# Current and Future Household Livelihood Adaptation to Changing Social-Ecological Context

## A Case Study in the Rural Coastal Areas of the Vietnamese Mekong Delta and Red River Delta

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Geographie

# Current and Future Household Livelihood Adaptation to Changing Social-Ecological Context - A Case Study in the Rural Coastal Areas of the Vietnamese Mekong Delta and Red River Delta

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## Abstract

Coastal deltas around the globe confront considerable social and ecological challenges. Among these regions, the Vietnamese Mekong Delta and Red River Delta are pronounced for their high vulnerability to hazards and climate variability, while playing the key role in terms of food security, economic development, and population density nationally. Therefore, examining the patterns and details of adaptation in these deltas are significant in the future under climate change.

The coastal areas of the Vietnamese deltas have been experiencing more frequent extreme weather events, typically droughts, typhoons, floods, and salinity intrusion, as well as drastic political and socio-economic transitions in the last three decades. Moreover, the deltas' social-ecological system is subjected to even more extensive changes in the future. This dissertation offers a conceptual framework to study the changing complex context in the rural coastal of the Vietnamese deltas in response to: firstly, the knowledge gaps in understanding the details and process of adaptation of these vulnerable communities, and secondly, the research needs of framing and operationalizing the social-ecological integrative approach. More specifically, this dissertation contributes to the interdisciplinary literature with a diverse case study to illustrate the linkage between macro trends and details of current and future livelihood changes at the household level. Along these lines, it emphasizes the connection between farm and nonfarm sectors, as well as between rural and urban contexts to overcome the fragmentation caused by separating research disciplines as well as by the case-study based literature on environmental change adaptation.

The findings from the case study of five coastal provinces in the two major deltas of Viet Nam show that the livelihood shifts of households are determined by the combination and interaction of social and climatic drivers. The research presents a typology approach, as a part of the mixed-method design to capture the dynamics of household livelihoods in the rural coastal areas in the past and present. The taxonomy of livelihood-change strategies of households generated from the case study takes into account multiple dimensions of livelihood shifts at the household level and thereby allows further identification of enablers and barriers to adaptation. The future adaptation is examined with the empirical data on a series of scenarios hypothesizing social and environmental changes to project emerging trends of change. Linking to the concepts of coupled social-ecological relationship, livelihood dynamics, and processual approach to adaptation, these results are able to shed light on the process of changes that emphasizes the interaction between the society and the environment, as well as between different social actors or scales of adaptive actions.

The insights into the diverse coastal areas of the two Vietnamese deltas showcase a good example of the complex social-ecological context which proves the need for an

integrative approach to study adaptation. The main findings complemented by an in-depth discussion on the role of policy intervention highlight the importance of this institutional factor in directing the regional development given the specific political system of Viet Nam. Based on this conclusion, implications and outlook were made to call for further efforts of researchers and practitioners to facilitate more adaptive pathways of vulnerable communities.

## Zusammenfassung

Weltweit stehen Küstenregionen vor großen sozialen und ökologischen Herausforderungen. Das gilt auch für das vietnamesische Mekongdelta und das Delta des Roten Flusses, die den Folgen des Klimawandels ausgesetzt und gleichzeitig von zentraler Bedeutung sind. Beide Deltaregionen sind die wichtigsten Anbauregionen für landwirtschaftliche Produkte, Motoren der wirtschaftlichen Entwicklung und die Bevölkerungsschwerpunkte Vietnams. Daher ist es wichtig, in diesen Gebieten die Entwicklung von Anpassungsmaßnahmen ländlicher Haushalte zu untersuchen, die maßgeblich die zukünftige Funktions- und Leistungsfähigkeit beeinflussen werden.

In den letzten dreißig Jahren haben die Küstenregionen der vietnamesischen Deltas sowohl immer extremere Wetterereignisse wie Dürren, Taifune, Überschwemmungen und Versalzungen von Böden als auch einschneidende politische und sozioökonomische Veränderungen erlebt. Diese Dissertation zielt darauf ab, die bestehende Wissenslücke beim Verständnis von Anpassungsprozessen in den exponierten Deltas zu schließen. Dazu wird ein sozio-ökologischer integrativer Ansatz entwickelt und operationalisiert, der den konzeptionellen Rahmen bildet, um die komplexen und sich ständig wandelnden Bedingungen ländlicher Küstenregionen zu untersuchen. Mit einer umfangreichen Feldstudie, die sowohl Makrotrends als auch individuelle Anpassungsstrategien ländlicher Haushalte vor dem Hintergrund sich ständig ändernder Rahmenbedingungen in den Deltaregionen verbindet, leistet diese Dissertation einen innovativen Beitrag zur interdisziplinären Forschung: Sie unterstreicht den Zusammenhang landwirtschaftlicher und nicht landwirtschaftlicher Aktivitäten sowie die Interdependenz ländlicher und städtischer Regionen. Dieses umfassendere Verständnis über Einflusfaktoren auf regionale Entwicklungsprozesse unterscheidet diese Dissertation von zahlreichen Studien zur Anpassung, die einseitig nur die Umweltveränderungen betrachten.

Die Untersuchungen in fünf Küstenregionen der beiden großen Deltas Vietnams zeigen, dass die Lebensgrundlage von Haushalten durch das Zusammenspiel sozialer und klimatischer Faktoren bestimmt ist. Die Untersuchung erarbeitet eine Typologie ländlicher Anpassungsstrategien, die die Dynamik der Lebensgrundlagen von Haushalten in ländlichen Küstenregionen in der Vergangenheit und Gegenwart erfassen. Die Dissertation deckt auf, welche Faktoren für erfolgreiche Anpassungen hinderlich und welche förderlich sind. Anhand empirischer Daten zu hypothetischen Szenarien veränderter ökologischer und sozialer Bedingungen werden künftige Anpassungsstrategien vorhergesagt. Anknüpfend an die Konzepte der gekoppelten sozio-ökologischen Beziehungen und der dynamischen Veränderungen von Lebensgrundlagen, sind diese Ergebnisse in der Lage, Veränderungsprozesse zu erklären, die sowohl die Wechselwirkung zwischen Gesellschaft und Umwelt beleuchten als auch die Wechselwirkung zwischen verschiedenen sozialen Akteuren und verschiedenen Anpassungsmaßnahmen.

Die Erkenntnisse zu verschiedenen Küstenregionen der beiden vietnamesischen Deltas belegen die komplexen sozio-ökologischen Zusammenhänge, die einen integrativen Ansatz erfordern, um Veränderungsprozesse untersuchen zu können. Die wichtigsten Ergebnisse wurden durch Tiefeninterviews zur Rolle politischer Einflussnahme ergänzt und betonen die Bedeutung dieses institutionellen Faktors bei der Steuerung der Regionalentwicklung angesichts des politischen Systems in Vietnam. Allerdings zeigen die Ergebnisse auf, dass es weiterer Anstrengungen in Forschung und Praxis bedarf, um ländliche Haushalte zu unterstützen, ihre Anpassungsstrategien zu optimieren.

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| | |
|---|---|
| ABM | Agent-based modelling |
| DARD | Department of Agriculture and Rural Development |
| DONRE | Department of Natural Resources and Environment |
| DPC | District People's Committee |
| GSO | General Statistics Office |
| HCMC | Ho Chi Minh City |
| IPCC | Intergovernmental Panel on Climate Change |
| MD | Mekong Delta |
| MONRE | Ministry for Natural Resources and the Environment |
| NCHMF | National Centre for Hydro-Meteorological Forecasting |
| PPC | Provincial People's Committee |
| RRD | Red River Delta |
| SES | Social-ecological system |
| SIWRR | Southern Institute of Water Resources Research |
| SLF | Sustainable Livelihoods Framework |
| SLR | Sea level rise |
| SRV | Socialist Republic of Viet Nam |
| UN | United Nations |
| VND | Vietnam Dong |
| WB | World Bank |

# 1. INTRODUCTION

## 1.1. The multi-exposure context in the Vietnamese deltas

The Mekong Delta (MD) and the Red River Delta (RRD) which are the two largest delta regions of Viet Nam and together home to forty-two per cent of the national population (GSO 2017) are renowned for their social-ecological multi-exposure context. More specifically, Viet Nam is ranked by the Intergovernmental Panel on Climate Change (IPCC) (IPCC 2007, 2014) as among the most prone countries to climate change where it is projected to face more frequent extreme weather events of the multiple traditional hazards (*e.g.* flood, drought, typhoons, *etc.*), as well as emerging concerns such as salinity intrusion and sea level rise. Meanwhile, it also remains among the most rapidly and dynamically developing societies which confronts the country with both challenges and opportunities ecologically and socially. Particularly, the drastic development since '*Đổi mới*'[1], the high density of inhabitants together with the ecological dynamics and increasing climatic variability bring to these two deltas both challenges and opportunities and makes them among the most researched areas regionally and globally. Numerous on-going conversations are held by researchers and practitioners on the governance level to tackle relevant questions of vulnerability, adaptation, and sustainability (Adger *et al.* 2001); yet comprehending the complexity at more micro levels furthermore receives urgent attention due to the large and heterogeneous communities involved in the context.

Coastal rural areas of both the MD and the RRD are, on the one hand, highly vulnerable to not only various hazard risks such as flood, typhoon, droughts, and salinity intrusion but also to increasing climate stressors from sea level rise as well as upstream dam construction (in the case of MD) (Rahman *et al.* 2019, Renaud & Kuenzer 2012, Nguyen *et al.* 2017). On the other hand, the regions are experiencing drastic shifts brought by rapid economic development and social progress, for instance, changes related to land-use (*e.g.* agriculture, aquaculture and so as urbanization) (Garschagen *et al.* 2012). In addition, these densely populated deltas, particularly the rural coastal areas are still under the pressure of the continuing population growth (Nguyen & Hens 2019, Rahman *et al.* 2019). The global environmental changes and the unique political and socio-economic background of Viet Nam enhance the uncertainties at the household level even further.

Research on the adaptation in the two deltas is increasingly urged to take into consideration this multi-exposure context. Firstly, despite the singularity of the two deltas, they both play a pivotal role in the political and socio-economic development of the country which is most obviously reflected through the high-density level as well as livelihood dynamics of the of their dwellers. Furthermore, the deltas' social development

[1] Đổi mới (English: Renovation/Renewal Policy) refers to the major economic reform initiated by the Vietnamese government delivered at the 6th Party National Congress in 1986. Its main goal was to shift from central planned and collective production towards a "socialist-oriented" market economy. Privatization of agriculture production by shifting from cooperative groups toward farm household was an important landmark in this process (Trinh, Muu).

interlinks tightly to their deltaic ecological environment. Therefore, neither of these two components of the coupled human-environment system could be overlooked in their vulnerability profile.

## 1.2. Adaptation to the changing social-ecological context

Experiencing strong social transitions and being among climate-risks prone areas worldwide, the complexity of the Vietnamese context is neither a surprise nor a new phenomenon. Nevertheless, these regions are more than often addressed by the literature in a fragmented manner across various disciplines and therefore often missing some components of the context's dynamics, particularly found in research that is either case-study based or narrowed to one specific level of analysis (*i.e.* macro, meso or micro). Between different disciplines, environmental drivers are dominant in studying on-farm livelihood change, whilst non-farm livelihood dynamics are often found disconnectedly in socio-economic studies. Given the increasing uncertainty and intensity of changes looking towards the future, an interdisciplinary research approach is pivotal to capture the vulnerability and adaptation pathway of communities at the frontline. This approach, therefore, responds to the need to integrate relevant research disciplines of environmental studies and development economics. The specific deltaic social-ecological setting rationalizes the importance of interdisciplinary research not only on these two most important deltas of the country but also to other deltas globally.

Among the core concepts of these fields, adaptation has been early raised and studied across various disciplines since many decades. Together with the rise of climate change subject, it is nowadays one of the most discussed terms in global environment studies. However, the endeavours to understand the details and dynamics of the adaptation process starting from the most micro social unit are fragmented timely and spatially across disciplines. On a conceptual level, a large number of studies have over the last decade framed climate change effects as the main driver for such changes. However, more recent studies also started to emphasize that livelihood changes are driven not only by environmental but also by socio-economic and institutional changes. The discourse of adaptation conceptualization among social scientists tends to be more controversial in the last few decades when it has to deal with fields of study such as anthropology and geography (Smithers & Smit 1997, Garschagen 2014). This research agrees with the school of thought in which adaptation should be understood as a process of interaction, *i.e.* reaction and anticipation, between the society and the biophysical environment and thus continuously produces changes including both risks and opportunities (Denevan 1983, Fankhauser *et al.* 1999, Garschagen 2014).

Meanwhile, despite the advanced achievements in conceptualizing the interdisciplinary approach in adaptation studies, the efforts to transfer it into applications are not yet convincing. While the rural setting, particularly in regions simultaneously experiencing

strong social transition processes and prone to climate changes effects has become more complex than ever before, majority of literature carried out in this dynamic context either endures stressing the links between climate change and agricultural practices as in adaptation studies or overlooks environmental elements as in socio-economics research.

## 1.3. The missing linkage between macro trends and changes at the household level in the Vietnamese deltas

The major trends of change have been well observed, recorded and analysed in the literature in the Southeast Asian region (Rigg 2006, Kelly 2011, Elmhirst 2012) in general and in Viet Nam particularly (Xuan & Matsui 1998, Can *et al.* 2007, Miller 2014). The links between these trends are also discussed and analysed (*e.g.* Klaus 2010, Garschagen *et al.* 2012, Biggs *et al.* 2009) in order to reflect more vividly the process of change in the country and delta regions. Notwithstanding, these studies rather shed light on the macro trends, *i.e.* at national and regional levels, with limited emphasis on the essential connection with changes at the individual level which not only takes place as dynamically but also explains the trajectory of changes and gives hints on future pathways.

In the MD and the RRD of Viet Nam, although the social-ecological changes are observable at the macro level, the details of drivers and patterns of changes have not been well addressed. Whereas research on the major shifts at the household level in these regions are often done separately on specific aspects and/or case studies. For instance, numerous studies look into the shift in a specific agrarian system such as rice cultivation, fresh-water aquaculture or shrimp farming (Bosma *et al.* 2011, Tung 2017, Tran *et al.* 2018, Nguyen *et al.* 2014). In parallel, recent research on socio-economic disciplines rather successfully highlights the changes in non-farm sectors (Brünjes & Revilla Diez 2012, Hoang *et al.* 2014) or on migration issues (Adger *et al.* 2002, Geest *et al.* 2014, Warner *et al.* 2012). Furthermore, other adaptation studies on these regions are often found focusing on either urban or peri-urban context (*e.g.* Pham 2011, Garschagen 2014, Garschagen *et al.* 2011); a farming system, e.g. fisheries and aquaculture (FAO 2018, Joffre *et al.* 2015), rice (Tran *et al.* 2018, Yen *et al.* 2016); or specific-hazard context (*e.g.* Schwab 2012, Vo 2014, Nguyen 2015, McElwee *et al.* 2016). Therefore, there remains a gap in the details of the links between the large-scale trends and the decision to change at the household level across complex contexts and heterogeneous populations when they are considered either together or in parallel.

## 1.4. Research objectives and questions

The application of the social-ecological integrative approach in interdisciplinary studies has been identified as an important research need for further contribution. Applying to the diverse case study of Viet Nam, this dissertation specifically responds to the research gaps in understanding the details of adaptation dynamics in the complex and changing social-ecological context. It, therefore, adopts the aforementioned approach as guidance in order

to achieve the two main objectives. Firstly, it is aimed to shed light on the household's decision-making process in livelihoods adaptation to the social and environmental changes in the Mekong and Red River deltas. Secondly, it examines the trends of the household's future adaptation as they are hypothesized to confront further changes and uncertainties. With that being said, the dissertation is structured step by step to resolve the following core research questions (RQ).

*On empirical results:*

**RQ 1***: How farmers' agricultural and non-agricultural livelihoods have been changing in rural coastal areas of the Mekong Delta and the Red River Delta?*

Sub 1.1: Which farmer groups are changing in what ways?

Sub 1.2*:* What was/is the process of change in each delta? Why?

Sub 1.3*: What are* the determinants and their roles in the process of change?

Sub 1.3.1: Which role do environmental versus non-environmental factors play?

Sub 1.3.2: Which role do pressures/threats versus opportunities play?

Sub 1.3.3: For which household, the change is reactive or proactive?

Sub 1.4: To what extent the changes are positive or negative? Who does benefit or suffer from the process of change?

**RQ2***:* How the current mechanism of livelihood-change at the household level will carry on into the future as the social-ecological contexts vary?

Sub 2.1: How will household livelihood change strategies be different in the future under various scenarios?

Sub 2.2*:* Will these changes be temporary or long-term that can lead to a transformation?

Sub 2.3: What are the implications of study the process of change in anticipating future trends in complex social-ecological contexts?

*On the conceptual approach:*

**RQ3**: How to operate the integrative social-ecological approach to study livelihood adaptation dynamics in changing context? What are the implications of the interdisciplinary research approach to adaptation study?

## 1.5. Approach to the research

This research addresses the research gaps and resolves the research questions by proposing an integrative framework focusing on individual household level in which the adaptive behaviours of households explain their decision-making process to inherently

adjust their livelihoods both on-farm and non-farm in order to adapt to not only climatic changes but also – and even more instantly to the political and socio-economic dynamics in the regions. As the research underpins the integrative social-ecological approach, both agricultural and non-agricultural sections of rural livelihoods are covered to explain the household's adaptation to the complex context and underscore the multiple-dimension nature of livelihood dynamics.

The research applies the mixed methods with a focus on behavioural analysis to respect the complexity of the household as an autonomous actor in the social-ecological system in order to avoid reductionism in studying adaptation (Pardoe 2016). This approach sets the base for the conceptual and methodological design of the dissertation.

Figure 1-1 is the simplified illustration of this approach which demonstrates the components of analysis that forms the foundation for the development of the analysis and results. The process in which households make their decisions to inherently adjust their livelihoods is explained by both internal and external factor components. The external factors to an individual household are the coupled social-ecological environment that accommodates all activities of the household. This integrative conceptual framework is argued as the optimum approach for the case study of the complex context that adaptation process could only be explained through the causal, perpetual, multidimensional and cross-scale interactions between: households and the political and socio-economic dynamics; households and climatic stressors; as well as politico-economic drivers and ecological changes. As such, the adaptive decision analysis applied to study the livelihoods shift of rural households given the coupled social-ecological context is argued as the comprehensive and feasible approach to capture most of the complexity and uncertainties. In other words, the coastal areas of the MD and the RRD are good examples that manifest the needs for such an approach. In addition, households' capitals and learning processes are the internal factors in the focus of the proposed approach, whilst they closely link to other sub-components (*e.g.* perception) which will appear in the detailed analysis in the coming chapters. The interconnections between and within these components (with examples displayed on the arrows) illustrate the complexity of the research problem.

Given that research objective, coastal villages of the MD and the RRD are chosen for the fact that they, more than any other areas, typically bear the "double exposure" situation – a term used by O'Brien and Leichenko (2000) to describe about places confronting both societal and environmental risks at the same time. In the last few decades, their social-ecological landscape has been drastically changing towards being more urbanized, modernized and market-driven, socio-economically speaking, and simultaneously more diversified and aquaculture land transformed. The dynamics are experienced by each household locating in the regions. Yet their actions and outcomes plausibly diverged. Bearing in mind the inevitable uncertainties and complexity of the context, we believe that comprehending this mechanism through learning its trajectory could shed lights on the

contemporary phenomenon as well as being the key for the purpose of projection future development pathways, and thus facilitating further implications in both terms of research and practice.

Further justification for the conceptual rationale and approach is presented in Chapter 3 and elaboration on the methodological design in Chapter 4.

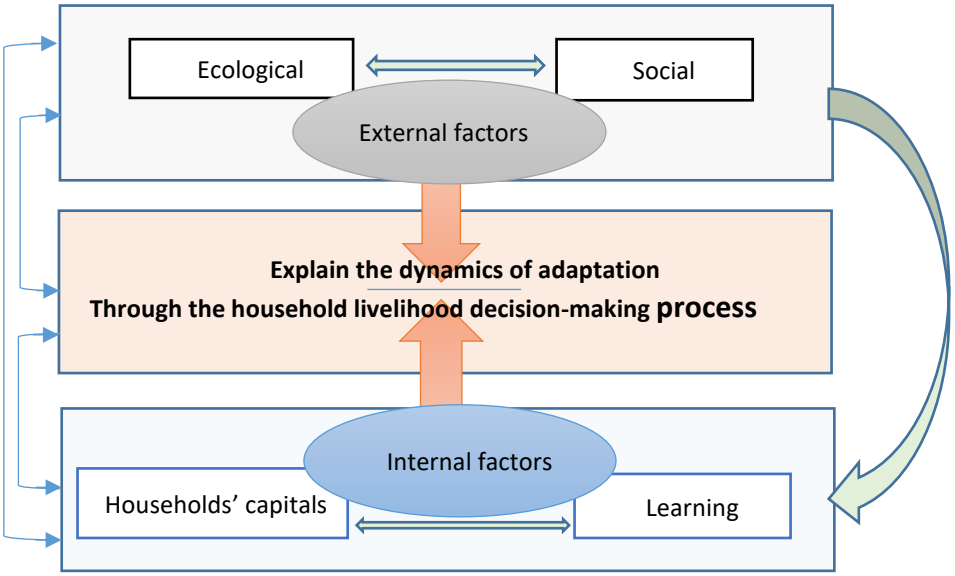



*Figure 1-1: A simplified illustration of the research approach*

## 1.6. Structure of the dissertation

The dissertation is organised into eight main chapters. The Introduction is prolonged with Chapter 2 which provides a more detailed background of the thematic and geographical scope to underpin the rationale and approach to the research. Given the geographical large coverage, and hence several diverse and complex case studies of this research, this chapter provides useful information in order to prepare readers into more condense analysis in chapters to follows. Chapter 3 is the outcome of the literature review and the heuristic process to develop a conceptual framework based on which the data collection, data analysis, and findings discussions grow. An overview of the research methodology and data is outlined in Chapter 4 to guide readers into the architecture of the dissertation from the study site introduction to data collection, the first glance at data overview and further description into the steps of data analysing. However, the detailed explanation of the methods for data analysis is placed vis-à-vis the presentation of the empirical results in Chapter 5 and Chapter 6 in order to improve the flow of the dissertation. Each of these chapters starts with the rationale and literature review on the most relevant issues to the chapter's focus accordingly. Their main bodies are the results and findings which respectively correspond to the two main objectives of the dissertation. More specifically, Chapter 5 provides the insights of historical and current trends of livelihood changes in studied areas. This not only includes the description of the changes at the household level

but also performs the investigation of the determinants to their decision to change. The key results in Chapter 5 are then also applied for developing the examination on the household's future adaptation which is presented step by step in Chapter 6. These chapters are followed by a general synthesis and in-depth discussions of the results and findings which reflect on their contributions to the research questions in Chapter 7. Methodological reflections and evaluations are also brought up in this chapter. The dissertation is closed with a conclusion that includes the main conceptual contributions, policy implications, and the limits of the dissertation followed by a number of suggestions for future relevant researches in Chapter 8.

# 2. CASE STUDY BACKGROUND – THE VIETNAMESE MEKONG DELTA AND RED RIVER DELTA

Locating oppositely at the Northern and Southern 'tails' of Viet Nam, the MD and the RRD together cover 18.6% of total area and are the home to 42% of the whole nation's population (GSO 2017). These two major deltas of Viet Nam play key roles in the historical, cultural, and politico-economic evolvement of the nation which holds for the contemporary context. On the other hand, the drastic development since Đổi Mới, the high density of inhabitants together with the ecological dynamics and increasing climatic variation are the reasons that both deltas share several common challenges and opportunities and make them one of the most researched areas at regional and global scales. Among the fundamental shifts, the experiences of the rural and particularly coastal areas are most pronounced with controversial impacts. New phenomena have been observed in the last few decades from different social-ecological perspectives. In particular, rural livelihoods, or more specifically, rural household incomes structure are substantially changing under the impacts of rapid economic growth and social progress which seem to be as dynamic and discernible as the climatic variation happening in these regions.

Therefore, this chapter is the introduction into the overall background of how the two deltas are sharing and different in regards to their contexts which underpins the chapters that follow. It first starts with a demonstration of the geographical scope of the research and thereupon its advantages and barriers to achieving the research objectives. The following sub-sections discuss in more detail the hazard risk context as well as the general socio-economic trends and the critical role of policy intervention in the coastal areas of the two deltas. The last section quickly sketches the image of the typical rural household which is the focused unit of analysis of this study. The chapter's content emphasizes the relevance and the need for an integrated approach that could explain the phenomena per se as well as to anticipate changes in the dynamic contexts under uncertainties.

## 2.1. Geographical scope of the research: challenges and opportunities of including two deltas in one research

The study areas of this research are selected based on the case studies within the framework of the DeltAdapt project[2] which aims to investigate the coastal adaptation to salinity intrusion in the two biggest deltas of Vietnam – the MD and the RRD. Therefore, the original design that includes both deltas is retained in the scope of this research, even

[2] "Adaptation to Salinity Intrusion and Potential Impacts in the Vietnamese Coastal Deltas" (**DeltAdapt**) is a bilateral research project between Germany and Vietnam funded by the Federal Ministry of Education and Research (BMBF), Germany from December 2014 to March 2018. The project is aimed to apply a transdisciplinary research approach to understand the multiple changing aspects in the coastal areas of the two Vietnamese deltas as it is confronted with the increasing pressure from salinity intrusion under the context of climate change. This research covers one out of the seven work-packages of the project.

though challenges in comparative analysis were foreseen due to the strong heterogeneity between and within the deltas.

*Challenges*

Despite the fact that the MD and the RRD are the two largest deltas of the same nation and locate roundabout 1500 kilometres away from each other, they surprisingly distinguish in various aspects.

Regarding the general demographic characteristics, the imbalanced areas of the two deltas make them significantly different from each other. With 40,816.3 square kilometres and a total population of more than 17.6 million persons spreading over 13 provinces, MD is the largest delta in Viet Nam (GSO 2017). Coming in the second place, the RRD includes 11 provinces with a population of over 21 million on slightly more than 21,000 square kilometres which makes it the most dense region of the country with 3.6 times higher than the country's average density and 2.3 times higher than that of the MD by the year 2016 (GSO 2017). Administratively, RRD includes the capital Hà Nội which might mislead the comparison of data at the regional level due to the fact that this city is the second crowded urban area (according to the data of GSO 2017) while playing the role of the administrative centre of the whole country. Therefore, the main secondary data sources often provide an option to exclude Hà Nội from the regional statistics, *e.g.* GSO, MARD. As such, the two deltas become more comparable.

In terms of the overall biophysical systems, the basic elements of their climate, soil conditions and topography also differ. While the MD in the South lies completely within the humid tropics zone, which is predominantly tropical savanna climate (Giuliani *et al.*, 2019), the climate of the RRD in the North is a tropical monsoon type – hot and humid (Devienne 2006, Nguyen 2017). They are not only differentiated by the annual season system, *i.e.* four seasons is the main system in the latter comparing to only two distinct seasons - dry and wet found in the former (Bucx *et al.* 2010), but also slightly by the temperature and rainfall patterns. The two deltas share quite similar annual average temperatures, yet less extreme in both terms of minimum and maximum temperature than in the RRD. Other detailed environmental background information of the two deltas is provided in the coming section about their climatic risks and climate change context (see 2.2.1). Yet it is important to remark here that this difference of the climatic system leads to disparate farming systems or cropping calendars (for the same farm type).

Their topography is most obviously distinct. The northern delta is in a triangular shape formed by the Red and Thai Binh river systems (Duc *et al.* 2012) with higher slopes in its corner and lower ones towards the coastline of 200km to Tonkin Gulf (McElwee 2016). The elevation of almost half of the RRD basin is at >1000m above the sea, which makes it rather mountainous typography (Hasan *et al.* 2016). Meanwhile, the MD is a pretty flat, low-level plain region with an average elevation of 0.5 – 1.2m above the sea level (0.3 -0.7 in the

coastal areas) and 700km length of coastline (Tri 2012). Although the deltaic coastal areas of the two deltas are expected to be more similar, an overview of their characteristics is relevant for the analysis at the regional level coming later in the dissertation.

All these landscape characteristics, together with the history of development are partly claimed to contribute to the cultural disparity between the two deltas. This aspect has been a lengthy conversation, typically in sociology research, where it is recognized by the literature that:

> "They combine high population densities with intensive agriculture. Agricultural activities are strongly shaped by the hydrologic regime, its floods, low flows in the dry-season and the tidal effect. Their historical development seen in terms of settlements, cultural origin and socio-political formation are nevertheless contrasting." (Dao & Molle, 2000).

All in all, the social-ecological complexity makes the comparison of the two regions a challenging task. Therefore, a limited number of researches so far have attempted to include the socio-ecological complexity of both deltas considering the high workload and resource consumption. Out of the rich pool of literature, Dao and Molle (2000) provide a good overview of the comparison of these two deltas which cover various social and ecological aspects. However, the heterogeneity of the two Vietnamese deltas becomes forcibly reduced due to the comparison with the Chao Phraya delta in Thailand. This dissertation, therefore, provides added value to the literature by inclusively and equally analysing very detailed the two deltas in its design.

These above-mentioned substantial differences required careful consideration for the harmonizing of the research foci and the methodology set. Moreover, keeping them balanced in the analysis is challenging which prevents the researcher from the risk of being distracted from its focus. Besides, the sensitivity analysis and validation of the result and findings that include the comparative analysis between the two deltas were applied to properly draw the conclusion and implications on explaining the adaptation process to the changing social-ecological context.

*Opportunities*

The MD and the RRD are the two key regions out of the six main administrative and socio-economic divisions[3] of Viet Nam. More specifically, they are the two important delta regions who play the role of socioeconomic powerhouses in the country. Therefore, the research that could cover both deltas will provide a larger picture of the Vietnamese rural coastal context. This particularly makes sense in clarifying the diversity of these deltaic coastal areas which in many cases is merely acknowledged. This has been evidently shown in the above list of biophysical and demographic differences.

[3] The six administrative and socio-economic regions of Viet Nam include: Red River Delta, Northern Midlands and Mountain Areas, Northern Central Area and Central Coastal Area, Central Highlands, South East, Mekong River Delta (GSO website).

Furthermore, the distinguishing historical development and ecological settings of the two deltas provide a unique opportunity for comparison and contrast. From future-forward perspectives, the mismatching points in their trajectories, landmarks of development as well as current context and issues are of great value for retrieving potential lessons learned from one to the other case study. In other words, if this objective is achieved, it will be able to offer important policy implications in regard to regional development and rural planning.

## 2.2. Social-ecological context of Viet Nam and the deltas

### 2.2.1. Climatic risk and climate change in the Mekong Delta and the Red River Delta

Since the study case covers large geographical areas as well as diverse ecological contexts, there is potentially high heterogeneity of hazard profiles and risk perception at community and household levels. Therefore, instead of basing on the literature on the studied deltas, climatic risks and variations are left to be identified openly in the data collection. It is by design aimed at collecting bottom-up data focusing on the perception of climatic risks and climate change of households. Nevertheless, it is essentially backed by the scientific data, which is form through the literature review and secondary hydrological data. Although this data is commonly found for the whole deltaic regions rather than specifically in coastal areas, it sufficiently backs the research design. The background information provided in this sub-section also closely links to the empirical analysis and discussion in the later chapters of the dissertation.

*Climate and risks in the Red River Delta*

Being built upon two big river systems: The Red River and Thai Binh River with a Northwest-Southeast slight slope from 15m to sea level (Devienne 2006), the RRD has the typical triangular shape with 130km of coastline at its bottom. The delta is divided into smaller regions with different agrarian systems according to the altitude: high, middle and low lands. The delta extends from the latitude of 21°34’ North to 19°5’ North, and the longitude of 105°17’ East to 107°7’ East and therefore bear the characteristics of tropical monsoon climate with four seasons: spring, summer, autumn, and winter. The annual average temperature is 23-24$^{o}$C in which the average temperature is higher than 20$^{o}$C in 8 to 9 months of a year. The highest temperature is normally between June and July while the lowest temperature normally falls within January and February. With a high humidity level of 80-85%, the annual average rainfall is approximately between 1700 – 1800 mm. However, about 80% of this amount concentrates between May and October which explains the high flood and inundation risks during this season (Nam Định PPC 2011). The delta experiences different wind mechanisms between summer and winter which could impose risks on the agricultural production depending on the speed, directions and in combination with temperature and humidity, as well as causing more severe damages if appearing with typhoons and sea storms.

Similar to the case of many other Southeast Asian countries, in the coastal RRD which contains most of the latter altitude type, typhoons, and tidal variability are the dominant hazard types. On a frequent basis, the RRD is hit by four to six typhoons a season (between June and October) on average (Kelly *et al.* 2001). Successive floods after typhoons and heavy rain are frequent hazard risks to RRD's inhabitants (McElwee *et al.* 2016) with 26 severe floods recorded in the last 100 years (Khanh & Le 2001). Coastal floods are highly concerned due to more frequent severe typhoons and storm surges in the last 50 years which is projected to become worse under the context of climate change in the next decades (Neumann *et al.* 2015).

*Climate and risks in the Mekong Delta*

Meanwhile, the flat, low-lying, with uncountable divergent channels[4] and mainly open MD is among the principal regions for rice-growing. This delta is located entirely in the tropical climate zone with a clear pattern of two seasons a year – rainy season lasting for from June to November and dry season when there is less than 10% of the annual rainfall throughout 6 months from December to May (Xuan 1975). The delta is strongly influenced by the south-western Monsoon system; the average annual temperature is about 27°C and the average annual rainfall is within 1500–2500mm (mainly concentrated in the rainy season) (Giuliani *et al.* 2019). Although frequent typhoons are found in the northern Viet Nam, they are rarely observed in the south (Imamura & To 1997). By ecological setting, the delta is more prone to floods in upper parts and saline water in coastal parts respectively (Käkönen 2008, MRC 2005). In the coastal areas of five studied provinces, these hazards usually occur as extreme events at infrequent patterns. Although the hydraulic system of the MD is quite developed as it has always been prioritized consensually through various development stages of this delta (Käkönen 2008, Biggs 2012), its coastal areas are much less diked than of the RRD which, therefore, explains why the prior's hazard landscape is more diverse. However, the frequency and intensity of hazards in MD are also projected to increase due to climate change which together with the high concentration of human societal and economic activities has increased the risk of the region in the past decades. In the past decades, the MD was hit by three strong typhoons which were rare cases in its earlier history (Chu 2017); whilst regular floods and also droughts occurred more often in the north-west part of the delta. Farmers in the coastal areas of the MD were overwhelmed by the most recent events of drought and high salinity taking place in-between 2015-2016 which is claimed at the most intense drought in the last 90 years (Binh *et al.* 2017) and the saline water that reached 25-30km inland caused severe damages for the inland diked areas that were made for the purpose of rice intensification (Nguyen 2017). Most of these rice fields, however, are not located on the coastline. Yet rice fields, either in mono or

[4] The Vietnamese name for the MD means Nine-dragon river delta (Đồng bằng Sông Cửu Long) which originates from the nine estuaries splitting up from the Mekong river branches of the delta (Nguyen 2008, Tas 2016).

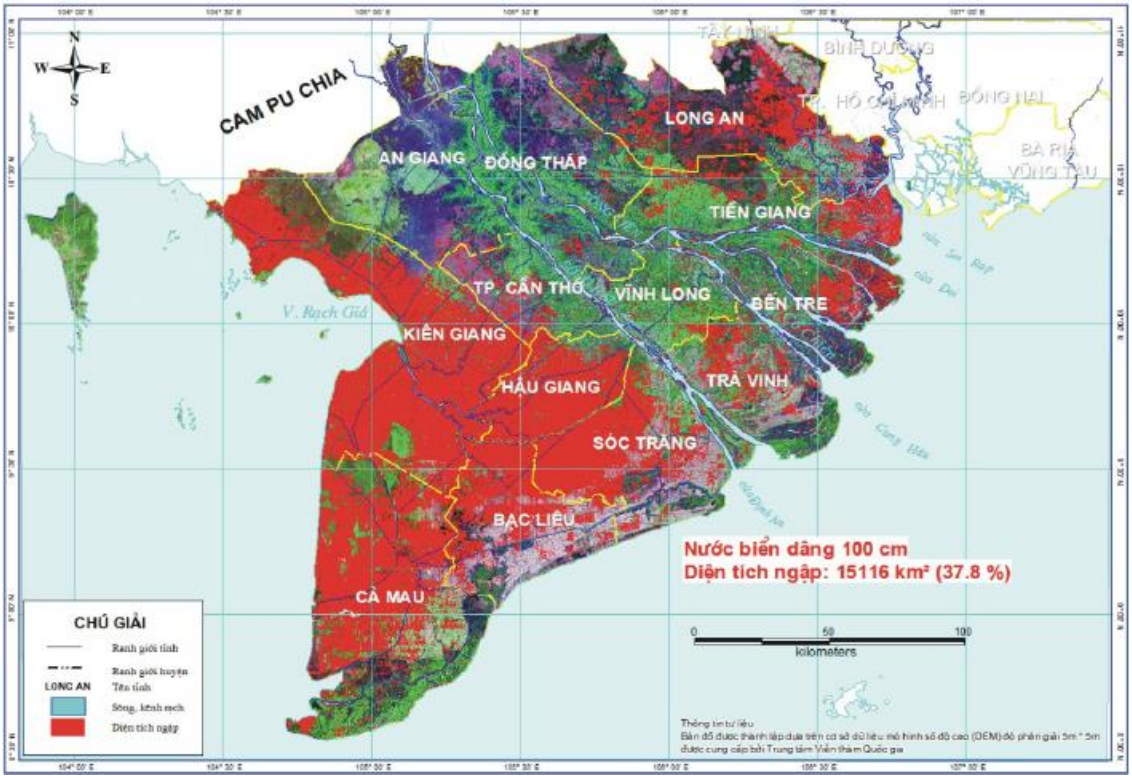
rotation culture system, included in the survey also experienced more or less the impacts which are well reported by local authorities as an extreme event.

*Under the context of climate change*

As aforementioned, recent studies largely stated that, Viet Nam in general and the RRD and the MD, in particular, are projected to be highly exposed to climate change effects. Warnings of extreme weather events with higher frequency and intensity lately echo in government's statements and also researches of different stakeholders (*e.g.* UN, WB, FAO). For instance, the Ministry of Natural Resources and Environment (MONRE) develops and updates different climate change scenarios including projection on sea level rise (SLR), salinity intrusion, temperature change, etc. which all show severe damages to these deltas: 38.9% of the MD (of which 75% of Kiên Giang province) and 16.8% of the RRD will be inundated for the scenario of 1m SLR by 2100 (MONRE 2009) (Figure 2-1).

Scientific data also reveal that the change of rainfall patterns, specifically longer dry season or late onset of rainy seasons which might causally link to the tendency of the temperature getting more extreme. That means lower minimum or higher maximum degrees of which the impacts are expected to have been displaying in the last decade and observed by farmers. Despite the basic difference between the MD and the RRD, Figure 2-2 clearly shows that both deltas share the same trends of climatic change, most notably increasing average temperature as well as slightly decreasing and fluctuating annual precipitation. There are also several studies attempting to anticipate the future patterns of changes of precipitation and extreme weather events, more often found in the MD region (Kontgis *et al.* 2019, Tran *et al.* 2019).

The issue of salinity intrusion in the MD and the RRD was initially framed as the starting point of this study. With the global environmental change, salinity intrusion and its impact on the large delta regions in the world in general and in Viet Nam, in particular, has gained increasing attention among scientists and practitioners in the last couple of decades. Salinity intrusion issues have been recorded in both deltas to be aggravated by other climatic changes. In the MD, it naturally links to the changes of rainfall and thus, to other issues such as drought and rising temperature (Karila *et al.* 2014). Whereas in the RRD, it is mainly about saline water penetrating into the rivers at high tide during the dry season (Devienne 2006, Yen *et al.* 2017). Under the context of climate change, salinity is projected to affect more intensively on prominent agrarian livelihoods of the coastal areas of both deltas (Karila *et al.* 2014; Dam *et al.* 2019, Tri *et al.* 2019).



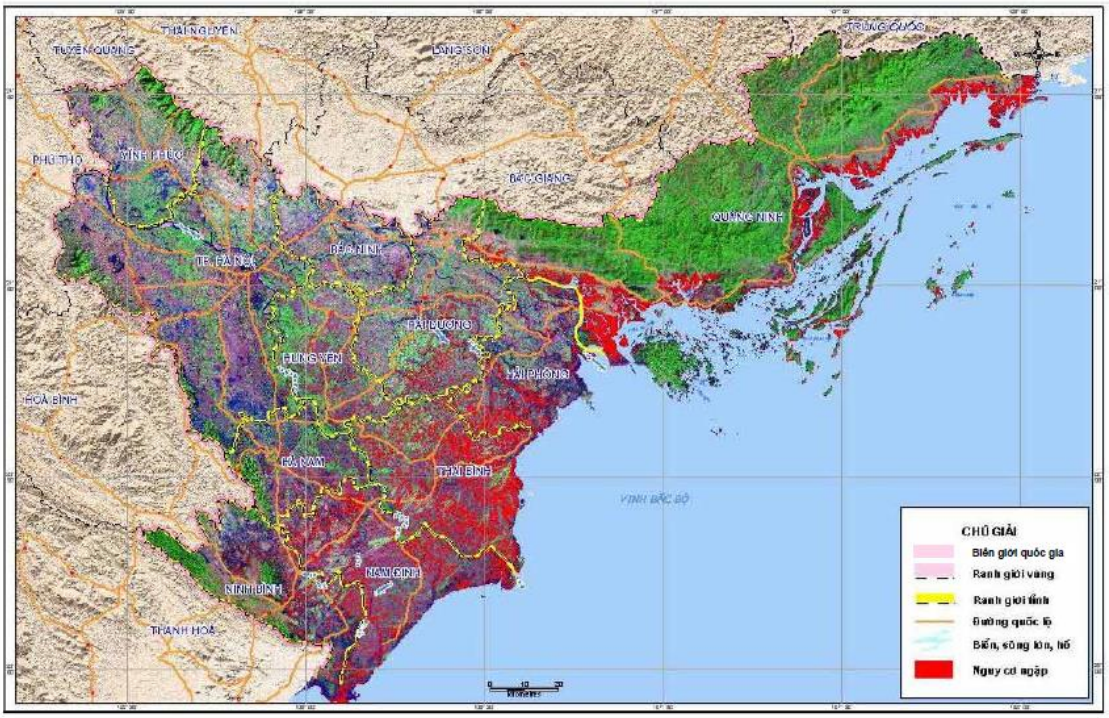




*Figure 2-1: Inundation map of the MD (above) and the RRD (below) at 100cm SLR scenario (Legend: Red colour indicated areas under the risk of inundation) (Source: MONRE, 2009)*

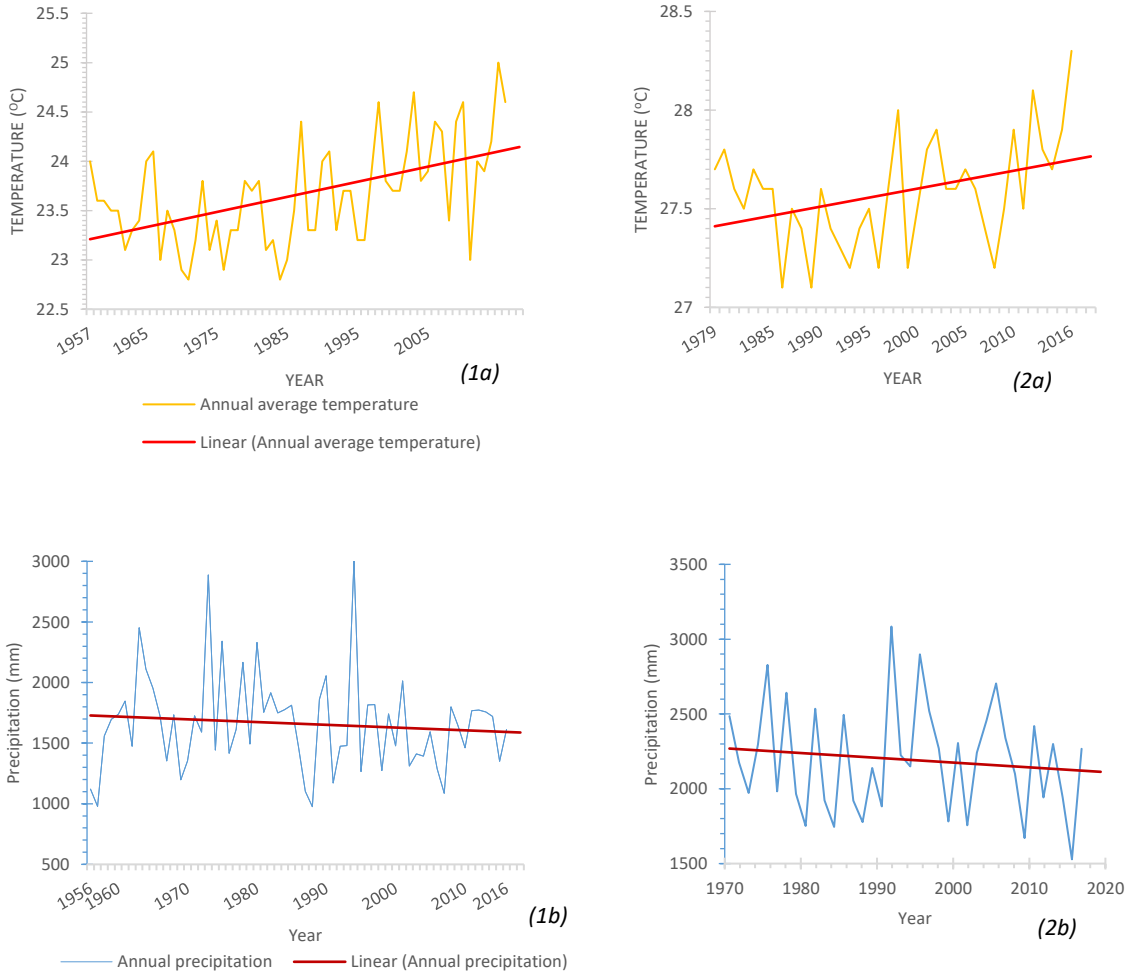



*Figure 2-2: Average temperature and annual precipitation in the MD and the RRD during 1957-2017*
(Data was respectively measured at: *(1a, 1b)* Nam Định (*to the left*) and *(2a, 2b)* Rạch Giá (Kiên Giang) (to the right) Meteorological stations. Source: NCHMF)

### *Environment degradation*

Ecological change and ecosystem degradation have been identified as a major challenge to the deltas of Viet Nam in environmental research (Renaud & Kuenzer 2012, Adger *et al.* 2005). According to the collection of literature in the book of Renaud & Kuenzer (2012), the rapid and extensive societal development in these regions is attributed for the process, most noticeably but not limited to: increasing pressure on land, surface and groundwater pollution, altered river flows, decreasing of sediments, damages on mangrove forest (*ibid*).

The deltaic coastal areas are among the most vulnerable region to these environmental issues. The anthropogenic change has substantial impacts on the health of the environment in coastal areas of the deltas (Betcherman *et al.* 2019, Biggs 2012, Renaud *et al.* 2013). Related to livelihood changes, land degradation in mono-shrimp farming areas is extensively concerned, especially in the MD. The ecological risk of shrimp business is merely a new topic. A large number of literatures provides numerous evident analyses on the severe long-term negative consequences of the intensive shrimp farming system in

which farmers pursue record profits in Viet Nam and globally (Bottema *et al.* 2018, Edwards 2015, EJF 2003, Joffre *et al.* 2018, Lan 2013, Ottinger *et al.* 2016). The ecological consequences of the intensification of rice production was also raised by several studies, for instance, Tong (2017), Chapman et al. (2017), Can and Khang (2009), to name a few, on the case of MD; Lamers *et al.* (2011), Braun *et al.* (2018) on the case of the RRD. More generally, after almost three decades of booming economic development in Viet Nam of which agriculture constitute a large part, many environmental issues have become alarming with increasing evidence provided by scientists. Intensive agricultural activities have caused serious pollution, particularly water-related problems in the MD (Sebesvari *et al.* 2012, Chau *et al.* 2015). On the RRD, Braun *et al.* (2018) also find that pesticide residual is highly accumulated right inside the sea dikes due to intensive rice farming in the upper parts of the delta.

Thereupon, environmental degradation should not be overlooked in studying the social-ecological changes and livelihood dynamics in the rural coastal areas of the MD and RRD particularly, and in the country generally.

### 2.2.2. Socio-economic transitions in Viet Nam

Contrarily to the environmental settings, the MD and the RRD share more similar characteristics regarding political and socio-economic dynamics. Among those, urbanization, industrialization and marketization processes are the most noticeable and relevant to discussing households' livelihood shifts. These strong transitions started with the social-economic reform *Đổi mới* since the second half of the 1980s which is, on the one hand, attributed for having lifted up the living conditions of the Vietnamese people, and on the other, associated with several social challenges in the country after three decades (Revilla Diez 2016).

*Urbanization*

Viet Nam in general and its deltaic regions, in particular, have witnessed as well as been obviously impacted by strong urbanization. General, Southeast Asian countries, including Viet Nam experience roughly five times faster urbanization speed than the developed countries group in the Organisation for Economic Co-operation and Development (OECD). Urbanization, on the one hand, is an agent of development, and on the other hand, it is also considered as an agent of risk when looking into the vulnerability profile and livelihood dynamics of these areas (Garschagen 2014).

As found in other similar dynamic regions in the world (e.g. in the Southeast Asia region), urbanization is a strong and rapid transformation process of the Vietnamese deltas' landscape since the last couple of decades. In Vietnam, this process links tightly with internal migration trends as well as changes in government's policy commencing with the renovation policy (Revilla Diez 1999). Historically, the human's settlement and exploitation started later in the MD than the RRD (Dao & Molle 2000). Recent research has covered

various aspects of urbanization, for instance, its link to risk and vulnerability (Garschagen 2014, Garschagen & Romeo-Lankao 2013), or migration (Padawangi 2019). However, this study focuses on the perspective of urbanization's impacts on the changes in rural households' livelihoods through the expansion and enhancement of rural-urban links. In the case of the MD, this rural-urban linkage has been fostered by the rapid development of the infrastructure for transportation (Pham & Pham 2011, Garschagen 2013). The improvement of the infrastructure also facilitates farm-products marketization as well as the inter- and intra-region labour mobility which includes the less researched yet interesting phenomenon of universalization of high education for rural younger generations (*e.g.* as explicitly discussed by Khue *et al.* 2016 on a case study in the RRD). These two elements of the urbanization process are considered to be among the foci of this research. An indicator of this process is the shift in urban-rural population structure that witnesses an increase of 20% of urban share within 1960-2016 (data from WB) and reached 34.6% in 2014 (GSO 2016). This proportion is projected by the GSO and UNFPA to continue until it reaches 58.8% by 2049 which is mainly attributed to the internal migration process (GSO 2016). This process, together with the industrialization of the Vietnamese economy has been changing substantially the rural-urban border. Cities, especially small and medium-sized ones in these deltas (International Centre for Environmental Management, 2015) and villages are getting closer, and the distinguishing line between them are getting blurred (Hoang *et al.* 2015). Overall, the rural-urban linkage plays an important role in the socio-economic development; in particular, it has added new important elements such as labour mobility, non-farm job opportunities, and access to market to the households' livelihood structures in these deltaic regions.

*Industrialization*

Industrialization, similarly to urbanization and modernization, also took off since the renovation process in the second half of the 1980s. Viet Nam's industrial policies were a strong part of the market reform during the period of 1989-2000 (Le 2018). The country achieved a remarkable development between 1991 and 1996 by the increase of industrial contribution to GPD by 14.5 per cent (Revilla Diez 1999). A steady increase of this contribution and employment distribution of industrial sectors are enhanced by the rise of the private sector and foreign investment which mostly come in forms of industrial firms or zones. These firms are attracting more and more labours with an increase of 4 times its share in the economy's labour structure within the period of 2000-2016 (GSO 2017), especially compared to other sectors such as the public or general private one which decrease in average. Most of the labour resource for this production comes from the rural force. At the local level, along the line of national target program to promote industrialization and modernization in the country – a direction that has been enhanced

lately with the Government's Decision 879/QĐ-TTg[5] that promotes to adjust industrial zones geographically as well as decentralization of management, the provinces take the opportunity to get support for planning more industrial zones within their administrative border (SRV 2014). Active province leaders manage to plan at least one industrial zone for each district. Even though, it is the responsibility of the local authorities at the provincial or district level to look for investments. In most districts, building industrial zone would mean converting land from agricultural to built-up land (Gore 2017). However, sufficient baseline assessment is an issue in terms of transparency. This will potentially foster the rural labour structure shift and intra-local rather than trans-local labour mobility.

*State-led marketization*

The under-control marketization or so-called market socialism (Labbé & Musil 2013), is the most intensive change out of 'Đổi mới' policy. This process has substantially enhanced the role of the market in production as well as posing huge impacts on all aspects of Vietnamese society. This fence-breaking opportunity (Kerkvliet *et al.* 2003, Dang 2009) was tremendously important in boosting the Vietnamese economic achievements. Agriculture, among the key economic components of this country, witnessed the substantial transformation particularly since the North-South reunion in 1976 (Do 1995, Garschagen *et al.* 2011, Garschagen *et al.* 2012, Renaud *et al.* 2013). This reform, despite the high dependence of agricultural production on the ecological system, is least to be attributed to environmental changes in those regions (Benjamin & Brandt 2002). On the other hand, the market economy plays an important role in driving many changes in both positive and negative ways. Since the early 1980s, agriculture commercialization movement in Viet Nam, and consequently the strong shift from labour intensive to capital intensive production facilitated by technology development (*e.g.* mechanization, fertilizers, crop varieties, *etc.*) and land privatization has indeed widened the gap between farmers groups classified on wealth; particularly for the extreme cases, it has enhanced local impoverishment (Adger 1999, Ho 2008, Nguyen & Tran 2014, Tarp 2015). Households lacking resources tended to be left behind in this "agriculture evolution" during the late 90s and early years of the XXI century. This occurrence links to the issues of the dynamics of land-use and landlessness tendency discussed in the next sections which is not only relevant for learning the trajectory but also for anticipating future trends.

*Structural shifts of the Viet Nam's economy*

In Viet Nam, the structural changes are most noticeably towards moving out of agriculture economically and socially between 1990-2008 of which one of the major movements is the drastic shift of employment from agricultural production toward services and industrial manufacturing sector, *e.g.* self-employment for household business to being employed by firms or private sectors in general (McCaig & Pavnick 2012, Tarp 2015, Revilla Diez 2016, Brünjes 2012). Although nearly a third of Vietnam's population is still occupied by farming

[5] An official government's document approved by the Prime Minister

which contributes 30% of the gross domestic product and up to 38% of exports (Devienne 2006), this labour restructure is predicted to go on for long term and implies transformation of the rural setting as well as in the whole country as strategically targeted by Vietnamese government (GSO) (see also Garschagen *et al.* 2012). Figure 2-3 shows this obvious trend of the whole country as well as of the two delta regions. The MD, though, seems to lag more or less behind in this trend by the current time when the share of labours in agriculture (47.8%) remains higher than the country's average (41.9%) (GSO*). The RRD, in contrast, started this process quite early which could entirely be explained by the limited land-resource per capita, its strategic location (*i.e.* close by the capital and the biggest gateway port – Hải Phòng) and mostly the innovation process whose impacts on the development of agriculture in the RRD is argued to be stronger than in the MD regardless the fact that the latter had a better position before this event happened (Nguyen 2017).

Also being increasingly discussed lately is the rising proportion of rural non-farm livelihoods and livelihood diversification trends of rural households in both deltas (Bosma *et al.* 2005, Can *et al.* 2007, Tarp 2015). This is not a new topic in socio-economic studies, yet until lately it is integrated into environmental change research strand (*e.g.* Adger *et al.* 2001, Miller 2007, Smith *et al.* 2013). However, since these livelihoods are mainly informal economic activities in the context of a developing country like Viet Nam, they are not fully shown in the secondary data.

In agriculture economics and rural development disciplines, a number of studies attribute this structural change to the agricultural revolution taking place in Viet Nam (McCaig & Pavcnik 2013, Tran 2014, Jesus & Dao 1997). Most noticeably, some authors claim that the technology development (*e.g.* mechanization, advance varieties) has led to the abundance of labours in agriculture and the increasing job demands in other sectors to absorb this labour pool (Devienne 2006, Ut & Kei 2006, Nguyen 2017).

The literature also records the strong shift within each livelihood sector. For instance, the expansion of aquaculture within the agricultural sector (Ottinger *et al.* 2016, Joffre *et al.* 2018), or the increase of wage jobs among rural labours (Brunjes & Revilla Diez 2012) is of great relevance to this research. Yet a more detailed analysis of this agricultural reform, as well as other main trends of the livelihood structural shift is presented in the background section (see 5.2.2) of Chapter 5 where changes in the context of rural coastal areas and how they link to household's livelihood strategies are focused.

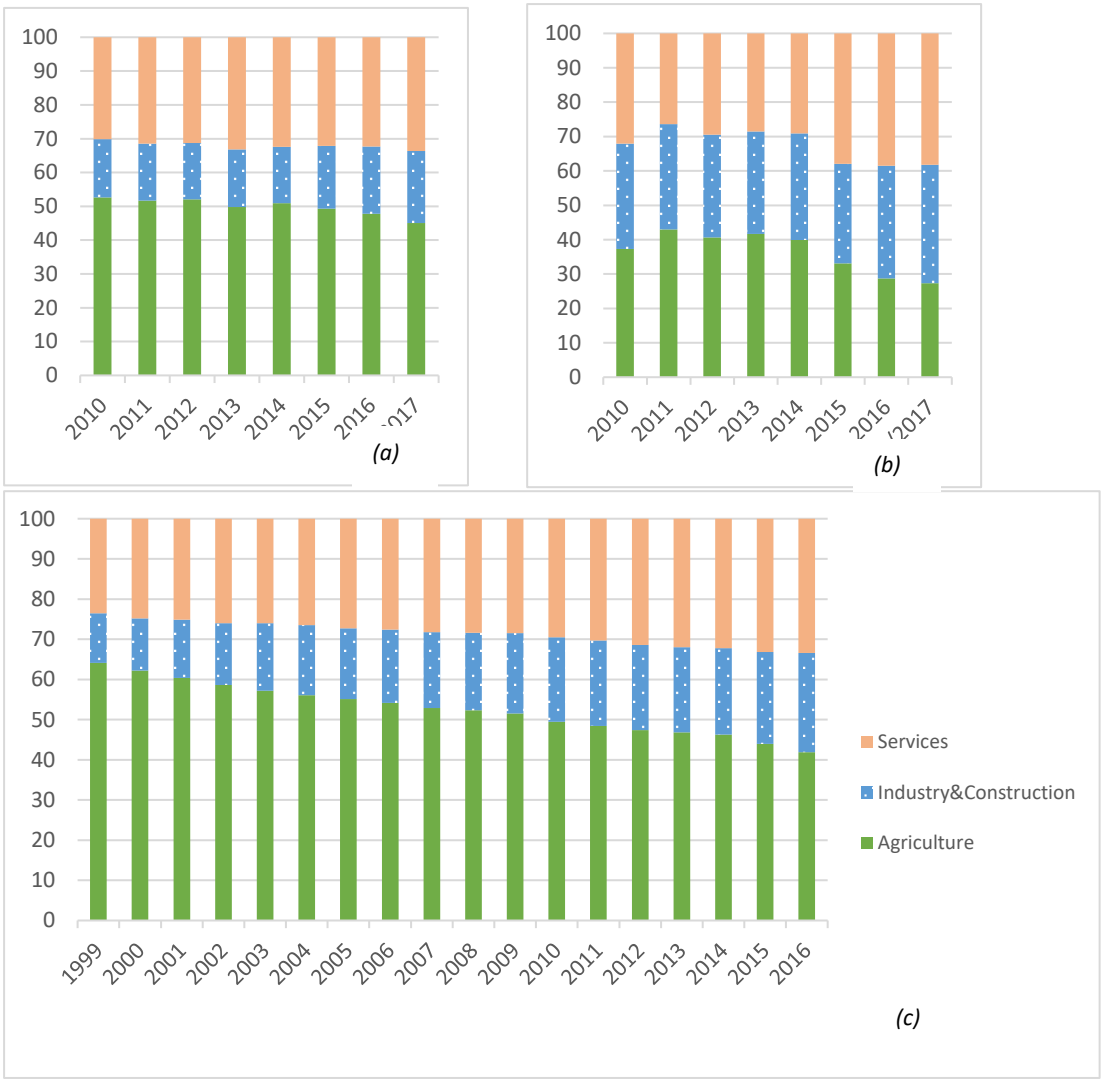



*Figure 2-3: Employment structure (in %) by economic sectors during 1999-2017*
Data is presented respectively of: *(a)* the MD, *(b)* the RRD[6] and *(c)* Viet Nam (Own graph, data source: *GSO 2009, 2010, 2011, 2012, 2013, 2014, 2015, 2016, 2017*)

### 2.2.3. Role of policy intervention to adaptation measures and regional development

Given the unique political context of Viet Nam, policy intervention is inseparable from any debate related to development and security. Therefore, in this research, the direct and indirect impacts of policy on the households' livelihood shifts in coastal areas are in the focus of the analysis. This nevertheless, implicitly and inevitably refers to a larger discussion of the Vietnamese government's measures to manage the regions towards political and economic development, as much as environmental pressures. The role of policy intervention here is mostly referred to the coping and adaptation measures to risks and hazards at the national level and its linkage to the market-orientation interventions which is a prioritized strategy of economic development. As a typical example, hydraulic and irrigation control, *i.e.* inland diking system in the MD and complete sea dike in the RRD, to a

[6] Hanoi city is excluded from the RRD region

larger extent, is a part of the government's land-use planning that directly forms the status of a household's farm-land - to be either fixed to rice production or flexible for other agricultural cultivation (*e.g.* aquaculture and vegetable). This intervention indeed reflects more than one national strategies towards regional economic development, agricultural transformation, as well as coping and adaptation to hazards risks of which the latter commenced earlier in history while the formers tend to show bold impacts in the last few decades (Biggs 2004, Käkönen 2008, Schwab 2012, Renaud *et al.* 2013, Vo 2014, Garschagen 2014, Nguyen 2017). This sub-section is a review of the main mechanisms that are argued to shape the social-ecological context in the two deltas not only in the past but also in the future.

*Sea dike in the Red River Delta*

Back in history, the sea dikes have been constructed and improved through hundreds of years in the RRD, primarily in response to water-related hazards (*e.g.* flood, typhoon) and to protect the delta from sea water, recorded in the document since the 1920s (Son Nam 2009). This so-called adaptation measure still remains among the prioritized concerns of local authorities as well as the central government. The "Law on dikes" was certified in 2006 for dikes, including river bank and sea dikes, protection, improvement and regional hydraulic planning. This law has been the basis for the Degree 58/2006/QĐ-TTg to reinforce and improve almost 1,700km of sea dike within 2006-2010 with up to almost 450 million USD for the whole country (SRV 2006). Annual budget is allocated for the coastal districts in order to examine, maintain and improve sea dikes which have even been enhanced and improved quite frequently to cope with climate change impacts. Dikes, in general, has been discussed by Devienne (2006) basing on the earlier work of Gourou (1936) to explain the major differences between the RRD and the MD regarding topography, natural conditions and cultivation:

> "Unlike the Mekong, in southern Vietnam, peasants have never been able to make use of the river's floods to grow their crops, but quite contrary, they have for years tried to protect themselves by building dikes along its banks and those of its main distributaries." (Devienne 2006:258).

In terms of farming culture, rice cultivation of the RRD's residents was undoubtedly impacted by the Chinese after a long colonial period started Before Christ's time which partially tells the heavy influence of this historical period on the overarching evolvement of this region. According to Devienne (2006), the development of the diking up process in the delta could be explained by the education culture heritage from the Mandarin which shaped the hierarchical system that enabled attaining tax for hydraulic projects which comes in the form of dikes system nowadays (see also Tran 1920). The similar systematic water management started in the MD much later than that in 18th century under Nguyen dynasty and being reinforced in the 19th century where it also came with the French colonial regime (who also managed to reinforce the system in the RRD) (Xuan 1975,

Devienne 2006, Biggs 2012). Despite preceding in terms of water management, inadequate distribution of water for farming across highlands-midlands and the lowlands partly remains until today in the RRD (Devienne 2006). Farmers, however, have a longer self-learning process to adapt to the shortage of water in the dry seasons and, on the contrary, long submersion caused by heavy rains no matter if the government supports the irrigation system in their area or not (*ibid*). The current landscape of institutional water management in the RRD has been mostly shaped since the establishment of the Vietnamese communist government in 1945 with the pivotal roles of both MARD and MONRE in the Red River Committee (see more at Molle & Hoanh 2008).

*Land-use management: a master plan driven by the national food security programme*

Land-use change has been considered as the main pillar of agricultural development in the deltaic region, it is therefore of high relevance to have an overview of its role in historical agricultural changes as well as its potential future impacts. In fact, the discussion on land-use rights and land-use change at household level counts solely since the first shifts towards the economic renovation process of the Vietnamese government in the 1980s. Around the beginning of the 1980s, the de-collectivization of farm production emerged (Pingali & Xuan 1992) and triggered an agricultural reform in Viet Nam (Abman & Carney 2018). This milestone is particularly critical to farmers in the RRD although less obvious to those in the MD partly because the collectivization process was applied much later in the latter (Pingali & Xuan 1992). The impact of this renovation process on the development of agriculture in the RRD is therefore argued to be even stronger than in the MD which indeed has a better position before this event happened (Nguyen 2017). In this transformation process, the most remarkable policy shift which is found relevant to the discussion on household's agricultural livelihood change is the "rice-first" land-use regime (*i.e.* prioritizing using arable lands for rice intensification and expansion) which was driven by government's consideration of food security issue. The regime aims to maximize the production of rice as the critical national staple food (Garschagen *et al.* 2012, Tran et al. 2018c). The implementation of this policy has played a pivotal role in shaping and reshaping the structure of arable land, especially in the coastal areas. During the rice-prioritized period which commenced differently in the two deltas within the 1970s-1990s, rice land expanded and highly intensified which is attributed to hydraulic engineering solutions[7]. Rice land is therefore tightly protected from conversion to any other farm system or to non-farmland. Although this policy has been retained until currently, the shift towards other annual crops (e.g. vegetable) and aquaculture since the beginning of 2000s has indicated some relaxation or the need for relaxation (at places where the practices occur without official permission) of this policy since farmers also claim that the shift has improved their income significantly comparing to rice farming (Nhan *et al.* 2003). This tendency is also reflected in policy

[7] More information on the irrigation development in the MD is provided in the next sub-section as a typical case study of hydraulic engineering interventions.

documents related to land-use change, most officially shown in the adjustment on the Law of land (SRV 1987, 1993, 2003), which thus implies intriguing future changes in the coastal rural context.

*Hydraulic engineering solutions in the Mekong Delta*

The history of the MD is the history of hydrological development to 'conquer' the wetland for land reclamation which is thus, about polders, dikes, and canals (Bigg *et al.* 2009, Olson & Morton 2018). The objective, and to some extent, the achievement of this process is the modernisation of agriculture in particular and rural economic in general in the MD over the last decades of the 20$^{th}$ century (Olson & Morton 2018). The complex hydraulic network of built-up canals, dikes and sluice gates has aimed at protecting some specific delta's areas from seasonal flood, salinity intrusion through irrigation system control for agriculture production (Käkönen 2008, Evers & Benedikter 2009:416, Hoanh *et al.* 2010).

This process has substantially intervened the original ecological setting of the MD. Moreover, deltas' inhabitants, as the micro actor in the system, are in fact mostly affected by these interventions because their livelihoods are entirely attached and susceptible to that social-ecological context. For example, the 'zoning' practice in the master plan of the MD is among the most obvious outcome. The whole delta is divided into three main zones by a system of inland dikes and canals. The zoning, therefore, reflects the salinity gradients which includes, from the coast to further inland: Brackish water AEZ - Transitional EAZ – Fresh-water AEZ (Trinh *et al.* 2018). Farming systems are distributed accordingly: aquaculture, rotation system and (fresh-water) plants. This man-made agro-ecosystem not only causes the lock-in effect to farmers in the zoned areas (Nguyen 2019) but also alter the relation between the zones, for instance, flood control and triple rice cultivation in the upper part of the Vietnamese MD and its effect on the downstream areas (Duong *et al.* 2018).

The Mekong Delta Plan (Mekong Delta Plan 2013), a product out of the cooperation between the Vietnamese government and the Dutch government, is among the most systematic endeavour to intervene the delta's ecology. In the saline water affected areas, the role of engineering measures on land-use change is evident. With the financial support of international organizations such as WB and ADB, the irrigation system in the MD has been comprehensively developed since the 1990s as protection measures against flood and saline water intrusion (Nguyen 2015:48). "Freshenisation" is a typical example of intervention to "protect" one specific area from saline water by diking and irrigation control (Can & Khang 2009). Cases could be found in several research sites. This programme started after the reunification and to some extent their benefits have been recognised by dwellers. However, in longer-term, these measures show the consequences due to the lack of sustainable perspectives in design as well as proper management of pilot projects such as lack of freshwater, especially in the case of extreme event such as drought in 2016 (Nguyen

2017); pollution due to agriculture intensification and irrigation system design (Can & Khang 2009, KG PPC 2017); reduce of soil sediments and quality (Le *et al.* 2015). In many cases, farmers have to change their farming system as a response to those impacts which have not been well considered since the engineering measures were first implemented.

Given such important influences, the hydraulic engineering solutions that were once labelled as adaptation to floods and salinity issues in the MD has been recently criticised to "have displaced the delta wetlands and the ecological services they provide and not solved the saltwater incursions into freshwater systems or acidification of soils (Taylor 2014)" (Olson & Morton 2018). Therefore, once again, the highly potential forthcoming changes will affect livelihood practices at the household level and thus of great relevance to bring up in the scope of this research.

## 2.3. Contemporary rural households as smallholders

With individual households being the central interest of this thesis, it is of importance to portrait a general background of this unit which will help to guide into more in-depth analysis in later chapters. This section, therefore, provides a glimpse of their basic characteristics, including remarks on the commons and disparities between these residents of the two deltas of which several points might be found perpetuated throughout the research.

As similarly found across the rural areas of Viet Nam, the vast majority of households in the two deltas are smallholders whose livelihoods still predominantly based on their land. Given the difference in development history and population density, the average arable land area per capita is higher in the MD (more than 1 hectare) than in the RRD (less than 0.3 hectares) (Deininger & Jin 2003), yet most of them still fall in the small-scale category. In general, the arable land is scarce in Viet Nam with an average area per household of 0.8ha and per capital of 0.12ha/person which is much lower than the global average (OECD 2015). According to Dao and Molle (2000), over 65 years until the year 2000 in Viet Nam, "[T]he agricultural land was reduced by one-third, and the land per capita decreased three times." (ibid:403). Up-scaling in agriculture, therefore, has been raised as an issue of rural development in many developing countries (Rigg 2016) and in Viet Nam in particular (Tran 2014, OECD 2015). This process, however, implies many social risks among which landlessness should be highly concerned. In Vietnam, landlessness was early captured by Gourou (1936) back in the 1930s where they described the link between landlessness and impoverishment facilitated by colonization that made the poor peasants more vulnerable to shocks (Devienne 2006). In the MD, shortly before the first agrarian reform carried out under President Ngô Đình Diệm's government during the 1950s, the share of landless male farmers was among the highest in the Cochinchina (Trần & Nguyễn 2016) and only got slightly better from 77% to 61% after the economic renovation "Đổi Mới" (Sansom 1970). According to a research of Ni and Xuan (1998), the proportion of landless farmers in the MD

was 15-20% of the whole population (Ni *et al.* 2001) The reordering process took place only after the country's independence through redistributing land to smallholders which reduced the proportion of tenant farmers to 5% by 1975 (Nguyen & Tran 2014). However, since the steep demographic growth commencing in the 1950s, fewer arable land per capita was available, especially in the RRD whose excessive population density has put a burden on land resources for decades earlier than that. "More able farmers acquired more land after the reform" in the late 80s-early 90s with the new Land law 1993 (Ravallion & Walle, 2008). Consequently, land amalgamation which has also been raised as a big concern since the start of the land reform campaign could, to a quite large extent, shows the evidence of its spreading across regions (Le 2010).

In a middle-to-long-term view, the potential of re-organising the distribution of arable land should raise the concern of disparity or even polarization, particularly within the rural communities (Smith & Binh 1994; Ravallion & Walle 2008). The emergence of the "semi-commercial" rural upper peasants and farm labour market out of the dynamics of agrarian system movement and land reform (Gorman 2013, Hồ 2008) and the barriers of smallholders economics will push changes to happen when it is approaching the threshold of this rural small-scale development and facing the needs to transform under the pressures of both local and global market rules as well as demographic movements and natural resource stressors (Trần 2014:30). The report of OECD (2015) also mentions the gradual shift from the current main system of smallholders towards, as predicted, unavoidable scaling-up trend. However, the process is often too ambiguous to observe; thus, it deserves more caution when considering this as a direct shift.

Interestingly, it is another story in the RRD where landlessness is less attributed to poverty due to the fact that each household could be provided with a very limited amount of land and consequently, their livelihoods, in general, are less dependent on farm incomes. Back further in history, land privatization has always been the dominant mechanism in the MD (Tran 2014, Nguyen & Tran 2014) rather than being strongly driven by collectivization or communalization as it was the case in the RRD, specifically during the second half of the twentieth century. Therefore, near-landless holders are very likely to maintain their land, sometimes even at an affordable price, for instance, to hire relatives or neighbours to cultivate on their land so that it will not be withdrawn by the local authorities for abandoning. Other factors could also be attributed to this North-South difference, such as labour needs on-farm, education level, and an equal amount of land received by households (Ravallion & Walle 2008, Benjamin & Brandt 2004). As an important remark, accepting and appreciating the heterogeneity and dynamics of the contexts regardless of scales fixed by the administrative borders, are essential to bring researches closer to the realities and to make a significant contribution to the policy-making process.

As the rural population is shrinking and the growth rate is decreasing, the average household size is also getting smaller (on average 3.5 persons in the RRD and 3.9 persons in

the MD by 2009 (GSO 2010). A big part of this process, as afore-discussed, is explained by the strong and persistent trend of rural-labour mobility within and cross-region in the last few decades in the country as a whole (Rigg 2016, Junge *et al.* 2013). Meanwhile, on fields, there has witnessed a significant decrease in the need for farm labours due to the so-called "labour-reduction revolution" (Hồ 2008). This process includes the technology development (*e.g.* irrigation, new varieties, more advanced farming techniques) and the rapid mechanization or the shift of farming systems towards less labour-demanding forms (e.g. aquaculture). Therefore, since early of the 1990s, it has become typical for a rural household to have at least one member living temporarily far from home (Deininger & Jin 2003). This is not always fully shown in the migration statistics.

All in all, smallholders remain popular in South East Asia in general and Viet Nam in particular, despite the observed development pathways as in many global north countries (Rigg 2016). Their persistence underpins the importance of research and governance to understand better the internal processes as well as the interactions of this autonomous unit with the external environment.

# 3. CONCEPTUAL FRAMING – AN INTEGRATIVE APPROACH TO STUDY RURAL LIVELIHOODS CHANGE AND ADAPTATION PROCESS AT HOUSEHOLD LEVEL

## 3.1. Linking adaptation, livelihoods adaptation decision making and adaptive behaviours

### 3.1.1. Adaptation as concept

Originally rooted from evolutionary theories in ecology and biology earlier in the 19th century, adaptation was adopted by social and particularly environmental scientists since more recently. Ecologists firstly applied to study adaptive ecosystems in the 1970s, *e.g.* Holling (1973) is most pronounced for framing system's resilience, self-organization, complexity and stability to the literature on adaptation. This strand of research focuses on a quantitative approach (*e.g.* computer modelling) to study human and landscape ecology. Meanwhile, the application of the adaptation concept in social and environmental disciplines mushroomed only during the 1990s with the early literature focusing on natural hazards and climatic disturbances (Nelson *et al.* 2007). Further insights into the early works of this strand could be found in, for instance, Burton *et al.* (1993), Smithers and Smit (1997), Rosenberg (1992). Along with the increasing concerns on global environmental issues, adaptation and relevant concepts have emerged sharply in environmental change literature. Since about 2000, adaptation to climate change has become the buzz words as a scientific topic and promoted not only at the policy-making level but also to public awareness through media channels (Moser & Ekstrom 2010).

To date, there has been a large pool of literature contributing to conceptualizing and advancing the application of adaptation. Nevertheless, there is a divergence in the conceptual framing of adaptation across disciplines, and even among climate change scholars. The most relevant debate to this research is between the thoughts on the outcome- versus process-based approach in defining adaptation. The latter calls for looking at adaptation beyond the achieving the status of "being adapted" (as an outcome) yet rather "to adapt well" (referring to the process) (Garschagen 2014) which concerns changes and the decision-making process of actors (Nelson *et al.* 2007). This approach is therefore argued by this dissertation to reflect better the complexity of the context in which adaptation is studied (see 3.1.2).

Also relevant, Birkmann (2011) refers to the time frame of adaptive actions to distinct between coping (short-term response) and adaptation (medium- and long-term changes). Meanwhile, first-order and second-order adaptation definitions are mainly aligned to climatic hazards (Birkmann 2011, Garschagen 2014). This distinction underlines adaptation as a cascade process in which the secondary adaptation appears as a response to the implementation of first-order adaptation (Birkman 2011). These definitions are found applicable to this research's context from the perspectives that second-order adaptation is

needed to deal with the (could be negative) consequences of an original or first-order adaptation solutions, often in the case of engineering and structural solutions, for examples dikes construction, uplifting land, early warning system (Birkmann 2011:818). This cascade process is related to a less popular concept yet worth reviewing in the scope of this study which is maladaptation. Maladaptation appears when the outcome of adaptive actions is prematurely claimed (Moser & Ekstrom 2010). The commonality between the ways secondary adaptation and maladaptation being framed is the occurrence of failure of some (first-order) adaptation solutions, *e.g.* dyke systems fail to protect from severe flood events, yet without explicitly label the status of "failing to adapt" to those measures.

In short, the existing debates as well as overlapping in framing adaptation and its relevant concepts are shreds of evidence that adaptation-related terminology, particularly in social sciences remains open. This fact, on the one hand, could be confusing and controversial, and on the other hand, granting opportunities for flexible framing and application into interdisciplinary researches. This interpretation of adaptation ultimately enlightens the designing of the conceptual framework as well as the methodology of this dissertation. The rest of this chapter is layered with relevant concepts to demonstrate how adaptation is conceptually framed specifically for the case study of the MD and the RRD in order to address the research questions.

### 3.1.2. Adaptation as a dynamic process - Processual approach to adaptation

Among the divergent development of adaptation framing, the overarching school of thoughts underpinned by this dissertation is to define adaptation as a dynamic process including not only reactive but also proactive or anticipatory actions of actors across scales compositing coupled human-nature interactions. In other words, it does not only take place as responses to changes but happens even before and, in some cases, stimulates sequel changes. This approach has since early been raised by Denevan (1983) and developed far beyond his focus of cultural geography (see also Garschagen 2014) who underlines the argument of Kirch (1980) that adaptation is "the process of becoming adapted, that is, of being viable and able to reproduce in a specific environment" (Kirch 1980:108). This is where he comes up with the term "processual approach" to capture how changes take place in order to comprehend adaptation. This approach has increasingly been adopted and applied, for instance by Garschagen (2014) to develop the integrative framework which captures the dynamics of adaptation to urban flood in the Vietnamese MD. While these interactions are being carried, people continually learn how to adapt individually and collectively, i.e. adaptive behaviours come through a learning process (Pelling *et al.* 2008, Reed *et al.* 2010). In line with these thoughts, adaptation is studied, on different scales, as an interactive process of the adaptive units which could vary from individual to human society to the environment that accommodates them. Explicitly, at the household level, this 'environment' should contain both climatic and social compositions. This interestingly, to some extent brings 'adaptation' back to its original common-sense as defined in the English dictionary few

centuries ago where it simply meant "process of change" rather than carrying heavy technical meanings as nowadays (Orlove 2009:132). This is, however, not surprising given the fact that the term 'adaptation' is indeed employed in the literatures of risk management, livelihoods and sustainable development with or without being mentioned explicitly (Smit & Wandel 2006) which might be distinguished from how it is defined in climate change field. This essentially means that adaptations should be considered in a mixed and complex process in which it is insufficient to "separate climate change adaptation decisions or actions from actions triggered by other social or economic events" (Ager *et al.* 2005:78). An interactive process which includes anticipatory actions brings the term 'adaptation' in this study beyond the definition applied widely in climate change literature that focus more on outcomes of adaptation as "adjustments in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities" (IPCC 2014:118). Ribot (2011) also takes this point to criticize that "adaptation framing does not automatically draw us to ask 'why people have to adapt at the first place'" (ibid: 2) where he believes the term got scored by the vulnerability concept for moving away from causality and towards response. Van der Leeuw (2008) shares the same argument that adaptation is referred to as a general concept instead of pointing to system dynamics.

Despite this complexity and controversy, 'adaptation' as a term is widely applied as an approach given it sheds light on the trajectory with all the advantages and limits, as well as anticipating future development pathways. I, therefore, frame adaptation as a loose concept focusing on complex interactive processes rather than sticking to its outcome to climate change and other environmental risks (Schipper & Burton 2009). This is in line with the so-called "practical application" of adaptation field that was suggested by Smit & Wandel (2006:285): "Rather, the focus is to document the ways in which the system or community experiences changing conditions and the process of decision-making in this system (or that influence the system) that may accommodate adaptations or provide means of improving adaptive capacity". This approach is also of great relevance in studying adaptation pathways in changing contexts as it focuses on the process rather than outcomes of adaptation, and moreover considering the complex interactions between human society and nature (Wise *et al.* 2014).

This study, nevertheless, is not seeking to cover the rich and, to some extent, controversial conceptualization of adaptation. Rather, it draws attention to forming an approach in which adaptation is studied through individuals' adaptation decisions when they interact with their social-ecological environment, which could be either *reactive* or *anticipatory,* either *autonomous* or *planned* (Klein 1998, Smithers & Smit 1997, Adger *et al.* 2001). It is important to highlight that the concept of *environment* applied in this study, although tightly link to climatic themes, goes beyond the ecological set-ups but strongly bearing non-climatic contents (Moser & Ekstrom 2010) that impose direct and indirect impacts on the decision to change of a household (also see Section 3.1.3). In this sense, the definition by Moser and

Ekstrom (2010) which is claimed to deviate from that of IPCC, is found highly applicable to this research:

> *"Adaptation involves changes in social-ecological systems in response to actual and expected impacts of climate change in the context of interacting non-climatic changes. Adaptation strategies and actions can range from short-term coping to longer-term, deeper transformations, aim to meet more than climate change goals alone, and may or may not succeed in moderating harm or exploiting beneficial opportunities." (ibid*:22026*)*

Despite leaning their definition on climate change adaptation conceptualization and more on macro approach, the authors have explicitly emphasized the interaction between the climatic and non-climatic components in the process, while considering all types of adaptive actions regardless of their time frame and outcomes that go beyond climate change goals and the debate of maladaptation.

It is common for adaptation studies to be guided by basic questions such as "Who or what adapts?", "Adaptation to what?" of Smit and his colleagues (2000). However, this dissertation argues that these questions are more appropriate in guiding researches that study adaptation to a specific hazard or observed climatic phenomenon. Therefore, framing a study by these questions might be insufficient to capture the complexity, diversity and all the dynamics of the research areas in the coastal areas of the MD and the RRD of Viet Nam. In other words, such a study bears a risk of being directed at either oversimplifying the context or towards reductionism in general. As such, it refers to the common problem of truncated explanation due to the lacunae of an applied integrative approach to adaptation and thus less convincing as policy implications as warned by Newell and his colleagues (2005) that "there has been a growing dissatisfaction with research that is carried out in a purely reductionist, discipline-based manner" (*ibid*:299). More challenging questions such as "How does the adaptation occur?" (Smit et al. 2000), nevertheless, are still valuable and highly applicable in a processual approach.

### 3.1.3. The social-ecological systems approach

The most agreeable and applied integrative approach in the global environmental study up to date is the coupled social-ecological system (SES) concept because it responds significantly to the urge of defragmentation among the main research disciplines. Although the achievements of the in-depth researches in undeniable, it more or less aggravates the segregation, particularly between natural and social scientists. Gallopín and his colleagues (2006), therefore, advocate for a merged systematic approach to actually understand and anticipate the "Earth system" (Schellnhuber 1999) in the past, present and future since society and ecology are the components in the "non-decomposable systems".

Numerous scholars revisit existing schools of thoughts in framing SES across disciplines, as well as the popular application in the field of risk and vulnerability (*e.g.* Turner *et al.* 2003, Birkmann 2007, Adger 2006, Renaud *et al.* 2010), adaptation and resilience (*e.g.* Folke 2006) in particular. The key words making the SES approach goes viral are basically the description

trying to explain the nature of the relationship between society and nature that also make it relevant for this study, namely mutuality (Oliver-Smith 2004, Damm 2009), complex interactions (Gallopín 2006, 2007), circular or multi-linear interactions (Folke *et al.* 2002; McLaughin & Diezt, 2008), structural multiple feedbacks (Renaud *et al.,* 2010), interactive process (Pelling and High, 2005) extensive network and interactions cross scales (Pardoe 2016), *etc.*. However, addressing these complexities in both conceptualizing and empirical work remains as challenging tasks for researchers, policymakers, and practitioners. A comprehensive comparison between existing SES frameworks is done by Binder and colleagues (2013). However, it still urges for further research to synchronize the available resources to make this approach more applicable and valid in practice.

