VULNERABILITY ASSESSMENT OF DIFFERENT SOCIO-ECONOMIC GROUPS TO FLOODS IN THE RURAL MEKONG DELTA OF VIETNAM

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Summary

The overall objectives of this study are, firstly, to identify and analyse the different factors that characterise vulnerability and that explain the losses people experience resulting from slow-onset floods and, secondly, to develop criteria and indicators to assess this vulnerability. The thesis aims to enhance an understanding of the dynamics of vulnerability and response capacities of people facing floods in rural areas in the upper Vietnamese Mekong Delta (VMD). The research was conducted within the interdisciplinary WISDOM Project (Water-related Information System for the Sustainable Development of the Mekong Delta) and embedded in Work Package 5000 on Water Knowledge and Vulnerability. Emphasis is thus given to how varying socio-economic groups access and use their livelihood resources to build livelihood strategies in the context of floods. It explores the influences shaped by the transforming processes and structures in their flood response.

Theoretically and conceptually, the study is based on a framework modified from the BBC Framework (Birkmann, 2006) and the Sustainable Livelihoods Framework (Chambers and Conway, 1992). The framework deconstructs vulnerability in the three components of exposure, susceptibility and capacity of response, and has provided conceptual means to explore the subject matter from a holistic perspective in an interdisciplinary approach. In order to get a more in-depth understanding of the framework components, the study draws on theoretical concepts of disaster risk management, coupled human-environmental systems, and institutional economics.

Both qualitative and quantitative methods were used to explore and triangulate information and accordingly ensure the reliability and consistency of data collected. A literature review and secondary data analysis provided information in terms of floods, flood damage, land use, resettlements and flood-related policies. In-depth interviews during the field research enabled the research to probe deeper research findings and explore the main relationships among determinants influencing flood vulnerability. These interviews, along with focus group discussions (FGDs) and participatory methods, were used for assessing the flood vulnerability of local residents. A standardised household survey of 370 households located in riverbank and inland areas in An Hoa and Phu Hiep Communes, Tam Nong District, Dong Thap Province, complemented the approach.

Flood vulnerability indicators were identified by combining scientific literature and investigated data. The indicators were then consolidated and validated through further household interviews, official flood damage reports, expert interviews and FGDs with flood-

exposed people. In accordance with the conceptual approach, this methodological proceeding enabled a selection of exposure, susceptibility and capacity of response indicators.

Subsequently, relevant indicators and their weightings, which were verified by stakeholders' perceptions, were operationalised. Vulnerability at the household level was then assessed using the seven most important drivers of flood vulnerability, viz. (1) access to agricultural land, (2) access to residential land, (3) type of house, (4) household assets, (5) demographic composition of household, (6) remittances, and (7) income dependency.

Main findings: exposure, susceptibility and capacity of response

Annual slow-onset floods have occurred for thousands of years in the VMD; however, flood characteristics have increasingly altered due to both climate change and human interventions. In particular, the northern provinces of the VMD have experienced severe losses of life and livelihood disruptions due to major floods, especially in the years 2000, 2001 and 2002.

The analysis of different flood patterns and the respective losses and damages due to high floods revealed that changes in cropping types and strategies and interventions to reduce flood risks, such as embankments, were the main drivers for the changes observed in exposure to floods and loss patterns for different actors and groups. These changes are not primarily a result of changing conditions in flood patterns, but rather are determined by socio-economic transformation (e.g. renovation, resettlement, embankments and rice intensification). For example, regarding the change in rice-based farming systems, rice-growing periods are extended into the flooding season (from two to three rice crops per year). This also implies a longer temporal exposure of these crops and assets to flood risk.

The analysis of flood vulnerability shows that access to agricultural land is particularly important in terms of the households' ability to respond to floods and sustain their livelihoods, since it can be transformed into or used to access other livelihood assets. Access to agricultural land enables people to generate income and access formal loans. In addition, land and land certificates also function as important securities when facing losses, especially flood impacts. Therefore, access to agricultural land is a major factor that determines flood vulnerability in rural areas of Dong Thap. Historically, access to agricultural land and flood-based benefits such as fishing, vegetable collection, flood-related agriculture and advantages of rice crop cultivation pushed many landless households to migrate to the Dong Thap floodplains. Yet the household survey showed that approximately 40 per cent of in-migrants could not access any agricultural land, because they had insufficient capabilities to reach or protect their land use rights. In this regard, accessing, accumulating and protecting

agricultural land can be viewed through the perspective of institutional economics to better explore how in-migrants try to protect their land for flood adaptation and how they secure their livelihoods. Although one might expect that in a socialist country like Vietnam access to land was easily facilitated by the government, the interviews and vulnerability assessment revealed that many farmers who failed to convert from growing floating rice to growing high-yielding rice in the 1990s were also likely to lose their land because of a lack of financial resources. In contrast, many of the households which are classified as wealthy have successfully accessed and protected their allocated land.

Still, some of the households classified as poor and landless have been able to reduce their flood vulnerability since they were able to gradually improve their housing conditions, to successfully conduct (seasonal) out-migration, or were better-off after having been relocated by the government. However, most households classified as poor and landless showed an increase in vulnerability and a further erosion of adaptive capacity. Rural people in Dong Thap have gained their flood-related knowledge through a trial and error process and through the experiences of other farmers over time. However, when abnormal floods occur, such as particularly high floods, their strategies fail to provide security. Past flood loss patterns show that flood damage becomes severe when local knowledge is inappropriate.

The assessment and study undertaken in An Hoa and Phu Hiep Communes revealed that economic opportunities for fishermen and poor households have significantly declined, so that these groups have to deal with an erosion of their livelihood options. Many of the breadwinners of these households migrate, seasonally or temporally, to urban areas for non-farm jobs. As a result, children of poor households are insufficiently protected by adults and also lack physical means of flood protection, such as appropriate shelters. A new trade-off and balancing exercise during the flooding season can be observed between strategies to generate remittances to deal with livelihood disruptions, and activities that require staying in the flood-prone area to protect human and physical assets. Young labourers have shifted to non-farm jobs in urban areas; however, they often undertake manual low-skilled jobs due to their low educational levels and lack of professional expertise. Although this might be a reasonable transformation process in some cases, various interviewed households either failed in temporal migration or were not able to provide stable levels of remittances because of getting low-skilled jobs. As a result, remittances, which could provide additional resources for livelihood adaptation to floods, are quite limited.

The forced resettlement of poor flood-prone households into residential clusters and dykes has helped the relocated households to either eliminate their exposure to floods or evacuate

rapidly when required. Although this resettlement has significantly reduced the flood exposure, the vulnerability assessment shows that it has also increased susceptibility in many cases due to new livelihood disruptions and insecurities. This results, for example, in increasing daily costs of living, changes in the rural lifestyle, loss of social networks and disruption of income-earning activities. Thus, many relocated households had to cope with the adverse effects of the new situation and had to undertake second-order adaptation measures to the above shocks triggered by the resettlement process. In this context, many relocated households have developed new strategies (e.g. off-farm labour teams) that enable them to cope with new types of shocks.

Furthermore, the analysis of capacities to respond to floods shows that flood-related coping and adaptation mechanisms are diverse and sometimes constrain each other since they are implemented by different actors and socio-economic groups without considering the negative effects for other households or regions. For example, embankments have helped landowners to protect their rice production from floods, but this has caused the decline in flood-related resources that negatively influence livelihoods of the poor. Both coping and adaptation have contributed to reducing flood damage, but informal or non-governmental versus formal/governmental strategies often encompass quite different actions and sometimes may even generate mismatches. Formal coping strategies conducted by the government, such as harvesting rice threatened by floods, evacuation, and distribution of relief food, encourage flood-affected households to respond to extreme flood events. Informal coping is linked to knowledge gained over the years. In the slow-onset flood context, coping processes have contributed to enhancing flood adaptation. However, in some cases, governmental adaptation strategies (e.g. embankments and resettlement) can contradict local knowledge, since the flooding conditions might have fundamentally changed and some resources for coping and adapting to floods (e.g. flood-related resources and local materials for housing) are not available any more.

The study has revealed that different socio-economic groups implement different coping measures because of their differential access to livelihood assets. Hence, households classified as poor usually undertake coping activities because of inadequate livelihood assets that would enable them to adapt while wealthier households mainly develop adaptation options, since they have resources to do so.

Finally, the vulnerability of local communities to floods is shaped by flood-related policies and transformation. The concept of "*living with floods*" that was formulated by a series of governmental decisions and socio-economic development programmes after the destructive

floods in 2000 is judged to be a beneficial strategy by various stakeholders since residents' livelihoods are closely associated with floods. However, major loss and harm in times of high floods also challenge the concept. The transforming structures, including relocation, embankments and agricultural intensification, have caused positive and negative impacts on local residents regarding their ability to "live with floods". Embankments, mainly built during the 2000s in order to reduce flood impacts, have strongly modified vulnerability profiles and have provided an important basis for further changes in the management of flood-exposed crops. Embankments have functioned on the one hand as measures to increase human security, and on the other hand as an intervention to support further intensification of rice production. Consequently, the findings underscore that, although the government has successfully reduced flood exposure with such embankments, it has introduced additional or intensified existing conflicts between landowners and flood-based resource users during the flood season. This illustrates that a comprehensive vulnerability assessment, differentiating the effects flood intervention tools have on various socio-economic groups, is a prerequisite for the identification of sustainable disaster risk reduction and flood adaptation measures.

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Abbreviations

ASEAN	Association of Southeast Asian Nations
AW	Autumn-winter rice crop
CCFSC	Central Committee for Flood and Storm Control
DARD	Department of Agriculture and Rural Development
DFID	UK Department for International Development
DOC	Department of Construction
DOET	Department of Education and Training
DOLISA	Department of Labour, Invalids and Social Affairs
DONRE	Department of Natural Resources and Environment
DOIT	Department of Industry and Trade
DPI	Department of Planning and Investment
FA	Farmer's Association
FGD	Focus Group Discussion
GDP	Gross Domestic Products
GSO	General Statistical Office
HYV	High-Yielding Rice Varieties
IPCC	Intergovernmental Panel for Disaster Reduction
IRRI	International Rice Research Institute
ISDR	International Strategy for Disaster Reduction
KIP	Key Informant Panel
MARD	Ministry of Agriculture and Rural Development
CMHF	Centre for Hydro-Metrological Forecasting
MONRE	Ministry of Natural Resources and Environment
MRC	Mekong River Commission
PAR model	Pressure and Release model
PC	People's Committee
PRA	Participatory Rural Appraisal
RCA	Red Cross Association
SA	Summer-autumn rice crop
SES	Socio-Ecological Systems
SPSS	Statistical Package for the Social Sciences
UNFCCC	United Nations Framework Convention on Climate Change
UN-ISDR	United Nations-International Strategy for Disaster Reduction
UNU-EHS	United Nations University-Institute for Environmental and Human Security
USD	United State Dollar
VBARD	Vietnam Bank for Agriculture and Rural Development
VBSP	Vietnam Bank for Social Policies
VMD	Vietnamese Mekong Delta
VND	Vietnamese Dong
WB	World Bank
WISDOM	Water-Related Information System for Sustainable Development of MD
WS	Winter-spring rice crop
WTO	World Trade Organisation
WU	Women Union
YU	Youth Union

1. Introduction

Vietnam is located in the southeast coastal region of Asia and is among the most disaster-prone countries in the world (Dasgupta et al., 2007; Carew-Reid, 2007). Slow-onset river flooding is among the most destructive natural hazards in Vietnam. They occur regularly and abnormally in the context of climate change and human interventions (e.g., land use change and embankments). Furthermore, Vietnam and the Vietnamese Mekong Delta in particular have been subject to major changes in recent history. The delta has not only undergone major socio-economic transformations but is also highly affected by climate change. Both have changed and will continue to significantly change the impacts of natural hazards.

For example, although historically the VMD has seldom been hit by typhoons (Mao et al., 1992), recent observations showed that the hurricane trajectories of Vietnam have shifted slightly to the south. Thus, because both flooding and typhoons have coincided, in the future typhoons and floods may occur concurrently in the delta. This is a concern since local people will be exposed to new and compound natural hazards. Indeed, recently, several typhoons passed the edge of the delta; however, these typhoons caused serious damage to local livelihoods. The extent of devastation that is possible was seen in 1997, when Typhoon Linda (also called Typhoon No. 7) in the south of Vietnam killed over 2,200 people working on the sea and caused significant damage to crops and properties in the VMD, even though it occurred at the end of the flooding season (CCFSC, 1991-2000). This means that local residents are facing different hazards patterns, particularly different flooding patterns, because they have changed due to climate variability.

Sea level rise will also shape the delta's impacts of flooding substantially. Regarding sea level rise scenarios of 20 and 45 cm, Wassmann et al. (2004) indicate that sea levels could potentially increase the water level during high flooding discharge in the delta from 11.9 and 27.4 cm, respectively. Moreover, flood regimes are strongly influenced by human physical interventions (e.g., dams for hydro-power plants or irrigation) in the Mekong Basin that have also shaped the livelihoods of people in the rural riparian communities in the lower Mekong Basin (Weaderbee, 1997; Dore et al., 2007; Greancen and Palettu, 2007). As flood regimes have changed in water discharge and duration, and a combination of floods and other natural hazards like typhoons and sea level rises have been predicted by scientists, the impacts of slow-onset floods on local communities have also been altered and need to be understood.

Slow or flash-onset river floods significantly affect human lives, infrastructure and income-earning activities in the world. According to Pedizzi (2006), between 1990 and 2000 the total

number of deaths related to floods worldwide was 170,010. In recent years, although the number of people killed by floods has decreased, the number of affected people and economic damage has increased significantly. Populous South East Asian countries are among the most exposed to annual catastrophic flooding, and Vietnam is one of the most highly exposed countries. In Vietnam, both slow and flash floods cause serious damage and loss of crops and infrastructure and are responsible for a high number of human fatalities[1]. Floods have killed about 6,000 Vietnamese people within the last 20 years, approximately 43 per cent of the total number of victims of natural hazards. While flash-onset floods usually occur in the northern and central regions because of the steeply sloped landscape, annual slow-onset floods severely affect the VMD in the south.

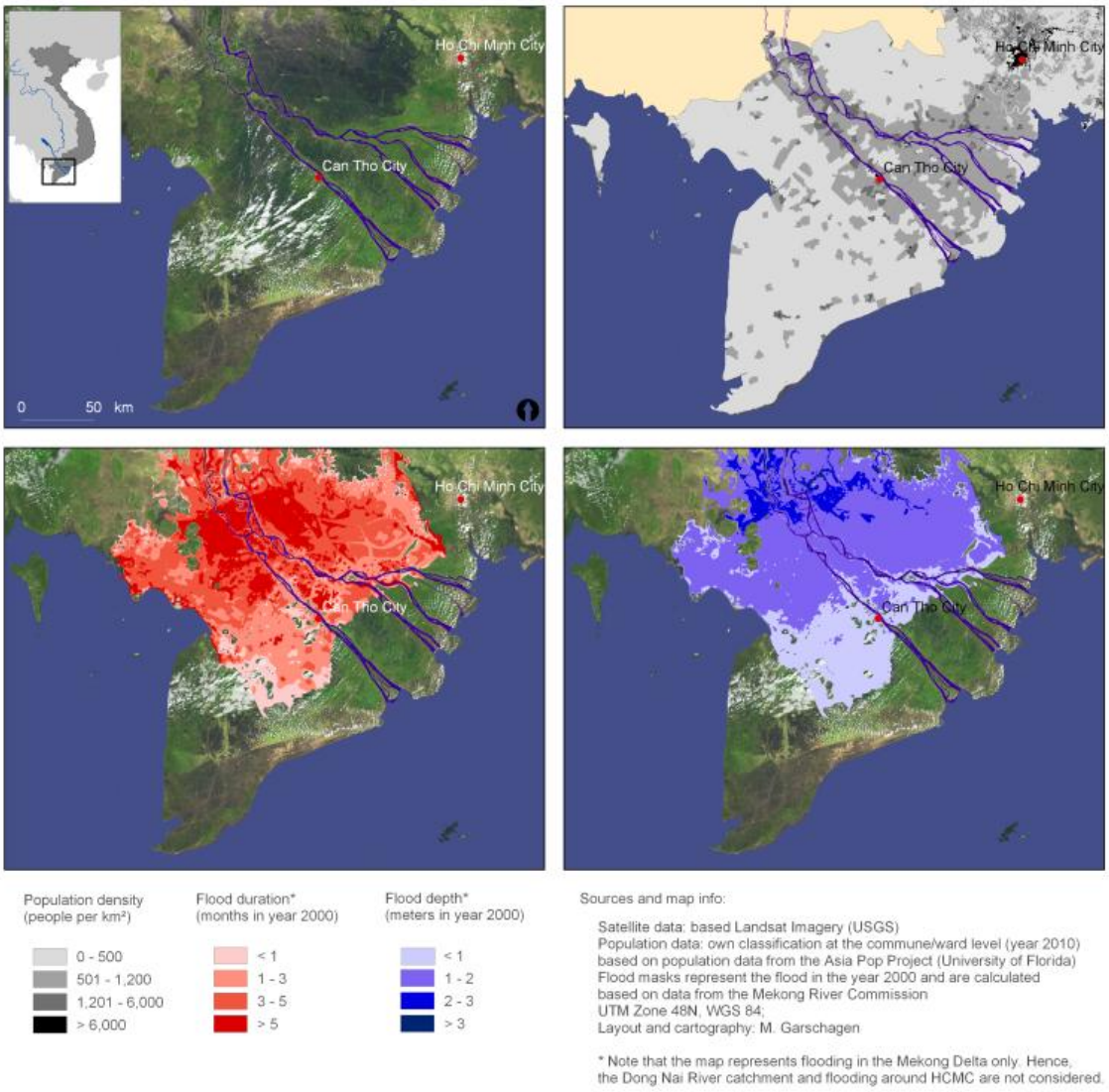


Figure 1: Flood duration and flood depth in the year 2000 in the Vietnamese Mekong Delta
(Source: Garschagen, 2013)

[1] According to data collected by the CCSFC (1989-2008), the total number of people killed by natural hazards in Vietnam between 1989 and 2008 was approximately 13,900; of which the number of deaths caused by slow-onset floods was 4,557, accounting for 33 per cent of fatalities caused by natural hazards.

In the Mekong River Basin, annual floods are natural phenomena; however, high floods result in human fatalities, damage to crops and infrastructure and disruption to social and economic activities (MRC, 2003). In the VMD, an approximately 1.9 million hectares of land, accounting for 50 per cent of its total natural area, is inundated by annual slow-onset floods. Within this area, 11 million people, 65 per cent of its population, are exposed to flood risks. Rice crops, basic infrastructure (e.g., houses, roads, and bridges) and people who lived in temporary houses and worked in floodplains were most exposed to slow-onset floods impacts. Since 2003, flooding has decreased because of a reduction in water discharge from upstream; however, the high floods that occurred in 2011 caused massive economic losses. One of the major reasons was that people started growing more the autumn-winter rice (AW rice) which is always grown during the flooding season through the construction of full flood-control embankments. Generally, flooding depths do not vary much; however, the level of damage will be significantly higher if flooding increases by only 20 to 30 cm given the flat shape of the delta (Nha, 2004). Significant economic losses and human fatalities are related to flooding depths exceeding 4.5 metres as measured at Tan Chau Gauging Station, which is located in the upper VMD. Small floods may also cause adverse effects for many rural residents since they constrain many parts of their lives. They cause a decrease in flood-related resources (e.g., wild aquatic species, alluvial sediments and freshwater) and an increase in grasses, pests (e.g., rats and insects), crop diseases, agro-chemical concentration in the upper delta as well as salinity intrusion in the coastal regions. Moreover, livelihood activities or agriculture in the delta follow seasonal schedules shaped by cyclic climate conditions. Therefore, any changes in not only the intensity but also the timing of floods may damage agriculture and rural livelihoods. Moreover, the impact of the flooding caused by high or low floods influences different socio-economic groups in a different ways.

Flood calamity is not only influenced by flood events or flood change, but also by natural and socio-economic conditions, which both enable and constrain exposed residents to respond to floods differently. Since the VMD was formed by slow alluvium deposition, has an elevation of mostly only 1.0 metres above mean sea level (Sanh et al., 1998; Hoi, 2005), and is located in the downstream section of the long international Mekong River, it is prone to both river-flooding from the upstream stretches of the Mekong River and to sea level rises from the ocean. Moreover, approximately 41 per cent of agricultural land in the delta is influenced by potential or active acid sulphate soils (Sanh et al., 1998), which are unfavourable for various types of crop cultivation such as fruit trees, rice and vegetables. Therefore, in the initial resettlement of the rural floodplains, when acid sulphate soils were still severe, farmers faced

many challenges in rice production. In such fragile conditions where there are groups of people or elements exposed to floods, their susceptible circumstances have also shaped their flood vulnerability. In reality, flooding which causes injury, death and financial loss mainly occurs in the remote floodplains where new settlers live and poor basic infrastructure dominates.

Although floods are considered natural destructive hazards, there are positive attributes associated with floods as well. In contrast to flash floods, slow-onset flooding provides both risks and livelihood opportunities to rural residents. In the rural VMD, people cope with and adapt to slow-onset floods that last nearly half a year. Floods are not only perceived as natural risky hazards, but also as livelihood opportunities. Crop damage, infrastructure damage, human injury and death are all aspects associated with floods; however, the annual slow-onset floods in the Mekong Basin also contributes to the wealth of biodiversity, abundance of fish, and soil fertility as well as helping to eliminate pests, crop disease, crop waste and agrochemicals (MRC, 2003; Hoi, 2005). Annually, the Mekong River provides a series of benefits for people's livelihoods in riparian communities (Hoanh et al., 2003). In the VMD, many households have created livelihoods out of flood-related resources. For instance, local residents take advantage of the floods by applying intensive cultivation (e.g., fresh water prawn or intensive snakehead fish) and extensive production (e.g., vegetables, fish, eels and frogs). In addition, other professions such as making boats, nets, hooks and fishing traps also benefit from floods. Moreover, people often consume flood-related resources as common-pool resources. During flooding seasons, the boundary between paddy field plots is unclear, creating an open-access regime for common-pool resources in large areas. Therefore, residents in the rural floodplains can earn much of their income and requirements for staple foods (e.g., fish, shrimp, snails and flood-based vegetables) in the flooded quasi-open-access areas. However, as a result of these livelihoods, these particular households, which live on the floodplains and are reliant on flood-related resources, are also severely exposed to flood risks.

Potential flood impacts are influenced by how local residents make trade-offs between livelihood opportunities and flood risks. In the VMD, landless and poor people migrate to rural floodplains for livelihood opportunities through both formal and informal mechanisms. Therefore, the net in-migration rate in the rural floodplains in Dong Thap was positive. Historically, in-migrants hoped to reclaim, buy or be allocated agricultural land as well as to exploit flood-related resources However, in previous years, the trend of migration flow has changed. The net out-migration rate in the VMD increased from 9.9 per cent in 1999 to 40.4 per cent in 2009 (Marx and Fleische, 2010). For example, in the past, Dong Thap experienced

high in-migration. Many households formally and informally resettled in the rural floodplains in order to access new livelihood opportunities, focusing mainly on fishing and obtaining agricultural land that was initially allocated to in-migrants. These residents accepted living with flood risks in order to take flood-related benefits and achieve their desired livelihood outcomes. This explains why many households resettled and thrived on the rural floodplains.

However, in recent years, this trend has reversed. Now out-migration dominates. This is largely because when natural resources decline alongside developing opportunities in urban areas, local residents, particularly landless residents, seasonally or temporally migrate in search of new livelihood opportunities in urban and industrial regions (mainly Ho Chi Minh City, Binh Duong and Dong Nai). It is therefore important to gain understanding into the different push and pull factors, the changes in migration flows and how migration is related to flood vulnerability. In short, floods and flood-related resources affect the livelihoods of various socio-economic groups differently, which in turn influences their vulnerability to floods. This means that the flood vulnerability of different groups also depends on changes in flood-related livelihood opportunities as well as their access to these livelihood resources.

Response(s) to a hazard play(s) an important role in reducing risks since some responses contribute to a decrease in the vulnerability of people at risk. Hence, vulnerability cannot be assessed without taking into account the capacity of a community to absorb, cope with and adapt to the impacts of a hazardous event (Westgate and O'Keefe, 1976). Each household has its own livelihood assets and capacity to access these assets, which are accumulated over time (Swain et al., 2008). At the household level, capacity to respond to a hazard is associated with people's property rights and their access to livelihood resources in order to build or adjust their response strategies to mitigate hazardous impacts. In the rural VMD, income from rice-based farming systems at the household level is a major income source as the planted area of paddy production accounts for approximately 99 per cent of the annual grain crops (GSO, 1990-2010). Therefore, access to agricultural land plays an important role in shaping rural livelihoods, which influence people's vulnerability to flood impacts.

Based on their livelihood assets, each socio-economic group is vulnerable in different ways to the same flooding conditions. However, many households have failed to access their agricultural land so that there are now a high number of landless households in the rural floodplains in Dong Thap. This is a significant concern given that land is the major productive asset for rural residents. Constraints and costs in accessing and protecting agricultural land in the floodplains could be one of the key determinants influencing in-migrants to respond to floods effectively. Therefore, it is important to understand how farmers could protect their

agricultural land better. In addition, the use of the livelihood assets of varying socio-economic groups may reshape flood vulnerability. For example, in the rural floodplains, the lack of access to agricultural land has constrained farmers' access to formal financial institutions as well as becoming a member of local famer associations (Swain et al., 2008).

In addition to the informal strategies of households, it is also important to take into account formal strategies developed by the government. In consideration of the fact that the VMD has both great potential for agriculture and high vulnerability to severe flooding (Miller, 2003; Sanh et al., 1998), the Vietnamese government announced a strategy of *"living with floods"*[2]. It has been applied in flooding areas through physical interventions (e.g., the construction of embankments and residential clusters and dykes) and via a set of policies stimulating income-earning activities and economic development in the rural floodplains. In consequence, a series of flood-related interventions (e.g., embankment, farming system change, relocation) have been implemented in order to mitigate flood impacts and develop agriculture within the full flood-control areas. In the upper VMD, the physical flood-related interventions of local governments are characterised by creation of semi-flood-control areas, full flood-control areas and residential clusters and dykes. These measures create substantial changes in residents' livelihoods (Nha, 2004; Miller, 2003). After the devastating floods that occurred in 2000, many semi- and full flood-control embankments were built in order to protect most areas that experience significant flooding.

However, while these aim to be positive changes, it has been shown that the technological interventions usually applied to mitigate hazardous impacts can actually increase vulnerability (McLaughlin and Dietz, 2007). In the rural VMD, embankments have influenced flood duration in full flood-control areas, which in turn have induced changes in rice-based farming systems. Rice crops, particularly AW rice crops are more exposed to dyke breakage due to high flood impacts. Moreover, the construction of residential clusters and dykes, mainly by the governments after the 2000 floods, were used to relocate poor households who have no residential land or live in areas severely prone to flood risks. Such flood mitigation projects, enforced since the 2000 floods, in many case have changed the rural livelihoods of people exposed to floods. The relocated residents have escaped from flood impacts; however, they

[2] The strategy of "living with floods" was launched in 1996 based on Decision No. 99-TTg of the Prime Minister. This strategy has promoted a long-term plan for the development of irrigation, transport and construction, especially embankments and residential clusters and dykes, to enable people to live with floods in the VMD.

are confronted with new socio-economic constraints such as livelihood disruption as well as high expenditure (Danh and Mushtaq, 2011).

Moreover, conflicts among natural resource users in the rural floodplains may occur regarding these embankments. Local residents in flood-prone areas compete in using natural resources since flood-related resources and agricultural land are located in the same areas; yet, these differentiated resources are expected to maximise the utility of both landless and land ownership groups. These land use purposes influence water management patterns through flood-related mitigation measures like embankments that make it possible to protect and develop rice crops from flooding but eliminates flood-related resources (e.g., fish and flood-related vegetables). In reality, embankments in the rural floodplains excluded landless households since mainly agricultural landowners joined meetings for decision-making processes. Landless residents are the main flood-related resource users but are relatively powerless in sub-regional land use decision-making. The decline in flood-related resources, one of the consequences of embankment projects, has reduced livelihood opportunities of both relocated and non-relocated poor residents. The concern is how impacts of flood-related mitigation interventions, especially embankments, have shaped people's flood vulnerability, especially regarding changes in flood-related livelihoods.

Vietnam's political-economic reforms, also called "Doi Moi" policy, have also affected rural livelihoods and influenced flood response capacity. Since the 1980s, Vietnam has shifted from a centrally planned economy to a free-market economy incorporating measures that have strongly contributed to changes in agricultural intensification in the 1990s. The transition has led to several essential reforms in the agricultural sector: households began to be considered autonomous and independent economic units, and agricultural land was distributed. Through these reforms, Vietnam began moving away from a country that faced food shortage in the 1980s to a country producing large amounts of food exports in the 1990s. This induced significant land use changes in the VMD. Within one decade of the "Doi Moi" policy's launch, the amount of rice-planted land in the delta increased by 60 per cent, of which a large area of single floating rice was converted to the double High-Yielding rice Varieties (HYV). This conversion has negatively affected flooding conditions and flood-related resources in the rural floodplains since changes in cropping patterns have also constrained natural resource development. In brief, the areas experiencing the most significant flooding have the maximum agricultural use potential. With over 17 million people in the VMD, of which approximately

12.3 per cent (Que and Thanh, 2011) live under the general poverty line[3] of less than 1 USD a day, the poor have struggled to both deal with floods and earn their livelihoods. Moreover, because of socio-economic constraints they face challenges in accessing livelihood assets, which impedes their ability to cope with and adapt to flood impacts.

Both flooding and flood-related interventions have strongly affected coupled human-environment systems, in which human activities (e.g., embankments, flood-related resource use) and environmental conditions (e.g., flooding conditions, flood-based resources) interact. However, a natural hazard (e.g., flooding) alone is not able to convert a risk into a disaster if there are no elements or people at risk, and hazardous impacts may be reduced if exposed elements have less vulnerability or high resilience to the hazard (Cardona, 2004; Adger, 1996). Therefore, vulnerability cannot adequately be characterised without simultaneously considering its major components, including exposure, susceptibility and capacity of response in a dynamic process (Birkmann, 2006; Cardona, 2004). Accordingly, understanding the vulnerability of varying socio-economic groups at risk before, during and after a particular disaster are critical activities for developing an appropriate disaster risk reduction strategy (Birkmann, 2006) and hazard-based livelihood enhancement (e.g., flood-related livelihoods).

Following this notion, a vulnerability assessment to floods in the context of the VMD implies that the susceptibility and capacity of response of exposed elements or groups of people should be examined within the transforming structure and process that exist. The building of coping and adaptation strategies for each socio-economic group may be shaped through their interpretation of the flood context, the transforming processes and structures, and their ability to create or access livelihood resources. Since flood vulnerability partly depends on their flood-based livelihoods, flood adaptation strategies are constructed and enforced through their own livelihood resources. Consequently, an assessment of people's vulnerability to floods is related to clarifying their level of access to livelihood assets for their flood response strategies. The significantly different flood damage outcomes experienced by various socio-economic groups in the rural floodplains indicates that many unidentified factors shaping human flood vulnerability need to be explored. A lack of studies into the vulnerability of different socio-economic groups regarding the impacts of slow-onset floods may influence the effects of physical interventions in order to mitigate flood damage in the delta. Thus, the emerging questions are how people in flood-prone areas are vulnerable to annual slow-onset

[3] The general poverty line is a minimal level of consumption including both food and non-food goods and services.

floods, and which factors have influenced different socio-economic groups in accessing their livelihood resources for coping with and adapting to flood impacts.

Since vulnerability research requires an interdisciplinary approach, more emphasis has to be given to understand and address the interrelated dynamics of social structure, human agency and environments (McLaughlin and Dietz, 2007). In this context Birkmann (2006) underscores the fact that a vulnerability assessment needs to be based on a comprehensive and holistic approach and should take into account the dynamic nature of vulnerability and the underlying causal factors. Moreover, flood vulnerability is related to the biophysical dimension (e.g., rural floodplains), human agency and transforming structures and processes. Vulnerability assessment at the household level should therefore encompass both qualitative and quantitative approaches in order to interpret human agency and the livelihoods of varying socio-economic groups in the rural floodplains of the VMD.

Taking into account all these issues, the main aim of this study is to understand how to analyse factors that characterise vulnerability and that explain people's losses and problems due to slow-onset floods in the rural floodplains of the VMD. The secondary aim is to develop criteria and indicators to assess vulnerability based on this analysis. The objective is to enhance knowledge regarding the dynamics of vulnerability and response capacities of people facing floods in rural areas in the upper VMD. To provide a comprehensive understanding of these issues, the study tries to highlight both negative and positive impacts of the transforming processes and structures on flood vulnerability.

The thesis consists of nice chapters. The introduction chapter explains the flood vulnerability of different socio-economic groups in the VMD. The second chapter examines theoretical and conceptual approaches to flood vulnerability and the research framework. The third chapter presents the general background of the VMD and Dong Thap Province that contributes to flood vulnerability as well as the capacity of response to floods. The fourth chapter presents the research objectives and questions and the methodology used. The fifth chapter analyses flood exposure and past flood damage and fatalities. The sixth chapter focuses on people's reactions to floods and access to livelihood resources for flood responses. The seventh chapter develops and describes the indicators and criteria to aggregate flood vulnerability at the household level. The eighth chapter discusses people's coping and adaptation processes regarding transforming processes and structures. The final chapter provides a general discussion, a theoretical reflection regarding vulnerability assessment, the major research findings, policy relevance and outlook.

2. Theoretical Background and Conceptual Approaches

2.1. Introduction

Theoretical debate is considered a key stage in the process of identifying research gaps or new scientific contributions. According to Frankfort-Nachmias and Nachmias (2004), knowledge is obtained from the achievement of experience; however, many events cannot be directly experienced or observed. These events are explained through employing concepts, theories and scientific terms, which are themselves open to change (Frankfort-Nachmias and Nachmias, 2004). In this study, a theoretical review provides the structure to explore the research problems, particularly the field research activities related to rural floodplains. A conceptual analytical framework is used to explore interactions among research components. With regard to this study, relevant analytical frameworks and theories were analysed according to their value and drawbacks in relation to the research aims and objectives. This provides the basis for building an analytical framework relevant to interpreting the main factors shaping the flood vulnerability of different socio-economic groups in the VMD.

Vulnerability research is varied and relies on the core concepts of disaster risks (Wisner et al., 2004; Wisner, 2004) and analyses of livelihoods (Chambers and Conway, 1992), food security (Sen, 1981; Watts and Bohle, 1993), and adaptation (Kelly and Adger, 2000). However, the core concepts of exposure, susceptibility and capacity of response are emphasised in the vulnerability assessment (Birkmann, 2006; Gallopin, 2006). It incorporates concepts regarding interactions between social and ecological conditions and the ability of individuals, households and communities to respond to hazards.

2.2. Disaster Risk Research

Issues related to disasters, risk and climate change have gained increasing attention over the last few decades. The concept of risk is discussed in relation to other concepts, such as hazard, disaster and vulnerability (see Birkmann, 2006). Various risk definitions have been formulated by different disciplines, creating a continuous debate about their meanings and relation to each other. However, similar terms sometimes have different meanings; this has impeded efficient and effective risk reduction (Cardona, 2004). Complexity, which is created by natural systems and social systems, and the additional contribution of interaction between natural and social systems creates challenges for single discipline analyses (Berkes et al., 2003). In this study, disasters therefore will be approached from an interdisciplinary perspective considering the interplay between natural and socio-economic transformation.

Hazards have increasingly occurred due to variations in climate change and socio-economic activities. Primarily, hazard studies were implemented by natural hazard scientists. A natural hazard is commonly understood as the threat of a naturally occurring phenomenon related to any atmospheric or earth or water-based occurrence that may have negative impacts on the natural and socio-economic conditions. Natural hazard losses are shaped by both the frequency and severity of these hazards. Following this notion, exploring characteristics of hazards is more focused rather than understanding major socio-economic features of elements exposed to these hazards. Hazard risk scientists usually use the term "risk" to characterise potential losses or damage to the economy or human lives due to a hazard event. In the natural side of risk, risk means the probability and severity of natural hazards and can be formulated by the following formula: risk=f (probability and severity of a hazard). A hazard may be created either by nature or through human activities; human-induced hazards which are socially constructed are becoming common. In some cases, human interventions aiming to mitigate natural hazard impacts become human-induced hazards causing different effects on socio-economic groups (Birkmann, 2011). Therefore, researchers pay more attention to human-induced hazards in the context of socio-economic transformation because of its negative consequences. For such an approach, a hazard is defined as a potentially damaging physical event, phenomenon and/or human activity which may cause loss of life, injury, damage to physical assets, socio-economic disruption or environmental degradation (UN-ISDR, 2004).

Currently, there are more studies addressing the social side of risk that significantly influence losses or effects on elements or groups of people exposed to hazard impacts. For example, an extreme event, such as a hazard impact, cannot cause a disaster in a place in which no human lives. Thus Cannon (1994) argues that hazards are natural while disasters are shaped by social processes that influence some people more prone to disasters than others. A disaster occurs when losses due to hazards exceed local people's capacity and resources to support them to respond to or resist the hazards (Cardona, 2004). Following this, a disaster is considered a specific outcome of the interaction between physical events and vulnerable social conditions, and includes significant negative consequences that cannot be managed by a community's own resources (IPCC, 2011). Disaster-related damage, therefore, differs among socio-economic groups given their varying vulnerability to extreme events. For example, in the VMD, floods are considered disasters since flooding depths exceeding 4.5 metres at Tan Chau, located in the upper delta, usually cause severe negative effects on people and property. In this circumstance, when flooding occurs, a large area and many houses become inundated

with floodwater, and many local residents, especially children in poor households in the floodplains, are exposed to floods. Severe negative consequences due to flood impacts exceed human capacity to deal with them; hence, the local government implemented evacuation and relief in the most flood-prone areas.

Disaster risk impacts are related to both the characteristics of hazards themselves and the main features or capacity of response of elements or groups exposed to these hazards. Therefore, human agency, defined as the capacity for human beings to make choices and to implement those choices on the world, plays an important role in mitigating hazard risks. Disaster risk research has identified the social side of risk, particularly vulnerability considerations. In this perspective, risk is associated with the expectation and degree of a hazard occurrence and potential losses that are influenced by the vulnerability of elements or groups of people exposed. It means that risk will be higher if elements or groups of people are more vulnerable to the hazard. The risk concept emphasises both determinants of risk: natural or physical events and the vulnerability of societies and communities. Therefore, the risk concept used in disaster risk research underscores the social construction of risk and, as mentioned previously, could be expressed by the following formula: risk=f (hazard and vulnerability). Risk can therefore be defined as the probability of the amount of damage and expected loss to exposed elements or systems, resulting from the interaction between hazards and the vulnerability of the society or elements exposed (Birkmann and Teichman, 2010; Cardona, 2004; UN-ISDR, 2004).

In many cases, it is difficult to diminish hazards; therefore, a decrease in hazard-related risks is associated with reducing vulnerability or enhancing the capacity of response of a household or a system exposed to those hazards. Therefore, assessing vulnerability is expected to contribute to the enhancement of risk reduction strategies, the reduction of susceptibility and also the development of social and climate change adaptation for exposed socio-economic groups. Generally, hazard risk reduction is implemented when major factors influencing vulnerability regarding different socio-economic groups to a certain hazard are identified. Thus, hazard risks are related to the livelihoods of certain groups. Therefore, livelihood research should be taken into account when assessing the vulnerability of target groups regarding access to resources for their response strategies (see Chambers and Conway, 1992). Regarding livelihood research, a hazard is considered to be an external risk factor of an exposed element (Cardona, 2004) that may cause disruptions in human livelihoods. People's livelihood assets and experience with hazards determine the impacts of the hazards on their lives.

Nowadays, disaster risk reduction approaches have shifted from relief to an adaptation and mitigation process; therefore, vulnerability play a critical role in disaster risk reduction (Thywissen, 2005). In the VMD, flood hazard events are annual yet are changing due to both climate change and human interventions. In the context of the slow-onset floods, flood risks may be explored through the interactions between the probability and magnitude of extreme flood events and the flood-related vulnerability of different socio-economic groups. Regarding the above discussion, the vulnerability concept can be utilised in order to outline major determinants shaping socio-economic groups who are vulnerable to flood impacts.

2.3. Vulnerability Research

2.3.1. Vulnerability

Vulnerability most commonly includes exposure, susceptibility and capacity of response (Birkmann, 2006). It is viewed from various perspectives such as bio-physics, human ecology, political economy, and constructivist and political ecology (see McLaughlin and Dietz, 2007; Miller et al., 2010). Vulnerability research normally emphasises how certain elements or groups of people are exposed to hazards, to what degree they are affected by the hazards, and how they can cope with and recover from the hazardous impacts.

Vulnerability concepts played a significant role in research related to food insecurity, famine and natural hazards (see Watts and Bohle, 1993; Blaikie et al., 1994; Adger and Kelly, 2001). Researchers have explored how different socio-economic groups are vulnerable to certain hazards. This concept was originally used in the study of natural hazards and poverty (Chambers and Conway, 1992) and has been used regarding environmental change since the 1990s (Janssen and Ostrom, 2006). Some scientists distinguish between social and biophysical vulnerability. The former deals with human susceptibility and the conditions necessary for people's livelihoods and responses, and the latter focuses on the extent to which a system or community is vulnerable to adverse effects and to what extent it could respond to any impact. According to Cutter et al. (2003), social vulnerability is partially the result of social inequalities, including individual income, age, gender and characteristics of communities which influence susceptibility of various groups to damage and govern their ability to respond to stresses or shocks. Social vulnerability consists of various aspects which are shaped by multiple stresses and differential exposure; it is rooted in varying human characteristics and social networks (Downing et al., 2005). Therefore, current studies attempt to relate to both physical exposure and the characteristics of human community in order to

explore capacity of response regarding the varying levels of exposure (Adger, 2000a; Burton et al., 2002).

Research on coupled human-environmental or social-ecological systems has also addressed vulnerability. Turner et al. (2003), for example, describe it as a function of exposure, sensitivity and resilience. However, many scholars pledge that vulnerability and resilience are two different concepts arising from different schools of thought. The concept of vulnerability originally came from sociological and development research and has been influenced by constructivist approaches. A vulnerability study is also influenced by theories of hazard research in the biophysical sciences, political economy, human ecology, political ecology and constructivism (McLaughlin and Dietz, 2007). The concept of resilience, in contrast, arose from ecological theories shaped by the positivist tradition and aims to understand the responses of systems or actors to changes or stresses as well as shocks (Miller et al., 2010). Recently, contributions to vulnerability and resilience research have intersected, and integrated research perspectives as well as the convergence between vulnerability and resilience are emerging (Turner et al., 2003).

A system or an actor normally responds to diverse external impacts; however, clarification is required of the correct response strategy to specific or compound hazards and to the factors that shape them, since the vulnerability assessment is usually based on a single hazard (e.g., typhoons, floods, droughts or salinity intrusion). In this study, vulnerability is defined as the conditions and processes determined by physical, social, economic and environmental factors which influence the susceptibility of a household to adverse hazards, particularly slow-onset floods, or reduce their capacity to cope with and adapt to these (Birkmann et al., 2009; Birkmann, 2006; UN-ISDR, 2004). Thus, for the purposes of this research, vulnerability is seen as a condition that is influenced by dynamic historical processes, entitlement patterns and economic and power relationships, rather than as a direct consequence of shocks or stresses (Blaikie et al., 1994; Downing et al., 2005). In the rural floodplains, vulnerability should be viewed as a dynamic process since major elements or groups of people have undergone major changes in the social and ecological systems.

Exposure

In the context of natural hazards, vulnerability often emphasises certain regions or groups of people, linked with specific geographical locations related to certain hazards. The most common elements are threats, a place or a sector, a socio-economic group and outcomes of vulnerability (e.g., loss of livelihood) (Downing et al., 2005). In the context of slow-onset

hazards (e.g., floods in the VMD), vulnerability research regarding livelihoods of different socio-economic groups is emerging since local residents respond to slow-onset floods (natural hazards) and gain their livelihoods. In this understanding way, exposure to hazards is strongly emphasised. Exposure to hazards is defined as the degree to which a group of people or an ecosystem comes into contact with specific stresses or hazards (Hewitt, 1995). Exposure to a hazard also relates to certain geographical locations. For example, the upper VMD is exposed to slow-onset floods while the lower one, the coastal area, is exposed to sea level rises and salinity intrusion. In comparison, the rural floodplains are more exposed to flood impacts. However, even assuming similar levels of exposure, the flood vulnerability of socio-economic groups or elements will be different since they are shaped by the conditions unique to their area, as well as their capacity to respond to flood risks.

Susceptibility

The most common way that vulnerability is understood focuses on the major features of social communities and the conditions that increase the degree to which they are affected by nature-related, social, political and economic impacts (Watts and Bohle, 1993; Blaikie et al., 1994; Kelly and Adger, 2000). Nowadays, the concept of vulnerability refers mainly to constraining conditions in which exposed elements are imbedded (see Cardona, 2004). In this way, characteristics of groups of people or elements exposed to hazards and socio-economic conditions are also some of the major factors shaping the susceptibility of an exposed system. That means the vulnerability of a community or a household is not only determined by its physical exposure to a hazard or stressor, but is also heavily influenced by internal and external social-ecological characteristics that shape their susceptibility. This means, for example, that people living in poor housing conditions who are confronted by a constraining institutional framework will be more affected by hazards than wealthier households with better housing conditions and access to social capital which can help them to overcome an adverse institutional environment.

Birkmann (2006) and other authors in the field of risk research define susceptibility as a predisposition or features that make elements, i.e. a household or groups of people at risk of suffering harm, experience negative consequences due to hazard impacts. The concept of susceptibility also indicates that a household or community exposed to a hazard will have a different degree of responsiveness to physical stimuli such as natural hazards. This is because the susceptibility of an individual, a household, a group or a coupled human-environmental system may be shaped by a multitude of social, political, economic and physical factors. In the rural Mekong floodplains, for example, the susceptibility of socio-economic groups may

be related to natural conditions (e.g., severe acid sulphate soils) and sources of income (e.g., flood-based income, remittance from low-skilled jobs) and may be heavily influenced by transforming structures and processes, such as agricultural reforms, agricultural intensification and embankment projects.

Capacity for coping and adaptation

Capacity of response has often been seen as "a system's ability to adjust to a disturbance, moderate potential damage, take advantage of opportunities, and cope with the consequences of a transformation that occurs" (Gallopin, 2006: 296). It encompasses those livelihood resources available within a household or a community to reduce the levels of risk of a disaster and can facilitate response measures applied before, during and after extreme events. Since it is difficult to diminish natural hazards, enhancing adaptive capacity is therefore considered a key strategy in reducing vulnerability to an extreme event. Capacity of response is associated with constructing and implementing coping and adaptation strategies. However, the differentiation between coping and adaptation is necessary to explore potential risk impacts and inherent limitations to a response and to intervene through risk governance.

