
    - If your crop fails, is your household able to take care of its daily needs?
    - If yes, how? If no, how do you try to solve this?

Think about crop or income diversification, knowledge (training), access to money (loans), severity of the shock, access to climate change information.

- Resilience building
    - Is your household trying to improve its ability to cope with climate change threats in the future?
    - If yes, how? If no, why not?

  For rice farmers only:
    - Would you like to change your farming model to Rice-Shrimp?
    - Why?
- Migration
    - Do you see yourself or other members of your household moving away because of climate change? Why?

Thanks for your time!!!