Damm (2010) clearly illustrates the two main conceptual schools of human ecology versus social ecology when it comes to the contemporary understanding and applying of SES yet also emphasizes on the common point of complexity and interactions between the main components of this system (*ibid*:21). They are possibly the two only ways of understanding, interpreting and applying the SES concept. This research employs the definition that considers SES as "a system that includes societal (human) and ecological (biophysical) subsystem in mutual interaction" ranging from individual households up to global scale (Gallopín 1994, 2007).

What is found of great relevance is the set of questions serving as a guideline in analysing is provided in an earlier work of Gallopín (1994) (Figure 3-1) which is discussed and slightly adjusted in Renaud *et al.* (2010). One of the applications that this framework offers is the remark in setting the scale and boundary for analytical units which is thus critical in terms of identifying internal versus external factors containing in "the environment" accommodating an agent. Relevantly, Bargatzky (1984) also earlier discussed this concept by defining the "unit of adaptation" that specifically addresses at the analytical unit: individual vs. collection actions in the cultural adaptive process.

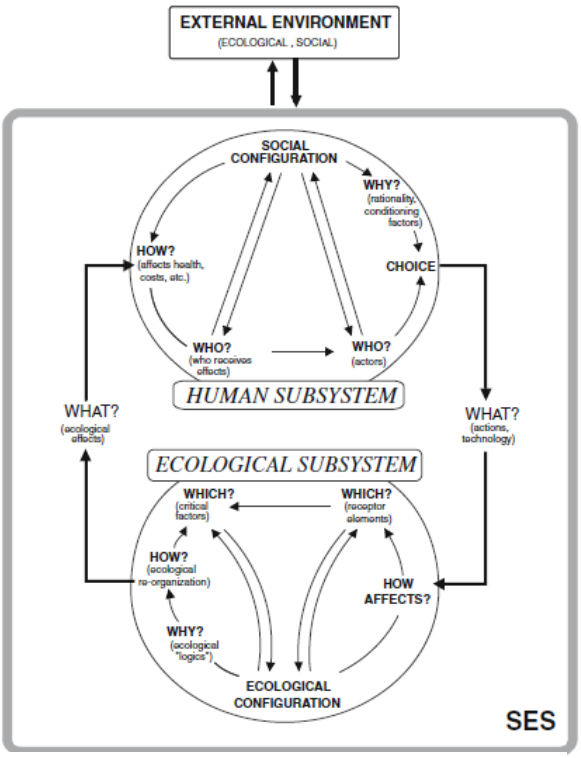



*Figure 3-1: Guiding questions in the analysis of socio-ecological systems*

(Source: Renaud *et al.*, 2010)

Becker and Jahn (2006) also emphasize that the relativity and flexibility of the term "environment" (in Damm, 2010) depending on the unit of analysis could be possible at

any scale and change when the scale of analysis changes. Moreover, the shares of social and ecological components in a unit's environment are often asymmetric depending on the analytical scale. At the individual level, their interactions with the societal structure often overweigh those with the ecological component which is, however, commonly overlooked in adaptation studies on farmers.

Nevertheless, the term could hold flexible and malleable for cross-scale analyses which are also a critical component when framing adaptation as a systematic process.

*Cross-scale interactions*

An approach focusing on system and process contains multi-scale and multi-level settings with specific actors and factors for each layer. Multi-level is here the nature of governance regimes (Pahl-Wostl 2009). The interactions of them within as well as across scale or level contribute and also reflect the dynamics of the system and the process. Adger and his colleagues (2005) thoroughly discuss how much scales matter in analysing adaptation decision-making. Given the unique political and social settings in Viet Nam, interaction across scales and levels, from individuals to state, is of great relevance to explain many on-going trends in deltas' coastal regions of Viet Nam (Le Phuong *et al.* 2018). The case study on adaptation to floods in Germany of Damm (2010) could be referred when explaining many land-use changes in the MD and the RRD where: "Cross-scale interactions can be observed, for instance, when land-use management imposed by human beings impacts single ecosystems or even whole landscapes. All changes in the ecological system feedback to the social system and trigger an institutional response." (*ibid*: 31). Shifting to intensive shrimp cultivation in the MD, for instance, is the typical case of the triggered and on-going process and the land-stripe just inside the sea dike in the RRD is much likely a similar showcase in near future. The demonstration of cross-scale interaction showed in Figure 3-2, therefore, could be adapted to analyse the complexity and dynamics context of our research areas.

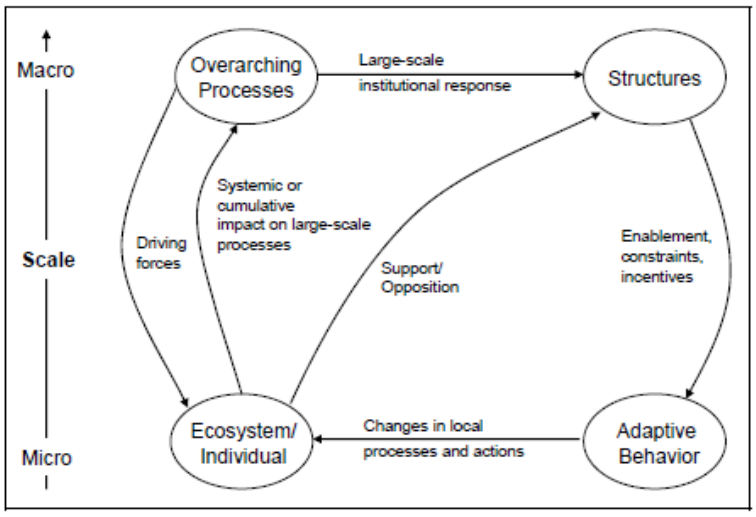



*Figure 3-2: Cross-level and inter-level interactions in social-ecological system*

Source: Damm (2010) adapted from AAG (2003))

*Analytical units and boundaries of adaptation*

Setting the analysis unit and its boundary is essential to identify the form and actors of adaptation. There are several schools of thought that could be related to such as *private* versus *public* (Klein 1998, 2003), the *micro* versus *macro* adaptation (Solecki 2012), *endogenous* versus *exogenous* nature of an event Gallopín (2007) or *first-order* versus *second-order* adaptation (Birkmann 2011). A clearly set analytical scale with unit and boundary is pivotal because it backs any argument for labelling a factor as external or internal to a process. This is particularly true in a cross-scale analysis since the role of a factor could flip over depending on how the unit and scope of research is set. The properties of the relationship between the components of analysis, therefore, could vary with the boundaries. More recently, the action theory in adaptation introduced by Eisenack (2012) attempts to overcome this challenge with a flexible guideline framework in which the traditional overlapping boxes demonstrating scales are removed whilst the *actors* and *actions* of adaptation are shifted to the centre of analysis instead. This approach is argued to be more intuitive for applying to contextualized frameworks.

In this research, although the focus is on the individual level of household, I argue that it could not be studied in separation to the broader system or the overall environment in which phenomena evolved and observed. Therefore, this dissertation underpins the need to keep it clear yet flexible in defining the internal versus external process of adaptation, as well as applying an appropriate scale of analytical units in investigating the adaptation process as a whole. For instance, a policy-making process at the local level is internal to that studied community, yet external looking from the perspective of households' strategies.

### 3.1.4. Vulnerability and adaptive capacity

Given the recent conceptual shift in risk studies related to human-nature relations, vulnerability has been increasingly applied and discussed, especially in the context of rising concerns on global environmental change. Basically, the literature has moved from hazard-focused risk analysis towards addressing the coupled social-ecological system in vulnerability analysis (Turner *et al.* 2003, Pelling 2011, Schwab 2012, Garschagen 2014). This shift plays a critical role in promoting an integrated approach by bridging different schools of thoughts, for instance contrasting climatic and non-climatic drivers (Füssel & Klein 2006, Birkmann 2013), social vulnerability measuring (Cutter 2013), or introducing 'double exposure' concept (O'Brien & Leichenko 2000) to name a few. The multi-scale nature of disturbances, together with the fact that "SESs are usually exposed to multiple, interacting perturbations" is widely accepted in vulnerability literature (Gallopín 2006:294). In spite of preceding in research, adaptation only gets more popular than vulnerability recently particularly due to the emergence of climate change issues. Nevertheless, it is highly agreeable that the conceptualization of adaptation could not be done in isolation with the latter. For instance, Kelly and Adger (2000) highlight the importance of the

relationship between vulnerability and adaptation in which "adaptation is facilitated by reducing vulnerability" (*ibid*: 348). Ribot (2011) even argues that vulnerability should come first before discussing adaptation to make sure that the internal components of social systems are not overlooked in framing adaptation. Heeding this argument, the research is aimed at analysing the adaptive decisions of households in the attribution of their vulnerability taken as a critical internal composition and as the "starting point" to study adaptation (O'Brien *et al.* 2004, Smit & Wandel 2006).

Along the same line, adaptive capacity is inseparable from adaptation study as together they are the determinants to a successful strategy to deal with disturbances (Birkmann 2011). As applying behaviour analysis at a micro-level approach, it is specifically indispensable to refer to adaptive capacity the typical converse element to vulnerability formula (Ribot 2011). Different aspects of this term are unfolded as it is vastly employed across disciplines such as adaptability, coping ability, management capacity, *etc.* (Smit & Wandel 2006:286). In line with the aforementioned regime shift in the application of vulnerability concepts, the development in framing adaptive capacity is incorporated in the emergence of the social component to study adaptation (Pelling 2011). Pelling (2005) also emphasizes that the way in which individuals interact with nature also reflects the association of social composition mainly through their social capitals and adaptive capacity. The social elements of adaptive capacity are agreeable in climate change literature. Birkmann (2011) mentions the emphasis of the relationship between adaptation and adaptive capacity with social and political power relations; the definition of adaptive capacity by Nelson *et al.* (2007) includes the social elements, just to name a few. This is of great relevance for this study as adaptive capacity is considered as a critical internal component embedded with households' profiles and attributed to their decision-making process. Looking into adaptive capacities at the individual and the household level, the sustainable livelihood framework by the DFID (1999) mentioning the five capitals type (*i.e.* physical, financial, human, social and environmental (more in Section 3.1.7)) as the determinants to adaptive capacities of actor is the most widely applied form (Garschagen 2014). Among those aspects, the 'social capital' concept has been of increasing interest to researchers recently which is also found highly relevant for researches in the context of Viet Nam (Garschagen 2014). According to Garschagen (2014:59), the changing political economy context and the predominant role of the state in Viet Nam urge to take into account the controversial aspects when engaging with social capital in adaptive capacity (i.e. both positive and negative impacts on collective adaptation momentum) as also argued by many scholars such as Pelling and High (2005), Fine (2001). Moving further from this framing, it is argued by this research that taking in account the difference between state and non-state actors in shaping adaptive capacity, social capital could also be complemented with the cross-level social learning which reflects the social interactions in the adaptation process of coupled SESs, for instance, the deltaic context.

Adaptive capacity, nonetheless, is also the trickiest component in measuring vulnerability due to the high complexities of the systems needed to be addressed (Engle 2011, Renaud *et al.*, 2010). Several endeavours have been put into identifying the key indicators of vulnerability, such as Adger and Kelly (1999), Yohe and Tol (2002), Adger *et al.* (2002), Brooks and Adger (2004), Pelling and High (2005), IPCC (2007), Engle (2011) who not only agree on the most fundamental vulnerability-related concepts but also feed the open discourse of theoretical and methodological evolution of adaptive capacity assessment with different perspectives. The literature applying one or many of the aforementioned methods for the case study of rural Vietnamese deltas (*e.g.* Schwab 2012, Vo 2014, Nguyen 2015) also provides relevant insights for the empirical analysis in this dissertation.

### 3.1.5. Social learning in adaptation

Learning as a phenomenon is rooted in behavioural and cognitive science since the mid of the 20$^{th}$ century (Watson 1967). Social learning as a concept has drawn the attention of social researchers across different disciplines namely political science, psychology, sociology, anthropology, etc. and later employed by the environmental research community, particularly in resilience subject (Olsson *et al.* 2004, Pelling 2011, Abeling 2015). In the adaptation scholarship, social learning is mostly discussed in its link with the resilience concept, specifically with social capital in climate change adaptation studies (Pelling 2011, Pelling *et al.* 2008). There has been rising interest among the research community to use social learning as an analytical tool. Yet due to the high complexity of human and social components involving in the concept, the conceptualization and implications still confront several challenges and are open to innovative approaches. The link between the learning process and the adaptive capacity of a system is discussed by Pahl-Wostl (2009) which emphasizes the multi-level social and societal learning process as an essential part of the adaptive capacity of a resource governance system.

In this study, social learning is relevant in analysing the process of change and adaptation individually and collectively. Similar to other activities producing out the interactions among actors within the same as well as among different levels, learning is a continual process. Particularly for the high complex research contexts, it fits in perfectly with behavioural analysis approach as well as improving the explaining power of an integrative systematic framework. Relevantly, risk and adaptation perception of an individual is also argued to be inseparable from other actors' behaviours in the social interaction field (Schwab 2012). Social capital is also a highly related concept, particularly to study state-individual interactions (as discussed in 3.1.4). Nevertheless, this dissertation employs the social learning approach out of other concepts since it is argued to bring more exploratory power when considering adaptation as an eternal interactive process. Social learning is embedded in the internal factor components to the decision-making process of households to explain their adaptive behaviours. Moreover, in the context of Viet Nam, it is important to consider the predominant role of the public entities in the learning process. Most

noticeably, this predominance in disaster risk mitigation practices might cause the redundancy of private adaptation and erosion of self-reliance (IPCC 2012, McElwee 2010).

Taking into consideration the cross-scales analysis, learning is the momentum of a system's adaptation process. In other words, interactions among actors as well as between groups of actors in a hierarchical system explain the dynamics and trajectory of the adaptation process of a community, a country or a society as a system. In the scope of this research, although the concept of social learning is mainly applied to individual-level analysis, an extended implication of cross-scale learning process in adaptation is found advantageous to capture the complexity of the case study which pushes forward the discussion on a larger-scale adaptation (*e.g.* on delta level).

### 3.1.6. Adaptation decision-making at the household level

#### *Human agency and decision-making*

The decision of human agency, as "socially and institutionally constructed" actors (Scott, 2008) is heterogeneous and unpredictable which determine an exclusive individual's profile as well as the trajectory of a social-ecological system and process of adaptation (McLaughlin & Dietz 2008, McGinnins & Ostrom 2014, Pardoe 2016). Rooted in economic and behavioural sciences, decision-making has then been acknowledged by researchers in other disciplines in the last couple of decades (Grothmann & Patt 2005) including adaptation studies. Adaptive behaviour analysis is important to understand the human decision-making process which contains such abstract aspects as beliefs and perception concepts, emotions and cultural values (Pelling & High 2005, O'Brien 2009, Pelling 2011). Meanwhile, culture has early been mentioned as one of the keys to understanding adaptation in social science by Bargatzky (1984) who was among the first to bring up the cultural adaptation concept to improve the explanatory power of the adaptation concept. This came after his critiques on the dominant views focusing on explaining adaptation through the biological process to the ecological stimuli in the 'adaptationism'. Detecting and measuring these aspects, however, remain considerably challenging which is widely agreed among scholars. Yet limited efforts have been made to expand this approach in risk and adaptation-related subjects in spite of its high relevance (Acosta-Michlik & Espaldon 2008, Schwab 2012).

In climate change subject, researches are typically driven by rational theories as in economics whilst underscoring socio-psychological aspects (Pelling *et al.* 2008, Schwab 2012) (see also 3.1.7). Studies of individual decision-making relating to adaptation actions typically stress the linkage between farming practices and hazards or climate change in a specific context, for instance examining land-use and land-cover changes as farmers' adaptation to these environmental changes (see also the review of van Wijk *et al.* 2012). Meanwhile, socio-economists rather build models to study non-agricultural livelihoods with limited consideration of environmental components. Theoretical discussions in order to

further develop this discourse thus are still on-going, i.e. human agency and action theories in vulnerability and adaptation researches (Eisenack & Stecker 2012, Garschagen 2014, Vo 2014). Detecting the endogenous aspects of human agents is far from an easy task, yet essential to properly explain and anticipate trends of change.

### *Perception and adaptation/adaptive capacity*

Perception is the key factor to understand adaptation or adaptive behaviours. In environmental studies, research typically concentrates on (hazard) risk perception, particularly climate change perception and adaptation with a focus on farmers and agricultural adaptation (*e.g.* Arbuckle *et al.* 2013, Nguyen *et al.* 2016, Zamasiya *et al.* 2017). Risk perception is framed as one of the key psychological factors that shape the social capacity to adapt to natural hazards (Werg *et al.* 2013). Still, there remains a lack of knowledge formalization on the link between individual perception and adaptation (Truelove *et al.* 2015). More importantly, researches are urged to look further into the individual perception in their interaction with the social-ecological environment as a whole and as a continual process, rather only towards climatic changes, which has been similarly argued by Gallopín (2006) to be considered in conceptualizing adaptive capacity. Recently, this approach has been increasingly taken up by behavioural analysis and SES modelling researches (Grothman & Patt 2005, An 2012, Truelove *et al.* 2015). What shapes perception and how to enhance it in a way that pro-adaptation are properly the most asked questions by studies on the subject. Personal experience (*e.g.* hazard events frequency) might be a key factor to perception or judgment of climate change due to the bias caused by the frequency of reoccurrence of an event – according to the theory on cognitive aspects developed by Tversky & Kahneman (1973). Perception also causally links to learning, which could take place in a two-way relationship – 'learn to perceive and perceive to learn' (Nguyen *et al.* 2016). Nguyen et al. (2016) emphasize that while the former is well acknowledged, the latter is in fact as much important to understand individual adaptation. This process comes in the form of perceptual learning where knowledge also shapes perception and thus enhances adaptive capacity and enables adaptation through a cognitive process.

Social influence through social interaction is also a factor of perception and the decision-making process. Baddeley (2011) discusses this topic in his economic behaviour study that social influence through social learning, particularly on aspects such as social norms and perception of others' attitude and response play a role in household economic decision-making. In adaptation studies, this is considered in the social capital concept as a property of adaptive capacity (Adger 2003). These are very similar approaches to understand social factors to individual perception and consequently household decision-making. In some other studies, perception of risk as an indicator to measure the adaptive capacity to assess vulnerability (*e.g.* Lohmann 2016) (in Ferro-Azcona *et al.* 2019). An actual adaptation action is only carried out in the presence of both perception of hazard risk (threat appraisal) and

perception of adaptive capacity (competence appraisal or coping appraisal) (Truelove *et al.* 2015, Schwab 2012).

It is also pivotal to understand the path from perception to attitudes to action and behaviour. Studies of natural hazards subject promote to consider individual responses as "a function of perceptions, beliefs and characteristics of the hazard" (Arbuckle *et al.* 2015) of which the cognitive aspects beliefs and perceptions shape the attitudes towards natural hazards and actions (Zamasiya *et al.* 2017:234). Nonetheless, they claim that little is done on the link between attitude and climate change adaptation comparing to that between perception and climate change adaptation, particularly in developing societies and the urge for further work. This is captured by several behavioural theories, particularly toward adaptation to SES recently. The theoretical frameworks diverse yet remarkably reflect either implicitly or explicitly the tight linkage between perception, attitudes and behaviour in the cognitive process of adaptive behaviour which could be found in comprehensive systematic reviews of Schlüter *et al.* (2017) on the most influential behavioural theories in SES models or of the WB (2010) on theories of behaviour change. They establish a sound foundation for flexible and relative innovation employment in the field. What following provides more details of this approach and rationale for its appliance to this research.

### 3.1.7. Cognitive and behavioural analysis approach in adaptation decision studies

As above-mentioned, decision-making, particularly at the individual level is rather a more complicated than just a standardised rational heuristic process as it involves complex trade-offs (McLaughlin and Dietz 2008, Pardoe 2016) or "potentially irrational behaviour, subjective choices, and complex psychology" (Bonabeau 2002). Strongly developed within social psychology and cognitive science, behavioural analysis has been applied widely by scientists in these fields owing its advantages in explaining the vast majority of phenomena (Simon 1992:2). The implications in adaptation and vulnerability subjects, nevertheless, remain limited, although in the early 80s, Denevan (1983), while discussing cultural adaptation, already expressed his scepticism that the insufficient understanding of the cognitive process makes it difficult to explain adaptive behaviours in the past. Yet there is an increasing number of publications calling on the importance of including the complexity of human behaviours in studying the coupled human-environment relationships, including aspects such as psychological and social influence (WB 2015), or cognition and culture (Kuruppu & Liverman 2011).

Researchers in the natural resource management disciplines have quickly responded to this school of thought by advancing the integration of behavioural analysis to the modelling of humans and environment interactions in social-ecological systems (Schlüter *et al.* 2017). Behavioural models in adaptation studies are the most noticeable strand of literature developing theories and methods to study cognitive aspects in individual adaptation decisions. Recent research has increasingly taken up this approach to study adaptation to

hazards on various actors and case study worldwide (Schwab 2012, Neise *et al.* 2018). The most influential theory for psychological work in this area is the protective motivation theory (PMT) that basically grows in health promotion literature (Truelove *et al.* 2015). In adaptation studies, it is normally used as a foundation for psychological modelling in studying individual adaptation to climate variation. Among the most renowned works, Grothmann and his colleagues (Grothmann & Patt 2005, Grothmann & Reusswig 2006) extend this approach and develop a socio-cognitive model (MPPACC) (Figure 3-3) to study individual adaptation and coping basically to climate change against the rationale that "[C]ognition of an individual always depends on his or her socio-physical context, and the social discourse is important" (Grothmann & Patt 2005:205). They explain adaptation options and behaviours through the "determinants of the motivation to adapt – what an actor *wants* to do, indicated by motives like goals, values or norms – is the relative risk perception" (*ibid*:202), in other words, to reflect in the risk perception and perceived adaptive capacity. In the lately paper, they improve the framework by integrating psychological dimensions in studying the adaptive capacity which is an important value added to fill in the research gap of proper investigation on psychological factors in relevant themes (Grothmann *et al.* 2013). There work is also widely applied with extension and modification which contribute to this nouveau subject in both terms of theorization and methodology, e.g. Schwab 2012 with the 'Socio-cognitive model of individual coping and adaptation' to evaluate coping and adaptation to flood in the Vietnamese MD; Truelove et al. 2015 with the 'Risk, coping, and social appraisal' (RCSA) model to explain adaptation behaviour of paddy farmers in Sri Lanka. These extended works have shown the potentials of further development of the subject based on the foundation of PMT and the MPPACC.

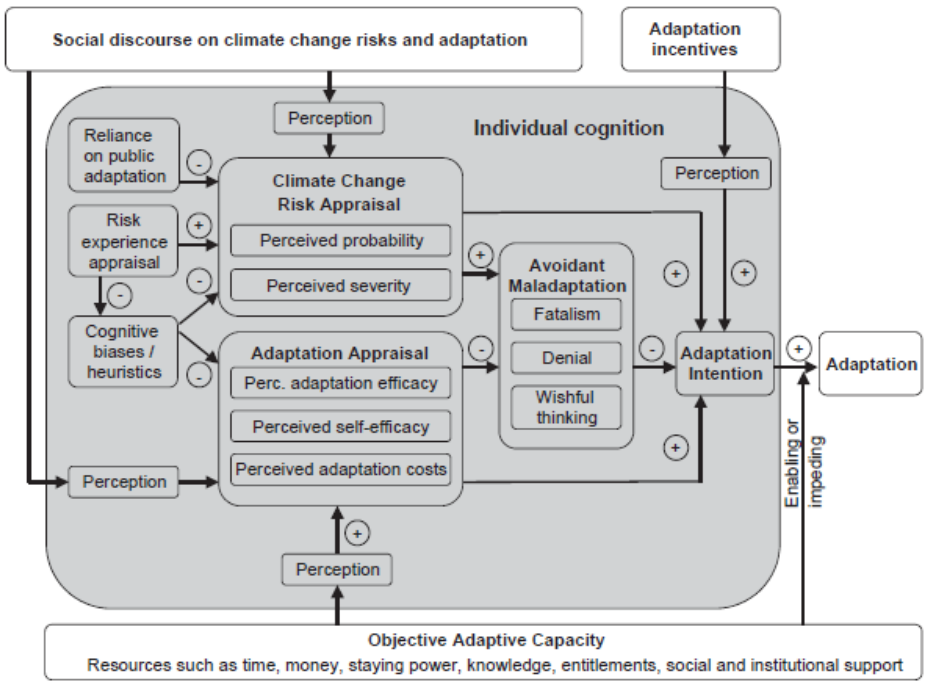



*Figure 3-3: Process model of private proactive adaptation to climate change (MPPACC)*
(Source: Grothmann and Patt 2005)

To date, there exists a large knowledge pool with dozens of models introduced in the last few decades, yet they are rather divergent and fragmentarily developed; they moreover have different levels of formalization and a lack of causality (but rather focusing on correlation) (Schlüter *et al.* 2017).

Behavioural analysis has its advantages in looking beyond reactive actions of agents to stimuli, i.e. “passive adaptations”, but rather “sufficiently taking into account the active, stress-taking, exploratory component of human behaviour” (Bargatzky 1984:400) at the individual levels as well as the heterogeneity, inconsistency and certain group conflicts at the societal level. It also addresses the assumption on illogical and irrational human decisions of outsiders, particularly researchers, when they approach special contexts, which deliberately are the case in the large part of the research. Various improved and innovative methods have been employed in order to capture this nature of individual adaptation decisions including qualitative analysis, scenario games (see Pardoe 2016) or modelling and simulation (see Acosta & Espaldon 2008). The most common challenge faced by any framework and methodology in dealing with these complexities is quantifying the immeasurable components of behaviour, for instance, the social learning process, risk perception (see also Yohe & Tol 2002) on dealing with indicators of adaptive capacity. However, given the high potentials of explaining individual adaptive actions, this is inevitably an important component in the integrative framework for studies of complex contexts.

Among several theories of behaviour change, the *theory of planned behaviour* (TPB) (Aizen 1991) is employed to back and validate future-forward empirical data, particularly justifying the use of the tailored scenarios for data collection and analysis (see Chapter 6) of this study. It is also applicable to explain the limitations and de-limitations in data collection regarding responses to future scenarios. Figure 3-4 is the illustration of the theory developed further by WB based on the theory firstly introduced by Aizen (1991). The theory explains the relationship between behaviours and intention which depends on the individual’s attitude and subjective norms taking into consideration the determinant impact of ‘perceived behavioural control (WB 2010). The TPB emphasizes on the contextualization of actions (Aizen 1991). By taking into account these aspects, predicting behaviours is more valid.

Originating in psychology science, the TPB has been applied to research of various disciplines involving behavioural analysis including environmental change studies recently in order to inform policy-making practices on adaptation (WB 2010).

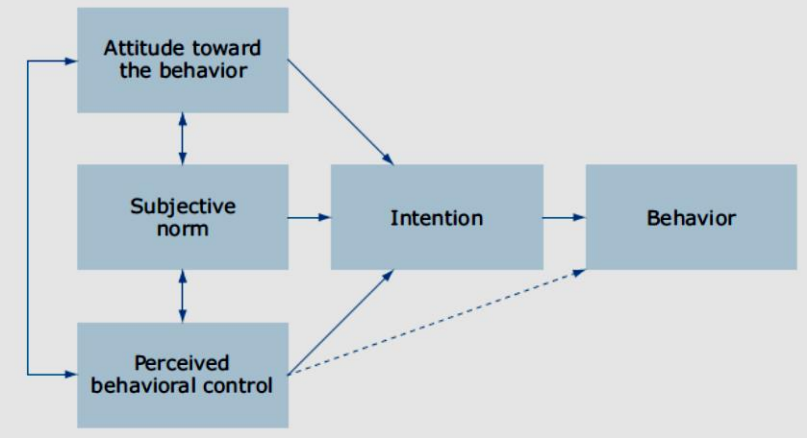



*Figure 3-4: Model of Theory of Planned Behaviour*
(Source: WB (2010))

### 3.1.8. Livelihoods approach in studying the adaptation of rural households

As being emphasized at the beginning, this study employs sustainable livelihood as the overall approach to study households' adaptation practices. Livelihood here is understood as the sources of income of a household which means there could be more than one source coming from both agricultural and non-agricultural activities. This is basically a simplified application of the definition used in the popular framework of DFID on sustainable livelihoods (Ellis, 2000) in which it defines: "[T]he term livelihood attempts to capture not just what people do in order to make a living, but the resources that provide them with the capability to build a satisfactory living, the risk factors that they must consider in managing their resources, and the institutional and policy context that either helps or hinders them in their pursuit of a viable or improving living" (Ellis & Freeman 2004:2-3). This framework (DFID, 1999) (Figure 3-5) largely forms the basis for data collection and parameterization of the main characteristics, i.e. profile of households used in data analysis. Particularly the five key components of livelihood assets are of great relevance for studying households in the context of developing rural communities. However, this study attentively avoids the gap that is often found in the literature on livelihood vulnerability and adaptation to climate change, particularly in rural contexts. A large body of literature typically stresses the link between on-farm changing and the land-use decision of farmers which is also the case found in the literature with case studies in Viet Nam (Le 2005, Ngo 2009, Drogoul *et al.* 2016). Nevertheless, this dissertation is deliberately connected to the emerging call since the last few decades on the 'divorce' between rural livelihoods and farming which comes hand in hand with the livelihood delocalization process, particularly in developing countries (Rigg 2006, Pritchard *et al.* 2017). Heeding these thoughts, Reed and his colleagues (2013) also advocate using the livelihood approach to connect the disparate set of concepts and theories in studying environmental change.

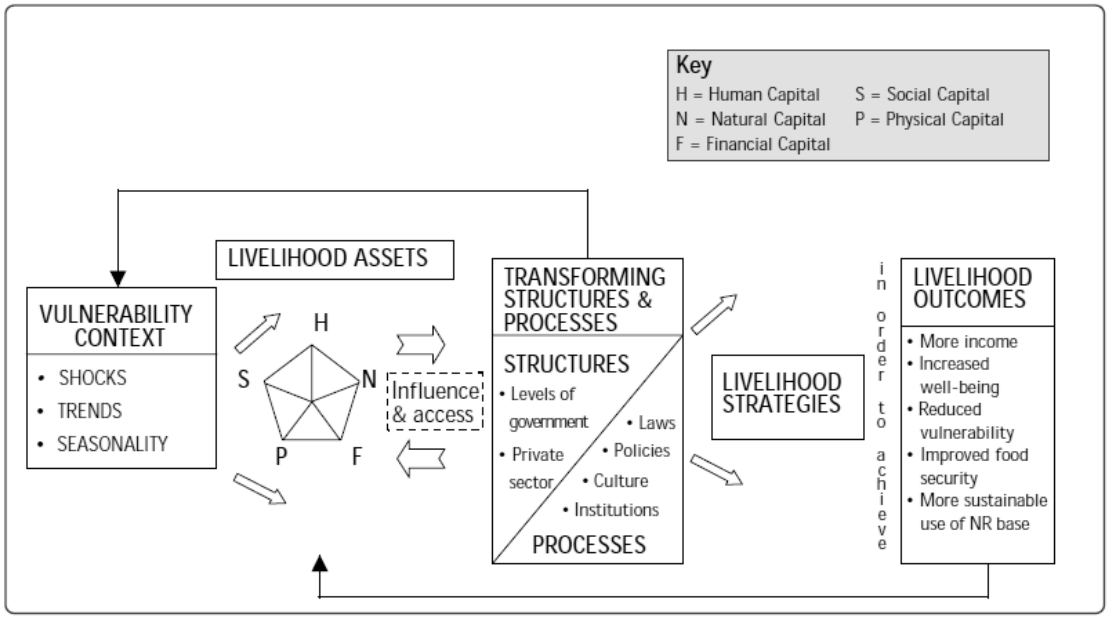



*Figure 3-5: Sustainable livelihoods framework*
(Source: DFID 1999)

Regarding this aspect, Viet Nam is among the most relevant case study owing its strong socio-economic transitions and land-use change happening in the last few decades which are still going on rapidly. Therefore, unsurprisingly, the body of vulnerability and adaptation literature investigating in this country shows the shift towards filling in this gap (Be *et al.* 2007). On the MD, Smith and his colleagues (2013) develop a "unifying adaptation framework" basing on DFID's sustainable livelihood approach. From an agency approach, Vo (2014) also integrates the sustainable livelihoods aspect in measuring the vulnerability of households in their interaction with institutional factors. Along this line, though, it urges more attempts to better embed sustainable livelihoods approach that to environmental studies goes beyond agriculture and land-use in the context of Viet Nam in order to better reflect the up-to-date dynamics.

The loose definition of livelihood is also for the purpose of including the multi-local livelihood strategy of the vast majority of households in these regions. The multi-locality or delocalization of livelihood has been early captured and been developed in research, particularly rural development studies (Thieme 2008, Steel & Zoomers 2011, Rigg 2006). Relevantly, I aim at considering labour mobility rather than migration by its traditional definition. The main difference is that this framing allows covering any kind of mobility of a household to improve their livelihoods regardless of purpose, duration and number of its members participating in this activity. As such, it reflects the fact that the majority of the households participating in this research had or having member(s) working or studying in other locals while maintaining their livelihoods at their original villages. This approach is promising to reflect better the reality, yet it has to deal with the flexibility and uncertainties embedded in this phenomenon.

The main application of this framework in environmental studies so far is for examining the determinants to farmers' adaptation, *i.e.* in specific hazard or climate change context with a focus on agrarian livelihoods.

## 3.2. Integrative framework for analysing the livelihoods adaptation decision-making process at the household level

*Why needing another integrative framework?*

- Adaptation, particularly to the mixed socio-ecological factors, should be studied as a process of interactions (*i.e.* including both reactive and anticipatory actions) between the society and the natural environment which thus continuously produces changes including both risks and opportunities. Given these mixed and heterogeneous effects of the adaptation process, its link to risk and vulnerability reduction, particularly at a household level should reflect this complexity. This approach has been long discussed, particularly in the theoretical literature; it is, nevertheless not yet explicitly demonstrated in one specific framework for application but rather several.
- The adaptation process, in reality, always reflects a mixture of who (heterogeneous) do what (more than one action at a certain time) in order to respond to what factors (various) which could happen either in a proactive or passive manner. Therefore, explaining adaptation for separate action-outcomes or to a context defined by a specific hazard limits the opportunity to capture the complexity of research contexts.
- Several interdisciplinary frameworks exist; however, there is a limited number of them studying adaptation decision-making process approaching from livelihoods perspectives which reflect equally both social and environmental components rather than being limited to either specific hazard contexts or rural economic development. This is expected to contribute to improving the theoretical and methodological framing of the integrative approach to fill in the gaps left by either overlooking or over-claiming one of these two elements.
- Unlike in vulnerability discourses, despite the drastic evolvement of the conceptualization of adaption terminology, applied frameworks remain limited and lack of transferability into concrete contexts in general. Rather up to date, researchers in this discipline more or less have taken the privilege of having freedom in interpreting and applying in mostly specific-case based studies.
- Nevertheless, adaptation gives a great chance in forming an integrative approach by its wide range of relevance to remarkable approaches across disciplines, namely in this study are over socio-economic and environmental divisions.

***Table 1*** is a brief summary of the relevant frameworks reviewed and applied for the development of an integrative framework to study the adaptation process through households' livelihood dynamics in the MD and the RRD of Viet Nam.

**Table 1**: Summary of reviewed literature relevant to the research approach

| Reviewed frameworks/ approach | Application in literature | Relevance to the research approach | Limits/gaps to apply to the Vietnamese case studies |
|---|---|---|---|
| **Coupled human-environment systems** | Gallopín (2006); Renaud *et al.* (2010); Damm (2011); Newell *et al.* 2005 | - Offering integrative and cross-sectional approach<br>- Reflecting on the interaction between societal and natural systems and highlighting the human's proactive actions in studying adaptation<br>- Therefore, capturing the complexity of a coupled system<br>- In line with the processual approach to adaptation, cross-scale interactions in adaptation | - Lack of concrete frameworks but rather offering overarching approaches<br>- Given its origin in ecological science, up-to-date applications remain limited inclusion of social components besides |
| **Process model of private proactive adaptation to climate change (MPPACC) by Grothmann & Patt (2005)** | Acosta-Michlik (2005); Schwab (2011) | - Social cognition and decision-making process at the individual household level<br>- Behavioural analysis in studying adaptive behaviours<br>- Social learning process across scales<br>- Psychological dimensions of adaptation | - Focus more on adaptation strategies as outcomes from environmental and climatic perspectives, therefore emphasizing on agricultural livelihoods<br>- The link between vulnerability and adaptation |
| **Integrative framework for vulnerability and adaptation analysis (Garschagen 2014)** | | - Linking vulnerability and adaptation domains<br>- The role of socioeconomic components in adaptation studies<br>- Adaptive capacity<br>- Agency analysis | - Adaptation decision-making process<br>- Interactive linkage between socio-economic and climatic-ecological changes in no-specific, but rather future-forward hazard context<br>- Therefore, missing the adverse impacts of adaptation process (*e.g.* through adjusting household's livelihoods) to (re)generate risks of the accommodating system |
| **Sustainable livelihood framework (DFID 1999)** | Ellis (2000); Smith *et al.* (2013); Vo (2014); and several adaptation-decision case studies | - Adaptation at the micro-level<br>- Household's capitals analysis<br>- Socio-economic component of adaptation | - Relatively discreet from environmental change discourse<br>- Endogenous process of household's decision-making |
| **Theory of planned behaviour (Ajzen 1991)** | WB (2010) | - Application to anticipate the intention and behaviour of future adaptation | - It includes complicated aspects to capture and measure which is very challenging applied to the heterogeneous study population |

*The proposed integrative framework*

Given argumentations to inclusively examine the components impacting the adaptation process at household level, I propose this framework (Figure 3-6) tailored for the case study of coastal areas of the MD and the RRD of Viet Nam as an attempt to bridge the well-developed yet fractured schools of thoughts (comprehensively reflected in the previous sections). The proposed framework is the elaborated version of the research approach demonstrated in the introduction of the dissertation (Figure 3-6). It is framed by identifying the social-ecological environment that facilitates individual human activities. In the scope of this framework, households are the central actors of the adaptive behaviours and actions which are carried out through a cognitive process internally and under the mixed effects of each external factor as well as combined effects of them simultaneously. In other words, the composition of impacts varies from household to household, which could work as either an agent of risk or opportunity depending on the vulnerability profile at the time it is examined. This strong assumption also means the roles of these factors could also be swapped case by case.

This flow of analysis examines the decision-making process of individual households which in accumulation, explains the livelihood shift phenomenon in the studied areas. Terminology-wise in this framework, aquaculture is included in agricultural livelihoods due to the specific context of the MD and the RRD regions that farmers traditionally cultivate both either on separate and the same land plot. Meanwhile, non-agricultural livelihoods include yet extend the definition of Ellis (2000) to count off-farm and nonfarm incomes regardless of where the income-generating activities take place (*i.e.* implemented by members currently living in the households or remittances).

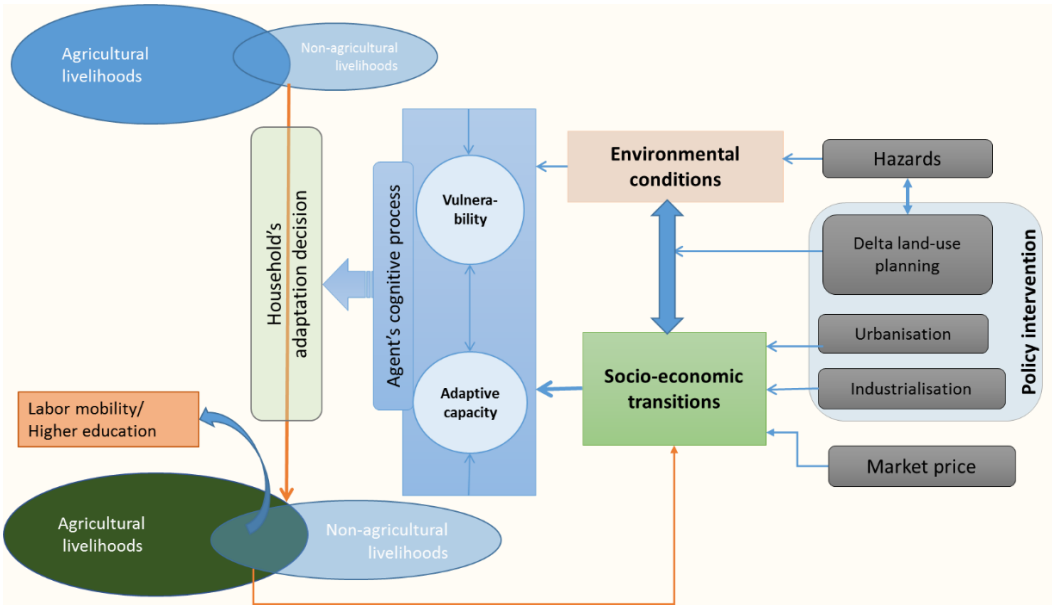



*Figure 3-6: An integrative analytical framework to study the livelihood-change decision-making process of households in rural coastal areas of the MD and the RRD*

*(Source: Own graph, partly inspired by Garschagen (2014), Acosta-Michlik and Espaldon (2008), Grothmann and Patt (2005))*

The decision-making process involves both external and internal processes of all households engaging in any kind of livelihoods with or without shifting in its history (not to change is also a decision). The internal process is indeed a cognitive process that could be explained by adaptive behavioural analysis and determined by their vulnerability profile including the adaptive capacity. The internal interaction between vulnerability profile and adaptive capacity components as well as the agentive factors framing explains how a household perceives, learns and takes adaptive actions as outcomes (see also Garschagen 2014). Similar to many other vulnerability analysing frameworks, a household's adaptive capacity is attributed to its capitals defined according to the Sustainable Livelihoods Framework (SLF) (DFID 1999). In order to understand the mechanism from the heuristic phase to actions in the decision-making process of households, the cognitive and behavioural analysing domain of the framework is largely employed from the framework of Grothmann and Patt (2005) and the advanced application of Acosta-Michlik (2008). While, as aforementioned, it is agreeable that the framework contains tricky aspects (e.g. in terms of measurement), these are inevitable dimensions in understanding the decision-making process. Parameterizing the household's cognitive process through such behaviours as learning, income maximization, imitation, repetition and risk-perception could accommodate the application of behavioural analysis. In short, this domain of the framework is basically developed in line with existing theories and conceptual framing across disciplines of vulnerability, adaptation and cognitive sciences.

On the contrary, external factors are more contextualized. Market price, in most cases, shows an explicit impact on the changes happening on the ground; the case study of the rapid spreading of shrimp farming in the majority of coastal villages in the MD and in areas locating right outside the sea dike in the RRD is a typical example. However, from a systematic and long-term point of view, policy intervention plays the most critical role. Market price fluctuation, in fact, highly interact with policy factor, for instance, the government has been putting control over rice price as a part of the rice-first policy in over three decades since the nation's reunion regardless of its market-orientation strategy. Moreover, given the political context in Vietnam, such factors as industrialization and urbanization closely link to the role of government in either pushing these processes in some districts or delaying in others, even regardless of their proximity to primary cities[8]. Moving away from household level to a more macro discussion, the framing of cross-scale interaction discussed in the theoretical part above could be well transferred into this context where it could explain well the interplay between the key factors and stakeholders as the momentum for collective adjustments of the system.

[8] A five-level classification is applied for Vietnamese urban areas basing on a set of criteria (e.g. population density, infrastructure development, GDP, *etc.*); there are: (1) Level I-city: primary (or national) level (only 5 cities in the whole country including the capital); (2) Level II-city: secondary (or provincial) level (mostly seen as the urban centre of a sub-region) ; (3) III, IV, V: towns or smaller (Resolution No. 1210/2016/UBTVQH13).

In order to guide the empirical data analysis, the framework could also be formed as a function of determinants to the household's decision to change their livelihoods as they interact with their social-ecological environment (Figure 3-7). The decision to change (or not to change) the livelihood strategy of a *household i* at the time *t* depends on how they are affected by policy intervention applied at their locals, climatic risks and variation, market drivers, household capitals (as defined in the aforementioned SLF), the social learning process of household, yet also other unobserved variables. This format manifests the relationships between the key components. Examples are displayed on arrows indicating how they relate by pairs. The break-downs of these components into variables used for survey data analysis are presented in the coming chapters on methodology and empirical results.

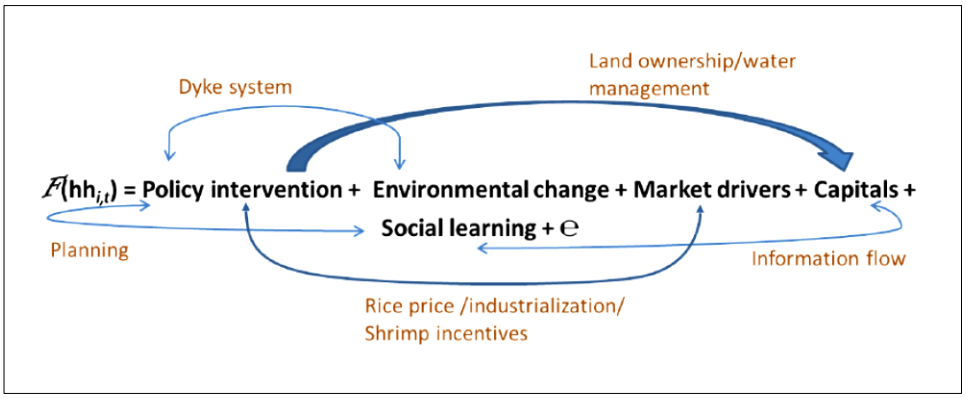



*Figure 3-7: Key components of determinants to household's livelihood-change decision making, illustrated from the integrative framework*

*Main advantages* of the proposed integrative framework to study adaptation in the context of Vietnamese deltas are:

1) An exploratory approach with livelihood changes at the household level at the starting point; therefore, it offers a less bias approach caused by either sticking to a hazard-specific context or emphasizing agricultural shifts versus climatic and environmental changes (which is mostly the case in the rural research context).
2) As a result, the balance in considering agriculture and non-agriculture livelihoods of rural households ensures covering the complex impacts of climatic and non-climatic factors which have been long called yet there is still a lacuna of application outcomes.
3) Explicitly for the context of Vietnam in general and the dynamic MD and RRD in particular, the framework is aimed to capture the most fundamental socio-economic transitions besides and in addition to the strong changes on farmers' land, namely marketization, industrialization, urbanization as well as the universalization of high-to-higher education. Meanwhile, it purposely emphasizes the manoeuvring role of policy interventions through-out the analysis of these dynamics which is not only immensely true in the context of the Vietnamese government but also transferable to the wider discussion of large-scale adaptation measures globally.

4) Furthermore, by including the endogenous mechanism in explaining the adaptation process, this framework forms a foundation for the designing of future studies. For instance, it enables future-forward-looking methodology such as simulation exercises which gives the potentials to get beyond explaining observable phenomena and current risks towards investigating the future potential risk context and anticipate societal transformation.

Given those merits, the framework is useful for the construction of interdisciplinary research, particularly those in the strands of adaptation study. Nevertheless, it is aimed to be left open for contextualising adjustments, thus to minimise the application of abstract concepts. It is, therefore, rather purposefully set to the limit of the research's case study while making a contribution to the progress of the interdisciplinary literature.

# 4. METHODOLOGY AND DATA

## 4.1. A mixed method approach

Due to the recognisable rise of the relatively new yet rather advanced school of the mixed methodology, it is employed from the preliminary phases of brainstorming and designing to the data analysing stage of this study in order to achieve the research objectives through producing validated and rigour results.

A choice of method represents the epistemological stance of a researcher. Mixed methods have been being underpinned by the community of social scientists, thus getting more popular in the last few decades. Morse and Niehause (2009:9) defined: "Mixed method research is, therefore, a systematic way of using two or more research methods to answer a single question. It includes using two (or more) qualitative or quantitative methods or it uses both qualitative and quantitative methods". By this choice, the researchers position themselves in the middle of the two trends. More precisely, they stand at the meeting point of these two separate methods, yet could still decide the prioritised method between the two in their research design depending on its specific objectives and characteristics (Morse & Niehause 2009). That is the position where researchers are inspired by both questions of 'what' and 'what if' from a quantitative approach, as much as 'how' and 'why' in a qualitative perspective when looking into a phenomenon of interest. Therefore, in a good way, more consensus than debates have been made on the advantages of moving towards this stance when making a research method choice because they, in integration, more likely complement than conflict with each other, both in terms of strengths and weaknesses (Bamberger 2000). Nevertheless, the approach faces harsh critiques on how actual this integration on an operational level. There are doubts if this mixture indeed "is only at a superficial level and within a single paradigm" (Bryman 2004). To a certain extent, promoting without a proper follow-up evaluation scheme has reasonably raised concerns among research communities. Therefore, this dissertation takes into account carefully those drawbacks in defining and framing the mixed methods.

In regards to research design, this study has the advantage of being a part of the collective efforts of the broader project DeltAdapt (see Footnote 2). Partly basing on the result of the collective knowledge of this project, a set of mixed methods was developed facilitated by a pre-visit and an intensive fieldwork. The mixed set of qualitative and quantitative methods is applied both in data collection and data analysis.

In the first phase - desk review, the findings of participatory rural appraisal (PRA) activities by project partners together with primary findings from interviews (with officers, experts, and farmers) as well as focused group discussions (FDGs) with local government officers conducted during the pre-visit fieldwork combined and cross-checked in order to develop the second phase of data collection (see Appendix 10.1). The pre-visit took place early in the first stage of this research. Therefore, a sound understanding of background and issues

of interest as well as a generous time budget was allocated for the preparation and improvement of the methods toolkit used for the extensive household data collection in the second phase of the research. Moreover, during two field-works conducted during the course of twelve months, complementary qualitative and secondary data collection activities were carried out in parallel to triangulate selected methods and research's preliminary findings. To deal with the diversity of the multiple case studies set-up in this research, a consistent set of methods was applied for all case studies according to the parallel sampling approach and allow their compatibility in analyses (Onwuegbuzie & Collins 2007, Pardoe 2016). This process is synchronised and illustrated in Figure 4-2.

## 4.2. Unit of analysis

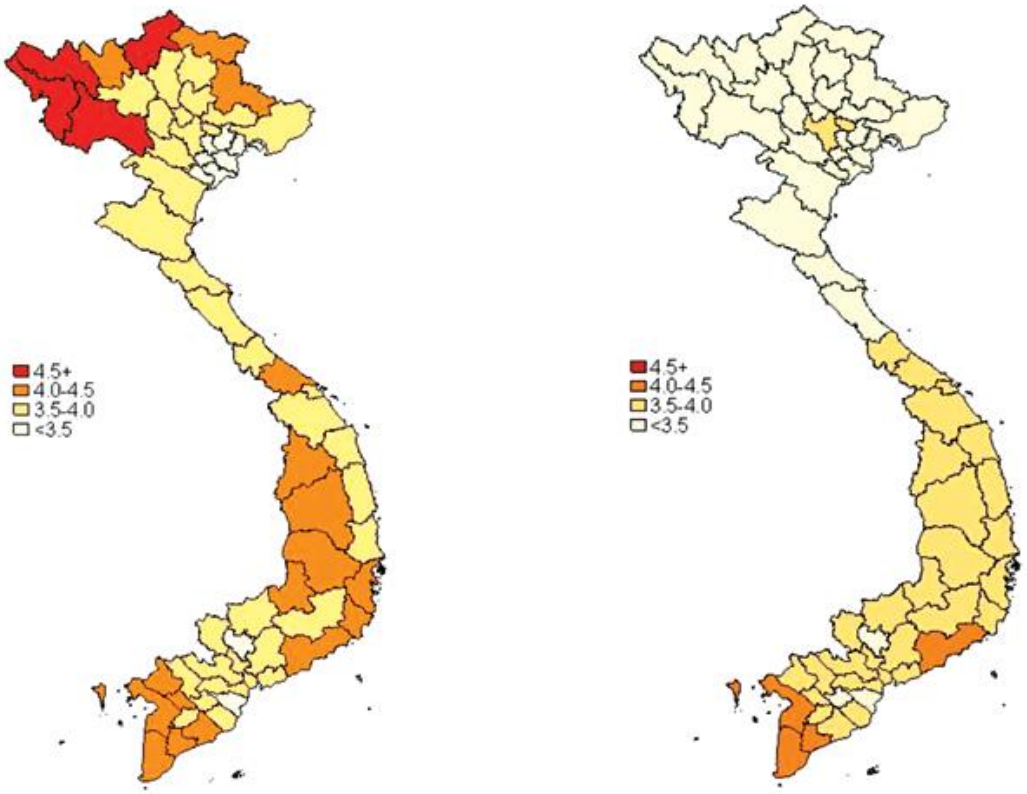
Setting the boundary and the focused level of analysis is the basic element of scientific research. A unit of analysis is defined as a subject – either '*what'* or '*who'* – on which analyses are generalised, thus could be different from the unit of observation (Lewis-Beck *et al.* 2004). It could vary from the most micro one (which is an individual in social sciences) up to a system that includes many sub-systems. In most of the cases, these levels interlink and thus could overlap and cause confusion in analysing (Long in Lewis-Beck *et al.* 2004).

Household is the principal unit of analysis applied in this research. The main analysis is generalised on the core database originally collected through the standardised household survey. However, a significant level of analysis is also made on different scales as well as crossing all levels from individuals up to the social-ecological system. This does not only ensure a more comprehensive approach to such a large and spreading research context, but also facilitate a substantial triangulation process of results. In a more strategic framing, while findings at the household level allow identifying the vulnerable groups to be targeted, the cross-scale analysis provides a sound background for potential policy implications arguments. A more in-depth analysis of the cross-scale analysis theoretical background is provided in Section 3.1.3.

There is no standardised definition of the household unit in the research community but rather varying across projects of different themes and contexts. This practice results in the variation of household composition as well as household size applications. Even within a specific research context, a household's arrangement changes over time (Deaton 1997, Beaman & Dillon 2011). Therefore, ensuring consistency in understanding since the designing phase and during the data collecting process (*i.e.* enumerators training and survey quality control) is critical to the quality of data.

In the Vietnamese context, according to the GSO, the definition applied for collecting data for the national database, particularly the census "Viet Nam household living standards survey" conducted every ten years, "[H]ousehold (or family household) is a person or a group of people living together" (GSO 2016). Although it is also stated in the report that this definition is not necessarily in line with several other research which is commonly

dominantly based on the legal household registration book[9], yet it could be referred to when establishing the definition used in this research. The latest census data collected in the year 2009 (GSO 2010) shows a decreasing tendency of household size and substantial difference between urban and rural areas (see Figure 4-1). These trends are reflected quite well in the empirical data (more details in Chapter 5).




**Average household size, Viet Nam 2009** **Average urban household size, Viet Nam 2009**

*Figure 4-1: Average household size by provincial level and for urban areas in Viet Nam, 2009*
(Source: GSO, *Census on Population and Housing 2009:81* )

The definition of a household in this research shares the same approach in which the membership is not identified by the legal registration book, *i.e. de jure*, but based on the *de facto* situation of that family (confirmed by respondents). Accordingly, household leadership and membership are defined based on the actual internal agreement among family members. Explicitly, a household does not only include people those are currently present at home, members that are temporarily (or more precisely non-permanently) living in other localities, yet remaining regular connections in terms of time, income contribution and closest members (*e.g.* spouse, parenthood) with the interviewed household are also counted in the household size. A definition of "extended household size" is also applied

[9] Household registration book (*sổ hộ khẩu* in Vietnamese) is the main management instrument (public security, economic planning, and control of migration) in the household registration system in Vietnam for more than 50 years (World Bank 2016). There have been many critiques raised on the pragmatism as well as many sequential social issues (*e.g.* discrimination to migrants in big cities) of this system; yet the debates are still on-going. Independent (including international) organizations such as World Bank and UN also contribute to addressing this issue.

where former family members who at one point in the past (regardless when) moved out to establish their own family; of which in most of the cases it happens after the marriage of household head's children. This data is expected to provide more information about social capital at the household level. Further intuition and application of this variable could be found in empirical analysis sections. Moreover, a certain variation of household composition between regions of Viet Nam, particularly between the Northern and Southern parts, is also discussed in the literature (Bryant 1996). Therefore, having a consistent definition and approach across large research areas is critical to a valid method. The questionnaire for the standardised survey was therefore designed accordingly.

The data pool is retrieved from the household survey, analysis at the household level is indeed generalised on the information from individual interviews. Deaton (1997) also discussed the issue of measurements at individual level versus household level and the importance to make the data available for better assessment. Related to a decision-making analysis, (Grossbard 2011) also discusses between independent individual models of decision-making and of joint decision-making in households whose views were taken into consideration in the research design.

In order to control for the bias and ensure the relevance between individual data of respondents and data at the household level, certain selection criteria with attention on respondents' representativeness are associated with the stratified sampling technique. In other words, not only the household characteristics, such as main livelihood/occupation, geographical locations, but also individual characteristics of respondents, including female versus male, age, role in the household are considered for proportional sampling. Therefore, the information provided by respondents could represent the household. In this way, the potential bias of data is controlled with the selection process.

## 4.3. Methodology overview

Figure 4-2 gives an overview of the flow of the methods of this research including two phases of data collection and steps of data analysis. The different methods applied to reflect the type of data and the most appropriate analysis for each research question or sub-question. In the multivariate analysis block, the classification and determinants analysis are used for explaining historical and current changes (RQ1), meanwhile, regression analysis applied on the empirical scenario-based data is used for a future study (RQ2).

Also as mentioned earlier, the main data source used for empirical analysis is from the two stages of data collection: (i) Exploratory phase with transect walks, unstructured and group interviews; and (ii) Household survey in both deltas (N=850). However, in each step of the analysis for analysis-based inference, these types of data which also imply a mixture of qualitative and quantitative data, are used in parallel for cross-validation.

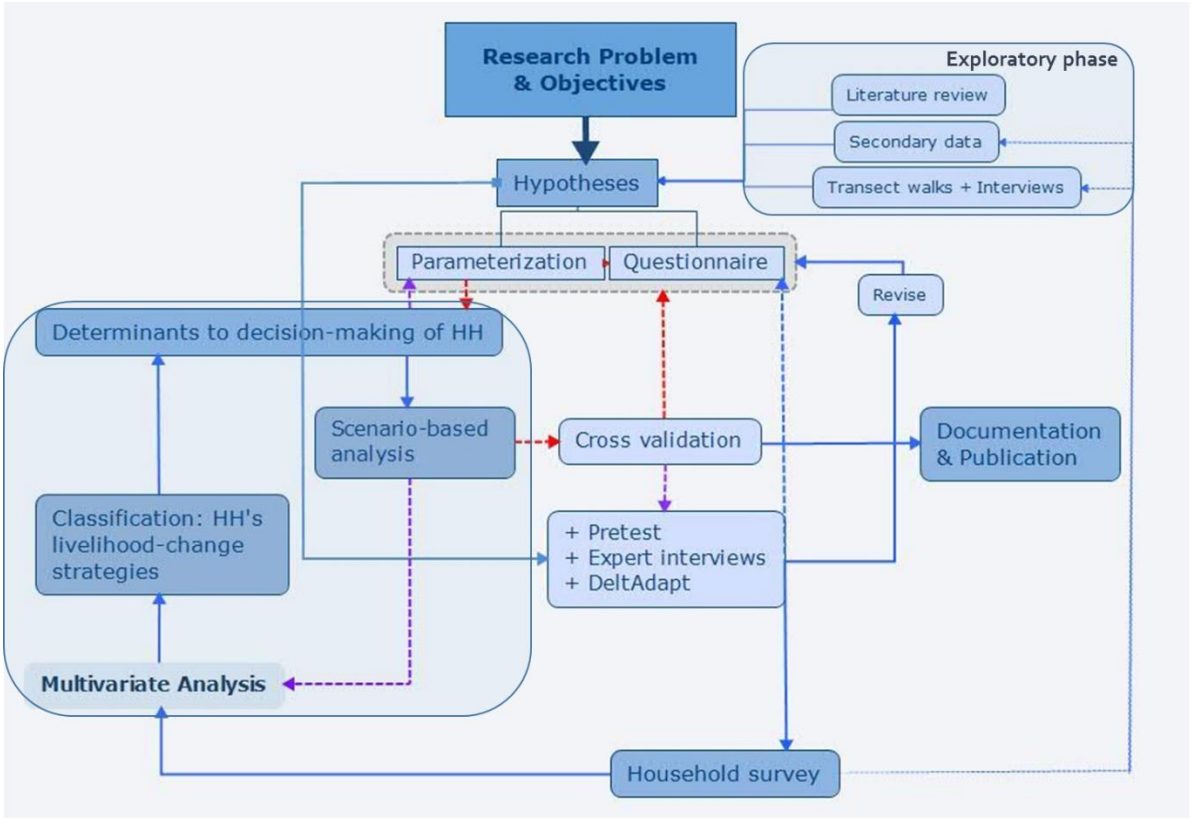



*Figure 4-2: Overview of the research methodology*

(Legends: solid blue arrows indicate the main flow; dashed blue arrows indicate feedback; dashed violet arrows indicate complimentary validation; dashed red arrows indicate constant validation through the process)

The following sub-sections describe further the main components if this research flow including the research sites, data collection methods, data analysis techniques and the first glance on data. Nevertheless, a detailed explanation of the methods applied in response to each specific objective of the dissertation is found in the two main empirical chapters (5 and 6). Their relevance, as well as merits and challenges, is aimed to make a smooth transfer into the results, findings, and discussions.

## 4.4. Case study selection

### 4.4.1. Selection criteria

The task and the first outcome of the exploratory phase is to identify the focused areas of research and a proper studied population size. Given the large geographical coverage of this study research, let alone their diversity and complexity, the sampling did not aim to fulfil the rule on representative sample size[10] as widely agreed among statisticians. Besides, the quantitative methods applied in this study are not used for generalisation (more in detail in Section 4.3) which allows certain relaxation of this rule. As a result, the sample size is likely to reflect the diversity across and also within (sub-)regions as well as relatively

[10] There is no simple rule to determine a proper sample size of a research, yet it rather depends on the research's objectives to determine a reliable sample. Definition of a representative sample could be found in Lewis-beck *et al.* (2004), and how to calculate the sample size for quantitative research in Levy and Lemeshow (2008).

ensuring the balance between the two deltas, *i.e.* the number of provinces, total areas, ecological set-up, *etc*. Among various proxies to be considered in selecting research sites, I prioritise a set of four criteria to minimise the selection bias as well as remain in line with the whole project which is: (i) locating in very coastal areas of the two deltas; consequently, (ii) the coverage should be able to reflect the salinity gradients from the coastline to further inland; (iii) naturally covering the transect of the main coastal farming systems; (iv) last but not least, proximity to urban areas; in other words, urbanization gradients are considered for a more comprehensive picture of these deltaic sub-regions. These criteria are adapted to the context of each delta, yet in principle, meet the research objectives and confirm their compatibility as looking into details.

### *Proximity to coast and salinity gradients*

The tidal scheme is a relevant characteristic for consideration as studying coastal areas, particularly on subjects related to salinity issues. Although most of Viet Nam border the East Sea (or widely known as the South China Sea[11]) to the East, the MD is a peninsula which also borders the Gulf of Thailand in the West with 250km length of coastline. This West Sea has a different tidal system than the East Sea. It is the semi-diurnal on the East coast, which means in 24 hours, there are two troughs and also two peaks of tides with varied height. Meanwhile, the West coast is dominated by the diurnal system in which a peak and a trough appear only within 24 hours with much lower average height than on the East coast (SIWRR (2005) in Phan (2012)). Although in reality, this distinction is not evitable in daily life activities, it is worth being considered in order to comprehend the whole coastal zone of this delta. For this reason, Kiên Giang province was selected as it, together with Cà Mau, are the only two provinces that face the Gulf of Thailand and could provide a similar transect with other research provinces.

Another relevant point to be discussed is the coast's structure. Although the transect presented here reflects the most common scene to be found on research sites, the coastline in each delta is complex as found at every other delta in the world. It normally shows the contrast situations of either erosion or deposition within a few hundred kilometres of coastline (Finkl 2004). For the household survey, this complexity is addressed by spreading the sites geographically along the coastline of the two deltas to cover as much of the structure as possible. Figure 4-3 showcases the diverse landscape outside the sea dikes across two provinces Nam Định and Hải Phòng in the RRD. For the case in the MD, some research shows the negative link between the engineering constructions (*e.g.* sea dikes) and the coastal erosion (Phan 2012).

[11] South China Sea is a disputed water area. Among these debates, Vietnamese has been long running a campaign on change.org to change the name from "South China Sea" as has been being used widely on global maps to "East Vietnam Sea" or "Vietnam Sea" or also "Southeast Asia Sea". This research takes a stand on this issue by supporting using the name "East Sea" - *Biển Đông* in Vietnamese which is the only official name used in all Vietnamese documents.


*Figure 4-3: Different landscapes at sea dykes in the RRD*

Legend: (a) concrete dike without mangrove outside of the dike, with erosion problem, at Giao Phong commune, Nam Định province; (b) concrete dike with mangrove and clamp farming outside the dike, at Giao Xuan commune, Nam Định province; and (c) semi-concrete dike with mangrove and shrimp farming outside the dike, at Vinh Quang commune, Hải Phòng province. *(Source:* Map by Google Earth; pictures by author*)*

As said, the three provinces selected in the MD namely Tiền Giang, Sóc Trăng and Kiên Giang share quite similar transects which are divided into three main zones along salinity gradients, *i.e.* from the coastline to further inland are: saline water zone, fresh-saline water rotation zone (with up to 6 months saline water a year), and freshwater zone. The main farm productions are mono-rice and/or vegetable or orchards (in freshwater areas), rotation between rice and shrimp or other saline-water aquaculture in the middle zone, and the same types of aquaculture, mainly shrimp (including white-leg and black-tiger shrimps) in the very coastal villages where farmers nowadays control their sluice gates to keep saline water inside the dike whole year around. More details of the transect of each province are provided in Section 5.2 since they link closely with the empirical analysis.

In two provinces of the RRD - Nam Định and Hải Phòng, the vast majority of households are rice or vegetable farmers owing to the fact that this triangular-shaped delta is protected from the seawater by the thousand-year-old sea dike system. Saline-water aquaculture has appeared more recently either outside the dike (Hải Phòng) or even started roughly within one kilometre from the dike to further inland (in Nam Định). This occurrence is also found in one of the few studies on salinity issues in the RRD by Nguyen and her colleagues (2017) recently where measurement shows salinity concentration is higher in the field closer to the dike. Fresh-water aquaculture of traditional fish types is also found in some researched villages yet remains at the small farming scale and for self-consumption rather than a farming business.

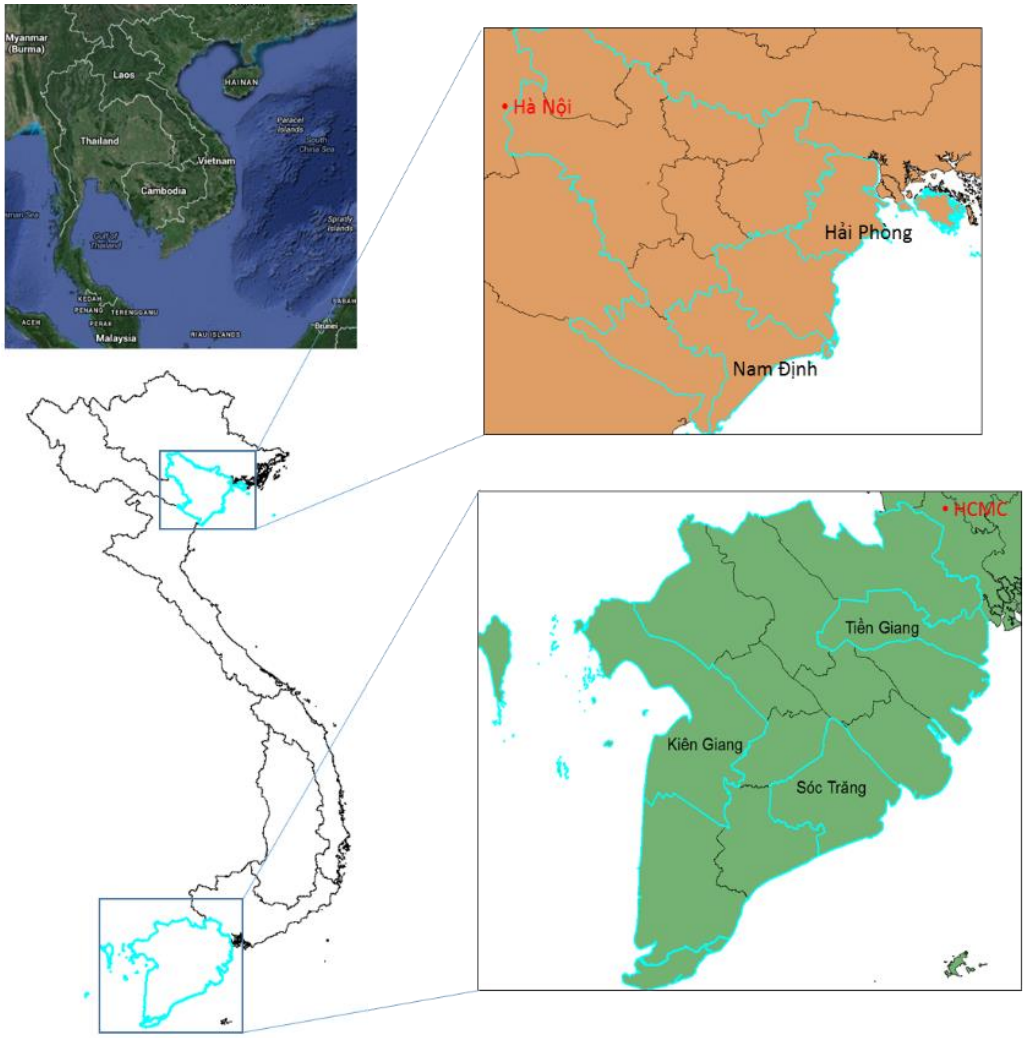



*Figure 4-4: Research areas in the RRD (2 provinces) and the MD (3 provinces)*

### *Urban proximity*

Tiền Giang is closest to HCMC among the three MD provinces (see Figure 4-4) and Hải Phòng is the most urbanised province of all studied provinces. Hải Phòng city – the urban centre of the province is a national primary city (see Footnote 8) with the second biggest seaport in the country. Unsurprisingly, this proximity is reflected in labour mobility data of households in roughly the last decade. The provincial net migration rate in the last ten years (Figure 4-5) though fluctuates through time, it is pretty obvious that Hải Phòng has the highest and positive rate of in-migration, higher than the RRD regional average; and Sóc Trăng and Kiên Giang mostly remain negative and lowest - lower than the MD regional average (GSO 2016). Interestingly, given the development of transportation veins in both deltas, and consequently the rise of transportation services as a lucrative business since the past few decades (Hoang *et al.* 2008), it shows the tendency that people from remoter provinces, particularly An Minh district of Kiên Giang province, are increasingly moving out. From a more macro discussion, this, together with local industrialization orientation, could imply rural-urban mobility yet at a more local or regional level (*i.e.* intra-region and intra-province) rather than national or trans-border (Junge *et al.* 2015).

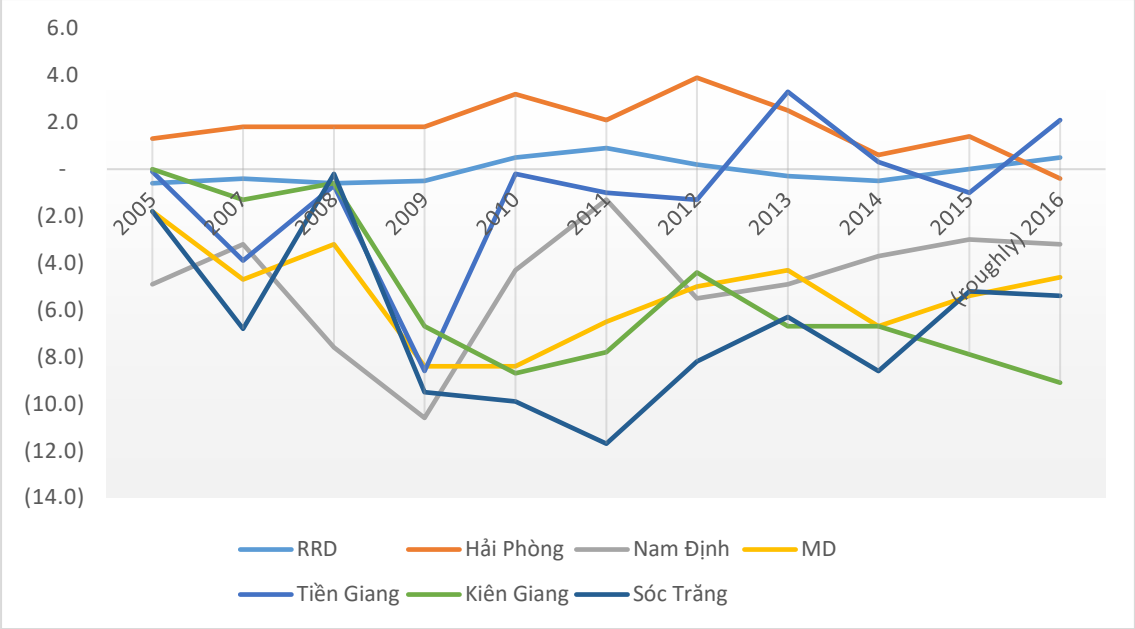



*Figure 4-5: Net migration of researched provinces in the MD and the RRD*
(Data source: GSO 2017)

In reality of the research context, due to the rather medium scale of these Vietnamese deltas, especially taking into consideration the modest size of the province as the main administrative unit, the difference in distance to urban centres among the selected sites are not substantially large. However, given the limited development of infrastructure systems until a couple of decades ago, this difference is objectively indicative to a certain extent in studying the historical impacts of changes in the rural-urban linkage.

### *Main groups of occupations*

As mentioned in the sampling technique, ensuring covering all main occupation groups within a village is an important step in selecting the households to be included in the survey. This kind of information is provided by village leaders, yet later discussed and confirmed by local guides (in the case they were different persons). Therefore, although the farmer group remains dominant in the household survey, other groups of villagers are included proportionally in line with the structure of village's population, namely fishers, retailers, self-employers, daily workers (including working on the field as well as other areas like constructions, farm-products processing). This also means that the landless group is covered by the survey and in a proportion that could represent the population at the village to commune level.

In the trend of rural livelihoods diversification which is generally discussed in previous sections (see Section 2.2.2), the same types of non-farm income sources could be found across all researched villages yet to different extents including self-employment, informal small trading activities, as well as wage jobs in industrial firms either nearby their villages (found in the RRD rather than in the MD), but more often in urban and suburban areas, and other urban-based economic activities either seasonal or long-term. In-depth interviews

and discussions with local officers, together with the day-to-day involvement of village leaders during the household survey were the main basis for identifying and proportionally selecting the sample to capture the main livelihoods of households representing in those villages. In both deltas, a sample of fishers is included in the survey to ensure the heterogeneity of typical groups in coastal regions.

### 4.4.2. Research sites

The following sub-sections portrait the overall picture of each province and particularly district which serves as the background before going into further details at community and household level which is the focused analysis unit of this research. The background information of this level is more pragmatic due to a large number of communes and villages covered by the research, as well as the availability of secondary data and for the purpose of cross-scale interpretation of results. In this sub-section, the background information at the provincial level and on the studied districts is provided on the specific characteristics related to socio-economic development as well as natural conditions (where applicable that goes beyond the information available at delta level as in Section 2.2.1.), besides their basic geographical and demographic attributes.

#### *The Mekong Delta: Tiền Giang, Sóc Trăng and Kiên Giang provinces*

The studied provinces, districts, and communes in the MD are illustrated in Figure 4-6.

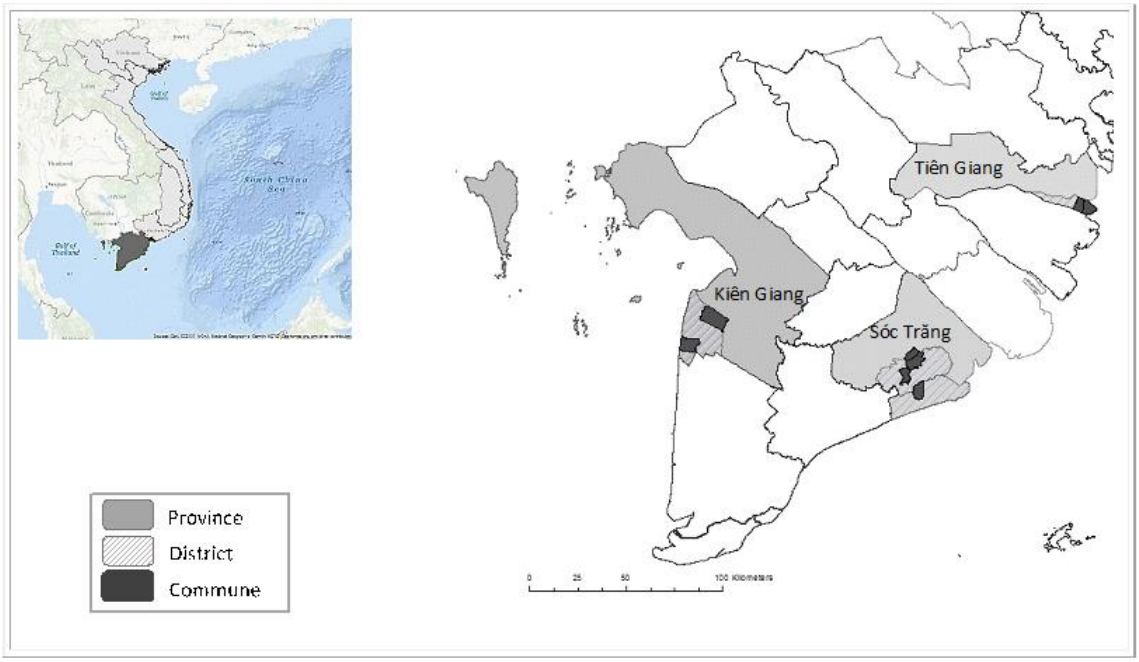



*Figure 4-6: Study sites in the MD*

*Tiền Giang* province locates to the North of the MD which also means that it is closer to not only Hồ Chí Minh City (HCMC) – the principal urban centre of the Southern Viet Nam, but also the largest industrial parks of the country – the South-East region. With the population of 1.751 million people on an area of 2510km$^2$, the population density in Tiền Giang is

higher than the average density of the MD (698 persons/km$^2$ comparing to 435/km$^2$) (GSO 2017). From a historical perspective, as the 'invasion' to the delta went South-ward during decades, particularly strongly since the French colonial time in the twentieth century (Biggs 2012) this province undergoes a longer and more diverse development process comparing to other provinces in the MD.

Tân Phú Đông (TPĐ) district of Tiền Giang province is a new administrative unit established since 2008 by merging two parts from two other districts of Tiền Giang province (Gò Công Đông and Gò Công Tây). However, this administrative change in the province's history of development does not affect this research's scope and objectives, particularly the empirical data at the household level. TPĐ district is an island located to the south of this province. Due to the strong development of the infrastructure system in the MD in recent years, this district is getting closer to HCMC, particularly since the effectiveness of Mỹ Lợi bridge (in 2015) that cut down the distance to one-third of before[12] which is among the main criteria for this district to be selected. Currently, there are six communes in TPĐ district of which the two most coastal ones are covered in the research: Phú Đông and Phú Tân.

*Sóc Trăng* has an average population of 1.314 million on a total area of 3,311 km$^2$ (GSO 2017). This is the only province that has two districts covered by this research because the main coastal farming systems spread on a longer transect. Therefore, in order to ensure the compatibility with other selected provinces (more details in Section 5.2 ), the survey was extended from *Vĩnh Châu* (a very coastal) district that is typical for land conversion to mono-shrimp farming to *Mỹ Xuyên* district – where both rice-shrimp rotations, mono-rice as well as annual crops vegetation and their combination are found. Apart from shrimp farming, Vĩnh Châu has a few other popular agricultural productions nationally such as purple shallots.

In Sóc Trăng, agriculture contributes the most (50% by 2010) to the province's total production and maintaining the income level of the resident. However, agricultural land particularly rice fields has the tendency to decrease since the last decade (Sóc Trăng PPC, 2010). Mỹ Xuyên and Vĩnh Châu are among the districts that are observed with the most dynamic land-use change toward aquaculture since the early 2000s (Tri *et al.* 2008).

Among the three studied provinces of the MD, Sóc Trăng is the closest to Cần Thơ, the urban centre of the delta (62km). It has borders with several other provinces and crossed by the national highway (named 1A). Therefore, the province is quite connected with the rest of the region. Between the two studied districts, Mỹ Xuyên takes advantage better in this respect. Meanwhile, Vĩnh Châu takes a large part of the 72km long coastline of the province.

There are three big estuaries in Sóc Trăng, yet the province is faced with increasing erosion along the coast. However, this hazard is mainly recorded in an island district. The studied

[12] Retrieved from tuoitre.vn 26/08/2015, accessed 25/11/2019

village *Vĩnh Hiệp* of the coastal district Vĩnh Châu does not locate by the coastline, thus has no record related to this risk. Vĩnh Châu also has mangrove forests outside of a semi-concrete sea dike which has gained increasing attention to preserve and restore as an important adaptation measure to climate change (IUCN 2013).

*Kiên Giang* spreads on a total area of 6,348.7km$^2$ with an average population of 1.792 million people (GSO 2017). The province includes 2 main urban centres and 13 districts. This is the only province of Viet Nam that completely faces the Gulf of Thailand (see 4.2.1.), or in other words, it bears different characteristics in terms of tidal and wind mechanism, as well as ocean resources particularly for fishing and tourism. Given the design of the DeltAdapt project (see Footnote 2) to investigate the impact of salinity intrusion on the changes of the region, *An Minh* district of this province provides a very similar transect with other sites in MD with slightly different environmental conditions as facing the West Sea rather than the East Sea. The difference among its communes regarding the topics of concern, however, is insignificant. At a province, Kiên Giang contributes more importantly to the aquaculture production of the country rather than agriculture. However, it does not sharply distinguish the province from the other provinces, thus being compatible with other selected sites.

The tidal mechanism of the Gulf of Thailand might also have an impact on the semi-natural shrimp cultivation technique which is based on the tidal water flow to exchange water from ponds and simultaneously harvest the shrimp while exchanging water. Nevertheless, there is no major difference between this area with the rest of the coastal areas of the MD in regards to the structure of agrarian systems, temperature, rainfall, and seasonal system.

Together with Cà Mau province, it is the most remote province of the MD. However, thanks to the rapid development of the transportation infrastructure in the last decade (Hoang *et al.* 2008), the transaction cost is being cut down which helps to boost economic activities including the labour mobility in and out of the province. In addition, it borders with Cambodia and the rich natural resources particularly from the Gulf of Thailand in terms of fishing and tourism are the economic advantages of the province; therefore, the local authority tends to favour shifting towards services from other productions (Kiên Giang PPC 2017, 2019). As a province, it has specific conditions for economic development. Kiên Giang's provincial GDP growth rate by 2018 is higher than the national average rate (Kiên Giang PPC 2018, GSO).

Although in general, the provincial authority strongly focuses on the aquaculture production, *An Minh* district is, in particular, relevant for the research since it has the relative strength of agriculture production which accounts for 92.12% of the district's total areas of cultivation (An Minh DPC 2012). The main fresh-water source of the province is from Bassac River through the long-history developed channel system and from rainfall. The channel system is not only important in terms of irrigation and providing water for all-

purpose usage, but also serves as the transportation system which was vital in the past and still critical nowadays to this remote region, particularly during the dry season (Poelma 2018, JICA 2013).

### *The Red River Delta: Nam Định and Hải Phòng provinces*

Figure 4-7 is the illustration of the studied provinces, districts, and communes in the RRD.

*Nam Định* province is located in the South of the RRD. The total area of NĐ is 1,651km$^2$ with an average population of 1,830 thousand. The province includes 9 districts and 1 city – Nam Định city which is the provincial urban centre (Nam Định PPC 2014). Giao Thủy district lies at the river mouth of the Red River when it reaches the Gulf of Tonkin. Half of the district's 72-kilometre long coastline is covered by the mangrove forest developing outside of the concrete close sea dike of the whole RRD, extended to the North central coast.

Due to the fact that the RRD is rather concentrated and urbanised, although located at the Southern end of the delta, Nam Định is solely 90km away from Hà Nội capital and Hải Phòng seaport. Besides, the development of the highway system in the last couple of years has facilitated the more intensive transaction between the province and region's urban centres (IDCJ 2003).