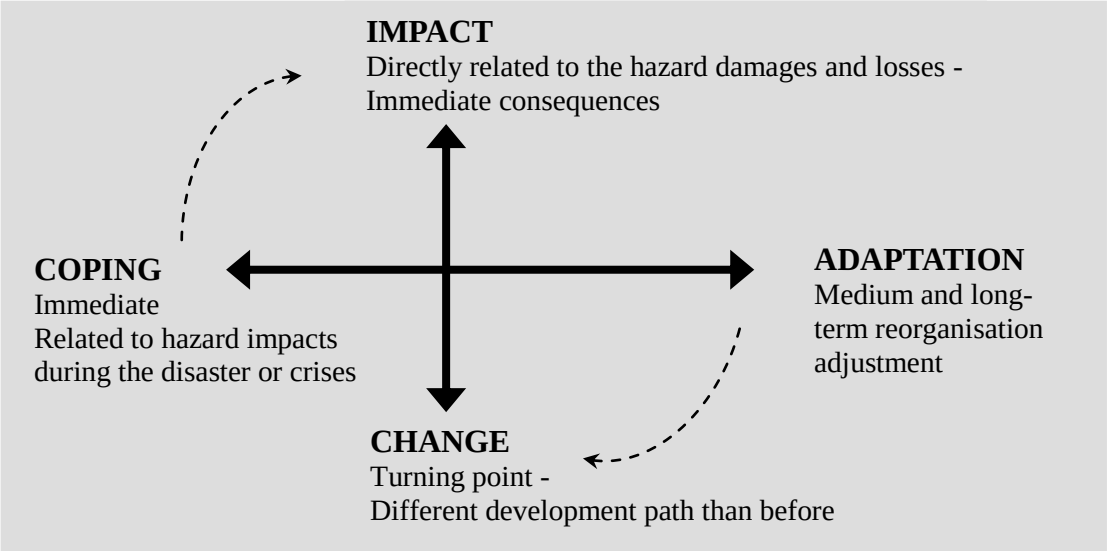


Figure 2: Coping and adaptation in relation to impact and change
(Source: Birkmann et al., 2009)

The difference between coping and adaptation is emphasised by various studies concerning timescale, types of stressor (a direct impact or a changing process) and purpose (survival or standard of living settings) (Birkmann et al., 2009). Coping is understood to be a direct immediate reaction to the impacts of an extreme event shortly before, during or after the hazard occurs in order to mitigate the hazard risks (Birkmann et al., 2009). Coping takes place in order to address short-term outcomes. Coping that can be implemented by various actors on different scales may be unplanned or planned activities. According to Cutter et al., (2008) the

total hazardous impact is a cumulative effect of the antecedent condition or precondition, hazard characteristics and coping responses. It means that coping can have an erosive effect that can harm people's lives. However, in the context of slow-onset and repeated hazards like annual floods in the VMD, coping is applied differently by various socio-economic groups regarding lessons learned and resources for response strategies.

In contrast to coping, adaptation refers to long-term strategies and is associated with local knowledge learned either before or after a hazard occurs (Birkmann et al., 2009). Coping and adaptation are correlated since adaptation can help households or societies to better cope with a hazard; in turn, a series of effective coping activities may constitute the process of adaptation to that hazard. For individuals or certain groups of people, adaptation to hazard impacts may increase the vulnerability of other groups of people (Barnett et al., 2008). In the rural floodplains of the VMD, for example, embankments, a formal type of adaptation, can enable the protection of rice production for landowners, but reduce flood-related benefits exploited by landless households.

Adaptation to natural hazards or climate change could be classified into three types, including anticipatory adaptation, autonomous adaptation and planned adaptation. Firstly, anticipatory adaptation occurs before hazard impacts happen or are observed, and is sometimes referred to as proactive adaptation (Klein et al., 2007). Secondly, autonomous adaptation is "triggered by ecological changes in natural systems and by market or welfare changes in human systems" (IPCC, 2007). It essentially responds to short-term climate variability and is the most common type of adaptation by local communities in developing countries (Ziervogel et al., 2008). Finally, planned adaptation is defined as "the result of a deliberate policy decision, based on an awareness that conditions have changed or are about to change and that action is required to return to, maintain, or achieve a desired state" (IPCC, 2007).

With regard to flooding, while coping is emphasised in connection with flash floods, adaptation is often associated with slow-onset flood risks. This is because its long duration makes it more possible for individuals and communities to develop and apply adaptive strategies. In the context of slow-onset floods in the VMD, livelihood strategies of flood-affected people are associated with income-earning activities before, during as well as after floods. Therefore, coping is in relation to the ability to survive and respond to the direct impacts during the flood events while adaptation is related to long-term alternatives that enhance livelihood security before and after floods. At the household level, improvements in capacity for flood adaptation are linked with access to key livelihood assets in the rural floodplains.

When discussing the coping and adaptation capacities of a system or a community to an extreme event, the resilience concept is usually mentioned. Resilience provides a household or a community with the capacity to absorb shocks or disturbances while maintaining the functions of a system. In social-ecological perspectives, resilience is associated with three features, including the magnitude of shock that a system can absorb and still remain within its given state; the degree to which the system is capable of self-organisation; and the degree to which the system can build capacity for learning and adaptation (Folke et al., 2002). According to Kasperson and Kasperson (2001), when social or ecological systems have low resilience, they become vulnerable to change that previously could be absorbed. This means that a change could create an opportunity for development and innovation in a resilient system and be devastating in a vulnerable one (Folke et al., 2002). Social resilience is the ability of a community to withstand external shocks such as environmental variability or social, economic and political changes (Adger, 2000b). It is determined by "the degree to which the social system possess the ability of organising itself to improve its capacity for experiencing and learning from the past disasters for better responses" (UN-ISDR, 2004).

In comparison, the adaptive capacity of society is influenced by the nature of its institutions and the natural systems on which it relies (Berkes et al., 2003). Therefore, vulnerability is partly affected by the livelihood security of an individual or groups of people (Berkes et al., 2003), which is in turn associated with the architecture of entitlement and access to resources (Sen, 1999). Enhancing the resilience of a household or a socio-ecological or human-environmental system can contribute to vulnerability mitigation or disaster risk reduction. In the context of slow-onset hazards like annual floods and the transforming structures and processes in the VMD, the importance of enhancing resilience of socio-ecological systems is seen as significant. Indeed, the interrelation between human activities (e.g., flood-related interventions and livelihood strategies) and environmental conditions (e.g., rural floodplains, flood-related resources and benefits) in the delta has provided several remarkable lessons with respect to flood-related policies and interventions and rural livelihood dependency reliant to vulnerable natural resources.

2.3.2. Bohle's Double Structure of Vulnerability

The concept of the double structure of vulnerability was introduced by Bohle (2001) in his work on vulnerability in the context of famine. He argues that vulnerability can be viewed both internally and externally. The internal dimension relates to the capacity to anticipate, cope with, resist and recover from hazard impacts. In contrast, the external dimension reflects the exposure to stressors and shocks (Bohle, 2001). In this framework, exposure is influenced

by entitlement theory, human-ecology perspectives and political economy approaches. In relation, coping is influenced by action theory approaches, models of access to assets and crisis conflict theory. According to Bohle (2001), vulnerability is related to assets, and the way individuals or groups of people manage and combine their livelihood assets in order to respond to hazards. Therefore, the more assets people control, the less vulnerability they have; this is because assets increase a person's capacity to cope with risks and disasters (Villagran, 2006). However, each livelihood asset either contributes to capacity of response or reduces vulnerability differently since it plays a specific role in people's livelihoods. In the floodplains, for example, since livelihoods are strongly shaped by floods and flood-related resources, the way in which exposure and coping both influence and influenced residents' livelihood strategy needs to be examined. In brief, Bohle's approach presents both internal and external dimensions of vulnerability; however, a limitation of this approach is that the coping dimension is not differentiated in terms of its short-term response (coping) and long-term reactions (adaptation).

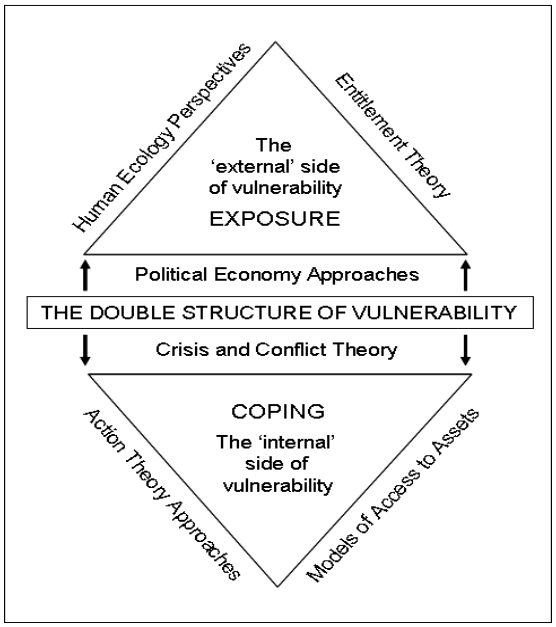


Figure 3: Bohle's conceptual model on double structure of vulnerability

2.3.3. BBC Conceptual Framework

The BBC Conceptual Framework, developed by Birkmann, Bogardi and Cardona (see Birkmann, 2006), emphasises the various vulnerabilities within social, economic and environmental spheres. It is characterised by the systematic cycle regarding varying elements at risks, and using this framework the three main pillars of sustainable development are integrated within the interaction process. It stresses the fact that vulnerability assessment goes further than solely estimating the deficiencies and assessing the impacts of previous disasters. It is, rather, necessary to view vulnerability as a dynamic process simultaneously focusing on exposure, susceptibility, coping capacity and potential risk governance to reduce vulnerability (Birkmann, 2006). This approach indicates that the natural environment interacts with socio-economic transformation as a human-environmental system; in certain research focuses, however, some target components, scales of elements and predominant relations within the human-environmental subsystem are selected and analysed.

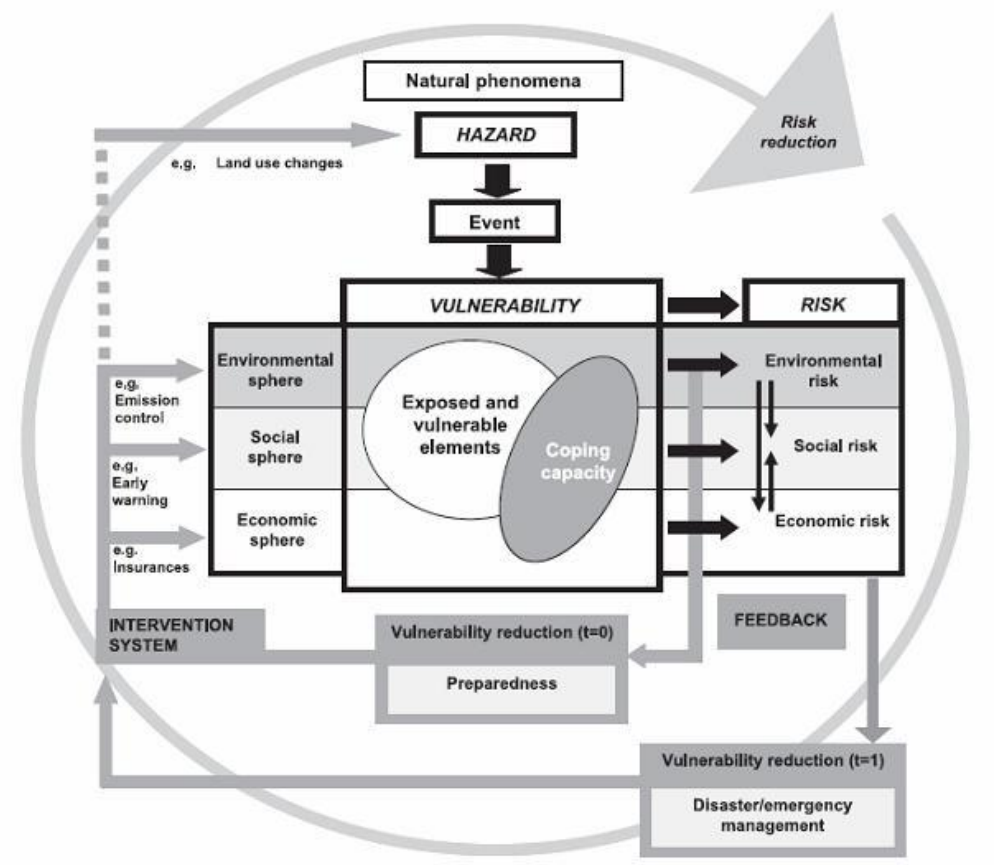


Figure 4: BBC Conceptual Framework
(BBC Framework is developed by Birkmann, Bogardi and Cardona) (Birkmann, 2006)

In the context of floods in the VMD, the BBC framework can be used to explore exposure, susceptibility and the coping and adaptation capacity of different socio-economic groups. It also emphasises intervention systems, particularly structural interventions, in term of flood damage mitigation that provides different impacts to local communities in the rural floodplains. However, the framework focuses on a broad range of socio-economic and environmental aspects which is too large to apply in specific studies. Moreover, the framework does not indicate the relationship between livelihoods and vulnerability regarding a certain hazard event and does not clarify detailed reasons shaping household vulnerability to hazards.

2.3.4. Coupled Social and Ecological Systems

A socio-ecological system (SES) or a human-environment system may be considered an interaction between people and nature. In a social-ecological system, people and nature interact and influence each other. According to the institutional perspective, both initial conditions and dynamic drivers and processes influence the interactions among major components of a socio-ecological subsystem, including resource users, natural resources, infrastructure providers and public infrastructure and institutions (Anderis et al., 2004).

Resilience that is essentially enhanced through the adaptation processes is an important component of the human-environmental system since it enforces the system to respond to a hazard; both exogenous and endogenous impacts (Turner et al., 2003).

The VMD floodplain is an example of a socio-ecological system where biophysical and cultural components are highly interactive. Major structural interventions (e.g., irrigation systems and embankment) have provided both incentives and constraints to different resource users who may have conflicts regarding the use of natural resources. Moreover, the SES is also shaped by dynamic drivers and processes, such as population pressure, modernisation, technological change and climate change, which have strongly affected the interactions within the SES in the Mekong floodplains. The SES, a reflexive system, can include either initiatives that resist or mitigate flood impacts or positive feedback loops that identify the flood risks. However, the question is how changes in flood regimes and flood-related interventions have influenced the duality between human society (e.g., residents' livelihoods) in the rural floodplains and environmental conditions (e.g., floods and flood-based resources).

In short, the concept of vulnerability is used by various perspectives and understood differently by certain disciplines. In recent years, there has been increasing convergence of theoretical perspectives on vulnerability (McLaughlin and Dietz, 2007). Following this discussion, a comprehensive theory of vulnerability must be understood in relation to the interrelated dynamics of social structure, human agency and environment (McLaughlin and Dietz, 2007). This requires us to assess the vulnerability of numbers of various socio-economic groups using an interdisciplinary approach.

2.3.5. Vulnerability Assessment

The vulnerability assessment aims to identify why certain systems or actors are vulnerable to individual or combined hazards. Vulnerability studies need robust and creditable measures that incorporate diverse methods and governance research (Janssen and Ostrom, 2006). Recently, vulnerability assessment has begun to emphasise specific groups or social units and to assess their risks relating to multiple and interacting social and environmental stresses (Hewitt, 1995). The vulnerability to a hazard is usually measured by aggregating selected indicators (Fekete, 2009; Cutter et al., 2003) since it is easily compared and visualised through vulnerability mapping or profiles within region or across countries. However, the weighting of indicators is different from spatial, temporal and human perceptions since vulnerability and capacity of response to a hazard are influenced by environmental, social, economic and institutional spheres (Birkmann, 2006). The major criteria for indicator

selection consist of validity, robustness, sensitivity, reproducibility, scope, availability, affordability, simplicity and relevance (Birkmann, 2006). However, the most important of these criteria are validity and robustness since several indices for assessing vulnerability are not representative and other shortcomings remain (Cutter, 2008). Currently, indicators influencing vulnerability as either direct or indirect are weighted by 1 or 0.5, respectively (Fekete, 2009; Cutter et al., 2003). Yet this seems not to meet varying perceptions of stakeholders in relation to flood-related livelihoods, management or research since each indicator contributes to flood vulnerability differently. Therefore, it is relevant since the weights of indicators range from 0 to 1 depending on their contributions to flood vulnerability. For the purpose of this study, the indicators are selected through various research tools, and their weightings are established through various stakeholders' perceptions. In short, the indicators that were selected should appropriately indicate the flood vulnerability of different socio-economic groups and could be used to aggregate flood vulnerability in the upper VMD floodplains.

In the context of a particular hazard, socio-economic groups are differently influenced by the transforming structures and processes present; however, the concern is how vulnerability is measured regarding livelihoods of socio-economic groups and the external impacts. Normally, children, women, the disabled and the elderly are the major groups vulnerable to hazards; however, what causes these groups to be vulnerable to floods needs to be addressed. Moreover, a population may be vulnerable to one hazard but it may not be vulnerable to others (Cardona, 2004). For instance, in the upper VMD, a stilt house seems to be adaptive to normal flooding but vulnerable to typhoons. Livelihoods and social systems are concurrently exposed to stress and are often unable to cope effectively with that stress (Adger and Kelly, 2001). In the context of slow-onset floods, a vulnerability assessment is needed in order to explore the exposure, the susceptibility and the capacity of response of different socio-economic groups.

2.4. Livelihood Research

2.4.1. Sustainable Livelihoods Approach

The sustainable livelihoods approach is considered to be one of the most formative elements in terms of the theoretical and practical discussion surrounding rural development. The approach, compiled by Chambers in 1989 and developed by the United Kingdom Department for International Development (DFID), has been used as a systematic way to understand livelihoods as well as to assess vulnerability targeting people, groups or communities. A

livelihood is defined as the capabilities, tangible and intangible assets, and activities required for a means of living (Chambers and Conway, 1992). A livelihood is sustainable when it can deal with stresses and shocks and maintain or enhance its capabilities and assets while not undermining the natural resources base (Chambers and Conway, 1992). The approach explores people's livelihoods and their surrounding environment from a holistic and dynamic perspective (Bohle, 2007). People experiencing vulnerability are at the centre of this approach and are the major actors in terms of identifying and selecting livelihood priorities. Therefore, the participation of internal and external actors is necessary to enhance the understanding of various stakeholders. This approach requires multiple-disciplines and levels and aims to addresses the phenomenon of poverty in a multifaceted way.

The livelihood approach provides important points to identify susceptibility and the capacity of different socio-economic groups to respond to hazards (Birkmann, 2006). Sen (1984) further emphasises the roles that endowment and entitlement play in providing opportunities for people to gain their livelihoods. Adger (1996) indicates that inequality in access to livelihood resources is considered a key component of individual vulnerability. Entitlement is used to understand people's ability to obtain livelihood resources for survival or to respond to stresses or shocks. Using Sen's analysis (Sen, 1981), each household has a series of entitlements made possible by endowments that determine the capability of household members to earn their livelihoods. Entitlement failures, resulting from an inability to access the necessary resources for survival, result in vulnerability since the entitlement of an individual or a household is disrupted, and they cannot access or substitute different types of livelihood assets for responding to shocks or stresses (Sen, 1981). Entitlements, therefore, play an important role in allowing individuals and households to access and manage their livelihood assets and to transform these assets into their hazard-based livelihood adaptation. The concern, however, is how the entitlement relating to access to livelihood resources has contributed to flood response strategies regarding different socio-economic groups.

Accessibility to livelihood assets plays a key role in building livelihood strategies in order to achieve desired livelihood outcomes. Accessibility is defined as the right to use and transfer a resource to others. It is formed by a wide variety of variables relating to natural and socio-economic situations. The vulnerability of a community or a group of people can be seen as a characteristic of social processes which constrain them and keep them from accessing resources required by the group to cope with hazard impacts (Blaikie et al., 1994). Therefore, access to key livelihood assets (e.g., agricultural land) or flood-related resources affecting household livelihood strategies as flood adaptation alternatives in the rural floodplains need to

be clarified in the context of the transforming processes and structures. Access to livelihood resources and the ability to create household livelihood strategies are influenced by various factors, of which entitlement is considered the major driving force.

Entitlements enable individuals to access their endowments, which are defined as the combination of tangible and intangible resources legally owned by an individual in order to respond to uncertainty. Entitlement is defined as all possible combinations of goods and services which individuals can legitimately or customarily command or obtain in a society by using the resources of their endowments (Sen, 1981). Entitlement failure, resulting from an inability to access the necessary resources for survival (Sen, 1981), means that residents are constrained in securing their livelihoods and adapting to natural hazards.

2.4.2. Sustainable Livelihoods Framework

The sustainable livelihoods framework enables researchers to explore major drivers as well as starting points of intervention to improve people's livelihoods. The key elements of the livelihood approach are the five forms of livelihood capital, comprising natural, physical, financial, human and social capital, the vulnerability context and the influence of the transforming structures and processes on livelihood strategies and outcomes (Chambers and Conway, 1992; Scoones, 1998). The framework outlines the availability of, access to and selected combination of livelihood resources, which are affected by the transforming structures and processes as well as the external vulnerability context. It indicates that each socio-economic group accesses and manages its livelihood resources differently since they build their own patterns of livelihood strategies (e.g., agricultural intensification, diversification and migration) in order to respond to stresses and shocks. The transforming structures and processes are viewed as driving forces of exposed elements or groups of people vulnerable to hazards (Birkmann, 2006; Wisner et al., 2004). Shocks and stresses caused by the transforming structures and processes are considered to be human-induced hazards, which affect residents' capacity to access and manage their livelihood assets as well as build their livelihood strategies. The framework builds a foundation for analysing people's livelihood strategies that attempt to achieve their desirable livelihood outcomes.

The understanding of vulnerability from the sustainable livelihoods approach is broad, and for the purposes of this study the framework needed several additional points in order to clearly explore the internal dimension of vulnerability. In the context of annual slow-onset floods in the VMD, the trade-offs between livelihood opportunities and flood risks may influence flood vulnerability at the household level. Annual slow-onset floods have caused damage, but

provided livelihood opportunities. For the latter reason, many poor households migrated and resettled in the rural floodplains in order to gain their livelihoods; however, at the same time they were severely exposed to flood impacts. In this context, the physical flood-related interventions (e.g., embankments, land use change and resettlement), and the transforming structures which are expected to tame flooding and flood exposure have influenced the coping adaptation processes and capacities of local people as well as their livelihood resource availability (e.g., flood-related natural resources). There is a lack of a debate on the susceptibility and coping and adaptation capacity of different socio-economic groups in the context of slow-onset floods and the transforming structures and processes. Rural livelihoods are associated with assets, structures, flood-related coping and adaptation strategies and outcomes since flood-affected households attempt to respond to flood impacts while earning their flood-based livelihoods.

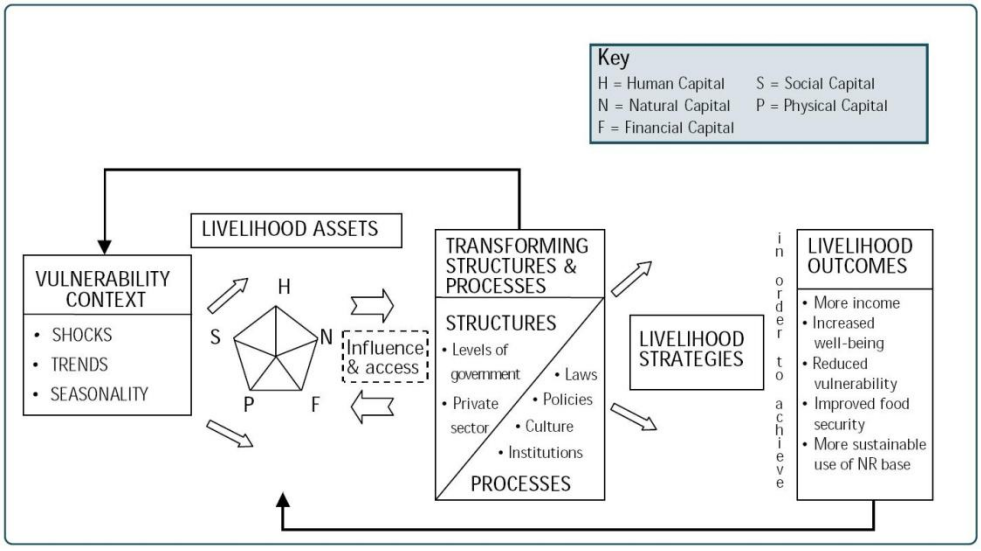


Figure 5: Sustainable Livelihoods Framework
(Source: Chambers and Conway, 1992)

2.5. Institutional Economics

The essential role of institutions is to reduce uncertainty by providing a stable structure for human interaction (North, 1990), therefore, an institutional approach can be employed to help explain how people respond to hazards while gaining their livelihoods. Institutions, defined as formal rules (e.g., laws, directives and contracts) and informal rules of conduct (e.g., norms, traditions, taboos and values, customs and practices, conventions) and the effectiveness of their enforcement, constrain or enable actors to cope with environmental changes (North, 1990). For example, formal rules may be coordinated through public systems, economic entities and educational organisations, but they may change suddenly (North, 1990). In contrast, informal rules that are reproduced by society are less likely to change since they are

constructed through the common knowledge and habitual development of society and are passed through one or several generations (Oskam and Feng, 2008). For the most part, habits that are formulated through human interaction are better able to cope with socio-economic and environmental changes; however, several habits (e.g., direct use in canal water), formulated through long-term human interactions, are not able to adjust in parallel to sudden environmental changes. In addition, the low frequency and high intensity of extreme events (e.g., high floods) may influence residents who are living in hazard-prone areas to be more subjective to these hazards. However, in several special cases, repeated hazards like slow-onset floods may also influence exposed people to be subjective to hazard risks.

2.5.1. Institutional Economic Approach

Institutions evolve over time (North, 1990; Young et al., 2008; Scott, 2008). New Institutional Economic Theory (NIE) provides an approach to analyse the interaction between institutions and production costs (North, 1993). Institutions influence human behaviour, which, in turn, affects economic outcomes (Brugere, 2006) since institutions may promote or hinder economic efficiency. Normally, changes in scarcity generate incentives to construct new effective institutions. Institutions may be constructed to benefit particular interests; therefore, conflicts can emerge among stakeholders whose behaviours are constrained or regularised. In addition, transaction costs, which are defined as search, negotiating and enhancement costs (North and Thomas, 1973), play a principle role in people's access to property rights which provide actors with a means for achieving their livelihood outcomes. Property right are defined as the rights individuals appropriate over their own labour, the goods they own and the services they can deliver (North, 1990).

2.5.2. Transaction Costs and Access to Major Natural Resources

Agency is socially and institutionally constructed, and it in turn alters the rules, relational ties and distribution of resources (Scott, 2008). Institutions also influence economic activities in terms of cost of exchange and production (North, 1990). In the VMD floodplains, the early in-migrants responded to annual floods by mainly relying on agriculture and the flood-based resources. Access to agricultural land was a major purpose of the early in-migrants; however, due to severe acid sulphate soil, agricultural land delivered benefits only through hard work. For this reason, high transaction and transformation (production) costs might cause in-migrants who expected to access agricultural land for their new livelihood opportunities to encounter both poverty and flood risks. Referring back to household's agricultural land access in the rural floodplains, significant costs for protecting and enforcing land use rights might be

shaped by the amount of expenses or losses regarding their early stages of resettlement or HYV conversion. Agricultural land was considered a major productive asset of rural households; therefore, the early in-migrants accepted to live in flood-prone areas in order to access agricultural land and other livelihood opportunities. As this resulted in accessing and protecting agricultural land use rights, in-migrants' livelihoods as well as their response strategies might have been initially enhanced by settling in flood-prone areas. It is also possible that these processes are shaped by many factors. A lack of access to financial resources for early resettlement and the HYV conversion were considered major reasons for such high transaction costs since in-migrants tried to access loans at very high interests for living and rice production. If farmers did not access the loan, they lost their potential assets, especially agricultural land. Constraints in response to flood impacts are clarified through how transaction costs, pertaining to accessing and protecting agricultural land use rights, were formulated, and how these costs affected the capacity of response of local residents to cope with and adapt to slow-onset floods.

2.5.3. Conflicts over Natural Resources

Livelihoods in developing countries usually depend on natural resources; therefore, natural resource competition is a major source of conflict regarding users' interests and used patterns. According to Brugere (2006), there are conflicts over natural resources because people compete for the same scarce resources in order to maximise their utility and satisfy individual interests and needs, and this cannot be simultaneously accomplished. One of the key concepts of New Institutional Economics is how an agent's decision affects others (Paavola and Adger, 2005). An agent's decision to physically modify or use a resource determines other agents' patterns of use; therefore, it may reduce other users' utility or demand and result in conflicts (Brugere, 2006). In the context of the rural floodplains in VMD, the conflicts between rice producers and flood-based resource users are emerging since structural interventions such as embankments are increasingly constructed as flood mitigation measures. The embankment project has influenced various socio-economic groups.

2.6. A Modified Analytical Framework

2.6.1. Conceptual Framework

In institutional perspectives, a conceptual framework is usually constructed from a set of meta-theoretic and methodological guidelines. Institutionalism, for example, does not look for a general theory of anything; however, it needs a coherent analytical framework (Hodgson, 1998). Conceptual frameworks that analyse vulnerability are developed from different points

of view. In recent years, vulnerability research has shifted from the double structure to systematic frameworks, which indicate interactions within a dynamic process and using feedback loops. These frameworks include, for example, the Sustainable Livelihoods Framework developed by Chambers in 1989, the Double Structure of Vulnerability developed by Bohle in 2001 and the BBC Conceptual Framework constructed by Cardona, Bogardi and Birkmann in 2006. Vulnerability assessment frameworks have continuously evolved to incorporate sustainable development situations. Thus, vulnerability assessment takes into account enlargements, revisions and integrations between natural and social sciences (Miller et al., 2010). This includes the capacity to treat coupled human-environment systems and their relationships within and outside of the systems that influence their vulnerability (Turner et al., 2003). The interaction between rural livelihoods and vulnerability highlights main causes enabling as well as constraining varying socio-economic groups to respond to hazard impacts.

2.6.2. A Modified Conceptual Framework

For this research project, a modified conceptual framework combining the BBC Conceptual Framework and the Sustainable Livelihoods Framework was employed. It is used to assess vulnerability as well as explain the major factors shaping the vulnerability of different socio-economic groups to flood impacts. Regarding the recurring annual slow-onset floods and groups of people exposed to them in the VMD, vulnerability should be assessed through the varying characteristics of socio-economic groups, their flood livelihood adaptation, and the negative impacts of floods and human-environmental conditions in which they are embedded. Historically, floods have been known not only as destructive hazards, but also as livelihood opportunities. It is apparent that many households are able to live in flood-prone areas given their coping strategies. This not only includes coping strategies to natural hazards, but also human-induced hazards that might be created by transforming structures and processes (e.g., the “Doi Moi” renovation policy, flood-related policies, embankments, land use change, resettlement). The impacts of hazards on people’s livelihoods vary among different groups depending on their capacity to access and manage their livelihood resources in order to build response strategies and the institutional setting. Additionally, the feedback processes explain major changes in people’s livelihoods and provide information that could be used for flood risk governance at different scales. This is why it is important to take a social-ecological perspective by integrating aspects of the Turner framework. Therefore, a modified analytical framework is applied to explore the systemic associations among vulnerability context, the transforming structures and processes, livelihood assets, coping and adaptation strategies and their livelihood outcomes. Furthermore, the relationships among these components indicate

the major factors influencing exposure, susceptibility and the coping and adaptation capacity of different socio-economic groups and can therefore provide a basis for an indicator-based vulnerability assessment.

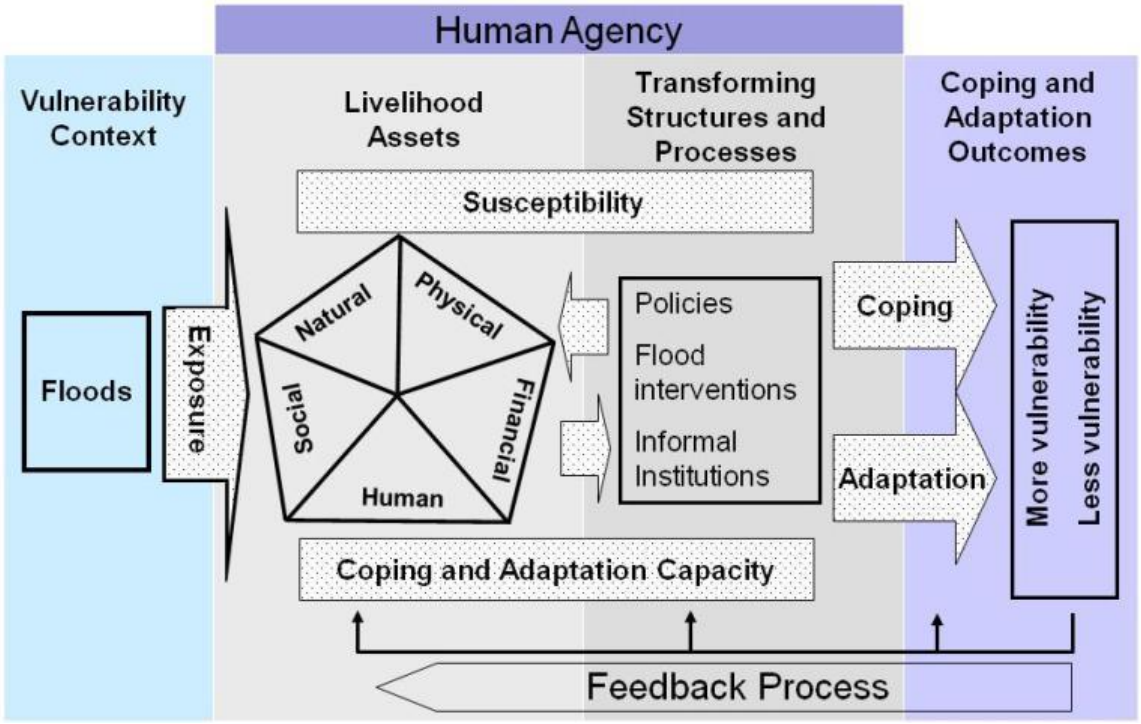


Figure 6: A modified analytical framework by the author based on the combination of the Sustainable Livelihoods and the BBC Conceptual Frameworks

The modified sustainable livelihoods framework that is employed for this thesis (see Figure 6) expresses the systematic relationships of the main components relating to the livelihood approach. Socio-economic groups have varying livelihood assets and are shaped by both flood impacts and the transforming processes such as "Doi Moi" policy and flood-related policies. The extent of access to the livelihood assets of socio-economic groups is influenced by the context of slow-onset floods and the efforts of the transforming processes and structures, and the coping and adaptation strategies they apply. This framework takes into account the vulnerability context (e.g., slow-onset flooding), livelihood resources, the transforming structures (e.g., land use change, embankment, relocation), livelihood strategies (e.g., migration) and livelihood outcomes. The causes leading to these changes can be described in terms of how socio-economic groups relate to exposure and susceptibility and their coping and adaptation capacity to floods.

Access to livelihood assets has been also influenced by transforming structures such as embankments and land use change, as well as forced resettlement. Entitlement enables local residents to combine intangible and tangible resources to help deal with floods and livelihood disruption. Equally however, in the rural Mekong floodplains the failure in entitlement to

livelihood resources or the substitution of different types of livelihood capital results in an individual or a household being vulnerable to floods. In this case, flood-affected residents may be unable to use their livelihoods; have constrained use of their livelihood assets; or switch to different livelihoods as a flood response strategy. This transformation affects the manner in which poor households access flood-related resources and use their assets and activities to respond to flood impacts. In the framework, the feedback loops reflected by the response outcomes of flood-affected households influence flood exposure and susceptibility with regard to access to assets and critical causes creating flood vulnerability. For instance, in the context of annually repeated slow-onset floods, coping and adaptation outcomes in the rural floodplains may provide a series of lessons for the flood-affected community. The outcomes are also associated with decision-making for flood-related interventions.

In an agriculture-based economy like the VMD, access to agricultural land plays a key role in obtaining livelihood outcomes. However, regarding natural condition constraints (e.g., severe acid sulphate soils) and undefined land use rights, transaction costs for protecting land use rights might lead in-migrants in the rural floodplains to be more exposed to livelihood insecurity and flood risks. Therefore, the relation between transaction costs and land property rights at the household level needs to be examined in order to understand how residents enhanced their flood response capacity. In addition, in the rural Mekong floodplains, different users use different natural resources, such as land and flood-related resources. These natural resources are located in the same areas, mainly paddy fields; therefore, the conflicts of resource use among local residents, natural resource users, should be explored since public interventions like embankments as well as irrigation systems have been constructed jointly and influence flood-based resources for rural livelihoods.

The residents in the rural flood-prone areas are at the framework's centre. The framework makes it possible to explore people's own resources and their agency to change their circumstances (Bohle, 2007). Agency, implying the capacity of human actors to influence their social world, changes the rules or distribution of resources, and agency, in turn, is socially and institutionally constructed (Scott, 2008). In the rural floodplains, local residents are not only exposed elements, but also creators to deal with floods, and therefore are intrinsically associated with the observed, analysed and interpreted situation of floods and the transforming structures and processes. Flood-affected residents try to construct strategies to cope with as well as adapt to high risky flood impacts. Agency has been much influenced by actors' interpretation, perceptions and evaluation (Troeger, 2002).

3. The Mekong Delta - Geographical and Thematic Context

3.1. Introduction

This chapter introduces the major physical, socio-economic and political situations that have shaped the flood vulnerability of various socio-economic groups in the VMD. Low topography, flat landscape, severe acidic sulphate soils and unexpected water availability (e.g., extreme low and high water levels) are considered essential natural conditions influencing rural livelihoods as well as flood vulnerability of community in the rural floodplains of the VMD. Also socio-economic transformations such as political reforms, embankments, land use change and forced relocation have influenced the livelihoods, capacities and coping and adaptation processes of local residents in the flood-prone area. Moreover, conflicts among natural resource users have affected rural livelihoods significantly. These issues will be examined in the following sections and will be analysed with regard to major research focuses in flood vulnerability. In addition, research gaps related to social vulnerability will be discussed.

3.2. Main Characteristics of the Vietnamese Mekong Delta

The VMD is an area with great potential for agriculture yet prone to natural hazards, particularly given the annual slow-onset floods in its upper regions (Miller, 2003; Sanh et al., 1998). It is also the granary of Vietnam, with approximately 4 million hectares of land. High-yielding rice varieties are the major food crop accounting for approximately 99 per cent of the planted grain crop area[4], while fruit trees, vegetables and aquaculture are also cultivated in its ecological zones. It contributes 80 per cent of the exported rice and 50 per cent of aquatic exports from Vietnam[5]. In the upper part of the delta, floods occur annually from late June through December, peaking in late September or mid-October. Flood levels vary from 4 metres in the upper region to 0.5 metres in the middle region, covering half the delta, which has 47 per cent of its natural areas, and contains almost half the population (De, 2006). This flooded area contributes 76 per cent of GDP, 75 per cent to its agro-fishery GDP, 79 per cent to its construction and industry GDP, and 80 per cent to the service GDP of the region. In short, the VMD, particularly the flood-prone area, plays an important role in both the domestic food security and agricultural exports of Vietnam.

[4] Calculated from the data of the General Statistical Office in 2008.
[5] Decision 173/2001/QD-TTg issued on 06/11/2001 by the Prime Minister on Socio-Economic Development in the VMD from 2001-2005.

The delta is an example of a natural resource-dependent society influenced by both human-induced and natural hazards. Its landscape is greatly affected by the fluctuation of water seasonally. The upper delta is subject to deep flooding while the coastal area is characterised by fresh water scarcity and salinity intrusion; therefore, human settlement in the delta is characterised by efforts to adapt to and benefit from these severe seasonal water variations (Miller, 2003). Regarding climate change, the VMD will be the worst hit area in terms of the percentage of population the affected, and the second most affected area in the world regarding the percentage of the land area inundated due to sea level rises (Dasgupta et al., 2007; Carew-Reid, 2007). Annual slow-onset floods provide many flood-related benefits (MRC, 2003), but high floods cause serious damage to crops, infrastructure and human life (CCFSC, 1991-2000). Human settlement in the rural delta, therefore, must both adapt to and seek to benefit from these seasonal water variations (Miller, 2003).

3.2.1. The Natural Condition in the Vietnamese Mekong Delta

3.2.1.1. Topography

The Mekong Delta was formed approximately 10,000 years ago through the 4,400 km long stream of the Mekong River, which originates from the Tibetan Plateau in China and passes through Burma, Laos, Thailand, Cambodia, and Vietnam to the East Sea (Sanh et al., 1998). The Mekong Delta stretches southward from Kratie in south-eastern Cambodia into southern Vietnam, accounting for about 5.9 million ha. It is characterised by alluvial flat and low-lying land with elevation ranging from about 0.5 to 4 metres above sea level, with small mountainous areas in the west-north parts of An Giang and Kien Giang Provinces. The flat landscape and low topography of the VMD have determined wide inundated areas during the wet season and influenced hydrological measures to control floods through zone-protected embankments instead of river-paralleled dyke systems. Regarding its flat and low-laying topography, the delta is also influenced by certain natural constraints. For instance, the Long Xuyen Quadrangle and the Plain of Reeds are the zones most affected by floods in the wet season, and the coastal zones are influenced by salinity instruction and water scarcity in the dry season. In the context of climate change, the VMD, particularly the coastal area, is severely exposed to sea level rises that are predicted to cause significant constraints to agriculture and human livelihoods. While extreme excess floodwater causes serious problems in the upper VMD, in the coastal areas, in contrast, small floods create adverse impacts through salinity intrusion. Regarding this sensitive point, any hydrological intervention in the upstream Mekong Basin as well as within the VMD itself could generate various impacts on water regimes that, in turn, will affect rural livelihoods.

3.2.1.2. Soil Condition

The VMD was formed with slow alluvium deposits through the various floods. It is classified in seven zones: the Plain of Reeds (0.5 million ha), Long Xuyen Quadrangle (0.4 million ha), Alluvial Area (0.9 million ha), Trans-Bassac Depression (0.6 million ha), Coastal Area (0.6 million ha), Ca Mau Peninsula (0.8 million ha) and Hills and Mountains (0.2 million ha). Each zone is typically characterised by soils and farming systems. The delta includes diverse soil conditions, accounting for 19 per cent of hilly and peat soils, 21 per cent of saline soils, 28 per cent of alluvial soils, and 41 per cent of potential or active acid sulphate soils (Sanh et al., 1998). Acid sulphate soils, accounting for half of the delta, are characterised by low pH and high aluminium, iron and sulphate concentrations that need to be leached out to improve soil quality and enhance crop yield (Minh et al., 1997). Among the seven agro-ecological zones specific to the VMD, the Plain of Reeds and Long Xuyen Quadrangle located in the upper delta occupy a large amount of acid sulphate soil area. Acid sulphate soils are unfavourable for diverse types of crop cultivation; therefore, in the initial reclamation and farming practices, farmers found and applied a series of indigenous ways to leach or wash away acidity (Minh et al., 1997; De, 2006).

The soil improvement processes are closely linked with canal excavation and settlement patterns in the VMD. In-migrants settled along newly excavated canals which were constructed for both agriculture and new settlements (see Biggs, 2010). In-migrants faced flood risks in order to produce their livelihoods in the rural floodplains. Therefore, local residents and physical household assets are exposed directly to flood impacts. The dense canal systems result in flooding coming from and releasing into main rivers quickly. Due to the severely acid sulphate soils mentioned previously, many farmers initially failed in the crop conversions from floating rice to HYV. In the context of severe acid sulphate soils, embankment, which is a major flood-mitigated measure in the Plain of Reeds and Long Xuyen Quadrangle, has created obstacles on leaching and washing acid sulphate soils as well as accumulating alluvial matters in the crop fields.

3.2.1.3. Climate Conditions

The VMD is located in a monsoon tropical semi-equatorial climate. It is characterised by a dry season lasting from December and April and a wet season extending from May to November. Precipitation varies geographically and seasonally, with a mean of 1,600 mm per year. In addition, approximately 92 per cent of the annual rainfall occurs during the rainy season (De, 2006) so that water scarcity typically occurs in the dry season. The duration of the

rainfall is spatially dependent, and the rainy season varies from four months in the north (the upper VMD) to seven months in the southwest (White, 2002). Water scarcity in the dry season is caused by very low precipitation in the delta as well as low water discharge from the upper Mekong River. This constrains SA rice crops and domestic water use, and influences salinity intrusion in coastal areas.

Seasonal climate conditions usually shape the patterns of farming systems and seasonal human responses to natural event cycles such as annual flooding, typhoons and rainy or dry seasons. The monsoons of East Asia have structured the adaptation of agriculture and social organisation in the Mekong Region (Lebel and Sinh, 2007). The widespread variability in precipitation and river regimes between the dry and wet seasons has shaped the manner in which communities use land, construct their houses and adjust their livelihood activities through the annual cycles (Lebel and Sinh, 2007). In this context, the concern is how socio-economic groups' livelihoods are influenced as well as how they cope with abnormal changes during the seasonal natural event cycles, particularly annual slow-onset flooding.

3.2.1.4. Hydrology

The hydrology in the VMD is shaped by the Mekong River and two tidal regimes, one in the East Sea (the semi-diurnal tide) and one in the Gulf of Thailand (the diurnal tide) (Sanh et al., 1998). The tide in the East Sea is a semi-diurnal regime with a large tidal range of about 3 to 3.5 metres. In the West Sea, the tide is a diurnal regime with lower tidal range of 0.8 to 1.2 metres. The Ca Mau Peninsula is strongly influenced by both tidal regimes, while the upper VMD is less affected by the tides. The average tidal levels reach their maximum in December and their minimum in July. For this reason, drainage can be limited if slow-onset floods coincide with the maximum tide periods. The VMD's landscape is also formulated by changes in water availability. Water is important in all the aspects of daily life in terms of navigation, communication, fishing, agriculture, aquaculture and domestic uses (Kakonen, 2008).

The upper delta is subject to deep flooding in the wet season while the coastal area is affected by water scarcity and salinity intrusion in the dry season (Miller, 2003). In the upper VMD, the duration of flooding has expanded from four to six months, but people also endure water scarcity in the dry season. This affects the SA rice crop and domestic water use that depend on shallow canals. A lack of water for the SA rice crop in the dry season seems to not to affect the exposure of this crop to floods; however, it does influence farmers' decision-making regarding the cultivation of AW rice for the next cropping season. People have had to learn how to respond to both too much and too little water (Lebel and Sinh, 2007; Kakonen, 2008)

as well as fresh and saline water regarding crop production and aquaculture. In the middle VMD (e.g., Can Tho City), flooding caused mainly by high tidal floods has influenced infrastructure, urban-based activities and fruit production. In short, the VMD is susceptible to unusual water availability since high flooding in the wet season, as well as water scarcity in the dry season, can strongly impact people's livelihoods.