*Giao Thủy* is a coastal district of Nam Định province which takes almost half of its coastline. It locates at the Red River mouth to the Gulf of Tonkin, thus covered by both river dike and sea dike system. The 32 km long coast of this district is very dynamic in terms of landscape as well as economic development such as protected mangrove forest (which is also a preserved area exploited for tourism activities), aquaculture (mainly clamp farms), fishing and tourist beach. Together with the advantages of having both river and road transportation systems, as the district level, Giao Thủy has a relatively balanced economic structure between agriculture, aquaculture and services, and industries. As reported by the DPC by 2015, agriculture and aquaculture account for 38.3% of the district's economic structure, while it is 20.1% and 41.6% from industries – construction and services respectively.

Two selected communes in Giao Thủy district are Giao Xuân – located to the North of the district which is typical for rice production, but also some salinity-affected areas and aquaculture outside of the sea dike (either shrimp or clamp farming); and Giao Phong in the South of the district which is typical for the cultivation of other types of annual or bi-annual crops (mainly vegetable) with also an area of aquaculture inside the sea dike and quite close to the sandy soil based annual crops field.

*Hải Phòng* province itself also includes the second biggest urban centre of the RRD – Hải Phòng city which is one of the only five primary cities (see Footnote 8) of the country that has been early developed due to the importance of the seaport located in the city. Therefore, the province has a higher population density than the average of the RRD (1,279

persons/km$^2$ to 1,004 persons/km$^2$). It covers 1,561km$^2$ of the Northern part of the RRD with more diverse topography and higher average elevation (at the provincial scale) than other provinces in the delta.

*Tiên Lãng* district is selected since it is the most rural district with a coastline. Either other coastal districts are rather urbanised, or other rural districts do not border the Gulf of Tonkin. Even though, this is the only district included in the survey that actually has some industrial sites with foreign-invested firms, mainly shoes and textiles production firms located within the district where a number of households interviewed reported sending their labours to work there recently. Although the district is among the furthest from provincial urban centres, this could still be explained by the proximity to Hải Phòng harbour and city, in other words, the lower transaction cost and the local labour abundant have attracted the foreign investment flows (IDCJ 2003).

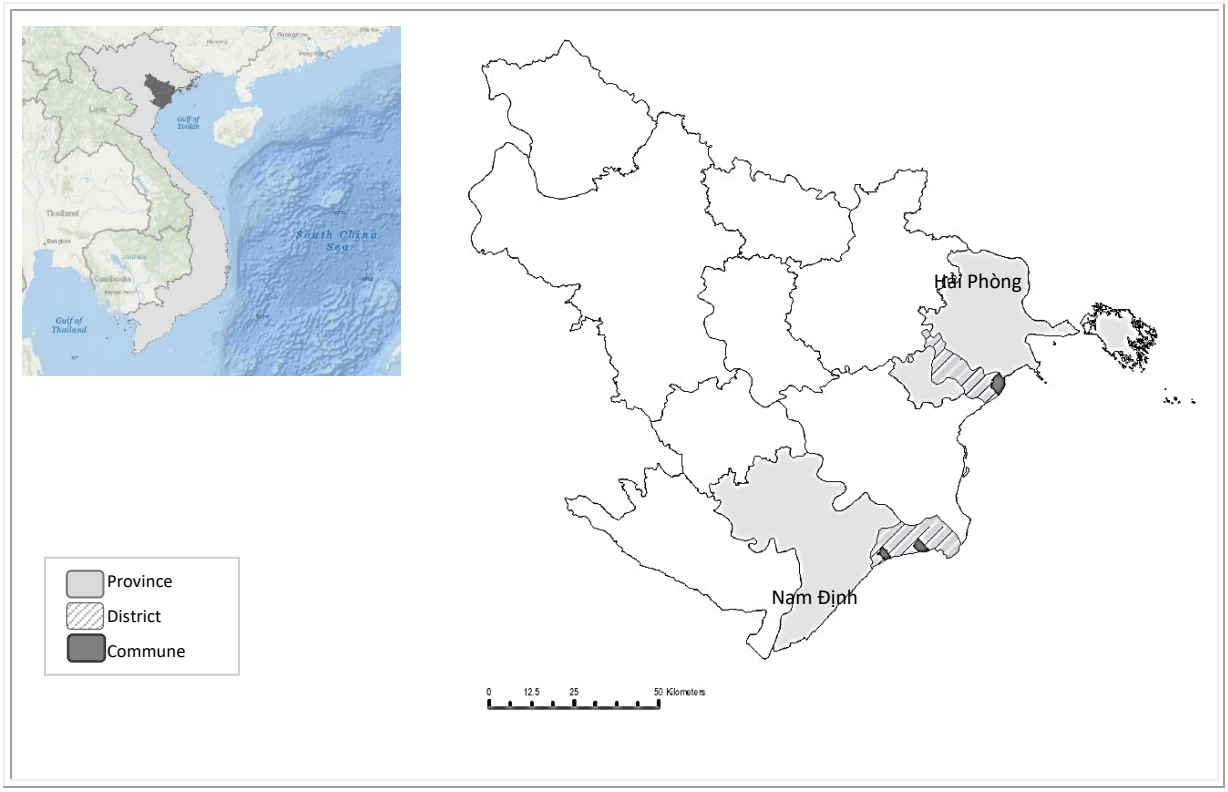



*Figure 4-7: Study sites in the RRD*

These dynamics of these deltaic regions are projected to be enhanced in the short-to-medium term where the contributions and also the share of land-use for agricultural activities will decrease and make place for other sectors. As an underlined note, despite the relevance and interest of this research design, it is no doubt that certain challenges need to be aware of when including the two major deltas in one study. The insights on specific cultural characteristics and farmers' perception as having been well acknowledged and analysed by the literature of various disciplines are important to be elicited in the specific context of the study sites. Moreover, these aspects need to be transparently discussed when analysing cognitive process at the micro-level. The distinguishing biophysical

conditions relating to the sea dike system in the RRD, and also deltas' history of evolvement make a substantial difference between their landscapes. However, this dissertation argues that the needs to capture the heterogeneity and future diagnostics of these regions deserve more research efforts providing that the disparities are handled with care to avoid bias in concluding.

## 4.5. Data collection

As this study aims at collecting and analysing the primary data to understand the adaptation dynamics through its details at an individual level, an intensive household survey with a sample of 850 households almost evenly distributed in five provinces of the MD and the RRD remains at the core of the data collection. The five provinces include two ones in the RRD (Nam Định and Hải Phòng) and three ones in the MD (Tiền Giang, Sóc Trăng, and Kiên Giang) (see Figure 4-3) and all together are six districts (each district in each province, except for Sóc Trăng of which two districts were included), 11 communes, 21 villages. The sites intentionally cover the main agrarian systems along the salinity gradients in the coastal areas of the two deltas. In practices, the width of the transects covered in the MD is much wider than in the RRD given the fact that an average farm plot is usually smaller in the latter and as earlier mentioned, the long-history existence of the concrete or semi-concrete of the sea dikes in this delta makes its cultivation landscape less heterogeneous than in the MD as no saline water is allowed to get inside the sea dike at all. The dynamics of land-use, though, are still evident along the coast of both regions which indeed fulfils the objective of the future-forward research approach. While distance to the coastline is not an important proxy between the two deltas due to the difference in spatially spreading of these systems, proximity to urban areas is an important selection criterion to ensure covering the livelihoods and reflect urbanization characteristics in those regions. The two provinces in the RRD are closer to the urban areas by distance, and also by the tighter connection between rural and urban areas, *i.e.* the average urbanization level within the region of the RRD is higher than in the MD. This is not only because of the inclusion of the capital - Hanoi in this delta comparing to the excluding of HCMC from the MD in the South, but also reflects the greater mobility in the Northern part which could be linked further back in history while the presence and land conversion by its residents commenced much later in the Southern part of Vietnam (Son Nam 2009).

### 4.5.1. Secondary data

As found in most of the researches in Viet Nam, the secondary data is largely taken from the General Statistics Office (GSO) of Viet Nam for data at the national and provincial level (statistical yearbooks and official website of GSO). Complementary data at the provincial, district and village levels, for instance, quarterly and annual socio-economic reports of People's Committees of the studied provinces, districts, and communes are collected during the two field trips.

Besides, key hydrological data, *e.g.* on rainfall and temperature were also collected at the explorative phase to provide the background information in Chapter 2. This data was mainly collected and provided by the Centres for Hydro-Meteorological Forecasting of Viet Nam (NCHMF). This type of data is analysed intensively at the first phase to draw on the background of the research, yet also reflected forth and back throughout the chapters for cross-validation.

### 4.5.2. Interviews, group discussions and transect-walks with experts

Interviews are not only the main method applied in the exploratory phase of this research, but also useful during and after the main data collection period for eliciting complementary information as well as validating the preliminary empirical results. The type of interviews could vary between semi-structured or entirely open depending on the purpose and context as long as it helps to gather rich data via oral communication (Bernard 2011).

Expert interviews and group discussions have been carried out with government officers at different levels from provinces to communes. In almost of these provinces, we had the chance to talk with officers from DARD (Department of Agriculture and Rural Development), DONRE (Department of Natural Resources and Environment), Department of Forestry, Department of Irrigation, Office of Flood and Storm Control, Statistical Offices, *etc.* The meetings were helpful, particularly in the exploratory phase, to learn from their expertise and also see the difference in management between administrative levels and have insights on the problems and issues confronted by the local communities.

In more detail, expert interviews and FDGs have been carried out with government officers at different levels from provinces to communes including DARD, DONRE, Department of Forestry, Department of Irrigation, Statistics Offices, *etc*. Complementing to this local knowledge, formal and informal discussions with experts who have been gaining their rich working experiences in these deltas give a better overview and valuable opinions at the region level. A list of approached agencies and institutions is presented in Appendice 10.1. These activities were done before, during and after the major data collection – an intensive household survey conducted in 2016. The former interviews and group discussions were aimed to get the background information as well as identifying the potential issues which are thematically relevant to the research scheme to develop hypotheses. While the latter ones were strategically added for the validation and enhancing the rigours of the dissertation's core arguments.

The information collected from these interviews are used for cross-validation and qualitative analysis. In the empirical chapters (5 and 6), these interviews are cited using a simple coding system in which II stands for "in-depth interview"; EI stands for "exploratory interview"; GI stands for "group interview"; TG, ST, KG, ND, and HP are the abbreviation of provinces' names respectively: Tiền Giang, Sóc Trăng, Kiên Giang, Nam Định and Hải Phòng; P, C, and V stands for administrative levels respectively: province, district, and village; numbers indicate the chronological order.

Another useful exercise is the transect-walk with experts. These activities were conducted in the pre-visit during the exploratory phase. In this phase, transect walks were conducted with the guidance of a local officer in each selected province to identify the compatible transect for the major data collection, *i.e.* household survey in the second fieldwork trip. In line with the overall project design, the transect crossed different agro-ecological zones and salinity gradients. These transects were complemented by random in-depth interviews with farmers and other households within these transects.

### 4.5.3. Standardized household survey

During the field-work time in 2015-2016, the core data collection was the standardised household survey carried out intensively between March-July 2016 in both MD and RRD. In order to fulfil the selection criteria, districts and villages are selected after consulting with provincial and district level officers such as DARD, DONRE, Statistics Office, *etc.* for the most relevant sites and coverage. The name list of these 6 districts, 11 communes and 21 villages with sample size by the district as well as by delta is presented in ***Table 2***, 850 households in these villages were selected out of the list of households with the support of the local leaders and local guides[13]. The information collected at those different levels was moderated and cross-validated to control for bias (Flick 2009).

Regarding the household survey, the stratified sampling technique (Lewis-Beck *et al.* 2004) was applied in the design rather than the standard simple random sampling due to the large coverage and complexity of research context, the administrative challenges to the research procedure, as well as the common objectives of the DeltAdapt project. First and foremost, sample design is of great importance in data collection as it determines data quality and the models' parameterisation step (Chambers & Skinner 2003). There are different sampling techniques documented and suggested by numerous works of literature (Moser & Kalton 1971, Levy & Lemeshow 1999). The stratified sampling is aimed at increasing the precision of population-level estimates and/or to allow for estimation at the sub-population level to increase the representation of the studied groups (Bernard 2011, Lewis-Beck *et al.* 2004). Considering the village unit, farming system recoded in regional and provincial transects, as well as existing households' main occupations, the sub-sample was selected proportionally respectively. A pre-test of the survey was carried out at the very beginning of the intensive fieldwork. Up to four weeks after the pre-test was intentionally allocated for adjusting and improving the questionnaire. During the survey period in 2015-2016, one-third of the survey was implemented by the author and the rest was done by trained research assistants who are experienced with the research areas and the research theme broadly. Training was also provided to this group of interviewees to ensure not only the quality of the data collection but also research ethics clearance.

[13] Those were normally village leaders or elders with high credits among the community. In most of the case, village leaders took part in the survey, otherwise, they nominated their staffs who also had deep knowledge about the area and people.

**Table 2:** Names of research sites from provincial to village level and sample size by district and delta

| Delta | Province | District | Commune | Village | Sample size by district | Sample size by delta |
|---|---|---|---|---|---|---|
| Mekong Delta | Tiền Giang | Tân Phú Đông | Phú Đông | Lý Quàn 2 | 170 | 524 |
| | | | | Bà Tiên 1 | | |
| | | | | Lý Quàn 1 | | |
| | | | Phú Tân | Phú Hữu | | |
| | Sóc Trăng | Vĩnh Châu | Vĩnh Hiệp | Tân Lập | 50 | |
| | | Mỹ Xuyên | Tham Đôn | Trà Bết | 132 | |
| | | | Đại Tâm | Đại Nghĩa Thắng | | |
| | | | Hoà Tú I | Hòa Trực | | |
| | Kiên Giang | An Minh | Vân Khánh | Kim Quy A | 172 | |
| | | | | Kim Quy B | | |
| | | | Đông Hòa | 7 Xáng II | | |
| | | | | 7 Xáng | | |
| Red-river Delta | Nam Định | Giao Thủy | Giao Xuân | Xuân Tiên | 167 | 326 |
| | | | | Xuân Phong | | |
| | | | Giao Phong | Liên Phong | | |
| | | | | Lâm Trụ | | |
| | | | | Lâm Quan | | |
| | Hải Phòng | Tiên Lãng | Vinh Quang | Kim | 159 | |
| | | | | Yên | | |
| | | | | Vam Trên | | |
| | | | | Đông Trên | | |

Among 850 observations covered by the survey, almost 60% of the respondents are the head of their households. The majority of interviewees are at their labour ages with an equal share between male (51.65%) and female (48.35%) which holds true across regions (Figure 4-8 and Figure 4-9). This structure will likely be able to reduce the bias of information in the models' specification process.

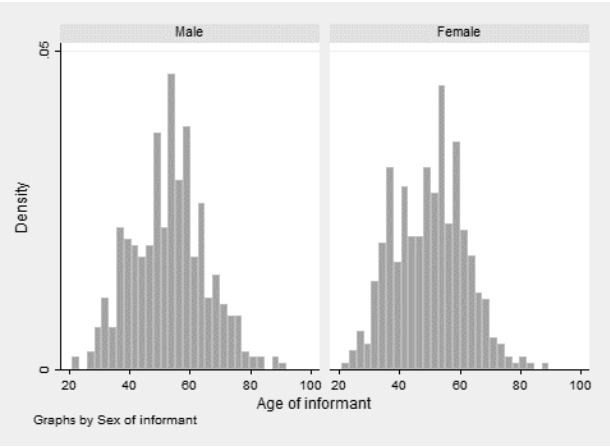



*Figure 4-8: Age of informants by gender (N=850)*

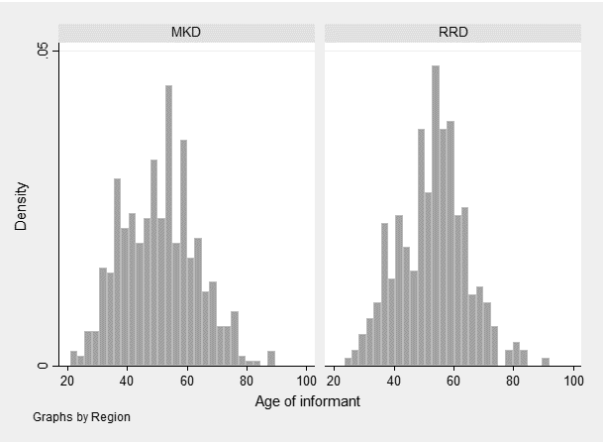



*Figure 4-9: Age of informants by region (N=850)*

In regard to other basic demographic characteristics reflecting local context, in the survey design phase, we took into consideration such factors as ethnicity, poverty rate, education

level, *etc.* For instance, the sample represents the actual proportion of the population in terms of ethnicity and further shows quite an equal share between men and women participating in the survey in general as well as by ethnicity (***Table 3***).

**Table 3:** Gender of informants by their ethnic

| Sex of informant | Ethnic of informant | | | Total |
|---|---|---|---|---|
| | Vietnamese (Kinh) | Khmer (Vietnamese | Chinese (Vietnamese) | |
| **Male** | 385 | 54 | 0 | **439** |
| **Female** | 368 | 41 | 2 | **411** |
| Total | **753** | **95** | **2** | **850** |

Overall, these characteristics unsurprisingly vary across the two deltas. These points are outlined and explained in Chapter 2 and further elaborated in Chapters 5 and 6. It is, however, critical to distinguish among specific contexts when applying all variables particularly newly constructed ones for joint models. Further details and explanations of variables are provided in the models' specification and parameterisation sub-sections of the empirical analyses. In line with the dissertation organisation, depending on which research questions addressed in each following section, relevant specific methods are presented and discussed and followed by analyses and results as well as sub-conclusions.

## 4.6. Data analysis techniques

The multivariate analysis (the biggest bloc in the methods flow chart Figure 4-2) includes a wide range of techniques namely descriptive analysis, bivariate analysis, and multiple regressions. As concisely defined by Hair and colleagues, the multivariate analysis looks at multiple variables in their relationships (Hair *et al.* 2014). In this stage, depending on the advanced level of data analysis including logistic regressions, ANCOVA, multinomial regressions. Regression models are set up to find out if a household decides to take one or many livelihood-change strategies that indicates their adaptation to changing the social-ecological context, and more advanced allows them to find out who (household) would take which option. The latter requires more advance analytical techniques.

Most of the logistic regression model's development follows the backward stepwise regressions technique (Efroymson 1960, Hosmer & Lemeshow 2000). It starts with the main components of factors as identified in the framework (Figure 3-7). The elimination of variables is done gradually with proper explanation to come up with most explanatory power regressions. Qualitative judgments of the researcher are critical in this process. The main group of variables represents for this could be found in ***Table 5***. Depending on the objective of each analysis (in Chapter 5 and Chapter 6), the retained variables are presented with the outcomes of the regressions. Technically, most of the multivariate analyses are processed on Stata (version Stata 14) – a software for statistic and data science developed by StataCorp.

Statistical explanation and more details of each step, as well as the triangulation process, will be presented in Chapter 5 (Probit and Multinomial regressions for comparative analysis) and Chapter 6 (Probit and multivariate regressions for a scenario-based analysis).

## 4.7. Introduction of data

In order to provide further details to Section 4.3, this section introduces and describes the empirical data from the household survey which are used in the analysis to address the research problem presented in Chapters 5. They also include the fundamental variables that used throughout the whole study, *i.e.* to answer the overall research questions that are partly addressed by Chapter 6 as well as the dissertation's synthesized discussions (Chapter 7).

### 4.7.1. Data overview

This section introduces the full lists of variables used for data analysis throughout the dissertation. Most of the variables are data at the household level collected in the household survey (2016). These variables are used for different regression model specifications to address the research questions and sub-questions. However, none of the models includes all of them. Meanwhile, various variables in these lists are qualitative variables which are solely used for descriptive analysis instead of regression analysis. Strictly speaking, these two uses of survey data could be contrasted (Chambers & Skinner 2003) which is subject to survey sampling techniques and requirements. In this study, they are used for supplementary purposes and triangulation of data analysis and inference.

Based on the format of the integrative framework (Figure 3-7), the variables are organised into the six key components of factors that are presented in ***Table 4***. The categories showed in each component could be either one variable or include several variables which that could be found in the more detailed list of ***Table 5***. Therefore, if all listed variables are included in one model, it will lead to over-fitted models. Yet as explained in Section 4.6 on the data analysis methods, this list is used as the starting point for data analysis (to feed later steps of the stepwise regression). Besides, some variables are used solely for descriptive analysis because it will cause selection bias problem if applying to regressions analysis (*e.g.* source of information – new livelihood, source of information - labour mobility have values only for households with a change of income source or having members working/studying away in the last 10 years respectively). The results presented in the later chapters show only the selected variables that retained for the most meaningful explanation.

**Table 4:** Key components of factors to the decision-making process at the household level

| Policy intervention | Environmental changes | Market driver | Capitals | Social learning |
|---|---|---|---|---|
| **Farm type** | Perceived hazard risks | Yield (last season/year) | Household-head (age, sex, education level) | Source of information - new livelihood |
| **Incentive** | Perceived/observed climatic changes | Number of income sources | Dependency ratio | Source of information - labour mobility |
| **Training** | Coping and adaptation measures | Share of non-farm income | Household size | Membership |
| **Change to adaptation measure** | Harvest loss | Proximity to urban centre | Skilled/high-educated members | |
| | | Perceived household's economic status change | Number of members working in a state-owned institution | |
| | | | Assets quintiles, House condition | |
| | | | Land area | |
| | | | Loans | |
| | | | The ratio of labour working far from home | |
| | | | Perceived wealth rank | |
| | | | Income | |

**Table 5:** Variables constructed from household survey data for analysis

| No. | Name of variable | Variable description | Variable type |
|---|---|---|---|
| 1 | hhsize_act | Actual household size | Count (1-11) |
| 2 | hhsize_ext | Extended household size | Count (1-11) |
| 3 | depratio | Dependency ratio | Four-level rank GSO (2011:21) |
| 4 | age_head | Age of household-head | Discrete |
| 5 | sex_head | Sex of household-head | Binary (0=male; 1=female) |
| 6 | Eduhead_cat | Education level of household-head | Ranking (1-4) |
| 7 | total_area | Total land area (*ha*) | Continuous |
| 8 | llh_nr | Number of income sources | Count (1-5) |
| 9 | plotnr | Number of land-plot | Count (1-5) |
| 10 | nonfarm_share | Share of non-farm income in total household's income | Continuous |
| 11 | qasset | Household asset index: *See below* | Quintiles (1=lowest; 5=highest) |
| 12 | house_cond | House construction condition: *See below* | Continuous |
| 13 | total_income | Total income of the last year*('000 VND)* | Continuous |
| 14 | total_yield | Total yield of the last year *('000 VND)* | Continuous |
| 15 | plotnr | Number of land plots | Count (1-5) |
| 16 | away_ratio | Ratio of labours working or studying away from home against total labours | Continuous |
| 17 | highedumem | Number of members with high education | Count (0-4) |
| 18 | highskill | Number of skilled workers | Count (0-4) |
| 19 | gov_mem | Number of members working in government (including extended members, e.g. children those moved out and established their own families) | Count (0-4) |
| 20 | membership | Household's membership in collective production groups | Binary (0=no; 1=yes) |
| 21 | ftype | Farm-type (*12 types: 1=crops, 2=extensive shrimp, 3=fresh-water aquaculture, 4=improved shrimp, 5=livestock, 6=mono rice, 7=no farm, 8=other saline aquaculture, 9=perennial trees, 10=rice-crop, 11=rice-improved shrimp, 12=rice-shrimp/fish*) (*See more below*) | Categorical (1-12) |
| 22 | highest_risk | Highest climatic risk perceived by households (*8 types: 1=flood, 2=high temperature/drought, 3=salinity, 4=unpredictability of rainy season, 5=typhoon, 6=erosion, 7=wind/cold weather, 8=others*) | Categorical (1-8) |
| 23 | adapt_hhA; adapt_hhB; adapt_hhC; adapt_hhD | Most important coping/adaptation strategies applied on-farm by households in response to their perceived highest risks *(A= Most important; D=Less important)* | Categorical (1-8) |
| 24 | adapt_gov_hightemp; adapt_gov_saline; | Most important coping/adaptation strategies (to highest risks respectively: high | Categorical (1-9); *number of categories* |

| | | | |
|---|---|---|---|
| | adapt_gov_typhoon; adapt_gov_rain | temperature, salinity, typhoon, and unpredictable rainy season[14]) of government that households are aware of | *depends on each type of hazard* |
| **25** | adapt_to_policyA; adapt_to_policyB; adapt_to_policyC; | Most important coping/adaptation strategies applied on-farm by households in response to government's coping/adaptation strategies that households are aware of | Categorical (1-9); *number of categories depends on each type of hazard* |
| **26** | loan | If a household takes loans (*at the time of interview*) | Binary (0=no; 1=yes) |
| **27** | farmchange | Recorded changes on the land of a household | Binary (0=no; 1=yes) |
| **28** | farmshift | Recorded farm-system shift by a household | Binary (0=no; 1=yes) |
| **29** | Income change | Recorded change of income-source in a household's livelihoods within the last 10 years | Binary (0=no; 1=yes) |
| **30** | Availability of local wage jobs | If a household has an off-farm income at local | Binary (0=no; 1=yes) |
| **31** | llhtrend | Typology of livelihood-change trend that a household belongs to; the variable is constructed with the classification tree method (see 5.4.3) | Categorical (1-7) |
| **32** | hightemp | Perceived high-temperature risk | Binary (0=no; 1=yes) |
| **33** | salinity | Perceived salinity risk | Binary (0=no; 1=yes) |
| **34** | cc_info | If a household has heard about climate change | Binary (0=no; 1=yes) |
| **35** | cc_percept | Household's perception of how important climate change is | Ordinal (1-4); Likert scales (1=Very important; 2=Important; 3=Not important; 4=Do not care) |
| **36** | cctemp; ccrain; ccsaline; cctyphoon; ccseason; ccdrought; ccsealevel; ccerosion | Household's perception of how the climate has changed in the last 20 years, respectively in terms of temperature, rainfall, salinity level, typhoon frequency and severity; seasonal pattern, drought, sea level; and erosion | Ordinal (1-5); Likert scales (1=Obviously increased; 2=Increased; 3=About the same; 4=Decreased; 5=Obviously decreased) |
| **37** | region | Delta region that a household belongs to | Categorical (1=MD; 2=RRD) |
| **38** | village | Village unit that a household belongs to | Categorical (1-21) (*see **Table 2***) |
| **39** | commune | Commune unit that a household belongs to | Categorical (1-11) (*see **Table 2***) |

The followings are the remarks and the detailed description of the variables with several categories and context-based which might cause confusion in understanding and interpretation.

[14] Regarding this phenomenon of climatic change which is considered as a risk by many interviewed households, they mostly refer to the late onset of rainy season, and also the change of rain patterns during this season. Further analysis is presented in Chapter 6 (Section 6.4.1)

### *Hazards risks*

Unlike other environmental studies for the same case studies, due to the large geographical coverage of the research, the questions on hazard risks are intentionally left open with multi-option risks listed for respondents. They identify and rank the three hazards that they perceive as the highest risks to their livelihoods and living conditions. The list of hazard risks was constructed and finalized based on literature review, consultation with experts and preliminary results of the first field trip.

### *Existing coping and adaptation practices on-farm - state-led versus individual*

As analysed in Section 2.2.3, given the high exposure to hazard risks and disasters of the two deltas, several studies have analysed the coping and adaptation practices in these regions. In the case of Viet Nam, it is essential in the literature of environmental change to contrast the roles of the government versus households as stakeholders in the adaptation process that leads to the observed changes nowadays (Schwab 2012, Nguyen 2015, Garschagen 2014). However, this section is based on that large body of literature to highlight the actors-and-actions nature of coping and adaptation measures, *i.e. who* does *what* in response to *what* - which is argued as pivotal to understand the adaptation decision-making at the household level.

This study is therefore designed to investigate the details of coping and adaptation in this direction. In the survey, households are asked to list not only what practices that they applied on-farm to cope and adapt to environmental risks that they perceived, but also which practice was indeed to respond to the coping and adaption measures of the government (that they are aware of). Therefore, in ***Table 5***, there are two parts of information related to coping and adaptation numbered 23 and 24 that should not be confused with each other. This type of data is aimed at exploring the details of livelihood changes related to coping and adaptation process at the household level, based on a hypothesis that policy intervention and secondary adaptation practice play a critical role in shaping the paths. The empirical results of the analysis are outlined in the next chapters as well as used for feeding the important discussions in Chapter 7.

Individual coping and adaptation practices are identified based on the relevant literature in the similar case study (*e.g.* Schwab 2012, Nguyen 2015), experts' knowledge and interviews conducted in the exploratory phase of the research. The main options outlined in the questionnaire include system shift, change variety, irrigation (dikes and sluice gates), adjusting seasonal calendar, applying machines/ technique, fertilizer/ pesticide/food, or others.

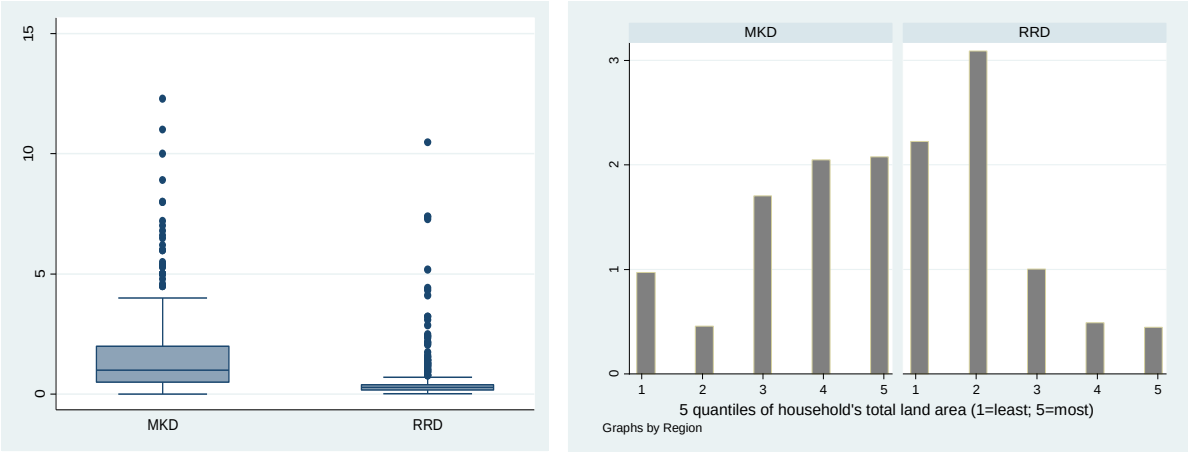
State-led coping and adaptation measures listed in the questionnaire are as follows: dikes, irrigation system, seasonal calendar suggestion, new species introduction, early warning system, post-hazard support, forestation, micro-credit, land planning, and others.

There are several options listed for respondents, yet some of them are applied only to the MD or the RRD. This is aimed at providing an overview for comparison of the hazard risks context as well as current coping and adaptation practices between the two deltas.

### *Households' capitals*

Given the significant difference between the two deltas in absolute numbers, variables that are shared by separate models as well as being used for the joint model of both deltas need to address these remarks. Figure 4-10 is a typical example of the difference between the two deltas which is showed through either the total land area of households (a) or their distribution over five quantiles of land area (b). Therefore, several variables representing capitals are constructed with quantiles to allow the compatibility in the analysis where applied.

The attached guideline of household survey data analysis by DFID based on the SLF is useful in exploring the survey data (DFID 2001).




*(a)* *(b)*

*Figure 4-10: Addressing the incompatible households' land-asset between the two deltas*
Box plots of total area (*in hectares*) *(a) versus* Five quantiles of total area *(b)* (Household survey, N=850)

*Social capital related variables* are identified because they are potentially important factors to the decision-making process of a household. They are tested in models through the set of variables as follows: the number of extended household members (who are children of the household-head yet no longer live in the house); source of information related to livelihood changes, mobility, new farming techniques, access to market, financial source; variables implying kinship and network and household's membership to any social group (*e.g.* farmer union, women union); yet only a few of those are retained for modelling which might vary across different models.

*Constructing asset index*

Related to the financial capitals of households, a discussion on monetary versus non-monetary indicators in a tricky context such as rural Vietnam and the lack of appropriate

non-monetary indicators such as assets, so far, has been approved to be a proper approach in this context (Cazzuffi *et al.* 2018, Sahn & Stifel 2003, Kolenikov & Angeles 2004, Garschagen 2014). These measures require information on income, expenditure and or consumption. However, the unavailability and unreliability of these types of data are big issues in many developing countries (Johnson *et al.* 2016). Meanwhile asset index "tends to fluctuate less over the short term compared to incomes" and contributes to household's future productivity (Cazzuffi *et al.* 2018:12); besides, this data is often more available.

In order to collect the primary data on household's wealth, the list of durable assets to be included in the questionnaire was constructed based on the pre-visit trip (households interviewing and observation) as well as the relevant literature on the topic (Garschagen 2014, Schwab 2012, Rademacher-Schulz *et al.* 2012). Due to the data type which is dichotomized, a tetrachoric[15] factor analysis (Christoffersson 1975) which follows quite similar techniques of index construction – the polychoric principle component analysis by Moser and Felton (2007). This method shows its advantage and relevance over other techniques of constructing asset index such as first principle components in principle component analysis by Cordova (2008), ROC and proxy means test (used by GSO), rural poverty index by Vu and Baulch (2010). A tetrachoric factor analysis was run on the set of durable goods items using the STATA14 platform to construct the asset index.

The dissimilarities between the two deltas in terms of culture and contemporary context (see Chapter 2) spotted out from field observation as well as data exploration support the methods of constructing separate sub-set of assets, and consequently sub-index for each delta. Therefore, not all items listed in ***Table 6*** are included in the analysis of both deltas. For instance, "small boat" and "audio system" (***Table 6***) are left out of the list for RRD.

**Table 6:** Difference between MD and RRD relating to assets index (Chi-2 test)

| No. | Asset item | Number of items | Ownership |
|---|---|---|---|
| 1 | TV | Yes** | No |
| 2 | Audio system | Yes*** | Yes*** |
| 3 | Computer | No | No |
| 4 | Laptop | No | No |
| 5 | Basic cell phone | Yes*** | No |
| 6 | Smartphone | Yes** | No |
| 7 | Internet | Yes*** | Yes*** |
| 8 | Refrigerator | Yes*** | Yes*** |
| 9 | Air conditioner | Yes*** | Yes*** |
| 10 | Motorbike (manual) | Yes*** | Yes*** |
| 11 | Auto motorbike | Yes*** | Yes** |
| 12 | Car | No | Yes* |
| 13 | Truck \| Cultivator | Yes *** | Yes *** |
| 14 | Pump | Yes *** | Yes *** |
| 15 | Small boat | Yes *** | Yes *** |
| 16 | Fishing boat | Yes *** | Yes *** |

*The difference between the two deltas (if Yes) is statistically significant at 0.1*, 0.05**, 0.01*** level*

[15] Tetrachoric correlation addresses the underestimation of the relationship between dichotomized variables (Lewis-Beck *et al.* 2004, Juras & Pasaríc 2006)

*House condition*, ranked *based* on construction materials, is constructed as a separate assets indicator, rather than being included in the assets index of households because it is potentially used for cross-validate. The previous literature has analysed the importance to take into consideration the cultural effects as well as climatic conditions in considering house status and spending habits of peoples from different regions (Wai-Poi *et al.* 2008, Wall & Johnston 2008). This point was brought up for cross-validation during the consultation with experts, in project workshops, as well as during in-depth interviews and observation on the field. For this research, it is of great relevance due to the fact that it covers a wide geographical area and across cultural aspects. Cross-validating (cross tab) between housing condition (and more precisely house-construction materials) and asset ranking shows that the asset index excluding house construction is a more credible indicator of wealth. This is due to the spending culture and also the level of exposure to hazards (*e.g.* typhoon in the RRD vs. flooding in the MD). This is also a critical supplementary indicator of total land/farm area and income in assessing the relative wealth of a household.

House condition rank is constructed as the composition of three main parts: roof, wall, and floor. In the questionnaire, three options of materials are given for each of these components in the order of increasing quality from 1 to 3.

#### *Farm types*

Farm systems classification and defining on-farm changes are based on the relevant literature on the MD (Xuan & Matsui 1998, Can *et al.* 2007, Joffre *et al.* 2015) to come up with 12 types with the main characteristics including [1]crops, [2]extensive shrimp, [3]fresh-water aquaculture, [4]improved shrimp, [5]livestock, [6]mono rice, [7]no farm, [8]other saline aquaculture, [9]perennial trees, [10]rice-crop [11]rice-improved shrimp, [12]rice-shrimp/fish. Types number 11, 12 could only be found in the MD, while type 3 only exists in the RRD. The description of these types, as well as their geographical distribution is presented in Chapter 5. This classification is heavily based on the context as well as the empirical observation and data. Nevertheless, it also reflects the findings of similar studies, for instance, the spatial analysis (using remote sensing technique) of Karila and colleagues (2014) which also indicates similar systems in the coastal areas of Bến Tre and Trà Vinh provinces of the MD.

### 4.7.2. Descriptive data of sample and sub-samples

***Table 7*** evidently confirms how the two studied deltas are distinguished from each other. Except for some basic demographical characteristics (*e.g.* age of household-head, dependency ratio) and variables that are used in quantile format to allow more compatibility, they are found significantly different in most aspects. For this reason, the method set is applied separately for them and the comparative analysis is provided where applicable. ***Table 7*** covers not all yet the pivotal and most frequently used variables that recurrently appear throughout the result chapters.

**Table 7:** Summary and *test of difference* results of the main variables
(*Mean/Median*) used for data analysis by delta (*1 & 2*) and the whole sample (*3*) (*Std. Dev. in parentheses*)

| Variables description | MD(n=524) *(1)* | RRD(n=326) *(2)* | Both deltas (N=850) *(3)* |
|---|---|---|---|
| Age of household-head | 54.14 (12.2) | 55.42(11.35) | 54.63(11.89) |
| Female headed *(1=yes;0=no)** | 19.5% | 14.7% | 17.6% |
| Ethnic minority *(1=yes;0=no)**** | 18% | 0% | 11.4% |
| Education level of household-head *(1=Below primary; 2=Primary; 3=Secondary, 4=High-Higher)**** | 1 (.746) | 2(.865) | 2(.175) |
| Dependency ratio *(0-49;50-99;100-199;>=200)* | 1(.827) | 1(.843) | 1(.833) |
| Household size*** | 4.43(1.63) | 3.97(3.817) | 4.26(.247) |
| Quintiles of households' assets*** | 3(1.42) | 3(1.54) | 3(1.47) |
| Total yield *('000vnd, sqrt)**** | 156.52(121.47) | 207.77(97.4) | 176.18(168.4) |
| Availability of local off-farm work *(1=yes;0=no)**** | 58.4% | 67.8% | 62% |
| Income change (last 10 years) *(1=yes;0=no)**** | 93.3% | 81.9% | 88.9% |
| Land-use change (last 5 years) *(1=yes;0=no)**** | 46.75% | 18.4% | 35.9% |
| Farm system shift (ever in farming history) *(1=yes;0=no)**** | 75.57% | 23.01% | 55.41% |
| Non-farm change (ever before) *(1=yes;0=no)**** | 46.76% | 58.59% | 51.29% |
| High skilled labours *(household members)**** | .25 (.62) | .90 (1.0) | .50 (.029) |
| Member working for government *(1=yes;0=no)**** | 12.8% | 27% | 18.2% |
| Total land-area (in *ha*)*** | 1.52(1.61) | .574(1.09) | 1.18(1.51) |
| Quintiles of land-area[16] | 4(1.32) | 2(1.18) | 3(1.416) |
| Proximity to urban centres *(1=close,2=average,3=far)**** | 3(.468) | 2(.500) | 2(.74) |
| Ever lost farm-income *(1=yes;0=no)**** | 77.3% | 85% | 80.2% |
| Number of years since the last harvest loss*** | 1.826 (1.75) | 2.78 (3.12) | 2.19 (2.41) |
| **Farm-type *(dummy: 10 categories)*** | | | |
| Mono-rice*** | 19.27% | 51.44% | 24.47% |
| Rice-crops*** | 9.16% | 15.03% | 10.35% |
| Other saline aquaculture | 7.25% | 10.12% | 8.35% |
| No farm | 14.50% | 12.88% | 13.88% |
| Crops*** | 9.16% | 15.03% | 11.41% |
| Rice-(extensive) shrimp/fish*** | 20.99% | 0.31% | 13.06% |
| Improved shrimp*** | 13.55 % | 0.92% | 8.71% |
| Fresh aquaculture/livestock/perennials | 0.19% | 0.31% | 0.24% |
| Extensive shrimp*** | 7.06% | 0.61% | 4.59% |
| Rice-improved shrimp*** | 5.15% | 0% | 3.18% |
| **Hazard risks *(dummy: 8 categories)*** | | | |
| No risk | 2.10% | 0.92% | 1.65% |
| Flood/inundation*** | 5.73% | 23.01% | 12.35% |
| Drought/high temperature*** | 87.02% | 38.65% | 68.47% |
| Salinity*** | 70.80% | 26.07% | 53.65% |
| Unpredictable rainy season*** | 54.01% | 13.80% | 38.59% |
| Typhoon*** | 37.02% | 93.87% | 58.82% |
| Extreme cold weather*** | 15.46% | 42.02% | 25.65% |
| Others* | 4.58% | 2.15% | 3.65% |
| **Household's coping and adaptation *(dummy: 8 categories)*** | | | |
| Nothing | 8.97% | 39.26% | 20.59% |
| System adjustments*** | 31.68% | 1.53% | 20.12% |
| Variety change*** | 36.83% | 14.11% | 28.12% |
| Irrigation | 14.50% | 18.10% | 15.88% |

[16] Quintiles of total land areas is used only in joint model for the compatibility between the two deltas.

| | | | |
|---|---|---|---|
| Seasonal calendar*** | 54.39% | 9.51% | 37.18% |
| Machines/ Technique*** | 8.21% | 15.64% | 11.06% |
| Fertilizer/ pesticide/food*** | 31.68% | 13.50% | 24.71% |
| Others*** | 4.77% | 19.02% | 10.24% |

*Significant difference between two deltas at p<0.01***, p<0.05**, p< 0.1* level (outputs from Chi2-test / T-test / Kruskal-Wallis test / Wilcoxon sign-rank test)*

# 5. RURAL LIVELIHOODS STRUCTURAL SHIFTS – TRENDS AND CAUSES OF HOUSEHOLDS' INTERACTIVE ADAPTATION PROCESS

## 5.1. Introduction

### 5.1.1. Agricultural and non-agricultural livelihood adaptation dynamics in the Vietnamese deltas

Rural economic transformation in developing countries has been discussed strongly since the second half of the twentieth century (Kerkvliet & Porter 1995, Kautsky 1988). Vietnam is a typical example of this process due to the additional effect of the government's economic reform programme, "Đổi mới", in the 1980s, which has had enormous impacts on the rural transformation, including the agrarian transition (*e.g.* de-collectivization of farm production) (Garschagen *et al.* 2012, Revilla Diez 1999). The most obvious outcome is the strong income diversification tendency, where rural households struggle to make a living out of any single income source or are barely able to survive without adjusting their crops and livestock (Newman & Kinghan 2015, McNamara & Weiss 2005).

At a conceptual level, numerous publications suggest rethinking the land-livelihoods nexus as a 'deagrarianization pathway' (Rigg 2006, Pritchard *et al.* 2017, McCaig & Pavcnik 2013), which reiterates the call to look beyond agriculture or land-based livelihoods and examine the rise of the rural non-agrarian sector. Along these lines, the most common response in the literature is to increase the weight of non-farm incomes when analysing rural livelihoods based on case studies in various parts of the developing world (Barrett *et al.* 2001, Kundu & Chakrabarti 2010); or to highlight off-farm diversification to complement the farming incomes and to improve the rural economy (Brünjes & Revilla Diez 2012, Sohns & Revilla Diez 2016, McNamara & Weiss 2005 Vu & Zerrillo 2016).

However, while this approach has been widely applied in rural development studies, environmental sciences commonly remain its focus on the direct links between human living and natural conditions. Rather, studies of this field in general, and in adaptation, in particular, are largely done on farmers and farming activities while limited and discreetly including non-agricultural livelihoods regardless of the rapid structural change as aforementioned. Nevertheless, a growing body of literature on the Vietnamese delta is attempting to fill in this gap. Scholars supporting the interdisciplinary approach in studying rural livelihoods and adaptation emphasized the need be studied non-agricultural components more inclusively across disciplines since it not only unfolds the trajectory of development but also addressing future issues and pathways of development in these regions (*e.g.* see Can *et al.* 2007, Garschagen *et al.* 2012, Brünjes & Revilla Diez 2013, Sohns & Revilla Diez 2016, Pham & Pham 2011). This Chapter underpins this research strand by not only simultaneously looking into the non-agricultural livelihoods together with the agricultural sector, but also including the impacts of the social component more equally in the analysis. As such, this approach pushes the study beyond the direct link between

environmental issues and the shifts on-farm as more than often found in the literature on environment change adaptation.

### 5.1.2. A typology approach to handle rural dynamics and heterogeneity

Farm typology approaches have mainly been developed in quantitative research on rural populations. They generally address farming systems and land use, intending to capture farm heterogeneity and allow comparison of the different groups. The approach is therefore originally agriculture-dominant with a limited inclusion of non-farm income, as this is intrinsic to any rural context. However, the increasing weight of the non-farm component has more frequently been found to be among the most important determinants for grouping in recent research (Righi *et al.* 2011). Furthermore, as expressed in the guidelines developed by Alvarez and colleagues (2014), typologies vary depending on the research question and the objective, i.e. they can be tailored. In the light of this argument, our study goes beyond agriculture to include non-agricultural livelihoods when grouping rural households. The outcome of this exercise is a typology of livelihood changes rather than one of farming or farmers.

The rich pool of methods used to classify rural target groups, which vary among farmers, households, farms or land, is reviewed in a comprehensive set of guidelines by Alvarez and colleagues (2014). The most popular methods are multivariate analysis, principal components analysis, multiple correspondence analysis, factors analysis, Hill and Smith analysis, multidimensional scaling and cluster analysis (Alavarez *et al.* 2014). Besides these, the decision-tree classification method could also be applied (Alavarez *et al.* 2014, Valbuena *et al.* 2008) when the research aims are clear and a dominant set of indicators has been identified to distinguish the population under observation. In any case, the desired outcomes are groups of households that are as homogeneous as possible. Despite the various methods ranging from simple to complex, proper classification is crucial for in-depth analysis.

Our case study covers a vast diversity of farming systems associated with geographical distribution and other important factors, such as policy intervention. The aim, however, is to capture the heterogeneity likely within each agro-ecosystem. The typology of livelihood change based on the decision-tree method ensures that the details of a change in households' agricultural and non-agricultural livelihoods are taken equally into consideration in the classification process. As such, we were able to prove that this framing method reflects more intuitively the dynamics and complexity of the studied sites and is thus expected to lead to empirical and methodological contributions.

The following sub-sections present a literature review of livelihood changes in the MD and the RRD and the specific research methods towards addressing the aforementioned objectives. In the last sub-section of the chapter, the results and findings interpretation show how research questions are answers, as well as reflecting on how much the applied

approach could respond to the research gaps with a consideration of the advantages and limitations of the methodology.

## 5.2. Rural livelihood under transformation in the Mekong Delta and the Red River Delta

The coastal zone of the two biggest deltas of Viet Nam has a long history of accommodating a dense population given their fertility as well as their geographical characteristics. In general, livelihood sources in coastal areas that accommodate up to eighty percent of the country's population (Giuliani 2019) are highly diverse, often more than other regions across the country (Adger 1999). The multiple dimensions of development of Viet Nam in general, and livelihoods in these diverse regions in particular, have shifted substantially since the nation's reunification in 1975[17] and especially the economic renovation initiative in 1986 (Revilla Diez 2016, Garschagen 2014, Boothroyd & Nam 2000). On the one hand, the large literature on the two deltas has managed to pick up these livelihood shifts in the last 50 years. On the other hand, they show a certain fragmentation across research disciplines and to some extent being driven by global or external concerns.

This sub-section reviews the main trends of livelihood-change recorded and analysed to provide a background on the case studies. Being in the focus of this dissertation, changes of both sectors – agrarian and non-agrarian are discussed in parallel rather than being approached from different disciplines. This is aimed to underline the overall approach of this study to shed light on the household livelihood adaptation to their complex and changing social-ecological context.

### 5.2.1. On-farm changes and the current coastal agrarian systems

On an agriculture-dominant economy like Viet Nam, the agrarian structural changes unsurprisingly have attracted the rapt attention of the research community for many decades. As aforementioned, the large body of literature reflects the shifts taking place since the nation's important milestone of reunion in 1975 and the '*Đổi mới*' policy reform initiated in the middle of the 1980s. This sub-section provides a brief synthetic of these main trends of change which comes separately for the MD and the RRD due to their distinct contexts, yet followed by a short comparison between them for a complete overview.

#### *In the Mekong Delta*

In the history of the development of the MD, the history of agrarians is an important part that has grown over the delta along with the hydrologic regime and human habitation (Biggs 2010, Renaud *et al.* 2013). From the starting point of being highly dependent on nature, farmers, through hydraulic development, have improved their farming over

[17] In 1975, the Second Indochina War (or also known as the Vietnam War or American War) ended; the artificial border divided Viet Nam into two political systems - North and South was removed with the victory of the Communist Party.

centuries to form quite diverse and complex agro-ecosystems as to how it looks today (Biggs *et al.* 2009). The changing process in the last fifty years is discussed by a large body of literature as this period witnesses the drastic shifts in agricultural production as well as in land use in general (Xuan & Matsui 1998, Can *et al.* 2007, Cosslett & Cosslett 2014, Ottinger *et al.* 2016, Nguyen *et al.* 2018). With a systematic review of MD's agriculture development, Xuan and Matsui (1998) record and publish the land-use changes in two decades 1976-1996 in their book. Figure 5-1 gives an overview of these shifts over these two decades by comparing the land-use maps of the MD between the years 1976 and 1996. The literature published later than this book more than often inherits and analyses further changes since the year 2000. Follows are the main trends that are not only highlighted by their work but also further analysed and updated by more recent research.

(i) Increasing rice *intensification* thanks to the improvement of the irrigation systems as well as farming techniques and higher-yield varieties. This mainly refers to implementing and increasing double rice[18] cultivation where farm conditions allow, *i.e.* in the middle and upper parts of the delta. This remains to be the case until today which would rather be in diked up areas and therefore less popular in the coastal areas. In many areas, farmers even cultivate up to three crop seasons per year (triple rice system) thanks to the new rice varieties which have a shorter lifetime and are more weather or salinity resilient. Not only rice, but intensification is also the common trend found on in other types of farming such as improved shrimp farming technique (Can *et al.* 2007, Tong 2017; Miller, 2007; Joffre *et al.* 2018).

(ii) *Shifting* from rice farming towards combining with aquaculture. The introduction of shrimp farming took place in the late 1990s into the regions where it was mainly natural shrimp catching before. In this period, it was mostly found to be integrated with rice farming across coastal provinces. Although mono-shrimp culture was described as an important business in the Cà Mau peninsula, it took quite some time to reach other coastal areas (Ottinger *et al.* 2016).

Also according to these authors, by the end of the 1990s, the rice-based land-use was still recorded to account for 70% of the arable land in the MD and mono-aquaculture was mainly developed in the Ca Mau peninsula but not along the coast of other provinces; rather rice-aquaculture was the dominant farming system in the coastal zones of the delta, although the tendency of abandoning rice-based system for mono-shrimp cultivation was concerned in their research. Also along the coast, mangrove forest exploitation was continued, and mainly

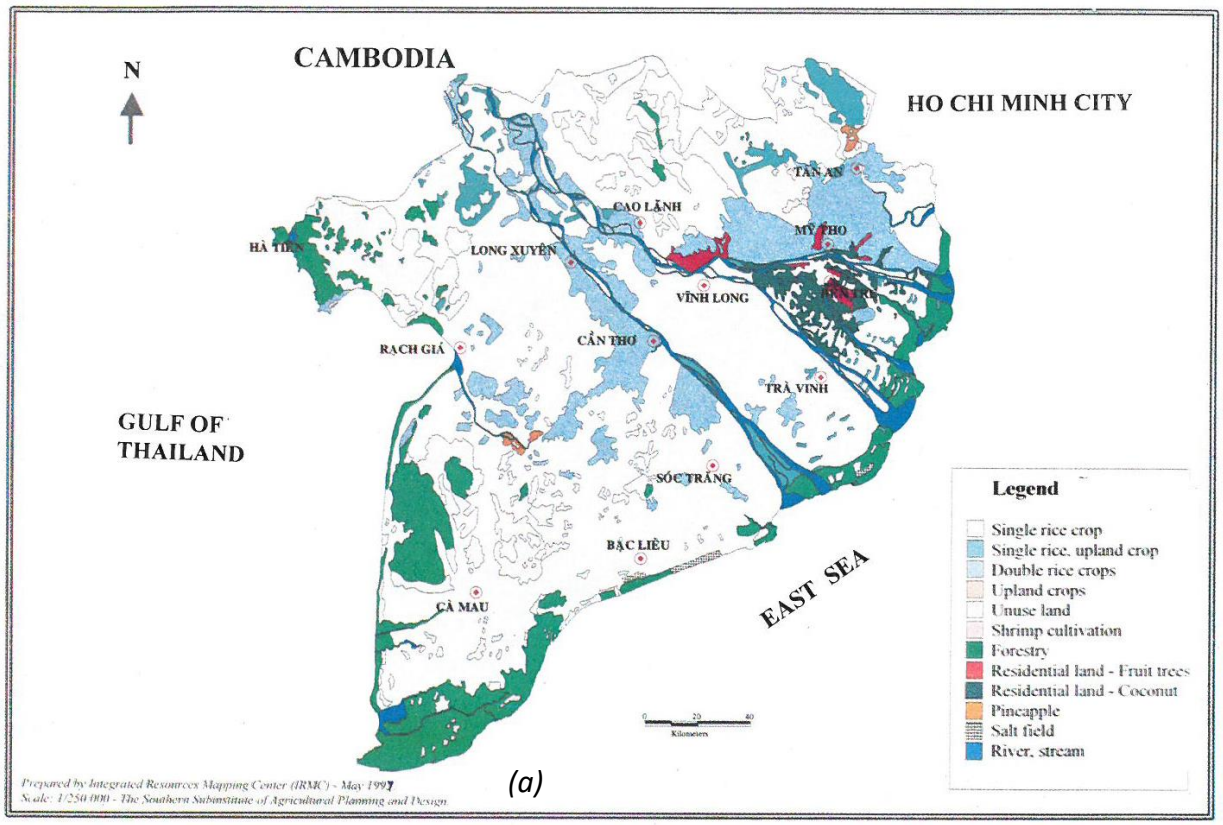
[18] There are three main types of rice cultivation with different level of intensification, respectively from low to high: single rice (one crop season per year), double rice (two crop seasons per year). and triple rice (3 crops per year).

for saline aquaculture which is also confirmed by more recent works (e.g.(Tong et al. 2004). This shift towards shrimp business became a phenomenon across its coastal areas in the early 2000s. Within one decade (*i.e.* by 2010), Viet Nam was among the world biggest shrimp exporters (Barange *et al.* 2018, Harris 2006, Lan 2013, Ottinger *et al.* 2016)

(iii) *Diversification* of perennials crops, particularly fruit trees were adopted in many regions across the delta depending on types of fruits being proper to be cultivated. Fruits became one of the major economic crops of the MD along with rice. However, the main production tends to concentrate in a few provinces and rather found popular and more diverse further inland than in its very coastal districts. Yet in general, agriculture diversification remains a strong trend and contributes to the rural livelihood transformation in the MD (Bosma *et al.* 2005).

Among these major trends, the farm-use shift towards aquaculture, particularly shrimp cultivation in the coastal landscape is most observable and considered to be strongly driven by the global market (Ottinger *et al.* 2016). This, however, was also concerned by many authors as they recognized the ecological changes that might negatively impact other farm culture (*e.g.* rice production) in these agro-eco zones. They, therefore, come to the warning that: "If this problem cannot be solved in the near future, farmers will probably all switch to shrimp monoculture causing problems of mangrove deforestation and soil salinity in this area." (Xuan & Matsui 1998:56). This argument has been supported by more recent works when they question further on the social and ecological costs of shrimp business, particularly in areas where farmers apply highly intensive farming or threatening the existence of coastal mangrove (Harris 2006, Joffre *et al.* 2015, Lan 2013, Renaud *et al.* 2015).

More recent works continue detecting further change on land use and farm production in the MD with different methods, e.g. remote sensing. The findings of the GIS-based research by Le and colleagues (2018) on the MD provide more evidence the main trends of land-use change in the delta including the rice intensification in its upper part, and the strong tendency towards aquaculture along the coast in the last two decades, as well as revealing fragmented changes in the central and coastal areas. It is unlikely that these changes will be redirected in the near future.



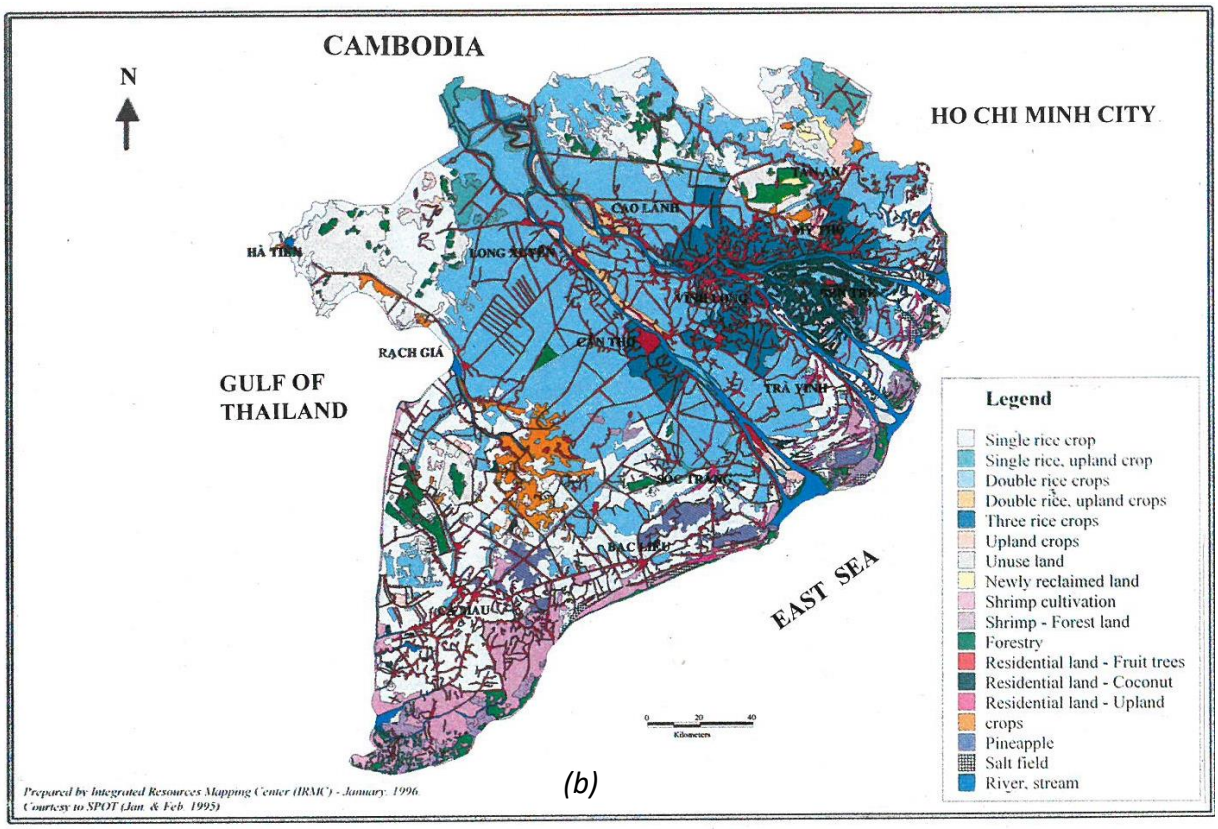




*Figure 5-1: Land-use maps of the MD at the year of 1976 (a) and 1996 (b)*
(*Source:* Xuan & Matsui, 1998)

In the studied coastal areas of the MD, there are three main ecological zones, and respectively three farming systems. Figure 5-2 is the illustration of a typical transect of the study site which, respectively from the coastline to further inland, are:

(i) The mono shrimp system including both intensive and extensive cultivation areas. The two main varieties found in this region are the white-leg shrimp (*P. vannamei*) and black-tiger shrimp (*P. monodon*) (Joffre *et al.* 2018, Lebel 2002). Technically, they are rarely cultivated together. However, some farmers are found rotating the two varieties between season crops. In this saline-water zone, salinity values remain above 0.4ppt all year round.

(ii) The middle zone is the rice-shrimp rotation system in which rice is cultivated during the rainy season and aquaculture (usually shrimp) production is found during the dry season. Respectively, rice could only be produced when freshwater dominates; this usually lasts for 4-6 months. On the same land (or pond), shrimp is farm when freshwater is lacking (usually from November to April). This is the natural ecological context in the coastal areas of the MD (Xuan & Matsui 1998).

(iii) In the fresh-water zone, either double-rice (two crop-seasons per year) or the rotated/integrative system of rice and annual crops could be found. Thanks to an inland dike system, freshwater is retained in these areas all year round.

As such, as also shown in Figure 5-2, this in-land dike system has artificially divided the coastal areas into different ecological zones. This was a gradual process that dated back in the late twentieth century and has been strictly controlled by the government (Sakomoto *et al.* 2009, Tong 2017, Tran *et al.* 2018). Specifically, on the farms in the fresh-water zone, farmers are restricted by law to change their land-use This restriction has not been changed through different versions of the "Law on land" (SRV 1987, 2003, 2013) which explicitly states that the conversion of rice land into aquaculture farming is not allowed in these regions, although shifting to the cultivation of other types of annual crops is permitted.

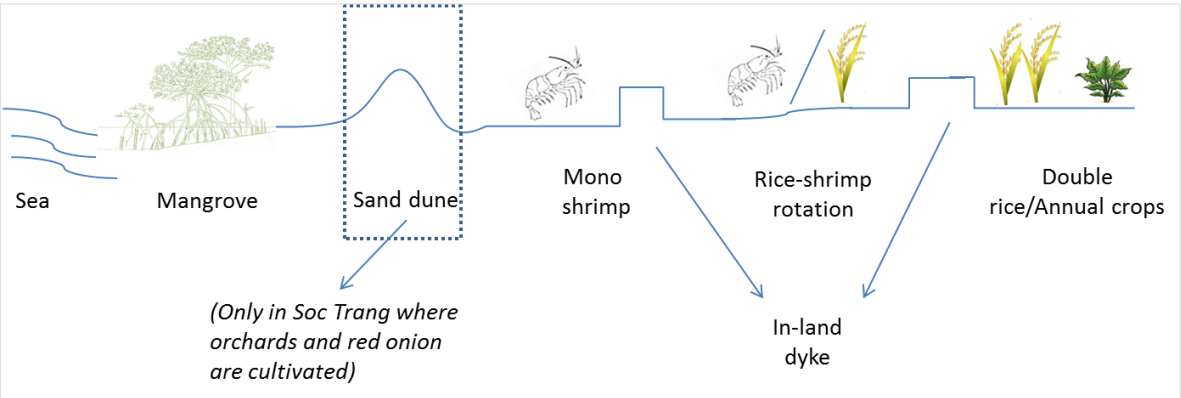



*Figure 5-2: The transect generalized from three studied provinces in the MD*

### *In the Red River Delta*

Being attached to the development of the dike system since the beginning of the twentieth millennium but rather completed during the French colonial time in the XIX century, the human's settlement and exploitation for agriculture have formed the RRD's land-scape quite earlier in history than the MD (Dao & Molle 2000). In other words, this deltaic agrarian system evolved over hundreds of years together with the construction of these large-scale hydraulic projects which, at its first point, deal with flood and seawater (Devienne 2006). In contemporary time, most of the recorded changes did not take place until the *Đổi Mới* process which commenced in the late 1980s. The landmarks in this process were the Vietnamese government's resolutions on enhancing the household's use-rights on the land[19] as well as on the de-collectivization of agricultural production (Revilla Diez 1999) which play a critical role in driving the development pattern of this region. The process of change related to land-use rights actually commenced a few decades earlier prior to the policy reform (Dang 2009, Nguyen 2017).

Given the topographic, climate and soil characteristics of the RRD (see 2.2.1) and most importantly the close sea dike system, the vast majority of arable land in the RRD is specialised on intensive paddy rice farming since its early days, integrated by other annual crops and short-term industrial crops, with a small part here and there exploited for small-scale (mainly fresh-water) aquaculture (Nguyen 2017). Yet rice farming intensification was practised at different degrees depending on the availability of irrigation system construction and typographic characteristics as showed in Figure 5-3, and the rice land area with higher intensification levels increased overtime during these couple of decades (Dao & Molle 2000). This phase of changes on (mainly rice) farm which is considered at the delta's 20$^{th}$-century agricultural evolution was less about shifting among the farming systems, but rather highlighted the process of mechanization, varieties improvement and chemicals using (i.e. fertilizers and pesticides) (Devienne 2006). The role of rice farming in the RRD was even intensified as it remained in the centre of the food security policy of the Vietnamese government after the nation's reunification in 1975 (Yen *et al.* 2017). The centralized production was aimed to achieve this nationally prioritized objective, yet it was not much of a success story which led to the next phase of policy reforming of which agricultural transformation, again, was in the focus (Dang 2009, Devienne 2006).

In general, this direction continued over decades until the important landmark of the *Đổi Mới* process during the 1980s. Given the fact that this Northern delta had been impacted enormously by the collectivization[20] period (which was not the case in the MD), the policy

[19] Resolution 5, passed in 1993 extended household's rights to exchange, transfer, lease, inherit as well as mortgage the land that they are allowed to rent from the government for a period up to 50 years depending on the type of land or farm (SRV, 1993)

[20] Collectivization is a phase of the Vietnamese Northern government's policy taking place during the course of 1954-1975 in which authorities (led by the Communist party) implemented substantial agrarian reform aimed at

reform was a turning-point of rural livelihoods since one of the most crucial changes was related to land redistribution, *i.e.* land rights reforming, and autonomous household farming (Devienne 2006). During this collectivization phase, rice farming was dependent on the central water management through the dike and channel systems which brought achievements in rice production at the first few years, yet soon after that showed its severe disadvantages that led to the renovation initiative in the late 1980s (Devienne 2006, Jésus & Dao 1997). Nguyen (2016), therefore, describes this change as "comprehensive, diversified and synchronised development from crop production and husbandry to forestry and fisheries" (*ibid* 2016:28); and within a decade, the rice productivity of the RRD took over that of the MD. However, the transformation of agriculture in this phase more or less reinforced the trend of rice farm expansion as well as intensification, mostly via varietal improvement (towards shorter cycle and higher yield), chemicals using and mechanization as aforementioned, rather than shifting to other systems. Yet in addition, farmers tend to diversify other types of crops (such as corn, soy, potatoes, garlic, shallots, *etc.*) either through integration with or shifting from rice, particularly in lower land of the delta. Other types of land conversion (*e.g.* to orchards) was still limited though (Devienne 2006). In fact, this change enabled the RRD to fulfil the food security goal by the 1990s and contributed to making the country a rice exporter at the end of the twentieth century.

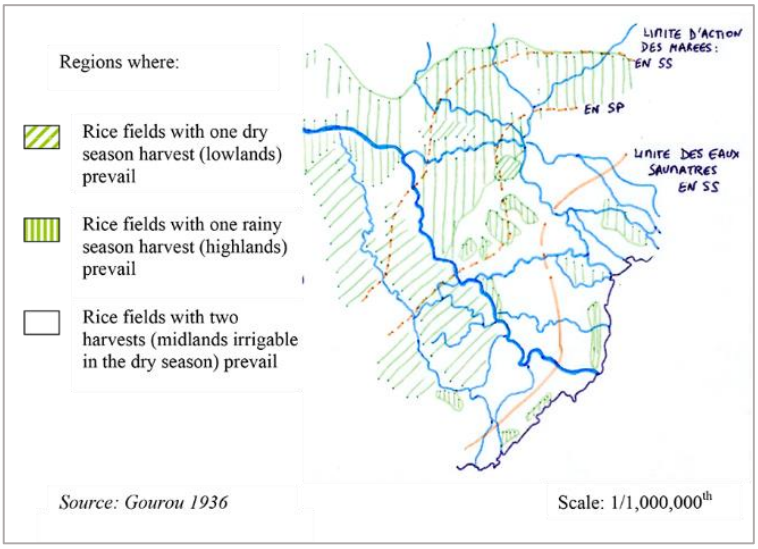



*Figure 5-3: Rice field in the Red-river Delta in 1930s*
(*Source: Devienne, 2006)*

*Current coastal agro-ecological setting*

Figure 5-4 illustrates the typical landscape of the coastal areas of the RRD. In general, the region is divided into different zones, although not necessarily different ecological settings as in the MD. Although the proportion of these zones are not displayed on the figure, the dynamic area, in reality, is rather narrow; in the case of Vinh Quang commune (Hải Phòng

redistribution farm to labours in order to boost productivity and equally improve living condition households of all economic situation; rice fields were central in this reform process (Devienne 2006).

province), only the fields next to the sea dyke could be listed under this category. However, this part is undergoing substantial changes, thus potentially the most dynamic area in the coming future. Also getting popular only recently, aquaculture (including extensive shrimp farming) outside of the sea dyke is an important factor of livelihood change along the RRD's coast.

In addition, not all parts of the transect are found in each studied commune. Mangrove, for instance, does not appear everywhere along the coastline of the RRD. It was found in two out of three studied communes (see Figure 4-3 for images of the context). Aquaculture inside the sea dyke is also limited to Giao Thủy district, yet rather not in Tiên Lãng district of Hải Phòng province.

Despite the divergence of the context, the role of the concrete sea dyke is indisputable in shaping the landscape of the whole delta. As shown above, most of the on-farm dynamics are related to this dyke system, thus implying the relevance of a policy discussion in regards to livelihood adaptation and the environmental change in these areas.

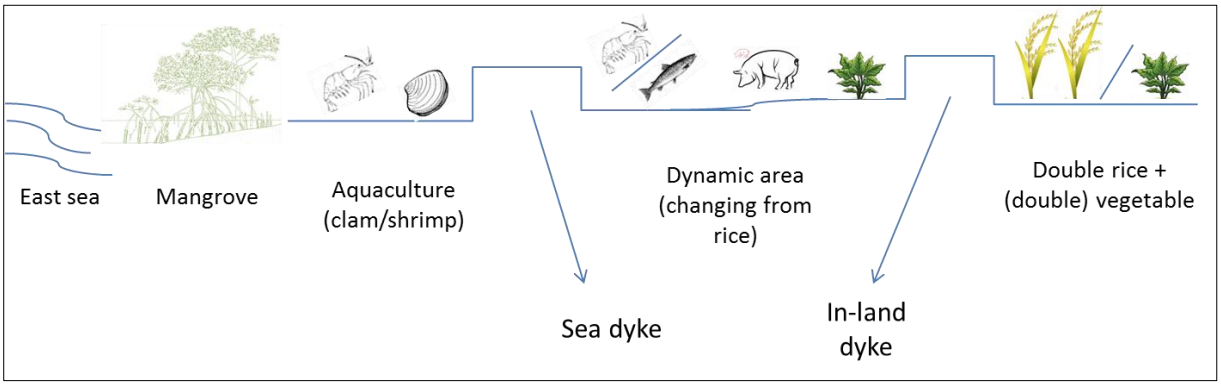



*Figure 5-4: The transect generalized from two studied provinces in the RRD*

### *A brief comparison between the two deltas*

In general, both deltas have undergone important changes on farm in the last fifty years, particularly with two major landmarks: the reunification of the country in 1975 and the policy reform process – '*Đổi mới*' in the 1908s. Nevertheless, the details and degree of changes varied across as well as within these regions. Rice production and aquaculture were the most dynamic sectors in this process which hold in both deltas, although not necessarily in the same directions. From both historical and future-forward perspectives, these trends are potentially non-linear, thus it is intriguing to look into the details of the changes.

Main trends of land-use change that could be synthesized as commonly found in both deltas are:

(i) After having retained at the top prioritized production for a couple of decades after the *Đổi Mới*, rice cultivation areas in on the drop (even though more intensification), while areas for aquaculture is increasing (Karila *et al.* 2014)

(ii) Even more obviously, farmers tend to farm less rice, yet more other annual crops (vegetable, corns, lemongrass). The vegetable is cultivated either in replacing rice crops or in integration on rice farms.

(iii) Highly diversification mostly in fresh-water cultures: towards an increasing number of crop varieties on the same plot which was found in the literature (Tung 2017) or with different plots (own findings)

(iv) Further intensification, or other works Intensity level of production can create a big difference between farms producing the same products. With crops, increasing intensification means more crop seasons on the same land patch per year. With aquacultures such as shrimp, the levels are distinguished by the density of stocks, added fertilizer, feeding frequency, etc. (Ottinger *et al.* 2016, Joffre 2015). Reducing the size of ponds is normally an observable sequel of shrimp farming intensification due to the convenience of technology and engineering interventions.

Overall, regarding rice production, there has been a trend towards concentration for commercial since the early 2000s which is noticeable in the MD. According to this report, 85% of the surplus from sales of the total rice volume is produced by the top two quantiles growers whose farm is rather large; *i.e.* rice farm was also expanded (*ibid* 2016:12). Meanwhile, farmers in the RRD practiced highly intensified rice production which reached the limit of land availability and capacity much earlier in history (Dao & Molle 2000). Relating to this difference in farm size and concentration, farm fragmentation and with smaller size and a higher number of land-plot per households on average in the RRD make on-farm diversification more frequently adopted in this region than in the MD (Tung 2017). Meanwhile, due to the historical legacy, farm fragmentation is hardly found a problem in the MD during the research.

Yet sequentially to the out-spread and intensification of shrimp farming, the coastal landscape is changing towards being patchier in aquaculture zones. In order to minimize the risk and manage more efficiently, the higher stock and more inputs (indicators of the level of production intensification) are put into ponds (Ottinger *et al*, 2016), the smaller the pond size that farmers tend to set although their ponds remain in one farm compound rather than being fragmented. Nevertheless, regarding farm system shifts including towards converting into aquaculture land, this trend is much more obvious in the MD than in the RRD where on-farm changes were rather about intensification than shifting. Thereupon, the literature on shifting towards aquaculture is mainly found for the MD case study rather than RRD.

During the whole of this period, the intensive agricultural transformation has posed positive impacts on the well-being of rural households throughout Vietnam as it had been targeted. Nevertheless, given the significant difference of contexts, farmers in the MD tend

to benefit more from this process comparing to their mates in the RRD; particularly for those related to market liberalization for both inputs and outputs of agriculture and aquaculture productions (Benjamin & Brandt 2002). However, the agricultural transformation process in the RRD is claimed to be more dramatic than that in the MD (Nguyen 2017).

The common part shared by the two deltas on the agriculture transformation process since the late of 80s toward modernization in Viet Nam, as reviewed and assessed by the WB group in 2016 within the "Vietnam development report" series, indicated that the large part of the land-use change process is driven by the global market (Ottinger *et al.* 2016). The process is, however, dominated by the government's policies. Further analysis of these drivers and impacts in the process of change, particularly at the household level, is presented in the results and interpretation sub-sections of Chapters 5 and 6.

As it showed above that the difference of dynamics on-farm is related to the level of intensity of change. Therefore, in this study, the detailed levels of intensity are taken into account in identifying the different farm change and farm-types which is argued to reflect on the various dimension of the process of change such as the peer learning, peer pressure, capacity to change and the role policy interventions. Further analysis is presented in the result of this chapter as well as in later discussion of this study. All in all, no up-to-date farming map on the delta level exists yet for either the MD or the RRD that particularly includes the changes since the beginning of the twenty-first century – which is likely to be the most dynamic phase of the country socially and ecologically, and thus hinting at forthcoming changes. This research, therefore, attempts to contribute to filling in this gap with more up-to-date primary data.

### 5.2.2. The increasing non-farm composition of rural livelihoods

The major changes of agriculture since the 80s were pivotal to the rural development of these two deltas as they were not only about farm-related livelihoods but also linked closely to the transformation of non-agricultural sectors during these decades. The census data of the rural survey conducted by the Vietnamese government in 2016 (GSO 2018:24) records that 7.07 million of rural households which account for 44.2% in the whole country attribute their largest income to non-farm livelihoods[21] which increases by 7.5 percentage point in comparison the data of the census conducted in 2011.

One of the most discussed aspects of rural livelihood dynamics is the divergence from farm incomes to other sources which is highly emphasized as the main channel of development of non-farm economic activities (Bosma *et al.* 2005). For the majority of households, this means a combination strategy of non-farm with farm incomes by reallocating their labours and adding more sources rather than quitting agriculture (Betcherman *et al.* 2019, Hoang *et*

[21] Calculated for 12 months between 01/07/2015 – 01/07/2016 (GSO 2018)

*al.* 2015). In this case, farmers are less dependent on agriculture which is therefore relatively losing its traditionally dominant role in the rural economic structure. This trend tends to enhance over the last decades and in the near future. The highlighted trends related to non-agricultural livelihood shifts could be listed as follows.

*Self-employment* has emerged as one of the most popular non-agricultural livelihood options to diverge from farming of rural households in Viet Nam (Benedikter *et al.* 2013, Hoang *et al.* 2015, Sohns & Revilla Diez 2016, 2018). This is more often than not an opportunity-driven process for entrepreneurs (Jürgen & Javier 2012) in which rural labours tend to proactively initiate their business or other economic activities. However, according to Brünjes and Revilla Diez (2012), the rising entrepreneurship in rural Viet Nam rarely relate to innovative business which does not really contribute to the local employment growth. In other words, apart from a small number of self-employed opportunities, the majority of other non-farm or wage jobs rather come from external investment. Nevertheless, because this typical informal economic activity remains at an individual scale, it is hardly captured in the secondary data and is sometimes overlooked in adaptation studies.

*Labour mobility* as a multi-local livelihood strategy. The large body of literature focuses on the strong migration process as an important phenomenon in the socio-economic changes since the aftermath of economic reform (Adger *et al.* 2002, Dang *et al.* 2003). In Viet Nam, the internal migration process has been to contribute substantially to lift rural households out of poverty since the commence of this economic transition (Huynh & Le 2011).

Regarding the MD and the RRD, this mostly refers to the outmigration from the region. Figure 5-5 shows the continuously negative of net-migration in both the MD and the RRD (even though less obvious in the latter due to the fact that the capital Hà Nội is also included in the region (GSO website, accessed 5/2019). One of the explanations to the increasing outmigration from rural areas is the multiplied number of workers in many industrial zones in the last decade which mostly situate in the neighbour regions to the MD and the RRD (if not within) (Garschagen *et al.* 2013, Hoang *et al.* 2015) .

On the RRD, it is found in the literature that migration has commenced quite early in its history. Dao and Molle (2000) recorded roughly 15,000 people migrated out of the delta in the 1930s which plays an important role in reducing the pressure of population over job availability which resulted in roundabout 13 % of the rural labour force emigrated (*ibid*). Also, according to these authors, an even older process was adding non-agricultural activities which were pivotal in making up for the lack of income together with the migration process. Their study recorded 250,000, or 6.8% of rural labours took part in these economic activities during the 1930s including handicraft, food processing and commerce (Dao & Molle 2000). The food crisis after a decade of collectivization phase, particularly among the poorest villagers led to the authorities' policy of encouraging outmigration from

the RRD to cooperatives in mountainous areas (Devienne 2006). In the early 1980s, the government designed a policy of reallocation population and labour which directly affected population movements. However, instead of encouraging rural-urban migration, it focused on rural-rural and urban-rural migration. Particularly, there were programs to push people from high-density provinces of Red and Mekong River Deltas to less densely settled regions, chiefly to the new economic zones in the Central Highlands (Dang *et al.* 1997:319). Nevertheless, it is reported by Deshingkar (2006) that after economic reforms in the late 1980s, temporary migration to urban areas and rapidly industrialising zones has become the largest flows. Cities are particularly attractive for temporary migrants engaged in trade and service work.

Also, according to a recent report of GSO (2018:23), by 2016 the labour-age force accounts for 53.8% rural population which has been reduced by roundabout 20% since 2011. This decrease is mainly due to labour mobility (among young labours) from rural to urban areas and also migrating to work overseas.

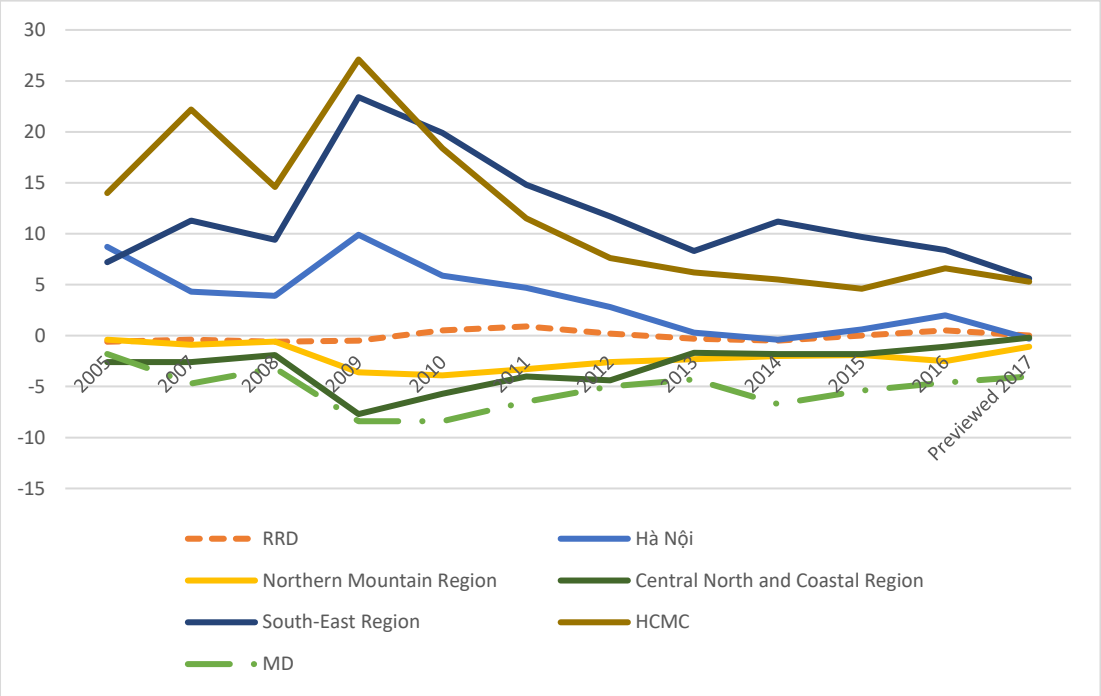



*Figure 5-5: Net migration by region during 2005-2017*
(Source: GSO website, accessed on 05/2019)

In addition to the mobility of people of their labour ages in these regions is the increasing participation in *higher education* which concentrates in inner urban centres rather than at the rural locals (Fan *et al.* 2018). It is getting popular for rural households to invest in their children's education of which higher education normally takes place in urban centres. This has significantly changed the livelihoods structure of the younger generation as compared to their parent's time (Nguyen *et al.* 2014). Therefore, this trend should not be overlooked in the process of a structural shift of the rural economy. The increase of skilled jobs in

general and in the rural areas in particular in the last couple of decades might be partly attributed to the return of improved education situation since the last few decades (Hoang et al. 2015). The statistics by GSO (2018:25) shows that among non-farm professionals, the proportion of labours participate in industrial production is predominant. By 2016, 37.6% of the 5.34 million rural labours (of the whole country) work in industrial production. At the regional level, the highest proportion was found respectively in the South-east (49.44%), the RRD (43.95%), the MD (33.39%) and the Northern Mountain (33.05%).

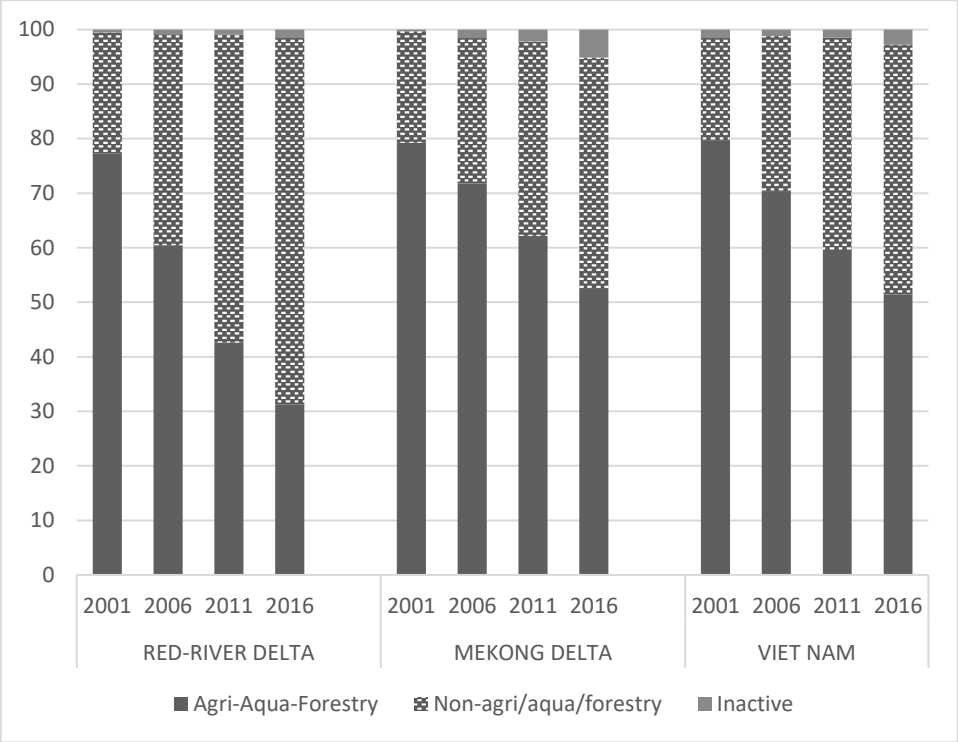



*Figure 5-6: Noticeable shift of household structure by economic sectors (in %) in rural areas 2001-2016*
(Source: Own calculation, GSO 2002, 2007, 2012, 2018)

Despite the major differences in terms of land-scape and also farm-land changes, the two deltas seem to share more common processes of socio-economic development such as urbanization (Hoang *et al.* 2008), industrialization and modernization (Boothroyd & Pham, 2000). Therefore, the dynamics of livelihoods in the non-agricultural sector are also found similar within and between the regions (Figure 5-6). The evolvement of these economic activities were mainly about household entrepreneurship (*e.g.* self-employment), market access and rural-urban linkages – including labour mobility (Jürgen & Javier 2012, Thanh *et al.* 2005). In the case of RRD, several studies argue that the limits of farm production, for instance, land areas, access to market are attributed to the development of other sectors (Dao & Molle 2000, Nguyen 2017). Although these phenomena are found in both deltas, increasing non-agricultural income sources is more likely to be the long-term strategy in the RRD rather than in the MD. This, together with the role of education or the returns of education, from a trans-generations perspective, could link to the discussions on the

difference in terms of income and sustainability of low-skilled jobs/education versus high-skilled jobs/education as well as the aspiration and expectation of younger generations (Khue *et al.* 2016). The research of Khue and colleagues (2016) is on a case study in Bắc Ninh province, in the RRD, finds that the high expectation to move out of agriculture among the young generation of smallholders farming in the RRD is strongly explained by the new development factors that facilitate the rural-urban connection (such as communication technology) and consumption habit.

In short, the trend of increasing weights of non-farm and off-farm income in the rural economic structure in the whole country and especially in the delta areas is by no mean a new phenomenon, yet it has been enhanced and keeps changing over time. This shift is also high on the agenda of the national economic development policy (GSO, 2018). It, therefore, deserves further concern given the highly uncertain context.

## 5.3. Methods of analysis

The source and detailed description of the data used for descriptive statistics and regression analysis in this chapter is provided in Section 4.7, particularly in ***Table 5*** and ***Table 7***. This section is aimed to unfold the technical explanation of the quantitative methods of analysis. It presents the description and results of the first part of the multivariate analysis stage (in Figure 4-2) which is aimed at solving the research problem explained in the previous sections.

### 5.3.1. Probit regressions to explore the determinants to household livelihood changes

In this step, binary outcome regression models are applied in order to examine the factors to the decision to change of households. Probit regression is one of the two types of binary outcome models[22] which are the basic type of regression models for categorical dependent variables (Long & Freese 2006). Binary Probit models are applied to explore the impact of each explanatory variable to the probability of occurrence or success of an event, *i.e.* dependent variables. In this case, the dependent variable is if a household changes their on-farm incomes, non-farm incomes; or sends their members away for working/studying) which is shown in form of the equation as (Wooldridge 2013, 2009):

$$\mathrm{P}(y = 1|\mathrm{x}) = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \ldots + \beta_k x_k$$

Logit and Probit models are often derived from a latent variable model that satisfies the classical linear model assumption:

$$y^* = \beta_0 + \beta_k X_k + e$$

Where $y^*$ is the latent variable so that:

[22] Binary outcome or dependent variables are code with two values: 0 for negative outcome and 1 for positive outcome. There are two types of binary outcome models: probit and logit which are distinguished by the different distribution assumption of models' residuals (see Wooldridge 2013, 2009, Hair *et al.* 2010, Long & Freese 2006).

$$y = 1 \text{ if } y^* > 0$$

$$y = 0 \text{ if } y^* \leq 0$$

Coefficients estimated from Probit models give information on the direction of impacts and the level of significance, but not the magnitude of effects. Rather, interpretation and conclusions are based on either odds ratio or the marginal effects computed from models. The main part of the results of Probit binary analysis in this section is based on the marginal effects coefficients (Long & Freese 2006).

The record of any change of livelihood of a household has ever made (either on or off their farms) in the last 15 years is used as the dependent variable. The main parameters for comparison and developing typology profiles are (for more details see ***Table 4***, ***Table 5*** and ***Table 7***): a set of households' main demographic characteristics, a set of household's capitals, households' farming systems, livelihoods diversification indicators, households perceived environmental risks. The first set includes variables on the number of members (*household size*), *dependency ratio* and representative characters of households' heads such as *age* and *sex*. In the second group of variables, main capital components of households (according to the SLF) inspected are human (*number of members working as skilled workers*), social *(number of members working as state employers*), natural (*total land area*), physical (*assets index, house-condition*), and financial *(total yield*). For the third parameters component, *farm systems classification* is an important parameter given the farmers-dominant target group of this study. Moreover, *farm type* also represents as an indicator of policy intervention, particularly relating to land-use management and land rights regulations[23].

Such variables as the *number of land-plot*, *number of income sources*, the *share of non-farm income* and *share of labours working away* are used to examine livelihoods diversification. *Salinity* and *high-temperature* are included as the two most frequent environmental risks perceived by households, thus used frequently in the regression analysis.

Basing on this set of parameters, determinants to farm and non-farm livelihood changes are identified using a series of Probit regressions on the major trends of livelihood change to identify the determinants to each trend in particular, but also in order to seek for common drivers and their impacts that allow explaining the overall picture.

In addition to these two main models on general change of on-farm and non-farm incomes of a household, the results of two specific cases of shifting to shrimp farming (as the typical on-farm change) and labour mobility (as the most popular non-farm livelihood strategy) are also presented for cross-validation the main results as well as providing more detailed analysis on some specific livelihood-change trends.

[23] For more details on background information, see Chapter 2; while further explanation of this variable's application are presented in the results and finding sections of this chapter.

### 5.3.2. Formulation the typology of household livelihood-change

The main variables for the classification are livelihoods change - a change of livelihood is recorded if the household has ever changed their income sources, including both agricultural and non-agricultural, in the last 15 years. The level of intensity of on-farm change is identified by distinguishing farm-system shifts versus farm-diversification based on the literature on farming systems in the VMD (Xuan & Matsui 1998, Can *et al.* 2007, Joffre *et al.* 2015) as well as qualitative data (expert interviews and field observation). This is important to reflect on the studied context based on the theoretical background and primary analysis of empirical data on the factors promoting or hampering livelihood-changes at the household level.

Regression analysis was applied to not only explore to seek for the most meaningful criteria and thresholds for classification but also validate after classification to confirm and finalise the argument and methods. This method step is applied on the main observed and described trends of livelihood shift including trend to send members to work or studying away; trend to move towards shrimp farming (only on the MD case study); determinants to change on-farm/shift farming system and to change of non-farm income sources.

Three key thresholds are identified for classifying the types of livelihood-change strategies at the household level:

(1) to *change* versus *no change*: At this very first layer, a group of households that have never made any substantial changes on their livelihood is spotted out. Further analysis could be applied to this group, guided by questions such as: Who are they? Why are they not changing? This is aimed to facilitate the identification of subgroups and thus the potential vulnerable target group.

(2) *the level of intensity* of changes applied on-farm is the second layer of analysis: This step aimed to distinguish between farm *diversification/intensification* versus *system shift*. In order to validate this threshold, the "Law of land" (SRV 1987, 1993, 2003), particularly the regulation of land for rice and the restriction of conversion to other farm type certified by the Vietnamese government for local implementation (for more details, see Section 2.2.3) as well as local officer interview and observation were considered to develop an *ad hoc* definition applied in the scope of this research. This step reflects the dynamic context of land-use change through the interaction between households and policy interventions on both dimensions of time and space. Empirical evidence and explanation are provided in Section 5.4.1.

(3) Identifying the extent of *changing non-farm income* sources is the third layer of classification which tends to be trickier in recording than changes on the farm. Therefore, this threshold of change is kept simple by looking at if there is a new nonfarm income replacing either an old nonfarm income or a farm income source.

In short, although the classification technique is simple, it is highly contextualized and therefore able to reflect very well the dynamics of these regions. Besides, the potentials to capture the complexity of the context imply high transferability to cover the large geographical research areas. Furthermore, given a large amount of similarity of rural context in the global South, it has the high potential to be applied in various diverse regions across borders. More details on how this method is operated are presented in Section 5.4.3, followed by the results and interpretation.

### 5.3.3. Multinomial logistic regressions for pairwise comparison

A comparison among the livelihood change typology with multinomial logit models allows further assignment the main distinctions of household groups belonging to each type. Multinomial logit models are in fact a series of binary logit models[24] for each pair of alternatives of the outcomes which are estimated simultaneously (Long & Freese, 2006). Technically, there are only *n-1* (with *n* alternatives of the outcomes) binary logit are estimated on different sub-sample, *i.e.* only those observations of the referred pair are kept in each model. The left-out alternative is called the base category for comparison.

According to Long and Freese (2006), the multinomial logit model can be written as:

$$\ln\Omega_{m|b}(\mathrm{x}) = \ln\frac{\Pr(y=m|\mathrm{x})}{\Pr(y=b|\mathrm{x})} = \mathrm{x}\beta_{m|b} \text{ for } m = 1 \text{ to } J$$

Estimated coefficients are interpreted as log odds and their corresponding confidence interval between alternatives and the base outcome that allows comparing (with signs and magnitude) between each category and the base category; *i.e.* similarly to interpreting binary outcome logistic regression (Hosmer & Lemeshow 2000, Long & Freese 2006).

## 5.4. Results and interpretation

### 5.4.1. Descriptive analysis of household livelihood changes

#### *5.4.1.1. Main patterns of changes on-farm*

In comparison to results reviewed in the literature, very similar trends are found from the empirical data on the recorded on-land changes at the household level.

In the survey questionnaire, a group of questions was asked to trace back the changes on the land of each household. These questions aimed to detect any changes in terms of farm-system, variety, ownership, and landscape, as well as the reasons for changes where applicable. The real-time main farming systems (Figure 5-7) are grouped from top to bottom and in colour ranges that reflects the ecological zones presented in the previous part, including rice/annual crops (in blue-range), rice-shrimp and shrimp/other aquaculture (in orange-range), located in fresh-water, rotating, saline-water zones respectively. The questionnaire was designed to capture both recent (in the last five years) and earlier

[24] Refer to Section *5.3.1* for a brief introduction and explanation of binary outcome models.

changes (which could be varied across households depending on their farming history[25]) that farmers have applied on their land. This exercise yields a clearer picture of the dynamic nature of the process of change in the studied coastal areas.

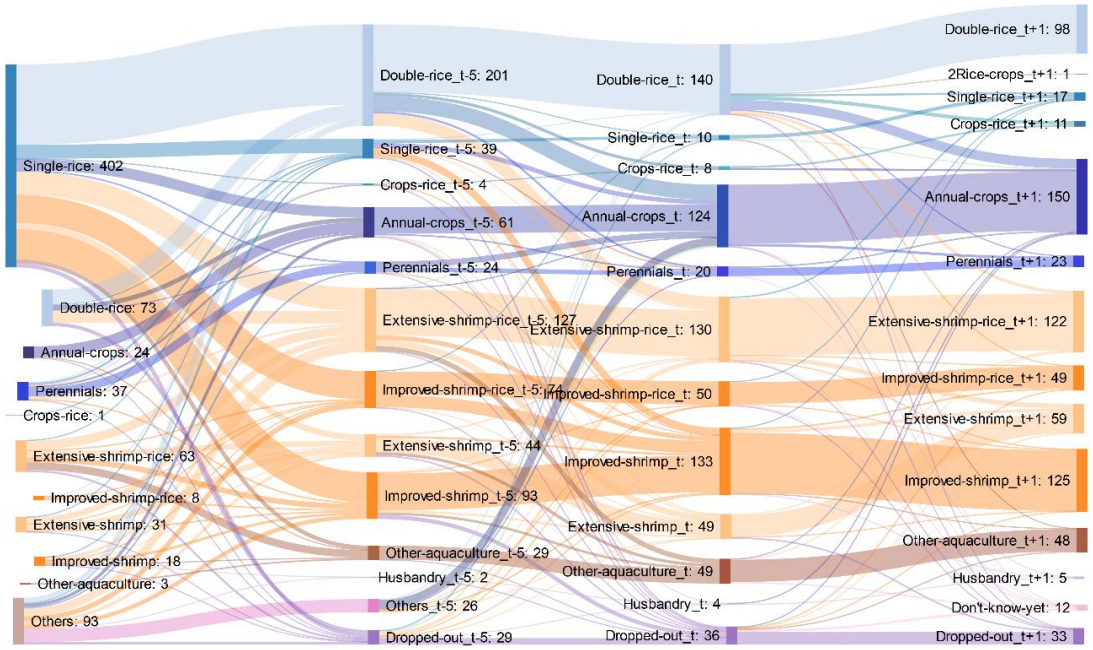



*Figure 5-7: Flow charts of households' land-use change in the last five years and further before in the MD*
(*N=524; number of land-plots presented on graph*)

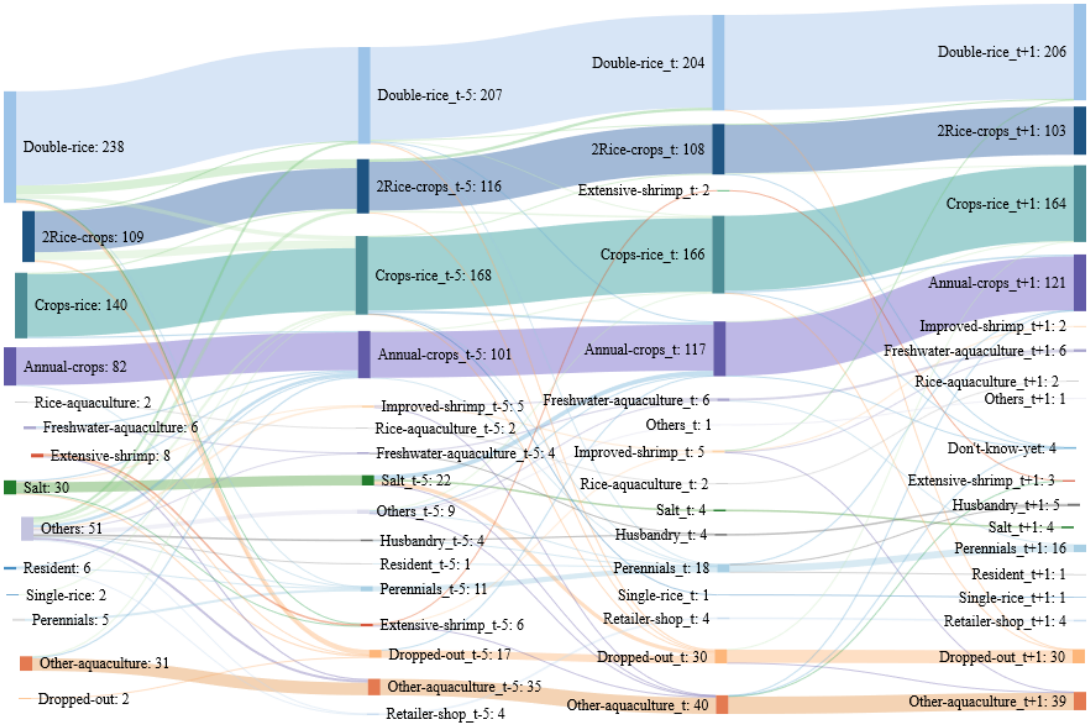



*Figure 5-8: Flow chart of households' land-use change in the last five years and further before in the RRD*
(*N=324; number of land-plots presented on graph*)

[25] The first vertical bars in Figure 5-7 and Figure 5-8 are intentionally left non-linear to indicate the various time frame.

Cases of different systems run by each farmer are also considered since the details of the change are collected per land-plot. Farmers are asked to distinguish their plots only in case of different systems, numbers of crop season per year or varieties. Each household could list up to a maximum of five different land-plots. The output of this exercise is presented in Figure 5-7 and Figure 5-8 for the case of the MD and the RRD respectively.

Unsurprisingly, the two deltas are non-identical due to the dissimilarity of their background (see Section 2.2). What could be foreseen is the unequal level of dynamics between them. Overall, the shifts are considerably more extensive and dramatic in the case of the MD than in the RRD. Nevertheless, there are major trends that could be spotted out that not only explain the current pictures but also are advantageous for discussing future trends. Two most remarkable trends of on-farm changes are as follows

*A strong divergence from rice production: diversification versus farming shifting*

The most recognisable trend is the divergence from single rice systems in the past. This trend is an on-going process that has been lasting over the last decade. The main patterns, unsurprisingly, head towards annual crops (other than rice) and aquaculture (mostly shrimp farming) which strongly mirror the overall trends of change in the region as portrayed above. Obviously, the change is bigger and more extensive in the MD than in the RRD. Similarly, on other farm-use, the RRD has been shaped much earlier. The dynamics start to appear recently, yet involving a small number of households rather than massive trends as in the MD. Therefore, it is intrinsic to also understand the roots of these changes and learn if they are transient or it is, in fact, a transition into a long-term trend.

The 'spaghetti' tracks of changes applied on-farm, particularly the case of the MD in Figure 5-7 also indicates that the products and intensity level of change on-farm matters as they bring more insights into why, how and who involved in these changes. Therefore, in this study, farm system shift is distinguished from diversification of crops for the following reasons: (i) it implies if a farmer is passive or (pro)active to change, *i.e.* if they are allowed to shift or not (*able to change versus unable to change*); in the case of no land conversion banned policy, why some of them chose to diversify instead of shifting (*wish to change versus do not wish to*); (ii) similarly to the level of farm intensification level, the intensity of changes applied on land also implies a link with non-farming income sources to some extent. This distinction is important in examining the determinants of on-farm changes (Section 5.4.2.1) as well as in developing the livelihood-change typology (Section 5.4.3). This research argues that such a distinguishing reveals the heterogeneity within each household group which is normally classified based on the similarity either in terms of location or social-ecological background (*e.g.* wealth ranking or exposure to a specific hazard risk).

Moreover, this distinction is applicable to explain the difference of on-farm change between the MD and the RRD, most noticeably the trend towards annual crops rather than rice. On the same observed divergence from rice, while rice farmers in the RRD opt for

diversifying by adding other crops to rice land so that rice production is maintained at about the same levels (*e.g.* two seasons per year), those in the MD tend to convert their rice fields entirely into other types of crop fields (*e.g.* vegetable, lemongrass). Regarding farm-shifting definition, in the RRD, new types of farm are more likely added with new land-plots by households rather than shifting from one farming system to another. This is particularly the case of saline-water aquaculture in which farmer buy or rent new lands either outside of the sea dike or by the dike (inside) where aquaculture is allowed to (cases found in Giao Xuân commune of Nam Định and Vinh Quang commune of Hải Phòng). This, together with the inherited problem of land fragmentation (see Section 2.2) might explain why farmers in the RRD, on average, have more plots than in the MD despite owning a much smaller average land area. In this respect, Figure 5-9 shows that while two-thirds of households in the RRD have at least 3 land-plots, only one-fifth of households in the south do. To some extent, it indicates the higher diversification of farm production in the RRD than the MD. Currently, this aquaculture area is by far smaller than agriculture systems (*i.e.* rice and other annual crops). Therefore, all in all, this does not appear as a noticeable trend in the RRD. However, due to the increasing concerns on salinity issues and other environmental changes in the delta's coastal case study areas, it is of great relevance to take into consideration these on-farm dynamics.

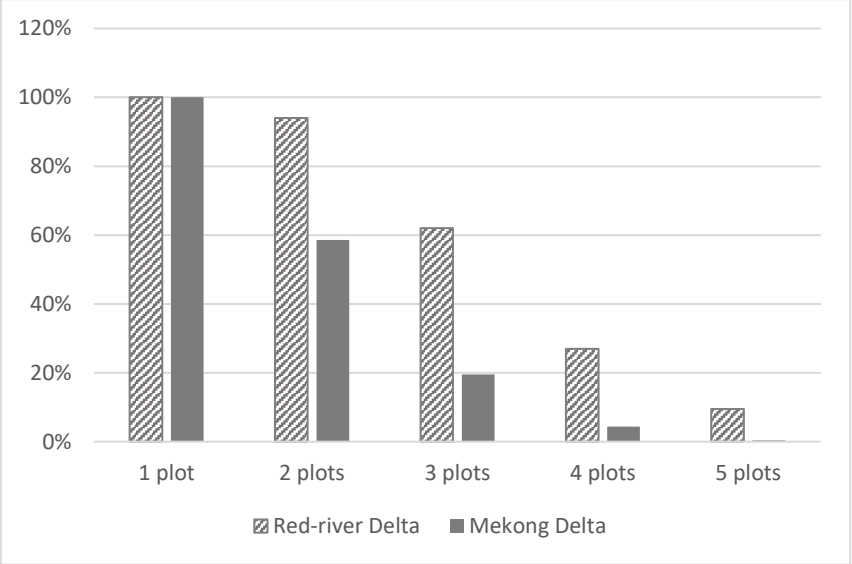



*Figure 5-9: Percentage of households having 1-5 land-plots in the RRD (n=326) and MD (n=524) deltas*

*Intensification is common across all types of farm production and emerging issues*

Improved varieties explain the major shift from single rice to double rice in the earlier stage in Figure 5-7 for the case of the MD. Other factors such as the development irrigation system and food security (rice-first national policy during the 1980s-1990s) are as much important in this process.

> "Since 1989, thanks to the new varieties the workload has been reduced because transplanting was much easier. Comparing to the new varieties, the old ones took longer for harvesting with lower productivity." (4112.580, 17/07/2016)

The difference between the two deltas regarding the history of rice cultivation development could be explained by the hydraulic management. Farming more than one season of rice a year (double rice and triple rice) is applied much later in the MD than in the RRD due to the centuries-aged sea dike in the latter. Yet farmers in inland diked areas of the MD have quickly caught up with the trend in the last two decades. Apart from irrigation and varieties, the availability of inputs (*e.g.* fertilizers, pesticides) and farm mechanization speed up this process (II-KG-P01, II-ST-D01-C04, GD-TG-D01).

A similar story could be found in aquaculture. Particularly, shrimp farming is increasingly intensified; especially in the mono-shrimp farming zone (Vĩnh Châu, An Minh districts) for higher profits in a shorter time (GI-ST-D02). This has been practiced earlier in the Cà Mau peninsula of the MD yet it only gets popular in the studied provinces (Tiền Giang, Sóc Trăng, and Kiên Giang) in the last ten years (GI-ST-D01, EI-TG-C02, GI-KG-D01, EI-KG-V01, II-KG-V02). More interestingly, intensifying shrimp farming is also found in the rice-shrimp rotation system which means farmers increase the stock density, food, and other inputs. This normally comes with smaller and deeper ponds as well as more shrimp seasons per year which leads to issues in the rotating calendar and *reversing* back to rice farming. Many households come up with missing one or even more rice seasons that explains partly the shift towards mono-shrimp farming in communes like Vĩnh Hiệp in the past and current trends in the rice-shrimp rotation system.

> "(I) also have the intention to farm rice again in order to improve the soil quality…yet don't know when…I'm afraid rice farming is not as easy as it was before because the ponds are too deep now." (2231.301, 09/05/2016)

Amongst the smaller aquaculture households in the RRD, they rather apply the intensive system from the beginning except for the large-size farm outside of the sea dike (*i.e.* either clamp farming or integrated with mangrove forest). More recently, the local authority in Vinh Quang commune has provided information about the piloting of a new rotating farming system: rice-rag worms[26] (*Tylorhynehus heterochaeta)* (II-HP-C01). Farmers are learning how "clean" rice farming could create the best environment to attract the most of ragworms to their field. This story might confirm the trend of increasing aquaculture in study communities in the future (II-HP-C01).

The survey data of the farm intensification level is available. Nevertheless, it is not reflected in the regression models to ensure the sample size requirement (for each sub-group). Rather, this type of data is found significantly helpful for detailed illustration which brings up interesting insights into on-farm changes.

[26] Ragworms grow naturally once a year (November - December) at estuaries areas and bring high profits (Chu 2018).

#### *5.4.1.2. Increasing weights of non-farm income sources*

Simultaneously, the data underpins the trend that rural non-agricultural livelihoods are rapidly increasing their visibility as well as contribution to the income structure of rural households (see Section 2.2.2 and 5.2.2). Our empirical data shows that these livelihoods vary from informal economic activities to different types of wage jobs (such as workforce for industrial firms) or local micro-business (*e.g.* retailer shops). Almost 73% of the households interviewed have more than one source of income that contributes up to 30% to the total income of the family on average in the last 5 years. Only 11% of the households have one income source. Therefore, besides changes on-farm, interviewed households were asked to list changes in their five main sources of income which could be from agriculture, aquaculture or non-farm professions. These questions will ensure to capture the latter which is more than often neglected by conventional farmers despite its rising contribution to households' total income (GSO 2018). As such, by recording the changes of livelihoods that go beyond agriculture, the empirical result shows more interesting insights. This is presented in Figure 5-10. Besides on-farm changes, the interviewed households were asked to recall the changes of their five main sources of income, which could be from either agriculture, aquaculture or non-farm activities. For each income source listed, households were asked a follow-up question of "What was in the place of this income source more than 10 years ago?". Only the respondents who reported a change are presented in Figure 5-10. The flows reveal that a large part of the divergence from rice has actually gone not only to other farm production but also to a large range of non-farm income sources. The destinations of this shift vary from informal economic activities (*e.g.* daily labour work, self-employment), to small business, waged jobs to remittances where, in most of the cases, households send their labour(s) away for either short-term or long-term income generation. Numbers on the figure are aggregated from the number of income sources listed by each household which could be five at the maximum.

Despite the substantial difference between the two deltas regarding the on-farm changes, when non-farm livelihoods are added to the picture, the divergence of household's income from rice-producing comes more obviously. The data of the whole survey sample reveals that almost 30% of the 26% of households perceiving rice as their most important income actually reported that rice accounts less than 25% of their total income on average in the last five years. In general, this source of income is not expected (by 95% of them) to increase in the near future (5-10 years). This is interesting as it shows that the perception of farmers on their "most important livelihood[27]" is somehow trapped with rice cultivation which might be potentially considered as one of the variables explaining the cognitive angle in the household decision-making process.

[27] Households were ask to list their income sources in the order of importance as they perceived, most important source came first.

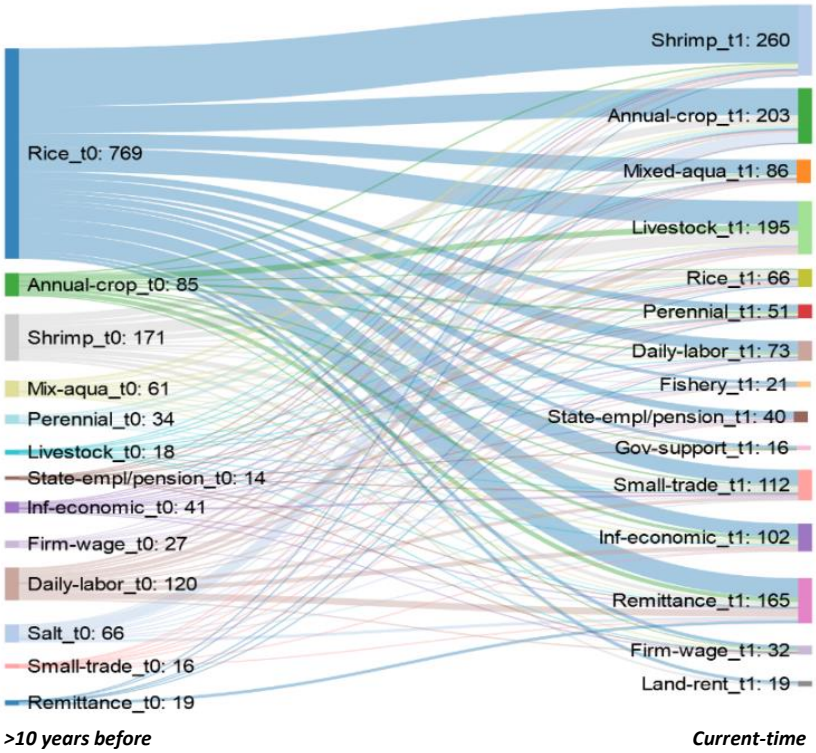



*Figure 5-10: Flow chart of households' income change in the last 10 years*

From a closer look, these non-farm income sources are 'younger' but strongly rising popularity among household's livelihoods which is confirmed by farmers when they are asked to recall how long they have been living off the current sources of income Figure 5-11. In general, the recently added income sources are more likely non-farm livelihoods. Yet according to households' estimation, their proportion of contribution to households' total income on average in the last five years outweighs that of farm income. Further shifting into non-farm livelihoods, therefore, might remain an important trend of rural transformation in the near future.

The increasing proportion of non-agricultural income implies the emerging labour mobility in these rural areas which potentially results in sources such as *remittance*, *firm wage* and *state employment*. The chart shows the inflated number of households considering remittances one of their main income sources. To the majority of these households, rice was the most important income source previously. In this study, this phenomenon is approached from the perspectives of multi-local livelihoods which involve the labour mobility and dynamic rural-urban linkages (see Section 3.1.8). However, related to remittances from abroad, this phenomenon has been found in the researched villages and confirmed through interviewing local authorities, mainly in the RRD studied villages yet limited supporting evidence was collected (EI-HP-C01, EI-ND-V01).

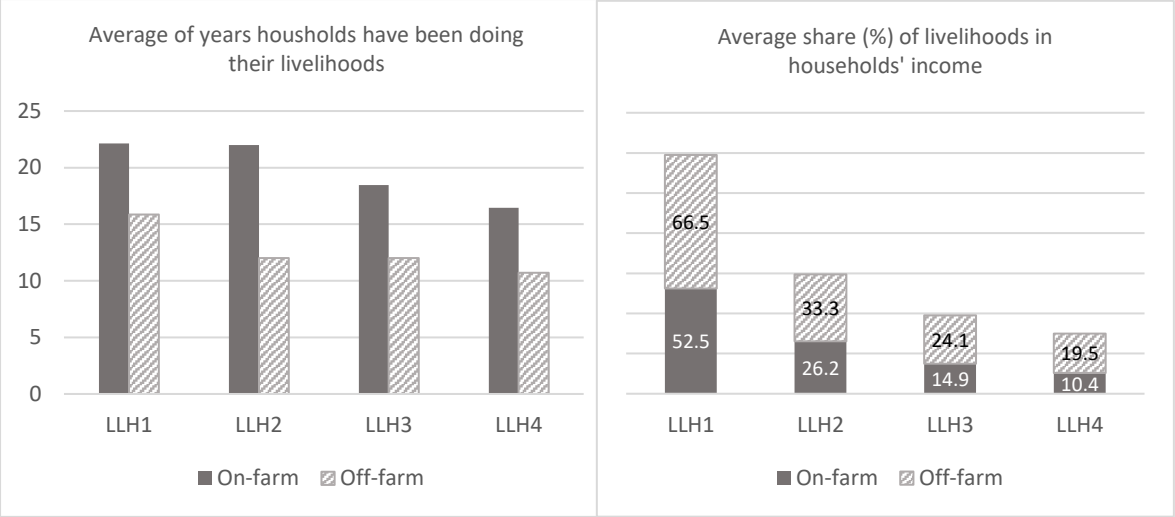



*Figure 5-11: The increase of non-farm component in households' income*
(*Household survey*, *N=850*)[28]

In line with this argument, higher education is a rising social phenomenon that could be intrinsically linked with rural livelihoods changes. It could be considered as a livelihood shift strategy, especially from a trans-generation perspective as a large number of households count on the younger generation's education so that they could "escape" from farming and improve their livelihoods for a better income and better future. With that expectation, farmers are more and more willing to invest in their children's education.

> "After finishing their high school, we put a target for all of them (children) to become teachers; so that they would have income and pension when they get old" (2211.249, 27/04/2016).

In contrast, some households consider education as a way to upgrade their farming business. These farmers are normally good at farming and accumulating capitals like land. Therefore, there might be some consequences of this divergent change where the latter group seizes the opportunity to take over the land resource in the long-term race. These findings feed a larger discussion that is coming in later chapters of this dissertation. Besides, due to the long-term returns of education and the mixed results of this investment as aforementioned, there is a group of households who are rather in doubt of the power of education. As mostly found, these farmers learn from the cases where educated young people failed to find a job while getting indebted because of paying education fee; hence they are discouraged to invest on their children's education:

> "I saw many families sold their land, their fields to cover their children's studying. But they (*the children*) are still living there (*in the village*) now because they could not find a job anywhere else or underpaid. Now they are also employed by others in the village… so, no better future!" (1121.159, 14/04/2016).

[28] The fifth income source is quite diverse and not really identified, hence being left out.

> "If they (children) have high grades, we'll invest; otherwise no… Education is costly while it's difficult to get jobs" (said a household below medium wealth-level with 3 sons at school – 4121.616,19/07/2016).

Nevertheless, in general, empirical evidence show that rural households are likely to be proactive or opportunistic in adjusting the livelihood strategy by either combining or shifting toward non-agricultural. Investment in children's education tends to get popular in these villages regardless of farmers' financial situation provided that they see the potentials of high return.

### 5.4.2. Determinants to household livelihood changes

#### *5.4.2.1. Environmental versus non-environmental factors*

As being highlighted in the introduction of the dissertation and this chapter, up-to-date literature rather stresses the direct link between on-farm changes and environmental issues (*e.g.* natural hazards, climate change), yet weakly examine the coupled role of other social factors to the process of change. In this section, the empirical data is displayed to prove that the reality, especially in the dynamic social-ecological context like Viet Nam urges to review this gap in research. In other words, data analysis is aimed at examining which role climatic and non-climatic factors play in explaining on-farm changes in the deltaic coastal areas.

When being directly asked on the reasons for change on-farm, interviewed households tend to provide mixed responses. Figure 5-12 is the case of the MD which shows the considerably strong economic drivers (i.e. *higher profit*) and state's interventions (*e.g. dyke* or top-down *planning*) behind farmers' decision to change their on-farm. Meanwhile, direct environmental factors such as *environmental changes*, *harvest loss* or *lack of water* (showed in patterned bars) were mentioned less frequently.

*Market drivers* tend to be dominant in directly pushing livelihood changes which holds across almost all groups of farmers. This is the typical case of shifting to aquaculture in areas close to the coast.

> "The price of shrimp increased and the majority of households in the neighbourhood just followed each other to change (from rice-shrimp) to mono-shrimp. And once my farm was surrounded by saline water, I had to change too." (2111.179, 4/2016)

Interestingly, supporting data shows that these market-driven shifts are on-going trends with emerging factors to further changes looking towards the future, particularly related to the shrimp business. In the case of shifting to mono-shrimp, when comparing the reasons for changes in the last five years with those of the previous phase (results not showed), farmers claim no more profit as a driver to change to double rice in the last five years. In the case of the MD, although shrimp farming is considered as the most money-making business, there is a tendency of households moving to other saline-aquaculture and/or

decreasing the level of intensification, *i.e.* shifting from improved shrimp-farming back to extensive shrimp farming because of shrimp harvest loss, particularly in the last five years.

Also found from this exercise, ***policy intervention*** is pivotal in explaining the farm use change, particularly in the current case of MD. In this empirical analysis, policy-intervention factors are revealed as households claim changes of their farms as responses to *diking*, *pumped-in saltwater* and *state's planning* (also in Figure 5-12). This could be the situation either in purposely diked areas (to keep fresh-water all year round) which links closely to the rice prioritising policy of the Vietnamese government; as rice is still considered the staple food nationwide (see Section 2.2.3); or in shrimp farming areas where sluice (outlet) gates are manually controlled (by local authorities) to keep saline water in the fields even during the rainy season.

> "I had no other way but following them." (*As talking about the "encouragement" guidance or incentives from local authorities*)
>
> "…Then the commune (*local authorities*) just pumped (*saline*) water into the field and we changed to shrimp". (EI-ST-V01, 08/2015)
>
> "We were fine with 2 rice crops per year… no worries, no anxiety (*about shrimp harvest loss*). I don't know why the authority did it (*encouraging farmers to shift the area toward aquaculture)"* (3122.476, 31/5/2016).

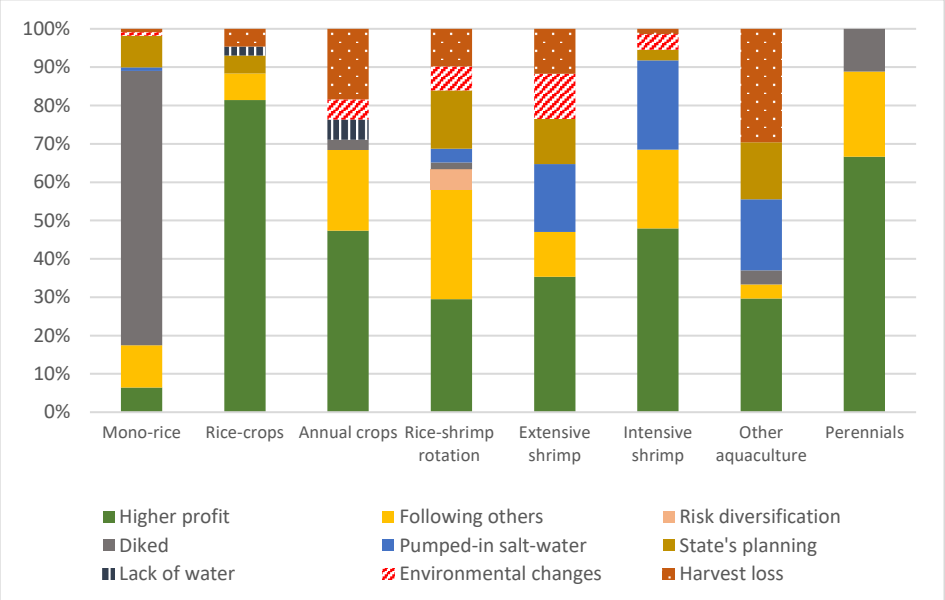



Figure 5-12: Primary reasons for changing to current farming systems of households in the MD

(N=428, changes on all land-plots (1-5 per household are covered))

The information from interviews with farmers, particularly those farming in the fresh-water zone shows the fact that they are well aware of what could be and could not be done on their land:

> "If we want to shift to annual crops, we have to ask for the authority's permission. Five years ago, I could just change if I wanted. Now, we are warned…we must ask for the permission first… Maybe they want to restrict (the conversion of land)!?" (2221.269, 28/04/2016)

This is also the explanation for the case in the RRD where producing a similar graph makes much less sense due to the fact that most of the farmers are restricted to make convert their land from the rice field. Regulations and the law related to land-use is strictly managed by the local authority and are well aware by farmers (II-HP-C01, EI-ND-C01).

> "Nowadays, the land conversion could only be approved by the provincial authority (*instead of by the commune authority as before*)" (4111.533, 15/07/2016)

> "This land (their farm) falls in the rice field category; it's impossible to convert into other plants such as 'hòe', 'đinh lăng' (perennial trees)" (4111.558, 16/07/2016)

In fact, adjusting farming systems is not claimed by surveyed households as the most popular coping or adaptation measure in response to their perceived climatic risks. Figure 5-13 shows that other practices such as adjusting their seasonal calendar, improving irrigation, varieties are as much or even more frequently applied in both cases of the MD and the RRD.

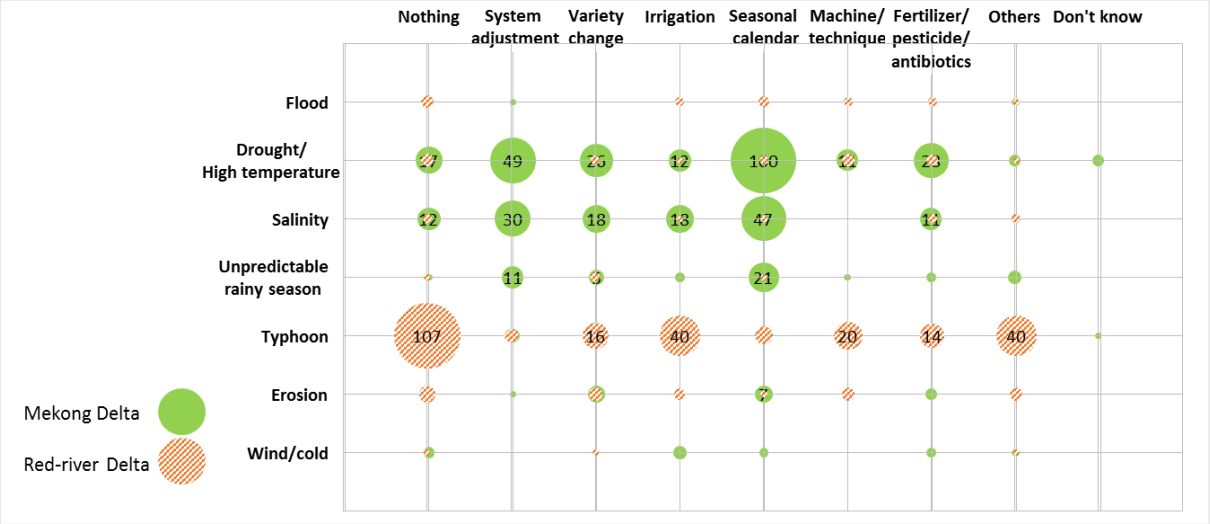



*Figure 5-13: Primary coping/adaptation strategies applied on-farm of households by their perceived highest risks* (*Household survey, N=850*) (*Number of responses presented on the graph*)

A further step into examining these coping and adaptation practices reveals the linkage between those at the household level and the measures implemented by the national government. Figure 5-14 shows the government's adaptation measures corresponding to specific climatic hazards that are aware and listed by households. The results of only four most frequently mentioned climatic risks are examined which are: high temperature, salinity (mostly in the MD), unpredictable rainy seasons and typhoon (mostly in the RRD). Therefore, although the survey data of both deltas shown on Figure 5-14, graph (B) is mostly driven by data of the MD's sub-sample (N=524), whereas graph (D) mainly reflected

the case of the RRD. This data appears that households, in fact, acknowledge the government's interventions, particularly those having direct impacts on their (mostly agricultural) livelihoods.

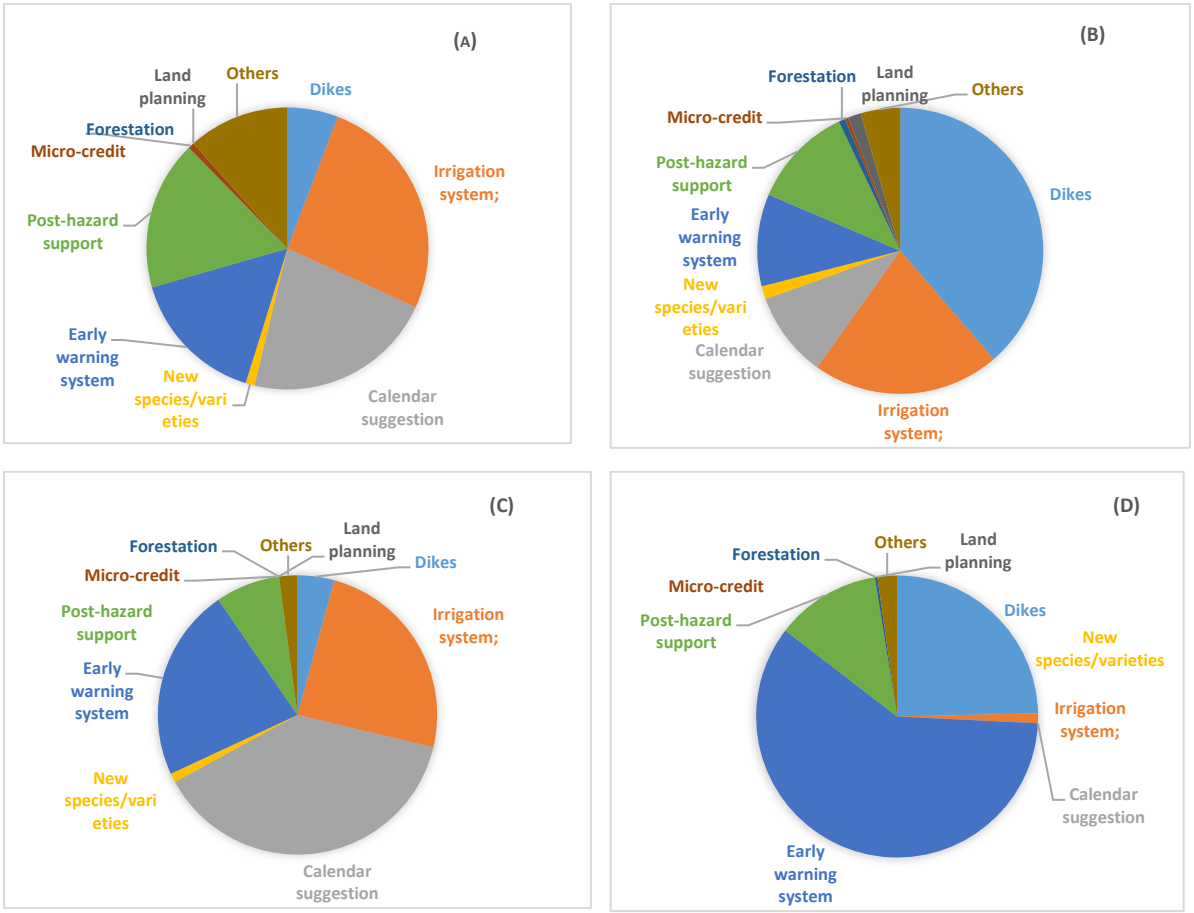



*Figure 5-14: Government's adaptation in response to specific climatic risks perceived by households*
*Most frequently listed (in decreasing order): (1) High temperature; (2) Salinity; (3) Unpredictable rainy season; (4) Typhoon (Household survey 2016, n=850)*

Interestingly, if comparing these that households list as their response to the government's adaptation measures versus those that they claim as their response to climatic risks (Figure 5-15), it actually discloses the correlation between coping and adaptation practices at the household level and those policy interventions. In other words, farmers are very responding to the authorities' intervention related to farming practices. Among these, farm-system shifts have mainly been their responsive actions to large-scale engineering solutions such as dikes and irrigation systems. The impacts of this hydraulic governance are also related. The "soft" coping and mechanisms (*e.g.* changing varieties, adjusting the crop seasonal calendar) also reflect the interaction between the coping and adaptation practices having been implemented at the household level with the interventions on the macro scale.

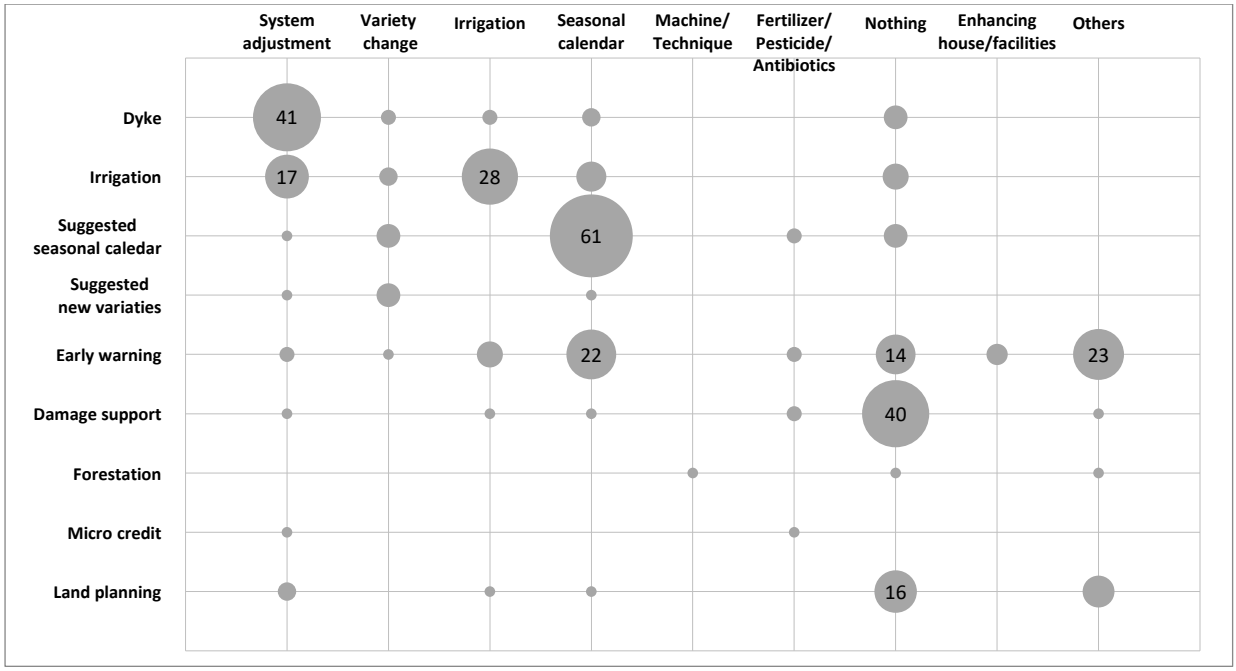



*Figure 5-15: Households' responses to government's coping and adaptation measures*
(Number of responses showed on figure, Household survey 2016, n=351[29])

The figure also reveals the interesting role of '*peer pressure*' factors which is *following others.* In this case, others are often neighbours, relatives or fellows in the same social groups of farmers. However, it is unclear if the involvement of farmers into this practice is active, reactive or passive.

Some described their unclear motivation in the middle of the period of change:

> "I saw everyone followed each other to convert to shrimp farming, so did I although I had little idea about the business…" (1111.012, 05/04/2016)

Some claim their passive situation due to the active practice – *following each other* of their neighbours:

> "All my neighbours were motivated by the high profits and followed each other to convert to shrimp farming…. we were surrounded by saline water…rice could no longer grow." (EI-ST-D02-HH01)

> "I've always preferred rice farming, but my neighbours farm shrimp on both side of my land, I have no other choice." (3111.375, 24/05/2016)

Ultimately, by one or another way, this operation at the household level clearly had an impact on the change process at the community level.

These findings support earlier explorative information on how a new (during the 1990s and early of the 2000s) livelihood such as shrimp business found its way into these studied communities. The outburst of shrimp cultivation among farmers themselves in the first place was also confirmed by the local authority, for the case of Sóc Trăng province, this

[29] Some answer option are left out to reduce noises in the data for analysis (*e.g.* '*do not know*', '*not applicable*')

dated back in the early 1990s (EI-ST-D02-V01). It was first a trial imitation practice of some 'pioneer' households due to the high profit that they learn from neighbour provinces (such as Cà Mau and Bạc Liêu). This farmer group then convince more farmers in their village to follow and later on earned the attention of local authority and the majority of their villagers which explains how shrimp was rapidly and widely applied in these areas (II-ST-D01-C02, EI-ST-D01-C01).

A similar example of "pioneer effect" in the dynamic regions of the RRD (Nam Định) was also found:

> "They allowed to bid for this land to try new farming systems, yet without any infrastructure or technical support…I initiated the idea to change and learned by myself how to do it….So if I succeed, many people will follow…But if not, no one dares to try again" (4112.568, 16/07/2016)

Therefore, this *social learning* process could be the key to speeding up individual and small-scale changes into macro trends. Figure 5-12 indicates that imitating and repetition play a certain role in driving the changes on-farm as a big portion of farmers claim "following others" as the reason why they shifted to the current farming systems. Figure 5-16 enforces these findings when looking into one case study of the trend moving towards shrimp farming (mostly found in the MD). More than two-third of shrimp farmers first learned about this livelihood from their neighbours and relatives. Also, another large part learned about shrimp farming from their local authorities which implies a passive path of getting information at the household level.

Preliminary findings show that as they both support the tendency to change so they by nature interconnect yet there is not necessarily a causal relationship. The causal relationship between the climatic issues and non-farm income diversification in rural areas is underpinned by the literature (see Section 1.2). However, in the studied coastal areas, their connections come in different forms, *i.e.* the change in this sector does not necessarily lead to the change in the other. Data related to labour mobility – one of the most noticeable non-farm livelihood changes shows that moving to urban areas is hardly driven by the loss of crops as showed in Figure 5-17. Rather, as also found in the case of on-farm changes, rural households in the studied areas mostly refer to economic drivers to their decision to send their members away such as higher income, employment or education/training opportunities. Income opportunities, and to some extent, the demand for cash is often referred to as among the most straightforward push-pull factor to the mobility of labours, particularly in the direction from rural to urban areas.

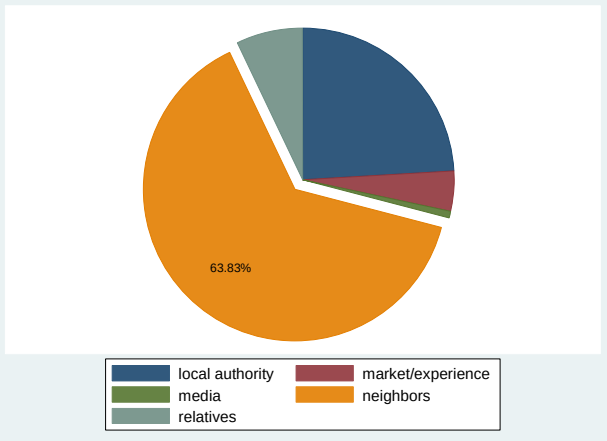



*Figure 5-16: Source of information of households to change to shrimp farming*
(Household survey, N=299)

The data from the household survey also allows inspecting the reasons for changes related to non-agricultural livelihood at the household level; driven by the questions: How do agricultural and of non-agricultural livelihoods actually link? What is the role of the environmental factor?

To a lesser extent, social capitals, for instance *following others*, or *knowing someone there* (at the destination) are listed quite frequently as the third important reason for a member to leave. This, interestingly, is in line with the findings on the social learning process as drivers for farm changes (see above).

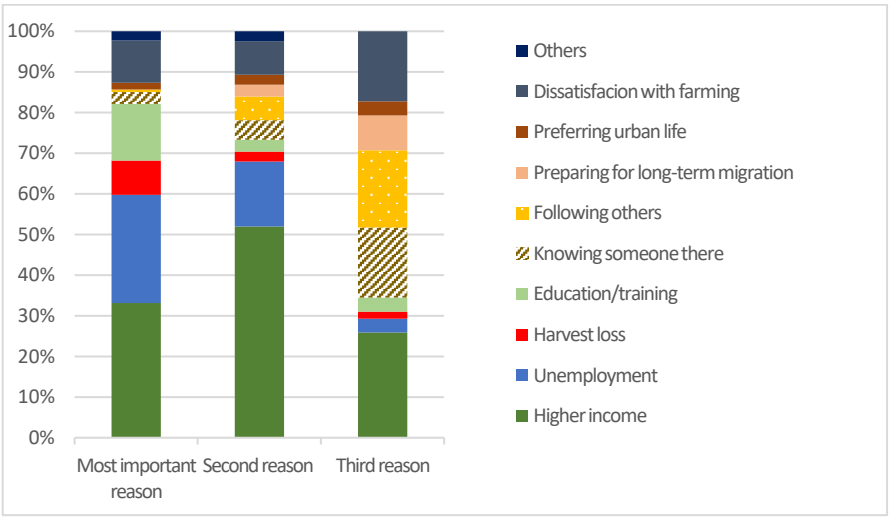



*Figure 5-17: Reasons for member(s) to leave the village of respondents*
(Household survey, N=537)

Nonetheless, farmers' decision to opt for self-employment or seasonal worker might respond to the relatively declining income from agriculture productions either because of the lack of production capitals, *e.g.* land, or the low market price of agricultural production, *e.g.* decreasing rice price. In other words, the link between agricultural and non-agricultural livelihood sectors might be explained through the available resources facilitating the change process of a household such as labour, financial, and social capitals.

"Farming (rice) at its best is just sufficient for our consumption. We need other jobs." (5112.757, 29/07/2016)

"…now that my parents are too old, and we don't have enough land to produce…we couldn't find a job in the village either…so I have to leave (the village to cities). If I could find a job around here, I wouldn't go. Before labours for rice farming was demanded, but it's not the case anymore…. now everything is done by machines, no more work for us." (2221.291, 29/04/2016)

*Barriers to changes*

Household not only opted for changing their main income sources in the last ten years as analysed in the previous section, but also wished to extend their changes on the current livelihood, or even to continue shifting to another source. In the case of the MD, shrimp farmers tend to favour expanding or intensifying their cultivation (patterned bars in Figure 5-18), yet relatively less of them wish to shift to another agricultural system than rice farmers. Meanwhile, in the RRD, a similar pattern is found for farmers doing annual crops. However, rice farmers in the RRD tend to also wish to intensify their cultivation.

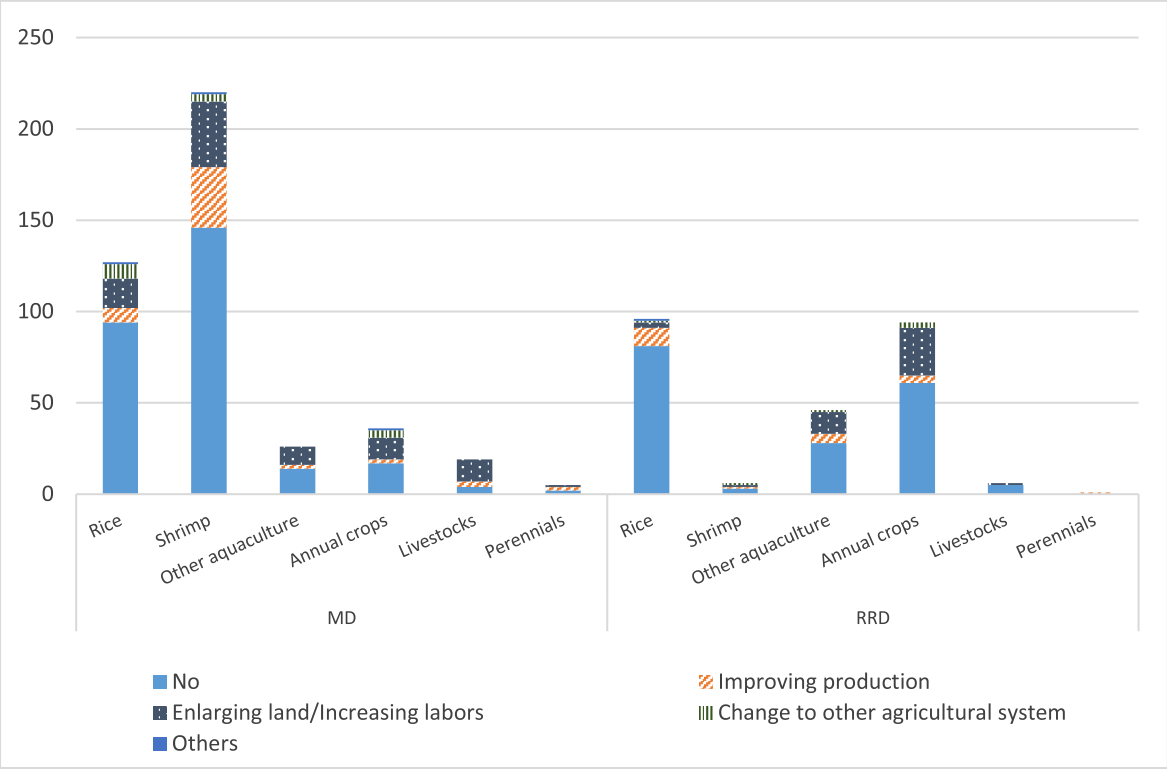



*Figure 5-18: Desired changes in income sources of households*
(Household survey 2016, N=310)

The questionnaire then seeks the reason why these households delaying further changes on their main income sources regardless of the agricultural or non-agricultural sector. Figure 5-19 shows that most of them claim the lack of capital was the main reason deterring them to change (patterned bars). The mostly mentioned is the financial constrain, followed by the lack of knowledge on the new livelihood or how to change, and lack of

labour. This seems to be the case of most farming systems, except for the case of mono-rice (in both deltas) and shrimp farmers (in the MD). Interestingly, rice farmers wishing to apply further changes are proportionally more concerned with policies/regulations change or guidance from local authorities. Meanwhile, shrimp farmers in the MD are likely to be concerned by the unfavourable climatic conditions in delaying changing. These insights are in line with the analysis of the reasons for the change in the section above.

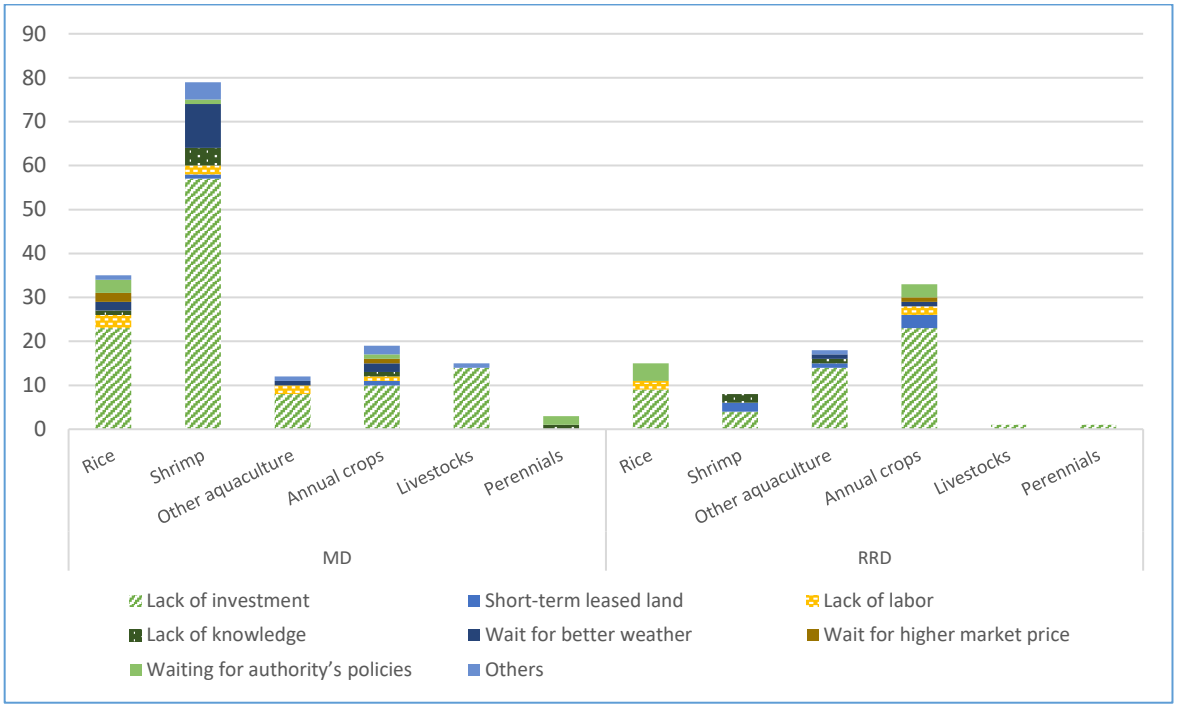



*Figure 5-19: Reason households could not be able to make changes in their income sources*
(Household survey 2016, N=310)

The following section provides further quantitative analyses to support these findings on factors to livelihood changes as well as the connection between the changes of agricultural and non-agricultural income at the household level.

#### *5.4.2.2. On-farm and non-farm shifts in parallel*

A large part of the literature analyses the factors to changes of rural on-farm and non-farm livelihoods separately, even though these two sectors are put in the same research, *e.g.* on the factors to the diversification strategy of households (McNamara & Weiss 2005), or on the role of non-farm activities as supplementing to farm income in reducing poverty of rural households (Hoang *et al.* 2014). Meanwhile, an expanding body of the literature attempts to examine the link between farm and non-farm changes on many aspects such as the connection between farmers' adoption of on-farm and non-farm diversification (Ullah & Shivakoti 2014), between non-farm share in total incomes with the rate of on-farm diversification (Tung 2017) which are getting more relevant given the new dynamic rural context. Therefore, in this study, the trends of change are examined in parallel for on-farm

and non-farm livelihoods in a balanced manner to figure out how they are driven and link in explaining the rural transformation.

Probit regressions (see Section 5.3.1) are set up separately for two levels of on-farm change which are: any type of farm change (1a, 1b) and farm-system shift (2a, 2b), and non-farm livelihoods (3a, 3b). Two sets of these three Probit models are run separately for the two deltas. The 1-0 dependent variables are generated of which yes (1) for any change recorded and no (0) otherwise. The distinguishing between farm-system shifts and other types of changes applied on-farm by households is explained in Section 5.4.1.1. This two-step regression analysis on households' decision of changing on-farm unveils more details of why and when farmers take one strategy instead of another because the level of change is argued to reflect the impacts of driving factors. Results in ***Table 9*** and ***Table 10*** show the determinants of each trend of change with the significance level of coefficients in the case study of the MD and the RRD respectively. Some of the insignificant coefficients that are irrelevant to the analysis were removed from these tables of regression results.

The description of the data used for these regressions of the MD and the RRD case studies is presented in ***Table 8***; a detailed description of these variables could be found in ***Table 5*** and ***Table 7*** (see 4.7). As also shown in ***Table 4*** most of the variables belonging to the main components remain the same as applied in these regressions, apart from the *Social learning* component.

In regards to *social learning* indicators, the available variables '*source of information*' and "*membership*" (as showed in ***Table 4***) bear the issue of sample bias. Instead, the interpretation of this component relies on variables '*number of skilled workers*' and '*number of state employers*' based on the argument that these indicators imply the social connection or network, thus having an impact on the social learning process at the household level in the context of Vietnamese rural areas (Tran *et al.* 2017, Clemens 2016). More specifically, higher values of these variables will increase the access to information related to livelihood sources.

**Table 8:** Summary statistics of variables – the MD case study

| Variables description | MD (n=524) | | RRD (n=326) | | Min | Max |
|---|---|---|---|---|---|---|
| | Mean | Std. Dev. | Mean | Std. Dev. | | |
| Farm change | 0.877 | 0.327 | 0.592 | 0.492 | 0 | 1 |
| Farm system shift (ever in farming history) | 0.755 | 0.43 | 0.23 | 0.422 | 0 | 1 |
| Non-farm change (ever before) | 0.467 | 0.499 | 0.585 | 0.493 | 0 | 1 |
| Age of household-head | 54.14 | 12.19 | 55.42 | 11.35 | 30 | 90 |
| Female headed *(1=yes;0=no)* | 19% | 0.396 | 15% | 0.354 | 0 | 1 |
| Household size | 4.438 | 1.632 | 3.970 | 1.446 | 1 | 11 |
| Education level of household-head *(1=Below primary; 2=Primary; 3=Secondary; 4=High-Higher)* | 1.740 | 0.922 | 2.860 | 0.82 | 1 | 4 |
| Dependency ratio *(0-49;50-99;100-199;>=200)* | 1.530 | 0.827 | 1.480 | 0.843 | 1 | 4 |
| Number of skilled workers *(household member)* | 0.257 | 0.627 | 0.901 | 1.008 | 0 | 4 |
| Number of state employers *(household member)* | 0.183 | 0.543 | 0.374 | 0.69 | 0 | 4 |
| Total land-area (in *ha*) | 1.52 | 1.61 | 0.574 | 1.096 | 0.005 | 12.3 |
| Quintiles of households' assets | 2.890 | 1.42 | 2.80 | 1.53 | 1 | 5 |
| House condition | 5.76 | 1.37 | 7.34 | 0.635 | 3 | 9 |
| Number of income sources | 3.16 | 1.19 | 3.58 | 1.11 | 1 | 5 |
| Total yield *('000vnd, sqrt)* | 156.52 | 121.47 | 207.77 | 97.39 | 0 | 735 |
| Number of land-plot *(1-5)* | 1.84 | 0.849 | 2.92 | 1.1 | 1 | 5 |
| Share of non-farm income (%) | 35.6 | 39.47 | 36.65 | 35.45 | 0 | 100 |
| Ratio of labour working far from home | 13.34 | 21.32 | 18.97 | 22.95 | 0 | 100 |
| Province | | | | | | |
| Kiên Giang | 33.0% | 0.47 | n/a | n/a | 0 | 1 |
| Sóc Trăng | 34.5% | 0.475 | n/a | n/a | 0 | 1 |
| Tiền Giang | 32.4% | 0.468 | n/a | n/a | 0 | 1 |
| Hải Phòng | n/a | n/a | 48.7% | 0.50 | 0 | 1 |
| Nam Định | n/a | n/a | 51.2% | 0.50 | 0 | 1 |
| Perceived salinity risk (1=yes;0=no) | 26.3% | 0.44 | 2.45% | 0.154 | 0 | 1 |
| Perceived high-temperature risk(1=yes;0=no) | 48.9% | 0.50 | 5.21% | 0.222 | 0 | 1 |
| Farm-type *(dummy: 10 categories)* | | | | | | |
| Mono-rice | 19.20% | 0.394 | 15.03% | 0.357 | 0 | 1 |
| Extensive shrimp | 7.06% | 0.256 | n/a | n/a | 0 | 1 |
| Fresh water aquaculture | 0.19% | 0.044 | n/a | n/a | 0 | 1 |
| Improved shrimp | 13.50% | 0.342 | n/a | n/a | 0 | 1 |
| Crops | 9.10% | 0.288 | 32.82% | 0.470 | 0 | 1 |
| No farm | 14.50% | 0.352 | 12.80% | 0.335 | 0 | 1 |
| Other saline aquaculture | 7.25% | 0.259 | 35.20% | 0.302 | 0 | 1 |
| Perennials | 1.71% | 0.130 | | | 0 | 1 |
| Rice-crop | 1.14% | 0.106 | 25.15% | 0.435 | 0 | 1 |
| Rice-shrimp | 26.10% | 0.440 | | | 0 | 1 |
| Others | n/a | n/a | 3.98% | 0.196 | 0 | 1 |
| Household's coping and adaptation *(dummy: 8 categories)* | | | | | | |
| Nothing | 13.2% | 0.338 | 40.0% | 0.490 | 0 | 1 |

| | | | | | | |
|---|---|---|---|---|---|---|
| System adjustments | 18.5% | 0.388 | 1.5% | 0.123 | 0 | 1 |
| Variety change | 10.7% | 0.309 | 8.0% | 0.272 | 0 | 1 |
| Irrigation | 7.1% | 0.256 | 14.4% | 0.352 | 0 | 1 |
| Seasonal calendar | 35.3% | 0.478 | 4.9% | 0.216 | 0 | 1 |
| Machines/ Technique | 2.5% | 0.155 | 9.2% | 0.290 | 0 | 1 |
| Fertilizer/ pesticide/food | 9.5% | 0.294 | 6.8% | 0.252 | 0 | 1 |
| Others | 3.2% | 0.177 | 15.0% | 0.358 | 0 | 1 |

**n/a: not applicable**

**Table 9:** Outputs of Probit regressions to study the determinants to household livelihood change– the MD case study

(*Changes on-farm* (1a), *Shift of farming systems* (2a) and *Non-farm income change* (3a))

| **Variables description** | **On-farm change *(1a)*** | | **Farm-system shift *(2a)*** | | **Non-farm income change *(3a)*** | |
|---|---|---|---|---|---|---|
| | AME | (Robust) Std. Err. | AME | (Robust) Std. Err. | AME | (Robust) Std. Err. |
| Age of household-head | -.0001 | (.001) | .0006 | (.001) | -.003** | (.001) |
| Sex of household-head | -.057 | (.034) | .019 | (.032) | .110** | (.050) |
| Household size | .017** | (.008) | .037*** | (.010) | -.006 | (.013) |
| **Education level of household-head** | | | | | | |
| Below primary *(reference group)* | | | | | | |
| Primary | -.026 | (.029) | .029 | (.031) | .078*† | (048) |
| Secondary | .002 | (.043) | .022 | (.041) | .065 | (065) |
| High-Higher | .023 | (.064) | .006 | (.058) | .119*† | (.085) |
| **Dependency ratio** | | | | | | |
| 0-49 *(reference group)* | | | | | | |
| 50-99 | .036 | (.028) | -.030 | (.040) | .096* | (.051) |
| 100-199 | .019 | (.040) | .015 | (.037) | .172*** | (.058) |
| >=200 | .075 | (.055) | -.035 | (.109) | .066 | (.152) |
| Number of skilled workers *(household member)* | .039 | (.061) | -.086** | (.042) | .191** | (.076) |
| Number of state employers *(household member)* | -.044 | (.066) | .159*** | (.054) | -.146* | (.087) |
| Total land-area *(in ha)* | .036** | (.018) | -.001 | (.009) | -.054*** | (.016) |
| **Quintiles of households' assets** | | | | | | |
| Quantile1 *(reference group)* | | | | | | |
| Quantile2 | -.005 | (038) | .047 | (.037) | -.018 | (.063) |
| Quantile3 | -.046 | (.041) | -.047 | (.044) | -.012 | (.061) |
| Quantile4 | .059* | (.033) | -.075 | (.065) | .016 | (.075) |
| Quantile5 | .010 | (.052) | -.044 | (.067) | -.050 | (.083) |
| House condition | -.004 | (.010) | -.007 | (.011) | .039** | (.016) |
| Number of income sources | .044*** | (.014) | .022*† | (.014) | .092*** | (.018) |
| Total yield *('000vnd, sqrt)* | -.0003 | (.0001) | .0003 | (.0001) | .0005** | (.0002) |
| Number of land-plot *(1-5)* | .007 | (.020) | .025*† | (.018) | -.019 | (.027) |
| Share of non-farm income *(%)* | -.0003 | (.0004) | -.001** | (.0004) | .002*** | (.0006) |
| Ratio of labour working far from home | -.0002 | (.0007) | -.0009*† | (.0006) | .003*** | (.0009) |
| **Province** | | | | | | |
| Kiên Giang *(reference group)* | | | | | | |
| Sóc Trăng | .011 | (.037) | -.088* | (.048) | -.063 | (.061) |
| Tiền Giang | .055*† | (.039) | -.063*† | (.048) | -.101*† | (.064) |
| Perceived salinity risk *(1=yes;0=no)* | .047 | (.037) | -.058*† | (.042) | .063 | (.057) |
| Perceived high-temperature risk*(1=yes;0=no)* | .019 | (.034) | .017 | (.037) | .058 | (.052) |
| **Farm-type** | | | | | | |
| Mono-rice | -.040 | (.033) | -.198*** | (.051) | .088*† | (.061) |
| Extensive shrimp | .058 | (.050) | -.148** | (.073) | .152* | (.083) |
| Fresh-water aquaculture | -- | -- | -- | -- | -- | -- |
| Improved shrimp | -- | -- | .065*† | (.044) | .123* | (.071) |
| Crops | -- | -- | -.107*† | (.067) | .013 | (.079) |
| No farm | -.329*** | (.112) | -.868*** | (.018) | .172** | (.073) |
| Other saline aquaculture | -- | -- | -- | -- | -.145* | (.083) |
| Perennials | -- | -- | -- | -- | -.074 | (.146) |
| Rice-crop | -- | -- | -.374*** | (.143) | .353** | (.151) |

| | | | | | | |
|---|---|---|---|---|---|---|
| Rice- shrimp *(reference group)* | | | | | | |
| **Coping/adaptation practices** | | | | | | |
| Nothing *(reference group)* | | | | | | |
| System adjustment | .138*** | (.038) | .029 | (.053) | -.092 | (.073) |
| Variety change | .105*** | (.039) | -.002 | (.062) | .018 | (.086) |
| Irrigation | .101** | (.041) | .026 | (.061) | -.025 | (.099) |
| Seasonal calendar adjustment | .066*† | (.041) | -.068 | (.056) | -.140* | (.067) |
| Machines/technique | -- | -- | -.184 | (.157) | -.280*** | (.098) |
| Fertilizer/pesticide/food | .051*† | (.036) | .006 | (.067) | -.110 | (.085) |
| Others | -.012 | (.090) | -.014 | (.106) | -.329*** | (.081) |
| Constant | -1.59 | 1.47 | 1.23*† | (.886) | -1.64*** | (.524) |
| Number of observations | 342[30] | | 471 | | 515 | |
| LR (chi2) | 240.04 | | 322.86 | | 154.97 | |
| Prob > chi2 | 0.000 | | 0.0000 | | 0.0000 | |
| McFadden's R2 | 0.728 | | 0.585 | | 0.217 | |

*Significant at p<0.01***, p<0.05**, p< 0.1* level; †: one-tailed test*

[30] Farming systems such as *improved shrimp*, *crops*, *other saline aquaculture*, *rice-crop* are predicted to change perfectly in the Probit regression, hence being dropped from the estimation, therefore the number of observation reduced.

**Table 10:** Outputs of Probit regressions to study the determinants to household livelihood change – the RRD case study

(*Change on-farm (1b)*, *Shift of farming systems (2b)* and *Non-farm income change (3b)*)

| **Variables description** | **On-farm change *(1b)*** | | **Farm-system shift *(2b)*** | | **Non-farm income change*(3b)*** | |
|---|---|---|---|---|---|---|
| | AME | (Robust) Std. Err. | AME | (Robust) Std. Err. | AME | (Robust) Std. Err. |
| Age of household-head | .002 | (.002) | .0007 | (.002) | -.005** | (.002) |
| Sex of household-head | .033 | (.072) | .020 | (.073) | .195*** | (.070) |
| Household size | .009 | (.021) | .001 | (.018) | .0084 | (.021) |
| **Education level of household-head** | | | | | | |
| Below primary *(reference group)* | | | | | | |
| Primary | -.180* | (.109) | -.019 | (.109) | -.2209** | (.111) |
| Secondary | -.061 | (.098) | .084 | (.093) | .004 | (.103) |
| High-Higher | -.120 | (.115) | .057 | (.122) | -.092 | (.115) |
| **Dependency ratio** | | | | | | |
| 0-49 *(reference group)* | | | | | | |
| 50-99 | -.019 | (.076) | .038 | (.077) | .101*† | (.078) |
| 100-199 | .098 | (.078) | -.010 | (.079) | -.040 | (.077) |
| >=200 | -.290*† | (.179) | -- | -- | .099 | (.201) |
| Number of skilled workers *(household member)* | .010 | (.033) | .053* | (.031) | .0216 | (.034) |
| Number of state employers *(household member)* | -.071*† | (.045) | -.049 | (.042) | -.0238 | (.0465) |
| Total land-area *(in ha)* | .140*† | (.104) | .012 | (.026) | -.037 | (.034) |
| **Quintiles of households' assets** | | () | | | | |
| Quantile1 *(reference group)* | | | | | | |
| Quantile2 | -.025 | (.075) | -.050 | (.067) | -.081 | (.074) |
| Quantile3 | .044 | (.087) | .097 | (.091) | -.098 | (.088) |
| Quantile4 | -.072 | (.075) | -.014 | (.067) | -.014 | (.076) |
| Quantile5 | -.055 | (.092) | .009 | (.081) | -.091 | (.086) |
| House condition | .009 | (.039) | .038 | (.037) | -.049 | (.037) |
| Number of income sources | .042*† | (.026) | .048* | (.025) | .088*** | (.025) |
| Total yield *('000vnd, sqrt)* | -.0006* | (.0003) | -.0003 | (.0003) | .001*** | (.0003) |
| Number of land-plot *(1-5)* | .057** | (.028) | .063** | (.026) | -.028 | (.026) |
| Share of non-farm income *(%)* | -.001** | (.0009) | .00006 | (.0008) | .004*** | (.0008) |
| Ratio of labour working far from home | .001 | (.001) | .001 | (.001) | .0005 | (.001) |
| **Province** | | | | | | |
| Nam Định *(reference group)* | | | | | | |
| Hải Phòng | .056 | (.061) | -.101*† | (.065) | .050 | (.061) |
| Perceived salinity risk *(1=yes;0=no)* | .190*† | (.130) | .158 | (.165) | -.132 | (.162) |
| Perceived high-temperature risk*(1=yes;0=no)* | -.078 | (.114) | -.112*† | (.074) | -.106 | (.109) |
| **Farm-type** | | | | | | |
| Mono-rice *(reference group)* | | | | | | |
| Crops | .256*** | (.063) | .541*** | (.071) | -.089 | (.081) |
| No farm | .058 | (.079) | -- | -- | -.017 | (.087) |
| Other saline aquaculture | .295** | (.114) | .224** | (.109) | -.247** | (.112) |
| Rice-crop | .049 | (.067) | .089*† | (.066) | -.147** | (.068) |
| Others | .291*** | (.109) | .535*** | (.106) | -.331*** | (.114) |
| **Coping/adaptation practices** | | | | | | |
| Nothing *(reference group)* | | | | | | |
| System adjustment | -.019 | (.224) | .0370 | (.189) | -.029 | (.199) |

| | | | | | | |
|---|---|---|---|---|---|---|
| Variety change | .044 | (.090) | .020 | (.083) | -.128*† | (.097) |
| Irrigation | .174** | (.073) | .044 | (.068) | -.097 | (.076) |
| Seasonal calendar adjustment | -.033 | (.113) | -.012 | (.108) | .040 | (.119) |
| Machines/technique | .252*** | (.074) | .150*† | (.095) | -.061 | (.092) |
| Fertilizer/pesticide/food | .141*† | (.091) | .258** | (.112) | -.075 | (.101) |
| Others | -.016 | (.077) | -.065 | (.072) | -.118 | (.074) |
| Constant | -1.56 | (1.24) | -4.85** | (1.55) | 1.03 | (1.19) |
| Number of observations | 319 | | 277 | | 319 | |
| LR (chi2) | 105.72 | | 102.37 | | 109.35 | |
| Prob > chi2 | 0.0000 | | 0.0000 | | 0.0000 | |
| McFadden's R2 | 0.245 | | 0.320 | | 0.252 | |

*Significant at p<0.01***, p<0.05**, p< 0.1* level; †: one-tailed test*

Overall, in six regressions, many variables share similar impacts (with expected sides and, to some extent, magnitude) on all types of change. Nevertheless, the decision of a household to change farm could be determined by those with no explaining power to the changes of their non-farm income. In other words, the dynamics of both farm and non-farm livelihoods could tell the story together. Moreover, the results show a significant difference in explaining the farmers' decision to shift farming systems with other adjustments on the farm. This backs the argument that the intensity of changes applied on-farm is significant in explaining the livelihood-change strategy at the household level in the studied areas.

As shown in ***Table 10***, variables *farm-type* and households' '*perceived salinity risk'* imply the restriction on land-use change. *Mono-rice* and *Crops* indicate the situation in purposely diked areas (to keep fresh-water the whole year round) which links closely to the promoting rice agricultural policy of the Vietnamese government as rice is still considered as the staple food nationwide (see Section 2.2.3). Comparing to the most flexible zone (represented by the *'Rice-shrimp rotation'* system), households in other zones are less likely to shift their farming system, except *Shrimp intensification* (usually changed from the extensive system). Meanwhile, farmers in other farming systems are more likely to change non-farm livelihoods.

Among the wealth indicators, house condition seems to be a better one in showing the difference of economic status between the changing versus no-changing household groups regarding the change of non-farm income. This could be linked to remittance which is likely to be used for improving house conditions. The first reason that the asset index is not significant is that this indicator also includes farm-production assets (*e.g.* pump, tractor, *etc.*) rather than only durable items. Secondly, the various value ranks of the same asset item (*e.g.* television) could mislead the analysis as it considers only the ownership of the items regardless of their values. Hence, it fails to provide information on spending habits due to the higher availability of cash.

The link between farm income and the changes in non-farm income is examined through total yield. However, the positive impact of total yield on driving non-farm income change

does not seem to support the literature finding that non-farm livelihoods are the means to make up for the loss of farm yield. This rather confirms the proactive strategy of households in adjusting their livelihoods, i.e. as long as farmers could change, they would rather change which, in return, improves their livelihoods and facilitate even further changes. Although the coefficients are significant, their magnitude on average is considerably small. Meanwhile, the insignificant marginal effect of *total yield* (last year) in the case of farm-change and farm-shift decision does not support the descriptive data where profit is found as a strong driver to households' decision (Figure 5-12). The first possible justification is that the shift usually took place 5-10 years ago, while the data on yield is solely collected for the last harvest seasons. Secondly, in the case of the MD, shrimp farmers also reported on the diminishing profit of this business in the last few years (see Section 5.4.2.1). Therefore, the *yield* of last year could not reflect this process. This is one of the limitations of the data for modelling.

Regarding the impact of geographical distance – '*province*' indicator, none of the models finds a significant difference among the provinces to changes of both types of livelihood. Even in non-farm sectors, changes are unlikely to be affected by distance to urban centres. Rather, households are quite proactive everywhere. This is the case found in both deltas which is more likely expected in the RRD than in the MD.

In general, the variables '*number of income sources', 'number of land-plots',* and *'share of non-farm income'* which indicate household livelihood diversification strongly associate with changes of both farm and non-farm income (see ***Table 9*** and ***Table 10***). These variables have significant coefficients to the change of either or both trends. Changes of non-farm income are more likely implemented by households with a higher share of non-farm income, and most noticeably more connected with labour mobility (higher ratio of labour working away in total labour number of a household).