3.2.1.5. Physical Geographical Features and their Interactions with Floods and People's Livelihoods

The upper VMD has affected natural hazards, vulnerability and livelihoods. Firstly, the flat and low-lying landscape means that a large area of the delta is susceptible to slow-onset floods; this means that complete control of annual slow-onset floods for the whole VMD is impossible (De, 2006). Therefore, embankments, which protect small-scale cultivated areas from floods, constrain floodwater to the sea. Secondly, acid sulphate soil conditions have constrained the ability of farmers to cultivate crops (De, 2006). These constraints are associated with various aspects such as crop cultivation, local farming knowledge, embankments and access to agricultural land. Thirdly, the trend of water scarcity has affected crop cultivation in the dry season. It has contributed to an increase in water pollution in the flood-prone area and caused salinity intrusion in the coastal regions. Finally, slow-onset floods, particularly high floods, have caused serious economic problems and human fatalities in the upper VMD.

3.2.2. Floods and Changes in Flood Regimes

3.2.2.1. The Context of Slow-Onset Floods in the Vietnamese Mekong Delta

Annual slow-onset floods in the Mekong River have existed for thousands of years. They occur from late July through December, peaking in late September or mid-October due to Cambodia's Great Lake (Tonle Sap) which functions as a large natural water retention pond. In the early part of the flooding season, water from the upstream area of the Mekong River is naturally restored in the Tonle Sap Lake due to its low topography, and afterwards floodwater is gradually released to the downstream basin. The VMD area that experiences slow-onset floods consists of eight upper provinces, including Long An, Dong Thap, Tien Giang, Vinh Long, Can Tho, Hau Giang, An Giang and Kien Giang, accounting for 53.3 per cent of the natural area and over 50 per cent of the population of the VMD (Xe and Dang, 2007). Floodwater mainly discharges from the Mekong and Bassac Rivers across the Cambodian floodplains. During high flooding, floodwater comes mainly from the Mekong and Bassac Rivers, accounting for 83 to 91 per cent of total discharge, and the rest of the floodwater

overflows across the rural floodplains from Cambodia to the Plain of Reeds and Long Xuyen Quadrangle. The flood discharges are about 40,000-43,000 m^3 s^{-1} and approximately 32,000-34,000 m^3 s^{-1} for high floods and normal floods, respectively. The river annually discharges approximately $5x10^{11}m^3$ of water into the VMD, accounting for 85 per cent of flooding during the rainy season and only 15 per cent in the dry season. The flood sediments are about 1.6 x 10^8 tonnes per year (Hoi, 2005). For these reasons, the VMD faces flooding during the wet season and water scarcity during the dry season; however, it has also provided alluvial sediments and fresh water for agriculture, aquaculture and flood-related resources for residents' livelihoods.

The inundation time and flooding depths differ in their spatial and temporal characteristics. The flooding levels geographically vary from 0.5 to 4 metres in the VMD. Flood depth increase or decrease per day is between 5-7 cm in normal floods and 10-20 cm in high floods (Hoi, 2005). Annual slow-onset floods are classified as high, normal or small floods in terms of flooding depths at certain gauging stations. For instances, in Tan Chau Gauging Station located in the upper VMD, the flooding depths below 4 metres, from 4 to 4.5 metres and over 4.5 metres are classified as small floods, normal floods and high floods, respectively. Normal flood is also called a nice flood since it provides various benefits for rural livelihoods. High floods are caused simultaneously by the combination of large upstream discharge due to tropical typhoons or low pressure systems, long and heavy rainfall in the delta itself and high tidal levels in the canals and rivers reducing their drainage capacity (Be et al., 2007). Looking at the short-term period, the high floods recorded from 1990-2002 seem to indicate an increase in frequency, with a big flood cycle every 1.9 years. However, high floods also occurred more densely from 1934 to 1948, with a high flood cycle of 1.4 years. At the end of the 2000s, there was no high flood event in the delta (Figure 8) which was predicted as the initial impacts of huge hydropower plants in the upper Mekong Basin. Moreover, in recent years, because of the impacts of hydropower dams, flooding is peaking later, which influences seasonal crop calendars. It may be seen then that, besides natural factors, the influence of climate change in flooding regimes has been shaped by human interventions in the upstream Mekong Basin as well as within the VMD.

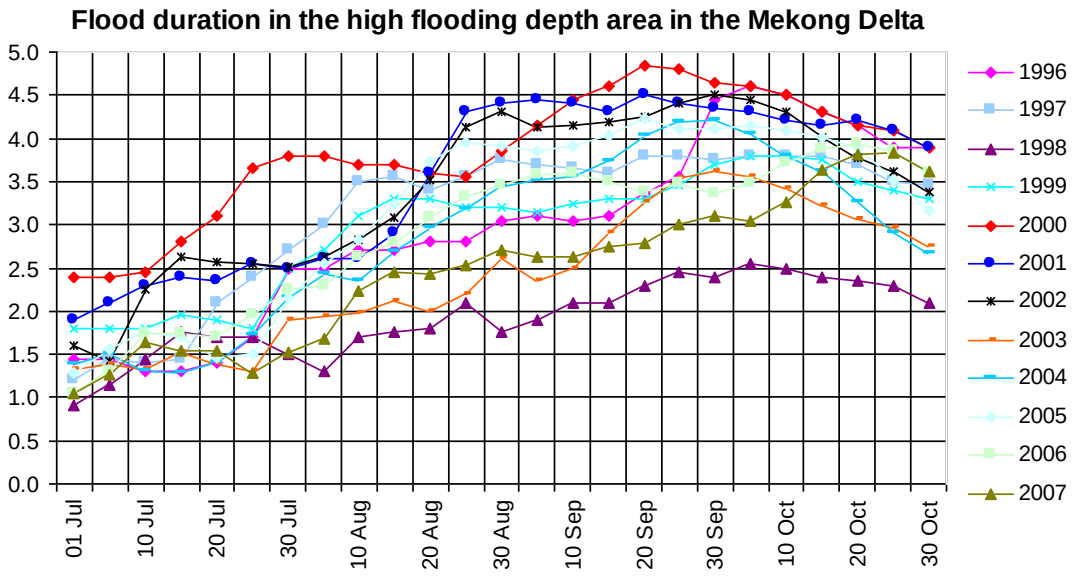


Figure 7: Flood duration in the high flooding depth area in the Mekong Delta
(Source: Author, based on data of Hong Ngu Hong Ngu Gauging Station, 1997-2007)

3.2.2.2. Changes in Flood Regimes in the Vietnamese Mekong Delta

Changes in flooding may be caused by both natural and man-made processes. In the upstream Mekong Basin, physical interventions, including the construction of dams and reservoirs for hydropower plants, irrigation, industrial and domestic use along the Mekong River and the drainage of waterways may cause changes in water discharge regimes and water quality (Dore et al., 2007; Weaderbee, 1997; Greancen and Palettu, 2007). These changes in water quantity and quality have shaped the decline in water-related resources (MRC, 2002), which have significantly influenced human livelihoods and socio-ecological systems in the Lower Mekong (Weaderbee, 1997; Lebel and Sinh, 2007). Large-scale water control structures have also affected the environmental sustainability and social equity (Kakonen, 2008). For example, while damming may initially reduce flooding in the downstream delta ,floods may increase above their present levels over the next 30 years due to sedimentation of the Mekong Estuary resulting from the dams.

This increase, along with occasional typhoon-driven storm surges, may contribute to an increase in flooding and human fatalities (Hoa et al., 2007). A close relationship between an increase in dam construction in the Upper Mekong Basin and the change in water discharge in the Lower Mekong Basin at the end of the 2000s indicates that flood regimes have been influenced by both climate change and human interventions. Moreover, in the VMD, land use change, sand extraction and flood-related reduction measures can increase river flow velocities causing riverbank erosion, particularly during the flooding season. The current

flood reduction measures may cause an increase in run-off flood peaks and prolong the duration of the flood recession (Hoa et al., 2007).

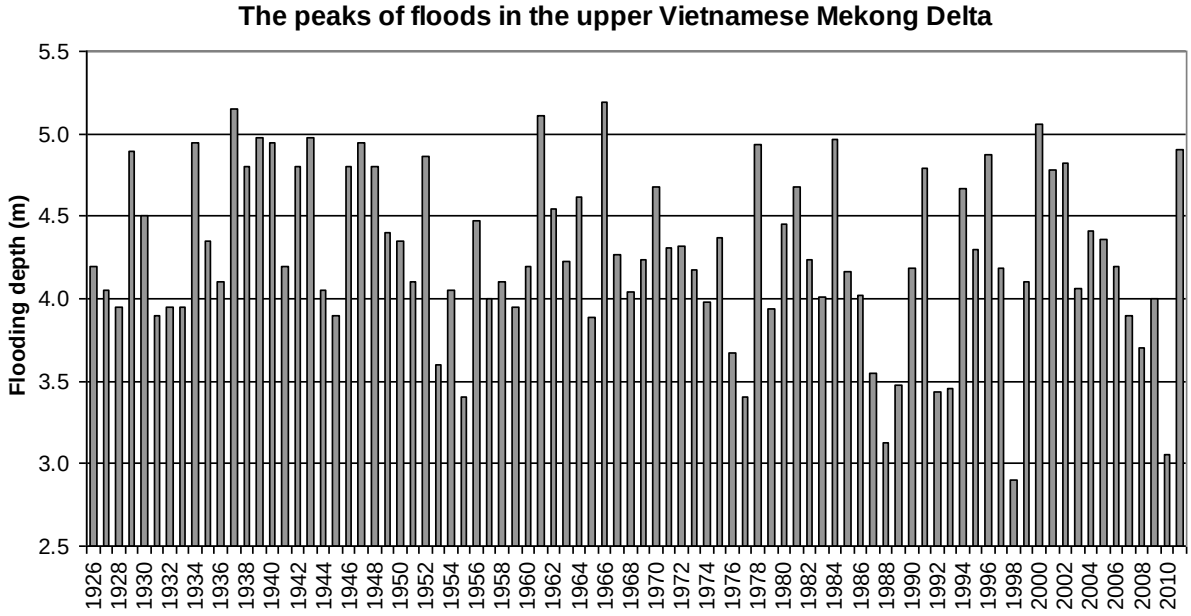


Figure 8: The peaks of floods in the upper Vietnamese Mekong Delta
(The flooding depths below 4 metres, from 4 to 4.5 metres and over 4.5 metres in Tan Chau Gauging Station are classified as low, normal and high floods, respectively)
(Source: Author, data from Tan Chau Gauging Tan Chau Gauging Station, 1926-2010)

Recently in the VMD, flood-related resources have declined at an alarming pace. According to Hoi (2005), the natural fish population decreased by 85 per cent in the full flood-control areas and 48 per cent in the semi flood-control areas which have influenced the livelihoods of communities relying on these resources. Regarding agricultural intensification, the VMD has been faced with fresh water scarcity for agriculture during the dry season. A lack of fresh water for the SA rice crop has already occurred in shallow canal systems in the Long Xuyen Quadrangle, the Plain of Reeds and the coastal areas. Furthermore, flood-related interventions, agricultural intensification and industrial and domestic water waste have gradually increased water pollution. Generally, people have struggled with not only flood hazards, but also changes in water regimes and decreasing water quality created by human-induced interventions. Besides the negative impacts, people's livelihoods have been protected by water-related benefits from the flood cycles since slow-onset floods have provided these additional livelihood opportunities to residents in the rural floodplains.

3.2.3. Socio-Economic and Political Transformation

Socio-economic transformation has influenced individuals, households and communities to access their livelihood resources (e.g., access to land) that are necessary to respond to uncertainty or hazard impacts. After reunification in 1975, Vietnam set up a governing system based on the Soviet model, facing a series of socio-economic and political crises described as

macroeconomic instability and stagnation as well as extreme market failure (Quang and Kammeier, 2002). Before "Doi Moi" in 1986, land, natural resources, productive facilities, materials and products were controlled by the state through a collective system and state-owned enterprises (Quang and Kammeier, 2002). In 1980, approximately 65.6 per cent of households were collectivised into collective production in about 126,000 cooperatives. However, the system of collectivisation created a food crisis in Vietnam because of the stagnation in agriculture that resulted in importing 1.6 million tons of food in 1980.

Because of the social and economic crises during the early 1980s, the 6th Party Congress of the Vietnam Communist Party adopted a reform policy "Doi Moi" in order to restructure Vietnam's legal, regulatory, administrative, investment and policies from the centrally-planned economy into a market-oriented economy with socialist characteristics (Bryant, 1998). The transition led to several essential reforms in the agricultural sector. Following Doi Moi, households were considered autonomous and independent economic units and they were given agricultural land and land use rights by the state (Quang and Kammeier, 2002). When the collective system was dismantled in 1988, and the land law was reformed in 1993 (and re-modified in 1998 and 2003), farm households gained the right to use their land over the long term and could transfer, exchange, lease, inherit or mortgage their land. The transition process resulted in a stable 3-4 per cent growth rate in agriculture, and Vietnam shifted from needing food imports to a relative food surplus.

Since 1999, Vietnam has become one of the largest rice-exporting countries in the world. Rural livelihoods have gradually improved and the poverty rate has declined: from 58 percent in 1993, to 24.1 per cent in 1996, to 14.7 per cent in 2007 and to 11.2 per cent in 2009. The VMD, the granary of the country, has been affected by the socio-economic and political reforms, particularly in the agricultural sector. Aquaculture and agricultural intensification processes have created huge challenges in terms of environmental degradation and expanding social disparities. The process has also influenced changes in land use patterns and the decline in flood-related resources, which in turn have affected rural livelihoods, particularly for poor residents in the rural Mekong floodplains.

"Doi Moi" has brought rapid changes towards both privatisation of business and decentralisation of the Vietnamese government (Quang and Kammeier, 2002). Vietnam continues to integrate into globalised political and socio-economic systems. It became a full member of the Association of Southeast Asian Nations (ASEAN) in 1995 and of the World Trade Organization (WTO) in 2007. This integration has created both opportunities and challenges for Vietnam. The boundary of the market for domestic commodities, particularly

agricultural products, is enlarged; however, competition is also more severe and the country faces external shocks from the global economy such as the current global economic crisis. The visible early impact of this process is that agriculture has intensified and been mechanised in order to deal with the competition and standardised requirements of the global market. Mechanisation in agriculture has contributed to a rapid decrease in off-farm wage activities that is considered the main income of poor households.

Table 1: Major reform events and interventions in Vietnam after unification in 1975

Timeline	Major events	Main content and results
1975	Reunification	End of the Vietnam War, establishment of Social Republic of Vietnam
1976-1980	Agricultural collectivisation	Most agricultural land was collectivised; input supplies and output distribution were managed by agricultural cooperatives
1975-1985	De-urbanisation	Resettlement of population in the New Economic Zones of the VMD (Zhang et al., 2006)
1981	Directive No. 100 CT "Contract System"	Farmers were given more autonomy in producing and distributing their products
1986	Renovation "Doi Moi"	Vietnam shifted from a centrally-planned economy into a market-oriented economy with "socialist characteristics"
1988	Resolution No. 10	Autonomy in production and business, stable land use rights, giving up top-down input supplies and state-based monopoly in food businesses
1993, 1998, 2003	Land law reforms	Farmers have the right to use their land over the long term and to transfer, exchange, lease, inherit or mortgage their land.
1995	ASEAN accession	Vietnam became a full member of the ASEAN
1997	Program 135 for poverty reduction	Program 135 was introduced in 1997 to assist in the building the basic infrastructure in 1,000 poor communes in the remote areas
1999	The 2nd largest rice-exporting nation	Vietnam has become one of the top rice-exporting countries in the world
2003	VBSP[6] established	The poor could access loans without land title certificates as collateral
2007	WTO accession	Vietnam became the WTO's 150th member

(Source: De, 2006; Swain et al., 2008; Zhang et al., 2006)

3.2.3.1. Population Pressure and Poverty

The population of the VMD increased quickly, accounting for 17.2 million in 2009, of which approximately 70 per cent derived their livelihoods from agriculture. The VMD became a densely populated area of the country with approximately 425 inhabitants per km^2 (GSO, 1990-2010). Almost all farmers in the VMD are smallholders, which constrains them from integrating into the global market. Agricultural land plays an important role for rural household income since rice is a major crop; however, the rate of landless households is approximately 39 per cent of the total rural households (Figure 2). These landless people rely mainly on off-farm income and fishing during flooding season. Their situation is likely to

[6] Vietnam Bank for the Poor was established in 1997, and renamed Vietnam Bank for Social Policies and separated from Vietnam Bank for Agriculture and Rural Development in 2003.

continue to be challenging given the decline in flood-related resources, severely seasonal off-farm wage activities and a lack of access to non-farm employment.

A decrease in rural income-earning activities "pushes" the rural-urban migration process; however, these migrants are also "pulled" to urban areas by economic and political transformation and the related increase in services and industrial jobs in urban areas. Labour migration can enhance rural households' financial capital through remittance, but it also reduces adults' labour power available to respond to hazards (e.g., annual floods). Moreover, most rural-urban migrants have been constrained in accessing non-farm employment because of their low human capital such as education, and professional training. Labourers in the VMD have lower educational levels compared to the rest of the country.

3.2.3.2. Migration Patterns and Access to Agricultural Land

Migration that is frequently described as a negative force in terms of its economic and social development refers to either forced (e.g., political and environmental relocations) or voluntary (e.g., economic and uninhabited resettlement) population movements (Zhang et al., 2006). Access to livelihood opportunities was considered one of the major reasons that caused poor people to settle in uninhabited areas or rural floodplains in the VMD. As noted previously, the VMD was formed about 10,000 years ago, but its major settlement only started within the last 300 years through the "southward march" of the Kinh people (majority Vietnamese ethnicity) from the Red River Delta in the Northern Vietnam to the VMD in the south (Sanh et al., 1998; Dien, 2001). The Vietnamese pioneers formally and informally settled in elevated areas or along rivers or natural canals that enabled them to gain benefits from natural resources and agricultural cultivation. In the floodplains, settlement patterns characterised by "residential clusters" at high elevations or "residential dykes" along canals was shaped by a "water-accessed culture" and linked with the history of canal excavation (see Biggs, 2010). Later, due to population growth and forced migration, people settled in uncultivated areas or rural floodplains, which gave them access to natural resources and allowed them to reclaim agricultural land but which also made them vulnerable to flooding.

Historically, human livelihoods in the VMD relied on natural resources, and local residents were the natural resource users. Within the last 200 years the delta has undergone rapid ecological and economic transformations thanks to engineering and human works, and its wild land has been converted into highly productive agricultural areas, particularly paddy fields (Brocheux, 2009). In the upper VMD, in the 1960s, formal resettlement organised by the government allocated land to the settlers together with specific regulations which

regulated that the allocated land was to be taken back by the government if the settlers left out the relocated communes. This means that farmers tried to live in the flood-prone areas in order to keep their relocated land. Another land allocation stage occurred in the Plain of Reeds in the 1980s when a large area of floating rice land was reallocated to farmers converting to HYV. According to government policy, farmers who received land under this scheme had to return their reallocated land if they could not continue to grow HYV because of rice production failures The failures were affected by several factors such as poor irrigation systems, new production technologies and a lack of financial resources. Therefore, farmers tried to cultivate HYV in order to protect their allocated land, although this rice usually provided losses or low returns within the first five years of the conversion. Consequently, many farmers lost their allocated land when they failed to continue cultivating HYV because they lacked financial resources. The question is how the initial settlers constructed their response strategies to deal with both flood impacts as well as the failures of HYV production in order to protect their allocated land in the new resettled areas in the rural floodplains.

Table 2: Major events affecting resettlement and land ownership in the Mekong Delta

Timeline	Major events	Main content and results
10,000 years	Formulation of the VMD	The delta was covered by forest
300 BCE - 550 CE	Funan or Oc Eo civilisation	People located in high elevated places (Ba The mountain) and Plain of Reeds
1705-1858	The early stage of the exploitation of the VMD under Nguyen dynasty	Three main canals, including Thoai Ha (1817), Bao Dinh (1818), and Vinh Te (1824), were excavated; reclamation and floating rice cultivation was developed
1858-1954	French colonial regimes	Many canals were excavated for rice cultivation and people's settlement; agricultural land was controlled by landlords
1954-1958	Big migration from the North[7] under the temporary separation at the 17th parallel	The migrants, mostly Catholic from Thai Binh and Nam Dinh, settled along new canals and communes
1957-1963	Land Reclamation Policy[8]	Land Reclamation Policy issued by the former government enforced migration to rural floodplains
1954-1975	Years of war	Canals were continuously excavated for leaching acid sulphate soil, but large parts of rural areas were not cultivated due to the Vietnam war
1966	High-Yielding Rice Varieties (HYV) introduced by IRRI	HYV (IR5, IR8) was cultivated; floating rice area gradually replaced by HYV
1970	Land reforms "Land to Tiller Act"	The reforms liquidated old landlord titles to "abandoned land" and redistributed it in small parcels to local tenant farmers

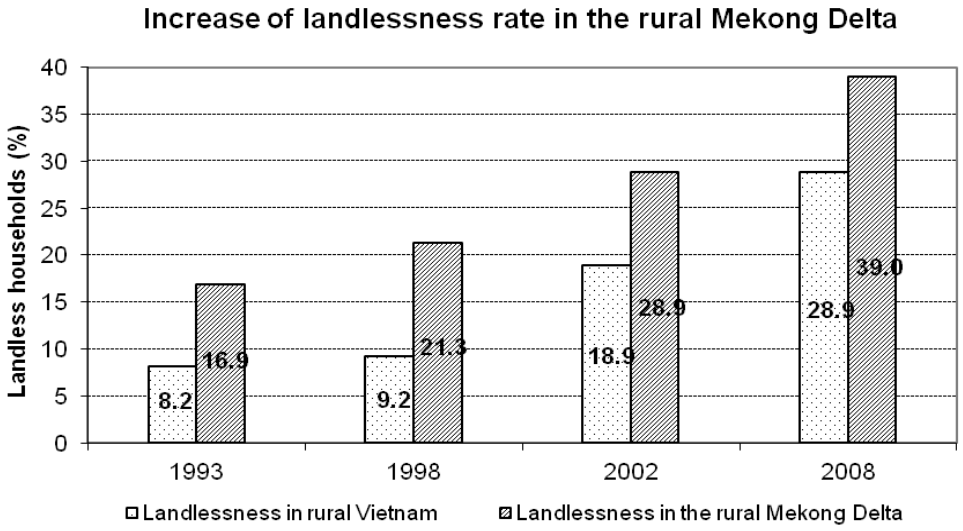
(Source: Sanh et al., 1998; Dien, 2001; Biggs, 2010; De, 2006; Zhang et al., 2006)

[7] According to Dien (2001), approximately 393,000 people migrated from the north to the south by 1958, of whom 23,000 people settled in the Plain of Reeds. Each household was subsidised temporary housing and reclaimed 3 hectares of agricultural land.

[8] Land Reclamation Policy (1957-1963) resettled approximately 289,700 and 11,600 people in the VMD and the Plain of Reeds, respectively (Dien, 2001).

3.2.3.3. Change in Agriculture

Agriculture in the upper VMD changed due to various factors such as the changes in varietal technology (e.g., HYV), agricultural policies (e.g., land allocation, the HYV conversion), irrigation system development and embankments, all of which have influenced flood-related coping and adaptation processes. Floating rice, one type of "adaptive" crops, which was grown since the early stage of settlement in the 1960s in the rural floodplains, was cultivated once per year and had one-third the yield of a crop of HYV. It was gradually replaced by HYV, which was introduced by the International Rice Research Institute in the 1960s. It was implemented in favourable areas of the delta, and its popularity grew towards the end of 1980s. Currently in the upper VMD, HYV has become the main crop in flood-prone areas and is also cultivated in the semi- and full flood-control areas. The conversion from floating rice to HYV caused significant changes to the exposure of rice crops in the rural floodplains regarding the ecological and economic aspects since cropping calendars, duration, HYV yield, farming technologies and investment for this type of rice were also changed (De, 2006). Although agricultural intensification has contributed to an increase in agricultural production, it has led local residents into landlessness because of agricultural intensification failures. The rate of landlessness in the rural VMD has rapidly increased over the two last decades (Figure 9). Furthermore, since flood-related resources have declined quickly, most inhabitants' livelihoods have shifted from flood-related resource exploitation to aquaculture intensification (e.g., snakehead fish and *Pangasius* production).



(Sources: Trang, 2011; VLSS, 1993; VLSS, 1998; VHLSS, 2002)

Figure 9: An increase in landlessness rate in the rural Mekong Delta

3.2.3.4. Vietnamese Governmental Transforming Structures at Flood Risk Reduction

In the rural VMD, after severe flood damage and human fatalities in the early 2000s, the Vietnamese government began to apply a series of measures, such as embankments and relocation, in order to mitigate flood risk. These measures are like to different impacts on various socio-economic groups in the rural floodplains. Firstly, the Vietnamese government mandated the building of residential clusters and dykes in order to relocate households severely exposed to floods and other hazard impacts. The construction of residential clusters and dykes and the relocation are divided into two phases between 2002 and 2013. So far approximately 1,000 residential clusters and dykes have been constructed in the VMD (Table 3). The relocation program aims to relocate around 210,000 households in the VDM; this will account for more than one million people who are severely prone to hazard impacts (e.g., floods and riverbank erosion). Besides subsidised housing foundations, the Vietnamese government has also provided more than 12,000 commercial housing foundations with the goal of mobilising businesses to invest in the new residential clusters and dykes.

The plan of the first phase of the residential place construction has faced various challenges (Xe and Dang, 2007) for several reasons relating to the provision of construction costs, the integration of related infrastructure (e.g., roads, sanitation, electricity supply, water supply, toilets) and the low capacity of infrastructure constructors. Moreover, although the end of the second phase has passed, several residential clusters and dykes planned for the first phase have not yet been completed. The second phase also progressed more slowly than planned, as the construction cost had to be adjusted due to the economic crisis at the end of 2010 (see Decision 1998/QD-TTg).

Table 3: The plan for the construction of residential clusters and dykes in the VMD and Dong Thap

Items	The first phase (2002-2007)		The second phase (2008-2013)	
	Mekong Delta	Dong Thap	Mekong Delta	Dong Thap
Number of residential places built	817	204	178	46
Construction cost (Mil. USD)	300	136	169	61
Number of relocated households	154,400	37,600	57,252	14,231

(Source: Decision 173/2001/QD-TTg of the Prime Minister, Decision 1171/QD-UBND.HC of Dong Thap People's Committee, Decision 1998/QD-TTg of the Prime Minister)

Secondly, embankments have been constructed in order to protect the SA rice affected by early floods as well as to develop AW rice during the flooding season. This was formally and informally implemented through the VMD but, these "demonstrated protected areas" were mainly built in low- or medium-flooding areas. In high-flooding areas, farmers also built these semi flood-control dykes to protect their SA rice crop from early floods. Dyke construction planning in the VMD was officially implemented in 1996 based on the Decision

No. 99/TTg of the Prime Minister (Table 1). The planning was to enhance the drainage capacity of main canal systems, to upgrade national roads to serve as full flood-control dykes, to build dyke systems to release floodwater towards the Gulf of Thailand, and to construct semi- and full flood-control areas to protect the SA and AW rice crops. Semi flood-control embankments are 1-2 metres in height and are inundated during high flooding, and full flood-control embankments are 4-5 metres in height and are not inundated because of their height.

3.3. Research into Rural Livelihoods and Water-Related Hazards in the VMD

Flood-related research varies in the VMD; however, vulnerability assessment pertaining to slow-onset floods is still in its infancy. Fatalities and significant flood damage have attracted many researchers to explore the exposure of local communities and elements in rural flood-prone areas. Several previous studies have identified the roles of Committee for Flood and Storm Controls (CFSC)[9] regarding flood damage mitigation activities (Be et al., 2004; Sanh et al., 2004). These studies indicate the major strengths and weaknesses of CFSCs in flood risk mitigation and management. Weaknesses include the fact that local CFSCs usually focus on coping activities, rather than adaptation strategies and that such studies usually identify the impacts of damage on rural people living on floodplains than the main factors making them vulnerable to floods.

Several recent studies have explored the relationship between livelihoods and poverty in the VMD. For example, Sanh (2003) indicated that social capital plays an important role in reducing rural poverty. He argued that social capital enabled the poor to enhance their livelihood strategies. However, his work did not explore the relations between rural livelihood improvement and flood vulnerability. Regarding the connection between financial capital and rural livelihoods, Swain et al. (2008) argued that financial capital contributes to reducing rural poverty through social capital improvement. Her research investigated how rural females coped with financial shocks regarding the interaction among the five forms of livelihood capital. The accumulation of livelihood assets through other livelihood assets is indicated in her findings. For example, human assets are enhanced by learning from the community and accumulated human assets significantly contribute to financial asset improvement. Accumulated financial assets, in turn, positively influence the enhancement of physical and human assets. In the context of slow-onset floods, however, predominant assets that are associated with flood situations and flood-related mitigation measures influence the

[9] The CFSC that was established based on the Decree No. 168-HDBT in 1990 approved by the Council of Ministers has served as a coordinating body for disaster reduction efforts at all levels (central, provincial, district and commune) in Vietnam.

accumulation of and interaction between livelihood assets of different socio-economic groups. However, the study did not focus on how these groups respond to annual slow-onset floods.

Concerning formal interventions in the rural floodplains, the livelihood opportunities of relocated households have been reduced given the lack of income-earning activities and an increase in other social problems such as gambling, drinking and living in very cramped conditions (Danh, 2007). This finding is correct during the initial phase of relocation and followed Scudder's four stages: (1) planning and resettlement recruitment, (2) transition, (3) potential economic and social development, and (4) handling over and incorporation (Scudder, 2005). These stressors are reduced due to formal interventions like basic infrastructure improvement and informal coping strategies (e.g., seasonal migration). His study tried to express the changes in the livelihoods of relocated households before and after relocation; however, his analysis did not take into account a rapid decline in flood-related resources in the rural floodplains.

4. Research Questions and Research Methodology

4.1. Research Questions

4.1.1. Introduction

Assessing different socio-economic groups' vulnerability to natural hazards is essential in order to understand how to reduce their vulnerability or enhance their resilience. Vulnerability assessment is associated with an interdisciplinary approach; therefore, a hybrid conceptual framework will be used to explore relations as well as explain its feedback loops (Miller et al., 2010). The VMD provides major natural, socio-economic and political characteristics that have both constrained and enabled residents' susceptibility and response capacity to annual slow-onset floods. Rural livelihoods are strongly related to flood vulnerability since any change in flood regimes has shaped rural livelihood strategies in the rural floodplains.

In the delta, studies by Danh and Mushtad (2011), Sanh et al. (2003; 2004), Be et al. (2004), Swain et al. (2008) have been integral in flood-related mitigation and livelihood improvement social capital in poverty reduction, and flood-related institutions in flood damage mitigation. These studies indicate a decline in relocated households' livelihoods (see Danh, 2007), an accumulation and substitution of livelihood assets to address financial shortage and poverty (see Swain et al., 2008), social capital improvement for poverty reduction in the rural floodplains (see Sanh, 2003) and coordination among members of CSFC (see Sanh et al., 2004; Be et al., 2004). However, a series of questions and research gaps need to be addressed concerning flood vulnerability of different socio-economic groups. These studies address certain issues regarding rural livelihoods and flood mitigation measures, but they do not apply a holistic approach that explores insights and systematic relations influencing flood vulnerability of rural communities.

Assessing detailed components of the flood vulnerability, including exposure, susceptibility and adaptive capacity, in the context of the socio-economic and political transformation allows major factors and processes affecting the livelihood and flood losses to be identified. Specifically, the effects of the reforms, embankments, intensive rice cropping and relocation in the context of flood vulnerability have not sufficiently been examined yet. Furthermore, while there are many indicators shaping vulnerability, in the context of slow-onset floods and socio-economic transformation, relevant indicators and their weighting could better indicate flood vulnerability at the household level. Assessing vulnerability based on locally selected

indicators is a promising way to identify major drivers shaping flood vulnerability as well as compare the overall flood vulnerability of different socio-economic groups.

4.1.2. Research Objectives

Against this background, the research objectives and research questions of this study try to understand the vulnerability of different socio-economic groups in relation to socio-economic transformation and flood risk-related interventions such as embankments, rice intensification and relocation, as well as rural livelihood transformation processes in the rural floodplains.

The overall objectives of this study are firstly, to identify and analyse the different factors that characterise vulnerability and that explain experienced losses and harm for people resulting from slow-onset floods, and secondly, to develop criteria and indicators to assess vulnerability. The study aims to enhance knowledge of the dynamics of vulnerability and response capacities of people facing floods in rural areas in the upper VMD.

The specific research objectives are:

1) To assess flood exposure, past flood damages, losses and harm for rural communities in the upper VMD;
2) To identify and analyse the reactions and capacities of people to deal with floods in relation to their access to livelihood resources;
3) To develop criteria and indicators for enhancing assessments of vulnerability and capacities of people to deal with floods and additional risks;
4) To understand how response strategies of people at risk, particularly in terms of coping and adaptation processes, are linked to the transforming structures and processes.

4.1.3. Research Questions

Based on the research objectives outlined above, the following research questions will guide the empirical work. These questions are subdivided into key questions and sub-questions.

Key research questions are:

1) Which trends in exposure to slow-onset floods and flood losses are apparent in selected rural communities in the VMD?
2) How do people react to slow-onset floods and their frequent exposure to flooding in relation to their access or limited access to resources?

3) Which criteria and indicators make it possible to assess different levels of capacities and the access to resources, as well as susceptibilities, with regard to the concept of vulnerability and risk to natural hazards?
4) How are the response strategies to floods – especially coping and adaptation processes – related to and influenced by transforming structures?

For each key question more precise and detailed questions are formulated. These specific research questions guide the empirical research of the study.

Which trends in exposure and flood losses, damages and harm for people are visible in selected rural communities in the Vietnamese Mekong Delta?

1) What are the key characteristics of flooding events (frequencies and intensity) in the selected rural communities in the VMD?
2) What were the major losses and damages faced by households in Dong Thap due to flooding?
3) What are the trends in flood losses and flood exposure?
4) How far have damage patterns changed in the last decade?
5) What are the major factors that influence people's exposure to floods, such as land use changes, migration and resettlement strategies?
6) How did migration processes affect people's livelihoods in the rural floodplains?
7) Given the risks, why do people still live in flood-prone areas?

How do people react to these floods and their frequent exposure to flooding in relation to their access or limited access to resources?

1) What kind of actions do people exposed to flooding perform in order to reduce flood risk?
2) What are the formal (governmental) and informal (individual) coping and adaptation processes to flood risk?
3) What are the key resources that help people withstand flood events?
4) How far do different socio-economic groups undertake different responses to floods based on their specific capacities and their access to resources?
5) What are the major factors that differentiate the ability of flood-exposed households to effectively respond to flooding?

Which criteria and indicators make it possible to assess different levels of capacities and the access to resources as well as susceptibilities with regard to the concept of vulnerability and risk to natural hazards?

1) How to operationalise the concept of vulnerability for flood-exposed households in rural areas of the VMD?
2) How to combine and apply different analytic frameworks effectively – such as the livelihood concept from the development research community and the BBC framework from the disaster risk research community – to ensure an integrative vulnerability assessment?
3) Which criteria and indicators at the household level can be identified that allow the assessment of vulnerability to high floods?
4) Which factors can be quantified and measured by using a semi-quantitative household survey?
5) How to validate and verify the selected criteria and indicators using statistical data for past losses and damages as well as in-depth interviews with people that have experienced floods?
6) How to weight and aggregate selected indicators using expert and local knowledge?
7) How to transfer the local vulnerability assessment developed for the specific characteristics of rural communities in the VMD to other communities prone to floods?

How are the response strategies to floods – particularly coping and adaptation processes – related to and influenced by transforming structures?

1) How do transforming structures regarding flood risk influence households' coping and adaptation processes to floods?
2) How do transformations at the individual household level influence coping and adaptation processes and capacity?
3) How to evaluate the positive and negative effects of major transforming structures on vulnerability, such as dyke constructions, flood control policies and large-scale resettlement projects?
4) How has human agency influenced the governmental transforming structures?

4.2. Research Methodology

4.2.1. Introduction

A research methodology is a system of explicit rules and procedures upon which a study is based and against which claims for research results or knowledge are evaluated (Frankfort-Nachmias and Nachmias, 2004). It provides rules for communication, logic and valid reasoning and inter-subjectivity to understand, explain and predict ourselves and our

environment in order to generally achieve research objectives (Frankfort-Nachmias and Nachmias, 2004).

Vulnerability is shaped by various factors. The study used triangulation. Gaps exist in many cases between empirical research and theoretical work on vulnerability assessment (Miller, 2003). Vulnerability to hazards is considered to be a process which interacts with socio-economic and cultural factors (UN-ISDR, 2004; Birkmann, 2006; Thywissen, 2005); therefore, it should be assessed through a mixture of qualitative and quantitative data. Both quantitative and qualitative methods can be applied in order to understand the context of the field research (e.g., the past flood losses and people's livelihoods in the rural floodplain) and to triangulate field research data (Grbich, 2009). This process increases data consistency and reliability. However, it is not easy to incorporate qualitative and quantitative methods since qualitative methods tend to be seen as an inductive and the quantitative method as deductive (Grbich, 2009). Quantitative methods, such as a standardised household survey, were used in order to remove bias from research results, while qualitative research allows for a deeper and more nuanced interpretation and description of processes. The quantitative evidence relating to the significant statistical correlation between appropriate variables is relevant but far from adequate (Hodgson, 1998). For example, the quantitative standardised household survey is not appropriate for providing in-depth understanding of an issue (Marsland et al., 2001); therefore, understanding and outlining the causal linkages and root causes (e.g., behind landlessness, which requires additional information and new methods) is integral to ensure comprehensive findings. However, informal surveys require a greater package of skills for investigators than formal work, and a multidisciplinary debate between investigators from different disciplines is needed (Marsland et al., 2001).

4.2.2. Research Design

4.2.2.1. Research Process

Logical validity and empirical validation to evaluate claims of research for knowledge are translated into research activities through the research process[10], which is cyclic and self-correcting (Frankfort-Nachmias and Nachmias, 2004). For the purpose of this study, a literature review and document analysis contributed to formulating appropriate research questions through understanding the livelihoods of households that are exposed to slow-onset floods and flood vulnerability in the context of the VMD and in the research sites. Reviewing the literature also enabled the researchers to interpret related theories and concepts, the

[10] The research process includes a problem statement, hypothesis, research design, measurement, data collection, data analysis and generalisation (Frankfort-Nachmias & Nachmias, 2004).

VMD's background as well as to explore the research gaps of the related studies in the delta. Through these activities, a list of criteria and indicators that were identified and consolidated by other research steps was used to aggregate flood vulnerability at the household level.

In addition to a literature review and document analysis, participatory research tools and household surveys were used to explore the main factors influencing flood exposure, flood losses, people's responses with regard to access to assets, as well as selected indicators for the local vulnerability assessment. Then, the weights for the selected indicators were explored through semi-structure interviews with the stakeholders. The purpose of vulnerability aggregation is to identify, understand and visualise varying characteristics of vulnerability as well as major factors shaping flood vulnerability of groups of people. These indicators were developed to explore the characteristics and qualities of an element or a household able to provide information regarding the degree of exposure, susceptibility and response capacity of an element or a household to natural hazard impacts (Birkmann, 2006).

Criteria and indicators were developed to improve the assessment of different levels of capacity of response and access to resources as well as susceptibility in relation to the concept of vulnerability and risks to natural hazards. Moreover, the influence of the transforming structures and processes, such as agricultural reform, agricultural intensification, embankment and relocation, on the coping and adaptation processes of local residents in the rural floodplains was examined in order to clarify major factors shaping flood vulnerability. Then policy recommendations regarding flood vulnerability were formulated. The recommendations are expected to contribute to decision-making processes and to building and implementing flood risk reduction strategies as well as livelihood strategies more effectively in the rural floodplains of the VMD.

4.2.2.2. Research Site Selection

In the upper VMD, the Plains of Reeds and the Long Xuyen Quadrangle are most affected by flood impacts in terms of economic losses as well as human fatalities. In the study, the Plains of Reeds were emphasised since they characterise major features of the rural floodplains in the upper delta and because of this they were chosen as the main research site of the Water-Related Information Systems for Sustainable Development of the Mekong Delta (WISDOM). The main criteria for research site selection are flood exposure, resettlement patterns, land use change and embankments. As discussed in the background section, the rural floodplains have experienced in-migration flow for livelihood improvement, agricultural intensification and flood-based transformation (e.g., embankments and relocation).

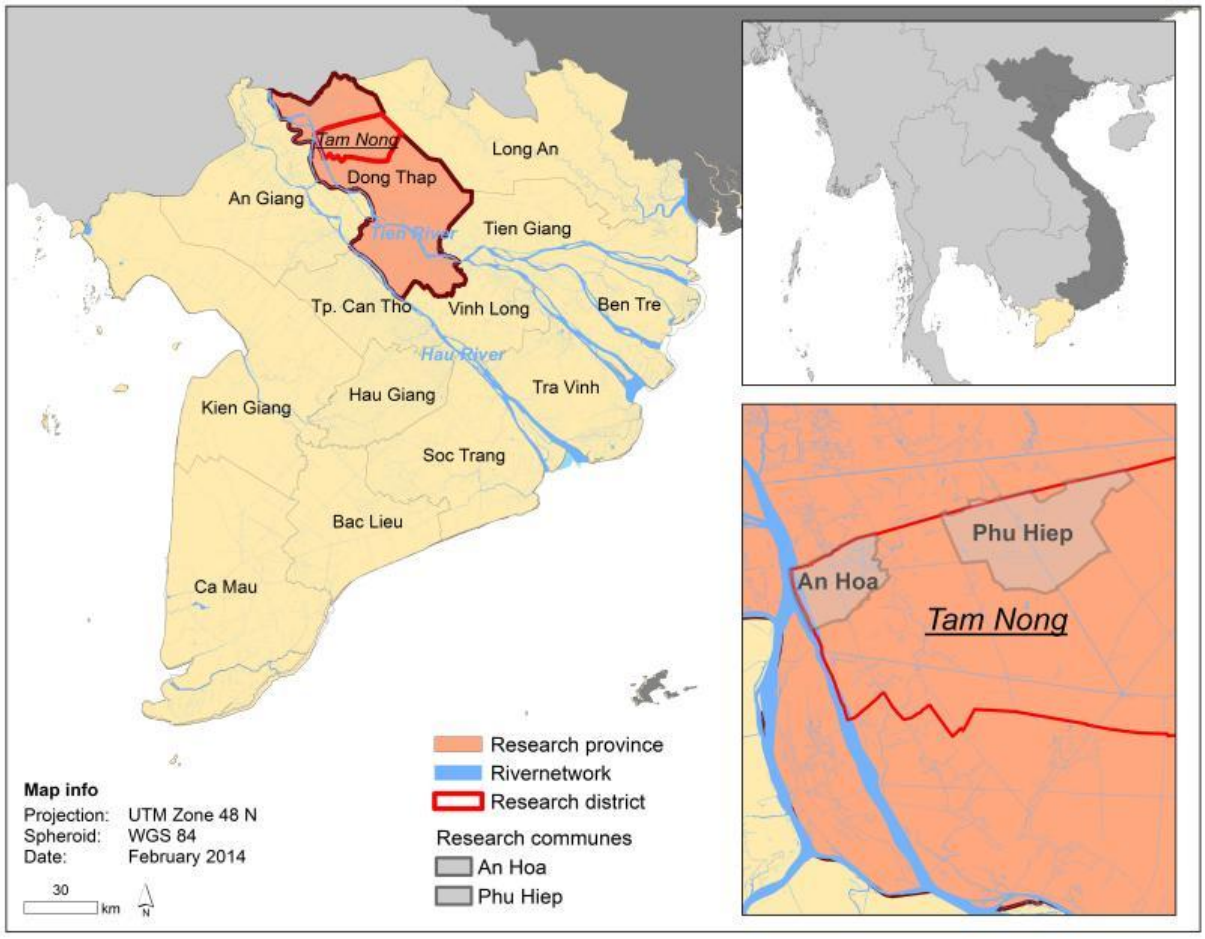


Figure 10: The locations of the research sites in the Vietnamese Mekong Delta
(Source: Author, based on the Sub-NIAPP 2000)

The research sites are located in Tam Nong District, Dong Thap Province and in the Plain of Reeds in the upper VMD where agricultural development has been shaped by three of four main factors influencing agriculture in the VMD, including irrigation development, flood depth and duration and acidity leached out from acid-sulphate soils (see Hoanh et al., 2003). The case studies were selected in both the inland and riverbank areas in the upper VMD, which is a low-lying area strongly affected by floods and acid sulphate soils (Hoi, 2005). The inland site was recently settled by in-migrants and is more exposed to floods while the riverbank site is a long-term settled area. These sites include the major characteristics of the flood-prone areas. These characteristics consist of embankments (e.g., full and semi flood-control areas with the potential for triple and double rice crops, respectively), flood-based resource utilisation, land use change (e.g., agricultural intensification) and relocation (e.g., residential clusters and dykes). In the case of Tam Nong District, a third annual rice crop, also the called autumn-winter rice crop, has been cultivated since 2011, but this rice crop belongs to one of the major crop seasons in the full flood-control areas. Thus, these research sites are excellent locations to examine past flood damage and the flood coping and adaptation processes of local communities in the rural floodplains of the VMD.

The first site, Phu Hiep Commune, is located in the inland floodplain which is characterised by resettlement patterns, land use change as well as flood impacts. The commune was established and farmers started to grow floating rice in the early 1960s. People live mainly in stilt houses built in a highly flood-prone area, residential cluster or along high roads. These resettlement patterns were shaped by various purposes such as land reclamation in the 1960s, HYV conversion in the 1990s and flood risk reduction in the 2000s. It has semi- and full flood-control areas built in the late 2010s for protecting rice crop production from flood risks, and a residential cluster built in the early 2000s for relocating poor households prone to flood impacts. The second site, An Hoa Commune, is located along a riverbank area. The commune was built in the 1860s and is characterised by an old built environment and settlement. It experienced significant remigration from Cambodia given the political conflicts of the 1970s. It also has semi- and full flood-control areas built the late 2000s for protecting rice crop production from floods and a residential dyke for relocating poor people prone to flood impacts. The exposure to floods of groups of local people could be reduced through relocation intervention; however, these relocated groups might be subsequently exposed to other types of human-induced hazards.

4.2.2.3. Target Groups

In the rural floodplains, socio-economic groups are characterised by major factors that have critically shaped rural livelihoods. Rural households rely mainly on agriculture and natural resources; therefore, their settlement in rural floodplains usually aims to access better livelihood opportunities. Previously, many households settled in the rural floodplains in order to access livelihood opportunities (e.g., fishing, off-farm activities and agricultural land), of which access to agricultural land has shaped major sources of household income. Therefore, the classifications of socio-economic groups are expected to explore major predominant points of the rural livelihoods. For the purpose of this study, major socio-economic groups in the rural Mekong floodplains are classified by settlement periods, land ownership, main sources of income, wealth and relocation patterns.