In the meantime, economic indicators such as *yield* or *household assets* do not show significant impacts (either significance level or magnitude). An indicator for diversification to formal non-farm income could potentially associate with education (*number of skilled workers*) where it imposes opposite impacts on the two trends. This, however, is not a conflict, but rather aligning with the discussion that high-education could be considered as a part of non-farm livelihood dynamics as discussed in Sections 5.2.2 and 5.4.1.2). In some cases, it is the alternative pathway of households whose farms locating in restricted-to-change areas, *i.e.* diked for freshwater zone, for instance, mono-rice farmers. Yet irrespective of the reasons, outcomes of the regressions manifest that it strongly increases the probability that a household would change their non-farm income.

In general, coping and adaptation practices by households which are argued to imply the role of *policy interventions* in Section 5.4.2.1, impose significant impacts on livelihood-change decisions of households. However, in model **(2b)**, the significant coefficients are

found only for the adaptation measures: *irrigation*, *fertilizers,* and *mechanization,* which indicate that farm-change strategy in the RRD mostly relates to the intensification process, particularly rice intensification. Also shown by this model **(2b)**, comparing to all other groups of farmers, *mono-rice* farmers are more active in changing their non-farm income, while they are less likely to change on-farm than any other.

Meanwhile, households in the MD that practice *irrigation* adaptation measures and *adjusting seasonal calendars* are less likely to apply changes to their non-farm livelihoods. This is likely to be the farmer group in the fresh-water zone because those coping measures may associate with *mono-rice* or *crop* farming systems. Apart from that finding, results from the regression on farm-change **(1a)** strategy in the MD provides limited information, e.g. no significant difference between farm types. The changes rather associate with *coping and adaptation practices*, yet do not show the connection between these practices and *perceived hazard risks*. This could be explained by the fact that this strategy is enormously popular among farmers in the coastal areas of the MD. Notwithstanding, the farm shifting model **(1b)** provides more insights on the divergent and multi-level changes on-farm. Results of this model **(1b)** manifest that farm-shifting more associated with farm-system than adaptation options taken by households. In other words, the decision *to shift* or *not to shift* dominantly links to policy intervention. Meanwhile, models on the RRD indicate that changes on-farm could already reflect the policy intervention which is shown through farm systems; yet in general, the models are less significant than the MD's sample. The *goodness of fit* of these models was tested.

All in all, household's decisions to adjust (e.g. intensification or diversification) or to shift farming systems as well as to apply changes on non-farm livelihood complement in most cases. Important results show that household groups that are able to change are often more proactive in improving both agricultural and non-agricultural livelihood sectors. The strategy that favours changes could take place *independently* or *in parallel* between those two sectors, rather than showing their causal relationship. The following sub-sections illustrate how those determinants work by looking into details of the two most popular trends of on-farm and non-farm livelihood change, respectively the household's decisions: *to shift towards shrimp farming* and *to send household's labours to work/study away from the village.* The findings of this step aim to reaffirm the direction of factors' impacts on the livelihood change. They, therefore, not only support the arguments on determinants to households' main trends of change in the prior analysis but also bring forth more evidence for important discussion later in this chapter and of the whole dissertation.

***Shifting towards shrimp farming decision making – A Probit model***

Given the fact that shrimp farming is more popular in the MD and applied by a very modest number of households in the RRD, this analysis is conducted solely for the case of MD. However, as it is of high potentials to turn into a trend in the RRD in the future due to the

on-going drastic changes. A similar analysis could also be applied for the case in this delta in the coming future with sufficient data and a larger and sample size. The outcome of the Probit regression is a binary variable that carries value 1 if a household has ever *changed toward shrimp farming* on their land, and 0 otherwise. The regression results are presented in ***Table 11***. The analysis of these results is limited to providing supporting evidence to the main findings presented above.

Overall speaking, it enhances further the results of the Probit models of farm-change and farm-shift in the analysis above. Particularly, Probit regressions results (***Table 11***) show the flexibility to change on-farm which is indicated by *farm types* show the dominant significance in explaining the shift toward shrimp farming in the coastal areas. Meanwhile, indicators of livelihood diversification such as number of income sources, number of land plots show their positive relationship with the decision to change to shrimp from any other source.

Besides, in this case, it reveals that wealth indicators such as the *assets index, total land area,* and *house condition* have significant impacts/reflections on the decision to change of a household. The possible explanation is the homogeneity of the sample in terms of context (geographical location) and livelihood groups. This, in fact, is in line with the qualitative data from observation and information from unstructured interviews with farmers and local authorities. Shrimp is a fast business, *i.e.* high profit could be earned in a very short time (and as does deficit) which promotes spending on physical or durable assets, and also house construction. Therefore, in the MD, in shrimp cultivation villages, house quality on average tends to be higher than in other regions

> "In this village, thanks to the shrimp, people could build houses and send their children to schools" (2231.312, 10/05/2016)

Nevertheless, some factor lost their significant impact. Non-farm related factors such as non-farm share and ratio of members working away could significantly explain the decision to shift farming system and to change non-farm income sources in the joint model for the whole MD (see ***Table 9***), yet have no significant impact on the decision to change to shrimp farming. This is indeed in line with the argument that household's decisions of livelihood-change on agricultural and non-agricultural sometimes are not interdependent and farmers could proactively change them in parallel.

In short, modelling smaller and more homogenous group (of only mono-shrimp farmers in this case) will not only proves the main findings in studying the determinant factors to household's decision of livelihood change but also provides even further detailed findings that support the analysis on the whole research population.

**Table 11:** Probit models of determinants to households' decision to shift towards shrimp farming (*Standard errors* in parentheses)

| Variables description | Change to shrimp | |
|---|---|---|
| | AME | (Robust) Std. Err. |
| Age of household-head | .001 | (.001) |
| Sex of household-head | -.033 | (.033) |
| Household size | -.014*† | (.009) |
| **Education level of household-head** | | |
| Below primary *(reference group)* | | |
| Primary | .024 | (.031) |
| Secondary | -.129*** | (.047) |
| High-Higher | -.016 | (.053) |
| **Dependency ratio** | | |
| 0-49 *(reference group)* | | |
| 50-99 | .021 | (.033) |
| 100-199 | -.001 | (.039) |
| >=200 | -.171*† | (.107) |
| Number of skilled workers *(household member)* | .039 | (.061) |
| Number of state employers *(household member)* | -.044 | (.066) |
| Total land-area *(in ha)* | .033** | (.014) |
| **Quintiles of households' assets** | | |
| Quantile1 *(reference group)* | | |
| Quantile2 | -.0005 | (.0404) |
| Quantile3 | -.011 | (.037) |
| Quantile4 | .1008** | (.047) |
| Quantile5 | .128** | (.059) |
| House condition | -.025** | (.0101) |
| Number of income sources | .052*** | (.013) |
| Total yield *('000vnd, sqrt)* | -3.05e-06 | (.0001) |
| Number of land-plot *(1-5)* | .0307* | (.017) |
| Share of non-farm income *(%)* | .0001 | (.0003) |
| Ratio of labour working far from home | -.0005 | (.0006) |
| Loans | -.006 | (.030) |
| Perceived salinity risk *(1=yes;0=no)* | .054*† | (.037) |
| Perceived high-temperature risk*(1=yes;0=no)* | -.006 | (.034) |
| Time since last lost harvest | .004 | (.007) |
| **Farm-type** | | |
| mono-rice *(reference group)* | | |
| extensive shrimp | 3.68*** | (.482) |
| fresh-water aquaculture | -- | -- |
| improved shrimp | 4.47*** | (.521) |
| crops | .711* | (.371) |
| no farm | 1.38*** | (.356) |
| other saline aquaculture | 3.89*** | (.603) |
| perennials | .781 | (.648) |
| rice-crop | -- | -- |
| rice-improved shrimp | 3.35*** | (.511) |
| rice- extensive shrimp | 2.78*** | (.312) |
| others | -.012 | (.090) |
| Constant | -3.59*** | (.765) |
| Number of observations | 495 | |
| LR (chi2) | 437.47 | |
| Prob > chi2 | 0.000 | |
| McFadden's Adj R2 | 0.548 | |

*Significant at p<0.01***, p<0.05**, p< 0.1* levels; †: one-tailed test*

***Labour-mobility decision making – A Probit model***

If the sub-sample of shrimp farmers were used to examine the factors to the decision to change on-fam, these regression models inspect the determinants to opt for sending members at labour age to work or study away from home. Labour mobility and the multi-local livelihoods are argued by this research to be an increasingly important non-farm livelihood strategy of rural households.

Among households contribute to the human rural-urban mobility in the deltas (63% of the survey sample), two-third is either having or once had (in the last ten years) member(s) sent away as labours with various reasons (Figure 5-20). It makes sense to see what are driving farmers and what might explain the decision of those who did not opt for change.

Looking into the descriptive data of this livelihood-related phenomenon, kinship and social connection play an important role in facilitating the mobility of rural labours. Personal network (patterned slices in Figure 5-20) is the main source of information (67%) of opportunities for moving in the studied communities. This could come from their peers in the community or directly from their own connections at the destinations. This information is usually about not only job availability but also living experiences. This source of information, to some extent, has an impact on the expectation of people looking for a job in other localities.

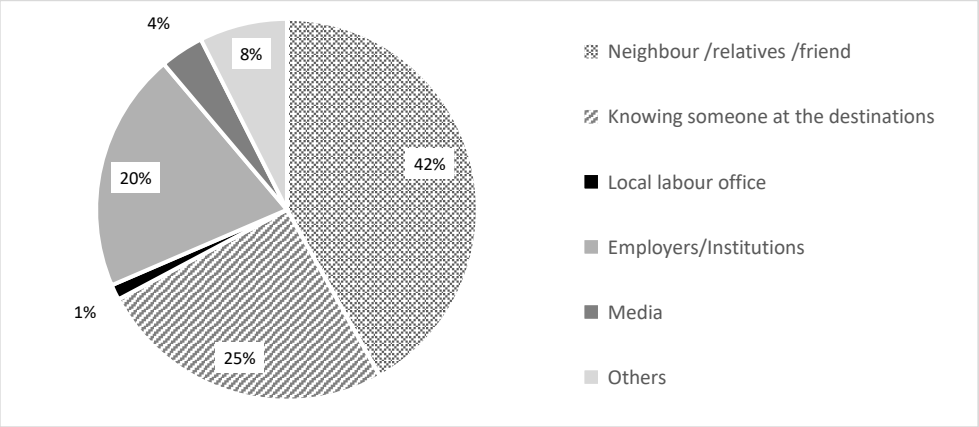



*Figure 5-20: Source of information of working/studying away by informants (Household survey 2016, n=537)*

As expected, the main destinations of the labour flow from the studied villages are big cities (Hanoi or HCMC) and concentrated industrial parks (mostly located in Bình Dương) (patterned slices in Figure 5-21). This could also be influenced by the purpose of higher education (*i.e.* universities) or professional training in these regional urban centres, particularly HCMC. Besides, moving forth and back between their villages and other areas within the same province remains an important option (account for 24%) of households which underlines the multi-local livelihood strategy of rural households in the studied areas.

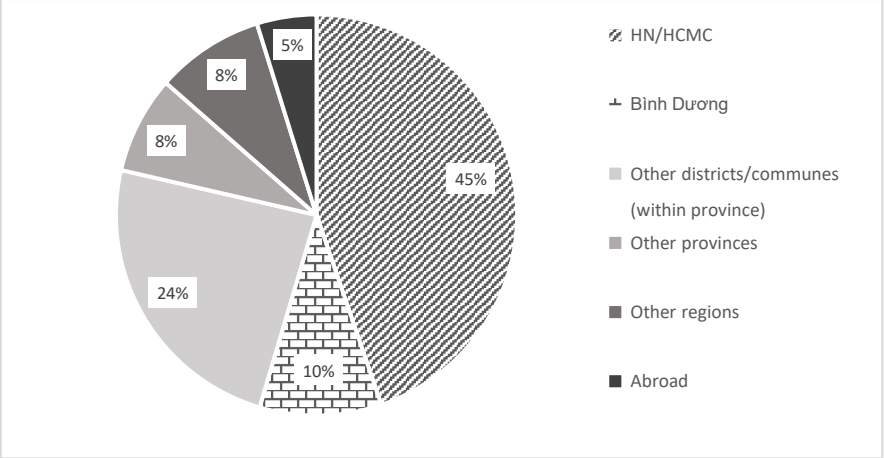



*Figure 5-21: Destination of households' members' outflow (excluding for marriage purpose)* (*Household survey 2016, n=458*)

Taking into consideration of differences between the two deltas, another series of Probit regression was then run to look into the determinants of the labour-mobility decision of household for each delta as well as jointly for both deltas in order to double-check the stability of the model specification. Generally speaking, the statistics of the significance test in ***Table 12*** shows that the model specification performs well on these three sub-samples regardless of the difference in scale. It, therefore, affirms the validity of the main explanatory factors to drive a household to send one or more members away. This supports the argument that this livelihood strategy is less context-based. In other words, it is less likely to be driven by local ecological setting and perhaps is more associated with the socio-economic transitions which pose similar impacts nation-wise speaking. However, looking into the details, the significance, as well as insignificance of some coefficients are able to reflect on the regional characteristics:

- The outputs of the regression confirming what has been discussed on the role of the social network to the decision at the household level.
- The education level of household-head makes more sense in the RRD and thus influences outputs of the joint model as well
- *Age of household-head* has explanatory power solely in the MD, potential because there are less options for change for the northern households; thus, this strategy is more widely applied in the RRD than the MD, therefore, the group that did not make the change is too small.

In general, the results support the arguments that the *availability* of options to change is critical in determining household decisions and thus the popularity of labour-mobility strategy above.

**Table 12**: Probit models of determinants to households' decision to send labour(s) away
(*Standard errors* in parentheses)

| Variables description | Model 1 – Mekong Delta | | Model 2 – Red-river Delta | | Joint model for 2 Deltas | |
|---|---|---|---|---|---|---|
| | AME | (Robust) Std. Err. | AME | (Robust) Std. Err. | AME | (Robust) Std. Err. |
| Age of household-head | .005** | (.002) | -.0001 | (.003) | .003* | (.001) |
| Female headed *(1=yes;0=no)* | -.037 | (.054) | .140 | (.100) | .025 | (.051) |
| Khmer ethnicity *(1=yes;0=no)* | .029 | (.092) | | | .036 | (.075) |
| **Education level of household-head** | | | | | | |
| Primary or lower (*reference group*) | | | | | | |
| Secondary-to-high school | .035 | (.064) | .128* | (.074) | .102** | (.045) |
| Higher education | -.106 | (.137) | .108 | (.153) | -.025 | (.102) |
| **Dependency ratio** | | | | | | |
| 0-49 | | | | | | |
| 50-99 | -.143*** | (.051) | -.299*** | (.073) | -.184*** | (.043) |
| 100-199 | -.211*** | (.043) | -.487*** | (.044) | -.292*** | (.037) |
| >=200 | -.238*** | (.061) | -.189 | (.190) | -.232*** | (.077) |
| Household size | .113*** | (.016) | .166*** | (.028) | .124*** | (.014) |
| **Quintiles of households' assets** | | | | | | |
| Quantile1 (*reference group*) | | | | | | |
| Quantile2 | .047 | (.071) | .085 | (.100) | .044 | (.059) |
| Quantile3 | .008 | (.068) | -.006 | (.109) | -.016 | (.057) |
| Quantile4 | -.172*** | (.061) | .047 | (.096) | -.072 | (.057) |
| Quantile5 | -.037 | (.090) | -.120 | (.10) | -.075 | (.065) |
| Total yield *('000vnd, sqrt)* | -.001*** | (.000) | .0001 | (.000) | -.001*** | (.0002) |
| Availability of local off-farm work *(1=yes;0=no)* | -.089* | (.050) | -.171** | (.074) | -.119*** | (.041) |
| Income change (last 10 years) *(1=yes;0=no)* | .112 | (.070) | .064 | (.090) | .036 | (.059) |
| Land-use change (last 5 years) *(1=yes;0=no)* | -.112** | (.049) | .039 | (.089) | -.072* | (.042) |
| Member working for government *(1=yes;0=no)* | .095 | (.080) | .171** | (.075) | .108** | (.052) |
| Total land-area (in *ha)* | -.054** | (.023) | -.123*** | (.043) | | |
| **Quintiles of land-area** | | | | | | |
| Quantile1 | | | | | .109 | (.086) |
| Quantile2 | | | | | 0.300*** | (.077) |
| Quantile3 | | | | | 0.220*** | (.069) |
| Quantile4 | | | | | 0.105* ψ | (.064) |
| Quantile5 (*reference group*) | | | | | | |
| **Proximity to urban centres** | | | | | | |
| close | | | | | | |
| average | -.036 | (.085) | -.071 | (.077) | -0.016* ψ | (.049) |
| far | -.148** | (.063) | | | -0.140** | (.055) |
| **Farm-type** | | | | | | |
| Mono-rice *(reference group)* | | | | | | |
| rice-crops | -.072 | (.152) | -.097 | (.090) | -0.039 | (.068) |
| other saline aquaculture | -.015 | (.100) | .090 | (.149) | 0.018 | (.081) |
| no farm | -.019 | (.095) | .211** | (.102) | 0.119 | (.077) |
| crops | -.034 | (.092) | .056 | (.113) | 0.046 | (.073) |
| rice-(extensive) shrimp | .072 | (.079) | | | 0.088 | (.076) |
| improved shrimp | -.088 | (.080) | .361** | (.164) | -0.067 | (.077) |
| fresh aquaculture/ livestock/perennials | -.047 | (.130) | -.352*** | (.120) | -0.173* | (.093) |
| extensive shrimp | -.020 | (.103) | | | -0.015 | (.105) |
| rice-improved shrimp | -.095 | (.093) | | | -0.113 | (.091) |

| | | | | | | |
|---|---|---|---|---|---|---|
| **Hazard risks** | | | | | | |
| No risk | -.037 | (.204) | -.285 | (.272) | -.110 | (.169) |
| Flood/inundation | .139 | (.246) | .074 | (.200) | .224* | (.124) |
| Drought/high temperature (*reference group*) | | | | | | |
| Salinity | -.025 | (.053) | .071 | (.280) | -.015 | (.057) |
| Unpredictable rainy season | -.111 | (.068) | | | -.052 | (.079) |
| Typhoon | .027 | (.102) | -.136 | (.148) | .016 | (.060) |
| Extreme cold weather | -.108 | (.090) | -.217 | (.145) | -.066 | (.079) |
| Others | -.008 | (.157) | | | -.111 | (.134) |
| Ever lost farm-income *(1=yes;0=no)* | .058 | (.059) | .237*** | (.083) | .133*** | (.049) |
| Constant | -1.88*** | (.512) | -1.66 ** | (.816) | -2.201*** | (.441) |
| Number of observations | 521 | | 312 | | 842 | |
| Wald statistic | 136.37 | | 91.68 | | 206.91 | |
| Prob > chi2 | 0.0000 | | 0.0000 | | 0.0000 | |
| Pseudo R2 | 0.240 | | 0.241 | | 0.218 | |

*Significant at p<0.01***, p<0.05**, p< 0.1* levels*
*ψ: one-tailed test*

Models' outputs show households with less *land*, larger *household-size* with *fewer children,* potentially *easier access to information* and relatively *closer to urban* areas are more likely to send their labours away (***Table 12***). Noticeably, the decision of households is strongly responding to the *unavailability of local work* (both on- and off-farm) which also correlates with the need for income diversification and land-use change possibility, rather than among various hazards risks and farm-types. It reflects the key differences between two deltas which emphasize that the *restricted land-use change* and the regional equivalent urbanization level in RRD in all studied villages (*i.e.* indicators of location and distance to urban centres) suppress their effects on explaining the labour mobility trends while showing significant in the MD.

In sum, similarly to the story of descriptive data of livelihood change presented in Figures 5-7 and 5-8 versus 5-10, the two deltas tend to share more common trends of non-farm change despite the incompatible farm-use change. Therefore, the Probit models to study household's decision to change their non-farm income are quite consistent across the delta-level sub-sample, which was not the case for Probit models on-farm system shifts (as shown in ***Table 9***). What holds across deltas is that similarly to the dynamics of agricultural sectors, the market was obviously an essential driver in the non-agricultural transformation process, whistle policy intervention and local authority play an important role in facilitating changes.

Thereupon, in the first step of detecting the trends of changes on farms, the fact that there have been fewer dynamics happening on-land in the RRD comparing to the MD has already implied the unbalance of impacts of the same factors across and between factors on the same area; yet the analysis also shows the variance between the impacts of factors on non-farm livelihood changes.

### 5.4.3. A typology of households' livelihood-change in the deltaic coastal rural

The results presented in Section 5.4.1 has been clearly showing that the process in which rural households change their livelihoods has been rapid and diverging in the last few decades in all study sites. While each household has been a part of this process to some extent, the level and pathway of change are not the same for all of them. This selection of livelihood-change strategy is argued here to imply the heterogeneity, particularly the capacity to adapt to households which is critical in understanding the adaptation process. Therefore, capturing the factors to their decision to change allows identifying the vulnerable groups as well as enablers and barriers to the process of changes not only at the household level but also potentially at a larger scale. A typology approach is applied for this purpose.

A classification tree with a simple Boolean rule (0-1) was used to identify if a household applies any change on their farm and non-farm income sources. There are three layers of change considered for each household which are illustrated with colours in Figure 5-22. The first layer identifies if a household has applied any change of income. In the case of change related to farm income, it classifies in the second layer of this tree: to what extent it was – diversification/intensification versus system shifts (see Section 5.3.2 for detailed explanation). After changes in farm income have been identified, changes related to non-farm income are added in the third layer. The chart then lets households group themselves where each household could solely belong to one livelihood-change type (Figure 5-22). In brief, the nature of livelihood changes considered in this classification tree includes:

- Farm-shifting: if there has been an agrarian shift on any land plot/new land plot listed by household
- Farm diversifying: if the system is basically the same; yet there has been a change in variety or intensification level
- Change non-farm: new income source replacing either an old farm or non-farm income source in the last 10 years, listed by households

The classification procedure results in seven types of livelihood-change strategies taken by households which range from no change at all to intensive changes in both farm (shifting farm system) and non-farm income sources (adding at least a new non-farm income in the last 10 years). They are also numbered increasingly according to this intensity of change, *i.e.* 1=no change, up to 7=most changes applied. Further description of each type is provided in the comparative analysis in Section 5.4.4. Each household can only belong to one type. However, as showed on the figure, due to very small number of the household belonging to type 2-*No farmland & non-farm livelihood changes* in the RRD and type 3-*No change on-farm & change non-farm* in the MD, they are eliminated from the multinomial models of these deltas accordingly (results is presented in Section 5.4.4).

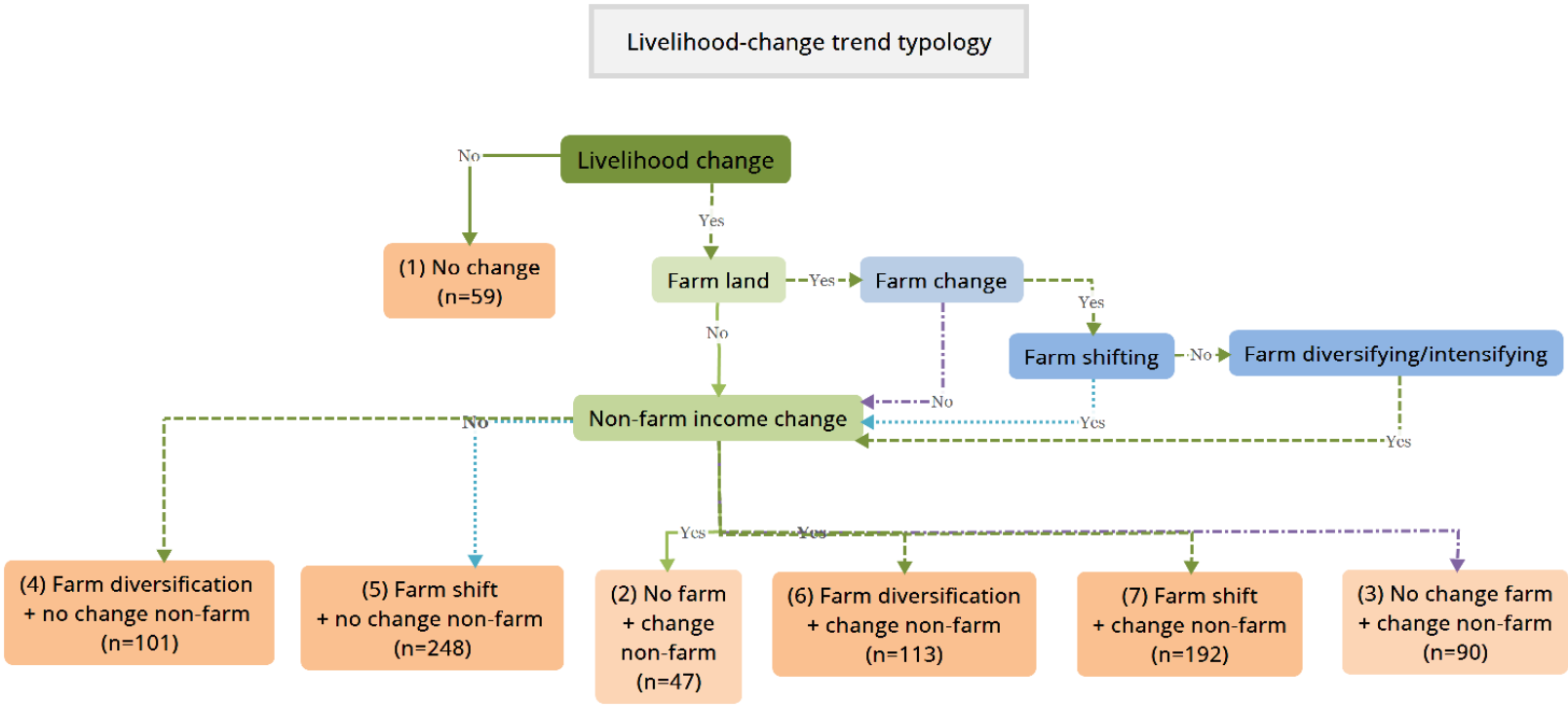



*Figure 5-22: Classification tree used to formulate the typology of livelihood-change trends applied by rural households*

(Green, blue, orange stand for three layers/steps of classification in order, Household survey 2016, N=850)

This classification method fulfils the objectives to cover both farm and non-farm dynamics of rural households in the coastal areas of the deltas. This is the first step towards better understanding the details of change at a micro-level and reflecting on larger trends. At a more detailed level, it is able to reflect well on the extensity of change, particularly in terms of household's land-use strategies, which might be the key to getting a more detailed level of household classification and thus detecting more precisely the most vulnerable groups.

The distinction between farm-shifting versus farm-diversification options also, in fact, implies the legal restriction of changes on arable lands which is argued here as a crucial factor in explaining the changes - as discussed before. Despite the simple rule of classification, the method was able to capture the livelihood dynamics in the coastal rural area, and therefore not only reflecting, but also explaining the macro trends in this region and others in the country. In this exercise, the administrative border (*i.e.* villages) becomes less relevant as a criterion to identify different rural household groups although it could rather reflect partly the distribution of farming systems. Furthermore, the typology adequately considers non-agricultural livelihoods which are less geographically divided.

*Distribution of typology and the regional effect*

Within each delta region, the distribution of livelihood-change types across studied communes shows the heterogeneity of livelihood-change strategies within each community which is irrelevant to administrative borders and proximity to the coast as well as to urban centres (Figure 5-23 is the demonstration of the MD case study). Nevertheless, also due to this artificial division between diked and non-diked areas within these villages, farm system shift versus farm diversification makes it significant to distinguish household groups based on the legitimate permission to change their farm-use. Therefore, on-farm diversification is obviously more dominant in fresh-water villages (*i.e.* diked areas). In contrast, farmers tend to opt for shifting to aquaculture where they are permitted.

The proportion of households with (patterned slices in Figure 5-23) and without changing their non-farm income within each commune is relatively equal. This active strategy towards non-farm income sources mainly distinguishes among the households that share the same on-farm change strategy, i.e. between groups 4 and 6 who opt for farm intensification/diversification; or between groups 5 and 7 who used to shift their farming systems.

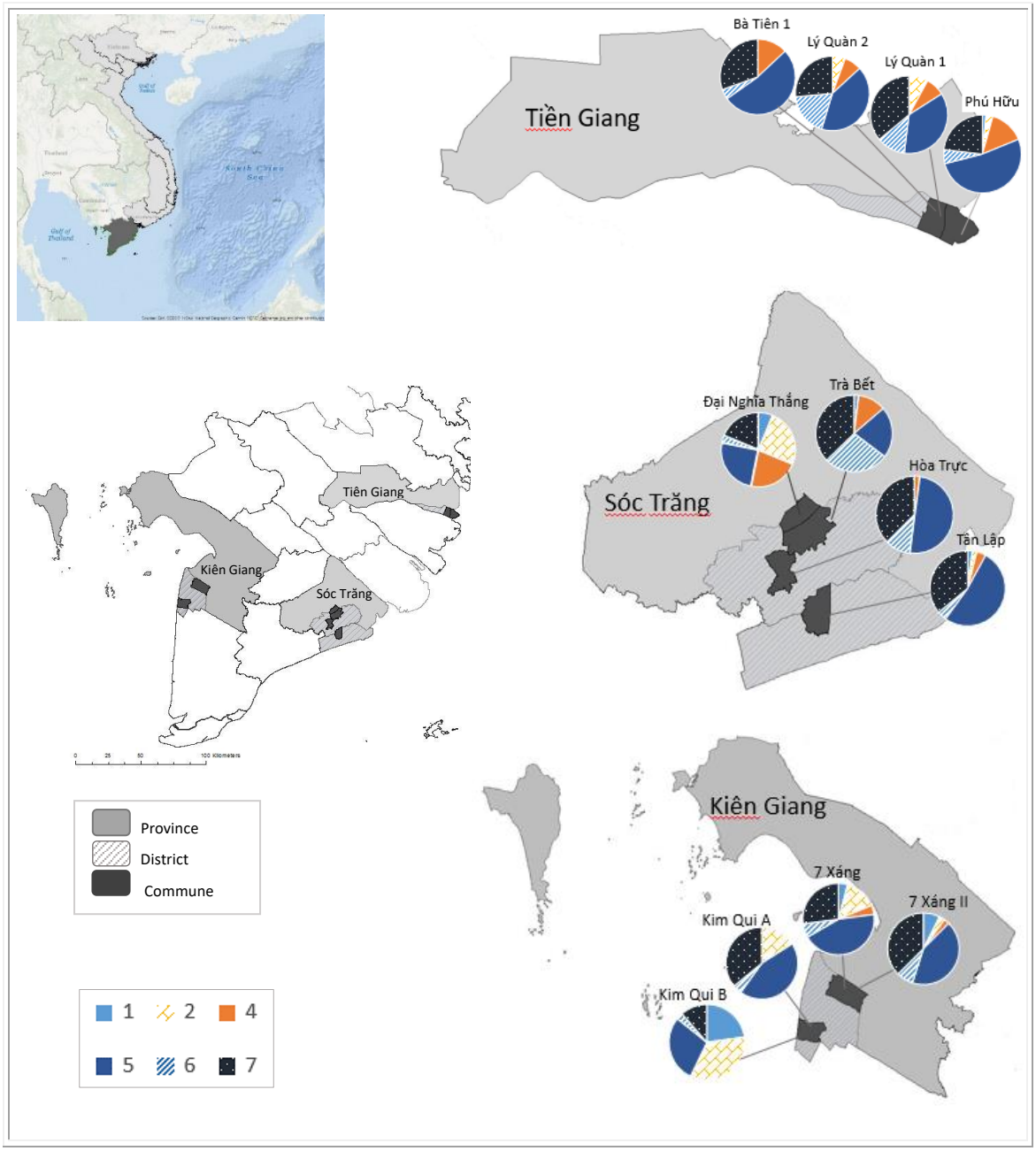



*Figure 5-23: Distribution of livelihood-change types by studied villages*
(Household survey 2016, N=524)

Meanwhile, there is certainly a divergence between the two deltas regarding the structure of typology distribution which could be explained with the regional typical characteristics. Overall, Figure 5-25 shows a more balanced distribution of household groups taking different types of livelihood change in the RRD while shifting farming system strategy tends to be dominant in the MD.

Farmers in the MD are more likely to shift their farming system than those in the RRD which reflects the impact of the close sea dyke system in the RRD. There are a number of reasons to explain this difference. Ecologically, the vast majority of farm production in the RRD is fresh-water cultures. Meanwhile, the MD is more diverse with rather equally divided zones which allow more conditions for different farming systems (See Section 2.2). This is the

consequence of the anthropogenic change, both at the individual level (farm reclamation towards the sea – the case of Liên Phong commune) and collectively (diking policies) actions) which shaped the current context and continue forming future changes.

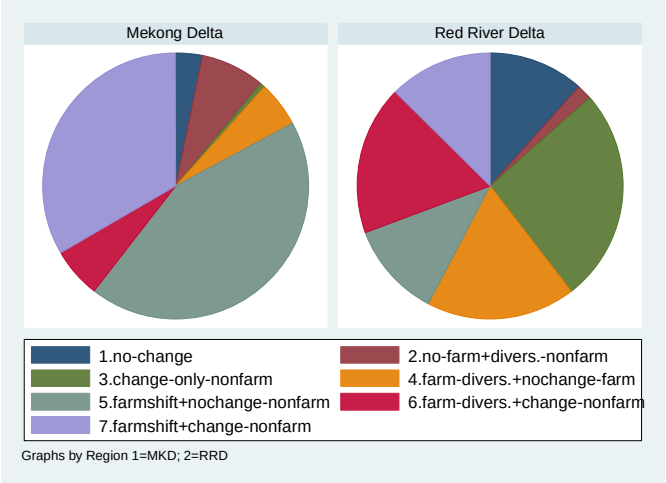



*Figure 5-24: Distribution of livelihood-change types by delta region*
(Household survey 2016, n=850)

In addition, the mismatching characteristics between the two deltas create a regional effect and justify their separation in statistical analysis. Figure 5-25 illustrates another typical example of differences in terms of average land area per household (on *Y* axis) for each group. In general, farmers in the MD have larger fields and also fewer plots (with the average number of land-plot by households is 1.84 comparing to 2.92 in the RRD). This affects farming practices in each region and urges for more detailed analysis given these regional effects. Therefore, it is important to take this into consideration.

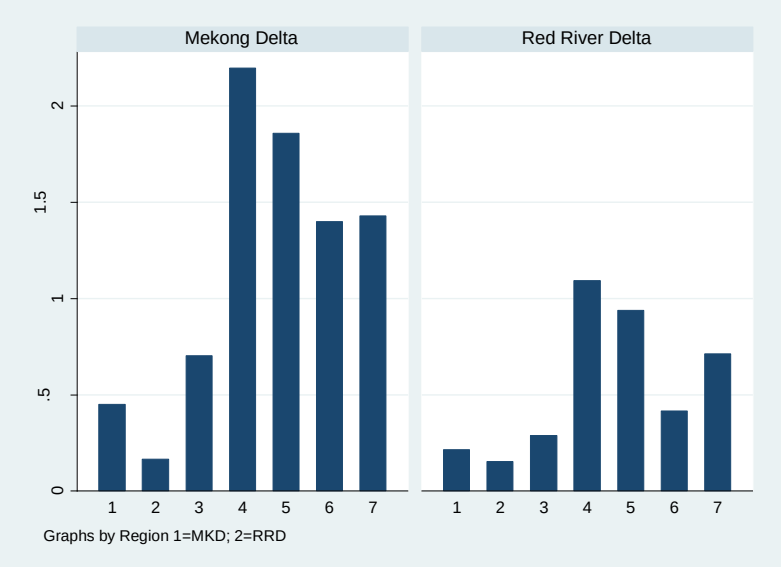



*Figure 5-25: Distribution of livelihood-change types by delta region*
(Household survey 2016, N=850)

### 5.4.4. A comparative analysis on livelihood-change typology

Selected tests are then run on the main metric variables (***Table 13***) to examine the characteristics that distinguish the household groups belonging to the seven types of the livelihood-change.

**Table 13:** Selected household characteristics by livelihood-change types
(*Mean* and *standard deviation(in parentheses)*) (*N=850*)

| Type | n | Age of house-hold-head* | House-hold size | Ratio of members with high education** | Share of non-farm incomes | No. of income source | Quintile of total land-area (in *ha*) | Quintile of asset | Quintile of total income* | Ratio of members working/ studying away | Share of remittance |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **1** | 59 | 55.16 (13.20) | 3.67 (1.51) | 0.14 (0.19) | 37.46 (43.97) | 2.38 (1.27) | 2.22 (1.36) | 2.64 (1.64) | 3.20 (1.22) | 10.39 (14.45) | 17.93 (9.29) |
| **2** | 47 | 51.27 (12.56) | 3.93 (1.92) | 0.11 (0.16) | 56.25 (45.66) | 2.17 (1.08) | 1.23 (0.72) | 2.36 (1.53) | 2.91 (1.36) | 10.02 (15.38) | 17.01 (32.14) |
| **3** | 90 | 52.75 (9.51) | 4.02 (1.40) | 0.18 (0.18) | 42.14 (32.59) | 3.58 (0.92) | 2.46 (1.14) | 2.88 (1.46) | 3.6 (1.16) | 19.06 (20.10) | 21.54 (28.79) |
| **4** | 101 | 55.29 (11.21) | 4.1 (1.37) | 0.20 (0.20) | 20.74 (32.69) | 3.28 (1.23) | 3.52 (1.46) | 2.83 (1.45) | 2.83 (1.34) | 15.51 (18.76) | 6.00 (17.31) |
| **5** | 248 | 55.45 (12.27) | 4.35 (1.61) | 0.15 (0.18) | 22.44 (34.94) | 3.18 (1.22) | 3.31 (1.36) | 3.01 (1.40) | 2.66 (1.38) | 10.34 (15.7) | 7.51 (21.25) |
| **6** | 113 | 55.6 (12.40) | 4.11 (1.67) | 0.14 (0.18) | 47.04 (34.60) | 3.87 (0.98) | 3.03 (1.34) | 2.64 (1.48) | 3.15 (1.34) | 17.94 (21.12) | 17.35 (27.87) |
| **7** | 192 | 54.19 (11.75) | 4.67 (1.47) | 0.18 (0.19) | 46.77 (36.21) | 3.66 (0.89) | 2.97 (1.30) | 2.98 (1.43) | 2.84 (1.33) | 17.93 (19.47) | 22.53 (30.7) |

** Excluding 'Total income', all variables are significantly different (at 0.05 or 0.1** level) among livelihood change types (ANOVA, Kruskal-Wallis test)*

Due to the mismatching distribution of livelihood-change typology between the two deltas as presented in Section 5.4.3 above, the same set of test methods is applied separately for each delta to double-check the method's consistency. ***Table 14*** is the comparison between the seven household groups on their main characteristics. It shows quite consistent results across delta subsamples that these groups are significantly different. This is, however, justifiable as it reflects the certain differences in their background that are discussed in the previous sections. This distinction, together with the mismatching distribution of the livelihood-change typology between the two deltas justifies the need to set separate multinomial regression models on the sub-sample of each delta (results presented in ***Table 16*** and ***Table 17***). This separation provides more details to the comparative analysis among the livelihood-change trends as it addresses the high level of heterogeneity of households in each studied area.

For the statistical test for differences among groups, the variable *'Quintiles of income (logarithm)'* is used as a wealth indicator. However, it does not result in a significant difference which could be explained by the possibility that the proportion of self-provision

in agriculture production might still be higher in the MD than the RRD, due to the significantly smaller farm size of the latter.

**Table 14:** Results of tests of significant difference
**(***Of selected household characteristics among livelihood-change typology by region and whole sample*)

| Variables | MD (n=524) | RRD (n=326) | Joint (n=850) |
|---|---|---|---|
| Age of household-head | | | |
| Household size | * | * | *** |
| Ratio of members with high education | * | | * |
| Share of non-farm incomes | *** | *** | *** |
| No. of income source | *** | *** | *** |
| Quintiles of total land-area | *** | *** | *** |
| Quintiles of asset | ** | | ** |
| Quintiles of total income | | | *** |
| Ratio of members working/ studying away | *** | ** | *** |
| Share of remittance | *** | *** | *** |

*Significant at 0.1*, 0.5** and 0.01*** level (ANOVA, Kruskal-Wallis test)*

Based on the tested variables, the main characteristics of household groups belonging to each type were identified and compared to sharpen the classification outcome. The main results are disclosed in ***Table 15***.

**Table 15:** Main characteristics – Trend types of livelihood change

(With the intensity of change increasing from Type-1 to Type-7, N=850; based on tests of significant difference (*ANOVA, Kruskal-Wallis*) between these 7 subgroups)

| Type No. | Type description | Main characteristics of household groups |
|---|---|---|
| **1** | No change *(n=59)* | • Mostly engaging in fresh-water farming systems (not allow to change) or no farm<br>• Less diverse livelihoods (64% have less than two over five income sources (maximum listed); less likely to send labours away for jobs<br>• Polarization: either with stable (and normally wage/high-skilled) jobs, better asset and income ranks, thus no need to change; or lack of resource to change (*e.g.* small farm area, low asset ranks (quintiles 1-2), *etc*.) |
| **2** | No farming + diversify non-farm (or add small-scale livestock) *(n=47)* | • No or very small farm-size (94% belonging to quintiles 1-3); limited resources, rather low income<br>• Mainly changed from rice-income dependent (35%) to off-farm/nonfarm income (including households dropped out of farming)<br>• High non-farm income share |
| **3** | No change on-farm + change non-farm *(n=90)* | • Mostly engaging in the fresh-water farming system (mono-rice, crops, rice-crops); rather diverse income sources and main occupations (of household-head)<br>• Also attempting to diversify crops varieties with more land plots<br>• More likely to send members working/studying away (higher remittance share) --> rather higher income; tend to move towards non-farm livelihoods |
| **4** | Farm diversification + no change non-farm *(n=101)* | • Mainly engaging in the less flexible zone for change: either fresh-water farm systems, therefore, applying farm expansion to add another type of farm system; yet mostly the case in the RRD; or saline-water area in the MD<br>• Larger farm-area --> less likely to add/increase non-farm income source (low non-farm share) |
| **5** | Farm shift + no change non-farm *(n=248)* | • Engaging in more flexible farm systems (rotation); mainly move towards shrimp farming<br>• Rather higher physical assets: large farm-size, higher rank of quantiles of assets<br>• Low share of non-farm and remittance<br>• Older household-head |
| **6** | Farm diversification + increase non-farm *(n=113)* | • Engaging in fresh-water farm systems; diversify on different land plots to make up for the impossibility on the fixed system (mono-rice, not allowed to change)<br>• High ratio of members working or studying away --> higher remittance<br>• Tend to move towards non-farm livelihoods (particularly younger labours to take a wage or skilled job) |
| **7** | Farm shift + increase non-farm *(n=192)* | • Polarization: Either engaging in flexible farm systems (to change) or tend to drop out of the fixed system (mono-rice, not allowed to change); also, where possible (e.g. garden land in the RRD), farmers tend to do less rice and move towards non-farm activities<br>• The high share of remittance and non-farm incomes<br>• More labour resource --> tend to diversify livelihoods; yet the share of skilled labours is not high |

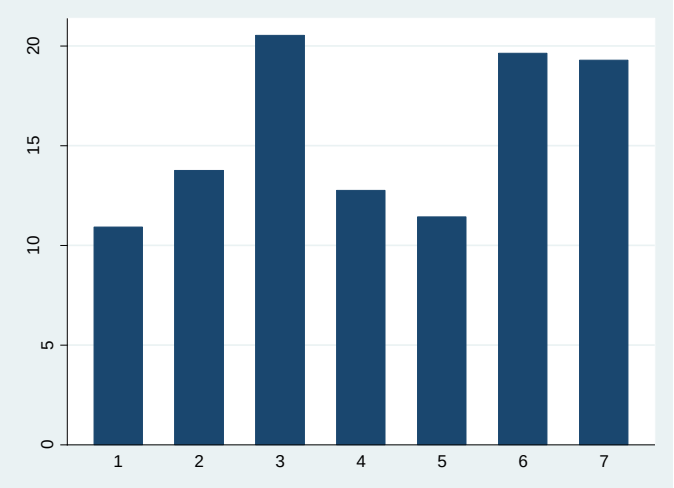



*Figure 5-26: The mean of the labour-working-away ratio by types of livelihood change strategy*
(Household survey 2016, N=850)

Changes of non-farm livelihoods are more obviously associated with labour mobility than opportunities in the village (Figure 5-26). Interestingly, the decision to send labour working away in urban and industrial areas is yet determined by the availability of local off-farm jobs (findings from the *Probit model of labour mobility)*. This also explains farmers' and also authorities' expectations for more wage employment opportunities in their locals.

> "This district is still unimproved comparing to others, there is almost nothing (*i.e.* firms) between here and the district's centre." (4111.556, 16/07/2016)

> "(The current number of firms) has partly solved the unemployment of the district, yet far from meeting the local job demand." (EI-ND-D02)

To compare among the livelihood-change typology, the multinomial regressions are first set up according to the Probit models run for farm and non-farm changes (see section 5.4.1.4), then following the stepwise regressions technique (see Section 4.6). In this process, insignificant variables are gradually dropped (one by one) if they tend to create noises to the multinomial models rather than help to explain the differences among the livelihood-change strategies. This is done until it shows the optimal models for both delta cases as presented below. Other variables like province are also excluded as they are unlikely to be among the indicators for comparison due to the spreading distribution of livelihood-change strategies in the studied region. Outcomes of these models are presented in ***Table 15*** and ***Table 16*** for the MD and the RRD respectively.

**Table 16:** Parameter estimates from Multinomial (logistic) models for the livelihood-change typology - the MD case study

| Variables description | (1) No change | (2) No farm + diversify non-farm | (4) Farm diversification + no change non-farm | (5) Farm shift + no change non-farm | (6) Farm diversification + increase non-farm |
|---|---|---|---|---|---|
| | Coef. (Std. Err.) | Coef. (Std. Err.) | Coef. (Std. Err.) | Coef. (Std. Err.) | Coef. (Std. Err.) |
| Age of household-head | .047 | -.009 | .002 | .014 | -.007 |
| | (.048) | (.039) | (.020) | (.011) | (.019) |
| Household size | -.662** | -.637** | -.206 | .008 | -.296* |
| | (.302) | (.271) | (.162) | (.087) | (.157) |
| **Dependency ratio** | | | | | |
| 0-49 *(reference group)* | | | | | |
| 50-99 | -1.48 | 1.61 | -.448 | -.171 | .868*† |
| | (1.51) | (.998) | (.651) | (.331) | (.546) |
| 100-199 | -20.33 | -1.25 | -1.29* | -1.13*** | -1.35* |
| | (2725) | (1.80) | (.659) | (.373) | (.713) |
| >=200 | -1.12 | -18.9 | -17.8 | -.224 | .890 |
| | (2.04) | (8721) | (11249) | (.972) | (1.15) |
| **Education level of household-head** | | | | | |
| Below primary *(reference group)* | | | | | |
| Primary | . 270 | .611 | -.767 | -.059 | -.101 |
| | (1.04) | (.981) | (.551) | (.298) | (.510) |
| Secondary | -1.38 | -2.28 | -.968 | .177 | .501 |
| | (1.99) | (1.80) | (.788) | (.408) | (.654) |
| High-Higher | -15.92 | .687 | -.483 | .273 | .669 |
| | (2937) | (2.86) | (.998) | (.532) | (.869) |
| Number of high-skilled labours | -2.06 | .662 | -.734 | -.334*† | -.451 |
| | (1.44) | (.722) | (.463) | (.128) | (.354) |
| Number of income sources | -3.90 *** | -.503 | -.128 | -.49*** | -.150 |
| | (1.09) | (.464) | (.230) | (.1188) | (.214) |
| Total land-area (in *ha)* | -.531 | -2.24** | .414** | .230** | .212 |
| | (.531) | (1.106) | (.161) | (.112) | (.183) |
| **Quintiles of households' assets** | | | | | |
| Quantile1 *(reference group)* | | | | | |
| Quantile2 | 1.91 | -.006 | -.272 | -.220 | -.959*† |
| | (1.79) | (1.20) | (.720) | (.395) | (.693) |
| Quantile3 | 1.267 | 1.03 | .809 | .053 | .344 |
| | (1.26) | (1.21) | (.665) | (.386) | (.605) |
| Quantile4 | -.589 | .214 | -.219 | -.455 | -.455 |
| | (1.57) | (1.55) | (.881) | (.478) | (.771) |
| Quantile5 | -.603 | 1.08 | -.315 | -.286 | -1.27*† |
| | (1.76) | (2.01) | (.966) | (.501) | (.838) |
| House condition | .006 | -.112 | -.225 | -.178* | .113 |
| | (.344) | (.341) | (.185) | (.101) | (.179) |
| Total yield ('000*vnd*, sqrt) | .344** | .014** | -.001 | -.001 | .003 |
| | (.007) | (.006) | (.002) | (.001) | (.002) |
| Number of land-plot (1-5) | -.634 | -1.18 | -.010 | .283* | .535** |
| | (.848) | (.815) | (.301) | (.166) | (.258) |
| Ratio of labour working far from home | -.010 | .012 | -.012 | -.012** | .009 |
| | (.026) | (.0204) | (.012) | (.006) | (.009) |
| Share of non-farm income | .029* | .024 | -.019** | -.013*** | .008 |
| | (.017) | (.015) | (.007) | (.004) | (.006) |
| Perceived salinity risk (1=yes;0=no) | -1.50 | -1.43 | .709 | -.059 | .210 |
| | (1.01) | (.983) | (.607) | (.301) | (.532) |

| | | | | | |
|---|---|---|---|---|---|
| Perceived high-temperature risk (1=yes;0=no) | -.123 | -1.008 | -1.16** | -.158 | -.396 |
| | (1.09) | (.948) | .491) | (.257) | (.450) |
| **Farm-type** | | | | | |
| Mono-rice | -.763 | 17.4 | 2.25*** | -.408 | 2.59*** |
| | (1.66) | (1480) | (.819) | (.385) | (.850) |
| Extensive shrimp | -20.2 | 16.05 | 1.6** | -1.02** | .305 |
| | (1.76) | (1480) | (.913) | (.507) | (1.32) |
| Fresh-water aquaculture | -3.70 | 15.91 | 1.203 | 18.32 | 2.32 |
| | (-3.70) | (40681) | (43085) | (19068) | (39003) |
| Improved shrimp | -19.75 | .749 | .014 | -.282 | 1.706* |
| | (2394) | (2600) | (1.28) | (.419) | (.932) |
| Annual crops | -17.23 | -1.02 | 2.26** | -.083 | .908 |
| | (2628) | (3126) | (.948) | (.454) | (1.13) |
| No farm | 20.93 | 40.94 | 23.87 | 17.33 | 24.1 |
| | (5928) | (6110) | (5928) | (5928) | (5928) |
| Other saline aquaculture | -18.15 | -1.704 | -15.52 | .917* | 1.54 |
| | (3463) | (3165) | (4325) | (.494) | (1.34) |
| Perennials | -10.84 | 1.011 | 2.56* | .575 | 2.57* |
| | (5493) | (6635) | (1.55) | (.872) | (1.507) |
| Rice-crop | -12.36 | .292 | -17.18 | -1.04 | 3.59*** |
| | (13642) | (13000) | (12811) | (1.24) | (1.34) |
| Rice-improved shrimp | 3.42* | .629 | 1.014 | .024 | .586 |
| | (2.07) | (3993) | (1.33) | (.552) | (1.38) |
| Rice-(extensive) shrimp *(reference group)* | | | | | |
| Constant | 6.89* | -13.41 | .305 | 2.78*** | -3.76* |
| | (4.14) | (1480) | (1.76) | (1.04) | (1.93) |
| Number of observations | | | 516 | | |
| LR (chi2) | | | 623.911 | | |
| Prob > chi2 | | | 0.0000 | | |
| McFadden's R2 | | | 0.411 | | |

**(7) *Farm shift + increase non-farm* is the reference group**

*Significant at p<0.01***, p<0.05**, p<0.1**

The environmental factors (household's risk perception of *salinity* and *high temperature*/*drought*) return some significant effects among the livelihood-change trends in the MD. However, they do not seem to be obvious, hence delivering limited explanatory power. Meanwhile, in the RRD, they do not show any effect at all. Therefore, in general, it confirms the minor direct role of climatic factors in explaining the different selection of livelihood-change strategies of households. Yet the indirect impact remains important at looking into the significant coefficients of farm-type (which links closely with land-use regulations) on the distinguishing between the most active household groups (Type 7) with the rest.

**Table 17:** Parameter estimates from Multinomial (logistic) models for the livelihood-change typology - the RRD case study

| Variables description | (1) No change | (3) No change on-farm + change non-farm | (4) Farm diversification + no change non-farm | (5) Farm shift + no change non-farm | (6) Farm diversification + increase non-farm |
|---|---|---|---|---|---|
| | Coef. (Std. Err.) | Coef. (Std. Err.) | Coef. (Std. Err.) | Coef. (Std. Err.) | Coef. (Std. Err.) |
| Age of household-head | .061* | .0119 | .068** | .016 | .038 |
| | (.035) | (.029) | (.031) | (.034) | (.031) |
| Household size | -.426*† | -.214 | -.243 | -.034 | -.287 |
| | (.262) | (.217) | (.228) | (.260) | (.225) |
| **Dependency ratio** | | | | | |
| 0-49 *(reference group)* | | | | | |
| 50-99 | -.700 | -.114 | -.831 | -.542 | -.059 |
| | (1.00) | (.728) | (.860) | (1.03) | (.791) |
| 100-199 | 2.06*† | .869 | - 1.99* | .543 | 2.61** |
| | (1.301) | (1.22) | (1.19) | (1.35) | (1.22) |
| >=200 | 17.47 | 15.98 | -1.26 | -.180 | 16.41 |
| | (5325) | (5325) | (6745) | (6964) | (5325) |
| **Education level of household-head** | | | | | |
| Below primary *(reference group)* | | | | | |
| Primary | 3.67 ** | 1.42 | 1.74*† | 1.93 | .097 |
| | (1.61) | (1.17) | (1.24) | (1.56) | (1.36) |
| Secondary | 1.11 | .424 | -.004 | .680 | .288 |
| | (1.45) | (.950) | (1.02) | (1.35) | (1.05) |
| High-Higher | 2.32 | .763 | .328 | . 1.92 | .714 |
| | (1.59) | (1.08) | (1.19) | (1.49) | (1.19) |
| Number of high-skilled labours | .224 | -.072 | -.392 | -.097 | .005 |
| | (.347) | (.296) | (.325) | (.362) | (.313) |
| Number of income sources | -.969*** | -.314 | -.552* | -.099 | .186 |
| | (.347) | (.296) | (.315) | (.352) | (.313) |
| Total land-area (in *ha)* | -1.52 | -.761 | .198 | .251 | .032 |
| | (1.25) | (.815) | (.370) | (.415) | (.405) |
| **Quintiles of households' assets** | | | | | |
| Quantile1 *(reference group)* | | | | | |
| Quantile2 | 2.42** | 1.603* | 1.67* | 1.42*† | 1.60* |
| | (.997) | (.858) | (.932) | (1.04) | (.893) |
| Quantile3 | .489 | .529 | 1.03 | .747 | -.142 |
| | (1.25) | (.948) | (.992) | (1.09) | (1.04) |
| Quantile4 | .356 | .182 | .242 | -.909 | -.322 |
| | (.936) | (.722) | (.802) | (.964) | (.779) |
| Quantile5 | 2.45** | 1.04 | 1.207 | -.062 | 1.33*† |
| | (1.10) | (.943) | (1.006) | (1.19) | (.970) |
| House condition | .267 | -.95** | -.771*† | -.228 | -.617 |
| | (.542) | (.483) | (.499) | (.585) | (.492) |
| Total yield ('000*vnd*, sqrt) | -.001 | .004 | -.001 | -.005 | -.002 |
| | (.004) | (.004) | (.004) | (.005) | (.004) |
| Number of land-plot (1-5) | -.201 | -.308 | .075 | .119 | .179 |
| | (.361) | (.317) | (.322) | (.377) | (.319) |
| Ratio of labour working far from home | -.037** | -.023* | -.016 | -.018 | -.026* |
| | (.0159) | (.013) | (.014) | (.016) | (.013) |
| Share of non-farm income | -.030** | -.012 | -.039*** | -.042*** | -.020* |
| | (.012) | (.010) | (.011) | (.013) | (.011) |
| Perceived typhoon risk (1=yes;0=no) | 1.053 | 1.15 | .580 | .583 | 1.08 |
| | (1.19) | (.998) | (1.01) | (1.22) | (1.003) |

| | | | | | |
|---|---|---|---|---|---|
| Perceived high-temperature risk (1=yes;0=no) | 1.096<br>(1.13) | -.505<br>(1.01) | -.177 **<br>(1.04) | -.408<br>(1.19) | -.874<br>(1.130) |
| **Farm-type** | | | | | |
| Mono-rice *(reference group)* | | | | | |
| Annual crops | 3.27***<br>(1.005) | 2.77***<br>(.734) | 2.246***<br>(.850) | -.008<br>(.926) | 3.97***<br>(1.22) |
| No farm | 18.79<br>(1079) | 17.46<br>(1079) | 17.69<br>(1079) | .6119<br>(1696) | 19.40<br>(1079) |
| Other saline aquaculture | 2.559*†<br>(1.91) | .231<br>(1.64) | 2.511**<br>(1.20) | .246<br>(1.33) | 2.58*<br>(1.54) |
| Rice-crop | 4.39***<br>(1.076) | 2.45***<br>(.7985) | 3.043***<br>(.896) | .150<br>(1.032) | 4.45***<br>(1.24) |
| Others | 3.330<br>(12962) | 19.04<br>(9902) | 19.93<br>(9902) | 20.57<br>(9902) | 20.98<br>(9902) |
| Constant | .242<br>(5.051) | 6.98*†<br>(4.34) | 4.35<br>(4.462) | 2.086<br>(5.07) | .381<br>(4.71) |
| Number of observations | | | 320 | | |
| LR (chi2) | | | 331.34 | | |
| Prob > chi2 | | | 0.0000 | | |
| McFadden's R2 | | | 0.3001 | | |

**(7) *Farm shift + increase non-farm* is the reference group**
*Significant at p<0.01***, p<0.05**, p<0.1**

In the RRD, the difference between the household group taking strategies 3 and 7 is significantly made by the absence of livelihoods relating to labour mobility among households in group 3. Besides, farmers doing other crops are more likely to take this strategy than rice farmers. However, demographic and environmental indicators do not show their significance in distinguishing these two groups. Majorly higher *dependency ratio* ("100-199") makes a household less involved in intensive changes on the farm which indeed distinguishes between group 6 (opting for diversification/intensification) and group 7 (opting for shifting to another farming system). Almost no significant difference between groups 5 and 7; although the results show more intensive changes applied on non-farm livelihoods by group 7 compared to group 5 which underpins the proactiveness of the household group of most intensive changes.

The similar sets of significant coefficients in both deltas case study show the common thing that makes group 7 (changing most intensively) different from the rest is the higher *non-farm share* and higher labour mobility (*ratio of labour working away*). And these two factors to some extend closely link to each other (see Section 5.4.2.2). Comparing pair by pair, Figure 5-27*(d)* shows income diversification, particularly labour mobility makes a difference between type 7 and type 5 (both could shift their farming systems): farmers have been increasing their non-farm income by sending members to work in other – mainly urban areas. Type 3 rather tends to send labours away to make of for the restriction of changing on-farm.

This confirms the less diverse context of farm-use change in the RRD than in the MD. And annual crops (except for rice) farming households seem to be most actively engage in comprehensive changes (*i.e.* both on-farm and non-farm) comparing to the rice-dominant

farming households. In contrast, farmers that are able to diverse to other types of production, particularly, aquaculture (farm-types 8 and 10) are less active in changing their non-farm livelihoods and therefore, they are more likely to belong to groups 4 and 6 rather than to groups 5 and 7.

The *size of household* (*i.e.* number of members) tends to be directly proportional to changes applied. The pressure to change for higher income, particularly cash might explain this trend. On the other hand, the abundance of labour capital is one of the conditions that facilitate changes in livelihoods. As the *dependency ratio* is controlled, in the case of the RRD, the age of household head significantly makes a difference between the households that changes non-farm activities with those do not. Households with younger heads are more likely to belong to groups who opt for changes related to non-farm incomes.

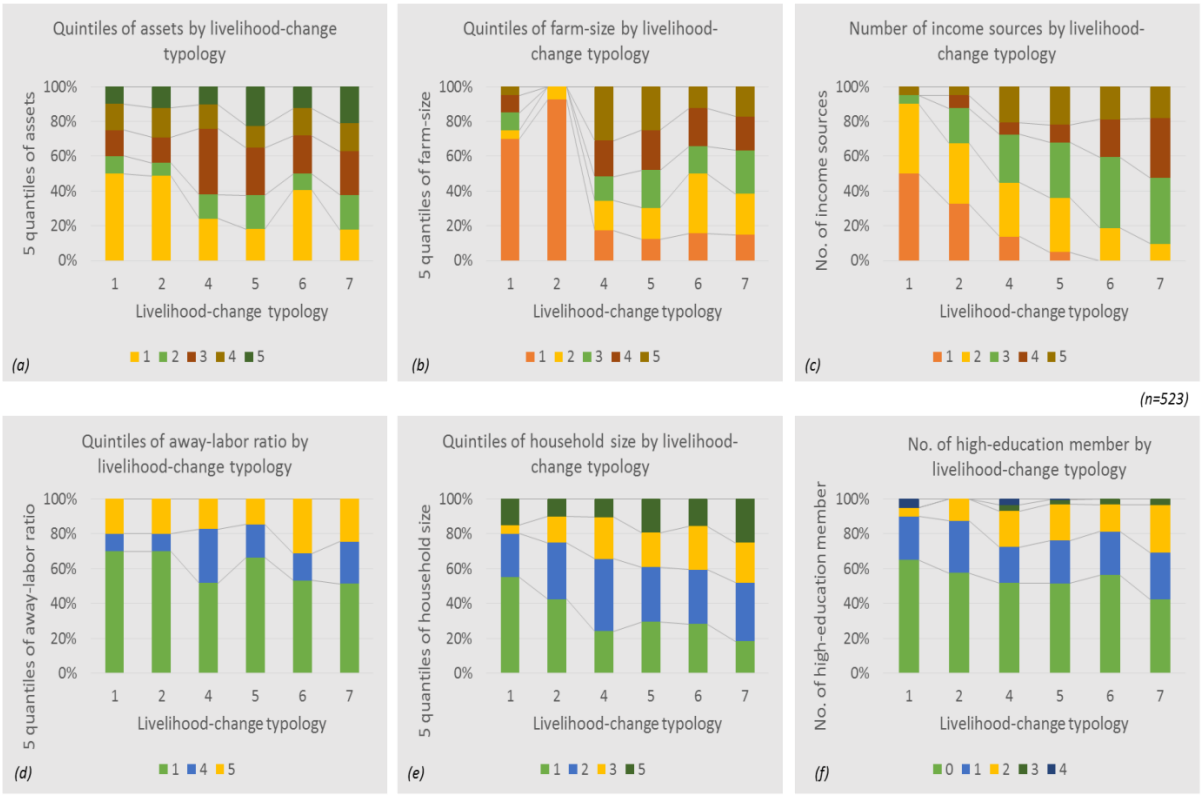



*Figure 5-27: Livelihood-change typology profiles*
(N=850)

The increasing pressure on land area per capita due to the increasing population in rural areas is also driving farmers to change their livelihoods more intensively ( Figure 5-27(*e*)). Pair-by-pair comparison between most similar strategies (*e.g.* between types 4 and 6, type 5 and 7) reveals that households that are able to shift their farming system tend to be better off than those that could apply diversification or intensification on their farms, *e.g. assets index.* Furthermore, land persists as a critical resource in facilitating the capacity to change of the households (Figure 5-27*(b)*). Other demographic characteristics play a role in describing groups and pair comparison (*results not shown*) such as *ethnicity*, *female-*

*headed*, *dependency ratio*, *etc*. They offer the potential for more detailed analysis within each typology in order to identify the most vulnerable groups.

Interestingly, investment in children's education is also proactive rather than responsive. Figure 5-27(*f*) implies the deliberation over investing in education to improve livelihoods; to make up for lack of capacity to change (mostly on-farm), but also proactively taken as a strategy by the groups with high capacity to change (type7). In other words, more active households in terms of livelihood changing regardless of what type, the more likely they would like to invest in education (including professional training) of their members.

### 5.4.5. Summary: Factors to household's past and present livelihood-change decision

In this chapter, a number of livelihood-change strategies of households have been investigated. The results not only showcase the description of the trends of change but also importantly provide the details of the decision-making process at the household level. Especially the findings show the potentials for generalising the process of change at larger scales such as community and regional levels, as well as transferring to similar case studies.

*Market and social learning are direct drivers*

Insights from the decision-making process at the household level in the main trends of livelihood-change shows the recurrent effect of the market drivers and the peer learning behaviours on the decision of a household. Besides household's demographic characteristics and capitals, the availability of livelihood-shift opportunities namely permission to change farm-cultivation, market demand, other income sources, and skilled worker employment explains well the decisions to change among households. More specifically, household livelihoods dynamics are evidently driven by market factors such as higher profit or better income sources (*e.g. wage jobs*, *higher education*). The market demand shows its impacts on households' decision of shifting between crops (rice to vegetable or perennial crops), from salt production to shrimp (case found only in the RRD), from shrimp and fish, or to quit doing rice in the rice-shrimp rotation system. In other words, households' livelihood dynamics are strongly and obviously driven by market factors even when these factors are considered side by side with environmental drivers such as *harvest loss* or *climatic changes*.

In addition, the process of change is sped-up by the social learning process as households respond to opportunities, such example as land-use-change flexibility, availability of other income sources/high-skill jobs, labour mobility are taken as opportunities by the household to improve their livelihood. More interestingly, in some studied villages, the empirical data unfolds that the process of change was triggered by a few individuals who were also members of those communities. Other actors such as households, local authorities, and even the national government participated in the process of change only at later stages. Despite several challenges to quantifying and modelling these factors, the descriptive

analysis, and the qualitative data are able to shed light on its pivotal role in effectuating the process of change. The process includes peer learning among households (through imitating, following), yet also the cross-scale interaction where this local practice affects yet is affected by authority's management from local to policy-making levels. The latter phenomenon is explained in more detail in the last sub-section.

The development of non-agricultural livelihoods in rural context has been often framed by the literature as the passive response or reactive strategy to the failure of the agricultural sector. However, as being put in parallel with the same weight in analysing, this study's finding underpins the growing research strands emphasising that this is not necessarily the current case. Farmers are even getting more initiative and creative with their capitals which are not always land as being set by default. In some cases, it shows the contrasting case that even with the endowment of capitals (*e.g.* land, financial investment), farmers insist on directing their children moving out of agriculture as their main professionals and most of the time, towards the non-farm sector and migrating to urban regions. The economic pressure is pushing people towards non-agricultural livelihoods more than ever seen before and therefore is partly attributed to the structural change of contemporary rural economics.

*The critical role of policy interventions*

As discussed, the biophysical setting of the delta regions is strongly linked to the intervention process of the government during the process of settling and developing of the human society. Several interventions are branded as adaptation and thus play a pivotal role in shaping the current coastal landscape. At the household level, these interventions account for changes in their farming practices. Therefore, it is unsurprising that the research findings reflect this linkage. The decision-making process for livelihood changes at the household level is sensitive to the policies that are directly (*e.g.* dyke built) and indirectly (*e.g.* incentives for shrimp farming to their neighbours) impact their income-generating activities. The empirical data unfolds that policy intervention is the enabling factor for households' livelihood change strategies to deter or promote the change process. This impact on the livelihood change at the household level was most observable as looking into engineering interventions such as dikes, or emerging structural shifts such as urbanization and industrialization.

More specifically on on-farm changes, farmers tend to opt for shifting to aquaculture where they are permitted to which gives an impression that staying in the same system (i.e. rice cultivation) and diversifying farm products (i.e. between rice and other annual crops) are less of a "choice" but more of a "must". This critical impact of policy intervention such as diking on the livelihood shift of farmers of the fresh-water zone has been more explicitly discussed lately (Tran & James 2017, Tran 2019). Tran (2019) brings up the debate of "free versus forced adaptation" to explain the adaptive livelihood changes of farmers in these areas. As such, the discuss further the social consequences of this process, most noticeably

the inequality income among farmers due to the divergent impacts of the policy on individual households (Fly 2016, Betcherman *et al.* 2019)

*The secondary impact of (biophysical) environmental factors*

As a common understanding, the coastal conditions facilitate the specific trends of farm-use change, especially the trend towards aquaculture given the seasonal abundance of saline water. However, the availability of these conditions does not necessarily drive the process of change alone. Rather, by connecting the above findings, this dissertation argues that environmental determinants have a *secondary impact* on this process of change.

More precisely, the impacts of environmental factors on the decision to change of households are more likely showed through the interaction between humans and nature. For example, rice farmers changed from single-rice to double-rice cultivation because their farm situated in the areas that the government decided to dike up in order to 'protect' them from saline water all year round[31]. Meanwhile, the coping and adaptation practices by farmers to directly respond to the disturbance of their biophysical environments are limited to adjusting seasonal/crop calendars, applying crop variety alternatives (*e.g.* salinity-tolerant rice, shorter-cycle rice), improving irrigation system rather than long-term changes. Rather, the structural changes such as shifting farming systems, for example from agriculture to aquaculture, were more likely to be driven by environmental change indirectly through the government's measure of adaptation (*e.g.* dikes, saline water control, incentives).

The same argumentation could be used in explaining the secondary impact of the environment on the decision to change off-farm livelihoods of households. The harvest loss caused by climatic disturbance (*e.g.* the drought and salinity intrusion event in the year 2015-2016) varies across various cultivation systems which were more or less shaped by policy intervention (e.g. engineering solutions, national master plan). Therefore, farmers' adjustment of their off-farm strategy in response to environmental changes is rather indirect. Similarly, the fact that farmers are locked in a farming system to fit in the master planning, *e.g.* fresh – brackish water 'zoning', also affects their decision to adjust or shift towards non-farm activities due to their disparate levels of susceptibility to risks. For example, an outbreak of the disease on shrimp in the mono-shrimp cultivation areas causes so severe economic loss to shrimp farmers that they could not recover in time for the next season, and thus face a higher chance of dropping off their farming either temporarily or long-term.

Nevertheless, the economic driver links closely with ecological changes of the regions, mainly with the assistance of the social learning process. The massive and rapid changes for

[31] This means to make fresh water available even during the dry season when saline water was supposed to invade the deltaic coastal areas.

profits created environmental issues which in turn drove further the livelihood change process.

In summary of this sub-section, findings show the secondary impacts of climatic factors that come after primary drivers such direct as market and policy, as well as more hidden ones like social learning and the pioneer effect. Having said that, climatic issues still play a critical role in driving changes; however, rather than directly, their impacts are more likely through the interaction with the social components such as government adaptation measures (*i.e.* dikes, irrigation system) and societal process. Because of this complex process of social-ecological interactions, there is no straight single answer to the multiple-choice question of the causality of observed changes. Therefore, the concept of second-ordered adaptation developed by (Birkmann 2011) is found the most relevant to guide the empirical analysis and more in-depth discussion. More of these findings are outlined in the synthesis and discussion chapter.

*The hierarchy of factors for analysing household's decision-making process*

Based on the above analysis of main factors to the decision-making at the household level, four layers of analysis are defined according to the level of impacts of factors, including policy intervention, market drivers and peer-pressures, capital and cognition, and available options respectively (Figure 5-28). Empirical proofs were found for the majority, yet not all of the cases in the studied sites.

In reading this decision tree, the first layer considers the existing policies that are effective in the areas that households and their farms locate. In the diked areas for rice-farming, for instance, the discussion of shifting farm system from crops to aquaculture is less significant because farmers do not hold the rights to convert their land from planting to aquaculture. Other *external* factors and their interaction are considered next in the second layer to analyse the livelihood-change decisions, including market driver, peer pressure, the interaction between them and between themselves and the ecological changes. In the third layer, *internal* factors such as a household's capitals and cognition (*e.g.* perception, attitudes) provide insights into how households perceive the impacts of external factors and decide on their actions.

The cognitive process of an individual household will decide if the two levels of external factors are *threats* or *opportunities* even though this does not necessarily contradict their observable outcome actions. Besides, their perception could also change over time. For example, shrimp farmers in mono-shrimp culture drop the rice-crop (in rainy season) to continue cultivating shrimp in response to the availability of saline water in the rainy season in their farm areas. For profit-driven farmers, this is an opportunity to change more conveniently to shrimp farming, whereas farmers in favour of rice farming considered saline water as a threat and was under the pressure to shift to mono-shrimp. Nevertheless, by the time that the household survey was conducted, several of them (belonging to both

former and latter types) wish they were able to do rice in the rainy season again, thus the presence of saline water during these months is no longer wanted. The story in Box 1 below describes in more detail of the process. Capturing this internal factor remains the most challenging step to understanding livelihood-change decisions of households.

Keeping in mind that at the macro level, there is a tight link among the factors, for instance between the real-time ecological changes and policy intervention which could rather be explained in the decision-making process on a broader scale and at the macro level such as the nation. The direction of their relations could be identified in the complete framework (see Section 3.2).

In some cases, the changes could not be explained given solely the unveiled observable factors as aforementioned. The additional special factor that could play a significant role in the process of change is found in the case study of the MD, particularly the expanding shrimp cultivation in the very coastal areas. The specific story presented in the box below illustrates how this factor is important in explaining the change as well as how it could be detected.

**Box 1.** A normative description of the shifting process in mono-shrimp areas compiled based on interviews and the household survey (2015-2016)

> The story started when the shrimp and its huge profit relatively comparing to rice was first discovered by the communities' pioneers (cases in Sóc Trăng, Tiền Giang) or was brought by outsiders who were looking for more "fresh land" to do it (case in Kiên Giang, Nam Định, Hải Phòng). They started doing shrimp despite being disapproved by the local authority, or even against the law (of land). However, due to the high profit, especially comparing to other farm production such as rice, they were allowed to do it and more farmers followed. The whole villages were, after a short time, encouraged to do more which led to the majority of farms quitting rice thanks to the incentives such as microcredit programs, technical support, and irrigation management (*i.e.* open sluice gates for saltwater in the dry season and close them in the rainy season to keep saline water inland). Finally, the minority rest of farms could afford to do rice no longer; not only because they have been surrounded by saline water during the supposed-to-be-fresh-water-season, but it was also more difficult to deal with all the natural challenges from mice and birds who were violently seeking for the scared food left (rice fields) in the areas. Yet, the household survey notes that a big group of farmers are wishing they could do rice again on their land "just like before" as they are suffering from shrimp harvest loss which not only causes much more severe damages but also idiopathic than rice harvest-loss and makes them concerned again of food insecurity issue and debts.

In such a story, the impact layers of factor components in Figure 5-28 have to be modified as the order of the layers and the flow is truncated by "the pioneers" who are not no one but often those with remarkably high capacity among a random community. Therefore, in those cases, the third layer is supposed to feedback to the first layer, *i.e.* it stands as the zero layer, assuming that the tree develops regardless of how policies are originally triggered. Nevertheless, evidence underpinning this finding was not found in every study case which reflects the fact that it was not always observable. Meanwhile, the effect of this

factor on modifying the decision-rule tree has enhanced its explanatory power in some specific context.

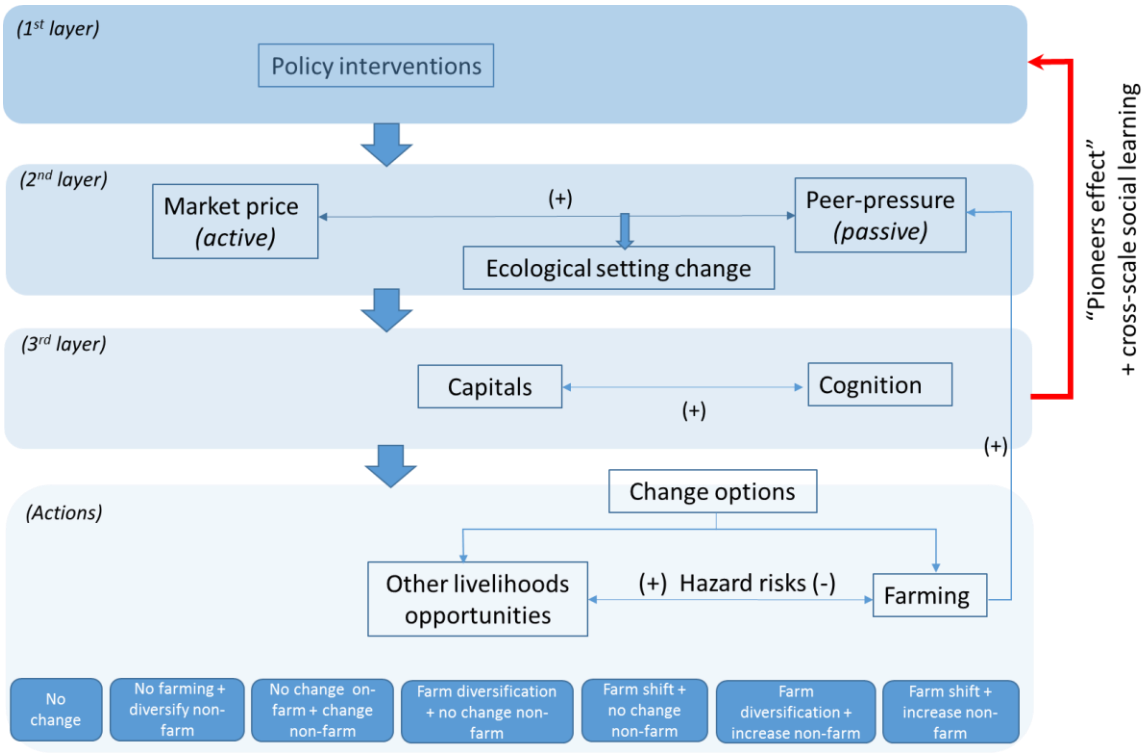



*Figure 5-28: Simplified decision tree*

Boxes indicate layers of impacts of the main determinants to the adaptation decision-making process of households with cross-scale feedbacks.

How this mechanism of decision-making will be reflected when households in the studied areas confront further social-ecological changes in the future? How much the same patterns will be reinforced and what might be the key factor for an alteration of these trends? These questions guide the analysis of the next chapter in which the hypothesized livelihood-related decisions to change of the same group of (surveyed) households will be investigated to elicit information and insights into future trends.

# 6. HOUSEHOLD FUTURE ADAPTATION TO SOCIAL-ECOLOGICAL CHANGES – A SCENARIO-BASED ANALYSIS

This chapter is aimed at answering the second big research question (RQ2) and its sub-questions that look into households' future strategies to continue improving their livelihoods while potentially confronting more intensive social-ecological changes, *i.e.* it is designed to gain initial insights into the potentially emerging trends and complexities projected to come. The below sections provide an introduction into future adaptation analysis based on subjective responses of interviewees to the simple scenarios. This data is collected as a part of the household survey questionnaire. In line with that, methodological explanations and discussions on selected results and findings are presented in response to the aforementioned research questions.

## 6.1. Scenario-based analysis approach to study future adaptation

The scenario as a futures study method gains more popularity across research disciplines lately, particularly in environmental studies due to its high potentials in assisting policy-making process to deal with rapidly growing uncertainties of both the climate change process and the social development globally (Gallopín 2018).

> "A scenario includes a possible course of events leading to a resulting state or image of the future world. Scenarios are most emphatically not predictions, but ways of exploring the possible futures." (Gallopín 2018:318)

### 6.1.1. Multiple simple scenarios to study complex future context

Scenarios are the hypothetical conditions that are designed quantitatively or qualitatively based on key assumptions of the drivers and their interactions to answer "What if" questions of the predictive future (Lamarque *et al.* 2013, Millennium Ecosystem Assessment 2005, Pardoe 2016). In order to achieve the second main objective of this research (see Section 1.4), a series of simplified scenarios questions of possible changes in the future are designed and posed to interviewees participating in the survey. The simple scenarios layout either one specific change or combined changes of the social-ecological context, mostly related to household livelihoods.

There are several future-study methods to study future adaptation, mostly popular in environmental and agricultural research disciplines, each of which has its merits and drawbacks. Dang and colleagues (2014) used structural equation modelling to study the intention to adapt to climate change of farmers in the MD which particularly emphasises on behavioural analysis. Social simulation using methods such as Bayesian analysis, Monte Carlo simulation or individual- and agent-based modelling (ABM) which originate in mathematics, natural science, and computer science emerges quickly in social sciences recently (Conte *et al.* 1997, Johnson 2011). This relatively innovative method has been applied widely in studying the coupled human-environment relationship given its merits in

capture the complexity of the system (see more at the review of An (2012)). In the same line of conceptualizing, participatory scenario development through role-play games or participatory game techniques is another popular method to study the future. One good reference for this implication is the scenario game to study household adaptation decisions under climate change stress in the case study of the West African community successfully applied by Pardoe (2016).

Almost all future analyses face the barriers in data collection, particularly because of the denial attitude of farmers to bad scenarios that might happen in the short-term and long-term future (Ziervogel *et al.* 2005, Pardoe 2016). Many researchers endeavour to "go around" with different innovative methods, *e.g.* role-play games, social experimental (*e.g.* Pardoe 2016, Neise 2018). Computer modelling methods such as agent-based modelling deal with this issue by working with assumptions instead (Gilbert & Terna 1999).

There are also various applications of scenario-based analysis on the conceptual level and for different scales. Among researches applying modelling in social sciences, van Dijk *et al.* 2014 use scenarios and modelling global impacts on local development in the attempt to contribute to the scenarios tool for policy-makers for the case study of Vietnam. Shared socio-economic pathways (SSPs) are developed as a scenario toolkit with alternative socio-economic futures for different climate scenarios (O'Neil *et al.* 2015) which have been also initiated for downscaling to the national and local level by Frame *et al.* (2018).

However, given the research design that provides an opportunity to collect data by integrating the simplified scenarios, this method was tested and thus shows its potential to shed light on the future-forward analysis and deliver valuable findings to answer the research questions.

### 6.1.2. The link between the perception of change and adaptive action

Related to this subject, the vast majority of the literature focus on the direct link between the farmers' perception of climatic changes and their adoption of coping and adaptation measures on their farms. Simply put, the main argument is that as households perceive changes and the potential consequences based on their experiences and observation, they would act or plan to act in an adaptive manner to preserve and improve their livelihoods (Spence *et al.* 2011, Tversky & Kahneman 1973, Weber 2016). This study picks up on this framing in its endeavours to examine emerging trends that rural households tend to opt for as they interact with forthcoming potential social-ecological variations. Notwithstanding, heeding the coupled social-ecological relationship in explaining all changes at the household level (see Chapter 0), this research is aimed to go beyond the climate-change centred adaptation. Rather, farmers' responses are equally recorded for comparison among all simple 'what-if' questions including climatic variations, and social shifts (*e.g.* market, policy) separately as well as in combination to illustrate the complex future context. The impacts of the to-be-identified factors to this multidimensional adaptation are investigated

by contrasting those identified for the historical and present trajectories in Chapter 5 and to support the anticipation of emerging trends.

The link between the individual's current characteristics with their planned behaviours in the future is backed by the TPB (see 3.1.7). More specifically, their experience in the past, their perception of the current situation as well as on the future changes that could pose potential impacts on their lives and livelihoods could be used to understand their future adaptive behaviours. As such, this theoretical approach justifies the use of households' responses to hypothesized changes to analyse their future livelihood-related strategies.

Nevertheless, this study is largely based on the existing literature in seeking variables that reflect on the link between perception and adaptation. Therefore, the parameterisation process for analysis in this chapter partly adopts the approach employed by the literature that emphasise determinants of farmers' decision to adapt to climate change. Meanwhile, the parameters correspond to the theoretical framework in Chapter 0 as well as inherit the main results of Chapter 5 to ensure the cohesion and consistency throughout the research. Although not explicitly parameterised, other factors to individual perception, in general, and to climate change in particular, such as social learning (Nguyen *et al.* 2016), cognition, psychology and/or culture (Weber 2016) pop up in the qualitative analysis which is useful for cross-validation as well as enriching the results discussion in response to the essential question of how perception on climate change could turn into action (Bryant *et al.* 2000, Gbetibouo 2009).

### 6.1.3. Review of future adaptation studies on the Mekong Delta and the Red River Delta

On the topic of future study related to environmental change, hydrologic modelling is most frequently found in climate change adaptation studies on the Vietnamese deltas. The MD seems to gain much attention in this respect. Several studies contribute to simulate hydraulic changes and increasing issues such as salinity intrusion on the delta, for instance, Doan *et al.* (2014) on river flow and salinity intrusion, Dat *et al.* (2012) on the decreasing flow from upstream and sea-level rise. With a more integrative approach, Smajgl *et al.* (2015) develop a model that includes hydrologic, agronomic and behavioural assessments to study land-use change in the MD under sea-level rise and salinity intrusion. Dang *et al.* (2018) pick up on these studies to develop a hydrodynamic model to project future hydrological alterations in the same region. On the RRD, Rossi (2016) also present a vulnerability analysis of the region under more extensive future pressures. The outcomes of this study are climate scenario (with a hydrological model) and socio-economic scenarios that could be used for simulation future vulnerability of the RRD.

The literature on future livelihood adaptation is also growing with various contributions to methods. Recent research has shown a great interest in the expansion of aquaculture in the coastal areas of the MD, particularly on the adaptive behaviours of shrimp farming. Since

this phenomenon is more popular in the MD, more researches are found in the MD. Dung et al. 2008 developed an agent-based model to simulate farmers' decisions on rice versus shrimp in the integrated rice-shrimp farming system in Bac Lieu province. Quite recently, Joffre *et al.* (2019) model and simulate risk management practices of shrimp farming using a cluster approach. More generally, Nguyen (2009) applies the system dynamics to model the socio-economic and environmental impacts of shrimp farming in the MD. Besides, several studies also model and simulate changes in rice farming such as the dynamics of rice land area or rice yield (Jiang *et al.* 2018). In the same strand, research also attempts to simulate land-use change at a regional level. Van Dijk and colleagues (2014) presented an innovative model to develop multiple scenarios of land-use change in both MD and RRD by 2030. Meanwhile, Arndt *et al.* (2015) built an integrative model to assess the impacts of anthropogenic climate change on multiple sectors. With this model, they are able to estimate the damage loss of the economy by 2050. Moreover, on non-farm livelihood change, modelling and simulate migration flows also received the attention of research on future (Huynh & Nonneman 2012, Nguyen B. 2019)

The majority of the literature of this strand uses secondary data and is based on assumptions. Few other uses empirical data at the micro level by asking respondents about their planned strategies under future changes (*e.g.* Smajgl *et al.* 2015). Yet in general, they attempt to contribute support the policy-making process in dealing with more extensive changes and uncertainties in the future. The scenario-based analysis applied to primary empirical data by this research is expected to enrich the knowledge of the case study of both deltas. The exploration of the methods is also aimed to improve the methodological approach to study the future.

## 6.2. Methods and data to study households' future responses

### 6.2.1. Research design

*Contextualized scenarios to illustrate the possible futures*

As said by Gallopín and Raskin (1998), "[A] scenario is essentially a story about the future" which should reflect both quantitative and qualitative elements (*ibid* 1998:8). In this study, these stories are learned by drawing the possible social-ecological changes that might have significant impacts on the lives of the rural coastal community of the MD and the RRD. Peoples' answers to their most likely strategies in response to each picture provided were then recording. Figure 6-1spells out the specific changes as well as the way they have impacts (*i.e.* separately or together) that are put in the questionnaire for data collection. On the ecological component of the scenarios design, climatic variation focus on the tendency of hazards to happen more frequently and extreme in the future with the climate change process. Based on the literature and the results of the exploratory phase, hazards related to the temperature and precipitation are brought up to the interviewee. More specifically, they were asked to provide their possible coping and adaptation strategy in the cases of (1)

lengthened duration of high temperature with decreasing rainfall; and (2) unpredictable rainy seasons (*e.g.* late onset of the season, change of duration, change of rainfall level). Based on larger project design (DeltAdapt), an increasing salinity intrusion scenario was also posed to survey participants (where applicable) to get more insight into potential impacts this growing concern might cause in the future.

Regarding social possible changes (Figure 6-1), market volatility (2) and influential policy intervention (3) are in the social scenarios to be examined. As most important to farmers in the two deltas, possible cases of increasing or decreasing the price of their main products – rice and shrimp (or aquaculture) were presented to examine their responses. Meanwhile, based on the overall research approach (Figure 1-1), land-use regulations and local industrialization policies are hypothesized as decisive to household livelihood strategies, thus being laid out to learn the importance of their impacts on future trends. Although few regulations on land-use[32], including those related to collective production, diked-up areas and land-ownership were presumed to strongly affect household's decision (Khanh 2013), the actual case shows that not all of them are perceived as influential. Therefore, solely selected results of the most intriguing scenario of diking up for fresh-water zoning will be presented. Household's response to a layout of enlarged local industrial production – which is considered as a strong tendency in the deltas' rural development, is also examined.

More interestingly, interviewed households were not only requested to think of their likely actions separately to those scenarios listed above, but they were also confronted with more complex scenarios in which changes of at least two out of the three issues of hazards, market and policy are assumed to happen simultaneously (showed on Figure 6-1 as: (1)+(2), (1)+(3), and (1)+(2)+(3)). From the observation of the past trends, these cases might be even more realistic and thus could bring us closer to the most likely future responses of households.

This approach is expected to bring valuable insights into the possible futures of these regions which also includes the impacts of policy interventions as aforementioned. Therefore, it might be of great relevance regarding national and sub-national policy decisions for regional development to deal with full of uncertainties in reality.

As the first step, descriptive data is used for a comparative analysis in order to highlight the compatibility of findings in the previous stage of this research (*i.e.* Chapter 5). In other words, this step works as a cross-validation of the main results found to explain the past and present context. Connected data are cross-tabulated and compared to find out those results that hold across different research time and those that emerge and imply new intriguing findings.

[32] Refer to Section 2.4 for a detailed background of the topic of land-use and policy intervention in the context of Viet Nam in general and the two deltas in particular.

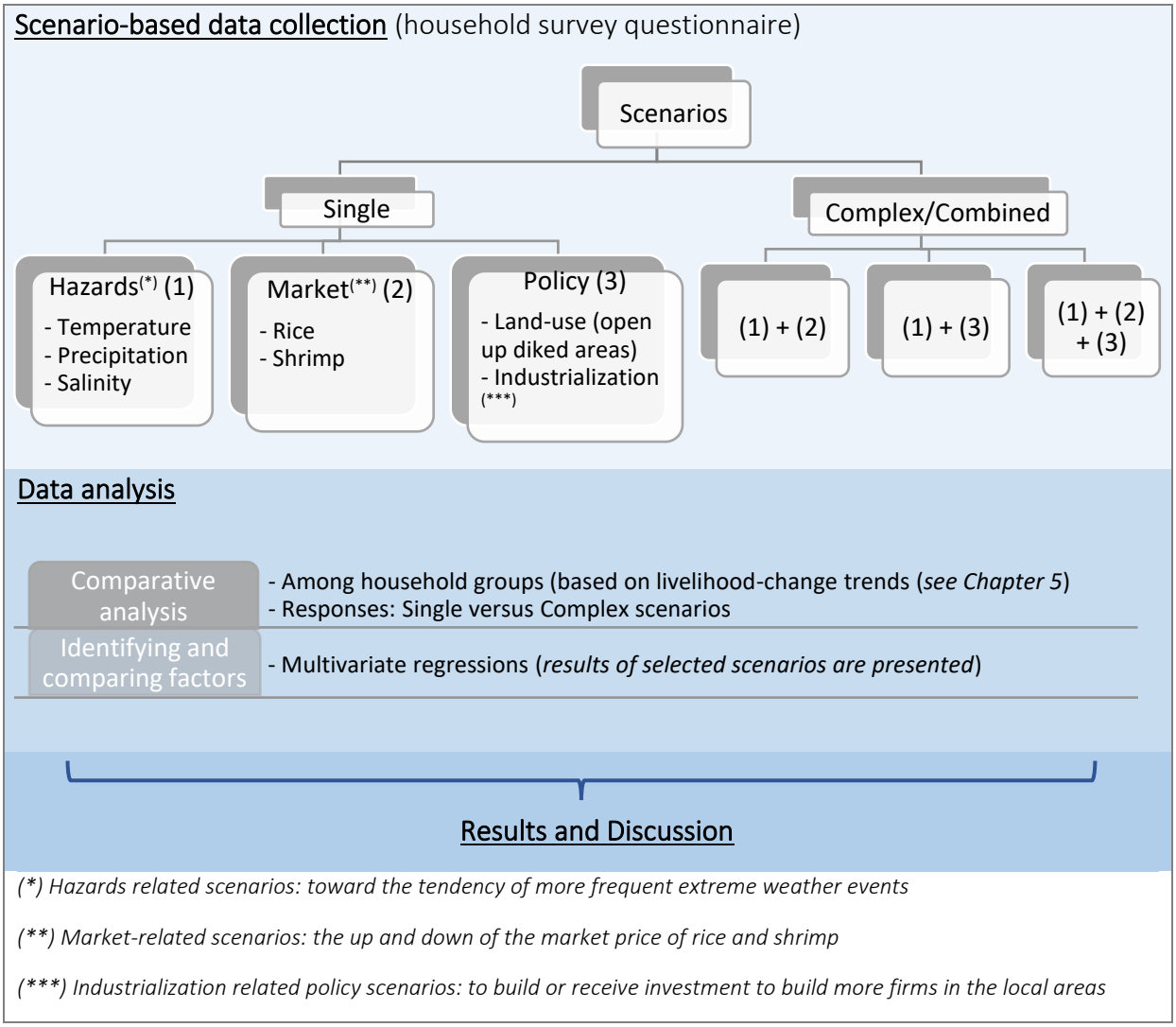



*Figure 6-1: Data and methods flow applied in Chapter 6*

*Multivariate and Probit regressions analysis*

In the second step of data analysis, multivariate regressions are applied as the main method to identify the main factors to future coping and adaptation decisions of households under presumably disparate contexts. Multivariate regression is also applied for non-linear categorical data; yet dissimilarly to multinomial regressions used for data analysis in Chapter 5 (see Section 5.3.3), multivariate regressions include a series of bivariate regressions conducted in parallel on each sub-set of a given category set. In other words, there are as many regressions as the number of categories given in the dependent variable (Liu 2016). Where there are only two categories, Probit regressions (see the introduction of the method in Section 5.3.1) are applied directly.

Nevertheless, in this chapter, multivariate regressions are used to identify factors and test the significance level before using those results for the comparative analysis as well as for later discussions. Meanwhile, a sequential step after running the regressions which are supposed to estimate and examine the magnitude of the significant factors (variables) is

less concerned here and thus no result related to level and magnitude of coefficients (*i.e.* either marginal effects or odds ratio as normally presented) is displayed.

Despite the simplicity of the methodology, this comparative analysis on the significance – taking into account also the non-significance, of the anew identified factors and those done in the previous stage (in Chapter 5) is expected to unfold the highlights of future trends and answer the research question. All meaningful results from the data analysis steps are then systemically presented in the last sections of this chapter to answer the research questions outlined earlier, as well as partly used for the research synthesis later in the dissertation. That also outlines the structure of the coming sections.

### 6.2.2. Challenges of the methods

Validating both data and results is the biggest challenge confronted by any future study approach (Alcamo 2008). As mostly seen in working with primary data that relies on subjective responses (*e.g*. perception), the attitude of respondents is crucial to the quality of data. This is a foreseen challenge, yet given the nature of scenarios approach which is hypothesized or assumed, uncertain and imagined (Pedde 2018, Galopín 2018), the analysis using this data necessarily bears a certain margin of error. For instance, as being asked to imagine extreme cases that do not sound realistic in the current time, some interviewee did not take the scenarios seriously, either because they denied these extreme changes in long-term, hence simplified their thoughts of future strategies; or because they found those questions unrealistic at the time the interviews were conducted, hence avoided discussing their real answers (- or their problems).

In this research, the denial attitude of the studied population (mainly in rural areas in this case) as analysed formerly (see 6.1) was identified as among the biggest challenges in data collection as well as data quality control in this study. Nevertheless, the responding rate to this section in the questionnaire was quite high (excluding '*Not applicable'* value, above 95% of interviewees responded to each scenario question). Therefore, the data is sufficiently qualified for analysis and drawing important findings as could be seen in the coming sections. The interviewers have been trained to bring up the questions on scenarios in a convincing way and to pay attention to the reaction of respondents for any adjustment needed in order to ensure the highest participation proportion of the interviewee.

In regards to the design of the questionnaire, besides simple scenarios integrated into the standardised household survey are aimed to detect the separate impacts of single environmental or social change on the possible future emerging trends, complex layout by combining different scenarios to illustrate the simultaneous phenomena of changes were also asked. This repetition of asking process in interviewing might cause confusion in data collecting, processing, as well as analysing steps.

Moreover, as more commonly found in using statistics (multivariate regressions in this chapter), one of the biggest challenges is quantifying and validating the cognitive aspects of

households. From the perspective of behavioural analysis, households' responses to hypothesized scenarios in the future are not validated, given the uncertainties of interviewees themselves. In other words, quality control of this type of data could not be guaranteed, and the models presented here bear the risk of omitted variables in this perspective. Specific explanations and remarks on these methodological limitations are unfolded in result and discussion sections below.

### 6.2.3. Data: variations of future coping and adaptation options

Taking into consideration of challenges and limitations as aforementioned, future-oriented analysis and results of this study, like all other scenario-based researches, are conducted and discussed mindfully. Especially, this chapter is supposed to extend on the results of Chapter 5 to highlight the history-future nexus analysis.

Although a large range of options was given to each scenario question, the wide variation of responses divides the survey sample into undersized sub-samples which were insufficient for regression analysis. Therefore, grouping households' responses to the scenarios questions was applied. The result of this restructuring data is a smaller set of categories for each and every scenario. This explains the difference between the results of the analysis presented in the following. This coping and adaptation categorization thus are not the same as the past and present strategies yet it allows more chance of getting insights into emerging trends.

One example of grouping similar options into 5 main (re)actions/answers to scenario questions on *hazards* is as follows:

(i) category 1 is the combination of options related to *decreasing/quitting farming* (number coded on the questionnaire as 2, 4, 6, 9 [33]);
(ii) category 2 is the combination of options related to *shifting to other farming systems* (10, 11, 12);
(iii) category 3 is the combination of options related to *resisting (by coping/adapting)* (1, 3, 8, 13, 14);
(iv) category 4 is the combination of options related to *passive (but could also be realistic)* (5, 7, 88);
(v) category 5 is the option *denying* (0); the missing values (including '*not applicable'* answers) were left out of the regression analysis.

In other words, the future coping and adaptation mechanisms included in the analysis are less detailed than the present ones (used in Chapter 5) which helps to project larger trends. Nevertheless, the categories are in line with the known mechanism which allows the compatibility in analysis and findings. Importantly, restructuring data is carefully

[33] There are numbers that are not displayed on the questionnaire because they were later generated from the option "others" during the data cleaning process.

conducted to ensure that its properties are unchanged while being fitted for the most feasible analysis.

## 6.3. Results and interpretation

### 6.3.1. Perceived present and future environmental context

*On current hazards risks*

While this type of data is partly discussed in Chapter 5 focusing on the link between these risks and policy interventions in explaining the past and current coping and adaptation of households, this subsection provides further details to feature the perception aspects, and thus improves the flow into more future-forward topics such as climate change and scenarios in the sections to follow.

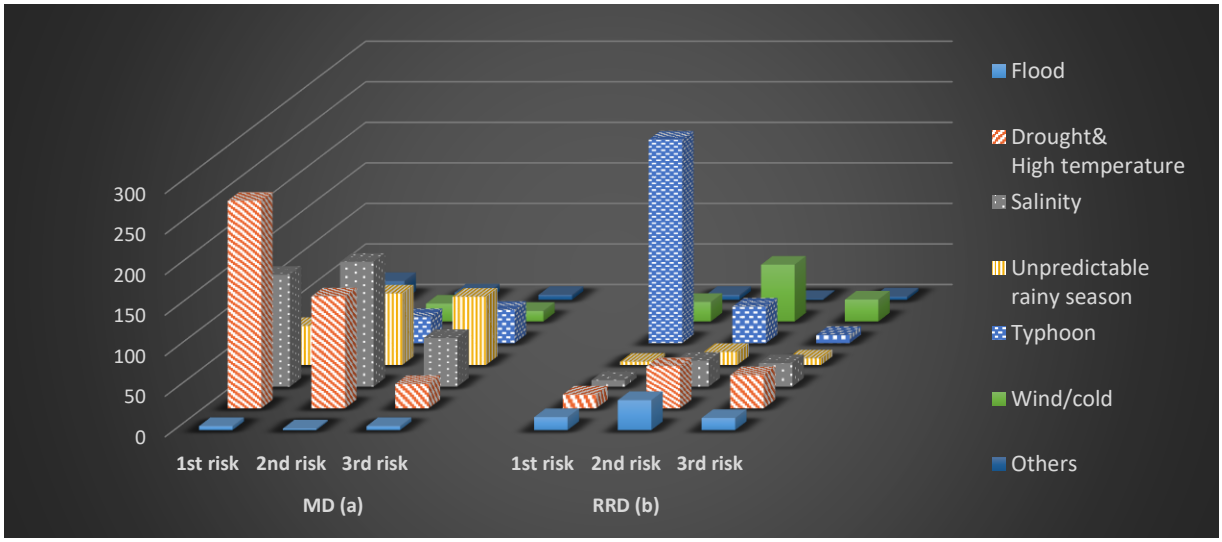



*Figure 6-2: Three top-ranked risks perceived by households in the MD (n=523) and the RRD (n=324)* (*Household survey 2016, N=847*)

By asking households to list their three top-ranked risks (Figure 6-2) the results reveal not only their risk perception but also give a hint of risk distribution and hence the exposure of the studied areas. Overall, the perceived hazard risks of farmers in the MD are more diverse than those in the RRD. This distribution of hazard risk for the case studies in the MD is thus illustrated in Figure 6-2). These answers also correspond with the livelihood activities, *e.g.* types of farming, of the respondents which thus tend to reflect on the diversity of their activities. Based on the frequency ranking, four (those patterned columns in Figure 6-2) out of the eight listed hazards are selected as the focused risks for further analysis, including drought and high temperature, salinity (mostly in the MD), unpredictable rainy season and typhoon (only the RRD). Depending on the objective as well as sub-samples (*i.e.* the MD or the RRD) of the analysis, some or all of these four main risks are examined in univariate and regression analysis.

As also showed in Figure 6-2Figure 6-2, unlike other parts of the MD whereby flood is carefully discussed as one of the major natural hazards as in the literature, in the very

coastal areas covered by this study, it is hardly recognized as a threat to inhabitants. Drought and high temperature (including a lengthy period of hot weather and higher peak temperature) seem to be the common concern between the two deltas, and also the most mentioned one that gets in line with the scientific climate change data in these regions (see Figure 2-2, Section 2.2.1). Salinity is the second-highest issue perceived by households in the MD, yet much less concerned by those in the RRD. In the RRD, salinity is only reported in the narrow land stripe right inside the sea dykes caused by a strong wind from the ocean or percolation from aquaculture field either inside (as in Liên Phong village of Nam Định province) or outside the dyke (as in Đông Trên village of Hải Phòng province).

Meanwhile, the typhoon is the dominant risk perceived in the RRD. Findings of the household survey in 2016 show that typhoon is perceived as the highest risk by the majority (77%) of the deltaic residents. Flood is well aware by people, yet in its association with typhoon risk, *i.e.* follow-up flood caused by overflow and slow drainage. All other risks are recognized as the highest important only by less than 30% of households. Besides, windy and/or cold weather seems to support the trend of more frequent extreme weather events in general. However, it is not in the focus of the analysis due to the fact that the concern on increasing temperature and drought risk is shared between households of both deltas which paves the way for potential comparison.

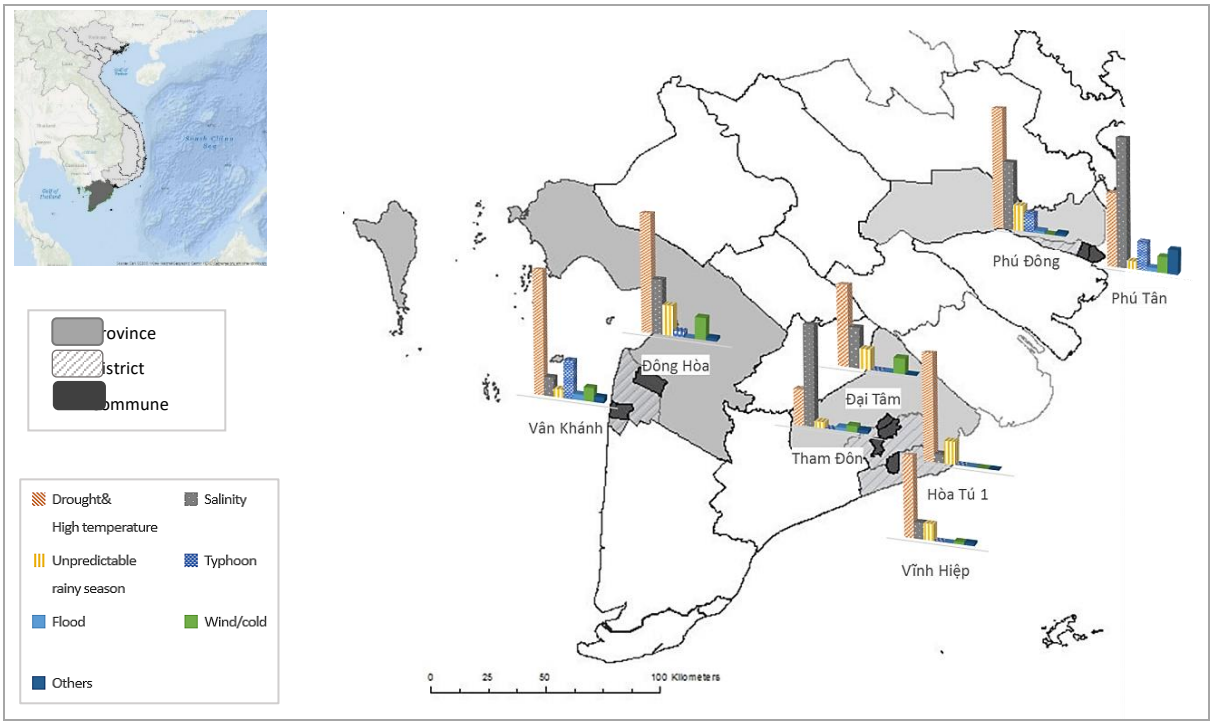



*Figure 6-3: Geographical distribution of household's perceived risks by commune sub-samples in the MD*
(Household survey 2016, n=513)

The geographical divide of risk perception obviously indicates that the level of risk perceived by the population varies even within each delta region. Interestingly, Figure 6-3 clearly shows that perceived salinity risk is not associated with the salinity gradient in the case of the MD. Except for the case of Tiền Giang district, the further inland, the more

farmers are concerned by salinity issues. Data from the interviews with local authorities of the studied district discloses that this unusual division is explained by (1) the complex context created by some policy interventions, more specifically it is caused by the pilot project of focus diking up for 'freshenization purpose'[34] in a few villages of this commune; (2) linked to that, the year 2015-2016 farmers experienced a severe lack of water due to long duration of high-temperature, late onset of the rainy season which apparently made villagers overwhelmed; (3) last but not least, in Phú Hữu commune, farmers keep farming rice much more often than their fellows in similar very-coastal villages of the other two provinces of Sóc Trăng and Kiên Giang. In these three cases, although the main cause is different, farmers' livelihoods are more exposed to salinity issues, thus reflected on the data.

This then raises the question of what actually drives this perception. If it is not directly the geographical divide exposure, their concerns possibly associate with other factors that have shaped this map of perceived risks? Households' dominant farming systems are thus examined to look for a more appropriate explanation. Figure 6-4 appears to support this analysis, and in addition, unveils the larger context:

- Rice farmers, either in mono or rotation (with aquaculture) system, are more concerned by salinity issues, rather than proximity to the coast. This also validates the justification of the case in Tiền Giang province as argued above.
- Other annual crops and shrimp farmers (either in mono intensive, extensive or rotation systems) perceived that risks related to high-temperature events (including extreme level and duration of the dry season, as well as drought events) are most threatening to their livelihoods.
- Thereupon, the farming system is included in the regression step to testified if it is a determinant in explaining the future household decisions. Besides, unexpected findings related to geographical distribution or proximity to the coast implicit that exposure level needs to be treated more attentively.

In the end, this distribution of risks fairly implies the exposure links to the geographical clusters of farming systems, which yet results in the opposite direction than as considering solely the impacts of environmental exposure, for instance, the proximity to the coast. In other words, climatic risks and their effects should not be considered separately from the multi-dimensional social-ecological context. In several cases, the ecological setting is normally taken for granted in the case of the salinity intrusion problem which does not stand in this case. That approach helps to reduce research bias and misleading analysis.

[34] This project is aimed at turning the two communes in Tân Phú Đông district into fresh-water zone by building a close dyke surrounding these communes (II-TG-C01).

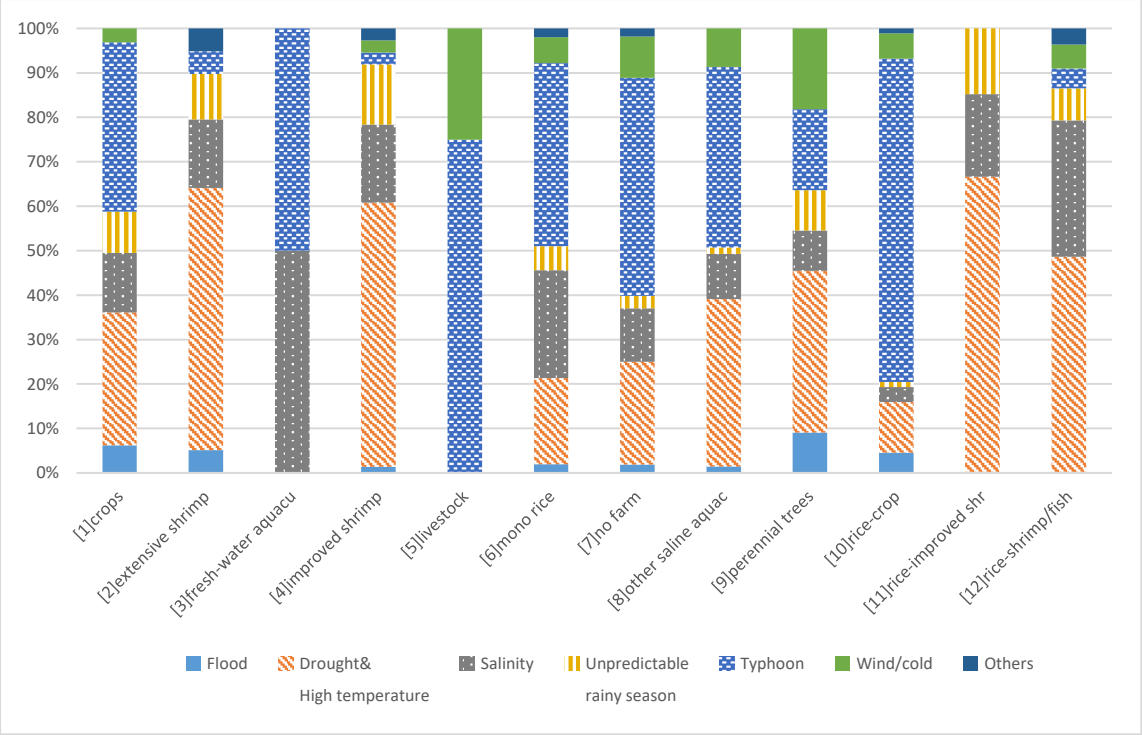



*Figure 6-4: Structure of perceived climatic risks by farm types*
(Household survey 2016, N=836)

However, this is not the case the RRD, for either case of salinity risk[35] or the case of the typhoon which is most frequently perceived as the highest risks? The main reasons are: (*i*) the proximity to the coast does not significantly vary among villages (only a couple kilometres different) which makes the difference in exposure to hazard such as typhoon less noticeable; and (*ii*) the delta is completed diked. Nevertheless, as looking further into the secondary risks listed by households in the RRD, salinity could only be found right next to the sea dyke from the inside where farmers still growing rice and/or other annual crops claim that seawater percolates through the dike. The sample, in this case, is not large enough to show a trend (therefore no result is shown), but it hints at a more extreme change in these areas in the coming time.

In general, this might imply that salinity issues dissimilar between the two deltas. However, despite geographical characteristics, farmers' purposeful livelihood activities, even more important than their exposure in some cases, determine their vulnerability, and thus their risk to an environmental issue.

### *On climate change*

Background information in Section 2.2.1 and the to-date large pool of literature on climate change studies in the two important deltas of Viet Nam show that the focus is put on the hydrology related issues. Particularly for the very coastal areas, recent research tends to be predominantly framed on vulnerability and adaptation to sea-level rise. This research

[35] Given the research design, salinity-related hazard is still considered in the RRD although there is a small number of household actually perceives salinity as a risk, and only secondarily listed (Figure 6-2).

employs more open questions which are aimed to elicit the information and insights of actual concerns of the people in the studied areas.

The tendency whereby farmers participating in the household survey perceive on climatic changes indeed matches the scientific background presented in Section 2.2.1. Figure 6-5 clearly illustrates this finding.

| | Temperature | Precipitation | Salinity | Unpredictable rain season | Drought | Typhoon | Sea level | Erosion |
|---|---|---|---|---|---|---|---|---|
| Obviously increased | 558 | 34 | 328 | 252 | 304 | 25 | 95 | 28 |
| Increased | 263 | 63 | 222 | 432 | 192 | 81 | 103 | 25 |
| About the same | 18 | 80 | 123 | 65 | 119 | 243 | 116 | 113 |
| Decrease | 0 | 376 | 10 | 6 | 3 | 170 | 16 | 4 |
| Obviously decreased | 0 | 203 | 0 | 3 | 1 | 94 | 1 | 1 |
| Unpredictable | 0 | 20 | 0 | 0 | 0 | 17 | 0 | 0 |
| Don't know | 5 | 12 | 16 | 10 | 10 | 7 | 20 | 10 |

*Figure 6-5: Respondents' perceived changes in climatic factors/events in their surroundings in the last 20 years*
(Household survey 2016, N=850)

As being asked on what kind of change related to climatic elements and events they have been observing in the last two decades, interviewees mostly report the trend that climate has become more extreme including noticeably increasing *temperature*, *drought,* and *salinity* risk, *higher frequency of unpredictable rainy season*, meanwhile agreeably *decreasing precipitation*, and even *rising sea level* according to their experience and observation. In contrast, the situation of *typhoons* and *erosion* issues is less likely to change in their perception.

> "Lately the rainy season no longer lasts for 6 months like before. There has been less rain and the weather is unpredictable" (2111.17219/-4/2016)
>
> "The rain season (last year) not only started later but was also shorter" (2231.301, 09/05/2016)
>
> "Currently, it is 30‰ in the channel; usually in June, it's just 15-20‰." (3121.436,27/ 5/2016)

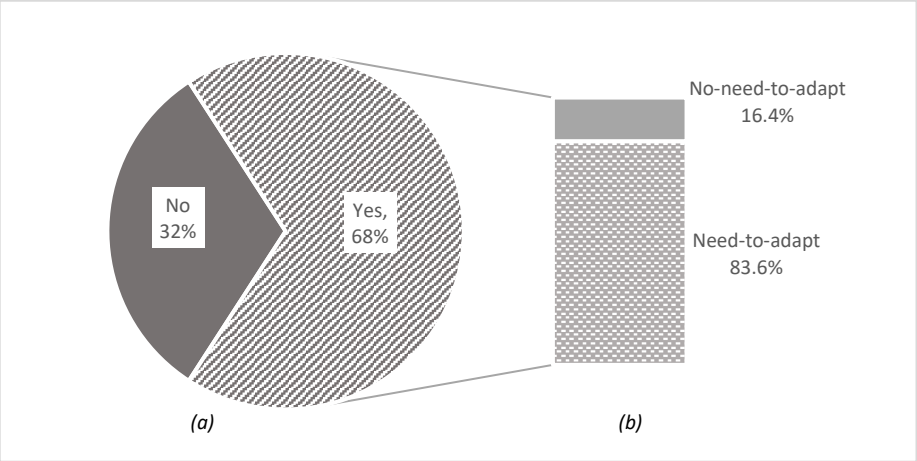



*Figure 6-6: Households' awareness of climate change (a) versus perception of adaptation (b)*
(Household survey 2016, n=848)

As argued in the literature, the perception of change could link to the perception of adaptation. Figure 6-6 also shows that among 68% of respondents who acknowledge the issue of climate change (the rest 32% (‘*not applicable’* value) have never heard the term “climate change” before), 83.6% thinks that they and their communities have to take action to adapt the changing climate. Yet interestingly there remains 16.4% who are not that concerned by these changes. Therefore, it is of great relevance to attentively decide on which variables to use that could reflect this cognitive aspect of adaptation in the later steps of the analysis.

Regarding the majority of households that agree on the need to adapt to the climatic changes that they have observed, Figure 6-7 manifests that more often than not, households refer primarily to on-farm coping adaptation mechanism such as a *shift to another farming system,* in which ‘*shift from farming to livestock*’ is mostly opted (result not shown)*, adjusting crop calendars*, *diversifying varieties and species* and *improving irrigation* are listed respectively in the order of decreasing frequency. Similarly to their past and present mechanism, those options of *quitting farming* such as migration and selling or leasing out farms are the last ones they would consider. Rather, they are more open with the option of increasing labours for *non-farm livelihoods*, yet more as an added option than a replacement. In all cases, this strategy is more frequently listed as the second important action of change roughly 10% (result not shown) comparing to around 5% as the primary option.

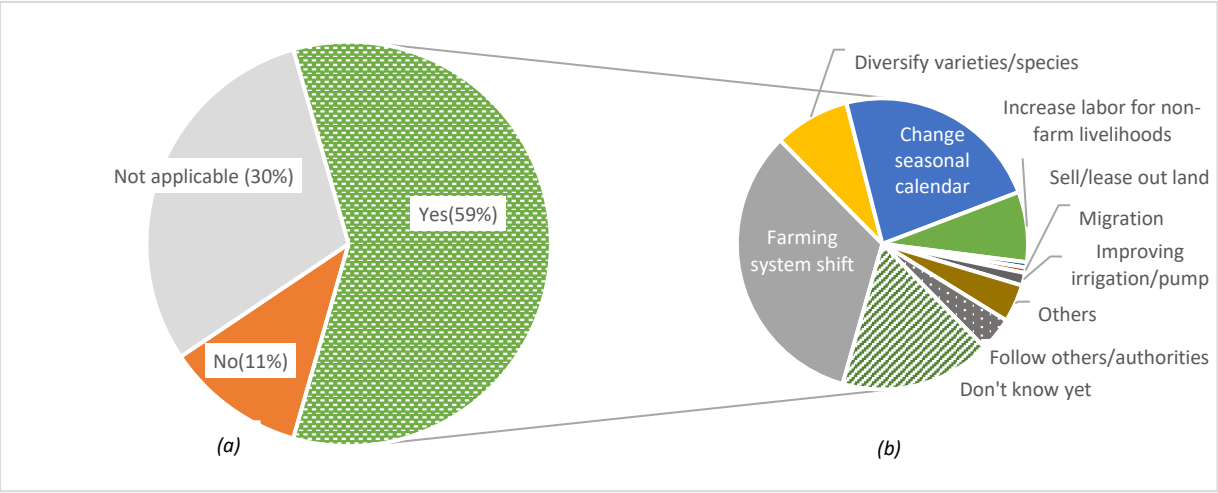



*Figure 6-7: Respondents’ opinion about (a) the needs to adapt to climate change, and (b) how (the primary option) (if Yes)* (Household survey 2016, n=850)

Remarkably, there is a group of households who are likely to stay passive in this process of change as they find it ambiguous in how to deal with the forthcoming alters. Hence this group prefers to wait for actions of neighbours and/or local authority. This group (patterned pies in Figure 6-7) accounts for roundabout 12% of the responses. Given the historical and current practices, this is unsurprising yet expected to add on the uncertainty and unpredictable elements to emerging trends.

Scenarios-based data in the coming sections disentangle more details of these strategies to various specific cases of change. Yet as frequently found in studies on the future, in the end, the link to the real actions (versus the thoughts/plan) of coping and adaption in future remains unfolded at this stage.

### *On environment degradation*

This topic is rather unexpected and unplanned for data collection within the scope of this study, yet as it was widely mentioned by households and local leaders involved in the research, which also underpins the findings of the recent literature on both deltas (see Section 2.2.1). Nevertheless, the environment quality is highly relevant to future-forward discussions particularly related to environmental change and sustainable development in these deltaic coastal areas.

Empirically, shrimp farmers participating in this research complained about the diminishing of quality in the last 5-7 years since they commenced farming shrimp more intensively than the traditional farming technique (Figure 6-8). They blame the highly intensive system for this degradation of soil quality since ponds suffer from the waste of shrimp farming (*e.g.* food, antibiotics, and pest) and exploitation as they are not given enough fallow time to recover in terms of nutrients and healthiness.

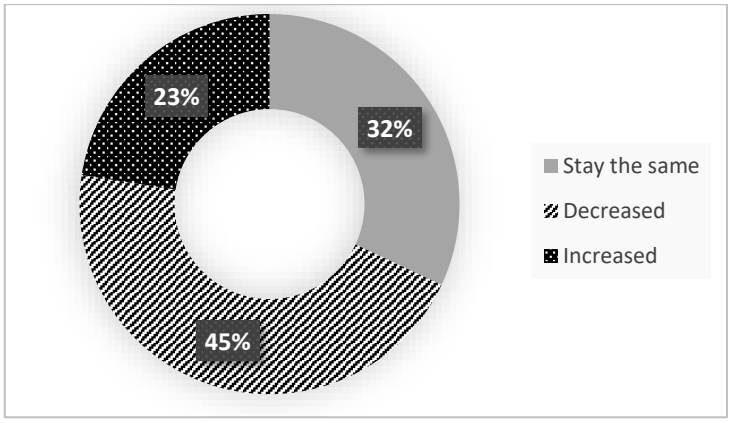



*Figure 6-8: Farmers' perception of how income from shrimp has changed in the last 5 years*
(Household survey 2016, N=297)

Therefore recently, the awareness to preserve their land by opting for more sustainable farming systems has been raised among farmers in these areas. Shifting to more extensive or rotation systems, as well as other technical initiatives have been discussed during several conversations with villagers and local authorities in the scope of this research. Future-forward speaking, these practices should be directly relevant to the discussion on forthcoming on-farm changes in Chapter 7.

> "We have to do rice-shrimp, we do intensive shrimp only, we can't survive after 10 years" (EI-ST-D02-V02, 09/2015)

Beyond livelihoods and farmland, villagers and local officers in the salinized areas (mostly referred to the mono-shrimp systems) noted the negative ecological change in their living space which indeed have negative impacts on household's economic situation:

> "Now we're really poor of natural resources like fruits and fish… 10 years ago, this area was much greener, fruit and fish abundance and watery (not as dry as currently)" (EI-KG-C02, 5/2016).

> "In old days, we could still have some saving even with only one crop/per year, because there were no such expenses like gas, oil, and buying food... natural fish and vegetable were abundant" (3121.438, 27/5/2016).

Besides, pollution particularly next to sea dike areas from the inside (*e.g.* Xuân Tiên commune in RRD) where both water and hard waste are accumulated is an emerging issue reported by villages locating in this area (*i.e.* at the down end of the irrigation system). Villagers and local authorities were highly concerned about the pollution situation, mainly due to living waste and agricultural waste (II-ND-V01).

In short, given the above information and empirical notes, even though the data was not aimed and thus insufficient to go deeper into this topic, this piece of information makes important remarks that are inevitable in discussing possible future trends.

### 6.3.2. Insights of future coping and adaptation

As shown in Figure 4-2 on the research design, this section presents the results and analysis of the scenarios examining households' coping and adaptation in response to the laid-out changes. As these scenarios tend to focus on farming cultures, *i.e.* the variation of hazards context and/or market price of farm productions, changes related to non-farm livelihoods are integrated as an option of coping and adaptation in a general manner. More detailed findings on non-farm livelihood sector come in the next section as it looks into the most common, with high potentials for change, non-farm income-generating activities of rural labours.

The case of the MD shows that the more active they have been in changing their livelihoods so far, *i.e.* groups 6 and 7, the less likely they are to deny the worsening trend of climate. Opting for *passiveness or the tendency of delaying actions* also support this variation among household groups, yet less clearly. More interestingly, those household groups with profiles of being active towards non-farm livelihoods show that they are more willing to "move on" from their current farming activities, *i.e.* to quit farming, if it is necessary. In short, at a less intense level, farmers seek a more adaptive system to shift to; while others could be more open to the option of decreasing or even quitting farming (illustrated at patterned bars in Figure 6-9). This to some extent, shows the advantage of the livelihood-change typology in the previous stage (Chapter 5).

Meanwhile in the RRD, although the link between livelihood-change strategies with the households' capacity to change does not show through *denying* responses as in the MD.

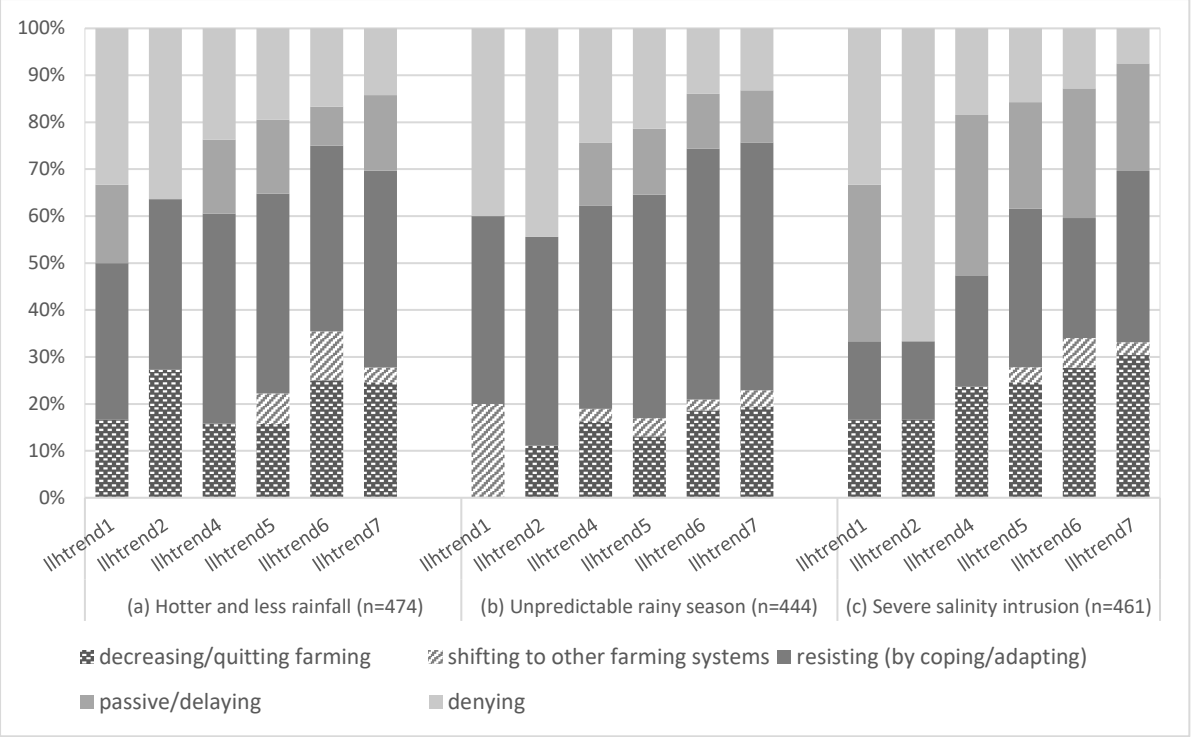



*Figure 6-9: Frequency of household responses to the three main scenarios (a), (b) and (c) of climatic changes in the MD*
(Household survey 2016, sample size showed on graph)[36]

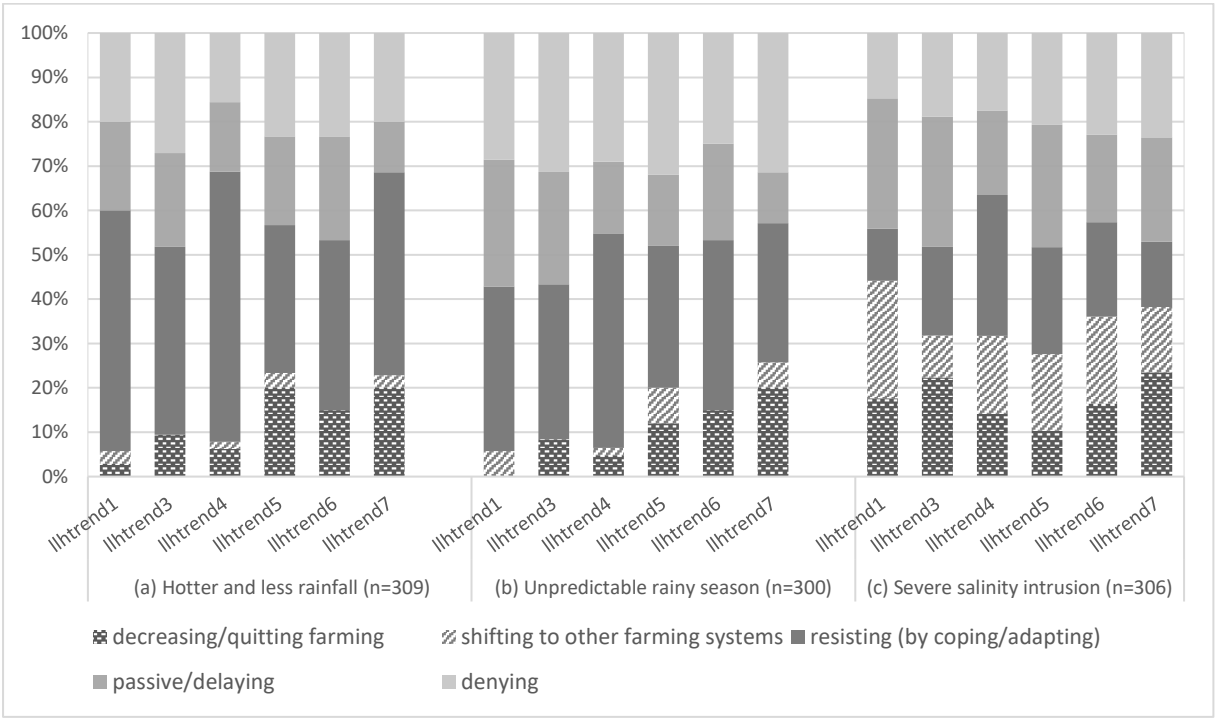



*Figure 6-10: Frequency of household responses to the three main scenarios (a), (b) and (c) of climatic changes in the RRD*
(Household survey 2016, sample size showed on graphs)

The rule holds though as looking into the openness of these household groups towards more active strategies including *shifting* to other farming systems and *decreasing farming*

[36] llhtrend1-7 = Livelihood-change trend typology – is the main results of analysis in the previous stage, more details in Chapter 5

*activities* (patterned bars in Figure 6-10 where groups 5, 6, 7 take this option more frequently in most of the cases. Moreover, similarly to the MD, the more active household groups as up to date, the less likely they are to delay their adaptive actions to the hypothesized changes.

In both deltas, *resisting* options are those that most similar to the coping and adaptation mechanism in the past and present. This option is often taken by a large proportion of respondents. To some extent, this practice confirms their positive attitude toward 'climate change issue' rather than denial attitude in their perception as discussed above. In the same line of argument, *resisting*, *delaying* and also *denying* altogether appear to be more un-frequent in the scenario of *(c) severe salinity intrusion* than the other two. This might be linked back to the coping and adaptation mechanism towards the salinity issue presented in Figure 5-13 where it is heavily focused on engineering solutions rather than "soft measures" of adaptation. In other words, farmers hardly imagine and less prepared for the case when these hazards worsen. It also means more intensive changes in livelihoods are highly potential if salinity intrusion issues increase in the region. Interestingly, this trend holds true across deltas even though salinity intrusion is less often perceived as a primary and urgent threat by farmers in the RRD.

An analysis of determinants to this decision of on-farm adaptation of households is presented in Section 6.3.4 to follow with a synthesised discussion of the whole chapter.

### 6.3.3. Factors to future coping and adaptation decisions

In the light of the prior analysis on how household groups change their strategies over time, this sub-section looks into the question that if the identified factors explaining their decisions to change in the past will hold for their future options when the context is presumed to alter intensively. If not, what are the factors that potentially take over the role? Which of those factors are comparable and what might make a difference and could be the emerging aspects worth further consideration? To answer these questions, a comparative analysis is applied on the dataset followed by a series of multivariate and Probit regressions using different sub-datasets of household responses to each scenario to illustrate the future distressed situations ecologically and socially. Because there are in total eighteen scenarios questions for different target groups (*i.e.* none of the households had to go through all those questions), it is found unnecessary to display all regressions on the cases of both deltas. Nevertheless, the whole dataset is analysed, tested in the background, and hence taken into consideration before coming to the main findings, discussions, and conclusions.

#### *Comparative analysis of single scenarios to investigate the impact of important factors*

As explained in Section 6.2.1 on how scenarios are designed by being based firmly on the analysis and findings of Chapter 5, the same principle factors are used to guide further

analysis in this section which are climate variations, market price volatility, and policy intervention.

The analysis of climate variation scenarios includes the showcases of determinants to the three most popular climatic risks that households also perceive to notably change in the last two decades. The case study in the MD is referred to more frequently than the one of RRD due to more sufficient sub-samples size. A cross-analysis for comparison and/or validating between the cases of two deltas is conducted in the background yet only displayed where applicable.

***Table 18*** is an overview of the outcomes of multivariate regression analysis on the scenarios of three hypothetical contexts of climate variation emphasizing the worsening conditions in terms of temperature, rain season pattern and salinity intrusion. Solely the coefficients with significant levels are displayed in this table which highlights the important insights that potentially explain household future decisions of coping and adaptation.

In the case of the MD, the results of multivariate regressions applied on the salinity scenario indicate that the farming system remains a good proxy (see also Section 6.3.1). Comparing to farmers of the rotation rice-extensive shrimp system, farmers of all other farming systems tend to be less active in changing their livelihood, yet more willing to shift to other farming systems. In contrast, other farmers are more likely to either *delay* action or *reject* to change or *deny* the possibility of scenarios where climate get unfavourable for farming. A household with a *membership* to one or more social groups tends to opt for delaying responding actions, and rather wait to '*follow others*'. Households of this group also tend to have older household-head.

The regression results show that the livelihood-change strategy of households (- their present profile) significantly indicates the coping and adaptation measures that they tend to opt for. Comparing to the most proactive group (7), other groups are more likely to doubt the climate variations and thus less likely to take active strategies such as decreasing farming activates or changing farm system, but rather denying the probability of less favourable change. As such, comparing among the five strategies of coping and adaptation that households opt for future changes unfolds the distinguishing characteristics between major household groups. On the link between the plan to change in response to the perceived climatic changes, the significant coefficients in ***Table 18*** show that households are concerned with the altered patterns of rainfall and the rain season. Meanwhile, they tend to persist with the current farming strategies if they have observed a change in the salinity level. This outcome confirms the hypothesized linked between farmers' perception and their planned livelihood-change.

**Table 18:** Outputs of multivariate regressions on five categories of households' response (1-5) to three scenarios on climate variations
((*a)* Hotter and less rainfall; *(b)* Unpredictable rainy season pattern; and *(c)* More severe salinity intrusion from the case study MD (*Household survey 2016*))

| Variables description | Decreasing/quitting farming (1) | | | Shifting to other farming systems (2) | | | Resisting (by coping/adapting (3) | | | Passive/delaying (4) | | | Denying (5) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | *(a)* | *(b)* | *(c)* | *(a)* | *(b)* | *(c)* | *(a)* | *(b)* | *(c)* | *(a)* | *(b)* | *(c)* | *(a)* | *(b)* | *(c)* |
| Age of household-head | -.002*† | | | | | | | -.006*** | | )04*** | .004*** | | | 002*† | |
| Dependency ratio level (1= 0-49; 2= 50-99; 3= 100-199; 4= >=200) | .045* | .046** | | | | | -.068** | -.08** | | | | | | | |
| Education level of household-head | | | | | | | | | | | | | | | |
| Below primary *(reference group)* | | -.08** | | | | | | | | | | | | | |
| Primary | | | | | 022*** | .037* | -.08*† | | | .09** | | | | | |
| Secondary | | | | | .06* | | -.16** | -.20** | | | | | | | -.10* |
| High-Higher | | | | | | | | | | .125* | | | | | |
| Number of members with high-education | | .040** | .038*† | | | | | -.03*† | | .03* | .03* | | .053** | 034*† | .03*† |
| Membership (social groups) (1=yes;0=no) | | | | | | | | | | .009** | .01*** | .007* | | | |
| Number of income sources | .047** | | | | | | | | | | | .028*† | | | |
| Total land-area (in *ha)* | | | | | | .015** | | .037** | 034** | | .018*† | | -.022* | -.026* | -.024* |
| Total yield (*'000vnd,* sqrt) | -1.00e-06* | -1.18e-06** | | | | | 4e-06** | | | 58e-07*† | | | | 1e-06*** | |
| Number of land-plot (1-5) | -.054** | | -.073*** | | .019*† | | | | | | -.037* | | .058** | .032*† | |
| Ratio of labour working far from home | | | | .0009*† | | | | | | -.001*† | | -.001*† | | .002* | |
| Share of non-farm income | | | | | | | | -.001*† | -.001*† | .0009* | | .001* | | | |
| Awareness of climate change issue (1=yes;0=no) | -.13*** | -.083** | | | | | .13*** | .133** | | | | -.10** | | | |
| Perceived salinity risk (1=yes;0=no) | | | | | | | | | -.119* | | | .113** | | | |
| Observed salinity-level change (1=less/indifferent; 2=increasing; 3=obviously increasing) | | | | | | | | | -.081* | | | .064* | | | |
| Perceived high-temperature risk (1=yes;0=no) | | | | | | | .07*† | | | | | | | | |
| Observed temperature change (1=less/indifferent; 2=increasing; 3=obviously increasing) | | | | | | | | | | | | | | | |

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Perceived unpredictable rain season risk (1=yes;0=no) | | .058*† | | | .046*** | | | .102** | | | -.044*† | | | | |
| Observed change of rain season | | .057* | | | | | | -.099** | | | | | | | |
| Farm-type | | | | | | | | | | | | | | | |
| Annual crops | | | -.277*** | .13*** | | .069** | | | -.168* | | | .39*** | -.09*† | -.15** | |
| Extensive shrimp | | | -.338*** | | | | | | | | | | | | .137* |
| Fresh-water aquaculture | | | | | | | | | .82* | | | | .681* | | |
| Improved shrimp | .136** | | -.267*** | | | | | | | | | .19*** | -.21*** | 21*** | |
| Mono-rice | | | | .046*† | | .068** | | .188** | -.11*† | | | | -.20*** | .26*** | |
| No farm | 259** | .172* | -.207* | .117** | | .074*† | | | | | | | -.26*** | -.21** | |
| Other saline aquaculture | | | -.326*** | | | | | | .132*† | | | | | | .20*** |
| Perennials | | | -.393** | | | | | | | | | .56*** | | -.20*† | |
| Rice-crop | | | | .134*† | | .39*** | | | -.37* | | | | | | |
| Rice-improved shrimp | .178** | .162** | -.189* | | | | | | | | | .29*** | -.21** | -.16* | -.11*† |
| Rice-(extensive) shrimp *(reference group)* | | | | | | | | | | | | | | | |
| Livelihood-change trends | | | | | | | | | | | | | | | |
| 1=No change | | | | | | | | 431* | | | | | .4*† | 17** | 32** |
| 2=No farming + diversify non-farm (or add small-scale livestock | | | | | | | | | | | | 24*† | 30** | 33** | 4*** |
| 3=No change on-farm + change non-farm | | | | | | | | | | | | | | | |
| 4=Farm diversification + no change non-farm | -.108*† | | | | | 05*† | | 166* | .175* | | | 15* | 15** | 201** | 11* |
| 5=Farm shift + no change non-farm | | | | | | | | 126** | .11** | | | 06*† | | .08* | 06*† |
| 6=Farm diversification + increase non-farm | | | | | | | | | | | | | | | |
| 7=Farm shift + increase non-farm *(reference group)* | | | | | | | | | | | | | | | |
| Constant | | | .58*** | | | | .67*** | 1.08*** | .53*** | | | | | | |
| Number of observations | 472 | 423 | 436 | 472 | 423 | 436 | 472 | 423 | 436 | 472 | 423 | 436 | 472 | 423 | 436 |
| Prob > chi2 | 0.003 | 0.006 | 0.006 | 0.051 | 0.036 | 0.004 | 0.012 | 0.00 | 0.002 | 0.004 | 0.013 | 0.00 | 0.008 | 0.00 | 0.006 |
| "R-sq" | 0.11 | 0.12 | 0.124 | 0.09 | 0.10 | 0.126 | 0.10 | 0.15 | 0.130 | 0.11 | 0.11 | 0.218 | 0.11 | 0.14 | 0.124 |

*Significant at 0.1*, 0.5** and 0.01*** level; or 0.1*† level for one-tailed test*

*Single scenarios for market price and policy change*

In market price-related scenarios (applied for rice and shrimp farmers), households do not show an immediate reaction to the volatility of the market, particularly in the case of rice cultivation. This could be explained by the fact that a proportion of rice production is used for household self-consumption, whilst the profit from rice is relatively low compared to other farm productions, i.e. it is hardly considered good business.

Policy intervention laid out in the scenario is about the restriction of converting from rice land to other land-use types for cultivation including annual crops, rice-shrimp rotation, and aquaculture in general, e.g. abandoning rice cultivating on the rice-shrimp rotation farms (during the rainy season) to shift to mono-shrimp farming.

Contrasting the responses of households to disparate scenarios on market-price change with those on policy intervention reveals the dissimilarity of their strategies. As shown in Figure 6-11, rice farmers tend to opt for changes if the regulations on land-use change are relaxed more often than if rice price drops. There is a group that claims they 'could not change' when the price of rice goes down actually choose to apply the change on their farms if they are allowed by the authorities (n=21). This change mostly refers to shifting from rice cultivation to other annual crops or livestock.

| | | *Scenario of removing land-use change restriction* | |
|---|---|---|---|
| | | Do not change | Change |
| *Scenario of decreasing rice price* | Do not want to change | 143 | 62 |
| | Could not change | 56 | 21 |
| | Any change | 38 | 47 |

*Figure 6-11: Cross tabulating households' responses to different single scenarios*
(Household survey 2016, N=367)

Unlike when examining the coping and adaptation to climatic change formerly, for the single scenarios of market and policy changes, the multiple options response was converted into binary dependant variables: *to change* (any option) (=1) versus *not to change* (=0) which is more suitable for regression. Some detailed changes are provided in the descriptive analysis. Separate Probit regressions run on these two sub-datasets also result in comparable models (***Table 19***). Largely the same set of variables as used for the regression analysis of other models are included to investigate if household decisions in these two scenarios share the same set of determinants.

The comparison in the MD case (***Table 19***) shows that these two models share the same impacts of the *number of (household) members with high-education* which is then argued as a better indicator of education level as well as access to information in these models of both

deltas, than the variable *education level of household-head* (which was hence dropped from these models). In the meantime, significant coefficients of the model run on the rice-price scenario *(a)* show that households with lower *dependency ratio* (*i.e.* with more labours) favour to change more often, and in the policy-related scenario *(b)*, younger household-head are more likely to respond to a change of policy. Meanwhile, a linkage to perception on climate change – the *perception of increasing temperature* shows that it positively impacts the decision to change of a household in the scenario related to the policy adjustment. *The perception of salinity change* does not pose a significant impact on thought. Being significant only in one-tailed test, the livelihood-change strategy variable results in expected effects whereby household groups of less intensive on-farm change (type 4 and 5 in model *(1a)*, and 4 and 6 in model *(2a)*) are less likely to respond to market and policy shifts than the most active one (type 7 as the reference group).

In the RRD, models of the two scenarios do not share the impact of *the number of members with high education* in the household. The variable is positively significant (< 0.1 level) only in the case of policy change. However, the perception of risk and climatic variation significantly increases the likelihood of change in these single scenarios. Households that *perceive high temperature and salinity as risks* and also being *aware of climate change issues* are more likely to opt for change if the price of rice decreases, whereas those that *perceive an increase in temperature* are more responding to a hypothetical change in land-use policy.

Besides, only in the case of rice price-related scenario, a higher income from the farm (*yield*), as well as a higher *share of non*-farm *income* indeed deter households from opting for changes due to market volatility which is reasonable because their limited experience with a fall in rice price (*i.e.* it was quite stable in history) makes this hypothesis inattentive. However, similarly to the case of the MD, the average marginal effects of these variables are minimal.

As comparing the frequency of responses on the three main factors of change by the single scenarios (of climate, market, and policy), it unfolds the evidence of the critical role of policy intervention in either promoting or hampering the livelihood-change decision. Figure 6-12 shows that across the single scenarios that illustrate the impacts of those three main factors, households surprisingly tend to be more responding with climate variations and rather than in dealing with market and policy change. The outcome could be explained in two ways: (i) either they are more sceptical about the change of the latter factors; (ii) or the hypothetical decrease and increase of the market price of rice or shrimp are not significant enough for them to feel the ‘shock’.

**Table 19:** Outputs of Probit regressions to study the determinants to households' future change to scenarios of decreasing rice price and removed land-use policy restrictions

(The case study of the MD (*1a, 2a*) and the RRD (*1b, 2b*) (average marginal effect (AME) reported, *robust standard errors* in parentheses) (*House survey 2016*))

| **Variables description** | **Scenario of decreasing rice price** | | **Scenario of removing land-use change restriction** | |
|---|---|---|---|---|
| | MD *(1a)* | RRD *(1b)* | MD *(2a)* | RRD *(2b)* |
| Age of household-head | | | -.024* (.013) | |
| Dependency ratio level (1= 0-49; 2= 50-99; 3= 100-199; 4= >=200) | -.248* (.132) | | | -.316** (.161) |
| Number of members with high level of education | .252** (.112) | | .54*** (.164) | .22*† (.14) |
| Membership (social groups) (1=yes;0=no) | | | .256*† (.198) | |
| Number of income sources | -.18*† (.113) | | | |
| Total land-area (in *ha)* | .085*† (.066) | | | |
| Total yield ('000*vnd*, sqrt) | -6.39e-06** (3.23e-06) | -8.37e-06** (4.25e-06) | | -5.00e-06*† (3.43e-06) |
| Number of land-plot (1-5) | | | | |
| Ratio of labour working far from home | | | | |
| Share of non-farm income | | -.015*** (.005) | | |
| Awareness of climate change issue (1=yes;0=no) | .507** (.229) | 1.15** (.546) | | |
| Perceived high-temperature risk (1=yes;0=no) | | 1.769** (.557) | | |
| Observed temperature change (1=less/indifferent; 2=increasing; 3=obviously increasing) | | | .655** (.326) | .928*** (.277) |
| Perceived salinity risk (1=yes;0=no) | | 1.17* (.672) | | |
| Observed salinity-level change (1=less/indifferent; 2=increasing; 3=obviously increasing) | | | | |
| Livelihood-change trends | | | | |
| 1=No change | | | | |
| 2=No farming + diversify non-farm (or add small-scale livestock | | | | |
| 3=No change on-farm + change non-farm | | | | |
| 4=Farm diversification + no change non-farm | -.587*† (.418) | | -.691*† (.448) | |
| 5=Farm shift + no change non-farm | -.424*† (.261) | | | |
| 6=Farm diversification + increase non-farm | | | .628*† (.420) | |
| 7=Farm shift + increase non-farm *(reference group)* | | | | |
| Constant | | | | -2.30* (1.30) |
| Number of observations | 220 | 200 | 124 | 178 |
| Prob > chi2 | 0.069 | 0.013 | 0.047 | 0.029 |
| " Pseudo R-sq" | 0.11 | 0.22 | 0.169 | 0.157 |

*Significant at 0.1*, 0.5** and 0.01*** level; or 0.1*† level for one-tailed test*

In the context of Viet Nam, farmers do not often involve in policy decision-making and informed much in advance. In some cases, they did not even expect changes of policy (see more in Section 5.4.1), therefore this change might be 'difficult to imagine' to them. They rather insisted that it could not happen:

> "If you have rice field, you can't convert into anything else (*couldn't be changed anyhow*)" (4123.667, 21/07/2016)

> "But even that (*the scenario of relaxing the regulations of land-use change*) If I want to change, I have to be approved anyway by the local authority" (4112.583, 17/07/2016)

Whereas if we recall, when shrimp was firstly introduced to the region, its rocket price simply outnumbers rice price which remains until the real-time of the survey. It acted as a price shock, sufficiently significant for farm shifting options to be considered by individuals, communities and also authorities. Whereas, this profit gap makes comparing the price volatility of these two farm products to become inconsiderable. This limit might have been overcome if there was a scenario of a new farm product that may or may not require a farm system shift in higher demand and thus more profitable. Nevertheless, it was not applied also to avoid risking the research to be out of focus.

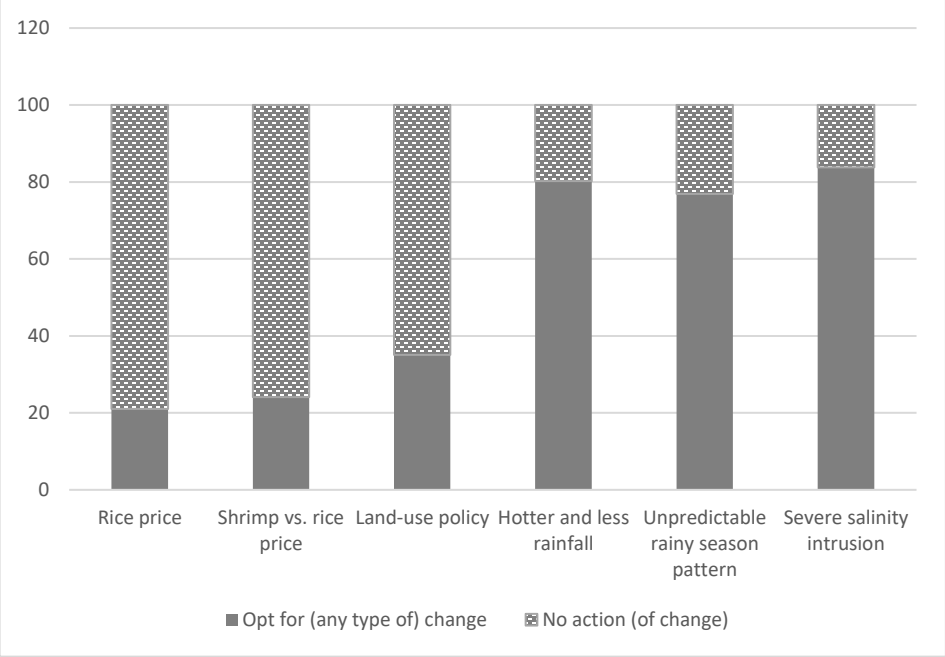



*Figure 6-12: Comparing households' responses across single scenarios of climatic, market and policy changes*
(Household survey 2016)

How households respond to each scenario of factor change is also confirmed by the expectation of their current livelihood in the middle-term future (5-10 years as framed here). It is explicit in Figure 6-13 that annual crops farmers (mostly cultivating vegetable or lemongrass like in Tân Phú Đông district) are the only production considered as market-dependent. Other farmers are more

concerned with climate variation. Meanwhile, a large proportion of household does not expect a substantial change to their current livelihoods. Interestingly, although rice relatively is not profitable, farmers tend to maintain their field; while there is a trend of increasing annual crops (even facing the risk of market volatility) and livestock considered by households. Nonetheless, it is important to note that this also reflects the politics-ignorant norm among farmers as they hardly discussed systematic changes currently and in the future. Policies in the past that impact their livelihood are better aware though. Therefore, it is meaningful to confront them with the policy-related hypothesis to learn their potential (re)actions.

| | Rice | Shrimp | Other aquaculture | Fishing | Annual crops | Livestock | Retailer shop | Informal economic activities | Firm wage | Salary | Daily wage | Remittance |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Replaced | 16 | 1 | 5 | 1 | 6 | 3 | 2 | 5 | 3 | 0 | 7 | 6 |
| Decreasing | 26 | 29 | 6 | 10 | 18 | 13 | 17 | 13 | 0 | 1 | 23 | 4 |
| About the same | 105 | 46 | 19 | 5 | 87 | 100 | 50 | 55 | 11 | 44 | 66 | 42 |
| Increasing | 15 | 38 | 13 | 18 | 93 | 106 | 26 | 16 | 9 | 14 | 17 | 9 |
| Depending on climate | 49 | 114 | 26 | 9 | 55 | 5 | 0 | 3 | 0 | 0 | 3 | 0 |
| Depending on market | 6 | 6 | 2 | 0 | 71 | 27 | 10 | 9 | 0 | 0 | 4 | 0 |

*Figure 6-13: Households' expectation of how current livelihoods will change in 5-10 years*
(Household survey 2016)

### *Paring single scenarios and complex scenarios to contrast the factors*

Policy intervention is examined to see if its critical role remains in directing emerging trends, especially under climatic stressors as found in Chapter 5. As comparing the answer of rice households to the single scenario of removing the restriction in land-use policy and the complex scenario in which this shift of policy is combined with the presumption of worsening climatic conditions and a fall of rice price. It occurs that households tend to change their responses when it comes to the combined scenarios into more active responses than in separate single scenarios.

Figure 6-14 compares the answers of rice households to the single (change of land-use policy toward more freedom to change) versus combined scenarios (change of land-use policy, increasing salinity issue and decrease of rice price). The number of '*Do nothing*' response drops by a half in the complex scenario. Interestingly, a significant proportion of this group changes to farm shifting options (patterned slices). Some others even think about dropping off farming while another large group feels the urge to act, yet slowly and uncertainly waiting to *'follow others*'.

Probit regression analysis is applied to the complex scenario *(b)* to purposefully investigate if farmers in the fresh-water areas are more willing to change when they are no longer restricted by land-use policy and face unfavourable climate change plus decreasing rice price.

The results (***Table 20***) also reveal other determinants to this decision *to change* versus *not to change* of the households which vary across the deltas.

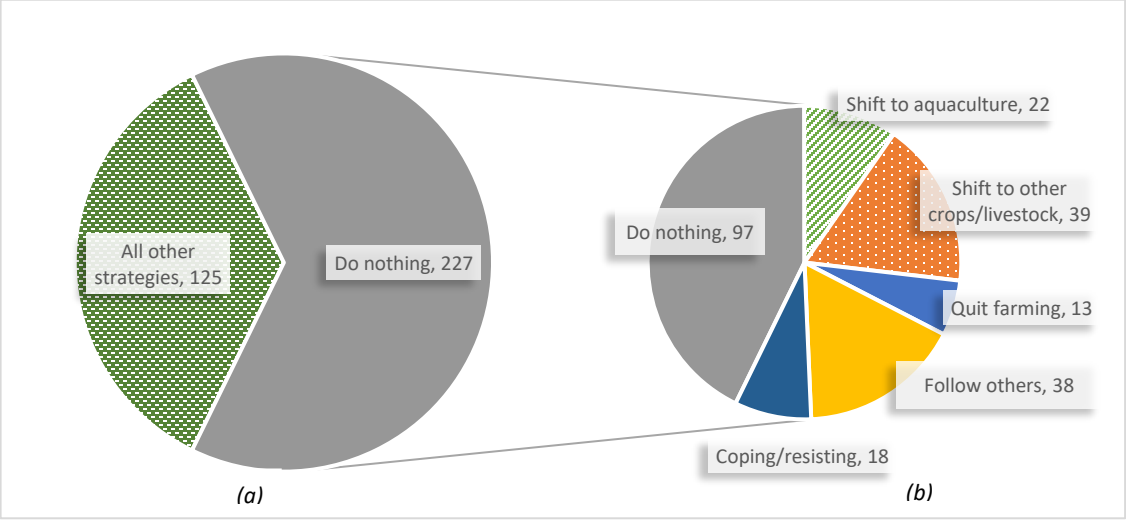



*Figure 6-14: Comparing rice household responses to scenario questions*
Between (a) the single scenario on land-use policy[37] and (b) a combined scenario of this with hypothetical increasing salinity intrusion and decreasing rice price (Household survey 2016, N=352)

In the case of the MD, the likelihood of households opting for change is predominantly and proportionally affected by the number member(s) with high-education and the number of income sources of a household. Noticeably, similarly to the Probit regression outputs of the single scenarios (see Section 6.3.2), there is a significant difference between households group belong to livelihood-change strategy 7 (as the reference group) with those of category 4 and 5. As expected, the former group is more likely to opt for change to the hypothetical future context.

Meanwhile, in the RRD, the historical and present livelihood-change strategy has no impact on the decision to change of the households in the combined scenario. Rather, the group wishing to change in this scenario is more distinguished by such characteristics as lower *dependency* rank, a higher *number of members with high-education*, having *membership* in social groups, having more *sources of income*.

While perceiving *salinity* as risk increase the likelihood of a future change of household in the MD (significant at 0.1 for the one-tailed test), *awareness of climate change issue* and *perception of increasing temperature* positively affect the likelihood of opting for a change in the RRD (both variables are significant at 0.01 level).

[37] *All other strategies* in displayed for the purpose of simplifying the figuring and draw the attention on '*Do nothing*' response; this include: Change partly/all to aquaculture-only; Change to livestock; Change to other crops; Others

**Table 20:** Outputs of Probit regressions to study the determinants to households' future change to the complex scenarios of climatic change, decreasing rice price and removed land-use policy restrictions

(The case study of the MD *(a)* and the RRD *(b)* (average marginal effect (AME) reported, *robust standard errors* in parentheses) (*Household survey 2016*))

| **Variables description** | **MD** | | **RRD** | |
|---|---|---|---|---|
| | AME | (Robust) Std. Err. | AME | (Robust) Std. Err. |
| Age of household-head | | | | |
| Dependency ratio level (1= 0-49; 2= 50-99; 3= 100-199; 4= >=200) | | | -.162*† | (.117) |
| Number of members with high-education (0-4) | .401*** | (.153) | -.197* | (.105) |
| Membership (social groups) (1=yes;0=no) | | | .726* | (.394) |
| Number of income sources (1-5) | -.227* | (.126) | .270*** | (.094) |
| Total land-area (in *ha)* | | | | |
| Total yield ('000*vnd*, sqrt) | | | | |
| Number of land-plot (1-5) | | | | |
| Ratio of labour working far from home | | | | |
| Share of non-farm income | | | | |
| Awareness of climate change issue (1=yes;0=no) | | | .690*** | (.243) |
| Perceived high-temperature risk (1=yes;0=no) | | | | |
| Observed temperature change (1=less/indifferent; 2=increasing; 3=obviously increasing) | | | .561*** | (.169) |
| Perceived salinity risk (1=yes;0=no) | .545*† | (.349) | | |
| Observed salinity-level change (1=less/indifferent; 2=increasing; 3=obviously increasing) | | | --- | --- |
| **Livelihood-change trends** | | | | |
| 1=No change | | | | |
| 2=No farming + diversify non-farm (or add small-scale livestock | | | | |
| 3=No change on-farm + change non-farm | | | | |
| 4=Farm diversification + no change non-farm | -.775* | (.459) | | |
| 5=Farm shift + no change non-farm | -.535* | (.320) | | |
| 6=Farm diversification + increase non-farm | | | | |
| 7=Farm shift + increase non-farm *(reference group)* | | | | |
| Constant | | | -2.8*** | (.975) |
| Number of observations | 149 | | | 266 |
| Prob > chi2 | 0.066 | | | 0.001 |
| " Pseudo R-sq" | 0.153 | | | 0.123 |

*Significant at 0.1*, 0.5** and 0.01*** level; or 0.1*† level for one-tailed test.*

***Variables excluded from the models are presented as ---.***

### 6.3.4. Scenarios and factors to the change of non-farm livelihoods

#### *Households' expectations of local livelihoods*

The background information (Chapter 2) and data analysis of the past and present livelihood changes (Chapter 5) have shown that the local non-agriculture sector is the key to the jump of rural development in the MD and the RRD. Given the increasing rural labour force shifting from agriculture to non-farm sectors, most noticeably to the emerging wage jobs as found in the analysis of the previous chapter, it is intriguing to investigate the middle- to long-term track this trend. With information at the household level, we attempt to see how far it will be carried out into the future and what impacts it might have in shaping the forthcoming rural context.

Comparing the single scenario of more industrial firms at local versus the combined scenario of this case with harvest loss reveals some interesting shifts of household livelihood strategy. Figure 6-15 illustrates this comparison shows the most obvious difference is the frequency of option *leasing out land and/or change to non-farm livelihood* being taken. This difference makes sense since harvest losses due to unfavourable climatic conditions might enhance further the wish to shift to non-farm livelihoods, particularly when they have found this strategy more profitable for the time being which was more often found in the RRD than in MD.

> Farming is just enough for two of us (*husband and wife*), we need to look for other income sources. Rice is not profitable at all, just for family consumption. We try to maintain farming because we are farmers." (5112.757, 29/07/2016)

This strategy includes labour mobility for higher income from the regions:

> "They all left for firms and housework in cities. Only elders stayed in the village because we are too old to be employed… Many people dropped off farming to work for firms." (5113.781, 01/08/2016)

Moreover, this implies that in normal conditions, farmers tend to prefer maintaining farming while considering non-farm activities as the added source of income. In other words, switching completely from farm to non-farm is a must in the worst scenarios rather than an option to them. As such, the combined scenarios with the layout of putting more production firms in the rural neighbourhood result in increasing the tendency of farmers to put more labours in this sector. That also implies that they will be more likely to decrease or even stop their farm production. However, the available data is not sufficient to tell if this trend will be a short-term strategy or implying a long-term structural change.

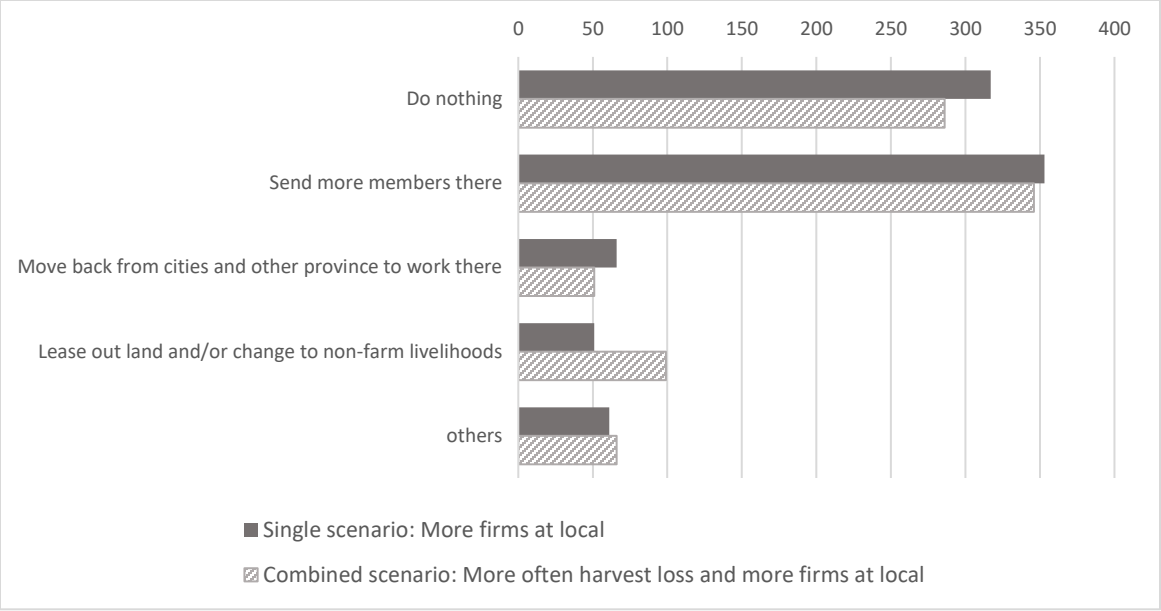



*Figure 6-15: Comparing farmers' responses to single versus combined scenarios of changes related to firm's job availability at the local*
(Household survey 2016, N=850)

Nonetheless, in both scenarios, it shows the great expectation of local people to have more job opportunities close to their home so that they could take advantage of their abundant labours to increase their cash in without splitting up their family. In other words, rural households tend to seek for non-farm income yet rather prefer staying in the village than moving out. An increase in availability of wage jobs might enhance the livelihood shift in the rural economies and thus also reshapes the agriculture landscape.

The results of Probit regressions models (***Table 21***) to compare single and combine scenarios related to the hypothesis to put more firms in the local area confirms some findings of the prior analysis on other scenarios as well as the past and current trajectory, but also bring up new insights. Noticeably, the principle categorization such as farm-type, past and present livelihood-change strategy, geographical location or hazard exposure hardly have a significant impact on the decision making of households in most cases anymore. This is the shared results across models apart from the case of the impact of livelihood-change strategy on the household's decision (discussed below). Very likely, this is because the majority opt for change regardless of which group they belong to.

**Table 21:** Outputs of Probit regressions to compare the determinants to households' future change to single versus combined scenarios of more firms and more frequent hazards

(The case study of the MD (*1a, 2a*) and the RRD (*1b, 2b*) (*average marginal effect* (AME) reported, *robust standard errors* in parentheses) (*Household survey 2016*))

| **Variables description** | **Single scenario of more firms in local areas** | | **Combined scenario of more firms and more frequent hazards** | |
|---|---|---|---|---|
| | MD *(1a)* | RRD *(1b)* | MD *(2a)* | RRD *(2b)* |
| Age of household-head | -.011**<br>(.006) | | -.015**<br>(.006) | -.012*<br>(.007) |
| Dependency ratio level (1= 0-49; 2= 50-99; 3= 100-199; 4= >=200) | -.121*†<br>(.09) | -.175*<br>(.106) | -.166*<br>(094) | |
| Number of members with high-education | .185**<br>(.084) | | .230**<br>(.089) | .184*<br>(095) |
| Membership (social groups) (1=yes;0=no) | | | | |
| Number of income sources | | | | |
| Total land-area (in *ha)* | -.133***<br>(.051) | | -.108**<br>(.050) | |
| Total yield ('000*vnd*, sqrt) | -5.61e-06***<br>(1.85e-06) | | -5.64e-06***<br>(1.91e-06) | |
| Quintiles of households' assets | | | | |
| Quantile1 *(reference group)* | | | | |
| Quantile2 | | .372*†<br>(.232) | .372*†<br>(.241) | .567**<br>(.236) |
| Quantile3 | | | | .534**<br>(.273) |
| Quantile4 | | | | |
| Quantile5 | | .485*<br>(.252) | .351*†<br>(.27) | .380*†<br>(.25) |
| Number of land-plot (1-5) | | | | |
| Ratio of labour working far from home | | | | |
| Share of non-farm income | | | | |
| Awareness of climate change issue (1=yes;0=no) | | | | |
| Perceived high-temperature risk (1=yes;0=no) | | | | |
| Observed temperature change (1=less/indifferent; 2=increasing; 3=obviously increasing) | | .634***<br>(.157) | | .603***<br>(.153) |
| Perceived salinity risk (1=yes;0=no) | | 1.09*<br>(.600) | | 1.18**<br>(.602) |
| Observed salinity-level change (1=less/indifferent; 2=increasing; 3=obviously increasing) | | | | |
| Perceived unpredictable-rain-season risk (1=yes;0=no) | | --- | | |
| Observed frequency of unpredictable-rain-season change (1=less/indifferent; 2=increasing; 3=obviously increasing) | | --- | | |
| Livelihood-change trends | | | | |
| 1=No change | | -.599*<br>(.326) | | -.588*<br>(.334) |
| 2=No farming + diversify non-farm (or add small-scale livestock | .542*†<br>(.392) | --- | | --- |
| 3=No change on-farm + change non-farm | --- | -.461*<br>(.280) | --- | -.381*†<br>(.286) |
| 4=Farm diversification + no change non-farm | .487*†<br>(.31) | | | -.443*†<br>(.308) |
| 5=Farm shift + no change non-farm | | -.766**<br>(.364) | | -.814**<br>(.369) |
| 6=Farm diversification + increase non-farm | | -.712**<br>(.291) | | -.574*<br>(.298) |

| 7=Farm shift + increase non-farm *(reference group)* | | | | |
|---|---|---|---|---|
| Constant | 1.37**<br>(.696) | | 1.89***<br>(.712) | |
| Number of observations | 428 | 310 | 411 | 312 |
| Prob > chi2 | 0.000 | 0.002 | 0.000 | 0.000 |
| " Pseudo R-sq" | 0.122 | 0.107 | 0.136 | 0.128 |

*Significant at 0.1*, 0.5** and 0.01*** level; or 0.1*† level for one-tailed test.*
***Variables excluded from the models are presented as ---.***

Rather similar to the output of other scenarios discussed above, demographic and capital variables such as the *age of household-head* (negative and significant), the *number of member(s) with higher education*, *total land area* and *total yield* (both decrease the likelihood of acting in response to the hypothesis in the MD. In the RRD, the household's *perception of temperature and salinity* rise increase the likelihood of change in the future strategy. There is still a significant difference in the decision of future change among groups of livelihood-change strategies.

The impact of the variable *dependency ratio* is negative and significant in both delta sub-samples. Specifically, younger households (*age of household head*) with more members in labour ages (lower *dependency ratio*) in both deltas are more likely in need of this non-farm job opportunity which clearly shows in the models of combined scenarios, and also the single scenario in the MD. In the combined scenario, the number of highly educated members becomes significant for both delta cases which is in line with the analysis of other scenarios presented earlier.

### *Labour mobility versus migration*

Since the multi-local livelihood strategy is frequently opted by households and plays an important role in lifting their income and employment, these scenarios are to examine the household's long-term plan and how it might change in future under more pressures.