Firstly, as previously discussed, the VMD has been exploited for 300 years, and these settlements have been established by various migration patterns (Sanh et al., 1998). The migration periods indicate how flood-affected households experience and respond to flood impacts. Access to livelihood opportunities in the rural floodplains has attracted many poor landless households to resettle in the flood-prone areas. The migration patterns were usually associated with forced policies or conflicts (e.g., the reclamation policy in the 1960s, the HYV conversion in the 1980s or the political conflicts in the 1970s) (Table 1, Table 2).

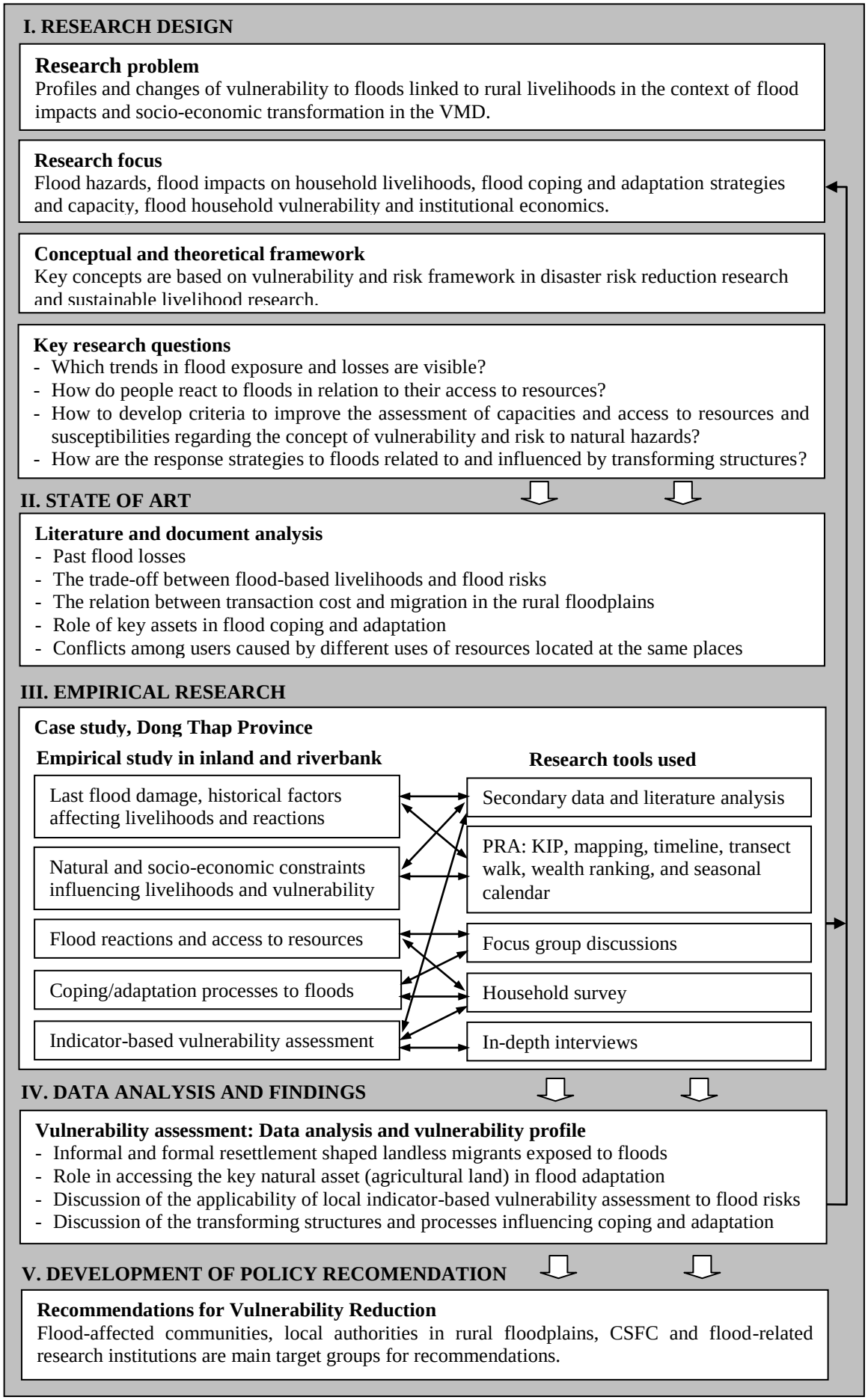


Figure 11: A schematic overview of the research process

Secondly, agricultural land ownership has influenced livelihood activities that encounter flood impacts differently; the difference in agricultural land ownership affects flood-related response strategies. Wealth is another important indicator as livelihood resources are necessary to construct livelihood strategies to respond to flood impacts. However, there is often a high correlation between wealth and agricultural land ownership which is why these factors are taken as one. Thirdly, household income sources are important factors to be considered in this context. However, main income sources also address how landless households who rely on off-farm income or remittances are differently susceptible to floods given the decline in flood-related resources and constraints in specific income-earning activities. Fourthly, the geographical location in the rural floodplains and location in residential clusters or dykes can show how formal intervention has affected livelihoods and flood vulnerability. Briefly, although there is overlap among the classified socio-economic groups, specific grouping selections can make it possible to specify and explore the main reasons influencing flood vulnerability.

4.2.2.4. Sampling

The target groups, which were identified based on resettlement periods, land ownership, main income sources, wealth and relocation patterns as well as a result of the literature analysis, provided a frame to select the groups investigated. The assessment of the changes in vulnerability is based on both qualitative and quantitative tools (e.g., the standardised household survey). Regarding qualitative methods, participants were selected in target groups in the research areas. Regarding the standardised household survey, 370 households were interviewed through the standardised questionnaire. Access to agricultural land was the main criteria used to classify the investigated groups (Table 4) since land ownership shapes livelihood activities, main income sources and household wealth. In order to include the varying characteristics of the target groups regarding resettlement periods, main sources of income and wealth, at each exposure level or settlement patterns approximately 80 households located in particular flood exposure levels were surveyed. Besides, the relocated households who were settled in the residential cluster in Phu Hiep Commune and residential dyke in An Hoa Commune were selected for the investigation.

The participatory research participants and the household survey interviewees were randomly selected from the stratified land ownership groups. The stratified land ownership groups included landless households, small landowners (less than or equal to 1 ha of cultivated land) and large landowners (larger than 1 ha of cultivated land) (Table 4). The grouping is based on particular area of agricultural land since each household was usually allocated approximately

1 ha of agricultural land, and these land size groups are major groups in the rural floodplains in Dong Thap. A particular area of agricultural land for each household indicates that rural households have concentrated or released agricultural land.

Table 4: Samples for the standardised household survey

Investigated Groups	Inland area, Phu Hiep Commune	Riverbank area, An Hoa Commune
1. Flooded areas	**81**	**0**
- Landless	31	
- Small land holders (< 1 ha)	17	
- Large land holders (> =1 ha)	33	
2. High/protected areas	**84**	**85**
- Landless	31	20
- Small land holders (< 1 ha)	24	41
- Large land holders (> =1 ha)	29	24
3. Residential cluster or dyke	**41**	**79**
- Landless	41	58
- Small land holders (< 1 ha)	0	21
- Large land holders (> =1 ha)	0	0
4. Total surveyed households	**206**	**164**

(Source: household survey, 2009)

4.2.3. Data Collection and Interpretation

Qualitative and quantitative tools were used and supplemented one another depending on the particular objectives and context of the study sites. While the secondary data analysis provided a first look at the study, participatory tools were used to explore and interpret information behind the previous findings, and the household survey aimed to reflect data among specific target groups. The secondary data analysis was useful in helping to understand and contextualise the broader flood impacts, property loss patterns, changes in land use, agricultural production or other income-earning activities, particularly access to natural resources, wealth and landlessness. Before conducting the household survey, the qualitative data were gathered to identify possible abnormalities and to gain a more in-depth understanding of the situation and processes on site. After carrying out the household survey, relevant qualitative tools were selected to clarify the statistical outputs (Grbich, 2009). However, incorporating the qualitative and quantitative data should be applied in flexible ways in order to overcome the oversimplifying of complex data and the rigours of theoretical interpretation in the qualitative data regarding the identification of emerging issues (Grbich, 2009). Along with the household survey, a set of qualitative methods and a Participatory Rural Appraisal (PRA) were used to further explore coping and adaptation trends. These combined methods help to determine major reasons that shape people's vulnerability and livelihood adaptation in flood-prone areas. The major PRA tools that were used included wealth-ranking,

mapping, Key Informant Panel (KIP), seasonal calendar, timeline, trendline, observations and in-depth interviews (Figure 12).

While the household survey tries to quantify vulnerability patterns for people from varying socio-economic groups according to specific indicators, the qualitative data aims to clarify the underlying causes of vulnerability of groups of people at risk from floods. PRA tools were applied to understand the context of the research sites regarding the historic records of main events, flood information, crops and seasonal income calendars and changes in flood-related resources. The wealth ranking exercises implemented by three local rankers were used early in the research project in order to classify the local communities into the three socio-economic groups based on their own criteria and understanding of the major characteristics of each wealthy group.

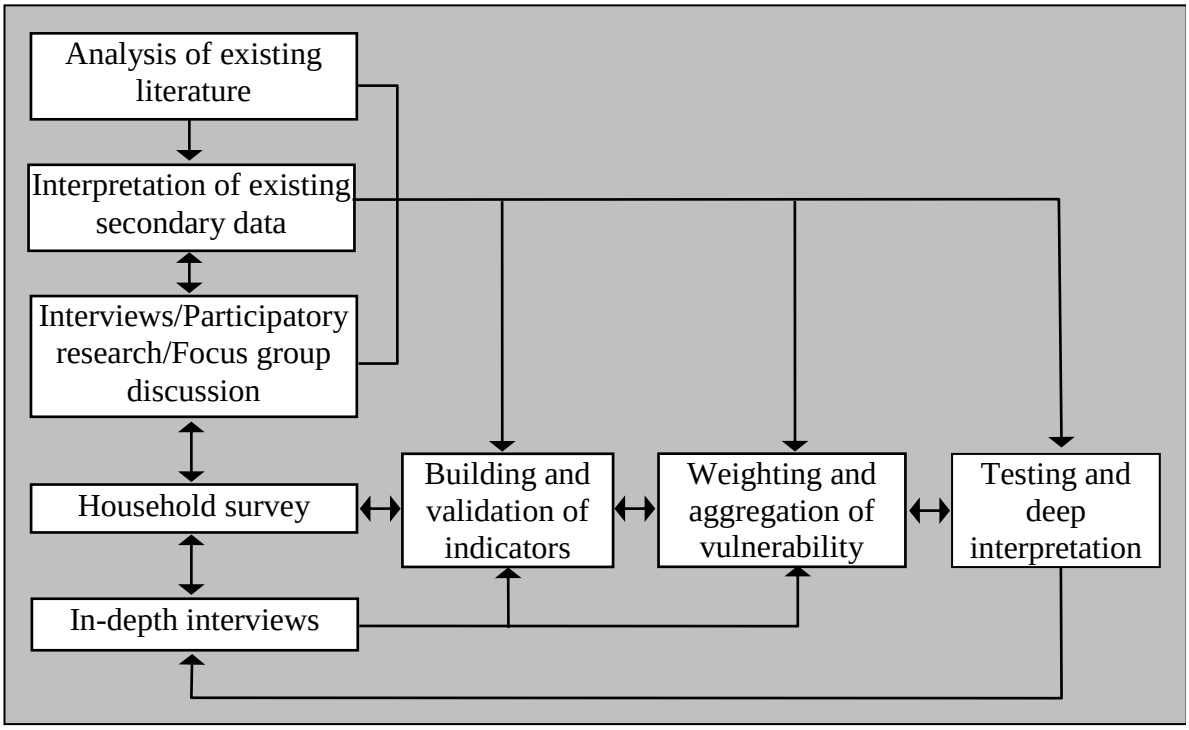


Figure 12: Indicator development and vulnerability assessment process

The results of the wealth ranking were used to select respondents of the wealthy groups and to clarify the relationships between their wealth and other indicators such as land ownership, occupation and physical asset ownership. Focus group discussions and observations were applied to clarify the similarities and differences of other groups with regard to livelihood susceptibility and the capacity of response to flood impacts. The qualitative methods therefore are meant to supplement or help better explain the quantitative data output. The discussions with the local residents, officers and researchers contribute to quantifying the flood vulnerability of different socio-economic groups based on the household survey data. The in-

depth interviews with local residents, local authorities and researchers were conducted in order to deeply probe and validate predominant points relating to the previous research steps. In brief, the combination of diverse data sources ensured data checking, supplementation and validation.

4.2.4. Data Analysis

The data were analysed during the research process, which triangulated and supplemented each other (Grbich, 2009). The literature review allowed the researcher to understand research-related issues, flood vulnerability and rural livelihoods. At this point, the research foci and research gaps were identified and developed. The secondary data analysis provided major socio-economic trends with regard to the study sites which aided in the explanation of the dynamic conditions of natural and human-induced hazards on the socio-ecological system. The interpretation of past flood damage aimed to explore exposed elements and their revealed flood vulnerability. It aimed to develop a checklist of research issues for the participatory discussion with research stakeholders. Preliminary findings found through participatory tools helped to understand the main elements exposed to floods, flood damage, flood-related experiences and people's response strategies. The main factors, which might shape people's flood vulnerability, were additionally collected using socio-economic maps, transect walks and historic events. These findings provided selected information in order to fully develop the standardised questionnaire for the household survey which explored the main data sets. Furthermore, these research methods and analyses helped to identify and validate the selected indicators measuring flood vulnerability at the household level in the rural floodplains.

Through the combined use of qualitative and quantitative tools for the data collection process (Figure 12), indicator development, indicator weighting and vulnerability aggregation were implemented in order to assess flood vulnerability at the community level. Firstly, indicators were developed through various research steps such as the analysis of literature reviews, secondary data, participatory research, standardised household surveys and in-depth interviews. The relevant literature provided a full list of indicators measuring flood-related vulnerability, and then a shorter list of selected indicators was formulated through the analysis of local and national statistical books and annual reports from flood-related institutions. The data set was used to express major socio-economic trends. Participatory interviews, household surveys and in-depth interviews were applied in order to identify and validate the indicators. Major indicators express the critical reasons shaping varying socio-economic groups vulnerable to floods. The list of indicators was continuously shortened through the standardised household survey analysis. Finally, in-depth interviews were conducted in order

to finalise these relevant indicators which would be applied in aggregating flood vulnerability through the standardised household survey data. Secondly, a weighting of each indicator was estimated in relation to the average of weighting which was done by different stakeholders. The weighting aimed to explore the importance of each indicator that has influenced flood vulnerability, based on the stakeholders' perceptions. Thirdly, regarding the socio-economic groups identified, data collected through the household survey were normalised to an interval of [0,1] with 1 being the highest level of flood vulnerability. Then the overall flood vulnerability regarding socio-economic groups was estimated through these selected indicators and their weights.

The household survey data was then analysed and charts were produced using SPSS. Mean comparison was used to statistically test the significant difference of major variables (e.g., income, age, educational grades, physical assets, agricultural and residential land ownership) between and within socio-economic groups. In addition to the narrative findings provided by the qualitative tools, the numeric findings through the qualitative tools were conceived through tables and figures in order to picture the flood vulnerability of different socio-economic groups. Regarding supplementation and triangulation between quantitative and qualitative methods, a vulnerability profile was constructed through major factors shaping people's flood vulnerability.

4.2.5. Research Limit and Focuses

Vulnerability is a broad term since it encompasses many aspects regarding qualitative considerations; therefore, after identifying major factors contributing to vulnerability, the study tries to quantify and aggregate them into a flood vulnerability index. In addition, besides annual slow-onset floods as a major natural hazard in the rural Mekong floodplains, other natural and human-induced hazards may affect rural residents and are the natural and socio-economic conditions influencing flood vulnerability of local residents.

It was difficult to select a research site, including major characteristics of the context of the rural floodplains since these characteristics (e.g., settlement patterns, relocation, embankment, and farming systems) are different; however, the riverbank and inland communes were selected as representative sites for this study. The riverbank area was chosen because it is usually characterised by long-term resettlements. In comparison, the inland area was chosen because it is characterised by short-term resettlements as well as strategies for livelihood outcomes. The full flood-control embankments were constructed in the research sites, but AW

crops have only been grown since 2011. The potential exposure of the third rice crop will be increased since the planted area of this rice crop during flooding time will be enlarged.

There were various socio-economic groups in rural floodplains in the upper VMD; however, groups of people classified by land ownership, wealth, main income source, and periodic resettlements were dominant. Several points of the classification of these socio-economic groups overlapped; however, the classification helped to explore different characteristics of rural livelihoods. For example, periodic resettlement groups indicate temporary access to livelihood opportunities while landownership groups present spatial livelihood strategies of the landless and landowners. In brief, it is hoped that the research results provided valuable insights into flood vulnerability, flood risks and rural livelihoods at the household level in the upper VMD.

5. Exposure Trends, Flood Losses

5.1. Characteristics of Flooding Events in the Rural Floodplains of Dong Thap

Annual slow-onset floods are a natural phenomenon in the VMD. In Dong Thap's rural floodplains, slow-onset floods have annually occurred from late July through December, peaking in late September or mid-October. Floodwater comes from the Mekong River through the dense canal systems and from the Cambodian floodplains. Daily flooding increases from 5 to 7 cm in normal floods and from 10 to 20 cm in high floods. Located in the Plain of Reeds, in the upper VMD, rural floodplains in Dong Thap are annually inundated with approximately 4 to 5 metres of water over a period of five to six months. Within the last five decades (1961-2011), high floods have been recorded in Dong Thap in 1961, 1966, 1978, 1984, 1991, 1994, 1995, 1996, 2000, 2001, 2002 and 2011. This means that there were appropriately 2.4 high floods per decade. However, high flooding frequency is not a regular occurrence. High floods occurred either successively (e.g., 1994 to 1996, 2000 to 2002) or discretely (e.g., 1966 and 1978, 2002 and 2011). Floods are caused by water discharge from the upstream Mekong River, rainfalls in the delta and high tides from the sea (Be et al., 2007).

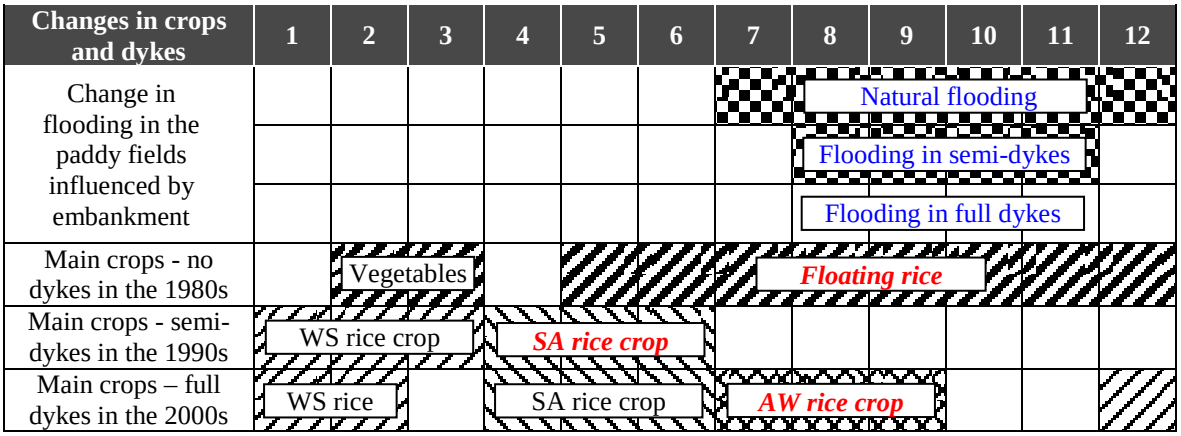


Figure 13: Changes in floods in the field and major crops in Tam Nong regarding embankment

(Note: Major wet season crops exposed to floods are indicated by italics in the table above)

(Source: KIP, Author, 2009; De, 2006)

In recent years, flood regimes in rural floodplains in Dong Thap, particularly in paddy fields, have been shortened or eliminated because of embankments (Figure 13). Rice producers prevented slow-onset floods from destroying their paddy fields during the rice harvest. Figure 13 indicates that inundation of the paddy fields has been shortened since farmers began closing the sluice gates during the early flooding stage and began pumping out floodwater during the end of flooding season. Such water management measures are used to protect the SA crops from early flood impacts and to start planting the WS crops earlier. Using

embankments has meant that the major cropping seasonal calendar has been adjusted, so the WS crops are sown earlier and the SA crops are also sown and harvested earlier (Figure 13). As a result, the SA rice crops are rarely any longer a flood risk because they are harvested before annual flooding begins. In some cases, paddy fields are fully controlled by embankments from flooding since all sluice gates are closed during the flooding season. New water inundation regimes in paddy fields have shaped the changes in rice-based farming system and main crops (e.g., the AW crops) exposed to flood impacts (Figure 13). However, the change in water management through embankment has also affected the livelihoods of numbers of different socio-economic groups differently since new water inundation regimes have led to a decline in flood-related resources which are relied on by landless households as well as changes in rice-based farming systems.

5.2. Loss and Damage Profile

The ways people are exposed to floods in the rural VMD floodplains are changing and therefore major losses and damages to households are also changing. Vulnerability assessment experts emphasise that in order to assess vulnerability it is necessary to identify those key elements or groups of people exposed to the stressor or selected natural hazards (Birkmann and Wisner, 2006). In the Dong Thap, annual floods occur slowly and annually over a prolonged period of about five to six months (July through December) and during this time local residents try to reap the benefits of flooding to benefit their livelihoods. Many people, especially the landless, rely on flood-related livelihoods. In the rural floodplains, people are exposed to floods for a long period each year. People's exposure levels depend on their settlement locations.

At the community level, wet-season crops, houses, public buildings (e.g., administrative buildings, schools and commune clinics), local roads and the dyke systems are highly exposed to floods. Moreover, the lives of the people, especially children and the elderly, are at risk during severe flood events. Exposure to floods in the VMD has been changing due to the interaction between human activities, environmental conditions and external forces, such as land reclamation policies, resettlement policies, crop intensification and key flood-related interventions in the rural floodplains.

5.2.1. Loss of Wet-Season Paddy

The types of rice crops exposed to floods are changing due to the changes in rice-based farming systems (e.g., floating rice monoculture, the double and triple HYV) and embankment (Figure 13). These changes have shaped rural livelihoods and flood

vulnerability. In 2008 the rice crop, accounting for over 99 per cent of the planted grain food area (GSO, 1990-2010), was a major crop exposed to floods in the delta. Before the HYV conversion in the Plain of Reeds, floating rice was the major crop exposed to floods since it was grown during the flooding season. Moreover, SA rice is exposed to flooding because its harvesting stage occurs at the same time as early floods. Currently, the AW rice crop that is grown within the full flood-control dykes is becoming the new major exposed crop. Although embankments are meant to protect the crop and override their exposure towards floods they are still exposed to the risk of dyke breakage (Figure 13). These changes are closely linked to the economic vulnerability of landowners; they have particularly influenced the livelihoods of landless residents due to the interdependence with regard to HYV production (e.g., off-farm activities) since landless labour is reliant on off-farm income. Embankment policies and the promotion of HYV have strongly influenced major exposed crops as well as overall flood damages. These changes are associated with the changes in rice-base farming systems which were partly shaped by the government's agricultural policy and the Green Revolution[11].

Before the 1980s floating rice was at risk the most during high floods (Figure 21). Floating rice which had a long history in the VMD started to be replaced by HYV in the 1960s, and was entirely replaced in Dong Thap Province by the mid-1990s (Figure 21). In low and normal floods, floating rice could adapt to the slow incremental flooding due to its natural characteristics. Consequently, even in the high flooding that occurred in 1961, 1978 and 1991, only small areas of floating rice were damaged. Although, as the floating rice yield was low, from 1-1.5 t ha^{-1} (Dong Thap Statistics Office, 1981-2011), the economic damage to this crop was not significant. In spite of this, floods caused a strong effect on people's social lives because floating rice was an annual single rice crop. Floating rice was a "flooded adaptive crop" as it was perfectly adaptive to normal floods. Its leaves and panicles developed quickly and were above the surface floodwater. In addition, according to long-term in-migrants in Phu Hiep Commune, floating rice also contributed to water wave reduction in the rural floodplains and was favourable for natural resources and fish growing. However, regarding its low yield and the annual production of a single rice crop, floating rice was gradually replaced by HYV. It could be grown as two or three rice crops per year because of a short-term life cycle, approximately three months.

HYV, which was introduced by the International Rice Research Institute (IRRI) in the delta in the 1960s (De, 2006), became the new crop exposed to floods, and was so popular that it was

[11] The Green Revolution contributed to the transformation of agriculture in the 1940s in the world. It referred to the establishment of series of agricultural research institutes, in which the IRRI initially introduced HYV in the 1960s such as IR8 and IR36 in the VMD.

grown twice a year in the Plain of Reeds towards the end of the 1980s based on the construction of irrigation systems and agricultural development policies. The severe acid sulphate soils were leached and irrigated for HYV. The policy that forced an expansion in agriculture, especially rice crop production, in the Plain of Reeds was directed by the central government in the 1980s as Vietnam implemented the "Doi Moi" policy. In addition, Vietnam was undergoing a food shortage in 1978 since the extreme flood events destroyed almost all floating rice crops. With one crop a year, the WS rice crop was not exposed to floods; however, given its relatively short three-month growing cycle, farmers usually planted rice crops twice a year. Therefore, with regard to HYV, it was the second crop, SA rice, which was most exposed, especially to the early floods. In the areas without embankments, the second season crop (SA rice crop) was at major risk of being damaged by early floods (Figure 13). For example, large planted areas of the SA rice crop were destroyed in the 2000 floods (Figure 14). This high amount of rice crop damaged by flooding has influenced decision-making for the construction of semi- and full flood-control dyke systems. The use of these embankments was expected to protect the SA rice crop damage from early floods as well as to develop AW crops during the flooding season.

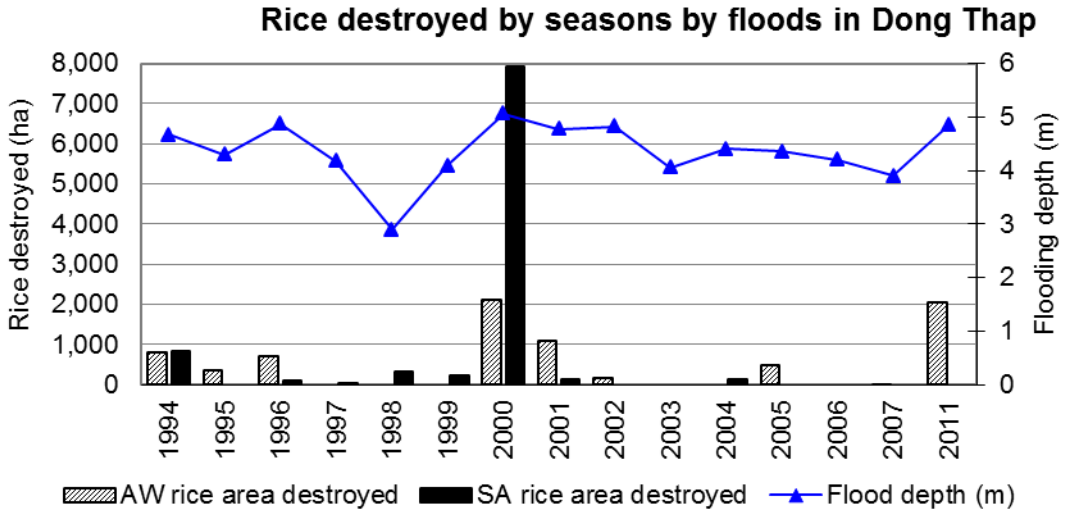


Figure 14: Rice destroyed by seasons due to floods in Dong Thap (1994-2011)

(The SA rice crop destroyed by floods in 2000 covered 7,913 ha)

(Source: Author, data from Dong Thap CFSC, 1994-2011)

In recent years, AW rice crops have been increasingly grown during the flooding season in the full flood-control areas. For example, in 2011, in Dong Thap, the planted area of the AW rice crop was increased by 100 per cent – from approximately 50,000 ha up to 100,000 ha. The AW rice crop therefore has become a newly exposed crop in reference to dyke breakage due to high flood impacts. In the Tam Nong District, the AW rice crop has been grown in several full flood-control areas since 2011; however, the planted area of AW crops has increased

rapidly due to the construction of full flood-control embankments. There, large areas of the AW rice crop were destroyed, and its yields were reduced by the past high floods, particularly by the 2011 floods (Figure 14). It is evident that regarding embankments the SA rice crop was entirely protected from floods, while almost all rice crops destroyed by floods in 2011 were in the AW crops (Figure 14). The damage to the AW rice crop provides an example of the change in (potential) elements exposed to floods. In the vulnerability assessment at the community level, the (potential) planted area of the AW rice crop may be one of the indicators to describe flood vulnerability.

Given the previously recorded flood damage in the VMD, this damage increased with high water depth and an earlier occurrence than normal. The highest amount of rice destroyed by the historic 2000 floods occurred when the water depth was over almost all semi- and full flood-control dykes. That flood occurred earlier than the others. Flood damage also occurred at low flooding depths due to climate variability and a lack of preparedness. In the research sites, the WS rice seedlings in 2008 and 2010 were greatly damaged towards the end of the flooding season given the late heavy rainfall. This considerably restricted water drainage and kept the water depth in the sown paddy fields high as well. In short, in the rural upper delta, wet season paddy and other crops are exposed to floods, while the exposed crops (e.g., floating rice, the SA and AW rice crops) have been changed due to changes in rice-based farming systems, crop varieties and embankments. Moreover, in the context of climate change and the changes in water use and management in the upstream Mekong Basin and within the VMD, wet season paddy or other crops, particularly AW crops, will continue to be exposed to not only floods but also climate variability and human interventions.

5.2.2. Damage to Temporary Housing and Major Infrastructure

In the VMD, the damage to critical public and private infrastructure by high floods is considerable. The increase in the in-migration flow for livelihood opportunities and public infrastructure construction (e.g., public buildings, rural roads, bridges, dykes) in the rural floodplains has caused an increase in the exposure of people and such infrastructure to floods. In normal floods, the physical infrastructure is little affected by floods since the building codes are over the normal flooding peaks. Moreover, floodwater velocity is not strong enough to cause the erosion of local roads and dyke systems. However, in high floods, the public infrastructure and houses located in new foundations as well as low-lying places are flooded and damaged.

5.2.2.1. Major Public Infrastructure Damaged due to Floods

Flooding depths of over 3 to 4 metres in the northern VMD have often significantly affected critical infrastructure. Public structures (e.g., dykes, local roads, bridges, schools, administrative buildings and local clinics) have been greatly affected and repairs are costly (Figure 17). The building codes for public infrastructure were usually set based on the previous highest flooding depth (e.g., the 1996 and 2000 floods); however, they were increasingly becoming out of date given the higher flooding depths. For example, the foundations of houses and the major public infrastructures that were built based on the peak of the 1996 floods were inundated and damaged by the 2000 floods. The dyke systems and local roads constructed after the 2000 floods are the main public infrastructure exposed to flood impacts. Dyke systems are along canal systems and made by soils that are easily eroded due to long-term inundation and high floodwater velocity. According to the Tam Nong CFSC staff in 2010, new roads and embankments were increasingly protected through annual maintenance, plastic sheet coverage and tree planting. These measures were aimed to reduce soil erosion. In fact, most collapsed or damaged infrastructure due to flooding was in low-lying areas and in new constructed places made of different types of soils or river sand or close to potentially eroded areas like the banks of canals or rivers. In addition to the flood magnitude, an increase in infrastructure construction contributes to the costly flood damage. The physical flood-related interventions in the rural floodplains are very costly (Figure 17) and have diverse impacts so these measures need to be considered carefully in order to evaluate and mitigate their negative side effects.

5.2.2.2. Temporary Houses Damaged by Floods

At the household level, almost all houses and physical household assets (e.g., animal cages, machines, motorcycles, water jars and wooden furniture) are exposed to floods; however, temporary houses and physical household assets in these temporary houses are more susceptible to floods. In the rural floodplains, houses can be classified into three types of houses, including a temporary type (made of leaves and low-value woods), a semi-permanent type (built of iron sheets and wood) and a permanent type (made of cement walls with an iron or tiled roof). Stilt houses are popular in the rural floodplains in the upper delta. These houses are constructed on 2-4 metres wooden or concrete stilts in order to set the house floors higher than the peaks of floods. In fact, almost all poor households have temporary or semi-permanent stilt houses which are easily damaged by high floods together with strong winds. During flooding, the pillars of stilt houses become weaker. Moreover, stilt houses in the rural floodplains are built separate from each other; therefore, these houses lack inter-dependent

forces that are created by clock housing. Besides, many stilt houses are located along canals or on the stems of dykes easily eroded by high floodwater velocity (Figure 19 and Figure 20). The major reason for constructing houses in susceptible places is a lack of access to residential land and financial resources. In the early in-migration stage, almost all stilt houses were temporary and lacked protection from trees surrounding the houses; therefore, these houses were severely affected by floods and strong winds. During this time, many temporary houses were damaged by high floods in the delta (Figure 15).

The exposure of houses to floods is also influenced by wealth. In the rural floodplains, most wealthier households build their solid houses on higher ground while poorer people have temporary houses in the low-lying areas or far from main roads or dykes. In addition, residents who have no residential land are not allowed to build semi-permanent or permanent houses in residential areas. Thus ownership of residential land also contributes to improving housing conditions and flood mitigation measures (e.g., tree planting, house foundation elevation). This means that the houses of poor people and their physical household assets are exposed to annual slow-onset floods, particular high floods.

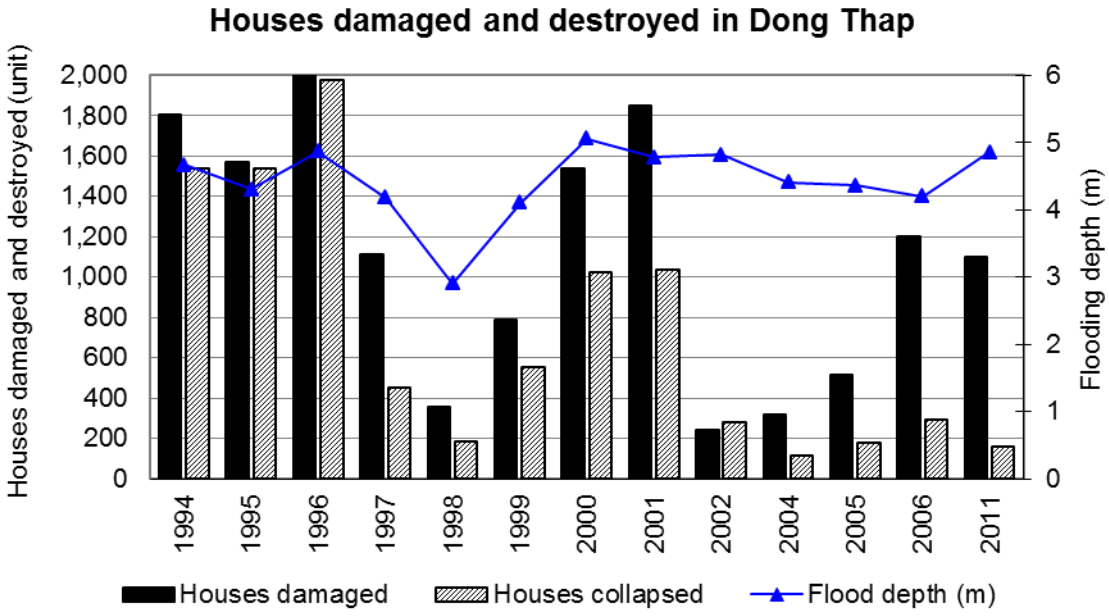


Figure 15: Houses damaged and destroyed by floods in Dong Thap (1994-2011)
(21,085 houses were damaged by floods in 1996)
(Source: Author, data from Dong Thap CFSC, 1994-2011)

Although more affected by flooding, the poor continue to live in flood-prone conditions since they hope to earn income through flood-based activities and small-scale production on their homestead land (e.g., small-scale livestock and extensive snakehead fish). It explained that flood-affected households did not leave flood risk areas for the residential clusters or dykes.

Consequently, a large number of houses, particularly temporary stilt houses, were destroyed and damaged by high floods, particularly the high floods in 1994, 1995 and 1996 (Figure 15).

The relocation policy issued after the 2000 floods has contributed to reducing the number of temporary houses directly exposed to flood impacts. According to Dong Thap CFSC, in the first phase of the relocation policy, by the end of 2008, approximately 48,787 households highly prone to flood impacts were relocated into the residential clusters or dykes. This contributed to reducing flood exposure in the rural floodplains in Dong Thap. Due to this, it is evident that fewer houses were destroyed and damaged due to the high floods in 2011 although the flooding depth that year was higher than the floods in 1994, 1995, 2001 and 2002 (Figure 15). The second phase of the relocation policy that was implemented during 2009-2012 continued to relocate more than 50,000 households prone to hazardous impacts to residential clusters and dykes.

5.2.3. Main Socio-Economic Groups Affected by Floods

The exposure to flood impacts of different households is associated with their livelihood activities as well as individuals in each household. For instance, poor households are usually located in bare and low-lying places; therefore, their houses and physical household assets are more exposed to flood impacts. Moreover, each socio-economic group has certain livelihood strategies that are also exposed differently to flood risks.

5.2.3.1. Children of Poor Households as Main Flood Victims

Protecting human life is one of the predominant concerns in the rural floodplains. There were approximately 400 people killed in every high flood, most of whom were children under six years of age (Figure 16). Almost all the deceased children were from poor households, and the majority of these deaths also occurred at night. In addition, children's deaths due to floods were mainly located in remote areas of the rural floodplains, in which there is low house density and child day care houses. Therefore, why almost all mortalities were children, and whether these deaths were related to access to assets and livelihood activities of their households should be explored

Other residents, particularly the elderly, the disabled and women, were also exposed to flood risks. The elderly and the disabled were aware of flood risks; however, they were often injured or killed given their low swimming capacity in severe flooding. Adults suffered from alcohol abuse were also harmed by floods because they travelled in rural flooded roads or small wooden boats. Women were more exposed to flood risks since they were physically and psychologically affected by floods.

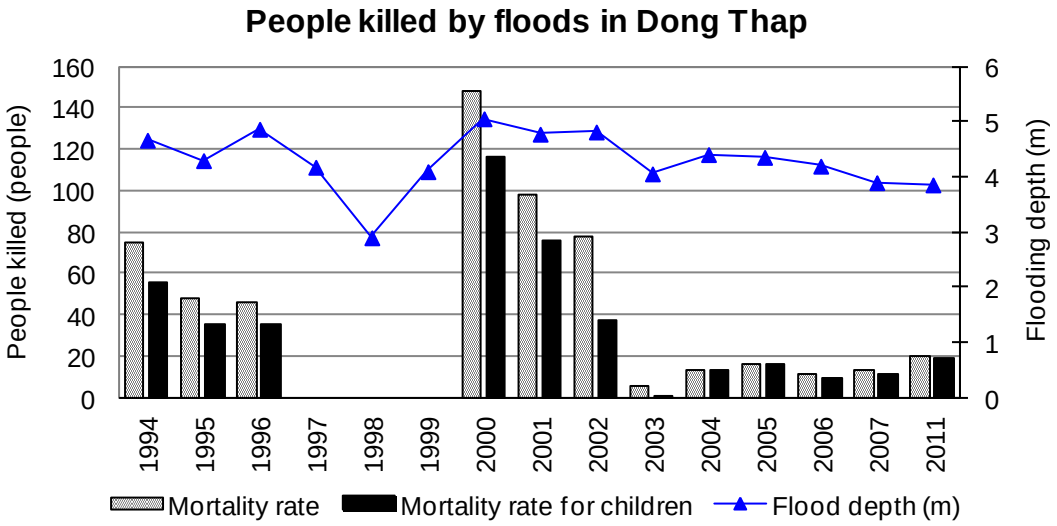


Figure 16: People killed by floods in Dong Thap

(Source: Author, data from Dong Thap CFSC, 1994-2011)

5.2.3.2. Poor People Exposed to Physical and Psychological Shocks and Stresses

Floods directly affect both physical and psychological health. During flooding seasons, poor adults are associated with flood risks since they usually work in the severe flooding conditions for flood-related benefits with small wooden boats. Any unlucky occurrence such as broken boats, sudden illness or other unpredicted accidents causes human injury or mortality. Women and children are more likely to be confronted with water-borne diseases, such as diarrhoea, parasite-related illnesses and dengue fever due to floodwaters. Poor women and children were usually more exposed to water-related diseases due to their income-earning activities (e.g., fishing and gathering vegetables) during the flooding season. Moreover, they usually contacted and used floodwater for their daily needs since they lacked access to the running water.

In addition to the physical and health dangers related to floods, the psychological impact can causes long-term effects which may be exacerbated by losing relatives, income-earning activity disruption, possible evacuation and the need to repair houses or replace physical household assets. Regarding the focus group discussions in Phu Hiep Commune in 2009, poor females were psychologically affected by flood impacts since they were usually responsible for taking care of their children as well as serving daily meals. In addition, they also said they were extremely worried about household assets being damaged, and their household members were prone to flood risks. Poor women faced more difficulties in taking care of food and healthcare responsibilities since they had to obtain informal loans from private moneylenders or landowners for daily needs. Sometimes poor women and their husbands worked in flooding conditions and were more exposed to water-borne diseases. They usually contracted water-

borne diseases during periods of water scarcity and at the beginning and the end of the flooding season. A middle-aged woman in the Phu Hiep floodplains said that "in the early stage of settlement in the rural floodplains, I could not sleep well and always worried about heavy raining at sunset during the high flooding because it was often accompanied by strong winds". She revealed that "during the flooding season, my husband mainly focuses on livelihood opportunities while I have to take care of many different responsibilities". In short, poor women were more physically and psychologically exposed to flood risks. However, although poor households were barely exposed and more susceptible to flood risks, a large number of poor households continue to live with floods rather than relocate to higher ground or residential clusters and dykes.

5.2.3.3. Landless Residents Exposed to Disruption in Income-Earning Activities by Floods

The poor and landless not only struggle with flood risks but also disruption of income earning activities. They work in flooding conditions since they usually have little or no agricultural land for on-farm activities and have little access to non-farm jobs. They usually catch fish in the evening by small wooden boats in the rural floodplains. As a result, they are significantly exposed to flood risks. Their main household income comes from off-farm activities and flood-related resources; consequently, when farming activities are disrupted due to floods, off-farm wage activities conducted by landless households are also affected. During flooding season, poor people have lost their main income sources from these off-farm wage activities which narrow their choice for other livelihood opportunities. The decline in flood-related resources has influenced poor residents' livelihoods in the flood-prone areas. Some of them are still employed through flood-related resources while the others have gradually shifted to non-farm activities in urban areas. The decline in flood-related resources has also influenced residents' perceptions in terms of flood risks and relocation from the flood-prone areas.

5.2.3.4. Changes in Flood Exposure for Landowners

As previously discussed, the types of rice exposed to floods are changing due to the changes in rice-based farming systems and the use of embankment; therefore, the flood exposure of landowners has also changed. Landowners have mainly cultivated rice crops which are exposed to the early and high floods. However, during the last decade, the livelihoods of people who had large agricultural land were the most exposed to flood impacts regarding the last flood damage to rice crops. Recently, landowners have earned their main income from rice production before flooding by using embankments as the major formal structural

interventions. These interventions have contributed to significantly reducing rice damage by floods. However, wealthier residents have had more advantages than poor people have since embankments functionally protect rice production rather than foster flood-related resources that provide livelihoods to poor local residents. In brief, currently landowners have reduced their exposure to floods, but over the long term, a single income source dependency from rice production could cause them to be more sensitive to rice damage due to climate change.

In summary, through annual slow-onset floods have existed for thousands of years, flood-related familiarity has influenced flood vulnerability at the household level. This is challenging to local residents given that the VMD is one of the most affected regions to climate change, particularly floods and sea level rise. For instance, when confronted with other natural hazards like Typhoon Linda in 1997, over 2,000 people were killed or registered missing and significant economic property was lost (CCFSC, 1991-2000). Throughout the history of the VMD, local residents have relied on natural resources; therefore, they have accepted flood risks in order to gain flood-related benefits.

5.3. The Changes in Flood Damage Patterns in the Last Decades

The changes in flood damage patterns have been shaped by flooding levels, changes in the elements exposed to flood impacts, susceptibility, capacity of response and flood mitigation measures. Flood losses are shaped by the flood vulnerability of elements or groups of people exposed to flood impacts, but the changes in flood losses are directly observed as the changes in elements exposed to floods. In the last decade, elements or groups of people exposed to floods were changing because of the changes in rice-based farming systems (e.g. floating rice, two HYV, three HYV), basic infrastructure development (e.g. an increase in embankments, dyke systems), and relocation (e.g. forced resettlement in the 1960s and 2000s, voluntary in-migration in the 1960s and 1990s).

Firstly, poor people and their temporary houses located in severe floodplains have been gradually moved to residential clusters and dykes directed by the relocation policy since the early 2000s. This policy has reduced the number of households located in severe flood conditions; therefore there are fewer people, houses and physical assets affected by flood impacts than previously.

Secondly, single floating rice was replaced by double/triple rice cropping systems whereby the third rice crop is grown in the flooding season and is therefore at higher risk of being destroyed. Rice crop cultivation has been intensified through using HYV and an increase in rice crop rotation which implies that the potential loss of yield also increased. The trend in

rice damage increased as the planted area of the SA rice crop increased rapidly without protection from embankments. Then, rice loss decrease since embankments protected the SA rice crop from the early floods. However, nowadays, the AW rice crop that is grown during the flooding season has increased within full flood-control areas (Figure 21) that are potentially exposed to dyke breakage caused by high floods. In fact, the damage to the AW rice crop increased (Figure 22). In fact, the damage to the AW rice crop due to floods in Dong Thap in 2011 indicates that it is a risky rice crop. However, although the AW rice crop is highly exposed to flood risks, according to local farmers in Dong Thap, it reaps a higher profit compared to the SA rice crop and avoids water scarcity during the dry season. Moreover, according to in-depth interviews with staff of the DARD in Dong Thap in 2011, the provincial government also advocates an expansion of the planted area of AW rice crops in the full flood-control areas. For this reason, damage to the SA rice crop is reduced while the AW crop season may continue to be increasingly exposed to dyke breakages.