Figure 6-16 explicitly shows that the majority of rural households consider labour mobility as a short- to medium-term livelihood strategy rather than a long-term one. As findings in Chapter 5 indicates, this group tends to send labour away for extra income and/or due to the lack of employment in their locals. Even though most of the respondents are not those that are sent away, at the household level, they believe that the migrant labours will return and take over their farm. This strategy could be the plan for a short course of a few couples of years, or longer until the migrants retire from their work in urban areas. Another proportion of households uses this means to transform the children's lives rather than for their own. In this case, their children might either return or stay where they moved to. Nevertheless, the elders hardly imagine themselves leaving their homeland no matter what might happen.

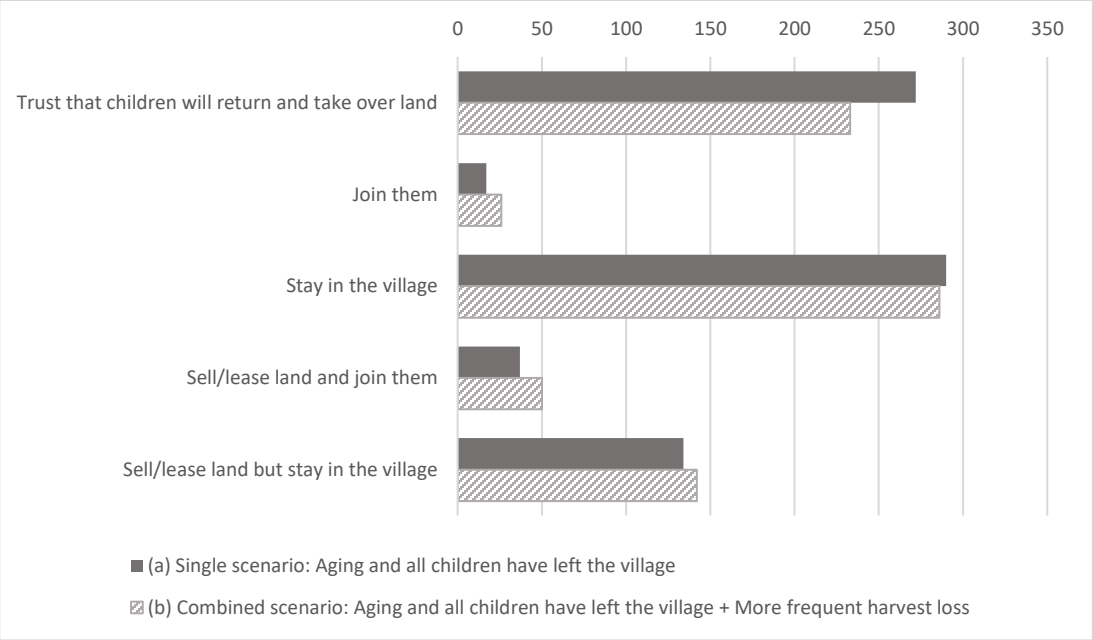



*Figure 6-16: Comparing farmers' responses to single versus combined scenarios of changes related to labour mobility strategy and future migration*
(Household survey 2016, N=750)

When the climatic factor is added to the scenario, it has some impact on the responses. If the conditions are less favourable for farming, households think twice about the plan to get their children back and more of them appear to be more willing to join the migrants. Even though, the change in the proportion is not substantial. This is another strong evidence of the attachment of farmers to their land, thus also explains their predominant decisions to cope, resist and save their farming by all means in the previous scenarios. Giving up their farm is more than often the last option they would like to take, especially emphasised by farmers in the MD:

> "Land is our livelihood and food…we will never sell out no matter what" (3122.474, 31/05/2016)

Across the studied villages, many rural households seek for opportunities for their children to shift their professionals with an expectation to lift their economic situation, rather than continuing doing what parents (current household-head) are doing as shown in Figure 6-17 which is likewise the aim of their investment on their children's education:

> "(*non-agricultural*) occupation is the future… we will try as much as we could no matter how hard it is to support them (*children*) to have one" (3111.352, 23/05/2016)

However, they have different aspirations for their retirement plan back in their homeland roots in the village. This phenomenon has been going on in the regions which also showed up in the in-depth discussion with local officers whereby they name

it “leaving farming without leaving land” (II-KG-P03). It is of great importance to capture this short-term versus long-term expectations and thus livelihood strategy of farmers to avoid misleading the analysis on future trends.

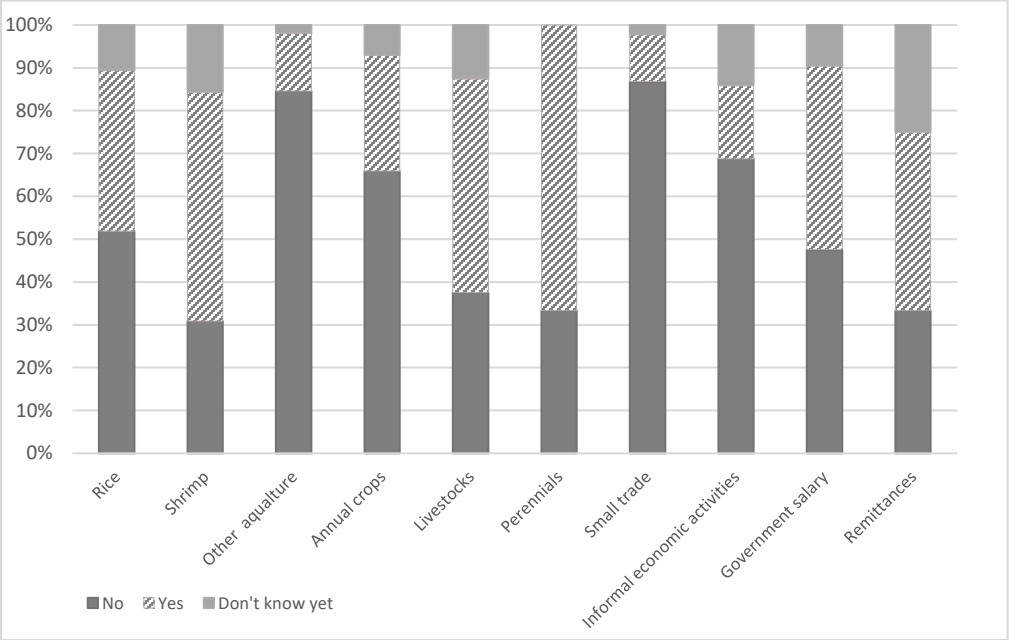



*Figure 6-17: Households' expectation to have children maintaining their main income source*
(Household survey 2016, N=850)

Due to the asymmetry of response structure whereby options to not to act (*i.e.* trust that children will take over land, stay in the village) outnumber those potentially acting, the regression analysis was not applied for this scenario.

### 6.3.5. Summary: Future adaptation and the uncertainties

#### *Insights of future adaptation and reflection of historical patterns*

In general, inhabitants in the deltaic rural coastal areas recognize the highly changing social-ecological context that accommodates their living activities. Furthermore, with or without explicit changes, they tend to continually adjust their livelihoods. Society-ecology interaction, therefore, remains as the momentum for change as looking toward the future.

Nevertheless, analysis based on data from single scenario-based questions appears that climatic factors tend to enhance their impacts on households’ further changes of livelihood. It seems that the hypothetical ecological changes are more incontrovertible than social ones, especially when they are policy-related. People hesitate to respond to scenarios of land-use policy changes that might be explained by (i) their experience of top-down policy implementation, and thus (ii) lacking of political culture to involve in the policy-making process. In all research activities, only a minority of informants thought that it made sense to

discuss policy change, the rest rather agreed to 'take it when it comes' which causally link to the waiting-for- 'superpower state' behaviour among them. This is an important aspect of individual adaptive capacity for further discussion later.

> "I was not invited (*to the meeting informing about 'dyke lifted' for aquaculture*), I heard from other farmers… no official informing. When I knew about it, everything had been set…I was still farming rice back then." (1111.011, 05/04/2016)

However, a change of policy interventions, e.g. the relaxation of land-use regulation in this case) when put in combination with climate and market factors shows its significant impact on the likelihood to act for change of household as they are confronted with those scenarios. Hence it is argued here that the state's intervention retains its critical role in shaping the future trend of livelihood change in both agricultural and non-agricultural sectors.

In line with that, the trend of increasing the non-farm sector proportion in the rural economic structure will be enhanced. The huge needs of employment might be resolved through on-time and on-spot policy intervention. Policies promoting local industrialization could be the channel to lift rural development down this path. Nevertheless, like any other process in the rapidly changing society like Viet Nam, improving the management level is the key to sustainable development.

Despite being rather implicit, the number of members with high education) in a household which is used as an indicator of education level is consistently significant across the models. This variable not only stands for human capital but also being referred to as a source of information or the social capital of a household that helps to enhance their adaptive capacity, *i.e.* to stay active or even proactive to future changes.

The level of diversity of income-generating activities also significantly increases the likelihood to change which might support the expected impacts of past and present livelihood-change strategy. In few models, the livelihood-change typology constructed based on data of the past and present changes of households (Chapter 5) significantly explains their future adoption of adaptive actions whereby the more they have been being proactive in adaptation, the more likely they will keep up this attitude confronting future changes.

### *Uncertainties of context and household strategy*

As foreseen, the scenario-based analysis reveals that households, in dealing with more intensive yet uncertain changes in the future, apply strategies with even higher uncertainties. In spite of the growing perception and also experience of climate varieties among households, as well as the good practices of their pro-activeness in improving their livelihoods in the past and present, their preparedness for future changes remains ambiguous in several aspects. This is entirely explainable due to the high sensitivity of their livelihoods to the complex societal

and ecological environment. Moreover, the non-linear interaction between these two components to some extent interrupts the direct link between households' perception and their actions, particularly between their farming cultures and climatic changes.

Similarly, to the analysis of the historical and current changes, an important factor to this complexity is the predominant role of policy intervention. Most obviously, 'to rice or not to rice', or rethinking the national rice-based food safety strategy has been a policy discussed since the last decade (Demont & Rutsaert 2017). There are signs of restructuring toward this direction found in recent policy documents, yet hardly any systematic and substantial shift has happened up to date. In contrast, changes are being made cautiously and hence, slowly which does not seem to meet the needs of rice farmers to improve this pivotal livelihood. This issue is of great relevance as it reflects important interventions including engineering solutions on the delta scale, *i.e.* diking up and land-use regulation that aggravate the uncertainties, thus possibly enhance the vulnerability of rural coastal households, especially rice farmers facing puzzling future.

In the case of non-farm livelihoods, labour out-mobility is ubiquitous in the current rural development process which has been emphasized as an important rural economic structural change (*e.g.* Adger *et al.* 2002) and raised concern of future agricultural development. However, the analysis of the response of households on their future perspectives related to this strategy might make this argument questionable. A large proportion of households did not seem to plan a long-term shift with migration but rather consider it a contemporary strategy whereas they insist on maintaining their farm and expect their children (at least one son) to come back and take over the land. The strategy to invest in children's education is another good example of these uncertainties. This strategy is rather an aspiration with a minimum guarantee of success since the return is ambiguous due to many aspects that farmers more often than not have limited control over, for instance, job opportunities in urban areas, an increase of income or a social upgrade of children's life (and perhaps theirs as well). Yet clearly it is a large and long-term investment in terms of finance and labour given their limited capitals at the time being.

If most of the uncertainties are retained or even reinforced under predictive future contexts, it is important evidence to prove that their 'capacity to change' is an important element in the individual adaptation process. The ability to stay pro-active or active in the past and present will also mean being more adaptive and resilient to future dynamics.

# 7. SYNTHESIS AND GENERAL DISCUSSION

The results and findings delivered in Chapters 5 and 6 have provided significant insights into the past and current patterns as well as potential future trends of livelihood change by rural households in the coastal areas of the Vietnamese MD and RRD. In this chapter, they are synthesized and reflected against the theoretical and methodological background to elaborate further on the answers to the research questions that have been provided in the previous chapters, specifically RQ1 in Chapter 5 and RQ2 in Chapter 6. In other words, this Chapter particularly addresses the sub-questions: Sub 1.3.2, Sub 1.3.3, Sub 1.4 as well as Sub 2.2, Sub 2.3 in the first section (7.1); meanwhile, the RQ3 will be addressed in sections 7.2 and elaborated further in Chapter 8. In light of this synthesis, the discussion is aimed to manifest the research contributions to enriching the knowledge of the case study. It also importantly contributes to promoting the conceptualization of adaptation and the individual decision-making process underpinning the interdisciplinary literature on livelihood adaptation dynamics in changing social-ecological contexts.

## 7.1. Synthesis and discussion of empirical results

### 7.1.1. Continuous household livelihood adaptation

The insights on the case study of the rural coastal areas in the MD and the RRD emphasized that the livelihood dynamics at the household level is an inherent process of adjustments to improve their well-being. Despite the agriculture-dominant rural context, this process could only be comprehended by looking in both agricultural and non-agricultural income. Adjustments applied on one or two of these sources could be done dependently or independently, yet quite often simultaneously and continuously. The intensity of change on-farm and off-farm also varied across household groups. This whole process took place as they interacted with the changing social-ecological context. Therefore, these two sectors complement forming flexible and active livelihood strategies of rural households which, through their interaction with their environment maintained the social-ecological dynamics of the studied regions.

These findings were not only discovered from the historical and current patterns of livelihood change but also reaffirmed by the scenario-based analysis that rural households in the delta's coastal areas constantly looked for opportunities to improve their livelihoods. Being confronted with a hypothesized future, they likewise kept their eyes open to changing factors and acted accordingly. In general, the results of the analysis manifested the strong tendency that historical and current livelihood-change trends of households to be reinforced. Their profile at present, indicated by the livelihood-change trend type that they belong to, could be used to learn their future decisions.

The perception of climatic change is widely found among the studied population. Households had observed the recent climatic variability and appeared to consider seriously the probability of worsening conditions for farming in the future, especially those they perceived as risks (*e.g.* increasing temperature, less rainfall or salinity). In other words, farmers' perception of the climatic variability affected their decision to change on-farm in the future hypothesized under climate change. Nevertheless, their coping and adaptation strategies barely differed from past and current ones.

Meanwhile, rural households instantly looked for new non-agricultural job opportunities. They expected there would be more local non-farm jobs created in the future and were highly willing to opt for manufacturing and service jobs in their neighbourhood since this option was much preferable than moving away to the urban areas, especially for young- to middle-age household-heads with children. This evidently indicated that the structural change of rural economic toward increasing non-farm activities would be enhanced in the future. Not only households but also local authorities favoured more industrialization opportunities for their localities which implied the high chance of further structural shifts in the local rural economy.

Remarkably, while households tend to find climatic changes incontestable and to be prepared for these changes, they were more hesitating discussing policy changes which indeed will be the game-changer to future context. As such, there remains a high uncertainty of future context as well as unpredictable patterns of change at the household level depending on what interventions are coming up and how they are implemented.

### 7.1.2. Livelihood shifts: adaptation to environmental hazards or reflection of socio-economic changes?

The overall objective of the research was to investigate the details of livelihood adaptation at the household level to explain the historical and current trends of change and which is then used as the foundation to anticipate future directions under extensive social-ecological changes. Given such an open approach to research applied to a complex social-ecological context like the rural coastal areas of Viet Nam, it is more or less looking into the questions of how and why changes happen at the household level.

The integrative social-ecological approach emphasizes to investigate both components in parallel, as well as highlighting the interaction between them in explaining the changes made at the household level and on larger scales. This research, therefore, analysed whether the observed past and current patterns of livelihood shifts indicating the adaptive practice of households are more responding to climatic variability or rather to the social transformation dynamics; or indeed to what combination of both dimensions.

The findings underscored that there is no such an easy answer to this question since adaptation is a dynamic interactive process accommodated in a complex social-ecological system. At the household level, it is the interaction between the individual and their societal as well as the biophysical environment. The individual is heterogeneous in terms of characteristics, while the environment is perpetually changing. Moreover, this environment is even more influenced by the interactions between the societies, including not only individuals, communities and the state, but also their interactions, with the ecological system (*e.g.* climate, natural hazards) in their coupled relationship. Therefore, studying the adaptation at the household level which was the focus of this research yields different views in explaining the adaptation process in the coupled social-ecological system in the case study of delta's rural coastal areas.

The dissertation found that factors to the inherent adjustment of household livelihoods in the studied areas were not limited to either climate-related elements or the social component. Households *directly* responded to profitable *opportunities* namely market price, access to non-farm income sources, and government's incentives and the peer pressure, *e.g.* learning from or imitating neighbours. The impacts of climatic issues such as hazard risks and environmental issues such as salinization tended to be *secondary* or *indirect* through the anthropogenic process. The environmental problem was more likely to link to policy interventions which could be explained through the second-ordered adaptation at the household level to macro adaptation measures, *e.g.* dike, irrigation system. They were also induced by agricultural activities, for instance keeping saline water inland during the rainy season to facilitate the massive shrimp cultivation. In other words, this whole process was sensitive to the policy intervention which was thus argued as the *enabling* factor to adaptation at the household level which means it could also *deter* the process if hindering the change at the micro-level. Institutional barriers were found crucial in some cases such as the ban on conversion of agricultural land from rice cultivation to aquaculture in diked areas, *i.e.* fresh-water zones. These findings explained well the main patterns of livelihood change yet not all the complexity. The special effect of 'pioneers' to the changes process was therefore added. Although it was not proved with data to appear in all patterns, adding this effect succeeded in capturing the interaction between individual and actors of macro-level, *i.e.* authorities, policies, through the social learning process (discussed below) as well as among the factors themselves (*e.g.* policy and market demand in promoting aquaculture; or policy and ecological change in controlling sluice gate for saline water). As the process was divergent across cases due to the heterogeneity of the studied context and population, the impacts of these factors also varied.

The linkages between *direct* versus *indirect* responses to *natural* vs. *anthropogenic* triggering factors in explaining the livelihood dynamics at the household level could be therefore rethought and reframed into a matrix as presented in Figure 7-1. The matrix is built on two main axes illustrating the driver-response mechanism whereby the main livelihood patterns find their slots that best explains how they have emerged and are emerging (Figure 7-1). *Environmental* factors indicate climatic and biophysical elements; whereas the *non-environmental* component is assigned with social and societal drivers such as the policy intervention and market demand. '*Directly'* versus '*indirectly'* mechanism of the adaptive behaviours reflects *primary* versus *secondary* impacts of the drivers on the household level. The content filled in the quarters is the main livelihood-change strategies of households including both farm and non-farm activities (see Chapter 5). This might not cover all activities yet the most popular ones that have been happening on the ground.

Some of the livelihood changes took place as households' directly and predominantly in response to non-environment factors. The most typical example is applying adjustments on-farm such as changing to salinity-tolerant crop variety in response to increasing salinity. Or the change by a household could be driven by indirect impacts of factors, normally through imitating or learning. For example, young labours tend to follow their neighbour fellows to find jobs in urban areas after learning their promising experience. As such, similar or even the same observed patterns could be explained differently depending on actors (*who*) of the adaptive actions (*do what*). Another typical trend found by this research is that profit-driven households are proactive in shifting from rice to shrimp; and thus, their livelihood-change strategy belongs to slot *(b)* in the matrix. Meanwhile, the same strategy is adopted in a more *passive*, or even forced, manner by farmers having their farm surrounded by saline water from their neighbours' farm or in the channels due to the authority-controlled operation of sluice-gates. Their actions, therefore, are located in slot *(d)*. Thereby, the process of change is diverse and complex. And the detailed characteristics of livelihood-change patterns could hardly be captured if studying solely the macro trends.

It is clearly explained by this illustration that at the individual household level, adaptation is not only reactive but also proactive and thus, impact and contribute to shaping the context. Households, as autonomous and complex actor, are pivotal in the process of change. By such, on a system level, adaptation is an interactive process where it is difficult to identify the specific starting point and there are more than one triggers to changes. Ultimately, adaptation at the household level is the question of their *capacity to change* or not to change regardless of if and how the context alters or does not alter. The findings of this research underscore that the more active and extensive livelihood dynamics applied by a household, the more capacity they have to adapt to the changing social-ecological context. In the discussion of the adaptive

capacity of the individual, it is of great relevance to understanding their cognitive process with built-in perception and social learning.

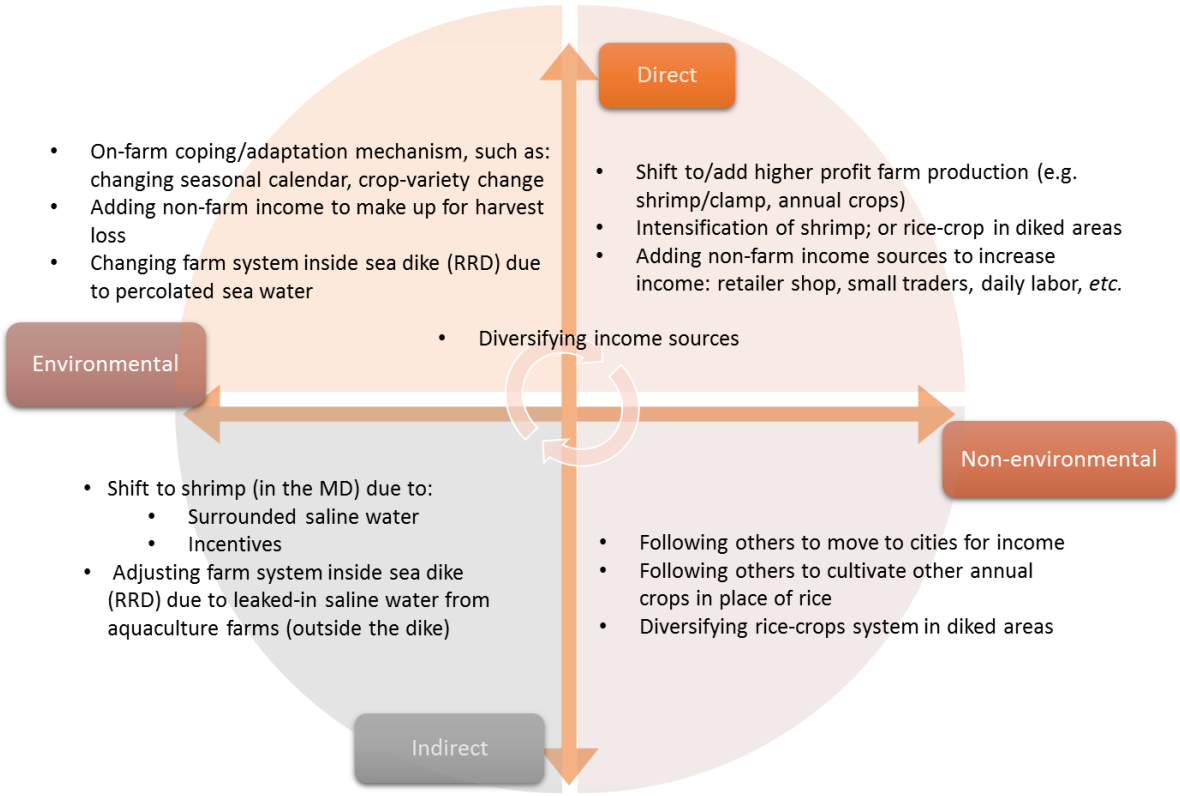



*Figure 7-1: Driver-response matrix explaining households' adaptive livelihood-change*

### 7.1.3. Perception and adaptive behaviour: threats versus opportunities interplay

In the process of livelihood adaptation, households were found to act upon changes in their social-ecological environment, yet with different mechanisms. To some households, it was proactive action in response to opportunities to improve their livelihoods; whereas others reacted, in many cases forcibly, to the same event. This sets the base for a more in-depth discussion on the household's perception of *opportunity* versus *threat*. In other words, it argues that from the perspectives of households, any element of the social-ecological environment (either with or without change) could be considered as either opportunity or threat.

The findings of this study underpin that most of the social-ecological factors could be taken as not only *'either-or'*, but also as *'both'* as illustrated in Figure 7-2. To some extent, this conclusion might be contrary to the way that those issues are normally framed in other studies or policy documents. Salinity was a good example in this case. Several studies on the land-use shift in the coastal areas not only in Vietnam but also other similar regions globally

(*e.g.* Bangladesh, Myanmar) more often than not define saline water as a threat that pushes; farmers to shift to aquaculture as an adaptation to the increasing salinity, for example, Nguyen *et al.* (2019), Pham *et al.* (2018), Nhung *et al.* (2018) on the case of Vietnamese MD; Johnson *et al.* (2016) on the case study of coastal Bangladesh. Whilst it was a fact that salinity could be of an urgent issue in areas with close dike, which mean the zones inside the sea dyke in the RRD and fresh-water zone "protected" by the inland dikes in the MD, *i.e.* much further inland rather than at the very coastal villages). Increasing salinity related to other climate factors, *e.g.* late rain on-set of the rainy season or drought, might be a threat in the rice-shrimp rotation system in the MD, yet found more controllable compared to the other problem (above-mentioned) in terms of coping and adapting as well as recovering due to the relative damages caused by this hazard. More specifically, as farmers in this system were less dependent on rice given the exceeding profit from shrimp, rice harvest loss caused by salinity events was less problematic than it was in the case of rice farmers in the mono-rice system. Notwithstanding, from the perspective of sustainable development, maintaining this system by increasing their resilience to salinity to avoid turning the entire region into a mono-shrimp system should be the main challenge in the discussions of adaptation. The policy intervention factor accordingly plays a critical role in the individual and collective adaptation in these cases.

In the same line of argument, Ngan *et al.* 2018, Tran and James (2017) also discuss on how livelihoods are changed in order to adapt to flood control regimes in the MD. Similarly is the case of on the triple rice cultivation or rice intensification in the MD (Tong 2017); or the study of Ha *et al.* (2018) on the adaptive freshwater management in the MD. This link between water-related policy, particularly to flood and salinity, and its impacts of livelihoods of the farmers in the MD has increasingly received the attention of the recent research (Käkönen 2008, Hoanh *et al.* 2003, Nguyen 2015, Schwab 2012, Bosma *et al.* 2005, Tran & James 2019) which stress on how the divergence between policy and practice, particularly the engineering solutions intensively built during the 90s have adverse impacts on farmers' livelihoods (Hoanh *et al.*, 2003:475). Diking up which was supposed to be a protection measure for agricultural livelihoods of deltaic farmers ultimately could pose a negative impact on their well-being. The findings of this study as aforementioned underpin this strand of literature.

In short, in the dynamic development process in Viet Nam in general and the MD and RRD in particular, salinity is not the only case that could be explained with this argument. Rather, Figure 7-2 demonstrates in which way each factor can act as a pro or cons, or as both to the well-being of households. The location of the factor on the matrix shows that some of them are more likely to be a risk agent (*e.g.* hazards) or the other way around do more good than harm (*e.g.* technologies). Otherwise, most of the factors have both positive and negative impacts at the household level. The side of their impacts on each household yet varies

depending on their adaptive capacity. In any case, it underscores the high importance to frame the context attentively to avoid overlooking its complexity.

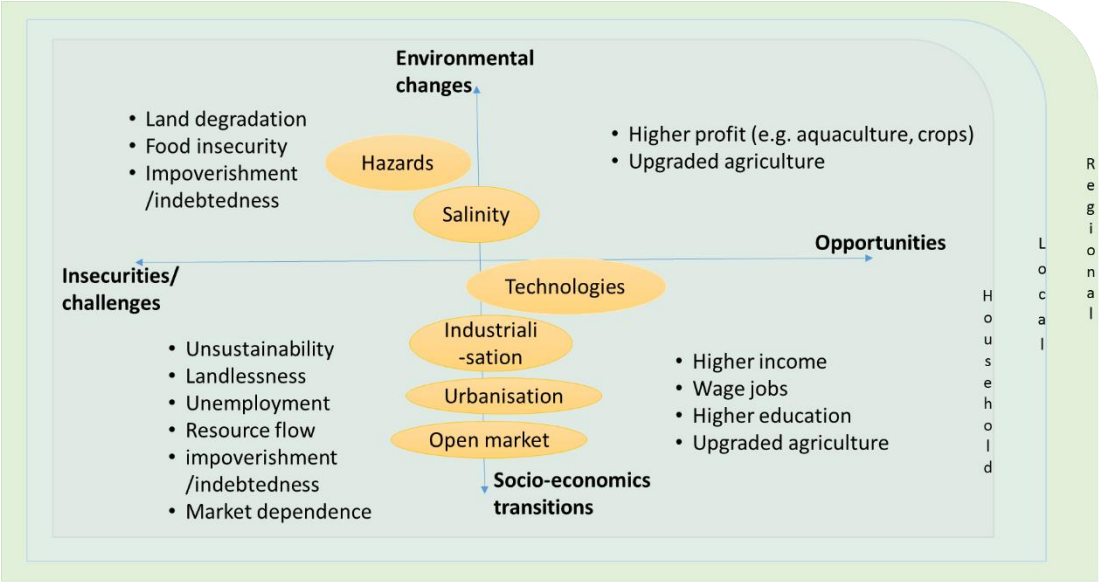



*Figure 7-2: Threats-versus-opportunities framing of factors of the social-ecological system*

### 7.1.4. Adaptation as a process: social learning and the coupled human-nature interaction

Social learning, as found by this research, plays a key role in the development and potentially good adaptation. The findings of this dissertation underline that the learning process was practiced not only at the individual level but also cross-level and collectively. Cross-scale social learning is relevant to the discussion on the policy-making process from local to national levels.

In the context of the case study, at a macro level, social learning was the engine of adaptive interaction given that adaptation is an interactive and cross-scale process built up from interactions between not only the society and nature but also different stakeholders across the many levels of that society. The process operated divergently and two-way with feedbacks. It is therefore of great relevance in explaining the adaptation process. In fact, given the fact that learning is a key societal process through which actors learn to be more adaptive (Baird *et al.* 2014), it deserves more attention in improving the adaptive capacity of a community, a country as well as a society in general.

With the empirical data, this research was able to shed light on the linkage between learning, societal interactions and the biophysical environment component embedded in the social-ecological system. The unique and critical role of “the pioneers” was argued as the key to explaining the process of change. According to the research findings (see Chapter 5),

'pioneers' were the members of a community that had initiated a process of change through their own learning process. Pioneering farmers is not an unusual phenomenon among rural communities. Sakamoto *et al.* (2009) also find that the third rice crop season was also started with pioneering farmers who saw the opportunities of available fresh water in the dry season due to diking measure in Sóc Trăng. In many cases, they may have broken the state's regulations or even laws to start a new trend. In some cases, pioneers were also local leaders yet acting more in a personal or mutual way than as governmental policy implementers. The case of shrimp farming in Kiên Giang in the past, and on-going shifts towards aquaculture in the salinity-affected area in Nam Định, and a new model of rice- ragworms (see footnote 26) outside the sea dyke that has just started in Hải Phòng are discovered by the research. Similar cases could take place more frequently in reality. This practice has also been found in several case studies of other countries, for instance *e.g.* Ghana (Conley & Udry 2001), Tunisia (Dolinska & d'Aquino 2016) as well as in other communities of the MD (Thong *et al.* 2017). Thong and colleagues (2017) have conceptualized the pivotal role of social learning and the geographically trans-local learning effect to stimulate innovations among farmers to the agricultural development of Viet Nam. This dissertation has gone one step further to link this practice to policy decision-making through the concept of cross-scale learning to reflect on the societal interactions and the coupled social-ecological relationship. In the case study of the MD and the RRD, the systematic occurrence of this practice could be interestingly documented (as in Section 5.4.5) as a social norm of the policy evolving process in the specific social-political context of Viet Nam. As such, it is useful for the lesson-learned exercise to obtain knowledge on the process as well as evaluating short-term versus long-term impacts on regional development.

However, it is important framing this factor faces tough methodological challenges in measuring and modelling which has been recognized in the literature (Baird *et al.* 2014). The nouveau behavioural analysis approach has great potentials to deal with these issues, yet quantifying and modelling require advancing the methods. Rather, within the scope of this thesis, the data collection showed its advantages in capturing the complex nature and make data available for a valid qualitative analysis. It, therefore, contributes by confirming this critical aspect in research and providing important findings with the specific case-study of the Vietnamese deltas.

### 7.1.5. Environmental issues as primary factors looking toward future

Scientific data shows that the MD and the RRD are projected of being highly impacted by climate change which will be worsening by the end of this century (see Section 2.2.1). Whereas, the coastal areas of these two deltas in specific and in the whole country, in general, are found to be more vulnerable to severe environmental changes due to the rapid economic

development of the country since the *'Đổi mới'* process initiated in the 1980s (Thao *et al.* 2014) and other human-induced environmental issues from activities external to the region such as dams construction in the upstream of the river basin (Kantoush *et al.* 2017). The MD is under the pressure of all four detected drivers of salinization according to the systematic review of Rahman *et al.* (2019) which are climate change, dam and diversions, brackish irrigation and ground extraction.

Along this line, findings of this research provide evidence of the environmental consequences of aquaculture in the coastal areas, particularly in the intensive mono-shrimp cultivation areas which raise alerts of land degradation and the question of irreversibility (see Section 2.2.1 and 6.3). Consequently, food and water security (Rahman *et al.* 2019) will be of great concerns particularly with the climate change effect in these coastal regions in the years to come. The drought in 2015-2016 which caused a severe lack of freshwater in the very coastal areas in the MD has been recognized as a historical event of drought and salinity intrusion hazard (Nguyen 2017). Similar events are projected to happen with higher frequency and intensity in the future under the context of climate change.

Most relevantly to the topic are the research findings on the on-going salinization process in the MD, and potentially in the RRD in the near future where the salinization is found in a limited area along (inside) the sea dyke. The opportunity-driven on-farm shifts explain the natural versus anthropogenic induced salinization process in the shrimp cultivation regions. The research also confirms the link between salinity problem and so-called adaptation policy such as diking which have been critically discussed in the literature by evidently arguing that policies to cope with salinization leads to changes in land-use and agricultural production in a way that has been aggravating salinity (Schwab 2012, Can 2009, Smith *et al.* 2012). This agrarian shift has been in response to a driver for short term profits (high demand from the global market) which might be a trade-off for longer-term impacts in a negative way for the ecological system (*e.g.* in Lan (2011) on the shift from rice to shrimp cultivation in rotation systems in the MD) and thus inhabitants' livelihoods (*e.g.* Trang *et al.* (2018)) on more frequent harvest loss of shrimp farming due to soil degradation). Proofs from similar cases in other deltas could be found in Jayanthi *et al.* (2018) on the impact of shrimp aquaculture development on ecosystems in coastal India, or Ali (2006) on soil degradation in the areas farmers shifting from rice to shrimp, Johnson *et al.* (2016) on social impacts of shrimp farming the case of Bangladesh.

Figure 7-3 illustrates how these impacts and relations work grounded from the case study of the MD and the RRD. The bolder arrow between the *household's land-use change decision* (toward shrimp farming in this case) and *salinization* demonstrate the substantial causal impact. The concept of second-order adaptation is of great relevance in explaining this

process. To the passive household groups in the change process, the emerging concerns on the conflict over water resource management might likewise be relevant as a serious environmental problem. The potential issues could come from the conflicts between saline water versus freshwater needs and the control power over sluice gates (Vĩnh Châu district), or of saline water percolating through dykes (Vinh Quang commune); and in the mixed system (vegetable versus clam cultivation in Giao Phong commune). In the RRD, the pilot practicing rice-saline aquaculture rotation outside the sea dike since the last couple of years (Vinh Quang commune) might potentially be another case whereby the profit is driving the expansion of aquaculture outside sea dyke, but also inside as found in the case study of Nam Định province. This, therefore aggravates the conflict in the areas of the mixed farming systems or of saline-water percolated through sea dyke because water kept available all year round for saline aquaculture.

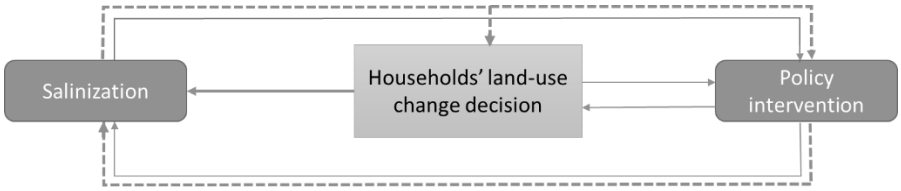



*Figure 7-3: Triggers and impacts circle between salinization, policy intervention and household's decision-making process*
( ——▶ the primary, direct causal effect; the bolder the arrow is, the larger its effect is.
– – –▶ the secondary or feedback effects.)

Engineering solutions and the zoning effect are also criticized for their side impacts on the ecological system of the deltas by the literature (see 7.1.3). The highly intensive rice farming system (2-3 crops/year) which normally is "protected" by a dike and locates further inland than other systems such as rotation rice-shrimp or mono-shrimp (as in the MD) is found more sensitive to increasing environmental change such as salinity intrusion. Intensive rice cultivation was actualised by dikes and irrigation systems (inland dikes in the MD and sea dike in the RRD) is, in fact, more at the frontline of salinity intrusion risk than the very coastal systems where farmers have more flexibility to change, i.e. the rice-shrimp and shrimp farming in the MD and aquaculture outside the sea dyke in the RRD. It has been increasingly discussed lately that along the coast, though, either being diked or not, the conditions for rice farming are getting less favourable. Therefore, it is important to consider in time converting rice farms, particularly those with decreasing yield, into more efficient systems (Edwards 2015). This issue was also concerned by local authorities and farmers in the study areas. Good planning and management are critical indeed for a smooth transition and low-regret or no-regret measures and outcomes. Besides, the dyke system in the RRD also reveals its disadvantages such as decreasing natural sedimentation, difficulties for drainage and increasing the vulnerability of the areas in the event of collapsed by flood (Dao & Molle 2000).

Pollution due to pesticide accumulation by the sea dike and living waste is also lately raised (see 6.3) which will be an add-on to the environmental problem of this coastal region.

Relevantly across research case studies, the scenario-based analysis found that farmers in the research areas tend to be more directly responding to the worsening climatic conditions related to temperature, rain, and salinity than other social impacts such as market volatility or policy shift.

All in all, the coastal zone of the two biggest Vietnamese deltas is evidently challenged by more intensive environmental issues in the coming future. The concerns on environmental changes thus gained the attention of households in the study areas and might cause more extensive livelihood shifts at the household level and hence social-ecological alterations to come.

### *Divergent household vulnerability profiles*

In a coupled social-ecological system, environmental issues certainly tight to social ones. This relationship is even intensified in the rural coastal context. The drastic shifts of livelihoods have substantially altered the socio-economic situation of households, thus their communities and larger scales across the village borders. The most typical issue is the increasing vulnerability of the household groups that fail to maintain agricultural livelihoods due to worsening farming conditions (shrimp farming) or severe damages caused by climatic changes such as drought, salinity intrusion (rice/annual crops farming).

The most evident issue found by this study is the increasing winner-loser effect among shrimp farmers. Shrimp is considered a risky business due to the high investment and poor risk management (EJF 2003, Fly 2016, Betcherman *et al.* 2019). As highlighted in the prior section on the threat of environmental degradation in intensive shrimp cultivation areas, farmers in the study cases found facing a difficult time. This has happened for a couple of years after the profitable period (lasting 4-5 years according to them) since they first started shrimp farming. Many households had to drop off farming and left the village because of indebtedness. It was, therefore, more popular that mono-shrimp farmers consequently wished to reverse back to rice production due to their debt situation and food insecurity.

The significant profit gap between disparate farm productions (*i.e.* rice versus shrimp) is also concerned particularly at the border between fresh- and saline-water zones. This together with the increased cash flows in rural economics has intensified the social pressure which might increase its role as a driver for further changes in the future.

Although being limitedly mentioned by the local authority and underestimated by households in the scenario exercise, market volatility is argued to have a significant impact on the development of the delta regions. The market-driven agriculture production such as rice,

fruits, and aquaculture in these coastal areas was pivotal to lift the economic situation of their communities. However, this dissertation argues that this factor also creates uncertainties and raises questions on sustainability.

The increasing flow of labour mobility, mainly to urban areas for remittances was accused of the social cost due to the trade-off of income and family separation (in the case one or two main family labours have to move). Thereupon rural households always prefer local non-farm incomes than moving. Yet in the meantime, the two deltas are still faced by increasing population growth and thus decreasing arable land per capita. This trend is projected to be reinforced in the near future.

Persisting on land despite all hypothesized changes is not a surprising behaviour of farmers. The literature on farmer's behaviour toward land grabbing and land conservation predominantly emphasizes the attachment of farmers to their land, for instance, those promoting 'peasant's persistence' in Scott's book (1985), 'peasant's way of life' to fight again acquisition (see also the review and critique of Natalia (2015)).

Related to that, the myth of the return of education would rather be not overlooked, particularly in studying future changes. Although there are opposite opinions of the role of education in improving the livelihoods and lives in general of the younger generation (see: some satisfaction yet some disappointment, some high hope yet some doubt; the overall vibe is the undeniably huge expectation of farmers. The wide spreading of good practices across villages enhances this belief and plants the wish in almost every household. Nonetheless, this is to some extent, a risky investment since households are uncertain about its return – it could either be a fast line to better-off future or a dream that never comes true. Yet it is argued to leave impacts on agriculture development in particular and the economic situation of the region in general. Their details, however, are not in the foci of this research. Relevantly, the insights on adaptive behaviours, particularly on the decoupling from the farm (Rigg 2006) raises the question if the rural youth's aspiration and expectation which tightly aligned to the rural-urban linkage, higher education and livelihood-change trends would be the momentum of change in future (Leavy & Smith 2010). Particularly in the case of Viet Nam, several studies find that younger labours tend to prefer off-farm jobs (McNamara & Weiss 2005) which was also confirmed by findings of this study. Meanwhile, the local job market, especially wage jobs, is barely sufficient for the employment (and also cash) demand of the labour pool. Even if there exists the foundation for the emergence of such trends, a supporting system (*e.g.* access to finance, professional training, and other social services) to facilitate an equal and sustainable development has not yet taken seriously so far.

### 7.1.6. A discussion on future policy intervention

As stated from the beginning of this research, policy intervention in the specific political context of Viet Nam is pivotal in not only understanding but also addressing any issue of concern in the country. This factor, therefore, has been decisive in sharpening the focus, framing the concepts as well as designing the methods of this thesis. This section aims at reviewing the relevant policy related to the research to facilitate a discussion into the potential evolvement of the policy, and consequently its impacts on the human-ecosystem in the studied regions in the future.

Regarding a future-forward vision for the trends of land-use and rural economic change in the MD, Tran (2014) also concludes that the institutional factor (or more precisely, political decisions will determine if the rural south (of Viet Nam) could enter the critical economic transition (ibid 2014:32) because basically, this factor has been driving the regional social-economic landscape through many centuries of history and its critical role is unlikely to change in the future context.

#### *RRD versus MD: lessons learned?*

This research is by design not aimed at a comparative analysis equally on every aspect between the case study of two big deltas of Mekong River and Red River. Notwithstanding, the findings from the parallel analysis shows the opportunities that they could learn from each other due to their similar deltaic and demographic characteristic yet different historical timelines of development.

In fact, this lesson-learned practice between the two deltas has been adopted by the Vietnamese government in the past, mainly in regards to hydraulic management (Hoanh *et al.* 2010). The biggest emerging question regarding the cross-learning between the two deltas is "to dike or not to dike?" in the MD which refers to the ambitious project of building the closed sea dike as what exists in the RRD. A system of close sea dyke has been proposed as an 'adaptation' measure to the rising sea level for the MD (SIWRR 2005). The main argument against this proposal is that diking could be cost-prohibitive yet regrettable. Salinity appears to be more obvious as a risk in the areas close to sea dike of the RRD than in the MD which might turn into higher concern for land-use planning and alternative livelihoods close these areas. Given the main consequential problem of engineering solutions presented in the prior sections of this research (see 7.1.3, 2.2.3), it stays in line with several practical and scientific works to promote no-regret and eco-based solutions rather than fix engineering measures. The former is argued to help to avoid intrusive intervention not only to the ecological system but also by discouraging the adaptive norms of individual and communities. The latter, however, as found in this research, as applied without a proper estimation of how the second-

ordered adaptation through the multi-level interaction would take place as well as how fast it would lay its impacts on the deltaic coastal social-ecological system could increase the vulnerability of the region.

The other way around, MD has its own experiences to offer to RRD. Against the empirical findings on the salinity intrusion issue along the sea dike of the RRD, adaptation to salinity intrusion gain increasing attention on the area; whereas there is also an on-going discussion on the desalinisation of brackish water in the context of salinity intrusion in the RRD (Hoang *et al.* 2017). The zoning effect to control salinity could be found relevant by authorities. Nevertheless, according to prior experience and findings on the case of the MD (see Chapters 5 and 6), this research would suggest applying selectively regarding allowing and supporting farmers to try on the shifts, yet attentively. Governance the implementation of the complex and divergent development of the process is pivotal to success. Meanwhile, cooperation is argued as the key. Further discussion will come in the policy implications (see 8.2).

### *The potential shift of land-use policy the discussion on policy intervention*

The above discussions affirm that further land-use change, especially in agriculture and aquaculture sectors is inevitable. Research findings related to agrarian shift and land-use, particularly on the difference between the permission to shift farm system from the restriction to diversification options solely is significant as it reflected the decisive effects of the land-use legislation on household's livelihood strategies. More specifically, the implementation of a land-use regulation could directly result in the lack of opportunity, thus acting as a barrier to the household's capacity to change. This finding made the discussion on policy interventions relevant for further research.

Continuing the discussion in Section 2.2.3, when the agenda is shifted away from food security prioritising rice volume toward profit maximization (shrimp or annual crops), it is likely that this direction of land-use policy will be enhanced in the coming years. It is agreeable in literature and confirmed by this study that a market-driven policy shift accommodates the expansion of shrimp businesses in the MD. A summary of some main policy interventions towards promoting coastal households to shift toward aquaculture to improve their livelihoods is shown in Figure 7-4.

The policy shifts strongly towards market-driven management took place between 1970 and 1990 (see Dang (2009) for a more detailed review). Nevertheless, on aquaculture, only in the last more than one decade, significant changes in terms of land-use management in the very coastal areas have been made (see Chapter 5). This process was deemed as the direct response to the dynamics of the context and glim further actions in the very near future.

Furthermore, it is very likely to be enhanced in the near future due to the burning needs for further change on the ground:

> "I wish you could help to propose to a higher level to change land management which allows people to have more freedom in changing their crops. Besides, the commune should have the authority to rent out public land for a longer period. Those changes will help the people to invest more in their production to generate higher income." (*II-ND-C01, 9/2015*)[38]

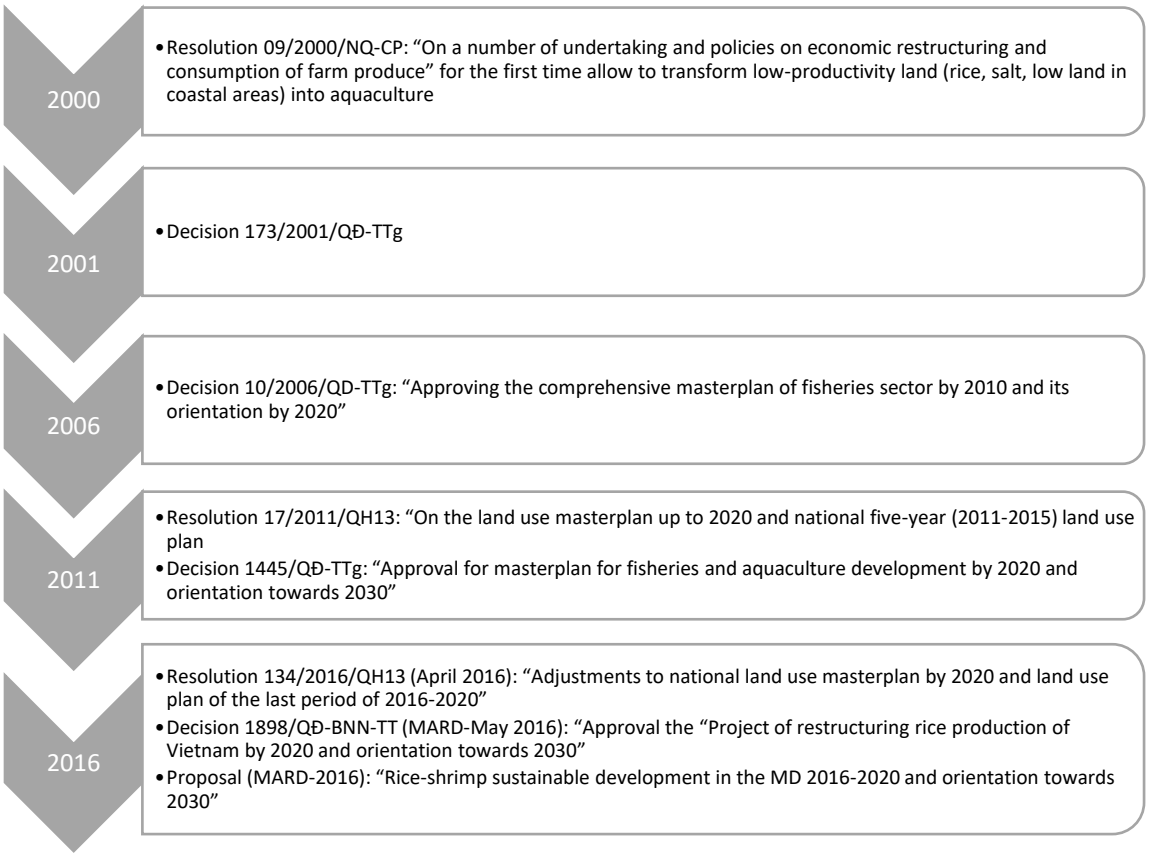



*Figure 7-4: Main policy documents favouring the land-use change towards aquaculture in the coastal areas*

The well-known "Mekong Delta plan" which is one of the products of the "policy branding" approach of the Dutch government (Minkman & van Buuren 2019) has drawn certain public attention and initiated few projects. The project suggested some engineering interventions have been influential to some extent to the forming of the current context of the MD. The project thus has an impact on master plans of the deltas and provinces of the MD. These so-called "protective measures" which include salinity-control measures might work in the past

[38] The proposal is made, however, only for the dynamic area (along the sea dke). For the rice area, they totally agreed with the rice-orientation policy and try their best to implement the national New rural development" programme, such as the contract farming model (II-ND-C01).

to increase rice-production in order to ensure local and national food security. Nevertheless, these measures have been increasingly being questioned lately regarding both social and ecological impacts. The on-going discussions on the future development of each delta more or less refer to this criticism. In the MD, the flood control for triple rice in the upper part of the delta and its impacts on the coastal part (Duong *et al.* 2018) together with the comparatively lower profits in both terms of environment and economics particularly in long-term perspectives (Tran *et al.* 2018c) have recently been challenged by the preference of flood-based farming of both farmers, local authority and experts (Tran *et al*. 2018b). Tuong *et al.* (2003) also discuss the negative impacts on the livelihood of the vulnerable groups due to the reduced salinity and increase of acidity (as a consequence) in the canal system in the MD mainly caused by the implementation of salt-water control measures led by government. Can and Khang (2009) also showcase these impacts in an area where the "water-freshionization" programme was implemented a couple of decades ago which has brought, along with positive economic benefits, also increasing negative ecological impacts that question the sustainability dimension of the whole initiative. Whereas, the evidence of increasing salinity issues along the sea dyke has also raised the question on the efficiency and resilience of rice production in coastal areas of the RRD (Nguyen *et al.* 2017). Whilst recently, the question of reversibility between shrimp-rice or the national/region food security which is likewise gaining increasing attention is also argued that in the MD, food security is referred to fish rather than rice (Olson & Morton 2018). Dao (1997) has also argued roughly 20 years ago that putting food security (by focusing on intensifying further rice production) high on the policy agenda would cause conflicts with livelihood diversification, hence increasing the employment and income of rural residents. Tarp and colleagues (2015) also promote that the relaxation of land-use regulation for farmers to change since the 1980s helped to boost the diversification and livelihoods in the rural areas of Viet Nam.

This policy discussion is particularly relevant taking into consideration the primary role of environmental factors in the future as found by this research. This in principle refers to the low return of rice production as well as the negative climatic effects such as salinity attack (regardless of the root cause of malfunction dikes/sluice gates or lack of freshwater) aggravated by changes of temperature and rain pattern let alone the potentially severe impacts from water management of upstream countries in the large Mekong basin. This, together with the lessons learned in the past on the outbreak of shrimp farming in the last two decades as well as the current practices in various deltas globally such as illegal development of shrimp farming is still recorded, such as cases in Bangladesh (Johnson *et al.* 2016), India (Jayanthi *et al.* 2018), and even elsewhere in Viet Nam. Such unstoppable

practices challenge the effective land-use planning and management if regional and national authorities do not opt for more proactive strategies.

A policy reform could be initiated with collaborations and dialogues where the state could "move along" rather than either creating barriers or running after practices. These resources, ideally in the current context of strong international cooperation and high commitment to collectively deal with such global issues of challenges facing the local communities should be able to bring advantages for Viet Nam. That could be achieve by providing good governance is made available.

The Resolution 120NQ-CP of the Vietnamese government issued in 2017 "On sustainable and climate resilience development of the Mekong Delta" (SRV 2017) is expected to be the way ahead of a policy shift towards this direction according to the experts on the region (EI-02). The Resolution tends to get along with the above-discussed issues and criticism which is a "very positive signal" towards the "right pathways" of adaptation and development of the MD as stated by several research informants.

Getting in line with this discussion, the research findings suggest another view on the policy decision-making process grounded from the context of the case study that might pave the way for institutional improvement. Figure 7-5 is the simplified illustration of potential land-use change process developed for the case studies in Vietnamese deltas, particularly based on the findings and analysis of the social learning role in adaptation in section 7.1.4.

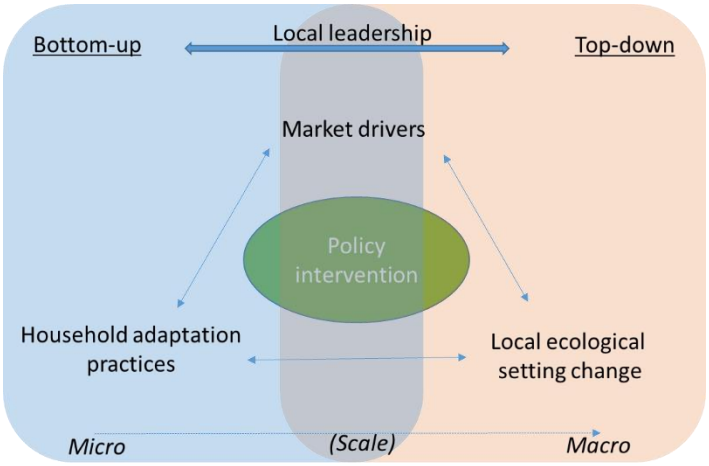



*Figure 7-5: Practice of policy evolving through cross-scale social-ecological interactions for the case study of Vietnamese deltas*

This illustration suggests that the key to policy implications gets beyond the debate top-down versus. bottom-up because in practice it lies, as usual, somewhere in between and depends substantially on the very micro level – villages. This actor includes its internal factors such as leadership, local pioneers of changes, communal cultural values, and community tights. Therefore, more trust and empowerment should be given to the farmers which also implies

more frequent and open dialogues between stakeholders of different levels, since ultimately, their initial and complete involvement is unavoidable. Initiating and facilitating these processes are of urgent need. This result implies that the dynamic context, including reaction and interaction among actors in the adaptation process, of the case studies, possibly makes them closer to the chance of getting into a *de-facto* polycentric system which also means they have higher adaptive capacity, and thus are more resilient to disturbances (Pahl-Wostl 2009).

## 7.2. Methodological reflections and evaluations

### 7.2.1. The livelihood-change typology

Methodology-wise, the proposed livelihood-change typology developed with a classification tree technique is able to capture the dynamics of both farm and non-farm livelihoods, the heterogeneous household groups, as well as the complex determinants to their decisions to change which are often studied separately across research disciplines of the environmental and social sciences.

The classification technique underscores the capacity to change as the key to enhance the adaptive capacity of households. It not only considers both environmental and non-environmental component factors but also distinguishes between direct and indirect (*i.e.* secondary) impacts of the factors on changes at the household level and thus: (i) avoid misguiding the interpretation of the adaptive actions as might happen in specific-hazard adaptation research; (ii) reveal the interactive process between society and the biophysical environment; (iii) and reflect partly on how the factors impact the decision-making process at the household level. As such, the results of this classification exercise are applicable for further steps of analysis.

The method, however, has its limitations. The 7-level of change results in numerous categories. It succeeds in capturing the heterogeneity within each sub-group of scenarios, yet the sub-sample is reduced significantly for each scenario, and the biggest challenge is that the models will not be sensitive enough to detect the small difference as well as large heterogeneity. Moreover, some statistical tests and regression models could be manipulated by the significant difference made by livelihoods with versus without non-farm income (see 5.4.2, 5.4.3, and 5.4.4). This could be explained by the fact that Group 5 (farm shifting without non-farm income change) and Group 7 (farm shifting with added non-farm income change) are the two dominant livelihood strategies with the largest sub-samples, therefore, the difference is more detectable. This typology proved its applicability for scenario analysis (Chapter 6). However, again, scenarios are substantially context-driven, and thus bears certain bias. Thereupon, the typology is useful for systematically synthesizing the dynamics in the coastal regions in general. Meanwhile, when it comes to specific cases of environmental

changes, *i.e.* natural hazards or ecological challenges, in these two deltas are too wide and diverse in their details, although, the social transition process is more independent of context. Due to these drawbacks, the method is rather be applied attentively.

This limitation could be overcome by adding more layers to distinguish the dominant types which are expected to provide more detailed profiles. Nevertheless, the operation of this step will require a larger sample and be dependent on new specific research objectives. Overall speaking, the performance of this technique set the foundation for further analysis. It is not subject to the fix classification thresholds while being open for contextualizing. Therefore, it has great advantages for flexible application cross various case studies.

### 7.2.2. The multiple simple scenarios analysis

As also discussed in Chapter 6, a scenario-based analysis using the data from one-to-one interviews integrated into the household survey provided interesting insights on the predictive context of the research areas despite the simplicity of the data collection and analysis methods. Being backed by the 'Theory of planned behaviours' (see 3.1.7), the available data was able to provide certain explanatory power in projecting the future adaptation at the household level. Nonetheless, there remain two major limitations to be highlighted for future research:

(i) The validity of the data might be questionable related to cognitive barriers and thus uncertainties in one-to-one interviews.

(ii) A further simulation based on this data might produce more added values to the research which has not been achieved within the scope of this research. Therefore, the validation of the results requires further endeavours.

Consequently, future studies with this method missed several intriguing findings from the previous stage such as social learning and the 'pioneer effect'. This was due to the lack of data given the limitations of data collection steps which relied on the standardized household survey. Consequently, the data was insufficient to feed a comprehensive behavioural analysis. Since the parameterisation for this analysis was mainly based on the literature, the relatively innovative contribution is to examine in parallel disparate scenarios to contrast and also compare the impact of the most pivotal factors in the process of adaptation at the household level.

Although the classification, as aforementioned based on both on-farm and off-farm incomes cover comprehensively livelihood changes at the household level, the details of change might vary significantly from current to future context. For instance, the complex changes affected by ecological alteration, market and policy will make it more difficult to predict the intensity of change on-farm. The higher pressure to change will also push households to act and thus

following this categorisation will lead to more homogeneity among their strategies, for instance, it would be highly possible that most households will have at least one non-farm income due to the higher availability of this sort of jobs in rural areas, and thus resulting in fewer categories. Alongside, the ambiguity in the household's plan on the return of labour mobility and higher education also contributes to the unpredictability of future household livelihood strategies. Thereupon, the compatibility between current and future changes needs to be handled with care. In this respect, the current livelihood-change categorisation, hence household-group typology plays a role in linking the present context with future changes which could result from comparing; yet it is not necessarily applicable to explain the forthcoming landscape of the studied sites.

### 7.2.3. The geographical scope

The large coverage of the research brings promising and exciting elements to the results yet also created numerous challenges in terms of practical data collection process and synthesising methodology, approach, and analysis. It confuses the flow of analysis and the presentation of results because the two deltas do not always appear together in all argumentation and findings. Meanwhile, the diversity of the two deltas sometimes overloads the analysis with contextual information and repetition in arguments which might cause some counter effects to the flow of the dissertation. Consequently, as also earlier mentioned in Section 2.1, this could easily lead to a distraction from the research foci. Therefore, despite the endeavours to equally include both deltas in all analysing steps, the imbalance was unavoidable. More specifically, the MD's showcases are to some extent more visible than those of the RRD. Yet this was intended to keep the research focused and refrained from being overfed.

The application of the method that could work for both study cases such as livelihood-change typology was relatively innovative in addressing the complex and heterogeneous context. Although these methods still showed its limitation in capturing the details of change which was a trade-off for generalizing the case study (see 7.2.1), it offered an important tool to match and synthesize the two diverse case studies.

Despite the imbalance in statistical analysis, several discussions on the results of the research emphasize the opportunities of lesson-learned exercise between the two deltas. They are useful as food for thought for more in-depth research in the future, and also as added values to the policy implications and management at the local level. The findings of this research also contribute to the final results of the large project which offers to provide a more complete picture of the studied deltas as well as inputs for triangulation and cross-validation of the findings.

# 8. CONCLUSION AND OUTLOOK

## 8.1. Current and future household livelihood adaptation

The overall objective of this research was to explain the livelihood dynamics of households in the coastal areas of the Vietnamese MD and RRD as their adaptation to the changing social-ecological environment. It responded to the research gap on the link between macro trends and the details of changes at the household level in the case study of dynamic rural coastal areas of these two deltas. It also identified the research need to progress further the interdisciplinary and social-ecological integrative approach in studying adaptation, particularly at the operational level.

Adaptation was, therefore, studied as an interactive process between households and their social-ecological environment as a part of the coupled human-environment relationship. Being accommodated in a complex environment, households inherently adjusted their income-generation activities, which in return added even more complexities to the context. This interaction, therefore, maintains the perpetual dynamics of the deltaic coastal context socially and ecologically. Understanding the details of this process is important to assess the current state as well as to anticipate future adaptation under more extensive changes.

The first objective of the dissertation was to explain the patterns of livelihood change at the household level. Research findings confirmed that the coastal communities had to inherently adjust their livelihoods as facing uncertainties and extensive social-ecological changes i. The adaptation process at the household level could be unfolded as looking at these changes of livelihood. A retrospective analysis based on observable households' livelihood dynamics employed by this research highlighted the livelihood shifts both on-farm and off-farm of rural households in the coastal areas of the MD and the RRD. The main trends of changes on-farm reflected the strong divergence from rice cultivation in the last few decades toward aquaculture as well as high farm diversification level where the land-use change to aquaculture was not permitted. Meanwhile, an increase of contribution by non-farm livelihoods to rural economics was prominent in the studied areas. A large part of this increase resulted from the structural shift from agricultural activities. Despite the typical rural context, findings show that non-farm income is not just a coping practice to the failure of farm-income. Rather, it is a proactive livelihood strategy to improve the economic status of a household. This conclusion was reflected in a typology of livelihood-change which was able to capture the heterogeneity of livelihood change patterns in the rural coastal areas.

Not only livelihood-change strategies were employed by disparate household groups, but the process of change also took place differently among the identified categories of a livelihood-change typology. The changes were found as a process in which households interact directly

or indirectly with social and ecological factors (*e.g.* the spreading of shrimp cultivation by farmers in response to the booming market demand and consequently the speedy salinization process in coastal villages). The results of the analysis on this process revealed the critical role of policy intervention as an enabling factor which linked to the secondary impact of environmental factors on the one hand and the direct effect of the market driver and peer-pressure on the other. Adaptive behaviour and social learning were identified as the keys to facilitate this process.

By looking beyond agricultural livelihoods in the rural context of these deltas, the research endeavoured to capture the heterogeneity of the livelihood-change strategies through which to explain the divergence of their adaptive behaviours. A focus on the decision-making process at the household level to study livelihood adaptation thus was embraced to underpin the integrative approach in adaptation study. Furthermore, the insights of the livelihood-change process at the household level underscored that the scale of analysis was important to study adaptation in complex systems. And the nature of the adaptive actions should be attentively retained to understand better the adaptation as an interactive process.

The second major objective of the research was to anticipate future livelihood dynamics in the changing social-ecological context in the coastal areas of the MD and the RRD which is predicted with more extensively shifts due to climate change and rapid social processes, *e.g.* industrialization, urbanization, and marketization. The scenario-based data collection and multivariate analysis were employed to gain insights into potential future coping and adaptation of households in the studied areas to the predictive social-ecological changes.

The findings of this stage supported the results of the previous analysis stage by showing that the key rules of adaptive behaviour at the household level tended to retain in the future context. Yet their strategies were also filled with uncertainties. These two facts were argued to have a causal link. The adaptive manners of households which were not only reactive but also proactive facilitated their perpetual adjusting of livelihoods hence resulted in flexible strategies and diverging open pathways. Climatic challenges were testable to the majority of farmers which urged them to respond readily to the hypothetical changes. Meanwhile, policy intervention would likewise be the game-changer in the future context. This was the key findings of the analysis of the combined scenarios in which policy intervention was associated with other social and ecological factors. The analysis manifested their significant impact on the plan to act in the future of households. This was found for both farm (*i.e.* land-use regulations) and non-farm (*e.g.* favouring industrialization) livelihoods.

## 8.2. Contributions to the integrative approach and interdisciplinary research

### 8.2.1. Implication of an integrative approach to study adaptation

This research underpins the integrative approach that underlines the importance to study adaptation as an interactive process of the coupled social-ecological system. This approach respects the complexity of the actors and actions in adaptation which not only explains the past and present trajectories but also enables studying future adaptation.

The results affirm emphasizes studying these two components in parallel as they interact and interlink closely. In other words, it is unlikely the right approach to filter and subtract separately their impacts in the adaptation process, especially at the household level. Insights from the case study of this research stress that the adaptation at the household level and possibly at a larger scale could only be explained through the interactive process between the society and the biophysical environment. In other words, it argues that specific-context framed studies face the risk of reductionism and/or simplification by subtracting the impacts of any component out of this complexity. With that being said, retaining and capturing this complexity is equally challenging.

The dissertation suggests a taxonomy of livelihood-change to classify households in the diverse studied areas. This research output is argued to progress one step closer to the integrated approach at the operational level. Household's livelihood-change typology which was not limited to one economic sector (*e.g.* agriculture or non-agriculture) or one specific risk context (*e.g.* one type of natural hazard) is argued to be able to capture the heterogeneity of the changes at the household level as well as the complexity of the diverse context. In other words, the livelihood approach to study household adaptation to social-ecological changes underpins the interdisciplinary approach to facilitate analysing the links between agricultural and non-agricultural livelihoods equally in the research. The method has some limitations (see 7.2.1). However, it was not supposed to be a one-size-fits-all solution. Rather, it offers great potentials for contextualized adjudgments. Therefore, it could be applied flexibly to not only similar deltaic coastal contexts but also rural communities in developing economies regionally and globally. In other words, it remains relatively open for innovations. The suggestion of advanced methods to overcome the drawbacks is presented in the outlook for future research (see 8.5).

Individual adaptive behaviour provides details to explain better the larger trends in complex contexts. On a conceptual level, adaptation was flexibly framed in a processual approach to reflect the nature of change and to avoid falling into the on-going confusing conceptualization discourse. The complexity level of adaptation is not proportional to the scale of analysis. More importantly, the complex nature of adaptation varies across levels. Therefore, the mechanism

should not be automatically understood regardless of the boundaries of adaptive actions. *i.e.* either a household's decision or a collective change or an adaptation policy. Overall, the coupled social-ecological system perspective is emphasized as a critical approach to achieve the integrative analysis framework. As such, the research contributes not only to enrich the knowledge on the case study of the Vietnamese deltas but also progress further the interdisciplinary and integrative approach to study adaptation of a system involving different levels.

### 8.2.2. Implication of individual decision-making to study adaptation in the complex social-ecological system

At a micro level, adaptive behaviour is the key to explain different cases of livelihoods adaptation simultaneously to social changes and climate variation of households. More specifically, while it is agreeable that a decision made at the household level is the outcome of combined effects of the social-ecological determinants; at the operational level, the details of this combination, as well as the impact mechanism remain a black spot in research. The findings from explaining the trends of livelihood changes allow systematically synthesizing into a hierarchy of the principal components that have impacts on the decision-making process at the household with also an explanatory power on a larger scale (see 5.4.5). The finding on the mechanism took into consideration the variations of the impact's side and magnitudes across trends and agent groups spatially and temporally.

This approach allows framing research with open questions and thus avoid reductionism. By such, it fits into the overarching integrative approach. However, there remain factors that could not be captured, for instance, the community "pioneers" of change or the social learning process. Therefore, the research promotes a more advance method (see 8.5). The findings of this research contribute to set the foundation for further research in this strand by providing the key insights related to decision-making rules of households in the rural context applicable to behavioural modelling methods.

At the operational level, the research encountered several methodological constraints, particularly in integrating cognitive and behavioural analysis to study the individual decision-making process in adaptation study. Challenges of measuring and quantifying individual cognitive aspects such as social capital; social learning, risk attitude, risk behaviours. In this respect, a mixed method approach was limited to providing alternative data as a complementary analysis to validate the key results. yet the data was insufficient to quantify some important elements. This does not change the important findings and is considered relatively innovative. However, it requires further development of the relevant methodology to fully take advantage of this approach.

Also, in this respect, the method was confronted by several challenges in capturing uncertainties due to the unpredictability of context and human internal elements (*e.g.* psychological aspects). This methodological gap in research of relevant topic has been recognized across several disciplines. Although researches in agriculture make important theoretical foundation and methodological improvements to include behavioural aspects (*e.g.* risk perception), particularly their roles to coping and adaptation decision in various case studies on environmental adaptation topics. Notwithstanding, as discussed earlier in the Chapter 3, despite various values added to these frameworks, an effective integrative method that could be able to deliver them in a comprehensive manner remain in need. In the MD region, Joffre and colleagues (2018) also pointed out that risk analysis approaches in aquaculture, both in environmental and economic researches, more or less bypassed this subject. They, therefore, initiate to build up a theoretical background to study the perception and risk attitude of shrimp farmers based on theories developed and applied in the agriculture domain. However, this method required data with a high level of details on a quite homogenous group (*i.e.* only shrimp farmers) which is, therefore, not applicable to the complex and heterogeneous studied population of this research.

However, the methodology of this research was designed with repetitive data and analysis steps to ensure to reflect on the diversity as well as the rigorousness of results and findings. Based on such, the general mechanism is systemized into analysis steps on the rules of the decision-making process at the household level (Figure 5-28, section 5.4.5) which is backed with validated empirical analysis. Thereupon, the findings contribute with added values to more advanced cognitive analysis methods for follow-up researches

## 8.3. Policy implications

Important findings of the research show that social learning, both peer and the cross-scale process has been fuelling the key social-ecological trends in deltaic coastal areas of the MD and the RRD. This is where argued by this research as the potentials for the improvement of the policy-making process towards efficient implementation and sustainable development as outcomes.

Section 7.1.6 indicates that the forthcoming intervention of the government on the social-ecological context of the two big deltas of this country is inevitable. Despite the rising concern on regret measures as well as irreversibility of the human-induced activities (*e.g.* intensive agrarian exploitation) to the ecological system from practitioners and scientist, turning this into practical solutions is not an easy task given the legacy of historical development (*e.g.* dike system) as well as the conventional dominant role of the state in shaping adaptation measures in these regions.

Understanding the decision-making process at the household level is promoted as a supporting tool for the policy-making process. The insights of this dissertation, on the specific role of policy intervention in the studied areas, as well as the households-communities–state strong interactions in shaping the adaptation trajectory and pathways in delta regions, could be applicable to policymakers in planning the implementation process, estimating the potential impacts and reinforcing sustainable development.

Importantly, the learning process among farmers as well as cross-scale from individual to policy-making level is highlighted by this research to play a key role in the adaptation process of the studied regions in particular and the country in general. The insights on the "pioneer effect imply information on the triggering point of a trend of change at the community level so that intervention could be made accordingly for the best effect. These findings also underpin the recently growing body of literature emphasizing on aspects of social learning in the practice of households' livelihood shifting in the rural context of Viet Nam (Thong *et al.* 2017, Joffre *et al.* 2019, Tran & James 2019).

Any initiative on collective strategy needs to achieve a census of the farmers. To do this, the leading agency/institution must offer win-win solutions for everyone, either short-term or long-term and its potential trade-off to each household, for instance, sustainable higher quality of the living environment with the cost of temporary lower profit.

Multi-level dialogue is thus suggested to achieve sustainable development in the coastal areas confronted with climate change. As discussed, the psychological effects of the household might be the key to policy implications in adaptation discussions. It has been confirmed that farmers' willingness to preserve their land is of great importance in explaining their farming practices in the past, present and also looking towards the future. In the context where traditional smallholders are still dominant among farmers, the persistence on land (Rigg 2016, Brookfield 2008) is still significant despite their decreasing dependence on farm livelihoods (Ellis 2000, Rigg 2006, Pritchard *et al.* 2017). Therefore, farmers are likely negotiable about long-term land preservation and hence, also about sustainable development. Although it is no doubt that they are under the pressure of generating cash as well as under the peer-pressure from better-off neighbours, the tight connection between land and farmers might be critical in shaping their attitude to preserve land, especially in coastal systems (Wright & Nichols 2019). Such aspects are likewise applicable to understand the adaptive behaviours of farmers in Viet Nam. One example is the rice-versus-shrimp decision of households in the rotation system of the MD. The reasons to keep rice in the rice-shrimp rotation system given by farmers were less about profit, but rather in line with sustainable development objectives: (i) rice self-provision, improving/preserving soil quality from degradation caused by intensive shrimp farming (see 6.3);(ii) or to stay in-line with the authority's guideline/regulations. In both cases,

it shows the positive attitude of farmers towards their environment or their awareness of social context.

In the context that there is a certain lack of trust among stakeholders in the resource management system (Huynh 2015, Biggs *et al.* 2009), particularly related to land-use change in this case, at the very local level, the dialogue is the key to future adaptation process where people are empowered (with information, knowledge, and voice) and the government is open. Otherwise, this process might have consequences on resources users, i.e. all actors on the ground from the state to individual (Biggs *et al.* 2009). Collective adaptation could be generated through a well-facilitated dialoguing process which is inevitably critical in the local context. Facilitating this process, however, will primarily require the involvement of different stakeholders, particularly the pronounced role of civil society parties should be taken advantage of. The social transformation, particularly in the rural areas of Viet Nam that aroused along with the new economic policies focusing on industrialized agricultural extension in almost the last half of a century (Evers & Benedikter 2009) could be taken as a significant step towards achieving this progressive societal mechanism. According to Evers and Benedikter (2009), in this process "new social groups have appeared, negotiating and struggling for increased access to resources and power" which is if well-facilitated would create further good practices and even form new social norms.

Empowering farmers is an important part of this process. Addressing the barriers to change livelihoods, *i.e.* to adapt, for instance, lack of capitals for investment and reinvestment (see 5.4.2), could be of great relevance for an instant intervention by the government in general and provincial level in particular. Financial support to facilitate sustainable livelihood shifts such as giving the opportunities of trial shifts or compensation for the trade-off of short-term profit might be the initiatives for policy considering. Such an initiative could easily fit in the 'Climate smart agriculture' policy of Viet Nam (Nguyen *et al.* 2017).

Industrialization and urbanization in the studied delta region are likewise in its strongest stage and promises further structural shifts. Enhancing these processes will meet the expectation and the employment needs of rural households as found by this research. Nevertheless, industrialization and market-driven management have also been discussed as a rising challenge to the sustainable development of Viet Nam in general and the rural areas in particular (Dao 1997, Jésus & Dao 1997). Thereupon, the future flow of foreign investment and the industrialization direction from the Vietnamese government to the local level is highly expected by local authorities. A good governance practice, particularly at the local level is argued to be the key to minimize ecological and social consequences in shaping the future development pathways of the country (Acemoglu & Robinson 2008).

## 8.4. Limits of the research

The findings of the research could only provide the first insights into potential adaptation at the household level to examine the decision-making rules rather than being able to predict the future vulnerability profile and adaptations in the regions. Typically, the internal aspects of household adaptive behaviour, such as learning, risk behaviour in the adaptation process have not been successfully measured and simulated. Therefore, although the research came up with a hierarchy of analysis steps on the factors to the decision-making process at the household level, it did not manage to measure the weights of these factors by either livelihood-change strategies or disparate household groups. It, nevertheless, set an important foundation to progress further into simulation methods such as individual/agent- based modelling (see next section - 8.5). In this respect, it offered great potentials for future research adopting the same approach.

Therefore, in this respect, besides the merits as presented in Section 3.2, the proposed integrative framework of by dissertation remains following *limitations* that call for further improvement by future researches:

1) This framework is, in principle, context-specific for the case studies in Vietnam. Although it could reflect well the diverse regional specifications, transferability, therefore, requires context-based analysis and adaptability.
2) The link to vulnerability is mainly reflected through the internal side with adaptive capacity and agentive factors of adaptive units, yet it is left open for factor specification to capture these endogenous aspects.
3) Linked to the previous point, the framework ideally suggests including several cognitive aspects and a behavioural analysis approach which remains challenging in terms of data collection, quantifying and calibration methods and techniques. Therefore, it requires to be delivered with a strong methodology in order to be fully effective.
4) The rules of the decision-making process at the household level are not yet focused and explicitly presented in the framework.

Regarding the second objective of this dissertation (see 1.4), the scenario-based analysis shows its advantages in studying the future adaptation at the household level. However, it is faced by several challenges in terms of data collection and rigorousness which have yet been to be overcome within the scope of this research. Thereupon, the fifth research question (Sub 2.2) has not yet completely resolved, particularly in identifying if the major trends of livelihood change will lead to a 'transformation' of the social-ecological system. Related to that, with the available data, the research has made limited contributions in terms of parameterization and modelling household future decision-making process (see 8.2). The complexity is captured, yet

not successfully built as a tool to support policy-making, and thus comes the recommendations for future research in the following section (8.5). Ultimately, this is still a huge challenge faced by the science community and needs more substantial resources to be addressed, namely a larger set of highly-detailed data and more valid methodology. Therefore, further steps are urged towards simulating the decision-making process at the household level to enhance its implications. This research is an effort to progress further this research strand.

## 8.5. Outlook for future research

Given the advantages and contributions of this research, it promotes further the advanced integrative method to study future adaptation. Behavioural analysis to quantify cognitive aspects of actors of adaptation was identified as a knowledge gap at the beginning of the research yet remained unsolved. Yet the findings on decision rules and scenario-based exercise have brought up intriguing elements that are promising in terms of policy implications (see 8.2 and 8.3) and thus worth further research endeavours. Simulation methods, for instance, the individual-bases or agent-based approach, are suggested due to its great potentials in modelling the coupled social-ecological system.

The ABM method has been widely applied and improved in the domain of environment and agriculture, particularly to study land-use and land cover change in adaptation to climate change, Liu *et al.* 2017, Le 2005, Ngo 2015 to name a few. Therefore, most of the existing work involves spatial analysis which leads back to the risk of stressing on the direct link between biophysical factors and adaptation decisions. Researchers, however, argue that the achievements of integrating multiple social aspects in the model, for instance psychological, structural and cultural factors are associated with the agent's characteristic. Besides, the ABM method responds to the limitations of current methods in data collecting, for instance, asking farmers about future visions as it allows modelling and simulating without data on the intangible variables as aforementioned (see 6.2.2). These flaws come most obviously when applying traditional methods such as surveys, semi-structured interviews, and group discussions. Ultimately, ABM performs a promising methodological approach that offers great potentials to overcome the limitations of this dissertation. This research has made an important contribution to progress further this strand. The scenario-based method has also established the first steps to build up more advanced techniques such as behavioural modelling such as livelihood-change typology, the hierarchy of factors to the decision-making process at the household level and data collection on social learning aspects.

In regards to the thematical scope, there are rising issues that could be of great relevance in understanding the future development of the MD and the RRD yet need in-depth analysis and

thus get beyond the foci of this research. The rising risk of land subsidence on the delta level which has been raised by recent research (Tran *et al.* 2018) and also by informants of expert interviews (EI-02, 4/2018). Moreover, Triet and colleagues (2017) discuss on the impact of the dike system in the upstream part (of the Vietnamese MD on increasing flood downstream in the MD as well as the construction of dams in the upper part of the Mekong river basin that poses potential impacts on downstream saltwater intrusion in Vietnamese MD (Mai *et al.* 2018). All of these factors might aggravate the vulnerability profile of deltaic coastal communities in the coming decades. Emerging concerns on the food security (more likely at the household level) and the irreversibility of agrarian development in the longer-term (discussed also in Section 5.4.1) in the saline-water culture areas has raised the relevant question of if there will be an ecological tipping point for the MD and the RRD (Renaud *et al.* 2014). Those research interests get beyond the scope of this dissertation yet bear the urgent need for future studies.

## 9. REFERENCES


Abeling, T. (2015). *Can we learn to be resilient? Institutional constraints for social learning in heatwave risk management in London, UK* (PhD). King's College London, London, UK.

Abman, R., & Carney, C. (2018). *Land rights, agricultural productivity, and deforestation in Viet Nam*. *WIDER working paper: 2018, 88*. Helsinki, Finland: United Nations University World Institute for Development Economics Research. Retrieved from https://www.wider.unu.edu/publication/land-rights-agricultural-productivity-and-deforestation-viet-nam

Acemoglu, D., & Robinson, J. (2008). *The Role of Institutions in Growth and Development* (The Commission on Growth and Development No. 10).

Acosta-Michlik, L., & Espaldon, V. (2008). Assessing vulnerability of selected farming communities in the Philippines based on a behavioural model of agent's adaptation to global environmental change. *Global Environmental Change*, *18*(4), 554–563. https://doi.org/10.1016/j.gloenvcha.2008.08.006

Adger, W. N., Hughes, T. P., Folke, C., Carpenter, S. R., & Rockström, J. (2005). Social-ecological resilience to coastal disasters. *Science (New York, N.Y.)*, *309*(5737), 1036–1039. https://doi.org/10.1126/science.1112122

Adger, W. N., Kelly, P. M., Winkels, A., Huy, L. Q., & Locke, C. (2002). Migration, remittances, livelihood trajectories, and social resilience. *Ambio*, *31*(4), 358–366. https://doi.org/10.1579/0044-7447-31.4.358

Adger, W. N., Lorenzoni, I., & O'Brien, K. L. (2009). *Adapting to climate change: Thresholds, values, governance*. Cambridge, New York: Cambridge University Press.

Adger, W. N., Lorenzoni, I., & O'Brien, K. L. (2009). *Adapting to climate change: Thresholds, values, governance*. Cambridge, New York: Cambridge University Press.

Adger, W.N., Kelly, P.M., & Nguyen, H. N. (e.) (Eds.). (2001). *Routledge Research Global Environmental*. *Living with Environmental Change: Social Vulnerability, Adaptation and Resilience in Vietnam*. London: Routledge.

Adger, W. N., & Kelly, P. M. (1999). Social vulnerability to climate change and the architecture of entitlements. *Mitigation and Adaptation Strategies for Global Change*, *4*, 253–266.

Ajzen, I. (1991). The Theory of Planned Behavior. *ORGANIZATIONAL BEHAVIOR AND HUMAN DECISION PROCESSES*, *50*, 179–211.

Alvarez, S. Alvarez et al. 2014_Typology-guidelines_v2.

Amoako Johnson, F., Hutton, C. W., Hornby, D., Lázár, A. N., & Mukhopadhyay, A. (2016). Is shrimp farming a successful adaptation to salinity intrusion? A geospatial associative analysis of poverty in

the populous Ganges-Brahmaputra-Meghna Delta of Bangladesh. *Sustainability Science*, *11*(3), 423–439. https://doi.org/10.1007/s11625-016-0356-6

Amoako Johnson, F., Hutton, C. W., Hornby, D., Lázár, A. N., & Mukhopadhyay, A. (2016). Is shrimp farming a successful adaptation to salinity intrusion? A geospatial associative analysis of poverty in the populous Ganges-Brahmaputra-Meghna Delta of Bangladesh. *Sustainability Science*, *11*(3), 423–439. https://doi.org/10.1007/s11625-016-0356-6

An, L. (2012). Modeling human decisions in coupled human and natural systems: Review of agent-based models. *Ecological Modelling*, *229*, 25–36. https://doi.org/10.1016/j.ecolmodel.2011.07.010

Arbuckle, J. G., Prokopy, L. S., Haigh, T., Hobbs, J., Knoot, T., Knutson, C., . . . Widhalm, M. (2013). Climate change beliefs, concerns, and attitudes toward adaptation and mitigation among farmers in the Midwestern United States. *Climatic Change*, *117*(4), 943–950. https://doi.org/10.1007/s10584-013-0707-6

Arbuckle, J.G., Morton, L.W., Hobbs, J. (2015). Understanding Farmer Perspectives on Climate Change Adaptation and Mitigation: The Roles of Trust in Sources of Climate Information, Climate Change Beliefs, and Perceived Risk. *Environment and Behavior*, *47*(2), 205–234.

Arndt, C., Tarp, F., & Thurlow, J. (2015). The Economic Costs of Climate Change: A Multi-Sector Impact Assessment for Vietnam. *Sustainability*, *7*(4), 4131–4145. https://doi.org/10.3390/su7044131

Baddeley, M. (2011). *Social Influence and Household Decision-Making: A Behavioural Analysis of Household Demand* (CWPE 1120).