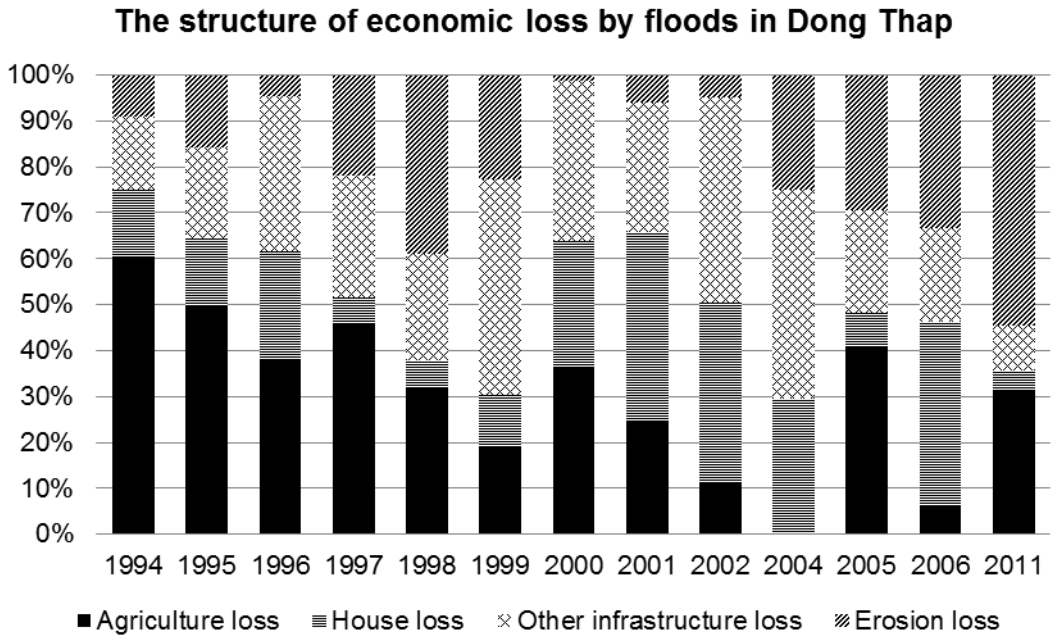


Figure 17: Structure of economic loss caused by floods in Dong Thap

(Amount of economic loss by floods from 1994-2011 was converted into in the year 2000 for comparison, USD/VND=14,177)

(Source: Author, data from Dong Thap Dong Thap CFSC, 1994-2011)

Thirdly, dyke systems were built or upgraded as local roads or residential dykes which therefore became further subjects exposed to floods; however, these basic infrastructures helped to reduce the risk of flooding for much of the agricultural land. Embankments enable local residents to diversify crops as well as economic activities within the full flood-control areas. For example, fruit trees were traditionally planted in homestead gardens which were greatly affected by the 2011 floods. Damage to houses and physical household assets was

mitigated; however, losses caused by soil erosion on dykes increased (Figure 17) because of the construction of new dyke systems and the impacts of high water velocity.

Therefore, the structure of economic loss due to floods is changing regarding the changes in major elements exposed to floods. There is significant correlation between economic loss and flooding depth, but the change in economic losses is different from certain major elements to floods (e.g., types of rice crops). Agricultural loss has been reduced due to the construction of embankments; however, in contrast, basic infrastructures such as roads, bridges, embankments, schools, and clinics have increasingly been damaged (Figure 17). For example, new dykes and embankments were severely eroded by flood impacts. The increase in physical measures such as the construction of houses, roads and dyke systems has shaped changes in the structure of economic loss. In reality, considerable damage to dykes and embankments due to soil erosion was caused by the high floods of 2011.

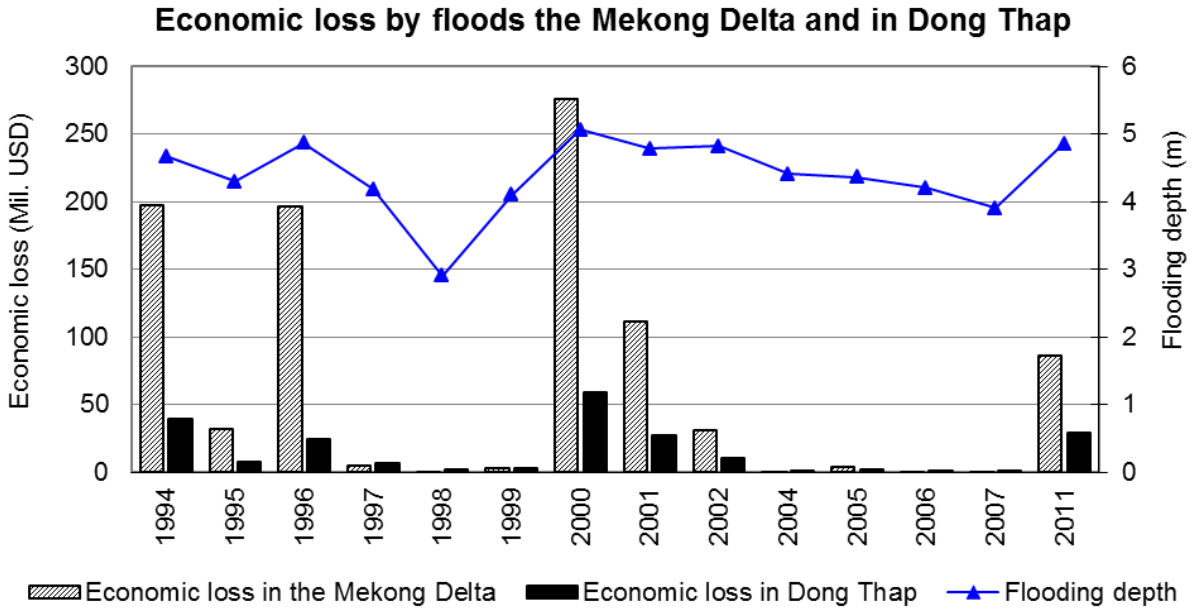


Figure 18: Economic losses due to flood impacts in Dong Thap Province

(Amount of annual economic loss by floods from 1994-2011 was converted into the year 2000 for comparison, USD/VND=14,177) (Source: Author, data from Dong Thap CFSC, 1994-2011)

The visible economic loss caused by floods in Dong Thap has shifted from private owners characterised by flood damage to wet season crops and individual housing conditions to public structural losses (e.g., rural roads, dykes and public buildings). It means that in recent years, the public sector has contributed more financial investment to the construction of basic infrastructures in the rural floodplains. Flood-related interventions have been implemented in the rural floodplains, but a strategy to reduce flood vulnerability of socio-economic groups has created a contradiction among these groups in the high flood-prone areas.

In sum, the trends in flood losses have changed regarding the changes in flood regime, land use patterns, economic development and human resettlement. The loss of SA crops has been reduced due to the construction of embankments; however, the loss of the AW crops will increase. Mortality due to flooding has also reduced since most exposed households are resettled in residential clusters and dykes, and their children are protected by day-care houses. The economic loss is partly transferred from local people (e.g. damage to rice, animals, houses, physical household assets) to the public sector (e.g. public buildings, roads, electricity lines, tap water systems).

5.4. The Trends in Flood Exposure

5.4.1. Flood Exposure in the Context of Climate Change

Major elements and groups of people exposed to flood risks are dynamic due to both internal and external driving forces. Changes in flood regimes affected by both climate change and human interventions in the upstream Mekong Basin and by embankments within the VMD have caused flood risk exposure to the delta. Regarding climate change, particularly sea level rises, floods are predicted to have higher peaks and longer durations (Hoa et al., 2007). Consequently, the AW rice crop in the full flood-control embankments will be more susceptible to dyke breakage. Moreover, floods and typhoons that may occur at the same time in the VMD can cause severe damage to wet season crops and stilt houses located in the rural floodplains or along canal systems.

5.4.2. Flood Exposures Shaped by Dams and Embankment

Besides climate change impacts, human interventions, particularly dams in the upstream Mekong Basin and embankments within the VMD, have shaped flood exposure in the rural floodplains. As previously discussed, dams for hydropower plants and irrigation in the upper Mekong Basin have influenced flood regimes and the periods of flood peaks (the later time) due to water management of these hydropower plants[12]. These changes in water flow may influence the downstream water discharge that directly affects agriculture in the VMD. The government has continuously implemented structural flood-related measures, particularly embankments, which have stimulated the planting of AW crops during the flooding season, the growing of fruit trees and the building of houses in the full flood-control embankments. It is clear that the construction of embankments gives an incentive to create new elements (e.g. AW crops, fruits, houses) exposed to flood risks. Embankments that have also constrained

[12] The changes in the period of flood peaks were measured by the main Gauging Stations in An Giang Province and Can Tho City, downstream of Mekong River.

flood-related resource development cause livelihood disruption to poor households in the rural floodplains. However, thanks to embankments, flood damage to the SA crops decreases quickly since embankments help farmers to adjust cropping seasonal calendars earlier and protect crops from the early floods.

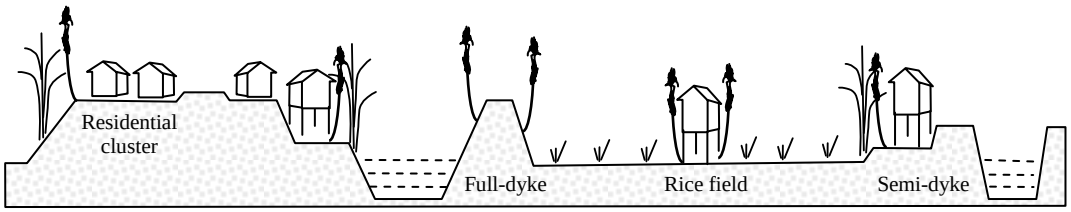
5.4.3. Resettlement Patterns Influencing People Exposed to Flood Impacts

In flood-prone areas, the changes in flood exposure are shaped by both in- and out-migration flows. The previous in-migration flows for livelihood opportunities in the rural floodplains and the current out-migration trends for income in urban areas have indicated the dynamics of flood exposures for different socio-economic groups in the rural upper VMD. Almost all in-migrants were landless and poor. They formally or informally migrated and settled along canals (Figure 19 and Figure 20). The settlers were searching for new livelihood opportunities in these new reclaimed areas; thus, there was a trade-off between new livelihood opportunities and flood risk. When the livelihoods of local residents shifted from the natural resource base to agricultural intensification, in-migrants gradually settled along the artificial canals in order to take care of crop cultivation.

Besides formal in-migration set by governments, poor households informally migrated to the floodplains to access livelihood opportunities. These in-migration flows contributed to an increase in water-related risks for new in-migrants. In the flood-prone areas, people live along artificial canals[13] or in the rural floodplains which provide water, food and water-based transportation (Figure 19 and Figure 20). As a result, these new in-migrants were more susceptible to floods. According to the household survey, most in-migrants had no or minimal agricultural land size; therefore, they migrated and looked for livelihood opportunities in the rural floodplains.

In Phu Hiep Commune, wealth seems to be a factor affecting local residents exposed to floods. Poor households usually settled in new established communes in the rural floodplains, while many wealthier or middle-class households temporarily migrated to these areas for their livelihood opportunities. As a result, poor households were directly exposed to flood impacts while other groups returned seasonally to their home villages during high flooding. Regarding severe damage to crops and physical assets and mortality due to the 2000 floods, poor and landless households prone to floods have been relocated in the residential clusters or dykes. However, many households have still lived in the rural floodplains and have therefore been exposed to damaging by flood risks.

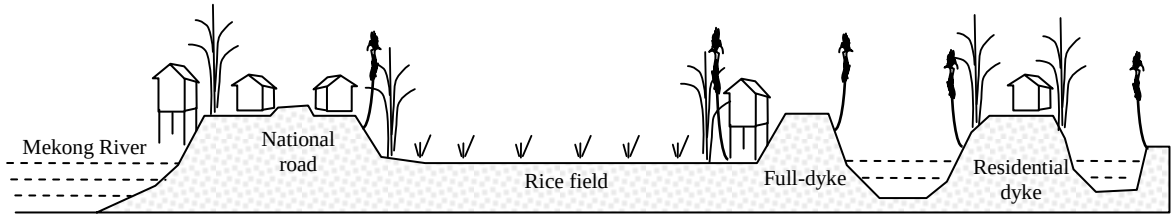
[13] In the VMD, there are more than 1,000 man-made canals that were essentially used for land reclamation and people's resettlement (Hoa *et al*., 2006).



Soil	Sand-clay	Sand-clay	Silt-clay	Silt-clay
Water	Tap water	Canal, tap water, deep well	Canal	Canal, deep-well
Plants	Few mango	*Eucalyptus*, bamboo, fruits (banana, mango)	Double HYV, taro and scallion	*Eucalyptus*, bamboo, banana
Animals	Several chickens	Pig, cow, chicken, duck	Duck herd	Cow, chicken, duck
Fish	no	Snake head fish	Wild fish	Snake head fish
Settlement periods	Relocated in 2003 by the relocation policy	Resettled in the 1960s for reclamation forced by the former government	Resettled in the 1990s for fishing and HYV farming after Renovation in 1986	Resettled in the 1980s for HYV farming and fishing
Access to infrastructure	Electricity, tap water, schools, market, local clinic, high elevated roads		Electricity (if close to an electricity line)	Electricity, schools, local roads

Figure 19: Transect map of the inland site, Phu Hiep Commune (west-east direction)

(Source: Author, KIP, Observations and Transect Walk in Phu Hiep, 2008)



Soil	Sand-clay	Silt-clay	Silt-clay	Sand-clay
Water	River/canals, tap water, deep well	Canals	Canals, deep water	Canals, tap water
Plants	*Eucalyptus*, bamboo, fruits	Double HYV or potential triple HYV	*Eucalyptus*, bamboo, fruits	*Eucalyptus*, bamboo, fruits
Animals	Pig, chicken, duck	Duck herd	Pig, chicken, duck	Few pig, chicken, duck
Fish	Snake head fish, *Pangasius* (ponds)	Wild fish, snails	Snakehead fish, *Pangasius* (ponds)	Snakehead fish (plastic ponds)
Settlement periods	Settled in the 1860s by "southern migrants" for livelihood opportunities	no	Settled in the 1970s from Cambodia due to political conflict	Relocated in 2004 by the relocation policy
Access to infrastructure	Electricity, tap water, school, market, transportation	no	Electricity, school, local roads	Electricity, tap water, schools, local roads

Figure 20: Transect map of the riverbank site, An Hoa Commune (west-east direction)

(Source: Author, KIP, Observations and Transect Walk in An Hoa Commune, 2008)

5.4.4. Agricultural Intensification Shaping the Changes in New Exposed Crops

Agricultural intensification in the VMD has shaped the changes in rice-based farming systems as well as major crops exposed to floods. Exploring the changes in flood processes from past, current and future situations aims to express the trends of flood exposure and the dynamics of flood vulnerability.

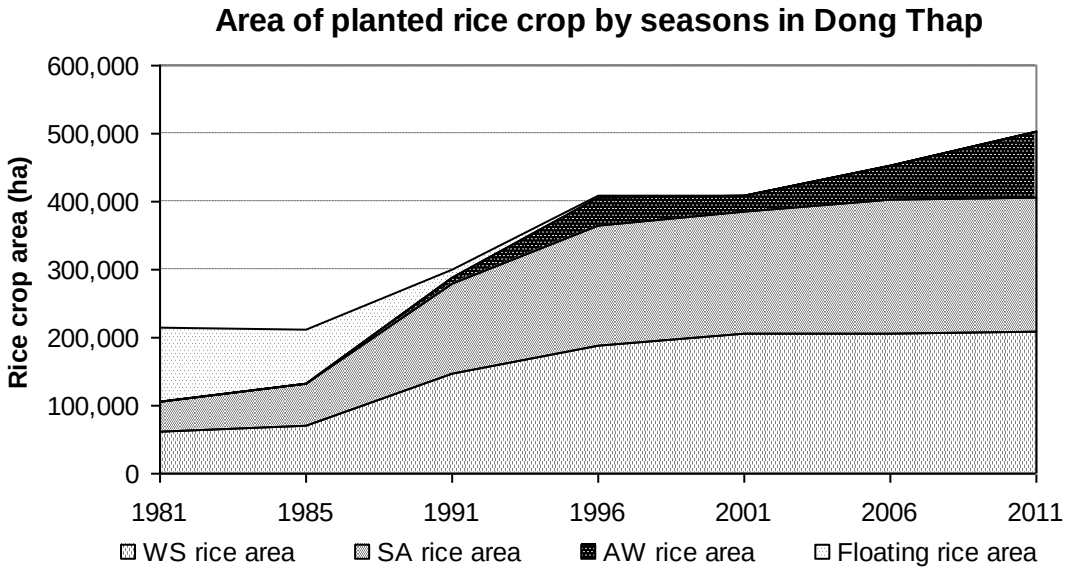


Figure 21: Structure of planted paddy area by seasons in Dong Thap Province
(Source: Author, data from Dong Thap Statistics Office, 1981-2011)

Agricultural intensification (e.g., HYV production) has shaped the changes in major crops exposed to flood impacts. For instance, in the research sites, before the HYV conversion in the 1980s, floating rice was a major crop exposed to floods. Then, after the HYV conversion and before embankments in the 1990s, the SA rice became a next main crop exposed to flood impacts. After the embankment stage in the 2000s, the AW rice is a successive major crop exposed to floods (Figure 21). HYV implemented by landowners is protected by embankment that enables the protection of rice production from flood impacts and the intensifying of agriculture within the protected area. However, the embankments have constrained flood-related resources development that has provided a major livelihood opportunity to landless households. According to Nha (2004), dyke systems contributed to reducing flood-related resources, particularly fish diversity, that provided livelihood opportunities to flood-affected people, especially landless households. Moreover, flooding conditions without the "adaptive" floating rice were not relevant to foster the flood-related resources (e.g., fish and vegetables). The rice intensification has shifted from mono floating rice to the double or triple HYV (Figure 21) that requires the use of a large amount of agro-chemicals (Figure 23). Rice intensification has initially provided more off-farm wage activities; however, the agricultural mechanisation and seasonality of rice-sowing schedules set by district agricultural managers have reduced off-farm income. This process has affected the income-earning activities of landless households who rely on these off-farm activities. The change in agriculture has shaped infrastructure development, such as irrigation systems and embankments. These physical measures have influenced flood-related resource development which, in turn, affected floods of socio-economic groups.

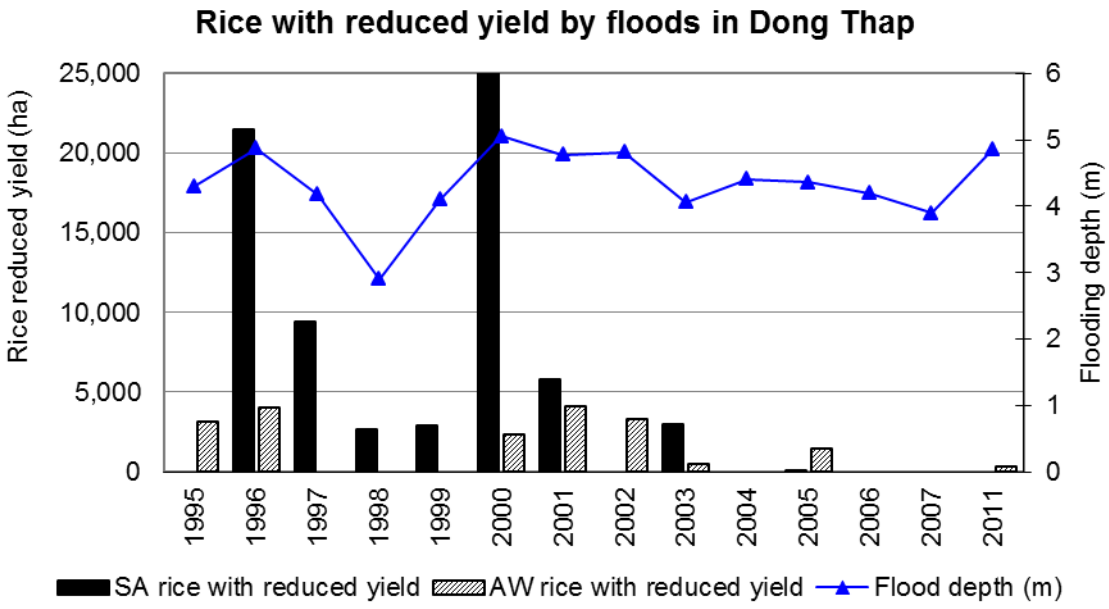


Figure 22: Rice with reduced yield due to floods in Dong Thap Province
(The SA rice crop destroyed by flood in 1994 was 136,129 ha)
(Source: Author, based on data of Dong Thap CFSC, 1991-2011)

In sum, the trends in flood exposures are shaped by various factors, such as climate change and water management in the upper VMD, resettlement patterns and agricultural intensification. These factors are shaped by both formal (governmental) and informal (individual) aspects. The links among these factors indicate that any flood-related intervention (e.g., land use change, embankments, and resettlement) has influenced differently the exposure of elements or socio-economic groups in the rural floodplains.

5.5. Positive Effects of Flood Exposure

As previously discussed, slow-onset floods provide many benefits to the local community. Recently, these benefits are changing due to human interventions, such as embankments and agricultural intensifications. However, the changes in flood-related benefits have had different effects on livelihoods of different socio-economic groups.

5.5.1. Food-Related Resources for Household Consumption

Local residents took flood-based food for household consumption (e.g., fish and vegetables) which helped them to reduce their daily cost of living. Fish that was collected during flooding was processed as other fish-based products, such as dried fish, salted fish and fish sauce in order to keep long-term duration for household consumption. In addition, poor people also collected vegetables, such as water spinach, lotus, water lily, water hyacinth and *Sesbania sesban* flower for household consumption or sale. Normally, dependents, such as the elderly, women and children, collected flood-related products for household consumption as well.

According to residents in the Phu Hiep floodplains, flood-related resources contributed to ensuring food security at the household level since fresh and processed flood-based foods served local residents during the six months of the flooding season.

Furthermore, flood-related resources are also valuable sources of feed for small-scale agriculture. When households raised pigs, chickens, ducks or other animals during flooding seasons, they were essentially fed through the flood-related feeds. When snakehead fish production was extensively cultivated, the water-related resource was inexpensive and a main feed for this aquaculture. Although floods disrupt crop production and major income-earning activities, local residents, particularly the poor, cope through fishing and collecting the flood-related foods. In short, flood-related resources play an important role in food security at the household level since they have provided food for both household consumption and small-scale agriculture such as snakehead fish, eel, duck, and pig.

However, the decline in flood-related resources has significantly influenced rural livelihoods because rice-based farming systems changed, and almost all wasteland or swallow areas were cultivated. Therefore, households relying closely on these susceptible resources (e.g., flood-related resources) are more affected by livelihood disruption due to floods. They have faced a decrease in both flood-related income and flood-based foods for household consumption. The interaction between flood-related interventions and flood-related resources has influenced the livelihoods of socio-economic groups differently.

5.5.2. Fishing as a Main Income Activity of Rural Landless Households

In the past, almost all people living in flood-prone areas earned a living from fishing during the flooding season, and they carried out different fishing strategies due to their flood-based conditions. For instance, better-off fishermen usually earned a higher income given the advantages of their adequate fishing tools and conditions, such as large natural fish ponds, high machine capacity, larger boats, modern fishing gears, nets and electronic fishing tools. The poor, in contrast, had small boats and lacked the advanced fishing tools. Previously the poor could earn higher flood-based benefits during flooding season compared to today. As a result, flooding was considered both a natural hazard and a livelihood opportunity. According to in-depth interviews with people in Phu Hiep Commune in 2008, recently, better-off outsiders have usually used larger boats, more advanced fishing equipment, and illegal fishing methods to catch fish in the rural floodplains. This negatively affects fishing for local poor households. Clearly, when a natural resource becomes scarcer, conflicts among natural

resources users occur and are more severe, and poor resource users usually are at a disadvantage.

Regarding the decline in flood-related resources mainly caused by land use change, embankments and illegal exploitation, wealthier fishermen have gradually shifted into other livelihood opportunities. For example, in Phu Hiep Commune, wealthier fishermen who have more quality livelihood assets to obtain other livelihood opportunities have started concentrating on high-yielding variety crops (e.g., HYV, taro, scallion) which require significant financial investment and farming experience. These wealthier fishermen have a wide choice of livelihood options while most poor fishermen continue to rely mainly on fishing. Poor residents lack access to agricultural land and financial sources for crop farming, and they also find it difficult to access non-farm income-earning activities. Consequently, it is difficult for poor fishermen to move to other livelihood opportunities. These livelihood adjustments indicate the way in which different socio-economic groups have altered their livelihood strategies in order to cope with environmental change. In short, regarding the decline in flood-related resource, livelihoods strongly depending on fishing are more vulnerable to livelihood disruption caused by floods.

5.5.3. Floods as Benefits for Crop Production and Flood-Based Agriculture

Although severe floods usually cause major damage to crop production, "nice floods" appear to be eagerly welcomed by almost all people, particularly landowners in the delta given the benefits to crop cultivation. First of all, flood sediments contribute fertile alluvial materials to the paddy fields. The secondary data and the narrative stories indicate that rice crops usually gained high yields after high floods. Secondly, floods sweep out agro-chemicals, pests (e.g., insects and rats) and diseases which cause an increase in both production cost and pesticide concentration in the crop fields. Thirdly, destroying grasses due to long-term flooding reduces production costs. Finally, flooding helps to wash and leach out acidic matters in acid sulphate soils (Minh et al., 1997). These advantages help to decrease production costs and increase the yields of major successive crops, particularly during the WS crop season.

Recently, wealthier households in the flood-prone areas have experimented with flood-related agriculture such as freshwater prawn, fish pen-culture and water-based vegetables that require agricultural land and significant financial investment. In Dong Thap Province, the annual increase in fresh-water prawn cultivation in the flooding season is approximately 47% (Dong Thap Statistics Office, 2000-2010). However, it is difficult for poor and intermediate households to adopt flood-related agriculture due to the high financial investment and

advanced technology required. Regarding this, major conflicts may occur due to embankments since these dyke systems may create obstacles to getting fertile alluvial sediments, releasing pests and harmful matter and implementing flood-related agriculture, as well as engaging in flood-related exploitation.

Given its overall advantages in the delta, slow-onset floods are perceived not only as disasters, but also as livelihood opportunities generated by flood-related resources. In the VMD, the livelihoods of residents are mainly shaped by water and the services provided by the surrounding natural environment (Hoanh et al., 2003). Recently, however, the VMD has changed due to rapidly growing and potentially conflicting demands on water and land resources (Hoanh et al., 2003). The rapid changes in water and land resources and population growth have influenced groups of people exposed to floods. They have led to increased costs owing to flood damage and flood-related interventions, particularly embankment construction. The flood impacts differ among varying socio-economic groups because of their particular exposure, susceptibility and coping and adaptive capacities. Concerning the pros and cons of annual slow-onset floods in the delta, flood vulnerability is shaped by how local residents are able to effectively trade off flood-related benefits and flood risks.

5.6. Main Factors of Susceptibility to Slow-Onset Floods

5.6.1. Susceptibility to Floods Shaped by Natural Conditions

5.6.1.1. Severe Acid Sulphate Soils

Acid sulphate soils are unfavourable for diverse types of crop cultivation; therefore, it was a major factor limiting early in-migrants in gaining their livelihoods in the rural floodplains. They found and applied traditional experiences and new technologies to leach or wash acidity for farming practices (Minh et al., 1997; De, 2006). Before responding to floods, local residents adapted to the negative impacts of the severe acid sulphate soil condition. In the early stage of settlement in Phu Hiep Commune in 1960s and in the initial stages of HYV conversion, many farmers failed in rice farming practices due to this unfavourable feature of soils. It is clear that severe acid sulphate soil conditions have negatively affected local people in the rural floodplains. Furthermore, embankments create obstacles to leaching and washing acid sulphate soils as well as accumulating alluvial sediments in the crop fields. According to in-depth interviews, farmers who had cultivated rice production inside the embankment in Phu Hiep Commune worried that soil conditions were not improving due to a lack of alluvial sediment as well as acid sulphate soil leaching.

Amount of fertilisers used	Floating rice (Kg/ha), (Mono crop)	HYV (the 1990s) (Kg/ha), (Double crops)	HYV (2010) (Kg/ha), (Triple crops)
1. Amount of fertiliser used per crop	**0**	**190**	**210**
- Nitrogen	0	95	100
- P_2O_5	0	45	55
- K_2O	0	60	55
2. Amount of fertiliser applied per year	**0**	**400**	**630**
- Nitrogen	0	190	300
- P_2O_5	0	90	165
- K_2O	0	120	165

Figure 23: Change in amount of fertiliser applied for rice production in the rural Mekong floodplains
(Source: Author, in-depth interview with a farmer in Tam Nong, Dong Thap in 2010)

5.6.1.2. Water Pollution

In recent times, natural resource usage has been shifted into agricultural intensification (e.g., HYV) which contributes to environmental degradation, such as water pollution, the decline in natural resources and soil degradation. According to the in-depth interviews with farmers in the Plains of Reeds in 2010, they revealed that they did not apply chemical fertiliser for floating rice. However, regarding rice intensification, the amount of fertiliser as well as other agro-chemicals used has increased rapidly from extensive (double rice crops) to the intensive cultivation (triple rice crops) estimated at 1.5 times annually compared to before (Figure 23). Furthermore, in the upper delta, a rapid increase in HYV planted areas, as well as snakehead fish and *Pangasius* production, have negatively affected the water environment. This agricultural intensification has created water pollution in flood-prone areas in terms of the overuse of agro-chemicals and untreated waste from intensification cultivations (e.g., *Pangasius*, snakehead fish, duck herds and pig production). The agricultural intensification that is mainly engaged in by wealthier or large landowners has influenced the natural environment, particularly water quality, which has in turn influenced the local community.

However, poor households are more vulnerable to environmental problems since they lack the capacity to access basic needs (e.g., tap water supply, electric pumps and financial sources). The rapid population and economic growth, overuse of agro-chemicals and untreated waste from agricultural intensification and human domestic use have contributed to the warning status of environmental pollution (White, 2002). White indicates that the total estimated annual output of nitrogen and phosphorus by the Mekong and *Bassac* Rivers is approximately 0.24 million tonnes and 0.07 million tonnes, respectively. In the rural flood-prone area, the trend in agricultural intensification is potentially increasing since the cultivated area of the AW crops in the full flood-control areas is being continuously enlarged since the AW rice crop

was considered a major annual crop as well as gaining more benefits compared to the SA rice crop. Therefore, these human-induced shocks and stresses could influence poor residents' health since they lack access to clean water sources and clinical services. Clearly, population growth has also caused pressure on the decline in the natural resources in the rural Mekong floodplains (De, 2006). The poor are negatively influenced by the decline in natural resources as they often lack access to other livelihood options.

Furthermore, in the VMD, tap water suppliers usually serve the densely populated areas; however, poor households usually settle in floodplains or far from high dykes so that they must use unsafe water in canal systems. In the dry season, these canal systems are gradually polluted due to agro-chemical concentration and untreated waste from agricultural intensification (e.g., HYV, vegetables, *Pangasius*, snakehead fish, duck herds and pig production) and domestic activities. Although local residents were aware of the fact that water pollution was considered one of the most dangerous factors in their lives, they also throw waste into canals. In the inland site, Phu Hiep Commune, many poor households who usually live far from the densely populated areas have used water in canals. It means that both in the dry and flooding seasons, these residents, particularly the poor, have to use unsafe water sources in the canals or floods. In brief, the agricultural intensification mainly engaged by wealthier households has resulted in environmental pollution. Moreover, poor residents are more exposed to this since they lack physical household assets such as tap water, electric pumps and financial sources to protect against environmental pollution. In addition, several existing habits, such as direct access to canal water for daily use and soaking in floodwater also affect local people more exposed to flood risks and water pollution. These existing habits in the rural floodplains have negatively influenced local residents, particularly the poor, who are more exposed to water-related risks.

5.6.2. Susceptible Sources of Income

In the rural floodplains, types of income sources have influenced local residents to cope with livelihood disruption caused by floods. These sources of income affect socio-economic groups susceptible to flood risks differently since they rely on different sources of income. The landless and small-scale landowners are mainly reliant on flood-related resources, off-farm income and remittances. However, these sources of income are more susceptible to changes in flood regimes and flood-related resources. First, as previously discussed, the decline in flood-related resources that was caused by the construction of embankments as well as agrochemical use has negatively influenced poor households who neither earn high incomes nor produce flood-related foods in order to reduce their daily expense. Secondly, a decrease in

off-farm income that has provided the main income for the poor has been caused by the synchronised sowing schedules in rice production and an increase in farming mechanisation. The seasonality of rice production increasingly occurs because of an increase in the construction of embankments and synchronised sowing schedules. The seasonality of rice production has caused a lack of off-farm labourers for farming activities so that agricultural mechanisation is needed. Thirdly, remittance was small and unstable because out-migrants usually undertake low-skilled jobs in the urban areas due to their low professional as well as educational expertise. According to the household survey in 2009 in the research sites, more than 96 per cent of out-migrants for urban jobs range from 18 to 35 years of age. It means that older people find it difficult to join the urban labour market. Clearly rural labourers are susceptible to livelihood disruption due to long-term flood impacts. In short, susceptibility to floods of different socio-economic groups is shaped by various natural and socio-economic factors. This will be discussed more detail in the Chapter 8, which emphasises coping and adaptation with respect to the transforming structures and processes that are present.

6. Local People's Reactions to and Capacity to Access Resources in the Context of Slow-Onset Floods

At the household level, formal and informal flood coping and adaptation strategies were explored differentially since each type of responses played different roles in terms of flood risk reduction. Formal coping and adaptation strategies are implemented by governmental institutions while informal flood coping and adaptation strategies are mainly implemented by various socio-economic groups. Regarding floods in the VMD, adaptation seems to be significantly enhanced through economic assets since residents have selected appropriate facilities necessary to respond to flood impacts. However, coping activity is an important strategy which responds directly to flood impacts and significantly contributes to the adaptation processes. Wealthier and poor households cope with and adapt to floods in various ways. In the rural floodplains in the VMD, flood coping is most important for poor households while flood adaptation is mainly implemented by wealthier households.

6.1. Coping Activities of Local Communities

An informal flood coping strategy is constructed by individuals or communities in order to quickly respond to direct flood impacts. Regarding annual slow-onset floods, coping activities are influenced by varying flood-related aspects such as traditional weather forecasts, household asset preservation, food preparation and income generation. In this study, a series of coping activities were explored in order to present how flood coping was changing regarding the environmental and economic changes. In the context of climate variability and the rapid rural change, coping activities are necessary to respond immediately to new shocks before residents enhance their adaptive capacity. For instance, in Phu Hiep Commune, unusual whirlwinds in 2008 and high rainfalls in the end of flooding seasons in 2008 and 2010 caused damage to 30 stilt houses and a large area of rice seedling since the occurrence of these natural hazards was unpredicted by local residents. Thus, differentiating informal coping capacity from formal coping and adaptation allows for a recognition of the construction, evolution and disappearance of coping activities. Informal coping at the household level is necessary to mitigate individual flood damage; however, collective informal coping at the community level is normally operated in the case of severe flood damage, such as mortality, dyke breakage and critical infrastructure destruction. In this chapter, informal coping and adaptation at the household level are focused upon, and formal coping and adaptation will be explored separately.

6.1.1. Coping with Human Insecurity

In flood-prone areas, much attention is paid to taking care of people, particularly children, by local residents in relation to flood risks. In the flooding season, in Phu Hiep Commune, adults were assigned to take care of their family children; however, because of a lack of primary labour, many poor residents had to carry their children while fishing in severe flooding conditions. Therefore, because of this, children were severely exposed to flood risks. In addition, in order to cope with daily income disruption, many poor residents accepted work in severe flooding conditions with unsafe equipment such as a small boat and temporary man-made life-vests. For any unpredicted occurrence, such as a boat accident, human sickness or unusual weather situations, these poor fishermen were extremely exposed to flood risks. The elderly were also protected from severe flood impacts. They were usually reduced to leaving their houses and seeking income-earning activities in the floodplains. They were usually assigned to take care of their family children. In the flooding season, each adult family member was responsible for certain coping activities in order to mitigate flood impacts.

6.1.2. Adjustment Flexibility Regarding Housing Condition

The adjustment in terms of housing conditions is regularly applied by local residents to mitigate direct flood impacts. In the research sites, in the earlier stage of settlement, local residents mostly lived in temporary stilt houses located along low canal dykes or in the rural floodplains. Regarding low topographical places, local residents had to elevate their houses for the entire flooding season. They either lifted up their house floors or took out floor planking depending on the increasing flooding in order to protect themselves and their physical household assets. Most poor residents who live in temporary stilt houses adjust their flooring during high floods. The number of houses which needed to adjust the house floor during the flooding season decreased since their housing conditions were upgraded, and a large number of households prone to floods were relocated in high elevated areas. Generally, this coping activity is contracted with the rural basic infrastructure and housing conditions improvement which are associated with rural economic development.

6.1.3. Temporary Evacuation

Seasonal evacuations are implemented as flood coping strategies by new settlers and those who lack appropriate human safe conditions (e.g., housing conditions, flood-related coping means and neighbours' support). In the early stage of settlement in the rural floodplains in the 1960s, almost all local residents returned to their home villages during flooding season since in the new settled communes in the rural floodplains their housing conditions were

undeveloped, and community networks for flood coping were weak. When they earn flood-related income, improve their houses and physical household assets and enhance social networks (e.g., neighbours and relatives' support), they permanently settle in the rural floodplains. In the Phu Hiep floodplains, in the early stages of settlement, several households tried to live with severe flooding in undeveloped housing conditions since they constructed their flood coping mechanism through mutual assistance with their neighbours and kin.

A regular evacuation pattern was when high floods reach the highest peaking stages and local residents who lived in flood-prone areas obligatorily and voluntarily evacuated to higher elevations, such as rural roads or other public infrastructures such as schools and communal buildings. In Phu Hiep Commune, most people sent their children, the elderly, valuable assets and animals to safer places like their relatives' houses without flooding while they protected their houses and earned the flood-related benefits. When floods receded, local people rebuilt their houses. In the early stage of settlement in the rural floodplains, their houses and physical assets were inexpensive so these assets were therefore easily damaged by flood impacts. Moreover, their houses and physical assets were not protected by trees surrounding their homesteads, which were gradually planted. However, previously it was easier for local people to recover their houses since there was a plentiful amount of housing material (e.g., trees, bamboos, leaves and wires). In general, local residents mainly relied on flood-related resources since they used flood-related resources (e.g., fish and vegetables) during flooding and processed foods (e.g., dried and salted fish) in the dry season.

In Phu Hiep Commune, another notable evacuation pattern is that wealthier households engage in rice production in the floodplains and return to their home villages during the flooding season. In contrast to those who engage in flood-based livelihoods, this group mainly relies on rice production since these wealthier households have a large agricultural land area. Their housing conditions and family members are not located in flood-prone areas. Unlike the riverbank site, these wealthier households occupy approximately 30 per cent of the agricultural land in Phu Hiep Commune. These beneficiaries of the HYV conversion bought agricultural land from poor residents who failed in the HYV conversion. In recent years, these wealthier households built concrete houses in the rural floodplains and registered as the commune's residents, which helped them access loans from the banks and implement AW rice crop during flooding season.

In short, in the context of slow-onset floods, an evacuation is an unexpected choice. The evacuation is accepted by local residents when their lives are at risk from floods, and currently they have a lack of support from basic infrastructures as well as social networks.

When their coping capacity is relatively enhanced through the improvement of physical assets (e.g., houses and other physical household assets) and social networks (e.g., support from neighbours and kin), local residents would like to live with floods in order to enjoy flood-related benefits and protect their physical assets from flooding. Recently, regarding the construction of roads and the high dyke systems constructed, local residents in the rural floodplains have built their houses on or along high dykes; consequently, the number of households evacuated during high flooding is reduced.

6.1.4. Coping with Livelihood Disruption

6.1.4.1. Flood-Related Resource Exploitation

Flood-related exploitation is an effective and valid coping strategy that provides both food and a main source of income for local residents during flooding. During the flooding season, farming activities are disrupted for approximately four to six months; therefore, income-earning activities for households, particularly the landless, who are prone to floods, are necessary. In the past, both the poor and wealthier households engaged in fishing during the flooding season. Wealthier fishermen usually had an ample supply of fishing tools so they benefited more than poor households. Before the HYV conversion, large landowners had large natural ponds that provided them with high yield of natural fish. However, the HYV conversion encouraged these landowners to fill up these natural fish ponds because of a decrease in natural fish and an increase in HYV benefits. Moreover, wild land that is favourable for natural fish is improved for rice cultivation. It means that flood-related livelihood opportunities, particularly fishing, for landless residents are gradually reduced (Figure 24). Recently, as flood-related resources have become scarcer, conflicts among poor and wealthier fishermen have occurred more regularly. Besides fishing for income, many households in flood-prone areas engaged in fishing for their household consumption for the entire year. They consumed fish in the traditional ways, including making fish sauce, dried fish and salted fish. Generally, fishing was not only a meaningful coping activity, but also a significant income-earning activity for local residents living in the rural floodplains.

As previously discussed, the decline in flood-related resources has shaped rural livelihoods in the flood-prone areas; therefore, people have gradually adjusted their livelihood strategies in order to adapt to the change in flooding and flood-related conditions. People's livelihoods change during flooding, but these changes depend on their household wealth or agricultural land ownership. It seems that coping is more important for the poor since it has occupied a large percentage of their flood-related response measures.

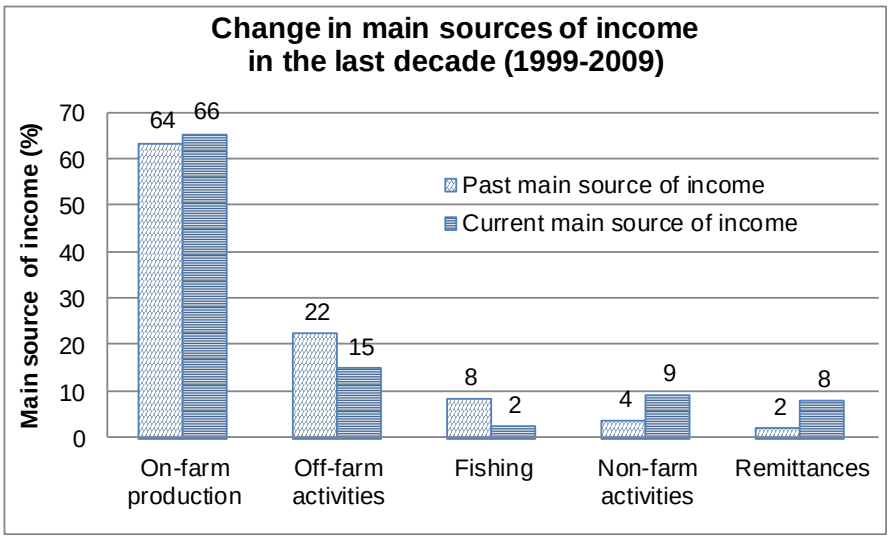


Figure 24: Changes in main sources of income within the last 10 years (1999-2009)

(Source: Household survey, 2009)

In the past, floods restricted local residents to growing crops and earning off-farm wages; however, landless people and landowners gained their livelihoods through fishing and flood-related production. In the Phu Hiep floodplains, long-term in-migrants revealed that they relied on savings derived from flood-related benefits during the flooding season; however, in recent years they borrowed private loans for daily costs of living or tried to look for new income-earning activities.

Table 5: Changes in the number of income sources regarding land ownership and relocated groups

Type of houses	Relocated group (N=120)	Landless group (N=82)	Small land ownership group (N=82)	Large land ownership group (N=86)	Group Total (N=370)
	Mean	Mean	Mean	Mean	Mean
Number of income sources in 1999	2.03^{ab}	1.95^{a}	2.45^{c}	2.30^{bc}	2.16
Number of income sources in 2009	2.17^{a}	2.26^{a}	2.74^{b}	2.60^{b}	2.42
Comparison between 1999 and 2009	na	*	*	*	

(Means with the same superscript in row do not differ significantly at 5% level; * significance within 10 years)

(Source: Household survey, 2009)

Figure 24 indicates that rural labour has gradually shifted into non-farm activities in the rural floodplains and into non-farm jobs in urban areas. However, the labour transition has been shaped by agricultural land ownership since a higher number of young labourers in landless households have migrated to urban areas for non-farm jobs (Figure 26). In recent years finding a source of income in urban areas seems to be a higher priority for landless people than saving their houses and household assets in the rural floodplains.

6.1.4.2. Seasonal Migration

In the VMD, seasonal migration is a strategy to cope with livelihood disruption caused by floods; however, migration patterns vary among socio-economic groups, as they are dependent on their capabilities and access to livelihood assets. Previously many poor households migrated to flood-prone areas for livelihood opportunities; however, due to the decline in flood-related resources, they have moved to other places (e.g., Ho Chi Minh City, Dong Nai, Binh Duong) for income. The study indicates that almost all people living in flood-prone areas fished or used the flood-based resources for commerce and household consumption. They were able to earn and save money from flood-related resources. In contrast, presently, local people, particularly the poor, are exposed to disruption in income-earning activities, and they have had to borrow money from private moneylenders or buy basic goods on credit for their daily needs. In recent years, many landless and small agricultural land households rely on flood-based resources and remittances from migration while households with large landholdings have gradually shifted to HYV or other intensive flood-based crop production as their main income-earning activity (Figure 26). It means that seasonal migration is mainly selected by landless and small landowners as a strategy to cope with livelihood disruption by flood impacts.

Since flood-related resources have declined rapidly, landless households have shifted from natural resource exploitation to income-earning activities such as being shoe and garment workers, shop keepers and construction assistants in urban areas. Remittances derived from out-migration during the flooding season became more and more popular; however, the remittance depended on a person's educational as well as professional expertise. Young labourers in landowning households usually find opportunities to enhance their education and farming activities, while young labourers in landless households usually look for low-skilled jobs in urban areas given their lack of skills and educational expertise. According to the focus group discussions in Phu Hiep and An Hoa Communes, early out-migrants have usually encouraged their family members, relatives and friends to migrate for non-farm income-earning activities in urban areas. These early out-migrants share information and experience in terms of looking for non-farm jobs as well as living in the urban areas for the later out-migrants. During rice harvesting, while temporal migrants have worked in urban areas, many seasonal migrants are forced to return to their home villages for off-farm earning activities because they obtain a higher income compared to their wages in urban areas. Clearly, seasonal migrants' income is low and unstable; therefore, they have seasonally returned to their home village for a higher income. According to migrants in the research sites, many out-migrants

hope to find a stable job in which they are guaranteed to work in the long term and earn a reasonable income rather than a seasonally high income at their home village. Moreover, rural middle-aged labourers find it difficult to look for non-farm jobs in urban areas since employers have mainly enrolled young labourers.

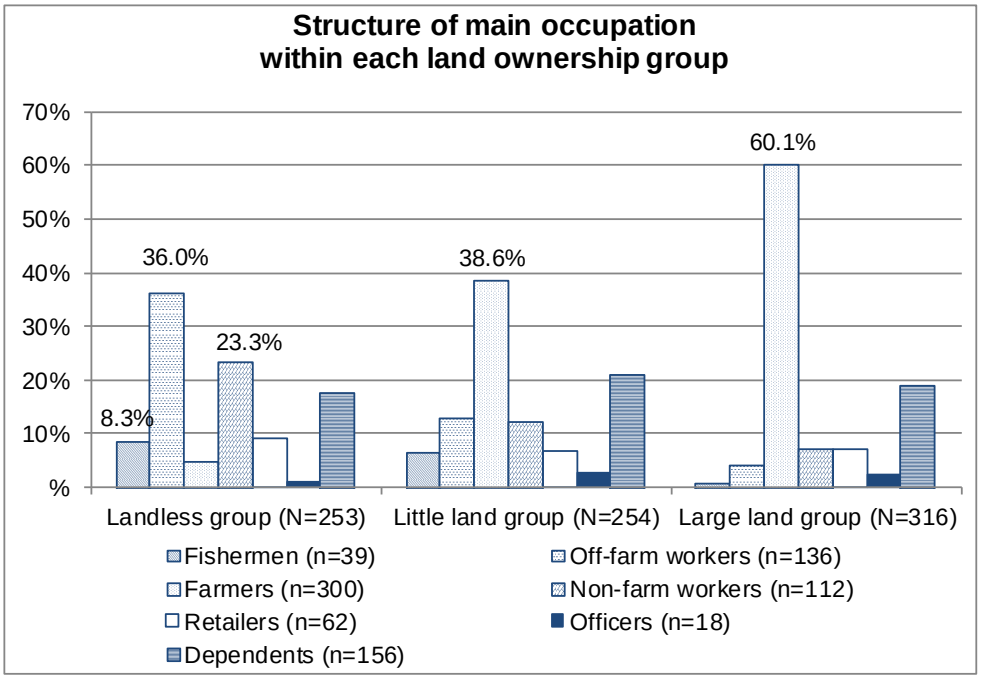


Figure 25: Structure of main occupation within each land size group

(Source: Household survey, 2009)

In the research sites, there are several types of migration patterns for income-earning activities. While young labourers in the inland area, Phu Hiep Commune, migrate to urban areas for non-farm activities, young labourers in the riverbank area, An Hoa Commune, undertook off-farm activities in the bordering areas between Vietnam and Cambodia. As previously mentioned, a large population in An Hoa Commune was relocated from Cambodia and the border's area due to the political conflicts in the 1970s. These informal relations enable local residents to establish social networks, which help migrants to reduce the transaction cost for accessing income-earning activities as well as the daily cost of living. Historically, these two communities mainly migrated from the Mekong provinces and Cambodia. Off-farm labourers in An Hoa Commune revealed that they engaged in off-farm activities for two months in the Cambodian paddy fields, since their households were also familiar with those living and working conditions. In short, the migration destination and income-earning activities of out-migrants depended on their interpretation and professional capacity. Low remittance as well as low-skilled jobs of rural-urban migrants implies that the "push" factors are stronger than the "pull" factors. Out-migrants have usually built up labour groups as informal social networks, which have helped them to look for income-earning

activities and assist each other to reduce the daily cost of living. In the rural floodplain, the purpose of out-migration flows is shifted from temporarily avoiding flood risks into obtaining remittance as a coping strategy.

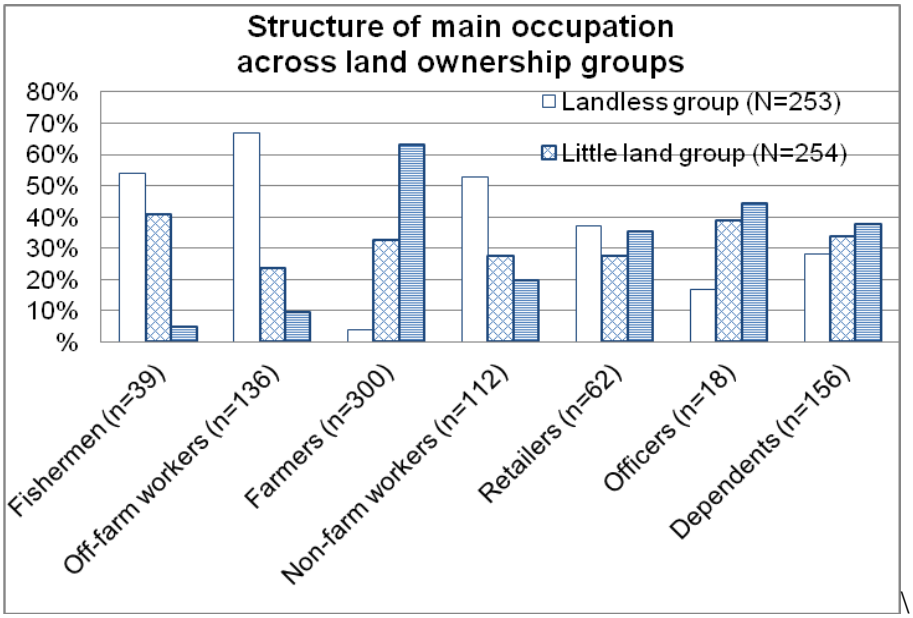


Figure 26: Structure of main occupation across land ownership groups
(Source: Household survey, 2009)

In short, in the context of annual slow-onset floods, while flood-related resources and off-farm based income decline quickly, migration to urban areas for income becomes a popular coping strategy for poor landless households. However, out-migrants have access to low-skilled jobs since their income-earning opportunities are constrained by their age, health and educational grades. Young labourers (ranging from 15 to 36 years of age) and their educational grades indicate their potential capacity to access remittances to cope with financial shocks due to flood impacts.

6.1.4.3. Collective Coping Patterns

People who were relocated in the residential clusters or dykes worked together as off-farm wage labour teams in order to cope with livelihood disruption due to floods and the relocation process. Since synchronised sowing schedules through embankments is popularly implemented in order to manage pests on rice crops, the need for off-farm activities has become severely seasonal. In addition, agricultural mechanisation is also progressive; therefore, the need for off-farm activities has gradually been reduced. Many landless labourers in the residential clusters and dykes have strongly competed in off-farm activities with off-farm labour outsiders. To address this problem, the relocated residents who have verbal contracts with agricultural landowners in term of off-farm activities establish off-farm

labour teams in order to enhance their capacity to compete with off-farm labour outsiders. This strategy aims to cope with the decrease and seasonality of off-farm activities. In the early stage of relocation in the residential clusters and dykes, this coping is expected to resolve their urgent livelihood disruption; however, in the long term, these off-farm labour teams have really enhanced their income from off-farm activities.

For instance, recently landowners usually look for off-farm labourers from labour teams since these labour forces are adequate and tied down by their team regulations. Team members implement off-farm activities based on team leaders' verbal contracts with rice producers in terms of wage, time and quality. As a result, according to the standardised household survey data, the off-farm income of these households is significantly higher than the income of non-members. This institutionalisation emerges from the problem-solving behaviour of actors; in this context, the relocated residents have dealt with the high competition and seasonality of off-farm labour needs during rice harvesting time. This institutionalisation is enforced by causal agents, team leaders, who are capable of incorporating the relocated labourers and connecting with rice producers.

Table 6: Major coping activities and adaptation patterns of local households in the rural VMD

Coping Activities	Adaptation Patterns
1) Adjusting housing condition - support houses with wires just before floods - make grass fence at low floods - remove several planks of house at low floods - lift up house floor during flooding - evacuate when houses are extensively flooded	1) Improving housing condition - gradually elevate homestead and house foundations - grow trees or bushes surrounding homestead - build wooden stilt houses - improve good wooden or concrete stilt houses
2) Coping with livelihood disruption - undertake small-scale fishing - collect flood-related vegetables - sell or give up agriculture just before floods - seasonally migrate for remittances - build off-farm labour teams in residential clusters/dykes	2) Improving flood-related livelihoods - undertake large-scale fishing - access agricultural land as a main productive asset - cultivate flood-related agriculture (snakehead fish, freshwater prawn and vegetables) - build high or solid cages - learn flood-related knowledge and experiences
3) Protecting dependents and people - prepare children protection facilities - take children following fishing or travelling - prepare man-made life savers	3) Living with floods - improve housing conditions and physical assets - assign adults to take care of children - informally relocate along high roads - teach children and residents to swim

(Source: Author, KIP, focus group discussions, in-depth interviews, Dong Thap, 2008-2010)

In the rural floodplains, local residents have usually helped or worked together in order to mitigate flood damage to individuals and the local community. Local residents have helped each other to upgrade or build houses, flood-related means, dykes, roads or bridges. They have helped local farmers to harvest agricultural products, mainly rice crops, which are threatened by flood impacts. Another important collective activity is that local residents have protected dyke systems that are strongly affected by high floods. After flooding, local people

again voluntarily recover houses, physical household assets, roads, bridges and public buildings. During the flooding season, local residents are also ready to rescue flood victims or evacuate houses damaged by flood impacts. In short, these collective coping activities are necessary to mitigate direct flood impacts.

6.1.5. Changes in Coping Processes

Generally, informal coping activities are important strategies of flood-affected households used to cope with direct flood impacts. With regard to the rural floodplains, in the context of poor infrastructure and an undeveloped economy, coping activities are predominant; however, gradually these selected coping activities have enhanced and significantly contributed to flood adaptation processes. In the rural floodplains, a series of coping activities is formulated and applied during flooding; however, these coping activities evolve and disappear due to environmental change. Relevant coping may enable local residents to significantly reduce direct flood damage and enhance their livelihood adaptation process over the long term. In contrast, many coping activities disappeared due to a lack of regular performance. For example, less attention is paid to swimming by the relocated residents since they are not exposed directly to flood risks. In the context of annual slow-onset floods, coping activities are repeated with each flood and these coping activities gradually become flood-related knowledge in terms of flood mitigation measures. It implies that informal coping is enhanced through lessons learned. In the flooding conditions, local adults teach young residents how to swim, prepare life-preservers, row a boat, fish, collect flood-related vegetables, protect physical household assets, build stilt houses etc. These are short-term activities which enable people in the community to respond to direct flood impacts, but they have also enhanced and contributed to the informal adaptation process.

6.2. Adaptation of Local Communities in the Context of Slow-Onset Floods

The long history of floods has forced local communities to create a series of adaptation strategies which are applied to adapt to flood impacts and disseminated within the community. If coping is necessary to respond to flash hazards, adaptation is more suitable for slow-onset hazards. In severe flood-prone areas in the VMD, including An Giang, Dong Thap and Long An Provinces, which can be inundated with over 3 metres of water for approximately four to five months a year, rural lifestyles have tried to adapt to annual floods. These adaptive responses include housing conditions, flood-related forecasts based on local knowledge, flood-related crops, crop calendar adjustments and in-migration for long-term livelihood opportunities (Swain et al., 2008; Yamashita, 2005; De, 2006). In the rural floodplains, stilt

houses or floating houses are adapted to annual slow-onset floods. These houses are protected by trees as buffer fences surrounding their houses. Flood forecasting is based on bamboo, grass or insects. Major flood-related crops include floating rice, flood-based vegetables, fish pen culture, fresh-water prawn and snakehead fish.

6.2.1. In-migration

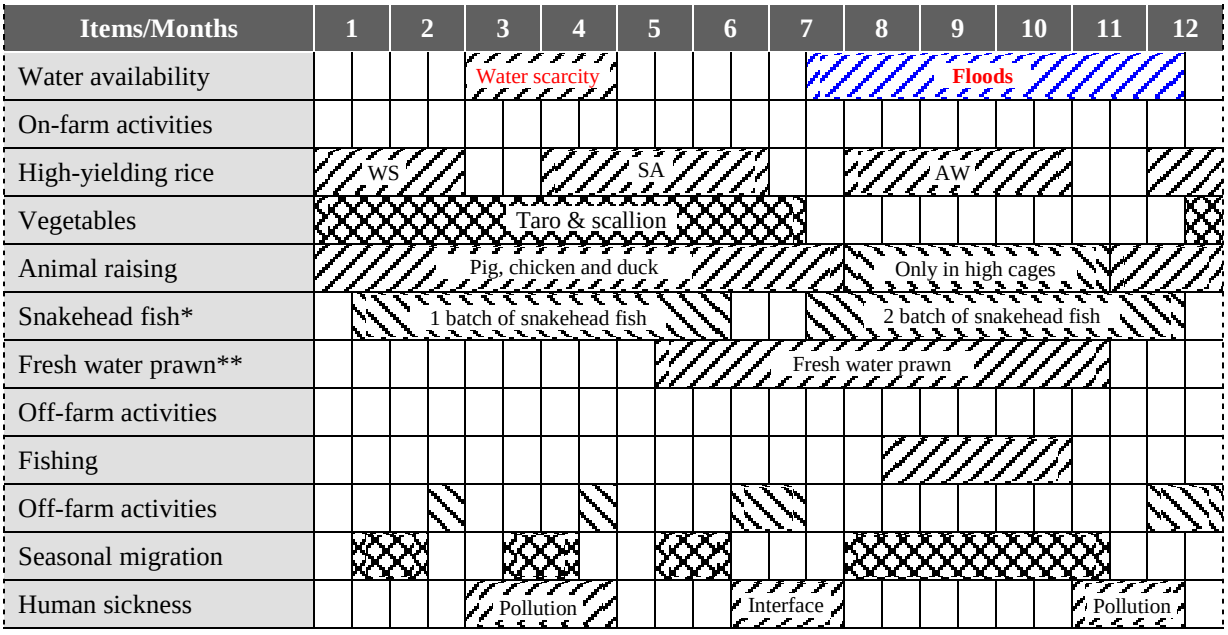
Floods have existed for thousands of years in the VMD before in-migrants settled in this area. Vietnamese culture has been influenced by migration and resettlement patterns. Hence, migration is considered a key factor in the historical evolution of state and society in Vietnam (Zhang et al., 2006). Historically, people in the north moved to the south to look for new livelihood opportunities. If they found potential livelihood opportunities, they chose and settled in high places, along rivers or natural trenches. Therefore, annual floods are not only main reasons for seasonal and temporal out-migration as current studies have emphasised, but have encouraged in-migration flows. Access to livelihood opportunities is an important factor for in-migrants in rural flood-prone areas. A trade-off between push- and pull-factors has shaped migration flows in the rural floodplains.

The decline in flood-related resources forced poor households to migrate and look for better livelihood options. At the study sites, many in-migrants turned back to their home villages or migrated to urban areas for non-farm jobs when they failed in adapting to their new livelihood strategies in flood-prone areas. The major reasons for temporal out-migration were linked to failure in terms of livelihood activity. Many households could not return to their old home villages since they had already sold their homesteads and agricultural land before they decided to settle in the rural floodplains. Clearly, migration is associated with complexity within nature and society (Oliver-Smith, 2009), in which urban-wards migration for income is related to the decline in natural resources and a reduction in off-farm activity.

6.2.2. Housing Adaptation

In flood-prone areas, the Vietnamese pioneers elevated their residential land, planted trees to protect their houses, built stilt houses, and learned how to protect themselves and their physical household assets during floods. The Vietnamese pioneers selected to settle in existing earth mounds or high elevated land along main rivers or natural trenches in the VMD (Nam, 1992). They elevated their homesteads gradually by digging ditches and building land beds which were not only useful for house building but also for agriculture given the fertile alluvial sediments produced by flood waters. The built beds could reconcile physical buildings and flooding. These measures made it possible to build high elevated places and concurrently

received flood-related benefits during the flooding season. In fact, through long-term improvement of informal dykes, the elevation of river-side areas is usually higher than that of the inland areas (Hoi, 2005). These traditional techniques took advantage of flood-related benefits, but did not constrain water-flow and alluvium sediments that are useful for crops. This means that human beings coexisted with nature. However, after the historic 2000 floods, local governments constructed dykes, roads and house foundations in the rural floodplain. In the early stage of construction, these infrastructures were easily eroded since water waves became stronger because of rural floodplains without grasses and floating rice.



Note: WS: winter-spring rice crop, SA: summer-autumn rice crop, AW: autumn-winter rice crop
(*) different from household wealth; (**) unpopular in Phu Hiep Commune

Figure 27: Seasonal crop calendar in Phu Hiep Commune, Tam Nong District
(Source: Author, KIP in Phu Hiep Commune, 2008)

Examples of flood adaptation in the rural floodplains are housing conditions. Stilt houses are gradually improved through their wealth and residential land. According to local residents in Phu Hiep Commune, building a quality house is the first priority to live with annual slow-onset floods. A good stilt house is necessary for local residents to adapt to floods, to store farming materials and products and to be seen as a wealthy symbol of a household in rural floodplains. Local residents who own residential land have a wide choice for building as well as upgrading their adaptive houses characterised by a high elevated house foundation, good quality houses and trees surrounding houses. While temporary houses and physical assets are susceptible to high floods, permanent houses make it possible to protect physical household assets and human lives. Thus, flood-related household assets enable local residents to both respond to flood impacts and gain flood-related benefits. In addition, local residents who own

residential land improve their housing condition actively; in contrast, other local residents who have no residential land are barely exposed to flood risks. In short, quality of housing, access to physical household assets and access to residential land influence the ability of local people to respond to flood impacts.

Households that have no residential land build their temporary houses in flood-prone areas (e.g., in floodplains and along canals or rivers). After the 2000 floods, poor landless households and those with small amounts of land were selected for resettlement, but it was difficult to convince some of them to relocate to the residential clusters and dykes. This was largely because these households tried to rely on both benefits from their homesteads and the existing socio-economic relations that were constructed in the long term. Clearly, residential land ownership influences local residents' decisions in terms of relocation since local residents have gained benefits through small-scale agriculture and improved their housing adaptation. The relocated residents in Phu Hiep Commune revealed that they escaped from direct flood impacts; however, they were exposed to new shocks as previously discussed.

6.2.3. Income Earning Strategies

Annual floods have provided both flood-related problems and income-earning opportunities to local residents; therefore, the actors simultaneously adapt to floods and actively try to reshape the flood-prone landscape and enhance their flood-based livelihoods. Their livelihoods have, in turn, shaped adaptation process and influenced people's flood vulnerability.

Figure 27 indicates that in the flooding season, major on-farm activities are the AW rice crop, snakehead fish, livestock and fresh water prawn; however, these farming activities are mainly implemented by wealthier households. In the rural floodplains, a part of the rural population who are mainly landless has still relied on flood-related resources. In brief, access to agricultural land enables local residents to implement on-farm activity as well as to access financial institutions owing to land title certificates as collateral; in contrast, landless people are more susceptible to livelihood disruption.

Table 7 presents the main sources of income of rural households that were changing during the last decade (1999-2009), but those changes were different regarding land size groups. The structure of household income of large landholders is stable, and more than 90 per cent of them rely mainly on on-farm income (Table 7). In contrast, the structure of the household income of landless people was changing. Income sources were shifted from farming-related activities to non-farm based activities. Although the relocated households and the landless

households were mainly poor, the changes in their income-earning strategies within the last decade were different (Table 7). The structure of on-farm and off-farm income sources of people who were relocated to the residential clusters and dykes changed a little while those of the landless households fell more than 10 per cent. The proportion of fishing income of these two groups was reduced; however, the decline in fishing of the relocated group was higher than that of the landless group. Similarly, the remittances of these two groups increased.

Table 7: Changes in the structure of household income in the last decade regarding different land ownership and relocated groups

Sources of Income	Relocated group (N=120)		Landless group (N=82)		Small land ownership group (N=82)		Large land ownership group (N=86)		Group Total (N=370)	
	1999	2009	1999	2009	1999	2009	1999	2009	1999	2009
	%	%	%	%	%	%	%	%	%	%
On-farm production	15.0	14.9	28.3	19.5	69.6	80.6	90.7	95.3	47.9	49.2
Off-farm activities	51.7	51.7	52.4	37.8	13.4	7.3	2.3	0.0	31.9	26.8
Fishing	23.3	7.5	11.0	6.1	12.2	1.2	2.3	0.0	13.2	4.1
Non-farm activities	7.5	10.0	2.4	17.1	3.7	8.5	4.7	2.3	4.9	9.5
Remittances	2.5	15.8	4.9	19.5	1.2	2.4	0.0	2.3	2.2	10.5
Group Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

(A main income is considered the highest income proportion among total household income sources)

(Source: Household survey, 2009)

6.2.3.1. Traditional Adaptive Crops and Practices

Severe acid sulphate soils and an increasing population have forced local farmers to generate indigenous ways to flush and leach the acidity out of the soil for food cultivation, especially rice crops (De, 2006). In the context of slow-onset floods and severe acid sulphate soil conditions in the rural floodplains, farmers have selected adaptive crop varieties and applied adapted techniques to farming. These farming techniques, which were found by farmers and used to adapt to flood impacts as well as environmental constraints, included shallow drainage systems, raised bed systems, acid avoidance techniques, zero-tillage techniques and the submerged seeding technique (De, 2006). These popular farming techniques were tested and improved through long-term application in the rural floodplains; however, several of them were applied in rice production in recent years because of changes in the environment and land use. Floating rice, which was popularly cultivated before the HYV conversion, grew quickly, and its leaves and panicles were above the surface of zero-tillage floodwater. This rice, which was sown approximately two months before zero-tillage floods and then harvested afterwards, was considered one of the most popular adaptive crops to annual slow-onset floods for a long period. In Phu Hiep Commune, floating rice was entirely replaced by the HYV since the 1990s; however, zero-tillage acid avoidance technique is still applied in order

to wash out zero-tillage acidity in soils. The raised bed system has rarely been used in rice production, but it has been popularly applied in vegetable cultivation (e.g., taro and scallion). According to local farmers in Phu Hiep Commune, new materials and techniques, such as agro-chemicals, irrigation systems, and new crop varieties, have gradually replaced these traditional techniques.

Farmer-originated technologies in cultural practices in the high flooding areas

- Shallow drainage system: Farmers constructed shallow drainage systems across the fields to remove soluble toxins accumulated on the soil surface in the early rainy season for floating or deepwater rice that usually provided low yields or failed due to extreme acidity in the early growing season.
- Raised bed system: Low and high soil beds were constructed to avoid flooding in the rainy season and to enhance the poor internal drainage of the heavy-texture soil
- Acid avoidance technique: Farmers replaced floating rice or deepwater rice at the beginning of the rainy season by short-duration rice by the end of the flooding season when the acidity was washed out by floods.
- Zero-tillage technique: This technique was used by farmers in the 1980s in the Plain of Reeds in order to wash out acidic toxicity in the reclamation soils that usually destroyed rice seedlings in the early rainy season.
- Submerged seeding technique: This technique was developed in the 1980s for rice grown in acid sulphate soils and flooded areas. Germinated seed was sown in clear-water fields 20-40 cm water deep but gradually reduced afterwards. When rice leaves came out of the water, the water level was kept constant at 10 cm and the first application of nitrogen and potassium fertiliser was needed for covering the rice plant.

Figure 28: Local knowledge pertaining to flood-related adaptation

(Source: KIP in Phu Hiep, 2008; De, 2006)

6.2.3.2. Agricultural Intensification

Intensive agriculture is an adaptive strategy in the rural floodplains since crop production is protected regarding concentrated production and harvesting before the flooding season. The intensive cultivation has significantly contributed to increasing total agricultural production in Vietnam, but it has also caused several problems such as landlessness and indebtedness. The conversion of single low yield floating rice (2 tons/ha) into the two or three HYV with higher yields (approximately 10 tons/ha) was implemented by farmers in the 1990s. Currently, there has been a shift from relying on flood-related resources to the intensive agriculture, particular HYV. In the rural floodplains, there are multiple replenishing and revitalising advantages pertaining to flood-related resources and agriculture. However, almost all wealthier households could apply costly flood-related agriculture. In Tam Nong District, small-scale farming (e.g., snakehead fish, duck herds) fed by natural feed has shifted to intensive agriculture (e.g., fresh water prawn, snakehead fish) supported by commercial feed. Flood-related production models such as freshwater prawn and snakehead fish have started to be developed by local farmers, particularly wealthier households; however, only wealthier households who have sufficient livelihood assets apply these agricultural models. In contrast,

landless households mainly rely on off-farm income, fishing and vegetables (Figure 29). In fact, several local residents who failed in the intensive agriculture (e.g., HYV, taro and scallion, snakehead fish) had to transfer their agricultural land to wealthier landowners or fall into indebtedness. In summary, intensive agriculture can provide high benefits; however, it also consists of significant risks and is considered a debt trap in the rural floodplains.

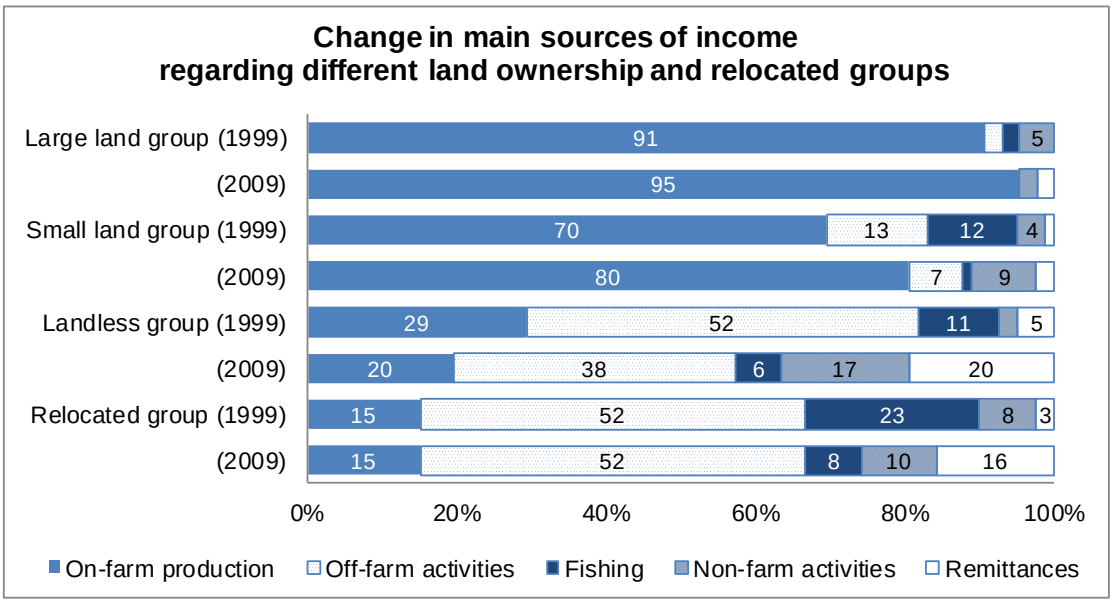


Figure 29: Changes in main sources of income regarding different land ownership and relocated groups
(Source: Household survey, 2010)

Since slow-onset floods occur annually and slowly, local residents engage in flood-related agriculture and fishing, such as freshwater prawn, fish-pen culture, snakehead fish and flood-based vegetables. These farming activities use flood-related resources since they are available and inexpensive. Through the principal of "*living with floods*", local governments issued a series of policies to support residents who engaged in flood-related agriculture. For instance, An Giang, one of the most flood-prone provinces in the upper VMD, issued specific policies supporting the establishment of an infrastructure, access to credit and an agricultural extension services for flood-related agriculture. In spite of this, poor households were marginalised from these processes since they lacked access to financial resources and agricultural land in order to implement these flood-related farming activities.

6.3. Capacity of Different Socio-Economic Groups to Access Resources and Respond to Floods

6.3.1. Introduction

Each household has a particular capacity of response concerning slow-onset floods. As coping is considered a short-term activity, adaptation as a long-term strategy may help them further

enhance their situations, particularly through accumulated experiences. However, depending on their livelihood assets and capacity, local people can build flood coping and adaptation strategies.

Access to livelihood resources plays an important role in building people's livelihood strategies in order to better respond to slow-onset floods as well as achieve their livelihood outcomes. Access to certain livelihood assets helps exposed socio-economic groups to cope with and adapt to hazards. However, people's accessibility to livelihood resources has usually been shaped by many factors, such as history, culture, knowledge, power and human capacity, as well as other livelihood resources. Thus, in the flood-prone area, understanding access to livelihood assets has highlighted major challenges and opportunities which have both constrained and enabled different socio-economic groups to respond to annual slow-onset floods. The study indicates that every group has applied both short- and long-term flood-related responses which depend on important levels, livelihood assets, capability of social groups and other factors. In fact, there are benefits from low-tech measures and traditional coping techniques that improve safety and enhance incomes in the large, mostly poor population.

6.3.2. Access to Natural Assets for Rural Communities in the Rural Floodplains

Vulnerability cannot be defined or measured without referencing the capacity of people to absorb, respond to and recover from the impacts of an event (Westgate and O'Keefe, 1976). Vulnerability is viewed as blockage, erosion or devaluation of local knowledge and coping practices (Wisner, 2004), which constrain exposed elements in responding to (potential) hazard impacts. Therefore, access to livelihood resources, particularly natural capital, is a crucial factor for response strategies. Natural capital assets include land and biological resources which are used by residents to earn means of survival (Ellis, 2000).

In the rural floodplains, flood-related resources and agricultural land are important natural resources for rural livelihoods. Paddy is a major crop, and large numbers of the rural population rely on rice-based farming systems and flood-related resources. Access to natural capital is considered an important factor influencing the livelihood strategies of landless and land ownership groups differently.

6.3.2.1. Access to residential land

Access to residential land enables local people to improve their housing conditions in order to better respond to flood impacts in the rural floodplains. In the rural floodplains, residents who temporarily build their houses on their neighbour's residential land are constrained in

applying any adaptive housing measures which help them to protect human lives, houses and physical household assets from flood impacts. This shows why, in the 2000s, almost all residential landless households in the floodplains agreed to be relocated to the residential clusters and dykes while the residential landowners tried to gain benefits based on their residential land as well as small-scale agriculture in their homesteads. Housing is gradually improved due to residents' economic wealth and flood-related knowledge that is learned within the rural community. Table 9 shows that there is a significant difference in terms of residential land sizes between the agricultural landless and large agricultural landowners. Moreover, poor households usually have no or small amounts of residential land that have negatively influenced their children's inherited residential land. A lack of access to residential land restricts poor households from implementing housing adaptation measures. The relocated households in the residential clusters and dykes have small homesteads so that it is difficult for them to engage in small-scale agriculture and other income-earning activities. Thus, a lack of access to residential land is one of factors impeding flood-affected people from adapt to flood impacts.

6.3.2.2. Constraints to Access to Agricultural Land

In the rural VMD, access to agricultural land helps landowners to earn their main income before flooding and have few flood-related resources on which to rely. Rice cultivation provides not only the main income for landowners, but also off-farm wage activities for rural landless labourers. Regarding the Land Reform Policy issued by the former government in the late 1950s, many households who had no land or little land in the VMD were allocated agricultural land in the new established communes in the rural floodplains. However, due to severe acid sulphate soil and a lack of basic infrastructure, many migrants failed in cultivating floating rice crops as well as protecting their allocated land. Consequently, large number of migrants returned to their home villages or continued to migrate and look for other livelihood opportunities. According to a long-term in-migrant living in the Phu Hiep floodplains, several in-migrants adapted to the severe flooding and acid sulphate soil conditions in order to protect their allocated land as well as to gain their livelihoods.

For HYV conversion in the Plain of Reeds at the end of 1980s, each household was allocated agricultural land based on the number of members in their household[14]. However, undeveloped irrigation systems and paddy fields and severe acid sulphate soil conditions influenced the effects of the HYV production. As a result, many poor farmers hesitated or

[14] In Phu Hiep Commune, each inhabitant was allocated 0.2 ha of agricultural land.

refused to take the land they were allocated since they lacked farming machines and facilities (e.g., water buffalos, cows, tractors) and financial sources for land improvement and HYV production costs. Before migrating to the rural floodplains, migrants hoped that they could be allocated agricultural land in new established communes based on the Land Reform Policy. However, due to a lack of physical and financial assets or livelihood substitutions, many in-migrants could not access agricultural land for their agriculture. In fact, approximately 76 per cent of the relocated households and 66 per cent of the landless households have neither bought nor been allocated agricultural land although these in-migrants expected to access agricultural land for their new livelihood strategies (Table 8). In Phu Hiep Commune, in the early stage of the HYV conversion, both poor and wealthier farmers failed in the HYV production; however, wealthier farmers had a higher capacity to access financial capital to cope with these financial shocks. Poor farmers, in contrast, mainly accessed private moneylenders at extortionate interest rates which gradually exceeded their financial coping capacity. In this situation, wealthier farmers concentrated agricultural land while poor farmers who failed in the HYV production and vegetables and snakehead fish intensification transferred their agricultural land to wealthier landowners or new in-migrants. In brief, in unfavourable natural conditions, access to agricultural land is not enough; agricultural land needs to be improved and used effectively in order to enhance people's livelihood adaptation.

Table 8: Past land ownership of current land ownership and relocated groups

Land ownership	Relocated group (N=120)		Landless group (N=82)		Small land ownership group (N=82)		Large land ownership group (N=86)		Group Total (N=370)	
	Freq.	%	Freq.	%	Freq.	%	Freq.	%	Freq.	%
1. Past land ownership										
Landlessness	106	88.3	59	72.0	70	85.4	56	65.1	291	78.6
Small land (<1ha)	5	4.2	16	19.5	11	13.4	20	23.3	52	14.1
Large land (>=1ha)	9	7.5	7	8.5	1	1.2	10	11.6	27	7.3
Group Total	120	100.0	82	100.0	82	100.0	86	100.0	370	100.0
2. Land transaction										
Did not access	91	75.8	54	65.9	0	0.0	0	0.0	145	39.2
Transferred all	8	6.7	28	34.1	0	0.0	0	0.0	36	9.7
Transferred partly	4	3.3		0.0	17	20.7	21	24.4	42	11.4
Did not sell	17	14.2	0	0.0	65	79.3	65	75.6	147	39.7
Group Total	120	100.0	82	100.0	82	100.0	86	100.0	370	100.0

(The past land ownership which was their agricultural land ownership before migrating into the floodplains, and the transaction in terms of farm land was implemented after they settled in the rural floodplains)
(Source: Household survey, 2009)

The "Doi Moi" in 1986 led to several essential reforms in the agricultural sector. Households were accepted as autonomous and independent economic units, and farmers were allocated

agricultural land. Since the collective system was dismantled in 1988 and the land law was reformed in 1993, 1998 and 2003, farm households had the right to use their land in the long-term, and could transfer, exchange, lease, inherit or mortgage their agricultural land (Bryant, 1998). The land law reforms, particularly the land concentration policy, have contributed to increasing the rural landless households quickly since wealthier households have tried to buy agricultural land. The failures in agricultural intensification as previously discussed were also the main reasons for increasing rural landless households. With high population growth pressures, a number of landless households and those with small amounts of land increased over the last decade. Furthermore, an increase in rural landless households is shaped by the land concentration policy as well as global market integration.

During the slow-onset floods in the upper VMD, susceptibility to floods at the household level has been influenced by natural, socio-economic and political factors. A large rural population relies on agriculture, particularly rice cultivation, and is lacking access to agricultural land, which is one of the characteristics of susceptibility. Landless households have been restricted in accessing formal loans and implementing livelihood diversification. They are dependent on susceptible flood-related resources such as open assets, which declined quickly through the increase in dyke systems, agrochemical use and illegal exploitation. Households with small landholdings, which have small-scale agriculture, have a low competitive capacity in terms of the standard, quality and price of agricultural products. According to rice producers in An Hoa and Phu Hiep, the small scale of agriculture and scattered land parcels have negatively influenced farmers in applying agricultural mechanisation and producing high quality rice, as well as maximising input and output prices. Landless households have been confronted with a decline in flood-related resources and the seasonality of off-farm activities. Having no access to agricultural land influences landless households' livelihood strategies and flood exposure since they try to rely on their livelihoods in severe flooding conditions. It means that access to agricultural land plays a key role in enabling farmers to enhance rural livelihoods and adapt to annual slow-onset floods.

Table 9: Agricultural and residential land of different land ownership and relocated groups

Type of land	Relocated group (N=120)	Landless group (N=82)	Small land ownership group (N=82)	Large land ownership group (N=86)	Group Total (N=370)
	Mean	Mean	Mean	Mean	Mean
Agricultural land (m^2)	0^a	822^a	$5{,}816^b$	$24{,}141^c$	7,167
Residential land (m^2)	83^a	400^b	505^b	740^c	400

(Means with the same superscript in a row per effect do not differ significantly at 5% level)
(Source: Household survey, 2009)

6.3.2.3. The Decline in Flood-Related Resources

The decline in flood-related resources has caused changes in rural livelihood options. The VMD is one of the most biologically diverse river systems in the world with approximately 1,700 fish species and diversity among other animal and insect species (White, 2002). In the Mekong Basin, many fish species move across borders during their life cycle. In the flooding season, fish enjoy the benefits of large and rich feeding grounds and opportunities to breed, spawn and raise fingerlings. Therefore, changes in flood regimes or water quality, obstructions to fish migration flows, and fingerlings destruction of the dry season negatively influence fish stocks (White, 2002). Regarding fish migration, the flood-related projects have influenced fish stocks that have in turn affected people's livelihoods derived from flood-related resources. The forest area was reduced quickly by the Indochina Wars due to defoliants, bombing (White, 2002) and changes in land use, including rice and shrimp intensification in freshwater and coastal areas. In the rural flood-prone areas, a large area of the *Melaleuca* forest in the Long Xuyen Quadrangle and Plain of Reeds was replaced by floating rice crops before the 1960s and by HYV since the 1990s. Forest and floating rice were considered buffer conditions to reduce water-wave impacts during the flooding season in the rural floodplains.

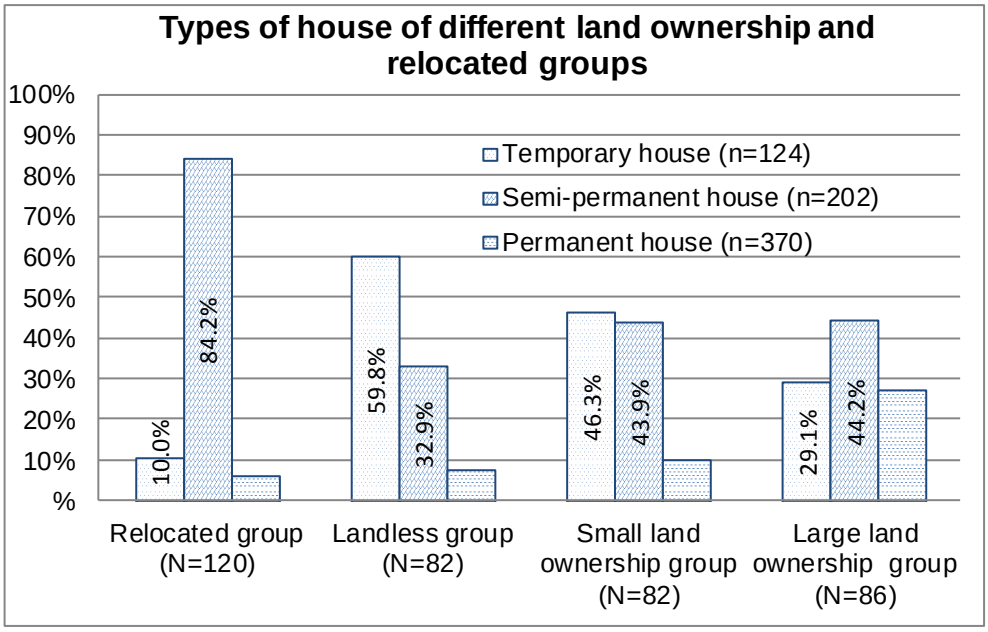


Figure 30: Types of house of different land ownership and relocated groups
(Source: Household survey, 2009)

The research sites are examples of a flood-related resource-based community. In the past, a part of the local community relied on other natural resources, particularly wild fish, during half a year or an entire year. As previously discussed, flood-related resources have declined

rapidly. The natural resource reduction not only decreases the total consumed energy, but also significantly influences the rural livelihoods derived from flood-based livelihood opportunities. Embankments that have been constructed since the 2000s aim to protect rice production from floods, but concurrently dispossess common-pool resources. The boundary of paddy rice plots is identified because of dyke systems; therefore, landless residents have lost their granted property rights to access to flood-related resources during flooding seasons. However, decision-making for dyke construction is out of the reach of landless households.

Flood-related resources play an important role in mitigating livelihood disruption due to floods. When annual slow-onset floods for during approximately five months, the boundary between paddy field plots is unclear; therefore, residents in the rural floodplains gain income and food through open-access regimes for common-pool resources. However, in recent years, the rapid decline in flood-related resources has shaped changes in the livelihood strategies of poor people. According to in-depth interviews with an old fisherman in Phu Hiep Commune, forest, grass and floating rice were considered "life-savers" in the case of boat accidents in the rural floodplains. Local residents usually use the natural vegetation to protect their homestead and houses from water waves during the flooding season. In fact, after the HYV conversion, water-wave impacts become more serious since in the rural floodplains floating rice, natural grass and forest are mostly reduced. In the same flood exposure, the number of people killed by floods increased after the HYV conversion. In addition, forest, natural grasses and floating rice also created favourable conditions for wild fish growing that in turn provided benefits to local residents, particularly the poor.

6.3.3. Access to Physical Assets

In the rural VMD, good housing conditions and physical flood-related assets have enabled flood-affected households to better respond to floods. Local residents said that stable settling and good housing were the most prioritised options for any household in the rural floodplains. Resettling usually links with their livelihood strategies while the construction and upgrading of housing conditions is dependent on a household's wealth. Besides, physical household assets, such as communication units, transportation means, fishing tools and high elevated animal cages, have enabled local people to construct and implement their response strategies.

This study indicates that almost all landless people live in temporary stilt houses while wealthier residents own semi or permanent stilt houses, which protect human lives and household assets. According to focus group discussions with members of the Phu Hiep Commune, local residents who had no residential land had settled in the Phu Hiep's

floodplains since the HYV conversion stage in the 1990s. They live temporarily on their neighbour's residential land and are not allowed to build semi- or permanent houses or plant trees in order to protect their family members and household assets. Regarding the relocation policy, the relocated households bought semi-permanent houses (Figure 30) on credit that would be paid back through annual instalments, usually at some point in the fifth to tenth year after relocation. However, according to in-depth interviews in the residential dyke in An Hoa Commune, several poor households had to transfer their relocation rights since they lacked access to money for supplemental housing and needed money to return their debts.

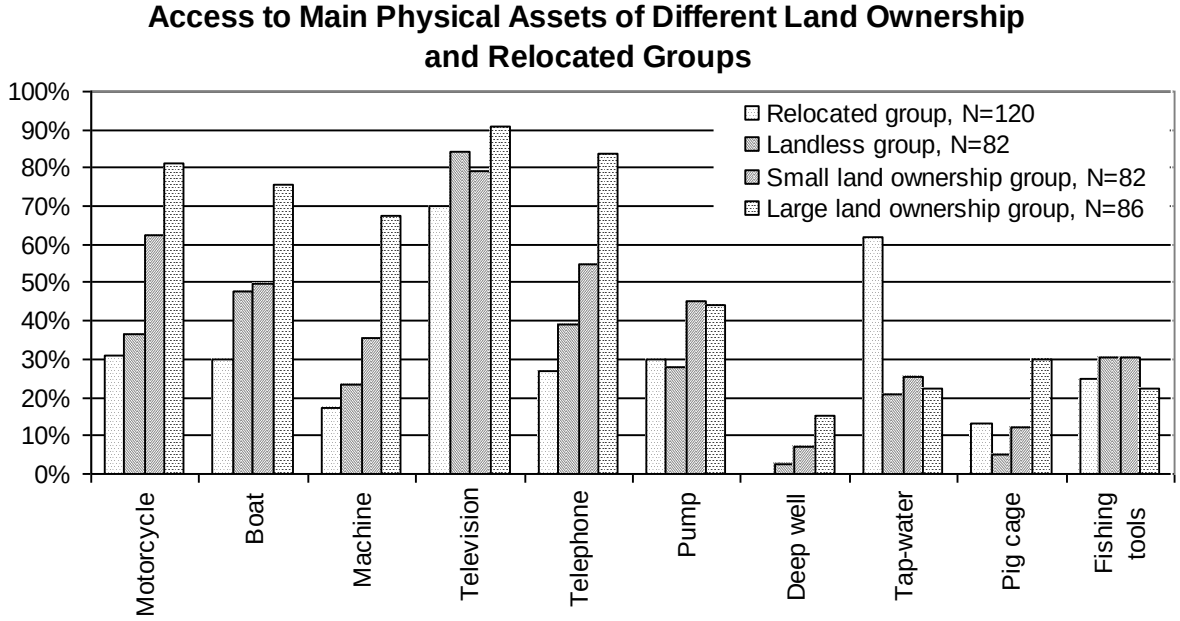


Figure 31: Access to essential physical assets regarding land ownership and relocated groups

(Source: Household survey, 2009)

Access to flood-based physical assets such as boats, machines, tap water suppliers and means for communications is necessary for flood-affected households to cope with and adapt to annual floods. In the context of long-term flooding, household assets not only allow for coping and adaptation to floods, but also the enhancement of household livelihoods. However, the improvement of household assets is shaped by households' wealth circumstances and livelihood strategies (Figure 31).

Regarding an increase in water pollution, access to tap water is subject to differentiation within socio-economic groups as well as specific areas. At the study sites, tap water systems are often established in densely populated areas which have been settled by long-term in-migrants or relocated households. In contrast, in the floodplains or areas of low population density, local residents usually use water directly in canals that are polluted due to

agrochemical concentration and human domestic waste. Currently, relocated households living in residential clusters and dykes have opportunities to access tap water (Figure 31).

Wooden stilt houses are popular in the rural floodplains. During the early stages of settlement in the rural floodplains, stilt houses were rebuilt annually using local housing materials (e.g., wood, leaves and wires) which were abundant around their communities and free of charge from their relatives. In recent years, people have gradually elevated their house foundations or constructed concrete stilt houses that can withstand floods better; however, these adaptation strategies are costly

6.3.4. Access to Financial Assets

Financial capital assets include available cash or savings, remittances or accessible financial sources that enable individuals or households to access other livelihood assets and implement livelihood strategies. In the context of slow-onset floods, access to financial capital has helped affected households to respond to urgent financial needs due to flood impacts (e.g. flood-related preparedness, the improvement of physical household assets, housing upgrading and livelihood diversification).

Access to financial capital is necessary for flood-affected people to deal with flood impacts as well as to enhance their livelihoods. In the rural areas, formal financial institutions include the Vietnam Bank for Agriculture and Rural Development (VBARD), the Vietnam Bank for Social Policy (VBSP) and rural shareholding banks. VBARD owns the largest proportion of formal loans and requires land title as loan collaterals. VBSP serves subsidised loans without collaterals to poor households and manages national funds that are used to improve skills and income-earning opportunities for labour. The formal financial institutions are expected to serve clients who are both landowners and landless people. However, it is hard for poor households to access loans from VBSP; therefore, they have accessed informal financial institutions, including private moneylenders, rotation of savings and credits associations, relatives and agrochemical shops with higher interest rates (Swain et al., 2008).

Agricultural land is not only necessary for on-farm production, but also for accessing formal financial mechanisms. Landowners can access loans from the commercial banks through their land title certificates as collaterals and prestige. The land title is used as a commercial product which can be officially transferred and used as collaterals for formal loans. Access to loans at acceptable interest rates has improved through the land titles issued and the commercial bank system widespread at the grass-roots level.