Baird, J., Plummer, R., Haug, C., & Huitema, D. (2014). Learning effects of interactive decision-making processes for climate change adaptation. *Global Environmental Change*, *27*, 51–63. https://doi.org/10.1016/j.gloenvcha.2014.04.019

Bamberger, M. (Ed.). (2000). *Integrating quantitative and qualitative research in development projects.* Washington, DC: World Bank.

Bankoff, G., Frerks, G., & Hilhorst, D. (Eds.). (2004). *Mapping vulnerability: Disaster, Development & People*. USA: Earthscan.

Barange, M., Bahri, T., Beveridge, M.C.M., Cochrane, K.L., Funge-Smith, S. & Poulain, F., eds. Impacts of climate change on fisheries and aquaculture: synthesis of current knowledge, adaptation and mitigation options.

Bargatzky, T. (1984). Culture, environment, and the ills of adaptationism. *Current Anthropology*, *25*(4), 399–4155.

Barretta, C. B., Reardon, T., & Webb, P. (2001). Nonfarm income diversification and household livelihood strategies in rural Africa: concepts, dynamics, and policy implications. *Food Policy*, *26*, 315–331.

Be, T. T., Sinh, B. T., & Miller, F. (Eds.). (2007). *Challenges to Sustainable Development in the Mekong Delta: Regional and National Policy Issues and Research Needs.*

Beaman, L., & Dillon, A. (2011). *Do Household Definitions Matter in Survey Design? Results from a Randomized Survey Experiment in Mali.*

Benedikter, S., Waibel, G., Birtel, S., Bui, C. T., & Tran, B. T. (2013). *Local Entrepreneurship in Vietnam's Rural Transformation. A Case Study from the Mekong Delta* (MPRA Paper No. 49866). Bonn.

Bernard, H. R. (2011). *Research methods in anthropology: Qualitative and quantitative approaches* (5th ed.). Lanham Md.: AltaMira Press.

Betcherman, G., Haque, I., & Marschke, M. (2019). Exploring livelihood transitions in the Mekong delta. *Singapore Journal of Tropical Geography*, *36*(2), 289. https://doi.org/10.1111/sjtg.12300

Biggs, D., Miller, F., Chu Thai Hoanh, & Molle, F. (2009). The delta machine: water management in the Vietnamese Mekong Delta in historical and contemporary perspectives. In F. Molle, T. Foran, & M. Käkönen (Eds.), *Contested Waterscapes in the Mekong Region: Hydropower, Livelihoods and Governance.* Routledge.

Biggs, D. A. (2004). *Between rivers and tides: A hydraulic history of the Mekong delta, 1820-1975* (PhD), Washington.

Biggs, D. A. (2012). *Quagmire: Nation-Building and Nature in the Mekong Delta*: University of Washington Press. Retrieved from https://books.google.de/books?id=Fk98qw8fVyQC

Binder, C. R., Hinkel, J., Bots, P. W. G., & Pahl-Wostl, C. (2013). Comparison of Frameworks for Analyzing Social-ecological Systems. *Ecology and Society*, *18*(4). https://doi.org/10.5751/ES-05551-180426

Binh, D. V., Kantoush, S., Sumi, T., T.P. Mai, N., & La Trung, V. (2017). Study on the impacts of river-damming and Climate change on the Mekong Delta of Vietnam, *No. 60B*.

Birkmann, J., Cardona, O. D., Carreño, M. L., Barbat, A. H., Pelling, M., Schneiderbauer, S., S.; Kienberger, S.; Keiler, M.; Alexander, D.; Zeil, P.; Welle, T. (2013). Framing vulnerability, risk and societal responses: the MOVE framework. *Natural Hazards*, *67*(2), 193–211. https://doi.org/10.1007/s11069-013-0558-5

Birkmann, J. (2011). First- and second-order adaptation to natural hazards and extreme events in the context of climate change. *Natural Hazards*, *58*(2), 811–840. https://doi.org/10.1007/s11069-011-9806-8

Birkmann, J. (Ed.). (2013). *Measuring vulnerability to natural hazards: Towards disaster resilient societies* (Second edition). Tokyo, New York: United Nations University Press.

Bonabeau, E. (2000). Agent-based modeling - Methods and techniques for simulating human systems. *PNAS*, *99*, 7280–7287.

Boothroyd, P., & Nam, P. X. (Eds.). (2000). *Socio-economic Renovation in Viet Nam: The Origin, Evolution, and Impacts of Doi Moi*. Singapore: The Institute of Southeast Asian Studies.

Bosma et al. Agriculture Diversification in the Mekong Delta: Farmers' motives and contribution to livelihoods. *Agricultural Systems*, *Vol. 2, Nos. 1&2*, 49–66.

Bosma, R. H., Udo, H.M.J., Verreth, J.A.J, Visser, L.E, Cao, Q.N (2005). Agriculture Diversification in the Mekong Delta: Farmers' Motives and Contributions to Livelihoods. *Asian Journal of Agriculture and Development,*, *2*, 49–66.

Bottema, M. J. M., Bush, S. R., & Oosterveer, P. (2019). Moving beyond the shrimp farm: Spaces of shared environmental risk? *The Geographical Journal*, *185*(2), 168–179. https://doi.org/10.1111/geoj.12280

Braun, G., Braun, M., Kruse, J., Amelung, W., Renaud, F. G., Khoi, C. M., . . . Sebesvari, Z. (2019). Pesticides and antibiotics in permanent rice, alternating rice-shrimp and permanent shrimp systems of the coastal Mekong Delta, Vietnam. *Environment International*, *127*, 442–451. https://doi.org/10.1016/j.envint.2019.03.038

Braun, G., Sebesvari, Z., Braun, M., Kruse, J., Amelung, W., An, N. T., & Renaud, F. G. (2018). Does sea-dyke construction affect the spatial distribution of pesticides in agricultural soils? - A case study from the Red River Delta, Vietnam. *Environmental Pollution (Barking, Essex: 1987)*, *243*(Pt B), 890–899. https://doi.org/10.1016/j.envpol.2018.09.050

Brookfield, H. (2008). Family Farms Are Still Around: Time to Invert the Old Agrarian Question. *Geography Compass*, *2*(1), 108–126. https://doi.org/10.1111/j.1749-8198.2007.00078.x

Brooks, N., & Adger, N. (2004). *Assessing and Enhancing Adaptive Capacity: Technical Paper 7*. New York.

Brooks, N., Neil Adger, W., & Mick Kelly, P. (2005). The determinants of vulnerability and adaptive capacity at the national level and the implications for adaptation. *Global Environmental Change*, *15*(2), 151–163. https://doi.org/10.1016/j.gloenvcha.2004.12.006

Brünjes, J. (2012). *Non-farm wage labour and entrepreneurship in rural Vietnam*. Zugl.: Hannover, Univ., Diss., 2012 (1. ed.). Göttingen: Optimus-Verl.

Brünjes, J., & Revilla Diez, J. (2012). Opportunity entrepreneurs – potential drivers of non-farm growth in rural Vietnam? In *Working Papers on Innovation and Space.* Symposium conducted at the meeting of Marburg Geography.

Brünjes, J., & Revilla Diez, J. (2013). Non-farm businesses in rural areas: response to crisis or exploiting opportunities? Evidence from Vietnam. In C. Tamásy & J. Revilla Diez (Eds.), *Regional resilience, economy and society. Globalising rural places (the dynamics of economic space)* (pp. 115–130). Aldershot: Ashgate.

Bryant, J. (1996). Northern Vietnamese households. *Journal of Population Research*, *13*(2), 169–186.

Bryman, A. (2004). *Social research methods* (2nd). New York: Oxford University Press.

Bucx, T., Marchand, M., Makaske, B., & van de Guchte, C. (2010). *Comparative assessment of the vulnerability and resilience of 10 deltas* (Delta Alliance report No. 1). Delft-Wageningen.

Burton, I., Kates, R. W., & White, G. F. (1993). *The environment as hazard* (2nd ed.). New York: Guilford Press.

Can, N. D., & Khang, N. V. (2009). Phân tích và đánh giá sự thay đổi về sản xuất và đời Phân tích và đánh giá về sự thay đổi đời sống của nông dân ở vùng ngọt hóa Gò Công, Tiền Giang. *Can Tho University - Science Journal*, *12*, 365–374.

Can N. D., Le, T.D, Nguyen, V.S, Miller, F. (2007). Livelihoods and Resource Use Strategies of Farmers in the Mekong Delta. In T. T. Be, B. T. Sinh, & F. Miller (Eds.), *Challenges to Sustainable Development in the Mekong Delta: Regional and National Policy Issues and Research Needs* (pp. 69–98).

Cazzuffi, C., McKay, A. D., & Perge, E. (2018). *The impact of commercialization of rice on household welfare in rural Viet Nam*. *WIDER working paper: 2018, 130*. Helsinki, Finland: United Nations University World Institute for Development Economics Research. Retrieved from https://www.wider.unu.edu/publication/impact-commercialization-rice-household-welfare-rural-viet-nam

Chapman, A., Darby, S., & Tompkins, E. (2017). Sustainable rice cultivation in the deep flooded zones of the Vietnamese Mekong Delta. *Vietnam Science & Technology*, *59*(2).

Chau, N. D. G., Sebesvari, Z., Amelung, W., & Renaud, F. G. (2015). Pesticide pollution of multiple drinking water sources in the Mekong Delta, Vietnam: Evidence from two provinces. *Environmental Science and Pollution Research International*, *22*(12), 9042–9058. https://doi.org/10.1007/s11356-014-4034-x

Christoffersson, A. (1975). Factor Analysis of Dichotomized Variables. *PSYCHOMETRIK*, *40*(1), 5–32.

Chu, T. T. H. (2017). Natural disaster, catastrophe and environmental protection in Vietnam. *Journal of Vietnamese Environment*, *8*, 1–3. https://doi.org/10.13141/jve.vol8.no1.pp1-3

Chu, T. V. (2018). Triển vọng từ mô hình Rươi - Lúa [The promising Rice-Rag-worms farming model]. Retrieved from https://www.quangninh.gov.vn/So/sonongnghiepptnt/Trang/ChiTietTinTuc.aspx?nid=6104

Clemens, M., Rijke, J., Pathirana, A., Evers, J., & Hong Quan, N. (2015). Social learning for adaptation to climate change in developing countries: insights from Vietnam. *Journal of Water and Climate Change*, jwc2015004. https://doi.org/10.2166/wcc.2015.004

Conley, T., & Udry, C. (2015, July). *Social learning through networks - The adoption of new agricultural technologies in Ghana*. Frontier Issues in the Microeconomics of International Development, Carleton University.

Connell, J., & Waddell, E. (Eds.). (2007). *Environment, development and change in rural Asia – Pacific between local and global*. New York: Routledge.

Conte, R., Hegselmann, R., & Temo, P. (Eds.). (1997). *Simulating Social Phenomena*. Berlin: Die Deutsche Bibliothek.

Cosslett, T. L., & Cosslett, P. D. (2014). *Water Resources and Food Security in the Vietnam Mekong Delta*. Cham: Springer International Publishing. https://doi.org/10.1007/978-3-319-02198-0

Cutter, S. L., & Morath, D. P. (2013). The evolution of the Social Vulnerability Index (SoVI). In J. Birkmann (Ed.), *Measuring vulnerability to natural hazards: Towards disaster resilient societies* (pp. 304–321). Tokyo, New York: United Nations University Press.

Dam, T. H. T., Amjath-Babu, T. S., Bellingrath-Kimura, S., & Zander, P. (2019). The impact of salinity on paddy production and possible varietal portfolio transition: a Vietnamese case study. *Paddy and Water Environment*, *17*(4), 771–782. https://doi.org/10.1007/s10333-019-00756-9

Damm, M. (2009). *Mapping Social-Ecological Vulnerability to Flooding - A sub-national approach for Germany* (Doctoral). University of Bonn, Bonn, Germany.

Dang, H. L., Li, E., Nuberg, I., & Bruwer, J. (2014). Farmers' perceived risks of climate change and influencing factors: A study in the Mekong Delta, Vietnam. *Environmental Management*, *54*(2), 331–345. https://doi.org/10.1007/s00267-014-0299-6

Dang, P. (2009). *Pha rao trong kinh te vao dem truoc doi moi [Breakthrough the barriers for economic innovation]*. Ho Chi Minh City: Tri Thuc [Knowledge].

Dang, T. D., Cochrane, T. A., Arias, M. E., & van Tri, P. D. (2018). Future hydrological alterations in the Mekong Delta under the impact of water resources development, land subsidence and sea level rise. *Journal of Hydrology: Regional Studies*, *15*, 119–133. https://doi.org/10.1016/j.ejrh.2017.12.002

Dao, T. T. (1997). Les transformations rurales récentes au Vietnam. *Agriculture et développement*, *15*, 13–18.

Dao The Tuan, & Molle, F. The Chao Phraya delta in perspective: a comparison with the Red River and Mekong deltas, Vietnam.

Deaton, A. (1997). *The Analysis of Household Survey: A Microeconometric Approach to Development Policy*. USA: The Johns Hopkins University Press.

Demont, M., & Rutsaert, P. (2017). Restructuring the Vietnamese Rice Sector: Towards Increasing Sustainability. *Sustainability*, *9*(2), 325. https://doi.org/10.3390/su9020325

Denevan, W. M. (1983). Adaptation, Variation and Cultural Geography. *The Professional Geographer*, *35*(4), 399–407.

Deshingkar, P. *Internal Migration, Poverty and Development in Asia* (ODI Briefing Papers No. 11).

Devienne, S. (2006). Red River Delta: Fifty Years of Change. Retrieved from https://moussons.revues.org/2042

DFID (April 1999). *Sustainable livelihoods: Putting people at the centre of development. Sustainable livelihoods guidance sheets*. UK.

DFID (2001). *Approaches to the Analysis of Survey Data*. UK.

Do, T. D. (1995). Con duong tu kinh te tieu nong den kinh te hang hoa o dong bang song Cuu Long. *Xa hoi hoc*. (1 (49)).

Doan, Q. T., Nguyen, C. D., Chen, Y. C., & Mishra, P. K. (2014). Modeling the influence of river flow and salinity intrusion in the Mekong river estuary, Viet Nam. *LOWLAND TECHNOLOGY INTERNATIONAL*, *16*(1), 14–25.

Dolinska, A., & d'Aquino, P. (2016). Farmers as agents in innovation systems. Empowering farmers for innovation through communities of practice. *Agricultural Systems*, *142*, 122–130. https://doi.org/10.1016/j.agsy.2015.11.009

Drogoul, A., Huynh, N. Q., & Truong, Q. C. (2016). Coupling Environmental, Social and Economic Models to Understand Land-Use Change Dynamics in the Mekong Delta. *Frontiers in Environmental Science*, *4*, 38. https://doi.org/10.3389/fenvs.2016.00019

Drogoul, A., Huynh, N. Q., & Truong, Q. C. (2016). Coupling Environmental, Social and Economic Models to Understand Land-Use Change Dynamics in the Mekong Delta. *Frontiers in Environmental Science*, *4*, 38. https://doi.org/10.3389/fenvs.2016.00019

Duc, D. M., Nhuan, M. T., & van Ngoi, C. (2012). An analysis of coastal erosion in the tropical rapid accretion delta of the Red River, Vietnam. *Journal of Asian Earth Sciences*, *43*(1), 98–109. https://doi.org/10.1016/j.jseaes.2011.08.014

Duong, V. H. T., Nestmann, F., Van, T. C., Hinz, S., & Oberle, P. (2018, May). *(Analysis the development of triple rice cropping area and its impact on flooding situation in A Giang province*. 10th Eastern European Young Water Professionals Conference IWA YWP, Zagreb, Croatia.

Dwayne Benjamin, & Loren Brandt (2002). Agriculture and Income distribution in Rural Vietnam under Economic Reforms: A Tale of Two Regions.

Edwards, P. (2015). Aquaculture environment interactions: Past, present and likely future trends. *Aquaculture*, *447*, 2–14. https://doi.org/10.1016/j.aquaculture.2015.02.001

Efroymson, M. A. (1960). Multiple Regression Analysis. In A. Ralston & H. S. Wilf (Eds.), *Mathematical Methods for Digital Computers.* New York: John Wiley.

Eisenack, K., & Stecker, R. (2012). A framework for analyzing climate change adaptations as actions. *Mitigation and Adaptation Strategies for Global Change*, *17*(3), 243–260. https://doi.org/10.1007/s11027-011-9323-9

EJF (2003). *Risky Business? Vietnamese shrimp aquaculture – impacts & improvements*. London, UK.

Ellis, F. (2000). The Determinants of Rural Livelihood Diversification in Developing Countries. *Journal of Agricultural Economics*, *51*(2), 289–302.

Ellis, F., & Freeman, H. A. (2004). Rural Livelihoods and Poverty Reduction Strategies in Four African Countries. *The Journal of Development Studies*, *40*(4), 1–30.

Elmhirst, R. (2012). DISPLACEMENT, RESETTLEMENT, AND MULTI-LOCAL LIVELIHOODS. *Critical Asian Studies*, *44*(1), 131–152. https://doi.org/10.1080/14672715.2012.644891

Engle, N. L. (2011). Adaptive capacity and its assessment. *Global Environmental Change*, *21*(2), 647–656. https://doi.org/10.1016/j.gloenvcha.2011.01.019

Fan, P., Ouyang, Z., Nguyen, D. D., Nguyen, T. T. H., Park, H., & Chen, J. (2019). Urbanization, economic development, environmental and social changes in transitional economies: Vietnam after Doimoi. *Landscape and Urban Planning*, *187*, 145–155. https://doi.org/10.1016/j.landurbplan.2018.10.014

Fankhauser, S., Smith, J. B., & Tol, R. S.J. (1999). Weathering climate change: some simple rules to guide adaptation decisions. *Ecological Economics*, *30*, 67–78.

Ferro-Azcona, H., Espinoza-Tenorio, A., Calderón-Contreras, R., Ramenzoni, V. C., Gómez País, M. d. l. M., & Mesa-Jurado, M. A. (2019). Adaptive capacity and social-ecological resilience of coastal areas: A systematic review. *Ocean & Coastal Management*, *173*, 36–51. https://doi.org/10.1016/j.ocecoaman.2019.01.005

Fine, B. (2001). *Social capital versus social theory. Political economy and social science at the turn of the millennium. Contemporary political economy series*. London: New York: Routledge.

Finkl, C. W. (2004). Coastal Classification: Systematic Approaches to Consider in the Development of a Comprehensive Scheme. *Journal of Coastal Research*, *201*, 166–213. https://doi.org/10.2112/1551-5036(2004)20[166:CCSATC]2.0.CO;2

Finn Tarp (2015). Growth, Structural Transformation and Rural Change in Viet Nam: A Rising Dragon on the Move.

Flick, U. (2009). *An introduction to qualitative research* (4th ed.). Los Angeles: Sage Publications.

Fly, J. K. (2016). Shrimp Aquaculture, Social Capital, and Food Security in Rural Vietnam. *Culture, Agriculture, Food and Environment*, *38*(2), 113–122. https://doi.org/10.1111/cuag.12076

Folke, C., Carpenter, S., Elmqvist, T., Gunderson, L. H., Holling, C. S., Walker, B., . . . Svedin, U. Resilience and sustainable development: Building adaptive capacity in a world of transformation. *Scientific background paper on resilience for the process of The World Summit on Sustainable Development on behalf of The Environmental Advisory Council to the Swedish Government*.

Folke, C. (2006). Resilience: The emergence of a perspective for social–ecological systems analyses. *Global Environmental Change*, *16*(3), 253–267. https://doi.org/10.1016/j.gloenvcha.2006.04.002

Frame, B., Lawrence, J., Ausseil, A.-G., Reisinger, A., & Daigneault, A. (2018). Adapting global shared socio-economic pathways for national and local scenarios. *Climate Risk Management*, *21*, 39–51. https://doi.org/10.1016/j.crm.2018.05.001

Füssel, H.-M., & Klein, R. J. T. (2006). Climate Change Vulnerability Assessments: An Evolution of Conceptual Thinking. *Climatic Change*, *75*(3), 301–329. https://doi.org/10.1007/s10584-006-0329-3

Gallopín, G. (1994). Impoverishment and Sustainable Development: A Systems Approach.

Gallopín, G. (2007). *LINKAGES BETWEEN VULNERABILITY, RESILIENCE, AND ADAPTIVE CAPACITY.* Potsdam Institute for Climate Impact Research. Formal Approach to Vulnerability, Postdam.

Gallopín, G. (2018). Back to the future. *Energy Policy*, *123*, 318–324. https://doi.org/10.1016/j.enpol.2018.08.060

Gallopín, G. C. (2006). Linkages between vulnerability, resilience, and adaptive capacity. *Global Environmental Change*, *16*(3), 293–303. https://doi.org/10.1016/j.gloenvcha.2006.02.004

Gallopín, G. C., & Raskin, P. (1998). Windows on the Future: Global Scenarios & Sustainability. *Environment: Science and Policy for Sustainable Development*, *40*(3), 6–11. https://doi.org/10.1080/00139159809603187

Garschagen, M., Renaud, F. G., & Birkmann, J. (2011). Dynamic resilience of peri-urban agriculturalists in the Mekong Delta under pressures of socio-economic transformation and climate change. In M. A. Stewart & P. A. Coclanis (Eds.), *Advances in Global Change Research. Environmental Change and Agricultural Sustainability in the Mekong Delta* (pp. 141–163). Dordrecht: Springer Netherlands.

Garschagen, M. (2013). Resilience and organisational institutionalism from a cross-cultural perspective: an exploration based on urban climate change adaptation in Vietnam. *Natural Hazards*, *67*(1), 25–46. https://doi.org/10.1007/s11069-011-9753-4

Garschagen, M. (2014). *Risky change? Vulnerability and adaptation between climate change and transformation dynamics in Can Tho City, Vietnam*. *Megacities and Global Change: Vol. 15*: Franz Steiner Verlag.

Garschagen, M., Diez, J. R., Nhan, D. K., & Kraas, F. (2012). Socio-Economic Development in the Mekong Delta: Between the Prospects for Progress and the Realms of Reality. In F. G. Renaud & C. Kuenzer (Eds.), *Springer Environmental Science and Engineering. The Mekong Delta System* (pp. 83–132). Dordrecht: Springer Netherlands. https://doi.org/10.1007/978-94-007-3962-8_4

Garschagen, M., Renaud, F. G., & Birkmann, J. (2011). Dynamic Resilience of Peri-Urban Agriculturalists in the Mekong Delta Under Pressures of Socio-Economic Transformation and Climate Change. In M. A. Stewart & P. A. Coclanis (Eds.), *Advances in Global Change Research: Vol. 45. Environmental Change and Agricultural Sustainability in the Mekong Delta* (Advances in Global Change Research 45, pp. 141–163). The Netherlands: Springer Science+Business Media B.V. https://doi.org/10.1007/978-94-007-0934-8_9

Garschagen, M., & Romero-Lankao, P. (2015). Exploring the relationships between urbanization trends and climate change vulnerability. *Climatic Change*, *133*(1), 37–52. https://doi.org/10.1007/s10584-013-0812-6

Gbetibouo, G. A. *Understanding Farmers' Perceptions and Adaptations to Climate Change and Variability: The Case of the Limpopo Basin, South Africa* (IFPRI Discussion Paper).

Gilbert, N., & Terna, P. (1999). *How to build and use agent-based models in social science.*

Giuliani, S., Bellucci, L. G., & Nhon, D. H. (2019). The Coast of Vietnam: Present Status and Future Challenges for Sustainable Development. In *World Seas: An Environmental Evaluation* (pp. 415–435). Elsevier. https://doi.org/10.1016/B978-0-08-100853-9.00027-0

Gore, C. (2017). Late industrialisation, urbanisation and the middle-income trap: An analytical approach and the case of Vietnam. Cambridge Journal of Regions, Economy and Society, rsw039. https://doi.org/10.1093/cjres/rsw039

Gorman, T. (2013). Moral Economy and the Upper Peasant: The Dynamics of Land Privatization in the Mekong Delta. *Journal of Agrarian Change*, *5*(1), n/a-n/a. https://doi.org/10.1111/joac.12047

Gourou, P. (1936). *Người Nông Dân Châu Thổ Bắc Kỳ [Les paysans du delta tonkinois]*. Ho Chi Minh City: Youth Republish.

Grossbard, S. (2011). Independent Individual Decision-Makers in Household Models and the New Home Economics. In J. A. Molina (Ed.), *Household Economic Behaviors* (Vol. 7, pp. 41–56). New York, NY: Springer New York. https://doi.org/10.1007/978-1-4419-9431-8_2

Grothmann, T., & Patt, A. (2005). Adaptive capacity and human cognition: The process of individual adaptation to climate change. *Global Environmental Change*, *15*(3), 199–213. https://doi.org/10.1016/j.gloenvcha.2005.01.002

Grothmann, T., & Reusswig, F. (2006). People at Risk of Flooding: Why Some Residents Take Precautionary Action While Others Do Not. *Natural Hazards*, *38*(1-2), 101–120. https://doi.org/10.1007/s11069-005-8604-6

GSO [General Statistics Office] (of Viet Nam) 2010, The 2009 Vietnam Population and Housing Census. Hanoi. Statistical Publishing House, Hanoi, Vietnam

GSO [General Statistics Office] (of Viet Nam) 2012, National Survey on Agriculture, Rural Development and Fishery in 2011. Statistical Publishing House, Hanoi, Vietnam

GSO [General Statistics Office] (of Viet Nam) 2016, Statistical Yearbook of Vietnam 2006. Statistical Publishing House, Hanoi, Vietnam

GSO [General Statistics Office] (of Viet Nam) 2017, Report on Labour and Employment Survey 2016, Hanoi, Vietnam.

GSO [General Statistics Office] (of Viet Nam) 2018, National Survey on Agriculture, Rural Development and Fishery in 2016. Statistical Publishing House, Hanoi, Vietnam.

GSO. (2018). Results of the rural, agriculture and fishery census 2016. Hanoi.

General Statistics Office of Vietnam website (GSO website). Socio-economic regions. Retrieved from http://portal.thongke.gov.vn/khodulieuldvl/MetaData.aspx?Mct=3&NameBar=SI%C3%8AU%20D%E1%BB%AE%20LI%E1%BB%86U%20%3E%20Kh%C3%A1i%20ni%E1%BB%87m,%20%C4%91%E1%BB%8Bnh%20ngh%C4%A9a,%20c%C3%A1ch%20t%C3%ADnh

Ha, T. P., Dieperink, C., van Dang Tri, P., Otter, H. S., & Hoekstra, P. (2018). Governance conditions for adaptive freshwater management in the Vietnamese Mekong Delta. *Journal of Hydrology*, *557*, 116–127. https://doi.org/10.1016/j.jhydrol.2017.12.024

Hair, J. F., Babin, B. J., Anderson, R. E., & Black, W. C. (2014). *Multivariate data analysis* (Seventh edition, Pearson new international edition). *Pearson custom library*. Harlow, Essex: Pearson. Retrieved from http://lib.myilibrary.com/detail.asp?id=527034

Hans-Dieter Evers & Simon Benedikter. Hydraulic Bureaucracy.

Ho, C. V. (2008). Chuyen dich lao dong cua ho nong dan vung dong bang song Cuu Long tu nhung nam 1990.

Hoang, N. V., Thanh, T. N., Roi, N. D., Huy, T. D., & Tung, T. T. (2018). Potential for the desalination of a brackish groundwater aquifer under a background of rising sea level via salt intrusion prevention river gates in the coastal area of the Red River Delta, Vietnam. *Environment, Development and Sustainability*, *20*(6), 2747–2771. https://doi.org/10.1007/s10668-017-0014-x

Hoang, X. T., Dinh, T. T. P., Dang, T. T. H., Le, D. L., & Ageless Consultants (2015). *Urbanisation and rural development in Vietnam's Mekong Delta: Revisiting livelihood transformation in three fruit-growing settlements 2006-2015* (IIED Working Paper). London.

(2008). *Working Paper Series on Rural-Urban Interactions and Livelihood Strategies: Vol. 14*. *Urbanization and rural development in Vietnam's Mekong Delta: Livelihood transformation in three fruit-growing settlements*: IIED.

Hoanh, C. T., Suhardiman, D., & Tuan, L. A. (2010, November). *Irrigation development for rice production in the Mekong Delta of Vietnam: What is next?* 28th International Rice Re-search Conference, Hanoi, Vietnam.

Holling, C. S. (1973). Resilience and stability in ecological systems. *Annual Review of Ecology and Systematics*, *4*, 1–23.

Hosmer, D. W., & Lemeshow, S. (2000). *Applied logistic regression* (2nd). New York: Wiley & Sons, Inc.,

Trang, Huyen. *Master thesis - Adaptation to CC in Ben Tre.*

Huynh, T. H. (2011). Analysis of the Employment Choice for the Mekong River Delta Migrants in Urban Destinations of Vietnam. In M. A. Stewart & P. A. Coclanis (Eds.), *Advances in Global Change Research. Environmental Change and Agricultural Sustainability in the Mekong Delta* (Vol. 8). Dordrecht: Springer Netherlands.

Huynh, T. H., & Le, N. D. K. (2011). Analysis of Labour Migration Flows in the Mekong Delta of Vietnam. In M. A. Stewart & P. A. Coclanis (Eds.), *Advances in Global Change Research. Environmental Change and Agricultural Sustainability in the Mekong Delta* (Vol. 8, pp. 115–140). Dordrecht: Springer Netherlands.

Huynh, T. H., & Nonneman W. (2012). Modelling migration flows in Mekong River Delta region of Vietnam: an augmented gravity approach.

Huynh Thi Phuong Linh. (2015). *State–Society Interaction in Vietnam - The Everyday Dialogue of Local Irrigation Management in the Mekong Delta* (Doctoral). University of Bonn, Bonn.

IDCJ (July 2003). *Impact Assessment of Transport Infrastructure Projects In Northern Vietnam.*

Imamura, F., & To, D. V. (1997). Flood and Typhoon Disasters in Viet Nam in the Half Century Since 1950. *Natural Hazards*, *15*, 71–87.

IPCC. (2007). *Climate change 2007: Impacts, adaptation and vulnerability contribution of Working Group II to the fourth assessment report of the Intergovernmental Panel on Climate Change*. Cambridge U.K., New York: Cambridge University Press.

IPCC (2012). *Managing the risks of extreme events and disasters to advance climate change adaption. A special report of working groups I and II of the Intergovernmental Panel on Climate Change.* USA: Cambridge University Press New, New York.

IPCC. (2014). *In: Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part B: Regional Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change - Chapter 24: Asia*. Cambridge: Cambridge University Press.

IUCN (2013). *Building Resilience to Climate Change Impacts: Coastal Southeast Asia: Soc Trang Province, Viet Nam* (Building Resilience to Climate Change Impacts in Coastal).

James, H. (Ed.). (2019). *Population, Development, and the Environment*. Singapore: Springer Singapore. https://doi.org/10.1007/978-981-13-2101-6

Jayanthi, M., Thirumurthy, S., Muralidhar, M., & Ravichandran, P. (2018). Impact of shrimp aquaculture development on important ecosystems in India. *Global Environmental Change*, *52*, 10–21. https://doi.org/10.1016/j.gloenvcha.2018.05.005

Jésus, F., & Dao, T. A. (1997). L'agricuture du delta du Fleuve Rouge face aux reformes economiques. *Agriculture et développement*, *15*, 67–73.

Jiang, Z., Raghavan, S. V., Hur, J., Sun, Y., Liong, S.-Y., van Nguyen, Q., & van Pham Dang, T. (2019). Future changes in rice yields over the Mekong River Delta due to climate change—Alarming or alerting? *Theoretical and Applied Climatology*, *137*(1-2), 545–555. https://doi.org/10.1007/s00704-018-2617-z

JICA (January 2013). *Vietnam Country report: Agricultural Transformation and Food Security 2040.*

Joffre, O. M. (2015). *Balancing Options for Shrimp Farming: A landscape approach to investigate the future of shrimp farming in the MD* (PhD).

Joffre, O. M., Bosma, R. H., Bregt, A. K., van Zwieten, P. A.M., Bush, S. R., & Verreth, J. A.J. (2015). What drives the adoption of integrated shrimp mangrove aquaculture in Vietnam? *Ocean & Coastal Management*, *114*, 53–63. https://doi.org/10.1016/j.ocecoaman.2015.06.015

Joffre, O. M., Poortvliet, P. M., & Klerkx, L. (2018). Are shrimp farmers actual gamblers? An analysis of risk perception and risk management behaviors among shrimp farmers in the Mekong Delta. *Aquaculture*, *495*, 528–537. https://doi.org/10.1016/j.aquaculture.2018.06.012

John, S., & Barry, S. (1997). Human adaptation to climatic variability and change. *Global Environmental Change*, *7*(2), 129–146.

Johnson, P. E. (2011). *Monte Carlo Analysis in Academic Research.*

Junge, V., Revilla Diez, J., & Schätzl, L. (2015). Determinants and Consequences of Internal Return Migration in Thailand and Vietnam. *World Development*, *71*, 94–106. https://doi.org/10.1016/j.worlddev.2013.11.007

Juras, J., & Pasaríc, Z. (2006). Application of tetrachoric and polychoric correlation coefficients to forecast verification. *Geofizika*, *23*(1), 59–82.

KANTOUSH, S., van BINH, D., SUM, T. I., & La TRUNG, V. (2017). IMPACT OF UPSTREAM HYDROPOWER DAMS AND CLIMATE CHANGE ON HYDRODYNAMICS OF VIETNAMESE MEKONG DELTA. *Journal of Japan Society of Civil Engineers*, *73*(4), I_109–I_114.

Karila, K., Nevalainen, O., Krooks, A., Karjalainen, M., & Kaasalainen, S. (2014). Monitoring Changes in Rice Cultivated Area from SAR and Optical Satellite Images in Ben Tre and Tra Vinh Provinces in Mekong Delta, Vietnam. *Remote Sensing*, *6*(5), 4090–4108. https://doi.org/10.3390/rs6054090

Kautsky, & Karl. (1988). *The Agrarian Question* (2nd ed., Vol. 1). London: Zwan Publications.

Kelly, P. F. (2011). MIGRATION, AGRARIAN TRANSITION, AND RURAL CHANGE IN SOUTHEAST ASIA. *Critical Asian Studies*, *43*(4), 479–506. https://doi.org/10.1080/14672715.2011.623516

KELLY, P. M., & ADGER, W. N. (2000). Theory and Practice in Assessing Vulnerability to Climate Change and Facilitating Adaptation. *Climatic Change*, *47*, 325–352,

Kerkvliet, B. J. T., & Porter, D. J. (Eds.). (1995). *Vietnam's rural transformation*. New York: Taylor & Francis.

Kerkvliet, B.J.T., Heng, R.H.K., Koh, D.W.H (Ed.). (2003). Getting organized in Vietnam: Moving in and around the Socialist [Special issue]. Singapore: Institute of Southeast Asian Studies, Singapore.

Khanh, N. V. (2013). Nghien cuu ve quyen so huu dat dai o Viet Nam. *Tap chi Khoa hoc DHQGHN*, *Tap 29, so 1*.

Khanh, T. T., & Le, N. K.D. (2001). *Nguyen Nhan Lu Lut Lon o Dong Bang Song Hong [Reasons for large floods in the Red River Delta]*. Hanoi.

Khue, N. T. M., Dien, N. T., & Lebailly, P. (2016). Smallholder farming and youth's aspirations: Case study in Bacninh province, Red River Delta, Vietnam. *ISSAAS 2016 International Congress & General meeting "National and Global Good Agricultural Practices (GAPs) in Southeast Asia*, 1–8.

Kiên Giang Provincial People's Committee (PPC) (2017). Socio-Economic Report. Kien Giang.

Kiên Giang Provincial People's Committee (PPC) (2019). Socio-Economic Report for period January-June. Kien Giang.

Kien, N. V. (2011). SOCIAL CAPITAL, LIVELIHOOD DIVERSIFICATION AND HOUSEHOLDS' RESILIENCE TO ANNUAL FLOOD EVENTS IN THE VIETNAMESE MEKONG RIVER DELTA.

Kirch, P. V. (1980). The Archaeological Study of Adaptation: Theoretical and Methodological Issues. *Advances in Archaeological Method and Theory*, *3*, 101–156.

Klaus, V. (2010). *Water Engineering, Agricultural Development and Socio-Economic Trends in the Mekong Delta, Vietnam* (ZEF Working Paper Series No. 57). Bonn.

Klein, R. J. T. (1998). Towards better understanding, assessment and funding of climate adaptation. *Change*, *44*, 15–19.

Kolennikov, S., & Angeles, G. (2004). *The use of discrete data in PCA-theory, simulations and applications to socioeconomic indices.*

Kontgis, C., Schneider, A., Ozdogan, M., Kucharik, C., van Tri, P. D., Duc, N. H., & Schatz, J. (2019). Climate change impacts on rice productivity in the Mekong River Delta. *Applied Geography*, *102*, 71–83. https://doi.org/10.1016/j.apgeog.2018.12.004

Kundu, A., & Chakrabarti, S. (2010). Non-agricultural informal sector in India: impacts of agrarian conditions. *The Indian Journal of Labour Economics*, *53*(2), 199–224.

Kuruppu, N., & Liverman, D. (2011). Mental preparation for climate adaptation: The role of cognition and culture in enhancing adaptive capacity of water management in Kiribati. *Global Environmental Change*, *21*(2), 657–669. https://doi.org/10.1016/j.gloenvcha.2010.12.002

Labbé, D., & Musil, C. (2013). Periurban Land Redevelopment in Vietnam under Market Socialism. *Urban Studies*, *51*(6), 1146–1161. https://doi.org/10.1177/0042098013495574

Lamarque, P., Artaux, A., Barnaud, C., Dobremez, L., Nettier, B., & Lavorel, S. (2013). Taking into account farmers' decision making to map fine-scale land management adaptation to climate and socio-economic scenarios. *Landscape and Urban Planning*, *119*, 147–157. https://doi.org/10.1016/j.landurbplan.2013.07.012

Lamers, M., Anyusheva, M., La, N., van Nguyen, V., & Streck, T. (2011). Pesticide Pollution in Surface- and Groundwater by Paddy Rice Cultivation: A Case Study from Northern Vietnam. *CLEAN - Soil, Air, Water*, *39*(4), 356–361. https://doi.org/10.1002/clen.201000268

Lan, N. T. P. (2013). Social and ecological challenges of market-oriented shrimp farming in Vietnam. *SpringerPlus*, *2*, 675. https://doi.org/10.1186/2193-1801-2-675

Le, C. D. (2010). Tích tụ đất đai và hiệu quả kinh tế theo quy mô đất đai trong nông thôn Đồng bằng sông Cửu Long: Trường hợp nghiên cứu ở tỉnh An Giang, *Journal of Science - Can Tho University*(15a), 293–302.

Le, D. D. (2018, July). *Reform and Industrialization in Vietnam*. Economic Society of Tanzania Annual Congress, Tanzania.

Le, Q. B. (2005). *Multi-agent system for simulation of land-use and land cover change: A theoretical framework and its first implementation for an upland watershed in the Central Coast of Vietnam*. *Ecology and Development Series: Vol. 29*: Cuvillier Verlag Göttingen.

Le, T. N., Bregt, A. K., van Halsema, G. E., Hellegers, P. J.G.J., & Nguyen, L.-D. (2018). Interplay between land-use dynamics and changes in hydrological regime in the Vietnamese Mekong Delta. *Land Use Policy*, *73*, 269–280. https://doi.org/10.1016/j.landusepol.2018.01.030

Le Phuong, T. H., Biesbroek, G. R., & Wals, A. E. J. (2018). Barriers and enablers to climate change adaptation in hierarchical governance systems: the case of Vietnam. *Journal of Environmental Policy & Planning*, *20*(4), 518–532. https://doi.org/10.1080/1523908X.2018.1447366

Leavy, J., & Smith, S. (June 2010). *Future farmers-Youth aspirations, expectations and life choices* (Discussion Paper No. 013).

Lebel, L., Nguyen, H. T., Amnuay, S., Suparb, P., Urasa, B., & Le, K. T. (4). Industrial Transformation and Shrimp Aquaculture: Pathways to Ecological, Social, and Economic Sustainability? *Ambio*, *31*, 311–323.

Levy, P. S., & Lemeshow, S. (2008). *Sampling of Populations: Methods and Applications* (4th ed.). New Jersey: A John Wiley & Sons, Inc., Publication.

Lewis-Beck, M. S., Bryman, A., & Liao, T. F. (2004). *The Sage encyclopedia of social science research methods*. Thousand Oaks Calif.: Sage.

Lipper, L. (Ed.). (2018). *Natural Resource Management and Policy: Vol. 52*. *Climate Smart Agriculture*: FAO.

Liu, X., Liang, X., Li, X., Xu, X., Ou, J., Chen, Y., . . . Pei, F. (2017). A future land use simulation model (FLUS) for simulating multiple land use scenarios by coupling human and natural effects. *Landscape and Urban Planning*, *168*, 94–116. https://doi.org/10.1016/j.landurbplan.2017.09.019

Liu, X. (2016). *Applied Ordinal Logistic Regression Using Stata*. USA: Sage Publications, Inc.

Lohmann, H. (2016). Comparing vulnerability and adaptive capacity to climate change in individuals of coastal Dominican Republic. *Ocean & Coastal Management*, *132*, 111–119. https://doi.org/10.1016/j.ocecoaman.2016.08.009

Lorenzoni, I., O'Brien, K. L., & Adger, W. N. (Eds.). (2009). *Adapting to climate change: Thresholds, values, governance*. Cambridge: Cambridge University Press. https://doi.org/10.1017/CBO9780511596667

(2012). *Working Papers on Innovation and Space.*

Mark S. Reed, Anna C. Evely, Georgina Cundill, Ioan Fazey, Jayne Glass, Adele Laing, . . . Lindsay C. Stringer. What is Social Learning?

McCaig, B., & Pavcnik, N. (2013). *Moving out of Agriculture: Structural Change in Vietnam*. Cambridge, MA: National Bureau of Economic Research. https://doi.org/10.3386/w19616

McElwee, P., Nghiem, T., Le, H., & Vu, H. (2016). Flood vulnerability among rural households in the Red River Delta of Vietnam: Implications for future climate change risk and adaptation. *Natural Hazards*, *86*(1), 465–492. https://doi.org/10.1007/s11069-016-2701-6

McGinnis, M. D., & Ostrom, E. (2014). Social-ecological system framework: initial changes and continuing challenges. *Ecology and Society*, *19*(2). https://doi.org/10.5751/ES-06387-190230

McLaughlin, P., & Dietz, T. (2008). Structure, agency and environment: Toward an integrated perspective on vulnerability. *Global Environmental Change*, *18*(1), 99–111.

McNamara, K., & Weiss, C. (2005). Farm Household Income and On- and Off-farm Diversification. *Journal of Agriculture and Applied Economics*, *37*(1), 37–48.

Millennium Ecosystem Assessment (2005). *Ecosystems and Human Well-being- A framework for assessment*. Washington.

Miller, F. (2007). Seeing "water blindness" – Water control in agricultural intensification and environmental change in the Mekong Delta, Vietnam. In J. Connell & E. Waddell (Eds.), *Environment, development and change in rural Asia – Pacific between local and global* (pp. 186–207). New York: Routledge.

Miller, F. (2014). Constructing Risk: multi-scale change, livelihoods and vulnerability in the Mekong Delta, Vietnam. *Australian Geographer*, *45*(3), 309–324. https://doi.org/10.1080/00049182.2014.930000

Minkman, E., & van Buuren, A. (2019). Branding in policy translation: How the Dutch Delta approach became an international brand. *Environmental Science & Policy*, *96*, 114–122.

Mira Käkönen (2008). Mekong Delta at the crossroads: More control or Adaptation?

Molina, J. A. (Ed.). (2011). *Household Economic Behaviors*. New York, NY: Springer New York. https://doi.org/10.1007/978-1-4419-9431-8

Molle, F., Foran, T., & Käkönen, M. (Eds.). (2009). *Contested Waterscapes in the Mekong Region: Hydropower, Livelihoods and Governance*: Routledge. https://doi.org/10.4324/9781849770866

MONRE (2009). *Climate Change, Sea Level Rise Scenarios for Vietnam*. Hanoi.

Morse, J. M., & Niehaus, L. *Mixed method design: Principles and procedures* (Vol. 2009): Walnut Creek, CA: Left Coast Press, Inc.

Moser, C., & Felton, A. (2007). *The Construction of an Asset Index Measuring Asset Accumulation in Ecuador* (CPRC Working Paper No. 87). Washington DC.

Moser, C., & Kalton, G. (Eds.). (1971). *Survey Methods in Social Investigation*: Ashgate Dartmouth.

Moser, S. C., & Ekstrom, J. A. (2010). A framework to diagnose barriers to climate change adaptation. *Proceedings of the National Academy of Sciences of the United States of America*, *107*(51), 22026–22031. https://doi.org/10.1073/pnas.1007887107

MRC (2005). *Irrigation Water Use Assessment: Annex, Programme to Demonstrate the Multi-*. Vientiane, Laos.

Nam Định Provincial People's Committee (PPC) (2011). KẾ HOẠCH HÀNH ĐỘNG ỨNG PHÓ VỚI BIẾN ĐỔI KHÍ HẬU CỦA TỈNH NAM ĐỊNH GIAI ĐOẠN 2010-2015 TẦM NHÌN 2020 [Climate change adaptation plan of Nam Định province for period 2010-2015]. Nam Dinh.

Neil Adger, W. (1999). Social Vulnerability to Climate Change and Extremes in Coastal Vietnam. *World Development*, *27*(2), 249–269. https://doi.org/10.1016/S0305-750X(98)00136-3

Neise, T. (2018). *Firms' adaptation strategies to floods and their potential implication on regional economic development – Insights from Jakarta and Semarang, Indonesia* (PhD). University of Cologne, Cologne.

Nelson, D. R., Adger, W. N., & Brown, K. (2007). Adaptation to Environmental Change: Contributions of a Resilience Framework. *Annual Review of Environment and Resources*, *32*(1), 395–419. https://doi.org/10.1146/annurev.energy.32.051807.090348

Neumann, J., Emanuel, K., Ravela, S., Ludwig, L., & Verly, C. (2015). Risks of Coastal Storm Surge and the Effect of Sea Level Rise in the Red River Delta, Vietnam. *Sustainability*, *7*(6), 6553–6572. https://doi.org/10.3390/su7066553

Newell, B., Crumley, C. L., Hassan, N., Lambin, E. F., Pahl-Wostl, C., Underdal, A., & Wasson, R. (2005). A conceptual template for integrative human–environment research. *Global Environmental Change*, *15*(4), 299–307. https://doi.org/10.1016/j.gloenvcha.2005.06.003

Newman, C., & Kinghan, C. (2015). *Local transformation in rural Vietnam: A commune level analysis*. *Working paper / World Institute for Development Economics Research: 2015/065*. Helsinki: WIDER. Retrieved from http://hdl.handle.net/10419/126362

Newman, C., & Kinghan, C. (2015). Local transformation in rural Vietnam: A commune level analysis: A commune level analysis. Retrieved from http://hdl.handle.net/10419/126362

Ngo, T. A. (2009). *Simulating Spatial Patterns of Shifting Cultivation: A village case study from the uplands of Vietnam* (PhD).

Nguyen, A. T., & Hens, L. (2019). *Human Ecology of Climate Change Hazards in Vietnam*. Cham: Springer International Publishing. https://doi.org/10.1007/978-3-319-94917-8

Nguyen, A. D. (2008). *Salt intrusion, tides and mixing in multi-channel estuaries*. Leiden: Taylor & Francis. Retrieved from http://site.ebrary.com/lib/alltitles/docDetail.action?docID=10335269

Nguyen, C. V., & Tran, A. (2014). Poverty identification: practice and policy implications in Vietnam. *Asian-Pacific Economic Literature*, *28*(1), 116–136. https://doi.org/10.1111/apel.12046

Nguyen, H., Chiong, R., Chica, M., Middleton, R., & Dhakal, S. (2019). *Agent-based Modeling of Migration Dynamics in the Mekong Delta, Vietnam: Automated Calibration Using a Genetic Algorithm.* https://doi.org/10.1109/CEC.2019.8790008

Nguyen, K. V., Dumaresq, D., & Pittock, J. (2018). Impacts of rice intensification on rural households in the Mekong Delta: emerging relationships between agricultural production, wild food supply and food consumption. *Food Security*, *10*(6), 1615–1629. https://doi.org/10.1007/s12571-018-0848-6

Nguyen, M. T., Renaud, F. G., & Sebesvari, Z. (2019). Drivers of change and adaptation pathways of agricultural systems facing increased salinity intrusion in coastal areas of the Mekong and Red River deltas in Vietnam. *Environmental Science & Policy*, *92*, 331–348. https://doi.org/10.1016/j.envsci.2018.10.016

Nguyen, N. A. (2017). Historic drought and salinity intrusion in the Mekong Delta in 2016: Lessons learned and response solutions. *Vietnam Science & Technology*, *1*(1), 93–96.

Nguyen, N. M. (2017). Agriculture of northern delta in first decade of the renovation period. *Vietnam Social Science*.

Nguyen, N. T., & Hoang, H. A. (2015). Vulnerability of Rice Production in Mekong River Delta under Impacts from Floods, Salinity and Climate Change. *International Journal on Advanced Science, Engineering and Information Technology*, *5*(4), 272. https://doi.org/10.18517/ijaseit.5.4.545

Nguyen, T. D., Lebailly, P., Vuc, D. T., & Peemans, J.-P. (2014). The Determinations of Household Agricultural Land Use Strategies in Red River Delta, Vietnam. In *Le Foncier Agricole Usage, Tension et regulations*.

Nguyen, T. P. L., Seddaiu, G., Virdis, S. G. P., Tidore, C., Pasqui, M., & Roggero, P. P. (2016). Perceiving to learn or learning to perceive? Understanding farmers' perceptions and adaptation to climate uncertainties. *Agricultural Systems*, *143*, 205–216. https://doi.org/10.1016/j.agsy.2016.01.001

Nguyen, Y. T. B., Kamoshita, A., van Dinh, T. H., Matsuda, H., & Kurokura, H. (2017). Salinity intrusion and rice production in Red River Delta under changing climate conditions. *Paddy and Water Environment*, *15*(1), 37–48. https://doi.org/10.1007/s10333-016-0526-2

Nguyen, Y. T. B., Kamoshita, A., van Dinh, T. H., Matsuda, H., & Kurokura, H. (2017). Salinity intrusion and rice production in Red River Delta under changing climate conditions. *Paddy and Water Environment*, *15*(1), 37–48. https://doi.org/10.1007/s10333-016-0526-2

NGUYEN, T. B. VULNERABILITY AND ADAPTATION TO SALINITY INTRUSION IN THE MEKONG DELTA OF VIETNAM.

Nguyen V.T., Mai, V.K., Vu, V.T., Nguyen, D.M., Nguyen, N.B.P, Le, D.D., Truong M.H., Luu, N.L. (2017). Changes in climate extremes in Vietnam. *Vietnam Science and Technology*, *1*.

Nguyen, TTN., Roehrig, F., Grosjean, G., Tran, DN., Vu, TM. (2017). *Climate Smart Agriculture in Vietnam* (CSA Country Profile for Asia Series). Hanoi.

Nhan, D., Phap, V., Phuc, T., & Trung, N. (2012). Rice production response and technological measures to adapt to salinity intrusion in the coastal Mekong delta.

Nhan Dang Kieu, Thanh Duong Ngoc, Marc Verdegem, & Le Thanh Duong. Towards Agricultural Diversification and Rural Poverty Alleviation --- Development of Integrated Agri-Aquaculture Farming in the Mekong Delta, Vietnam.

Ni, D. V., Safford, R., Maltby, & Edward. (2001). Environmental change, ecosystem degradation and the value of wetland rehabilitation in the Mekong Delta. In W.N. Adger, P.M. Kelly, & H. N. (e.) Nguyen (Eds.), *Routledge Research Global Environmental. Living with Environmental Change: Social Vulnerability, Adaptation and Resilience in Vietnam* (pp. 122–136). London: Routledge.

O'Brien, K., Eriksen, S., Schjolden, A., Nygaard, & Lynn (March 2004). *What's in a word? Conflicting interpretations of vulnerability in climate change research* (CICERO Working Paper).

O'Neill, B. C., Kriegler, E., Ebi, K. L., Kemp-Benedict, E., Riahi, K., Rothman, D. S., . . . Solecki, W. (2017). The roads ahead: Narratives for shared socioeconomic pathways describing world futures in the 21st century. *Global Environmental Change*, *42*, 169–180. https://doi.org/10.1016/j.gloenvcha.2015.01.004

O'Brien, K. L. (2009). Do values subjectively define the limits to climate change adaptation? In I. Lorenzoni, K. L. O'Brien, & W. N. Adger (Eds.), *Adapting to climate change: Thresholds, values, governance.* Cambridge: Cambridge University Press.

O'Brien, K. L., & Leichenko, R. M. (2000). Double exposure: assessing the impacts of climate change within the context of economic globalization. *Global Environmental Change*, *10*, 221}232.

OECD (2015). *Agricultural Policies in Viet Nam 2015*. Paris. https://doi.org/10.1787/9789264235151-en

Oliver-Smith, A. (2004). Theorizing Vulnerability in a Globalized World. In G. Bankoff, G. Frerks, & D. Hilhorst (Eds.), *Mapping vulnerability: Disaster, Development & People* (pp. 10–24). USA: Earthscan.

Olson, K. R., & Morton, L. W. (2018). Polders, dikes, canals, rice, and aquaculture in the Mekong Delta. *Journal of Soil and Water Conservation*, *73*(4), 83A-89A. https://doi.org/10.2489/jswc.73.4.83A

Olsson, P., Folke, C., & Hahn, T. (2004). Social-Ecological Transformation for Ecosystem Management: The Development of Adaptive Co-management of a Wetland Landscape in Southern Sweden. *Ecology and Society*, *9*(2).

Onwuegbuzie, A. J., & Collins, K. M.T. (2007). A Typology of Mixed Methods Sampling Designs in Social Science Research. *The Qualitative Report*, *12*(2), 281–316.

Orlove, B. (2009). The past, the present and some possible futures of adaptation Chapter · January 2009 CITATIONS 19 READS 98 1 author: The past, present and some possible future of adaptation. In I. Lorenzoni, K. L. O'Brien, & W. N. Adger (Eds.), *Adapting to climate change: Thresholds, values, governance.* Cambridge: Cambridge University Press.

Ottinger, M., Clauss, K., & Kuenzer, C. (2016). Aquaculture: Relevance, distribution, impacts and spatial assessments – A review. *Ocean & Coastal Management*, *119*, 244–266. https://doi.org/10.1016/j.ocecoaman.2015.10.015

Pahl-Wostl, C. (2009). A conceptual framework for analysing adaptive capacity and multi-level learning processes in resource governance regimes. *Global Environmental Change*, *19*(3), 354–365. https://doi.org/10.1016/j.gloenvcha.2009.06.001

Pardoe, J. Multiple and more frequent natural hazards - The vulnerability implications for rural West African communities.

Pedde, S. (2019). *Advancing the development and use of climate-change scenarios: A multi-scale analysis to explore socio-economic European futures.* https://doi.org/10.18174/466803

Pelling, M., High, C., Dearing, J., & Smith, D. (2008). Shadow spaces for social learning: a relational understanding of adaptive capacity to climate change within organisations. *Environment and Planning*, *40*(4), 867–884.

Pelling, M., & High, C. (2005). Understanding adaptation: What can social capital offer assessments of adaptive capacity? *Global Environmental Change*, *15*(4), 308–319. https://doi.org/10.1016/j.gloenvcha.2005.02.001

Pelling, M., & Manuel-Navarrete, D. (2011). From Resilience to Transformation: The Adaptive Cycle in Two Mexican Urban Centers. *Ecology and Society*, *16*(2).

Petersen, E. (Ed.). (2017). *Vietnam food security policy review*. Canberra: Australian Centre for International Agricultural Research (ACIAR).

Pham, D. Q., & Pham, T. T. T. (2011). Urbanization Mekong Delta in Viet Nam: The challenges of urban expansion adapting to floods.

Pham, H. T. V., Febriamansyah, R., Afrizal, & Thong, A. T. (2018). Government Intervention and Farmers' Adaptation to Saline Intrusion: A Case Study in the Vietnamese Mekong Delta. *International Journal on Advanced Science Engineering Information Technology*, *8*(5).

Pham, Q. D., & Pham, T. T. T. (2011). Urbanizing Mekong Delta in Vietnam: The challenges of urban expansion adapting to floods. In *The 5th International Conference of the International Forum on Urbanism (IFoU)*.

Phan, K. L. (2012). *THE MEKONG DELTAIC: PAST, PRESENT AND FUTURE MORPHOLOGY* (Master). Delft University of Technology, The Netherlands.

Pingali, P. L., & Xuan, V.-T. (1992). Vietnam: Decollectivization and Rice Productivity Growth. *Economic Development and Cultural Change*, *40*(4), 697–718. https://doi.org/10.1086/451973

Poelma, T. (2018). *Transitioning to rice-shrimp farming in Kien Giang, Vietnam Determining rural household resilience to changing climatic conditions* (Master). University Utrecht, The Netherlands.

Pritchard, B., Vicol, M., & Jones, R. (2017). How does the ownership of land affect household livelihood pathways under conditions of deagrarianization? 'Hanging in', 'stepping up' and 'stepping out' in two north Indian villages. *Singapore Journal of Tropical Geography*, *38*(1), 41–57. https://doi.org/10.1111/sjtg.12180

R. L. Chambers, & C. J. Skinner. Analysis of Survey Data (Wiley Series in Survey Methodology).

Rahman, M. M., Penny, G., Mondal, M. S., Zaman, M. H., Kryston, A., Salehin, M., . . . Müller, M. F. (2019). Salinization in large river deltas: Drivers, impacts and socio-hydrological feedbacks. *Water Security*, *6*, 100024. https://doi.org/10.1016/j.wasec.2019.100024

Ralston, A., & Wilf, H. S. (Eds.). (1960). *Mathematical Methods for Digital Computers*. New York: John Wiley.

Ravallion, M., & van de Walle, D. (2008). Does rising landlessness signal success or failure for Vietnam's agrarian transition? *Journal of Development Economics*, *87*(2), 191–209. https://doi.org/10.1016/j.jdeveco.2007.03.003

Renaud, F. G., Le, T. T. H., Lindener, C., Guong, V. T., & Sebesvari, Z. (2015). Resilience and shifts in agro-ecosystems facing increasing sea-level rise and salinity intrusion in Ben Tre Province, Mekong Delta. *Climatic Change*, *133*(1), 69–84. https://doi.org/10.1007/s10584-014-1113-4

Renaud, F. G., Birkmann, J., Damm, M., & Gallopín, G. C. (2010). Understanding multiple thresholds of coupled social–ecological systems exposed to natural hazards as external shocks. *Natural Hazards*, *55*(3), 749–763. https://doi.org/10.1007/s11069-010-9505-x

Renaud, F. G., & Kuenzer, C. (Eds.). (2012). *Springer Environmental Science and Engineering*. *The Mekong Delta System*. Dordrecht: Springer Netherlands. https://doi.org/10.1007/978-94-007-3962-8

Renaud, F. G., & Kuenzer, C. (Eds.). (2012). *Springer Environmental Science and Engineering*. *The Mekong Delta System*. Dordrecht: Springer Netherlands. https://doi.org/10.1007/978-94-007-3962-8

Renaud, F. G., Syvitski, J. P. M., Sebesvari, Z., Werners, S. E., Kremer, H., Kuenzer, C., . . . Friedrich, J. (2013). Tipping from the Holocene to the Anthropocene: How threatened are major world deltas? *Current Opinion in Environmental Sustainability*, *5*(6), 644–654. https://doi.org/10.1016/j.cosust.2013.11.007

Revilla Diez, J. (1999). Vietnam: addressing profound regional disparities. *Southeast Asian*, 358–374.

Revilla Diez, J. (2016). Vietnam 30 years after Doi Moi: achievements and challenges. *Zeitschrift für Wirtschaftsgeographie*, *60*(3), 872. https://doi.org/10.1515/zfw-2016-0035

Ribot, J. (2011). Vulnerability before adaptation: Toward transformative climate action. *Global Environmental Change*, *21*(4), 1160–1162. https://doi.org/10.1016/j.gloenvcha.2011.07.008

Rigg, J. (2006). Land, farming, livelihoods, and poverty: Rethinking the links in the Rural South. *World Development*, *34*(1), 180–202. https://doi.org/10.1016/j.worlddev.2005.07.015

Rigg, J., Salamanca, A., & Thompson, E. C. (2016). The puzzle of East and Southeast Asia's persistent smallholder. *Journal of Rural Studies*, *43*, 118–133. https://doi.org/10.1016/j.jrurstud.2015.11.003

Righi, E., Dogliotti, S., Stefanini, F. M., & Pacini, G. C. (2011). Capturing farm diversity at regional level to up-scale farm level impact assessment of sustainable development options. *Agriculture, Ecosystems & Environment*, *142*(1-2), 63–74. https://doi.org/10.1016/j.agee.2010.07.011

Rosenberg, N. J. (1992). Adaptation of agriculture to climate change. *Climatic Change*, *21*, 385–405.

Rossi, S. (2016). *A VULNERABILITY ANALYSIS OF THE RED RIVER BASIN, VIETNAM, UNDER CO-VARYING CLIMATE AND SOCIO-ECONOMIC CHANGES* (Master). SCHOOL OF CIVIL, ENVIRONMENTAL AND LAND MANAGEMENT ENGINEERING.

Sahn, D. E., & Stifel, D. (2003). Exploring alternative measures of welfare in the absence of expenditure data. *Review of Income and Wealth*, *49*(3).

Sansom, R. L. (1970). *The Economics of Insurgency in the Mekong Delta of Vietnam*: The MIT Press; First Edition.

Schellnhuber, H. J. (1999). Earth system' analysis and the second Copernican revolution. *NATURE*, *402*(2), C19-C23.

Schipper, E. L., & Burton, I. (2009). Understanding Adaptation: Origins, Concepts, Practice and Policy. In L. Schipper & I. Burton (Eds.), *The Earthscan reader on adaptation to climate change* (1–8.). London: Sterling: Earthscan.

Schipper, L., & Burton, I. (Eds.). (2009). *The Earthscan reader on adaptation to climate change*. London: Sterling: Earthscan.

Schlüter, M., Baeza, A., Dressler, G., Frank, K., Groeneveld, J., Jager, W., . . . Wijermans, N. (2017). A framework for mapping and comparing behavioural theories in models of social-ecological systems. *Ecological Economics*, *131*, 21–35. https://doi.org/10.1016/j.ecolecon.2016.08.008

Schwab, M. (2012). *Nature and values of coping and adaptation: An evaluation of response mechanisms to changing water-related risks in rural areas of the Vietnamese Mekong Delta* (Graduate Research Series No. 7). Bonn.

Simon, H. A. (1992). What is an explanation of behavior. *Psychological Science*, *3*(3), 150–161.

SIWRR (2005). *Research, propose feasible cross-sections for sea dikes in accordance with different dike types and local conditions from Ho Chi Minh city to Kien Giang province (Vietnamese)*. Ho Chi Minh City.

Smajgl, A., Toan, T. Q., Nhan, D. K., Ward, J., Trung, N. H., Tri, L. Q., . . . Vu, P. T. (2015). Responding to rising sea levels in the Mekong Delta. *Nature Climate Change*, *5*(2), 167–174. https://doi.org/10.1038/NCLIMATE2469

Smit, B., Burton, J., Klein, R. J.T., & Wandel, J. (2000). An Anatomy of Adaptation to Climate Change and Variability. *Climatic Change*, *45*, 223–251.

Smit, B., & Wandel, J. (2006). Adaptation, adaptive capacity and vulnerability. *Global Environmental Change*, *16*(3), 282–292. https://doi.org/10.1016/j.gloenvcha.2006.03.008

Smith, T., Thomsen, D. C., Gould, S., Schmitt, K., & Schlegel, B. (2013). Cumulative Pressures on Sustainable Livelihoods: Coastal Adaptation in the Mekong Delta. *Sustainability*, *5*, 228–241.

Smith, W., Williamson, I., Burns, A., Chung, T. K., Ha, N. T. V., & Quyen, H. X. (2013). The Impact of Land Market Processes on the Poor in Rural Vietnam. *Survey Review*, *39*(303), 3–20. https://doi.org/10.1179/003962607X164952

Smith, W., & Binh, T. T. (1994). *The impact of the 1993 land law on rural households in the Mai Don District of Son La Province*. Hanoi, Vietnam.

Smithers, J. & Smit, B. (1997). Human adaptation to climatic variability and change. *Global Environmental Change*, *7*(2), 129–146.

Soc Trang PPC (2012). *Bao cao thuyet minh*. Soc Trang.

Social Republic of Vietnam (SRV) (2006). *Decision 58/2006/QĐ-TTg*. Hanoi.

Social Republic of Vietnam (SRV) (2014). *Government's Decision 879/QĐ-TTg*. Hanoi.

Socialist Republic of Vietnam. (1987). *Law of land by National Assembly – 3-LCT/HĐNN8*. Hanoi.

Socialist Republic of Vietnam (SRV) (2003). *Law of land by National Assembly – 13/2003/QH11*. Hanoi.

Socialist Republic of Vietnam (SRV) (2013). *Law of land by National Assembly – 45/2013/QH13*. Hanoi.

Socialist Republic of Vietnam (SRV) (2016). *Resolution No. 1210/2016/UBTVQH13*. Hanoi

Socialist Republic of Vietnam (SRV) (2017) *"On sustainable and climate-resilience development of the Mekong Delta"*. Hanoi.

Sohns, F., & Revilla Diez, J. (2016). SELF-EMPLOYMENT AND ITS INFLUENCE ON THE VULNERABILITY TO POVERTY OF HOUSEHOLDS IN RURAL VIETNAM—A PANEL DATA ANALYSIS. *Geographical Review*, 1–24.

Sohns, F., & Revilla Diez, J. (2018). Explaining micro entrepreneurship in rural Vietnam—a multilevel analysis. *Small Business Economics*, *50*(1), 219–237. https://doi.org/10.1007/s11187-017-9886-2

Solecki, W. (2012, March). *Coupled Human-Natural Urban System Tipping Points as Opportunities and Challenges for Resilience and Sustainability Analysis and Practice*. Planet Under Pressure, London.

Son Nam. (2009). *Lich su khan hoang Mien Nam.*

Spence, A., Poortinga, W., Butler, C., & Pidgeon, N. F. (2011). Perceptions of climate change and willingness to save energy related to flood experience. *Nature Climate Change*, *1*(1), 46–49. https://doi.org/10.1038/nclimate1059

Steel, G., & Zoomers, A. (2011). Social mobility in the Central Andes of Peru and Bolivia: Towards a more dynamic and multi-local vision of poverty alleviation. *International Development Planning Review*, *31*(4), 378–396.

Steel, G. and Zoomers, A. (2011). Social mobility in the Central Andes of Peru and Bolivia: Towards a more dynamic and multi-local vision of poverty alleviation. *International Development Planning Review*, *31*(4), 378–396.

Stewart, M. A., & Coclanis, P. A. (Eds.). (2011). *Advances in Global Change Research*. *Environmental Change and Agricultural Sustainability in the Mekong Delta*. Dordrecht: Springer Netherlands. https://doi.org/10.1007/978-94-007-0934-8

Stewart, M. A., & Coclanis, P. A. (Eds.). (2011). *Advances in Global Change Research: Vol. 45*. *Environmental Change and Agricultural Sustainability in the Mekong Delta*. The Netherlands: Springer Science+Business Media B.V.

Tamásy, C., & Revilla Diez, J. (Eds.). (2013). *Regional resilience, economy and society. Globalising rural places (the dynamics of economic space)*: Aldershot: Ashgate.

Tarp, F. (2015). *Growth, structural transformation and rural change in Vietnam - A rising dragon on the move*: UNWIDER.

Tas, S. (2016). *Coastal protection in the Mekong Delta* (Master thesis). Delft University of Technology, The Netherlands.

Thao, N. D., Takagi, H., Esteban, & Miguel (Eds.). (2014). *Coastal disasters and climate change in Vietnam: Engineering and planning perspectives* (1st ed.). London: Elsevier. Retrieved from http://proquest.tech.safaribooksonline.de/9780128000076

The World Bank (2010). *Theories of behavior change*. Washington DC.

The World Bank (2015). *World Development Report 2015: Mind, Society, and Behavior.*

Thi Nhung, T., Le Vo, P., van Nghi, V., & Quoc Bang, H. (2019). Salt intrusion adaptation measures for sustainable agricultural development under climate change effects: A case of Ca Mau Peninsula, Vietnam. *Climate Risk Management*, *23*, 88–100. https://doi.org/10.1016/j.crm.2018.12.002

Thieme, S. (2008). Living in Transition : How Kyrgyz Women Juggle Their Different Roles in a Multi-local Setting. *Gender Technology and Development*, *12*, 325–345.

Tong, Y. D. (2017). Rice Intensive Cropping and Balanced Cropping in the Mekong Delta, Vietnam — Economic and Ecological Considerations. *Ecological Economics*, *132*, 205–212. https://doi.org/10.1016/j.ecolecon.2016.10.013

Tran, D. D., van Halsema, G., Hellegers, P. J. G. J., Ludwig, F., & Wyatt, A. (2018). Questioning triple rice intensification on the Vietnamese Mekong delta floodplains: An environmental and economic analysis of current land-use trends and alternatives. *Journal of Environmental Management*, *217*, 429–441. https://doi.org/10.1016/j.jenvman.2018.03.116

Tran, H. Q. (2014). Nong dan va ruong dat o Nam Bo: Nhung dac trung va bai toan phat trien. *Sociology*, *3(127)*.

Tran, T., & James, H. (2017). Transformation of household livelihoods in adapting to the impacts of flood control schemes in the Vietnamese Mekong Delta. *Water Resources and Rural Development*, *9*, 67–80. https://doi.org/10.1016/j.wrr.2017.04.002

Tran, T., & James, H. (2019). Changing Livelihood Options as Adaptation: A Comparative Analysis of Three Flood Control Schemes in the Vietnamese Mekong Delta. In H. James (Ed.), *Population, Development, and the Environment* (Vol. 2, pp. 137–154). Singapore: Springer Singapore. https://doi.org/10.1007/978-981-13-2101-6_9

Tran, T. A., James, H., & Pittock, J. (2017). Social learning through rural communities of practice: Empirical evidence from farming households in the Vietnamese Mekong Delta. *Learning, Culture and Social Interaction.* Advance online publication. https://doi.org/10.1016/j.lcsi.2017.11.002

Tran, T. A., Nguyen, T. H., & Vo, T. T. (2019). Adaptation to flood and salinity environments in the Vietnamese Mekong Delta: Empirical analysis of farmer-led innovations. *Agricultural Water Management*, *216*, 89–97. https://doi.org/10.1016/j.agwat.2019.01.020

Tran, H. Q., & Nguyen, N. (2016). Reframing the “Traditional” Vietnamese Village: From Peasant to Farmer Society in the Mekong Delta. *Recherche en sciences humaines sur l’Asie du Sud-Est*. Retrieved from http://moussons.revues.org/3643

Tran, Q. Đ., Nguyen, H. T., & Kanchit, L. (2012). Mo phong xam nhap man Dong bang song Cuu Long. *Tap chi Khoa hoc DH Can Tho*. (21b), 141–150.

TRANG, N. T., TU, V. H., KHAI, H. V., & YABE, M. (2018). The determinants behind changes of farming systems and adaptation to salinity intrusion in the coastal regions of Mekong Delta. *J. Fac. Agr., Kyushu Univ.*, *63*(2), 417–422.

Tri, N. H., Choowaew, S., van Ni, D., & Kansantisukmongkol, K. (2019). Impact of saline intrusion and adaptation options on rice- and fish-farming households in the Mekong Delta of Vietnam. *Kasetsart Journal of Social Sciences*. (40), 427–433. https://doi.org/10.34044/j.kjss.2019.40.2.10

Tri, V. K. (2012). Hydrology and Hydraulic Infrastructure Systems in the Mekong Delta, Vietnam. In F. G. Renaud & C. Kuenzer (Eds.), *Springer Environmental Science and Engineering. The Mekong Delta System.* Dordrecht: Springer Netherlands.

Triet, N. K. V., Dung, N. V., Fujii, H., Kummu, M., Merz, B., & Apel, H. (2017). Has dyke development in the Vietnamese Mekong Delta shifted flood hazard downstream? *Hydrology and Earth System Sciences Discussions*, 1–27. https://doi.org/10.5194/hess-2017-123

Trình, M. Giáo trình Lịch sử Đảng Cộng sản Việt Nam [The history of the Vietnamese Communist Party]. Retrieved from http://voer.edu.vn/c/f402b395

Trinh, N. X., Quang, T. T., Ha, P. D., Le Xuan, T., Dinh, C. D., Thanh, T. N., . . . Thanh, H. N. (2018). Delimitating inland aqua-ecological zones under different climate conditions in the Mekong Delta region, Vietnam. *Journal of Water and Climate Change*, *46*(2), wcc2018181. https://doi.org/10.2166/wcc.2018.181

Truelove, H. B., Carrico, A. R., & Thabrew, L. (2015). A socio-psychological model for analyzing climate change adaptation: A case study of Sri Lankan paddy farmers. *Global Environmental Change*, *31*, 85–97. https://doi.org/10.1016/j.gloenvcha.2014.12.010

Tuan, P. A., & Shannon, K. (2010). Water management in Vietnam indigenous knowledge and international practices: the case of the Red River Delta. In *11th N-AERUS Urban Knowledge in Cities of the South*.

Tung, D. T. (2017). Measurement of on-farm diversification in Vietnam. *Outlook on Agriculture*, *46*(1), 3–12. https://doi.org/10.1177/0030727016689512

Tuong, T. P., Kam, S. P., Hoanh, C. T., Dung, L. C., Khiem, N. T., Barr, J., & Ben, D. C. (2003). Impact of seawater intrusion control on the environment, land use and household incomes in a coastal area. *Paddy and Water Environment*, *1*(2), 65–73. https://doi.org/10.1007/s10333-003-0015-2

Turner, B. L., Kasperson, R. E., Matson, P. A., McCarthy, J. J., Corell, R. W., Christensen, L., . . . Schiller, A. (2003). A framework for vulnerability analysis in sustainability science. *Proceedings of the National Academy of Sciences*, *100*(4), 8074–8079.

TVERSKY, A., & KAHNEMAN, D. (1973). Availability: A Heuristic for Judging Frequency and Probability. *COGNITIVE PSYCHOLOGY*, *5*, 207–232.

Ullah, R., & Shivakoti, G. P. (2014). Adoption of On-Farm and Off-Farm Diversification to Manage Agricultural Risks. *Outlook on Agriculture*, *43*(4), 265–271. https://doi.org/10.5367/oa.2014.0188

Ut, T. T., & Kei, K. (2006). The impact of Green Revolution on rice production in Vietnam. *Dev. Econ.*, *44*, 167–189.

Valbuena, D., Verburg, P. H., & Bregt, A. K. (2008). A method to define a typology for agent-based analysis in regional land-use research. *Agriculture, Ecosystems & Environment*, *128*(1-2), 27–36. https://doi.org/10.1016/j.agee.2008.04.015

Van der Geest, K., Nguyen, K. V., & Nguyen, T. C. (2012). Internal migration in the upper Mekong delta, Viet nam: what is the role of climate related stressors? *Asia-Pacific Population Journal*, *29*(2), 25–41. https://doi.org/10.18356/7b7d7273-en

Van der Leeuw, Sander E. (2008). *A New Initiative on Vulnerability, Resilience and Adaptation* (IHDP Update).

Van Dijk, R. M., Michiel, van Rooij, W., & Hilderink, H. (2014). Land Use Dynamics, Climate Change, and Food Security in Vietnam: A Global-to-local Modeling Approach. *World Development*, *59*, 29–46. https://doi.org/10.1016/j.worlddev.2014.01.020

Van Wijk, B. C. M., Beek, P. J., & Daffertshofer, A. (2012). Neural synchrony within the motor system: What have we learned so far? *Frontiers in Human Neuroscience*, *6*, 252. https://doi.org/10.3389/fnhum.2012.00252

Vo, T. V. (2014). *Vulnerability assessment of different socio-economic groups to floods in the rural Mekong Delta of Vietnam* (PhD Thesis). University of Bonn, Bonn, Germany.

Vu, K., & Zerrillo, P. C. (2016). Vietnam's economic transformation: Embracing change.

Vu, L., & Baulch, B. (2011). Assessing Alternative Poverty Proxy Methods in Rural Vietnam. *Oxford Development Studies*, *39*(3), 339–367. https://doi.org/10.1080/13600818.2011.599207

Waibel, H., Pahlisch, T. H., & Volker, M. (2018). Farmers perceptions of and adaptations to climate change in Southeast Asia - The case study from Thailand and VN. In L. Lipper (Ed.), *Natural Resource Management and Policy: Vol. 52. Climate Smart Agriculture.* FAO.

Wai-Poi, M., Spilerman, S., & Torche, F. (2008). *Economic Well-being: Concepts and Measurement with Asset Data* (Working Paper Series No. 20). New York.

Wall, M., & Johnston, D. (2008). Counting Heads or Counting Televisions: Can Asset-based Measures of Welfare Assist Policy-makers in Russia? *Journal of Human Development*, *9*(1), 131–147. https://doi.org/10.1080/14649880701811468

WARNER, K., van der Geest, K., KREFT, S., & HUQ, S. (2012). *LOSS AND DAMAGE IN VULNERABLE COUNTRIES INITIATIVE: EVIDENCE FROM THE FRONTLINES OF CLIMATE CHANGE: LOSS AND DAMAGE TO COMMUNITIES DESPITE COPING AND ADAPTATION* (No. 9). Bonn.

Watson, R. I. (1967). Psychology: A prescriptive science. *American Psychologist*, *22*(6), 435–443.

Weber, E. U. (2006). Experience-Based and Description-Based Perceptions of Long-Term Risk: Why Global Warming does not Scare us (Yet). *Climatic Change*, *77*(1-2), 103–120. https://doi.org/10.1007/s10584-006-9060-3

Werg, J., Grothmann, T., & Schmidt, P. (2013). Assessing social capacity and vulnerability of private households to natural hazards – integrating psychological and governance factors. *Natural Hazards and Earth System Sciences*, *13*(6), 1613–1628. https://doi.org/10.5194/nhess-13-1613-2013

Wise, R. M., Fazey, I., Stafford Smith, M., Park, S. E., Eakin, H. C., van Archer Garderen, E.R.M., & Campbell, B. (2014). Reconceptualising adaptation to climate change as part of pathways of change and response. *Global Environmental Change*, *28*, 325–336. https://doi.org/10.1016/j.gloenvcha.2013.12.002

World Bank Group (April 2016). *Vietnam Development Report 2016: Agricultural Modernization Transforming Vietnamese Agriculture: Gaining More for Less* (EAST ASIA AND PACIFIC).

Wright, L. D., & Nichols, C. R. (Eds.). (2019). *Coastal Research Library: Vol. 27*. *Tomorrow's Coast: Complex and Impermanent*: Springer International Publishing AG.

Xuan, V.-T. (1975). Rice Cultivation in the Mekong Delta. *South East Asian Studies*, *13*(1).

Xuan, V.-T., & Matsui, S. (Eds.). (1998). *Development of farming systems in the Mekong Delta of Vietnam*. Ho Chi Minh City: JIRCAS, CTU & CLRRI.

Yohe, G., & Tol, R. S.J. (2002). Indicators for Social and Economic Coping Capacity - Moving Toward a Working Definition of Adaptive Capacity. *Global Environmental Change*, *12*(1), 25–40.

Zamasiya, B., Nyikahadzoi, K., & Mukamuri, B. B. (2017). Factors influencing smallholder farmers' behavioural intention towards adaptation to climate change in transitional climatic zones: A case study of Hwedza District in Zimbabwe. *Journal of Environmental Management*, *198*(Pt 1), 233–239. https://doi.org/10.1016/j.jenvman.2017.04.073

Ziervogel, G., Bithell, M., Washington, R., & Downing, T. (2005). Agent-based social simulation: a method for assessing the impact of seasonal climate forecast applications among smallholder farmers. *Agricultural Systems*, *83*(1), 1–26. https://doi.org/10.1016/j.agsy.2004.02.009

## APPENDIX A.

Below is the list of interviews conducted with governmental organisations. These interviews and/or group interviews were conducted during the two field trips. Some of them were added after the first phase of data analysis which was useful for cross validation.

| Date | Place | Interviews/discussions conducted with |
|---|---|---|
| 25/08/2015 | Sóc Trăng | Department of Irrigation; Department of Forestry, Department of Aquaculture |
| | Mỹ Xuyên district, Sóc Trăng | Office of Agriculture and Rural Development |
| | Vĩnh Châu district, Sóc Trăng | Office of Economy |
| 27/08/2015 | Kiên Giang | Department of Finance; Department of Irrigation, Department of Forestry; Aquaculture and Agriculture |
| | An Minh district, Kiên Giang | OARD |
| 28/08/2015 | Tiền Giang | Department of Water Resources Management |
| | Gò Công Đông dist., Tiền Giang | OARD |
| | Gia Thuận commune | Commune Officer of Agriculture |
| 01/09/2015 | Giao Thủy dist., Nam Định | OONRE, |
| | Giao Xuân commune, Nam Định | Commune vice-president |
| 03/09/2015 | Tiền Hải district, Thái Bình | OONRE |
| 04/09/2015 | Nam Phú commune, Thái Bình | Commune Officer of Land Management |
| 09/09/2015 | Vinh Quang commune, Hải Phòng | Commune Officer of Land Management |
| 11/09/2015 | Giao Thủy dist., Nam Định | Statistical Office |
| 18/09/2015 | Tân Phú Đông dist., Tiền Giang | OARD, OONRE |
| 23/09/2015 | Vân Khánh commune, Kiên Giang | Commune Officer of Agriculture |
| | Đông Hòa commune, Kiên Giang | Commune Officer of Agriculture |
| 2016 | Cần Thơ, Hà Nội | Experts from Can Tho University, VNUA |
| 2017 | Hà Nội | Expert - UN Viet Nam |
| 2018 | Cologne | Expert - Freelancer savingwetland |

## APPENDIX B.

### Eigenständigkeitserklärung

Ich versichere, dass ich die von mir vorgelegte Dissertation mit dem Titel:

"Current and Future Household Livelihood Adaptation to Changing Social-Ecological Context - A Case Study in the Rural Coastal Areas of the Vietnamese Mekong Delta and Red River Delta"

selbständig angefertigt, die benutzten Quellen und Hilfsmittel vollständig angegeben und die Stellen der Arbeit − einschließlich Tabellen, Karten und Abbildungen −, die anderen Werken im Wortlaut oder dem Sinn nach entnommen sind, in jedem Einzelfall als Entlehnung kenntlich gemacht habe; dass diese Dissertation noch keiner anderen Fakultät oder Universität zur Prüfung vorgelegen hat; dass sie − abgesehen von unten angegebenen Teilpublikationen − noch nicht veröffentlicht worden ist, sowie, dass ich eine solche Veröffentlichung vor Abschluss des Promotionsverfahrens nicht vornehmen werde.

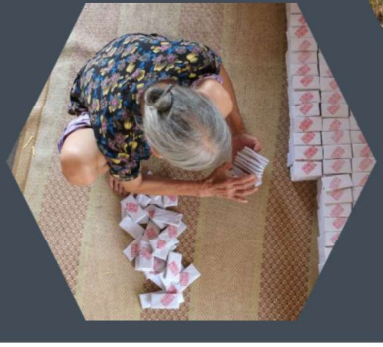
Die Bestimmungen der Promotionsordnung sind mir bekannt. Die von mir vorgelegte Dissertation ist von Prof. Dr. Javier Revilla Diez betreut worden.

Datum, Ort

Pham Thi Thanh Hoai

The Vietnamese Mekong Delta and Red River Delta are among global coastal deltas pronounced for their high vulnerability to hazards and climate variability while playing a key role in socio-economic development nationally. Therefore, examining the patterns and details of adaptation in these deltas are significant in the future under climate change. The two deltas have experienced drastic social-ecological changes in the last three decades which are projected to become more extensive. This dissertation offers a conceptual framework to study their changing complex context in response to firstly, the knowledge gaps in understanding the details and process of adaptation of these vulnerable communities, and secondly, the research need of framing and operationalizing the social-ecological integrative approach. This dissertation thus contributes to the interdisciplinary literature by addressing the fragmentation caused by separating disciplines and the case-study based research on environmental change adaptation.

The findings show that the households' livelihood shifts in the case study are determined by the combination and interaction of social and climatic drivers. The livelihood-change typology approach considers multiple dimensions and the dynamics of livelihood shifts at the household level and thereby allows further identification of enablers and barriers to adaptation. The future adaptation is examined using scenarios hypothesizing social and environmental changes to project emerging trends of change. Linking to the concepts of integrative social-ecological relationship, livelihood dynamics, and processual approach to adaptation, these results emphasize the process of change with the interactions between the society and the environment, as well as among actors or scales of adaptive actions. The insights into the diverse coastal areas of the two Vietnamese deltas showcase a good example of the complex social-ecological context which proves the need for an integrative approach to study adaptation. Based on the main findings complemented by an in-depth discussion on the critical role of policy interventions in Viet Nam, implications and outlook were made to call for further efforts of researchers and practitioners to facilitate more adaptive pathways of vulnerable communities.



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