Landless households can borrow small subsidised loans without collaterals from VBSP, which usually provides loans for small-scale production. This bank provides loans to poor residents who are members of social associations such as the Veteran Association, the Farmer's Association, the Women Union and the Youth Union. In both the Phu Hiep and An Hoa Communes, many poor households failed in implementing small-scale livestock or snakehead fish production and became indebted to VBSP. As a result, these poor clients were rejected by the bank to access any formal credits again. Regarding the high risks of livestock and snakehead fish cultivation, loans from VBSP were likely debt traps for poor households. These have constrained both the poor and VBSP to use their subsidised funds effectively. It means the poor could not access formal urgent loans in the flooding season except for urgent material relief (e.g., food, medicines, clothes and fishing tools). Relief mainly comes from both private and public external actors. Moreover, poor households, which have no main labourers, are excluded by the bank from accessing the subsidised loans. They have received monthly financial supports from local community.

In the Phu Hiep Commune, local residents can access external financial supports (e.g., CARE International) which have assisted local residents in improving their physical household assets (e.g., upgrading houses and providing water filters, fishing tools, boats, and loans for small-scale agriculture) and capacity building (e.g., costs for training courses and flood risk management for local people and authorities). According to local residents in Phu Hiep Commune, particularly poor households in the remote rural floodplains, these financial supports are necessary for them to enhance their flood responses.

Regarding the disruption of income-earning activities by floods, almost all poor households lack an income in the flooding season. As mentioned, they lack access to formal financial mechanisms so that they have to access informal financial institutions, mainly private moneylenders. Private moneylenders, usually rich households in the commune, decide the size of loans and interest rates based on their understanding and relationship with the poor. The monthly interest rates of private loans vary from 5 per cent to 20 per cent, compared to approximately 1.5 per cent specified by the formal banks. The informal financial institutions charge high interest rates for clients; however, these loans are necessary for local residents to cope with financial shocks (Swain et al., 2008). However, chronically poor residents were excluded by private moneylenders even if they agreed to borrow loans at extortionate interest rates. For urgent financial needs during the flooding season, these households depend on their neighbourhoods' financial support or relief as social capital. Their neighbours sometimes helped them to borrow informal loans, but it was not usual.

Through the seasonality of crop cultivation, local residents are confronted with seasonal financial shortages. Agro-chemical and household commodity shops have provided goods and materials as credit (Swain et al., 2008). In Phu Hiep and An Hoa Communes, almost all farmers have accessed agro-chemicals for their crops. Moreover, local residents can buy or install household physical assets (e.g., TV, electronic pump, tap water supply, furniture) and food on credit, which is then repaid in seasonal instalments. However, it is not easy for the poor to access this informal financial service in the flooding season because of their low and unstable income. According to the in-depth interviews, goods providers would exclude poor clients if their income-earning sources were low and unstable. However, a decrease in off-farm income and flood-related resources have negatively influenced poor households to access their basic needs in the flooding season.

In a transitional economy like Vietnam, remittances are an important financial source for rural livelihoods. The linkage between rural and urban areas is one of the important factors that help rural households to respond to natural hazards. In the research sites, young rural labourers have shifted from off-farm and on-farm based activities to non-farm jobs in urban areas. However, according to focus group discussions with residents of the Phu Hiep and An Hoa Communes, out-migrants undertook low-skilled jobs and their jobs were therefore unstable, and their remittance was therefore still limited. Local residents revealed that their remittance was low. Many of them returned or wanted to take income-earning activities in their home villages. In this situation, income-earning activities for poor rural labourers really play an important role in improving their livelihoods as well as coping with floods.

In short, access to income-earning activities plays an important role in coping with floods. Financial resources contribute to the enhancement of houses and physical household assets that improve both their security from flood impacts and their ability for income-earning activities. Lack of access to financial sources narrows the income-earning opportunities and choices for poor residents. Land is not only necessary for agriculture, but also for accessing formal loans from commercial banks. Access to a variety of financial resources helps landowners to diversify income sources. Moreover, access to financial resources has helped people recover from crop failures or financial setbacks. Besides income from rice production, wealthier households can earn additional income from others (e.g. agro-services, agri-business, and aquaculture) through their adequate financial sources. For instance, flood-related and intensive agriculture (e.g., fresh water prawn and snakehead fish) are mainly applied by wealthier farmers.

6.3.5. Access to Human Capital

Human capital at the household level is defined as the amount and quality of household labour, influenced by health status, knowledge, skills, and education, which have enabled households to implement their flood responses and livelihood strategies. In the rural floodplains, when infrastructure for education such as schools, transportation means and rural roads are undeveloped, pupils usually give up their schooling early.

6.3.5.1. Acquirement and Dissemination of Flood-Related Knowledge

Flood-related knowledge learned and disseminated within rural communities in the rural floodplains plays an important role in dealing with flood impacts. In the context of repeat hazards, knowledge is accumulated and transferred to the local community. Flood-related knowledge has enabled local residents to mitigate hazard impacts through their flood adaptation strategies. Local knowledge is generated from both the local community and outsiders who were experienced themselves or learned from other flood-affected communities. Local knowledge is constructed through the combination of local knowledge and accepted outside knowledge. However, the application of local knowledge to flood response strategies depends on people's livelihood assets, particularly income, homestead ownership and education.

Flood-related experiences obtained by local residents or by the previous generations are used and transferred to the next generation. Regarding the long history of floods, the water-related culture has contributed to the flood adaptation of local communities. The early settlers in the VMD relied mainly on natural resources, and through this they learned how to adapt to floods and to rely on the flood-related benefits. Living in flooding conditions, local residents who settled in the rural floodplains earlier improve their coping capacity which gradually contributed to their flood adaptive capacity. Moreover, adaptation patterns were constructed through a series of coping patterns. Therefore, local residents have gradually enhanced their capacity to adapt to these hazards.

In flooding areas, local adults teach the young how to swim, prepare life-vests, row a boat, fish, collect flood-related vegetables and build stilt houses etc. These response activities have enhanced and contributed to the informal adaptation process. Previously, the elderly usually predicted flooding according to the nature-based observations, including insect behaviours (e.g., ant movement and flying patterns of dragonflies, white ants and swallows), grasses growth (e.g., bamboo, young grass shoots) and the lunar calendar. In addition, the daily weather was also taken into account by observing natural phenomena (e.g., cloud, winds,

sunlight and phase of the moon). Based on their own and their neighbours' predications, flood-affected residents prepared coping and adaptation strategies to respond to floods. However, according to the in-depth interviews conducted with residents in Phu Hiep Commune, flood-related knowledge (e.g. nature-based forecast and flood-related experiences) has gradually been lost because of quick environmental change as well as physical-technological interventions (e.g., embankments).

Local knowledge in terms of flood-related income activities and housing construction is learned and disseminated within the community. Flood-related knowledge is acquired through informal communications (e.g., daily talks and anniversary parties) and observations. The neighbourhood in the rural floodplains plays an important role in learning, disseminating and practicing flood-related knowledge as well. However, financial capital capacity significantly influences the transformation of flood-related knowledge into reality. According to focus group discussions in Phu Hiep Commune, most adults know how to build solid stilt houses or apply flood-based agriculture; however, they lack access to financial institutions in order to implement these "adaptive" ideas. This means that poverty influences the application of local knowledge with regard to the coping and adaptive capacity of local residents. In reality, poor people usually have few or no means for flood-related income-earning activities given their financial situation. Local knowledge is usually associated with adaptation; however, it also significantly contributes to enhancing local residents' coping capacity due to a repeated natural hazard like annual slow-onset floods in the VMD. Annually, flood-affected people learn and practise flood-related experiences. Furthermore, since local people are familiar with floods, sometimes they are subject to flood risks regarding a lack of flood preparation. Their long-term exposure to floods has formed daily habits such as the direct use of canal water, the release of waste in flooding water or canals, the drainage of polluted water to flooding or canals etc., which, in turn, affects the community. Polluted water affects local residents differently due to their wealth and flood-based properties (e.g., filtered containers, tap water access and deep wells).

Children who are the most susceptible to slow-onset floods, are usually trained how to swim at six years of age by their family members or teachers. Therefore, children above six can swim and cope with floods when falling down in flood water. Children have also learned how to respond to high floods and to protect physical household assets. This seems to be effective given that the majority of the drowning in the rural floodplains affects children under six years of age. It is clear that the likelihood of a child drowning in a flood decreases when swimming skills are acquired; however, children's swimming capacity has reduced through

the adults' flood risk perception. According to in-depth interviews with residents living in the residential cluster and along high roads in Phu Hiep Commune, they said that their children were totally safe from flood risks since they were living in higher built places.

When the government initiated several flood-related interventions discussed earlier, flood-related knowledge and preparation experience and preparedness reduced or lost. For example, many people living inside full flood-control areas built low foundation houses instead of stilt houses. It is important to note that extensive damage inside the full flood-control embankments would occur if the dykes are broken by floods. Clearly, crop, infrastructure and people in the full flood-control embankments are still susceptible to high floods since these exposed elements are embedded in the vulnerable conditions.

6.3.5.2. Constraint to Human Capital Generation

Human capital is an important factor that influences both local residents as well as their flood response capacity. As previously discussed, dependents, particularly children below six years of age, are susceptible to floods. In the rural VMD, almost all mortalities caused by floods were children in poor households located in the remote floodplains. During flooding events, poor children are inadequately supervised by adults given that their parents and other adult family members are usually working in the floodplains. Sometimes poor children are with their adult family members in small wooden boats in severe flood risks. In addition, with children six and above, school starts during the period of high flooding which increases exposure to flood risk as well. This is because students often go to school in narrow wooden boats that lack life-vests or life preservers. Out-door activities during flooding season also contribute to an increasing number of children being more exposed to flood risks. However, children above six years of age, especially above ten years old, can individually cope with boating accidents given their swimming capacity. In brief, children under six years of age, particularly poor children, are more susceptible to floods since they are in the flood-prone areas with insufficient protection. It means that mortalities due to floods are associated with severe flood exposure, dependents, poor housing conditions and poverty.

According to focus group discussions in the flood-prone area of Phu Hiep Commune, it was difficult for pupils to go to school because of a lack of schools and transportation means, poverty and flood-related constraints. In addition, adults were usually busy with their flood-related livelihood opportunities so that they could not bring their children to go to schools regularly. Wealthier households usually sent their children to town centres for schooling while poor children had to give up their schooling earlier. In general, poor children in flood-prone

areas were constrained in accessing schools; therefore, school grades were significantly different among land ownership groups (Table 10). Moreover, according to local residents in the research sites, education and vocational training, not much attention was paid by local residents since they could rely on flood-related resources. It meant that local residents could select a wide range of choices of livelihood options as their livelihood strategies. In brief, severe flood conditions and abundant flood-related livelihood opportunities have constrained rural labourers, especially poor people, in terms of their ability to access educational institutions that have in turn narrowed their income-earning opportunities, especially in the urban areas.

Table 10: Basic family profile of different land ownership and relocated groups

Items	Relocated group (N=120)	Landless group (N=82)	Small land ownership group (N=82)	Large land ownership group (N=86)
Main labourers	3.09	3.10	3.13	3.67
Family members	4.30	4.30	4.45	5.01
Total main labourers	375	253	254	315
Main labourers' school grades	3.70^{a}	4.67^{b}	5.51^{c}	6.20^{d}
Head's school grades	0.93^{a}	1.07^{ab}	1.17^{b}	1.22^{b}

(Means with the same superscript in a row do not differ significantly at 5% level)

(Source: Household survey, 2009)

The decline in rural livelihood opportunities, such as fishing and off-farm activities, has strongly shifted rural labourers to migrate into urban areas for income. Local residents complained that they did not believe that they became unemployed in their home village which absorbed off-farm labourers both from local areas and other places (e.g., the coastal zones). In recent years, urban-wards migration for non-farm jobs has increased. Therefore more attention is paid to education and vocational training by local residents and authorities; however, it is difficult for poor pupils to acquire the high school grades required for workers in factories. High schools and vocational training centres are mainly located in the provincial centres, and schooling costs exceed families' financial capacity. However, there have been some improvements – for example, in recent years, pupils can borrow loans without collateral for their schooling costs from the VBSP. Poor labourers not only lack money for schooling accessibility, but have to earn income for their daily cost of living. As a result, in urban areas, rural labourers mainly undertook low-skilled jobs with limited wages. However, rural labourers' education influences their urban income-earning activity employment (Table 11). The low educational grades and professional expertise have negatively influenced rural labourers' ability to access non-farm jobs in the urban labour market as a flood coping

strategy (Table 11). In spite of the decline in flood-related resources and income-earning activities, educational grades as well as professional expertise are important factors that influence their flood coping capacity.

Furthermore, it is difficult for middle-aged labourers to look for non-farm jobs in the urban areas since they cannot adapt to manual non-farm activities. According to the household survey in 2009, young labourers ranging from 15 to 35 years of age, accounting for 96 per cent of out-migrants, can find low-skilled jobs in urban areas. The solutions that are convenient for middle-aged labourers need to be further explored. Income-earning activities during the flooding season have decreased, and rural labourers lack the knowledge and skills for the effective labour transition. The fact that remittances are small has constrained migrant labourers to reinvest or contribute to flood responsive strategies in the rural floodplains. This is a challenge for the rural landless labourers, especially overcoming the labour transition from the rural to urban labour markets.

Table 11: Basic profile regarding the different occupations of main labourers

Occupations of main labour	N	Educational grade[15]	Age
Fishermen	39	3.69^{a}	34.33^{cd}
Off-farm workers	136	4.21^{ab}	31.94^{bc}
Detailers	62	4.39^{ab}	38.98^{d}
Farmers	300	5.07^{bc}	38.05^{d}
Non-farm workers	112	6.54^{d}	24.07^{a}
Dependents	156	7.00^{d}	27.79^{ab}
Officers	18	11.44^{e}	29.72^{bc}
Total	**823**	**4.94**	**33.07**

(Means with the same superscript in a column do not differ significantly at 5% level)
(Source: Household survey, 2009)

Briefly, in the context of the decline of flood-related resources and the seasonality of off-farm wage activities in the rural floodplains, poor middle-aged residents are excluded from the urban labour market. The demographic composition of households is one of the major factors influencing the capacity of response of different socio-economic groups in the rural floodplains. Furthermore, weak, elderly or poor residents who are marginalised in obtaining off-farm activities and mainly rely on rice by-products and flood-related resource exploitation have been significantly affected by agricultural mechanisation since landowners have used combine harvesters rather than hired in off-farm labourers. In short, human assets play an important role in mitigating direct flood impacts and enabling flood-based income.

[15] In the current Vietnamese educational system, the common education includes 12 grades which are divided into primary school (grades 1-5), secondary school (grades 6-9) and high school (grades 10-12).

6.3.6. Access to Social Capital

Social capital is an important factor that enables individuals and the community to work together as members of a close-knit group or a network (Paavola and Adger, 2005). Social capital and networks of reciprocity help to cope with the impacts of natural hazards (Pretty and Ward, 2001), and are essential to adaptation strategies to environmental stress like climate change (Adger, 2003). In the context of floods in the VMD, both the private and public dimensions of social capital work mutually to enable flood-affected residents to respond to floods.

6.3.6.1. Neighbourhood and Off-farm Worker Teams

In the context of annual slow-onset flooding, a household's neighbourhood plays an important role in dealing with flood impacts in terms of food, housing, flood-based physical assets, flood-based livelihoods, flood-related knowledge as well as urgent flood impacts. Local residents cooperate to protect themselves and their livelihoods. In the rural floodplains, residents share transportation means, work together in dyke protection and crop harvesting and help each other through financial and spiritual assistance regarding flood damage or livelihood disruption. Additionally, they also share knowledge in order to cope with slow-onset floods. Knowledge exchange plays a critical role in flood risk management as well as in flood-related income-earning activities; however, households living far from high dykes or housing areas lack access to this social assistance. Local people usually help their neighbours to build houses or rebuild houses damaged by flood impacts. Although this help is low in financial value, the informal activity is significant and necessary because formal coping activities implemented by the army as well as governmental institutions do not immediately rescue affected people or houses damaged by floods.

Off-farm wage labour teams are established in the residential clusters or dykes in order to cope with the reduction and tight seasonality of off-farm activities. Off-farm wage labourers work together as a team, and they predominate over separated off-farm wage labourers. However, only main labourers who are close relations or share interests with core team members or team leaders can be enrolled as team members. These off-farm labour groups are built and operated by individual actors who make verbal contracts with rice growers. These off-farm labour teams better compete with off-farm non-members to harvest rice. The short duration of rice harvesting helps rice producers deal with a lack of family labour for harvest management and possible rice damage due to abnormal rains or early floods. Regarding the

severe seasonality of harvest time and an increase in out-migration, landowners have struggled with a lack of off-farm labourers during the rice harvesting time.

As mentioned, rural young labourers have gradually shifted to urban labour markets. Experience and information in terms of non-farm activities are necessary for out-migrants to search for non-farm jobs before the flooding season. Rural labourers get information regarding income-earning activities from their relatives, friends and neighbours. Then these out-migrants become new informants who provide experiences and information to (potential) urban-wards migrants. The migrants share their daily costs of living and boarding houses which help them to save their remittances. In sum, this social network helps out-migrants to cope with and adapt to livelihood disruption due to flood impacts.

6.3.6.2. Religion

In the rural floodplains, religion plays an important role in urgently mitigating flood impacts. Believers of religions in the rural floodplains help flood-affected residents reduce flood-related impacts due to their charitable funds. The charitable funds contributed by outsiders usually help flood-affected households during high floods. The other charitable funds are voluntarily contributed by both local beneficiaries and contributors. These mobilisations have funded poor households in terms of medical help, small-scale infrastructure and assistance in building houses. The household survey data indicated that contributions to the charitable funds were statistically significant difference among religions and between believers and non-believers (Appendix 4). Local residents and religious institutions have socially contributed to enhancing relief funds.

The study indicates that religion positively influences the charitable financial contributions of local residents. Seasonally, these charitable funds are voluntarily mobilised by local religious actors. Almost all villagers, including both believers and non-believers, voluntarily contribute to the charitable financial funds. These funds are used to freely provide food to poor (flood-related) victims and help poor residents to improve or rebuild their houses as well as to provide financial assistance to construct small public infrastructure (e.g., small bridges, local roads, traditional healthcare houses). Besides, these funds are always used to provide food free of charge for ill residents in the local hospitals. According to an in-depth interview with an elderly resident in one of the research sites, previously believers of Hoa Hao, one of major religions in the VMD, mainly contributed to these charitable funds; however, many non-believers have gradually agreed to contribute to this informal financial institution. A non-believer in An Hoa revealed that these financial funds were used for charitable activities

which helped local residents, particularly the poor, to cope with urgent shocks, especially flood damage. Although this financial fund is small, it is useful for collective informal coping.

The voluntary human activities which are usually organised by religion have contributed to building small-scale public infrastructure as well as houses for the vulnerable groups. Local people, particularly believers, have understood their environment and gradually reshaped it in order to adapt to annual slow-onset floods. In the context of dense canal systems in the rural upper delta, the construction of small bridges that are funded or built by local residents, especially believers, is necessary for local residents to gain their livelihoods as well as to evacuate in terms of hazard disasters (e.g., high floods).

6.3.6.3. Local Flood-Related Institutions

Access to social networks or external supports is necessary for poor households in the rural floodplains to mitigate flood damage. CFSCs built at all administrative levels (e.g., central, provincial, district and commune) provide relief and information related to floods and flood responses for people prone to floods. However, residents who live in remote floodplains and areas far from rural roads have lacked access to relief and flood-related information. During high floods, residents, especially the poor, receive relief from both formal and informal institutions; however, they must move long distances or pay additional money (e.g., transportation fees) for relief. These households have restricted access to schools or child day-care houses that have in turn negatively affected adults in these households from earning their flood-related income during the flooding season. Floods occur annually, but flood-related relief is largely provided during high floods.

In conclusion, access to livelihood assets plays an important role in flood coping and adaptation. The study indicates that in the rural floodplains a key livelihood asset like agricultural land has helped to enhance farmers' capacity to access other livelihood assets such as houses, boats, and machines and shaped their overall flood-related response strategies. For instance, accessing agricultural land enables farmers to access the formal financial institutions and the social network (e.g., the Farmers' Association) while enhancing informal relationship networks helps urban-wards migrants to access non-farm activities and to reduce the costs of living in urban areas.

6.4. Effects of Adaptation Strategies on the Adaptive Capacity of Local Communities

6.4.1. Livelihood Change Initiated by Resettlement

Livelihood change has been shaped by different patterns of resettlement. Resettlement, according to Scudder (2005), includes four stages (1) planning and settlement recruitment, (2) transition, (3) potential economic and social development, and (4) handing and incorporation. The major purposes of resettlement in flooded areas implemented by the former government in the 1950s (Biggs, 2010) and 1960s and by the current government in the 1970s, 1980s and 2000s were improving the livelihoods of poor and landless households and enhancing human security from both natural and human-induced hazards. These resettlement patters were shaped by different reasons, including ideological conflicts in the 1950s, land reclamation in the 1960s, political conflicts in the 1970s, the reforms of the 1980s, and the natural hazard-related mitigation of the 2000s. Following these formal resettlements, landless households and those with small amounts of land also informally resettled in these new communes that were established by the local governments for formal resettlements. These resettlement patterns were shaped by various factors; however, almost all in-migrants were mainly influenced by looking for new livelihood opportunities in new established communes.

Table 12: Historical events at the riverbank site in An Hoa Commune, Tam Nong District

Time	Events and impacts or changes
1860s	An Hoa Commune was established; people settled along the Mekong River
1975-1978	Overseas Vietnamese migration from Cambodia
1978	High floods caused damage to floating rice and houses; people evacuated to National road No. 30; floating rice was starting to be converted to HYV
1981	Overseas Vietnamese resettled along primary An Hoa-Hoa Binh canal
1983	Secondary canals were constructed; the HYV was cultivated popularly
1991	High floods caused damage to the HYV and houses
1993	Issued red book which was collateral for loans
1996	High floods caused damage to the HYV and houses
2000	Historic floods caused damage to the HYV, house; people evacuated to National Road No. 30
2002-2004	Accommodation built and poor households resettled in residential clusters and dykes
2004	Completed semi-dyke systems, drained out water for rice early sowing
2005	Built fully-protected dyke systems in No.1 hamlet for future third crops
2005	Sudden increase and failure in snakehead fish production
2005	Quick decrease in natural fish in the flooding season
2007	Started to raise *Pangasius* for export which have contributed to water pollution

(Source: Author, KIP in An Hoa Commune, 2009)

The formal resettlement of the 1950s[16] and 1970s[17] affected by ideological conflicts led many households from the Northern Vietnam and Cambodia to resettle in the rural Mekong floodplains (Table 12). In An Hoa Commune, the riverbank research site, many households were resettled from the bordered region between Cambodia and Vietnam. They were allocated both residential and agricultural land in destination communes. According to in-migrants from the VMD, they were familiar with flood impacts in their former home villages so that they usually focused on income-earning opportunities rather than flood exposure. In contrast, in-migrants migrated from the North of Vietnam who were not exposed to annual slow-onset floods yet were initially shocked due to flood risks. These in-migrants tried to learn how to respond to flood risks as well as to improve their livelihoods. In short, these in-migrants were exposed to flood impacts differently, and their response strategies were influenced by their flood-related capacity and access to livelihood assets.

The formal resettlement policies of the 1960s set by the former government aimed to enhance in-migrants' livelihoods in the flood-prone areas. Poor households who had no or small amounts of land were selected to resettle in the newly established communes. These in-migrants were allocated residential and agricultural land and accessed flood-related opportunities. In the inland site, Phu Hiep Commune, in the 1960s, the former government established new communes in the flood-prone areas without basic infrastructure (Table 12). In-migrants formally settled along canals which were barely exposed to flood impacts. These in-migrants came from other districts of Dong Thap or other provinces in the VMD, in which they were exposed to flood impacts differently. Following the formal resettlement, many households informally migrated to these newly established communes in the rural floodplains in order to look for new livelihood opportunities. Some informal in-migrants hoped to buy residential and agricultural land from the formal in-migrants who failed in adapting to floods in the rural floodplains. Yet, both formal and informal resettlements contributed to an increase in the population and additional infrastructure in the flood-prone areas. In the early stage of resettlement, in-migrants were exposed to floods since their houses and household assets were minimally protected by trees surrounding their houses as well as basic infrastructure such as roads, dyke systems and concrete buildings. In the riverbank area, An Hoa Commune, the settlement and HYV were implemented in the 1970s (Table 13). The population growth has gradually shifted many landless households and households with small landholdings to move to the rural floodplains to gain their new livelihoods. It also indicates that long-term

[16] Vietnam was tentatively separated into two parts which followed contrary ideological systems.
[17] Cambodia, ruled by Khmer Rouge from 1975 to 1979, acted against the Overseas Vietnamese.

resettlement in the rural floodplains has helped flood-exposed households to enhance their flood response capacity.

The formal resettlement of the 1980s forced by the government aimed to transform the old social relations after reunification in 1975. Many New Economic Zones were established in the rural areas in order to resettle and develop agriculture which was managed by agricultural cooperatives. Residents who belonged to other social groups were shifted into "workers and farmer classes" who were expected to be the core labour forces for building a socialist state. In reality, a large wasteland area in the rural areas, particularly the Plains of Reeds, was used to grow crops; however, the limitations of collectivisation in the 1980s restricted the accomplishment of transforming outcomes. Like these previous resettlement patterns in the rural floodplains, these forced in-migrants in the 1980s were severely exposed to floods and livelihood insecurity since they were not familiar with floods. They tried to learn and construct their response strategies in order to respond to flood impacts as well as achieve their livelihood outcomes mainly derived from agriculture and flood-related resources.

Table 13: Historical events in the inland site, Phu Hiep Commune

Time	Events and impacts or changes
1963	An Long-K12 primary canal was built; Phu Hiep Commune was established; people formally and informally settled along the main canal and grew floating rice and fished
1977	Overseas Vietnamese resettled from Cambodia and were allocated land
1978	High floods caused damages to floating rice and houses
1988	Started to convert from floating rice to the HYV, planned to enlarge HYV area
1990	Secondary canals were built, popular cultivation of HYV
1991	High floods caused damage to the HYV and houses
1993	Red book on land use rights was issued and used as collateral for loans since 1997
1996	High floods caused damage to the HYV and houses
1998	Settled and transferred agricultural land by migrants from farmers who failed in the HYV
1999	DT843 road was upgraded; people informally relocated from low or flood-prone places
2000	Historic floods caused damage to the HYV and houses
2003	Residential cluster was built; the poor were relocated in the flood-prone areas
2004	DT843 road was asphalted; transportation accidents increased
2004	Completed semi-protected dyke systems that protected the SA rice from early flooding & were used to drain out water for early rice sowing
2008	Completed a fully-protected dyke system that is expected to develop the third crops

(Source: Author, KIP in Phu Hiep Commune, 2008)

However, when flood impacts and flood-related resources have severely changed due to the changes in flood regimes and covered surface in the rural floodplains, building houses in the high built roads and places is prioritised by both local residents and the local governments. In recent years, the formal resettlement of households prone to floods was one of the major structural adaptation measures to annual slow-onset floods particularly regarding flood

damage. In the Phu Hiep residential cluster, the relocated households have escaped from direct flood impacts; however, they were initially exposed to new socio-economic shocks and stresses such as a decrease in off-farm income and small-scale agriculture in their homesteads, an increase in daily expenses and social violence and indebtedness given that they bought their houses on credit. Local residents who have residential land continue to build their houses along high roads. These formally and informally relocated households escape the direct flood impacts. They have better access to basic infrastructure (e.g., roads, schools, markets, tap water systems, electric services) since these types of infrastructure are mainly constructed in densely populated areas. However, local residents who resettle along high roads are faced with other shocks like motorcycle and car accidents. In short, resettlement is an adaptive measure to respond to flood impacts; however, improving the livelihoods of relocated households plays an important role in adapting to both annual slow-onset floods as well as livelihood disruption.

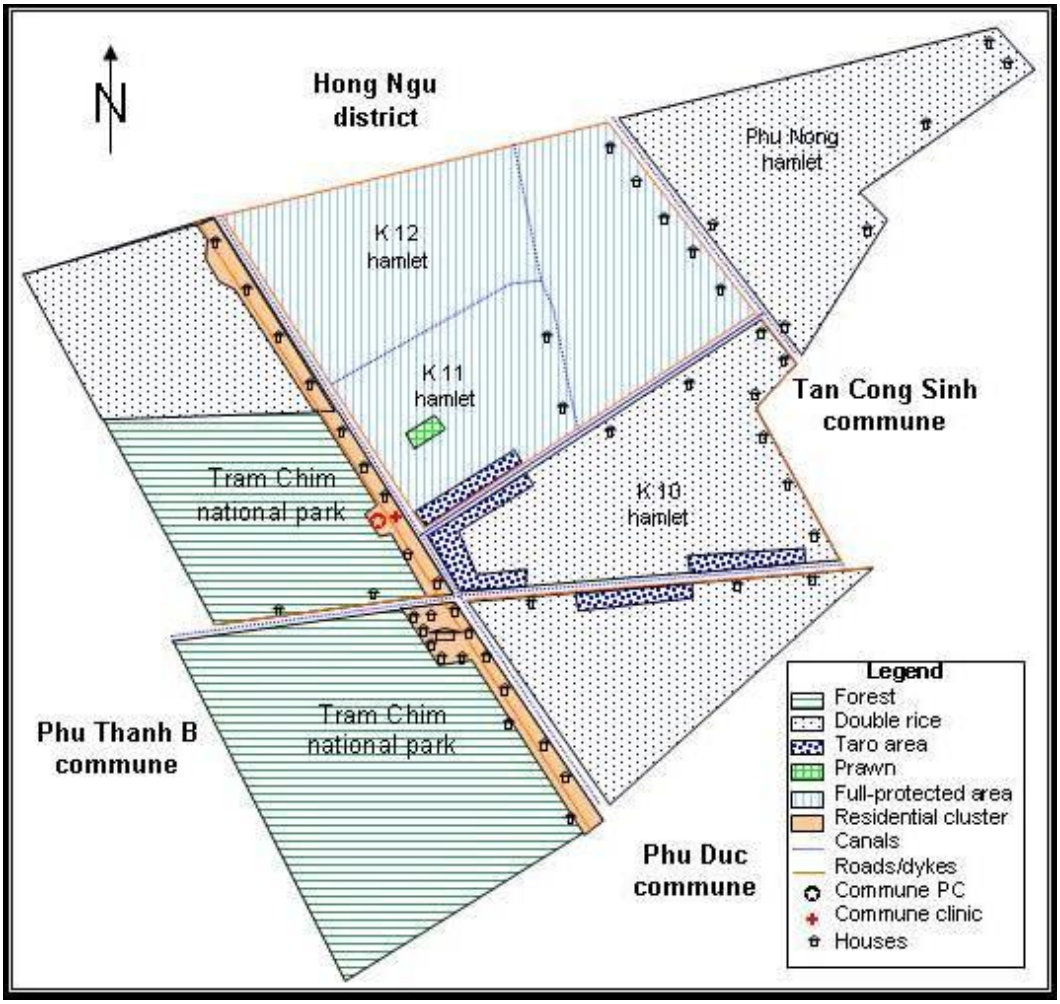


Figure 32: Social and crop map of Phu Hiep Commune
(Source: Author, KIP in Phu Hiep Commune, 2008)

6.4.2. Livelihood Change Caused by Agricultural Intensification

Agricultural intensification, which has significantly influenced human livelihoods in the rural floodplains, has been shaped by the construction of embankments and changes in rural floodplains (e.g. population growth, improved irrigation systems, enhanced farming technologies). Since the "Doi Moi" policy in 1986, the government has emphasised an increase in agriculture which has also forced agricultural intensification through the construction of irrigation systems in the VMD, particularly in the Long Xuyen Quadrangle and Plain of Reeds. The major agricultural intensification includes HYV production, high valuable vegetables (e.g., taro and scallion), and intensive aquaculture (e.g., *Pangasius* and snakehead fish production). In the research sites, riverbank and inland areas, the agricultural intensification has been mainly implemented by wealthier households since they have owned adequate livelihood assets.

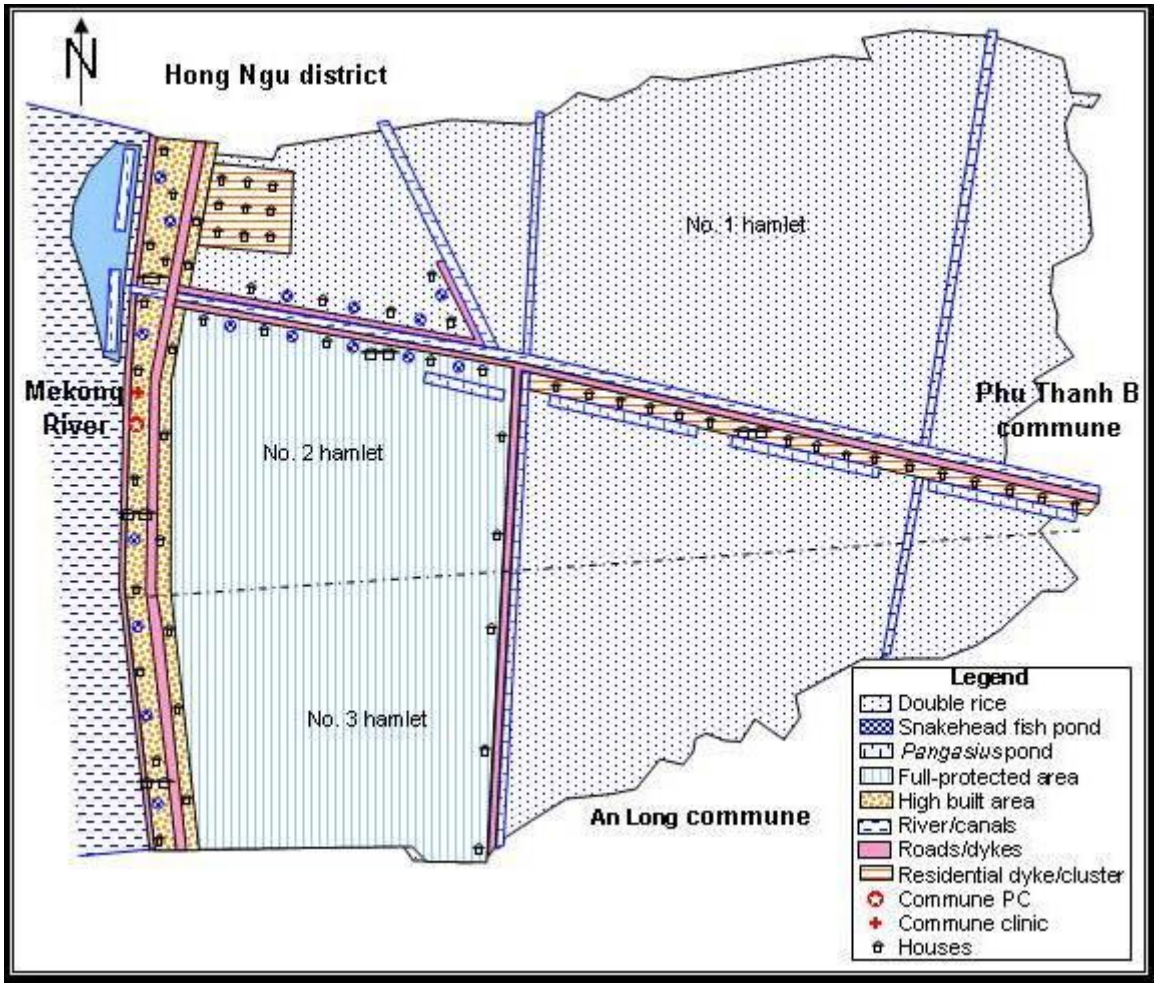


Figure 33: Social and crop map of An Hoa Commune

(Source: Author, KIP in An Hoa Commune, 2009)

High-yielding rice, which is a predominant crop in the agricultural intensification process, is severely exposed to slow-onset floods. The harvesting period of SA and the entire life-cycle

of the AW rice crops are strongly impacted by floods. During the HYV conversion, both poor and wealthier households implemented the HYV which required high demand in terms of agrochemicals and other inputs compared to those for the floating rice. However, the HYV production yielded low returns since it was cultivated in unfavourable conditions such as severe acid sulphate soils, poor irrigation systems and low farming technologies. Consequently, during the first four to five years of the HYV conversion, farmers failed or received low net income which led them to become indebted to local private moneylenders or reduced their agricultural land. According to the focus group discussions in Phu Hiep Commune in 2008, while wealthier people who had relatively good financial resources coped with these shocks and maintained their agricultural land, poor households transferred their agricultural land or released their household assets. During the HYV conversion stage, farmers continued grow the HYV although they usually failed in the cultivation.

In recent years, there has been a decline in wild fish and an increase in the value of common indigenous fish[18]. Local people have shifted from flood-related exploitation or extensive fish production to intensive aquaculture, such as snakehead fish and *Pangasius*. *Pangasius* is raised in floating houses or large ponds along main rivers while snakehead fish is usually cultivated in ponds in farmers' homestead. Snakehead fish cultivation is shifted from the extensive level fed by flood-related resources (e.g., small wild fish and other aquatic species) to the intensive level fed by concentrated feeds since the 2000s. Poor households usually stocked low numbers of snakehead fish in small plastic ponds while wealthier households cultivated higher numbers of snakehead fish in large ponds. Snakehead fish production has provided relative returns; however, it has been faced with diverse risks such as water pollution, market failure or high production costs. High stocking density and the use of concentrated feed for intensive snakehead fish in turn cause water pollution.

According to the in-depth interviews with local farmers in Phu Hiep and An Hoa Communes, many households failed in cultivating the intensive snakehead fish because of the low yield and low price of fish; therefore, they became either indebted to local private moneylenders or had to sell their agricultural land to wealthier farmers. Recently, in Tam Nong District, freshwater prawn production is intensified by wealthier households since they have adequate financial resources as well as farming techniques. In general, it is difficult for poor households to implement the agricultural intensification because they have a low capacity in terms of financial resource and farming technologies.

[18] Main indigenous fish in the flood-prone area include snakehead fish, climbing perch, broadhead catfish (CaTre) and *Pangasius.*

Table 14: Changes in mechanisation and labour used in winter-spring rice production (1 ha)

Rice farming activities	The last 10 years	Current medium mechanisation	Current high mechanisation
Paddy field Plough	M	M	M
Paddy field preparation	2(O)-4(F)	2(O)-3(F)	M-2(F)
Sowing	3(F)	3(F)	3(F)
Replanting	2(O)-3(F)	1(F)	1(F)
Irrigation	2(F)	2(F)	2(F)
Weeding by hand	2(O)-3(F)	1(F)	1(F)
Herbicide application	1(O)-1(F)	M (sprayer)-1(F)	M(sprayer)-1(F)
Insecticide application	1(O)-3(F)	M(sprayer)-1(O)-2(F)	M(sprayer)-2(O)-1(F)
Fungicide application	1(O)-3(F)	M(sprayer)-1(O)-2(F)	M(sprayer)-2(O)-1(F)
Fertiliser application	1(O)-3(F)	1(O)-3(F)	1(O)-3(F)
Harvesting	7(O)	M(harvester)-1(F)	M(combine harvester)-1(F)
Collecting	7(O)	7(O)	M(combine harvester)-1(F)
Threshing	M(thresher)-1(O)-2(F)	M(thresher)-1(O)-2(F)	M(combine harvester)-1(F)
Transport	2(O)-1(F)	M(tractor)-2(O)	M(tractor)-2(O)
Drying	1(O)-3(F)	1(O)-3(F)	3(O)-6(F)
Total	28(O)-30(F)	16(O)-24(F)	10(O)-24(F)

(Note: F: one family labour, O: one hired off-farm labour, M: machine)

In addition, in Phu Hiep Commune, high valuable vegetables such as scallion and taro are also intensified by wealthier households. These crops are considered promising crops in the rural floodplains areas since these crops provide high economic value and are harvested before flooding. However, these vegetables require advanced farming technologies as well as a high amount of financial investment and they usually face market problems (e.g., low prices).

In general, agricultural intensification, which is mainly conducted by wealthier households, has contributed to increasing agricultural production (e.g., rice, vegetables, snakehead fish and fresh water prawn) in the floodplains. The process has also provided off-farm activities to off-farm wage labourers; however, in the context of agricultural mechanisation (Table 14) and the severe seasonality of farming activities, off-farm wage is unstable and reduced. It explains why a large number of rural labourers seasonally migrate to urban areas for income although non-farm income-earning activities and living conditions in the urban areas have not met migrants' expectations. Clearly, regarding low accessibility to livelihood assets and livelihood opportunities, labourers in the rural floodplains have been restricted in responding to flood impacts, livelihood disruption and reductions in flood-related resources. Moreover, failures in agricultural intensification such as high-yielding rice cultivation and intensive snakehead fish raising have strongly forced an increase in rural landless households.

Agricultural intensification has led to an increase in agriculture in the flood-prone areas. It has caused environmental problems and a decline in flood-related resources that has mainly affected the livelihoods of landless households. Rice intensification has contributed to increasing agricultural mechanisation that has in turn reduced off-farm labour needs (Table

14). Clearly, agricultural mechanisation has provided more benefits to rice producers and farming service providers who are wealthier households while poor households have been exposed to the reduction of off-farm labour income. The seasonality and reduction of off-farm activities in rice cultivation have led to rural-urban migration. Agricultural intensification does not seem to be linked with the rural industrialisation that can absorb a large number of rural labourers, particularly landless labourers. Sustainable livelihoods in the flood-prone area have been exposed to both annual slow-onset floods and changes in rural socio-economic conditions, especially agricultural intensification. It indicates that in the rural floodplains of the VMD flood vulnerability is shaped by both natural and socio-economic factors.

7. Assessment of Local Flood Vulnerability

7.1. Introduction

Flood vulnerability at the household level depends on a variety of factors, of which the livelihood of each socio-economic group is an important factor in affecting their flood vulnerability. Each socio-economic group has its own livelihood strategies, access to different livelihood assets (see Chapter 6) and is shaped by specific transformation structures and processes as well as the vulnerability context specific to them (e.g., floods, sea level rises and natural resource degradation) (see Chapters 3 and 5). It is these factors which also shape flood vulnerability at the household level; however, there are some factors which determine flood vulnerability in the rural floodplains more than others. These quantitative and qualitative indicators were identified through a series of research tools such as the secondary data analysis, participatory methods, in-depth interviews and household surveys (see Chapter 4). The weighting of each selected indicator was done by various stakeholders in the rural floodplains, such as water-related researchers, Tam Nong CFSC staff, Commune staff, wealthier groups, middle-income groups and poor groups. Finally, vulnerability aggregation is implemented in order to identify the principal groups who are vulnerable to floods and the main reasons for their flood vulnerability.

7.2. Indicator Development

Vulnerability includes exposure, susceptibility and coping capacity (Birkmann, 2006); therefore, selected indicators aggregating vulnerability are characterised by its major components. Regarding the scales of the study and extreme events like the context of annual slow-onset floods in the VMD, relevant indicators were selected for aggregating the flood vulnerability of socio-economic groups exposed to flood risks. As previously discussed in the methodology chapter, a full list of indicators (Table 15) was developed based on the secondary data analysis (e.g., the past flood-damaged reports), participatory tools, and the standardised household.

Through the indicator development process, seven indicators were selected for vulnerability assessment at the household level in the context of annual slow-onset floods in the VMD. These indicators are 1) access to agricultural land, 2) access to residential land, 3) type of house, 4) access to physical household assets, 5) household demographic composition, 6) access to remittances, and 7) income dependency (Table 15). These indicators are associated with the progression of the vulnerability of the Pressure and Release Model (PAR Model), including root causes, dynamic pressures and unsafe conditions and hazard dimension

(Blaikie et al., 1994). The PAR Model indicates that many factors influence human vulnerability to natural hazards; in this study, in the rural floodplains in the upper VMD, several factors that significantly contribute to the flood vulnerability of exposed units will be examined.

Table 15: Major indicators to measure flood vulnerability in the VMD

Main indicators	Derived from	Reasons for selection	Mean	Std.
1) Access to agricultural land	Hectares/household	HHs earn their main income before onset of floods (seasonal calendar)	0.56	0.39
2) Access to residential land	Hectare of homestead per household	HHs could conduct flood-preparedness (plantation, housing improvement) (FGD)	0.27	0.40
3) Type and quality of house	Value given to type of house lived in	Major flood damage occurred in temporary housing (CFSC, 1996-2007; interviews)	0.65	0.36
4) Household assets	Value given to number of physical assets/total major physical assets	HHs actively cope with floods & engage in income-earning activities (FGD)	0.46	0.25
5) Demographic composition of household	Number of children under 6 and between 6-10 and persons over 60	73% of drowning fatalities were children (Dong Thap CFSC, 1996-2007)	0.19	0.19
6) Remittances	Number of young main labourers from 15 to 35 and their educational grades	95% of migrant workers were under 35 years of age (HH survey)	0.17	0.17
7) Income dependency	% of income derived from off-farm activities	Flood-related resources & off-farm activities declined quickly (FGD)	0.22	0.32

(Source: PRA, secondary data, household survey, 2008-2010)

At the household level, these selected factors affecting flood vulnerability are associated with root causes, dynamic pressures, unsafe conditions and flood hazards. First of all, root causes are mainly characterised by access to livelihood resources (see Chapter 6). Access to agricultural land and residential land are very important factors affecting rural livelihoods as well as their flood adaptation. Secondly, dynamic pressures are shaped by the decline in flood-related resources and rapid population growth (see Chapter 5). The income dependency indicator emphasises the livelihoods of local residents who are dynamically susceptible to flood impacts. Dynamic population growth has also influenced in and out-migration flows for livelihood opportunities in the rural floodplains. Thirdly, unsafe conditions include poor living locations, neighbourhood, temporary houses and a lack of physical household assets (see Chapter 6). Finally, the flood hazard dimension is defined as the impacts of annual slow-onset floods and the change in floods (see Chapters 3 and 5).

These factors were identified through field research carried out during 2008 and 2010 at both the riverbank and inland research sites. The standardised household survey data were normalised to an interval of [0,1], with 1 being the highest level of flood vulnerability. In

general, access to agricultural land, physical assets and appropriate housing conditions are essential problems for local residents in the rural floodplains (Table 15) in terms of effectively responding to flood impacts and enjoying flood-related benefits. Access to agricultural land is considered a very important productive asset to deal with livelihood disruption in the rural floodplains while access to appropriate housing and physical household assets has enabled households to respond to direct flood impacts. It means that local residents have paid attention to both coping and adaptation which enable them to mitigate flood risks and sustain their income-earning activities. In addition, currently the number of poor households dependent on flood-related resources has decreased; however, it is noticeable since it is difficult for poor households to shift to other livelihood opportunities.

7.2.1. Access to Agricultural Land

In the rural VMD, access to agricultural land has influenced household livelihood activities as well as livelihood strategies. Land ownership households usually earn their main income from crop production before flooding while landless people must look for other income sources during flooding seasons. The livelihood activities of landless residents and landowners encounter flood risks differently. As discussed in Chapter 6, agricultural land significantly contributes to household wealth as well as financial access which enables people to cope with and adapt to annual slow-onset floods. It was evident that many landless households agreed to settle in the rural floodplains in order to reclaim as well as concentrate agricultural land. In this study, with regard to agricultural land sizes, land ownership households were classified into three groups, such as landless households, small-land ownership households and large-land ownership households. Small-land ownership households have between 500 to 10,000 m^2 of land, and large-land ownership households have over 10,000 m^2 of land. The classification is mainly based on local residents' choice in the rural floodplains and the land size allocation for a relocated household in the rural floodplains in the 1960s. Moreover, currently in the rural floodplains in Dong Thap, each household has five members, and each member has average of 0.2 ha of agricultural land; therefore, more than 1 ha of agricultural land per household is grouped as the large-land group. The indicator relating to access to agricultural land is estimated through coding landlessness, small land and large land areas equal to 1.0, 0.5 and 0.0, respectively (Table 15).

This means that in the rural floodplains in VMD, flood vulnerability and access to agricultural land are contrarily correlated. Different land ownership households indicate how these types of land ownership households have shaped their flood vulnerability at the household level. Regarding the pressure of population growth, if either rural labour use or rural-urban labour

transition is not effective, agricultural land size at the household level will continuously reduce. However, reducing agricultural land size in the rural floodplains influences not only livelihood disruption due to floods, but also integration into the global market because of high production costs. In short, access to agricultural land is an important root cause that affects rural households with a low adaptive capacity to deal with flood impacts. Furthermore, this factor also shapes rural households' unsafe conditions since landless and small landowners have gained their main income in the severe flooding condition (see Chapters 5 and 6).

7.2.2. Access to Residential Land

Access to residential land enables local residents in the flood-prone area to enhance the safety of their housing conditions by planting trees surrounding their houses and housing improvement (see Chapter 6). People who temporarily live on their neighbour's residential land are not allowed to implement housing condition adaptation. Therefore, their housing condition is significantly exposed to floods because of a lack of appropriate housing materials or trees surrounding their households. Residential land ownership households were classified into three groups, such as residential landlessness, small residential land ownership (<=100 m^2) and large residential land ownership (>100 m^2). This classification is based on the benefit from their residential land as well as local residents' choice. There is significant difference between residential land ownership and residential landlessness in term of housing improvement and small-scale agriculture at their homesteads. Normally, less or equal to 100 m^2 of residential land is only enough space for housing without other additional advantages like small-scale agriculture and strong buffer fences with trees. The indicator relating to access to residential land is calculated through coding three groups as 1.0, 0.5 and 0.0, respectively. Table 15 indicates that a large number of households in the rural floodplains have residential land which enables them to carry out a series of coping and adaptation options to respond to floods. The relocated households have been expected to have residential land in the residential clusters and dykes which is subsidised by the government. However, it are difficult to return these costs for residential land within 10 years since their savings are not enough to cover both their daily costs of living and housing costs. In short, access to residential land is a factor mainly affecting the unsafe conditions of rural households since it directly influences their living locations, their housing conditions and flood response measures (e.g., buffer fences with trees). This factor has influenced all components of flood vulnerability (exposure, susceptibility and adaptive capacity) of households in the rural floodplains.

7.2.3. Type and Quality of Houses

Regarding the past flood-damaged profiles, almost all damaged houses were temporary stilt houses in the rural floodplains. The housing conditions which are damaged or destroyed by flooding have negatively affected human security and their physical household assets exposed to flood risks. Concrete and solid housing conditions are very useful for local residents in the flood-prone areas to protect their human lives and physical household assets. Therefore, the type of housing is one of the major factors affecting households during the flooding season. Housing condition and household wealth in the rural floodplains are correlated. Temporary, semi-permanent and permanent houses are coded as 1.0, 0.5 and 0.0, respectively, according to their (potential) flood damage. Different types of housing would contribute to flood vulnerability at the household level. The study indicates that a large proportion of houses in the rural floodplains are temporary stilt houses (Table 15) which can cope relatively well with annual slow-onset floods, but are vulnerable to typhoons. In sum, in the rural floodplains, solid housing enables flood-affected residents to better protect themselves and their families, their physical household assets and small-scale agriculture from flood impacts. The relocated households that were relocated in the residential clusters and dykes were allocated semi-permanent houses. Clearly, housing conditions affect unsafe the conditions of flood-exposed households in the rural floodplains. Solid housing contributes to enhancing the capacity of a household's response to flood impacts while poor housing influences their physical household assets that are more susceptible to flooding.

7.2.4. Access to Physical Household Assets

In flood-prone areas, residents cope with annual slow-onset floods while earning their livelihoods; therefore, physical household assets enable them to respond to both direct flood impacts and livelihood disruption. Major flood-related physical household assets which were selected by local residents in the research sites consisted of high pig cages, boats, machines, pumps, motor cycles, televisions, tap water supply, deep-wells and fishing tools. According to residents who lived in areas prone to floods in Phu Hiep and An Hoa Communes, these physical household assets are necessary for them to cope with and adapt to flood impacts and enjoy flood-related benefits. Recently, when flood-related benefits declined quickly, physical household assets were essentially used to cope with floods. There were eight major types of physical household assets identified by local residents in the flood-prone area. The indicator relating to access to physical household assets is estimated by subtracting the maximum number of major physical household assets (eight) and available assets of each household (Table 15). This factor is also one of the root causes of vulnerability. It means that in the rural

floodplains, households which have more flood-related physical household assets have a higher capacity to improve physical assets, respond to flood impacts and gain flood-related income.

7.2.5. Demographic Composition of Households

Different demographic compositions cause human security to be affected differently from flood risks. With regard to past flood-related mortality, the majority of drowning victims were children. In the flooding season, households with children assign an adult to take care of their children; therefore, the children are extremely exposed to flood risks, and adults have also been hindered in enjoy flood-related benefits. Clearly, adults play an important role in ensuring their household livelihoods since they take care of children and look for livelihood opportunities in flooding conditions. Moreover, young labourers have migrated to urban areas for non-farm jobs which enable them to cope with livelihood disruptions caused by floods. The demographic composition indicator is estimated regarding the number of family dependents, including the number of family members under 6 years old, those between 6-10 years old and those over 60 years old (Table 15). This factor influences local residents' capacity to both reduce flood risks and improve their flood-related income.

7.2.6. Access to Remittances from Urban Areas

Regarding six-month flooding, livelihood disruption is considered a predominant problem for rural households, especially for landless households in flood-prone areas. Limited savings and a lack of access to financial institutions affect residents who look for flood-related income or assistance through credit and indebtedness. Although rural labourers usually take low-skilled jobs, their remittances have contributed to responding to financial shocks during flooding. Additionally, given the decline in flood-related resources and the seasonality of off-farm wage activities, remittances have become one of the major sources of income for landless households. However, the household survey data shows that almost all main labourers (approximately 96 per cent) who provide remittances range from 15 to 35 years of age. This means that middle aged and elderly labourers in rural area are marginalised in the urban labour market. For this reason, the remittance capacity is calculated by multiplying the number of young main labours aged between 15 and 35 years of age by the mean of their educational grades (Table 15). The indicator relating to access to remittances is estimated by subtracting the maximum remittance of the investigated population by the available remittance of each surveyed household. This factor mainly influences the capacity to deal

with income-earning disruption due to flood impacts. It is associated with unsafe conditions since remittances enhance household income in the flooding season.

7.2.7. Income Dependency

Income dependency is defined as a source of household income which relies on susceptible sources of income or resources. Recently, flood-related resources have reduced rapidly; therefore, an income source derived from these flood-related resources has decreased as well. For this reason, flood-affected households have shifted from natural resource exploitation to non-farm or off-farm activities. However, many households lack access to livelihood assets which enable them to diversify their livelihood strategies; therefore, they continue to rely on flood-related sources of income that are susceptible to environmental change (see Chapters 5 and 6). They have few choices in building their livelihood strategies; consequently, their income has gradually reduced or become unstable pertaining to the decline in flood-related resources. The income dependency indicator is estimated by normalising the percentage of off-farm income among the total household income (Table 15). The high income dependency indicates that these households have essentially relied on susceptible flood-related resources, and they have also had to shift to other livelihood strategies. This factor influences rural households, particularly poor households, which are susceptible to flood impacts.

7.3. Indicator Weighting

The major factors which were identified through varying research tools affect flood vulnerability at the household level differently due their specific functioning. Furthermore, the importance of these factors was perceived differently by specific socio-economic groups and stakeholders. Therefore, in order to aggregate flood vulnerability at the household level, these factors were weighted through different perceptions of stakeholders, including socio-economic groups. Groups of people most associated with annual slow-onset floods and livelihoods were interviewed in order to weight these indicators. These groups of people were water-related researchers, members of the district CFSC, commune leaders, rich/large land ownership groups, middle/small land ownership groups and poor/landless groups (Table 16).

The first stakeholder was the group of water-related researchers from Can Tho University who conducted water-related studies in the rural floodplains. These researchers have expertise in various disciplines, such as agriculture, farming systems, environment, rural development and economics, and were able to provide more theoretical views regarding the selected factors of flood vulnerability. The second stakeholder was the members of the Tam Nong CFSC. These staff provided more managerial points of views concerning flood-related risk reduction

since they have annually participated in planning and implementation processes at the district level. The third stakeholder was the members of the People's Committee of the research sites. These members who were both managers and practitioners provided empirical points regarding flood-related reactions at the commune and household levels. Finally, socio-economic groups at the household level which were classified by land size ownership and wealthy groups could reflect their thinking about the selected indicators. These stakeholders had different livelihood resources, and they were also influenced differently by floods.

Table 16: Weights of indicators measuring flood vulnerability at the household level

Indicators	Researcher, N=15	District CFSC, N=10	Commune leaders, N=15	Rich group, N=15	Middle group, N=15	Poor group, N=15	Mean, N=55
1) Access to agricultural land	0.49	0.30	0.73	0.89	0.68	0.71	0.65
2) Access to residential land	0.46	0.46	0.43	0.51	0.52	0.63	0.50
3) Type and quality of house	0.89	0.68	0.52	0.63	0.63	0.63	0.66
4) Access to household assets	0.37	0.38	0.35	0.28	0.36	0.41	0.36
5) Demographic composition	0.53	0.70	0.61	0.35	0.45	0.29	0.48
6) Access to remittances	0.39	0.40	0.33	0.40	0.31	0.33	0.36
7) Income dependency	0.49	0.68	0.63	0.55	0.65	0.60	0.60

(Source: Semi-structure interviews, 2010)

Each investigator individually weighted all seven indicators from 0 (the lowest importance) to 1 (the highest importance). The weight of each stakeholder or group is the mean of all investigators in each stakeholder or group, and the weight of each indicator is the mean of all stakeholders and groups investigated (Table 16). The weighting from these various stakeholders and socio-economic groups could be expected to reduce the bias regarding single disciplinary perception. Moreover, the disparity of the weighting regarding different stakeholders and groups also provide more interesting points that reflect the fact that flood vulnerability is influenced by people's perceptions.

Regarding perceptions of these stakeholders, three indicators, including the type of house, access to agricultural land and income dependency, were considered more important than the others (e.g., access to residential land, demographic composition, access to physical household assets and access to remittances). According to local residents in the research sites, access to agricultural land and the quality of houses and income dependency influenced their direct flood impacts and livelihood sustainability. Generally, the importance of each indicator was not different from stakeholders' perceptions which emphasise specific roles in flood vulnerability at the household level. However, there were disparities in the selected indicator weighting by district CFSC members and others regarding access to agricultural land. The

difference presented gaps in local people's needs and CFSC members' approaches. The district CSFC members considered access to agricultural land as a minor important indicator; in contrast, commune leaders and local communities viewed it as a most important indicator for flood vulnerability reduction (Figure 34). It means that the local community pays more attention to major livelihood assets while the district CFSC members consider security for children to be the most important priority. These perceptions have shaped coping and adaptation strategies at both the household and regional levels differently.

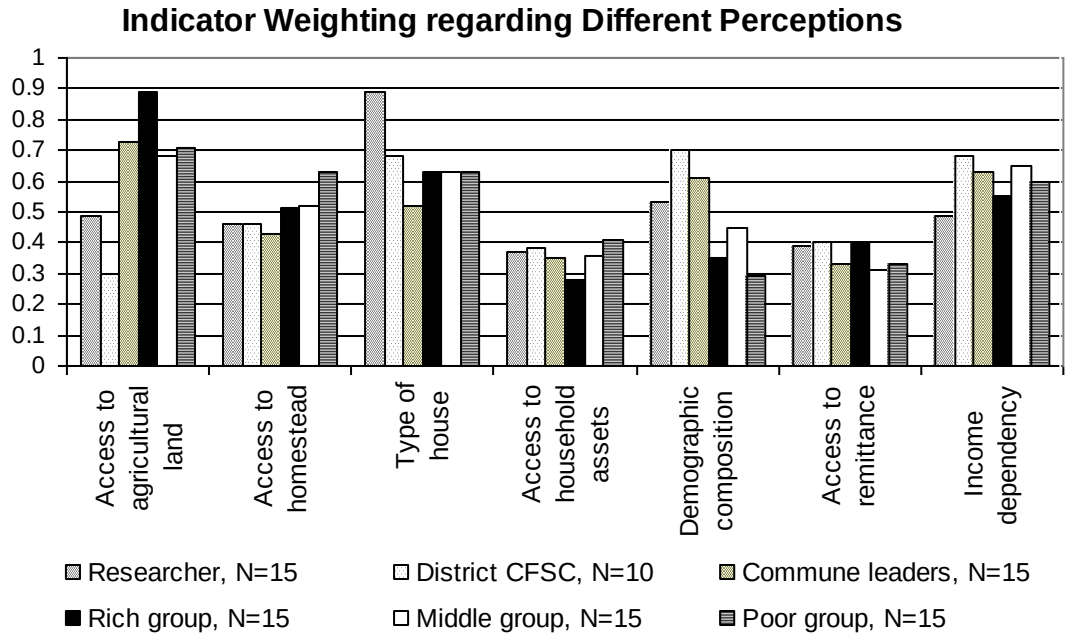


Figure 34: Indicator weighting regarding different perceptions
(Source: Household survey, 2009)

7.4. Vulnerability Aggregation

It is not easy to measure vulnerability since it is associated with various qualitative aspects; however, quantitative data can be collected and try to quantify qualitative answers. Flood exposure levels are indentified regarding varying living locations. In the rural VMD, there are four major types of settlement locations, including settlements in flood-prone areas, those close to low dykes or roads, those close to high dykes or roads or those in high elevated areas (e.g., residential clusters or dykes). Taking this into account the past flood damage and the essential settlement patterns in the rural Plain of Reeds, households were classified into the four flood exposure levels. These four settlement locations in flooded areas, close to low dykes or roads, close to high dykes or roads and in high elevated places were exposed to annual slow-onset floods as 1.0, 0.75, 0.5 and 0.25, respectively. The classification was implemented by local people's opinion of their (potential) flood impacts.

Among the seven selected indicators, type of house, access to physical household assets and demographic composition, are significantly affected by different flood exposure levels since they respond to direct flood impacts. The others, including access to agricultural land, access to residential land, access to remittances and income dependency, are indirectly influenced by flood exposure levels as they mainly influence a household's livelihood strategies. Therefore, flood vulnerability is aggregated through both direct and indirect groups of the indicators. The latter is influenced by exposure levels. Flood vulnerability at the household level is aggregated through the sum of multiplying indicators, weights and exposure levels. The formula is calculated as follows:

$$\text{Vulnerability} = \sum W_i I_j + \sum E_k W_n I_m$$

Where: W: weights of indicators

I: indicators

W_i: a weight of indirect impact indicator i

I_j: an indirect impact indicator j

E_k: an exposure level of a direct impact indicator m

W_n: a weight of direct impact indicator n

I_m: a direct impact indicator m

7.5. Socio-Economic Characteristics and Their Impacts on Flood Vulnerability Patterns

Flood vulnerability at the household level was estimated through the selected indicators, their weights and the exposure levels as discussed previously. Flood vulnerability regarding different socio-economic groups is shaped by various factors and depended on their accessibility to livelihood assets. As previously argued in Chapters 4 and 7, the criteria for group classification consisted of agricultural land ownership, main income sources, household wealth, in-migration periods and relocation patterns (Table 17). Although these criteria are closely related to each other and partly overlap, the classifications help to highlight and compare flood vulnerability within and across socio-economic groups in the rural floodplains. These criteria are expected to comprehensively present flood vulnerability at the household level since vulnerability is associated with the history of the exposed elements, a development condition in which exposed elements are embedded, and social relations which exposed people are dealing with everyday.

Table 17: Aggregated vulnerability of different socio-economic groups

Criteria	Socio-economic group	Notes	N	Mean	Std.
Agricultural land ownership	Large land group	Land>10,000	86	0.750[a]	0.39
	Small land group	Land<=10,000	82	1.30[b]	0.43
	Landless group	Land=0	82	1.84[c]	0.47
Main sources of income	On-farm group	Agricultural farming	145	1.05[a]	0.54
	Remittances	Non-farm activities far from home	40	1.29[b]	0.39
	Non-farm group	Non-farm activities at home	24	1.37[b]	0.58
	Off-farm group	Off-farm wage and fishing	41	2.08[c]	0.40
Wealth	Wealthier group	WR score<=70	73	0.73[a]	0.38
	Medium group	30<WR score<70	106	1.31[b]	0.51
	Poor group	WR score<=30	71	1.81[c]	0.48
In-migration periods	Long in-migration (before 1970)	Reclamation and land allocation	40	0.98[a]	0.51
	Medium in-migration (1970-79)	Resettlement from the border	71	1.10[a]	0.51
	Short in-migration (1980-1999)	HYR production	117	1.43[b]	0.61
	New in-migration (after 2000)	Others	19	1.72[c]	0.77
Relocation patterns	Relocated group in AH	Relocated in AH residential dyke	79	1.59[a]	0.33
	Non-relocated group in AH	Poor people living in AH	20	1.60[a]	0.43
	Relocated group in PH	Relocated in PH residential cluster	41	1.80[b]	0.24
	Non-relocated group in PH	Poor people living in PH floodplain	31	2.12[c]	0.40

(Source: Household survey, 2009) (AH: An Hoa Commune, PH: Phu Hiep Commune)

(Notes: same superscript characters in a column (mean) and a row (criteria) is significant difference)

First, as mentioned, agricultural land is a key productive asset which enables rural households to engage in farming activities (see Chapter 6); therefore, understanding flood vulnerability regarding agricultural land ownership indicates that different accesses to agricultural land have shaped their livelihood adaptation differently. Secondly, exploring flood vulnerability regarding main sources of income shows that rural households relying on migration, off-farm activities or farming activities are more vulnerable to flood impacts (see Chapter 5). Thirdly, in the rural floodplains, wealth and capacity of response are correlated since the wealthy conditions of rural households enable them to enhance their housing conditions, physical household assets as well as income-earning options (see Chapter 6). These physical assets are necessary to protect their lives and physical assets from flood impacts as well as to conduct livelihood activities. Fourthly, understanding flood vulnerability regarding in-migration periods in the rural floodplains indicates that the in-migration patterns which were in relation to flood-related experiences and forced in-migration in the rural floodplains influenced flood vulnerability (see Chapter 5 and 6). Finally, viewing relocation patterns in the residential clusters and dykes forced by the relocation policy shows that the relocation policy has affected flood vulnerability regarding the relocated and non-relocated groups. In short, understanding flood vulnerability through different criteria helps to explore major factors

shaping flood vulnerability regarding different socio-economic groups in the rural floodplains in the upper VMD.

7.5.1. Agricultural Land Ownership

Access to agricultural land contributes to flood vulnerability reduction at the household level as land ownership influences household livelihood strategies in the rural floodplains. The vulnerability of large land ownership households is lower than that of small and landless households (Figure 35) as large landowners usually have semi- or permanent houses with adequate physical household assets. These large landowners are usually wealthier residents. Rice producers usually earn their main income before flooding; therefore, they rarely rely on flood-related resources which are severely susceptible to environmental change. In contrast, landless households mainly rely on flood-related resources and low-skilled non-farm activities in urban areas. Thus, flood vulnerability is significantly different among different agricultural land ownership types (Table 17), and landless households are the most vulnerable to annual slow-onset floods (Figure 35). Clearly, access to agricultural land in the rural floodplains is a powerful point to access other livelihood resources that have helped landowners to better apply their flood response strategies.

However, allocating agricultural land to poor households in order to reduce flood vulnerability is an impossible measure since this scarce resource becomes so expensive. The improvement of the access to agricultural land could be replaced by other income-earning options that could enhance people's capacity of response to flood impacts. Moreover, scattered land plots and small land sizes in the rural floodplains have restricted local residents from effectively integrating into the globalised economy due to high production costs. In addition, agricultural mechanisation and land concentration have continuously pushed the increase in the proportion of rural landless households. These dynamic pressures, such as the globalised markets, agricultural mechanisation and the land concentration policy, have strongly influenced local residents, particularly poor households, to access agricultural land as a major livelihood resource for flood adaptation strategies. Another noticeable solution is that the capacity of rural poor labourers should be enhanced in order to achieve income-earning activities and better respond to annual slow-onset flood impacts in the rural floodplains

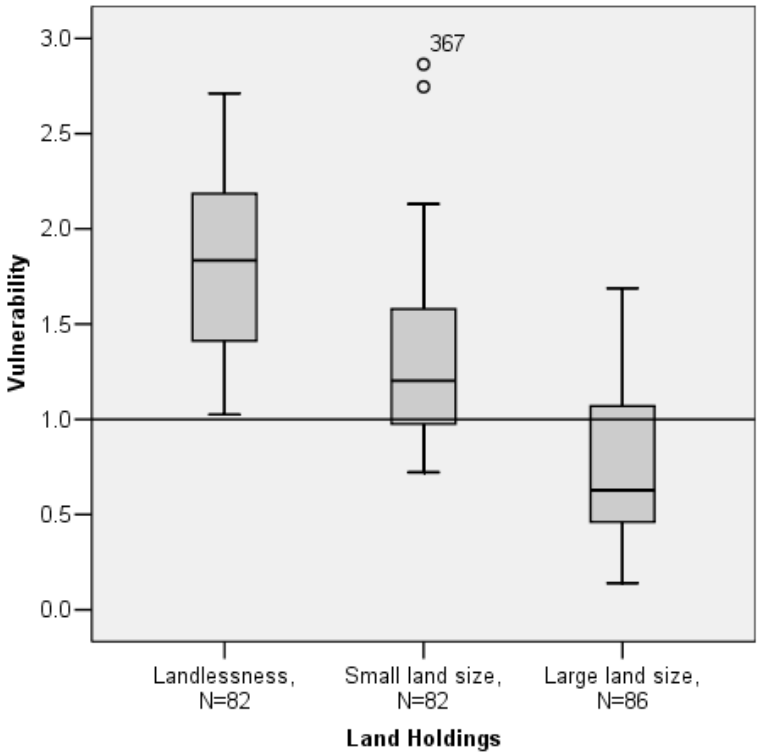


Figure 35: Household vulnerability regarding land ownership
(Source: Household survey, 2009)

7.5.2. Household Wealth

Household wealth has also contributed to flood vulnerability reduction (Figure 36). This is because wealthier households usually own a large area of agricultural land and sufficient physical household assets which enable them to cope with both direct flood risks and income-earning activity disruption. The study indicates that household wealth and land ownership are significantly correlated (see Chapter 6). Regarding high capacity to access to household resources, wealthier households have a wide choice to build and alter their livelihood strategies in order to deal with annual slow-onset flood impacts. In contrast, poor households have poor housing conditions and lack physical household assets (see Chapter 6); therefore, they rely on unstable income sources. In addition, most poor households have no land which has constrained them to diversify agriculture and to access the formal financial institutions with reasonable interest rates. Consequently, poor households have to work in severe flooding conditions and temporally or seasonally migrate to urban areas for income. In short, household wealth has influenced flood vulnerability at the household level, and poor households are the most vulnerable to annual slow-onset floods (Figure 36). Both Figure 35 and Figure 36 indicate that in the rural floodplains socio-economic groups classified by wealth and agricultural land ownership are significantly correlated.

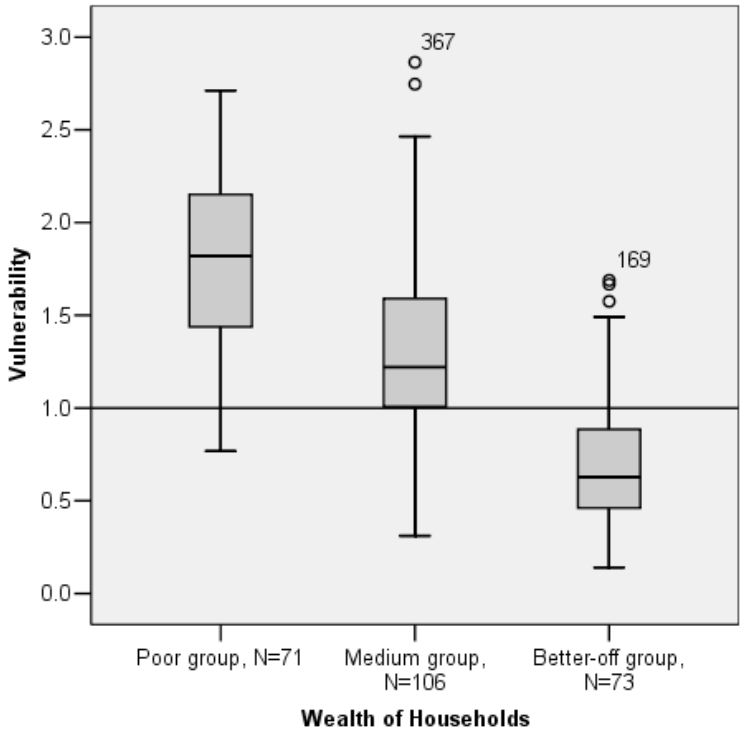


Figure 36: Household vulnerability regarding household wealth
(Source: Household survey, 2009)

7.5.3. Types of Main Income Sources

A main source of income expresses flood vulnerability at the household level since income-earning activities are influenced differently by annual slow-onset floods and rural environmental change. In the rural floodplains, there are four main types of income-earning sources which come from on-farm activities (e.g., HYV, vegetables and snakehead fish), off-farm activities (e.g., daily off-farm wage, fishing), non-farm activities (e.g., business, services and vendors at home villages) and remittances (e.g., non-farm activities in the urban areas). These types of main income sources are also closely correlated to agricultural land ownership and household wealth. Understanding the flood vulnerability of socio-economic groups classified by the main types of income sources emphasises the vulnerability of specific occupations of rural households. The study indicates that households reliant on off-farm activities are the most vulnerable to annual slow-onset floods since these resources are declining quickly (Figure 37).

As previously discussed in Chapter 6, these households lack access to capital assets which help them to shift into other strategies. In the past, landowners who mainly engaged in paddy production were exposed to annual slow-onset floods since their major rice crops such as the SA and AW crops were often damaged by floods due to no embankments. Presently, households reliant to farming are less vulnerable to floods since they can earn their main

income before flooding season, and paddy production is protected by embankments from flood impacts. However, in the long term, household income which is reliant on a single farming source of income is a risky livelihood activity since the VMD is a one of the most vulnerable regions to climate change in the world. An increase in rice damage due to unusual raining in the research sites in 2008 and 2010 and high floods in 2011 presents several examples where climate change has impacted on-farm activities, particularly rice production.

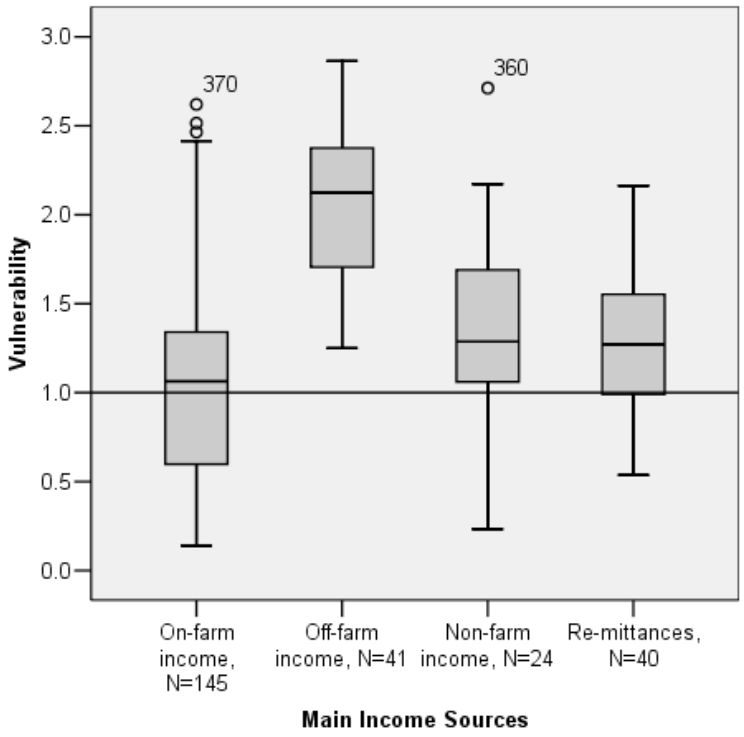


Figure 37: Household vulnerability regarding main income sources
(Source: Household survey, 2009)

7.5.4. Residents' In-migration Periods

The long-term in-migration in the rural floodplains has contributed to in-migrants' capacity to deal with floods. The early in-migrants who still live in the rural floodplains have experience of annual slow-onset floods and have learned and disseminated flood-related knowledge. Regarding local knowledge sharing, they have gradually improved their housing conditions and flood-related experience. The study indicates that the earlier in-migration contributes to flood vulnerability reduction (Figure 38). For example, local residents who settled in the rural floodplains in the 1960s are less vulnerable to flood impacts than the later in-migrants. The earlier in-migrants usually live in densely populated areas which have adequate basic infrastructures, such as electricity lines, tap water supply, transportation, markets and schools (see Chapter 5 and 6). Many in-migrants who could not adapt to flood impacts and sustain their livelihoods moved to other places for new livelihood strategies. Therefore, long-term in-

migrants who have enhanced their capacity of response and experienced different patterns of annual slow-onset floods are less vulnerable to flood impacts. In comparison, new in-migrants who have settled since the 2000s usually live in the rural floodplains or close to low roads in which are in low populated areas and have insufficient basic infrastructure. New in-migrants who resettled in the rural floodplains after the 2000 floods have been exposed to livelihood disruption due to flood impacts and the decline in flood-related resources. Thus, in this context, flood vulnerability could be understood as a lack of development (Cardona, 2004) since the early in-migrants were rarely supported by basic infrastructures in order to respond to flood impacts.

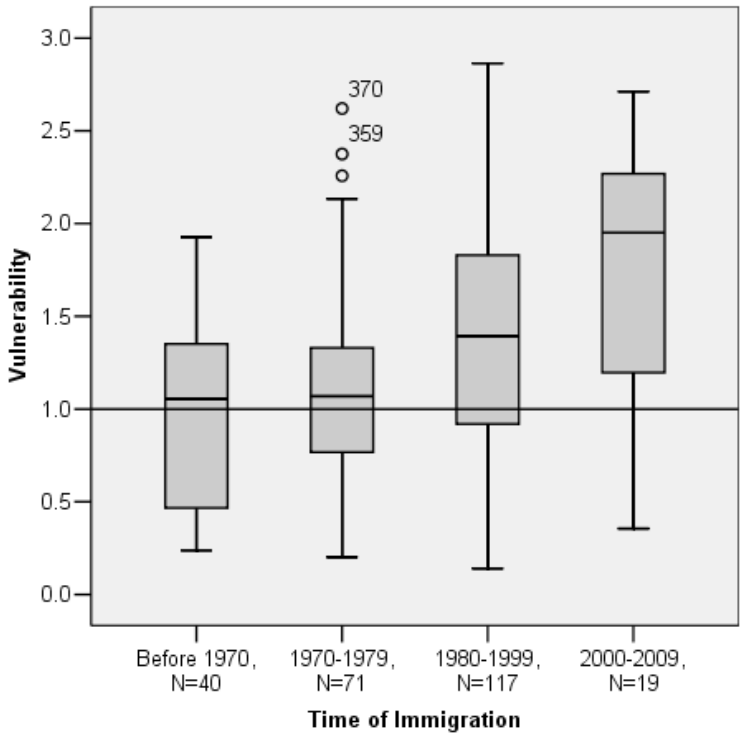


Figure 38: Household vulnerability regarding in-migration periods
(Source: Household survey, 2009)

7.5.5. Relocation Patterns

The relocation policy has been popularly implemented in the rural floodplains since the 2000s; therefore, exploring the flood vulnerability of both relocated and non-relocated groups after a decade of the relocation indicates major changes in flood impacts and their livelihoods. The study indicates that the flood vulnerability of both relocation patterns in the riverbank site (An Hoa Commune), which was less exposed to flood impacts, was not a significant difference (Table 17). Their livelihoods and flood exposure show little difference between before and after relocation. Nevertheless, the flood vulnerability of the relocated group was lower than that of the non-relocated group in the inland site (Phu Hiep Commune), which was

more exposed to flood impacts. In Phu Hiep Commune, the non-relocated residents used to gain flood-related benefits and small-scale agriculture at their homesteads; however, recently, these income sources have been reduced. Thus, these non-relocated households encounter both flood risks and livelihood disruption. For this reason, in severe flood-prone areas, the relocated households have reduced direct flood impacts. Flood vulnerability at the household level was a significant difference between the relocated and non-relocated groups in the inland areas (Figure 39). Generally, the relocation policy is more effective in the severe flooded areas since it enables the relocated households to escape direct flood risks.

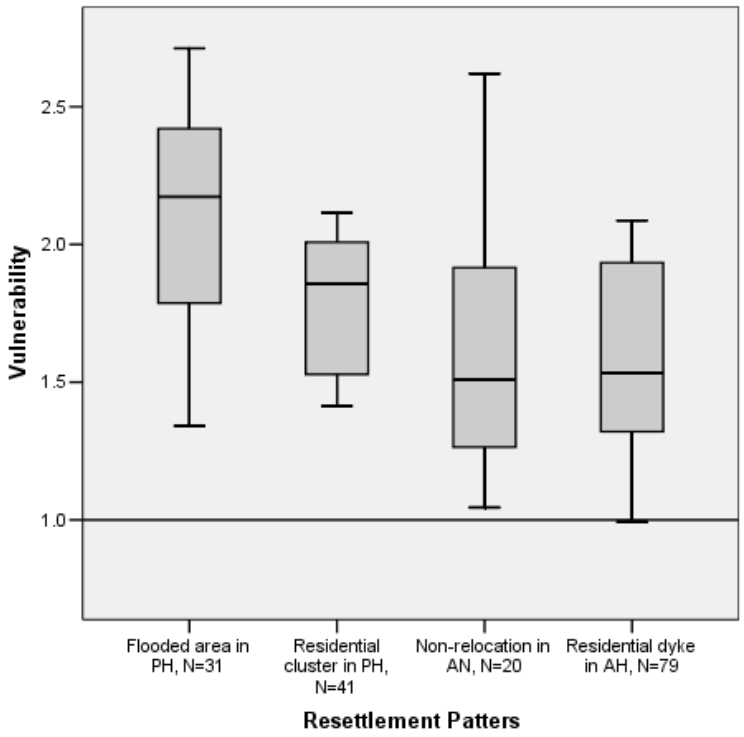


Figure 39: Vulnerability of households regarding relocation patterns

(Source: Household survey, 2009)

(Residential clusters and dykes are relocated places for households prone to annual slow-onset floods)

The flood vulnerability assessment of different socio-economic groups based on different criteria is useful to understand the major factors influencing flood vulnerability at the household level. In the rural floodplains, a vulnerability assessment closely links with residents' livelihoods since their livelihoods and physical household assets strongly influence their flood exposure, susceptibility and capacity of response. For this reason, local residents are interested in both coping and adaptation strategies based on their access to livelihood assets. Measuring flood vulnerability at the household level indicates that major socio-economic groups are vulnerable to flood impacts, and main reasons influence them to cope with as well as adapt to flood risks. Thus, the use of the local vulnerability assessment is

necessary to upscale the assessment to the whole flood-prone region in order to build the regional vulnerability profile.

7.6. Transferability of the Local Vulnerability Assessment

7.6.1. Disaster Risk Reduction in General

Human fatality and economic problems caused by natural hazards have been increasing for years (Birkmann et al., 2009); disaster risk reduction, therefore, is a prioritised task of the international community, in which the implementation of the Hyogo Framework for Action[19] is strongly supported by almost all nations in the world. A series of applied measures for disaster risk reduction include early warning systems, evacuation plans, emergency response training and rural and urban planning, among other things. These measures have achieved effective results when major factors of root causes, dynamic pressures and unsafe conditions (see PAR Model) are identified. In the rural floodplains, the main factors affecting the flood exposure, susceptibility and capacity of response of different socio-economic groups are clarified. For this reason, the vulnerability assessment is necessary in order to indicate which and why certain elements or groups of people are exposed and vulnerable to specific hazards, and which factors mainly influence the vulnerability of exposed units. Thus, vulnerability assessment contributes to climate change adaptation since the assessment process identifies major factors shaping local residents' flood vulnerability.

Systematic links between disaster risk reduction (DRR) and climate change adaptation (CCA) concepts and sustainable development and human security are being discussed by scientists; however, regarding a review of the existing literature, the differences between the two concepts, including different spatial and temporal scales, knowledge types and sources and norm systems, have constrained their integration in practice (Birkmann and Teichman, 2010). In the rural VMD, both concepts are necessary to respond to direct flood impacts and sustain people's long-term livelihoods.

7.6.2. Climate Change Adaptation in Vietnam

Vietnam in general, and the VMD specifically, is the area most exposed to climate change impacts, particularly sea level rises, and socio-economic transformation. The Vietnamese government, especially the Ministry of Natural Resources and Environment (MONRE), developed a national strategy for climate change adaptation in 2009 and updated it in 2010

[19] The Hyogo Framework for Actions 2005 – 2015 agreed in 2005 at Hyogo, Japan, aims to build the resilience of nations and communities to disasters, emphasising national implementation and follow-up regarding participation and collaboration involving stakeholders at different levels.

and 2011. The strategy involved various ministries and institutions since climate change adaptation was associated with bio-physical and socio-economic factors. Thus, the interdisciplinary approach was necessary to construct as well as implement a comprehensively adaptive strategy; however, cooperating between participating institutions in order to achieve outcomes was limited. Although the national strategy for climate change adaptation was built, the specific planning of each involved ministry or institution sometimes caused conflicts with others or constrained the general integrated implementation[20]. The strategy for climate change adaptation, particularly sea level rises, was constructed regarding the middle scenario (also called B2 scenario), which assumed that the sea level would rise by 1.0 metres by 2100. Regarding this scenario, approximately 15,000 km^2 (40% of the area) of the VMD would be inundated. In the special landscape of the VMD, sea level rises and floods or water discharge are closely interrelated, and any flood-related interventions, for example a sea level rise adaptation strategy, influence human livelihoods in the VMD.

The strategy for climate change adaptation has provided a general framework for involving ministries and all provinces to build and implement specific planning to adapt to climate change impacts. This strategy was built to deal with climate change problems at national and regional levels and mainly focused on the principal structural and non-structural measures. However, as discussed in this chapter, the flood livelihood adaptation strategy of each socio-economic group is shaped by different factors in terms of their accessibility to resources, resettlement patterns and major types of income sources. Therefore, a specific climate adaptation strategy at each administrative level needs to clarify the major factors influencing climate change vulnerability for socio-economic groups, particularly their livelihoods. The strategy for climate change adaptation will not achieve expected outcomes if disaster risk reduction is not effective to deal with disaster risk impacts. It is clear that coordination between CCA and DRR is extremely necessary to effectively reduce climate change impacts on social-ecological systems.

7.6.3. Local Vulnerability of Flood Risk Reduction Strategies

Vulnerability is influenced by the social process, susceptibility and lack of resilience of elements or socio-economic groups in the disaster-prone areas (Cardona, 2004). Flood risk reduction strategies are connected to socio-economic systems; therefore, vulnerability reduction is shaped not only by reactions immediately following a disaster, but also by policy formulation and development planning in order to mitigate hazard impacts. Risk reduction is

[20] The general discussion in the workshop on "Scenarios for Climate Change and Sea Level Rises for Vietnam", organised by the MONRE, WB and UNDP at Ho Chi Minh City, Feb 2011.

shaped by relevant interventions in terms of vulnerability progress, including root causes, dynamic pressures and unsafe conditions (Blaikie et al., 1994). The aim is how to provide visible results and a full causing factor explanation to local policy-makers who formulate flood risk reduction strategies and policies.

Flood risk management requires estimating risks to take into account not only losses in terms of the expected physical assets, economics and human lives but also social and institutional factors. Flood risk is related to the both occurrence of physical phenomena and the vulnerability conditions which influence or facilitate disaster when these extreme events occur. As previously mentioned in this chapter, it is not easy to measure these complex issues; however, indicators which have essentially influenced these aspects can be used to quantify household vulnerability regarding a certain hazard like annual slow-onset floods. In this study, the selected indicators were chosen by understanding the transformation processes which explore root causes, dynamic pressures and the unsafe conditions shaping flood vulnerability at the household level. These identified factors are starting points for flood-risk reduction interventions for certain socio-economic groups or regions. For these reasons, the local vulnerability assessment contributes to the development of a flood risk reduction strategy. It identifies major socio-economic groups as well as communities vulnerable to flood impacts and provides the main reasons affecting their flood vulnerability. Generally, disaster risk reduction as well as capacity enhancement are important measures both to support adaptation to hazards shaped by climate change impacts and to assist societies in building their efforts (Birkmann and Teichman, 2010). However, in order to assess local vulnerability, the databases, particularly the local vulnerability profile, at the grass-roots level should be built up and updated since the databases make it possible to scale up the local vulnerability assessment in the larger rural floodplains.

7.6.4. Transferability on Different Social and Spatial Scales

7.6.4.1. Flood Vulnerability at the Household Level

An indicator-based vulnerability assessment is useful to aggregate the vulnerability of certain groups of people to a certain hazard. The vulnerability aggregation is used to visualise and compare hazardous vulnerability regarding different socio-economic groups. In the context of the rural VMD, it can be modified and applied to identify the vulnerability of varying communities prone to annual slow-onset floods. In the indicator-based vulnerability assessment, indicators need to be understandable, available, accessible, measurable and consistent. Regarding the seven selected indicators and their weights in this study, the flood

vulnerability of rural households can be aggregated, if the vulnerability profile at the household level is available and accessible. The first five indicators, including access to agricultural land, access to residential land, access to physical household assets, types of houses, and demographic composition can be formulated as the basic household vulnerability profile. The rest of the indicators such as remittances and income dependency can be estimated due to each household income.

Household profiles which consist of basic information of households in the rural floodplains are available from the databases at the hamlet and commune levels. The official statistical data provide basic information regarding the community level; however, these databases are poor and rarely updated because of the lack of human resources and basic infrastructure for data management. Moreover, in many cases, agricultural land was inherited by the next generation, but land title certificates have not been divided among inherited households. Therefore, data relating to household land ownership as well as landless rates at the community level need to be crosschecked using other research tools. In short, the basic household profiles currently available need to be organised and updated if flood vulnerability at a household level will be scaled up for the larger rural floodplains. Moreover, several major questions in terms of the household vulnerability profile should be integrated into the periodic national surveys that can be used to measure vulnerability to a hazard at the household level.

7.6.4.2. Flood Vulnerability at the Community Level

When scaling up, the indicator-based vulnerability assessment has been dealing with changes in the principal indicators and their weights. For instance, besides access to household physical assets, each community can access critical public physical infrastructures, such as schools, main dyke systems, roads, local clinics and administrative buildings differently. The changes in principal indicators occur since hazard exposure and the main elements and groups of people exposed to a certain hazard are temporally and spatially changing. In order to overcome these constraints, zoning hazard-based areas and weighting these selected indicators need to be implemented. Flood vulnerability at the community level can be estimated using household vulnerability indicators. Consequently, the community vulnerability profile can be constructed through both existing statistical data and supplemental investigated data. In short, the indicators aggregating household vulnerability could be adjusted in order to measure vulnerability at the commune level because of their close relations.

7.6.5. The Local Vulnerability of Water-Related Information Systems for Sustainable Development in the Upper Rural Flood-Prone Areas

The Water-related Information System for Sustainable Development of the Mekong Delta (WISDOM)[21], one of the most important projects, has constructed the databases as well as knowledge hubs relating to water-related issues in the VMD. The project's goal is to clarify major water-related problems and develop feasible measures to mitigate negative impacts caused by water-related hazards in the VMD. This important task is mainly undertaken by both Vietnamese and German scientists and participating organisation. This system is expected to provide a package of interdisciplinary data and knowledge concerning water-related issues which will be used by various water users and managers, especially policy-makers. As previously discussed, vulnerability to a certain hazards is shaped by the natural condition and the socio-economic transformation which is related to public policies and development planning.

A local vulnerability assessment can contribute to the water-related information system development since it attempts to identify and measure the vulnerability of different socio-economic groups to annual slow-onset floods in the rural floodplains. It also shows that the schematic causal factors influence vulnerability at the household level regarding root causes, dynamic pressures and unsafe condition. It presents major factors affecting flood vulnerability in terms of its components, including exposure, susceptibility and capacity of response that are necessary for flood-related interventions as well as flood risk governance. It explains how groups of people or elements exposed to floods are changing regarding driving factors such as farming system development, embankments and resettlement. Within the water-related vulnerability assessment section in the WISDOM, vulnerability is assessed across the VMD from the upper, middle and downstream regions that are exposed to floods, high tidal floods and salinity intrusion, respectively.

The flood vulnerability assessment was coordinated with the other work packages given specific research activities within the WISDOM. First of all, the hydrological section of the WISDOM provided information relating to flood regime patterns and flood trajectories in the context of climate change. It presented changes in sedimentation in both the canal systems and rural floodplains of the upper VMD and human interventions in the upstream Mekong Basin. It is extremely important since the changes in flood regimes have significantly

[21] WISDOM is a project relating to integrated water resource management in the Vietnamese Mekong Delta. It is funded by the German Ministry of Research and Education (BMBF) and the Vietnamese Ministry of Science and Technology (MOST). Its first phase lasts from 2007 to 2010, and the second phase from 2011 to 2014.

influenced the livelihoods of the riparian residents. Secondly, the pesticide research section of WISDOM indicated surface water pollution caused by agrochemical application and water use patterns of local residents in the rural floodplains. As rice production is related to the main source of income of a large population in the rural floodplains, pesticide application and its consequences are closely linked with household vulnerability. The pesticide section described how the rural population was susceptible to surface water pollution due to agrochemicals. Thirdly, the endocrine disruptor research of WISDOM provided pathways of water pollution and their negative impacts on human health and reproduction. The warning of endocrine disruptor research into water pollution and its consequences were geared towards water users as well as regional planners since agricultural intensification and embankments have popularly developed in the rural floodplains in the upper VMD. Finally, the water-related knowledge and governance section provided various water-related issues in terms of water-related knowledge, regional land use planning due to embankments, and rural drinking water governance. These studies presented water-related problems in terms of social aspects. All these studies within the project across the VMD have contributed to a better understanding of relations within the Pressure and Release Model (Blaikie et al., 1994) in which various factors regarding root causes, dynamic pressures and unsafe conditions have influenced the vulnerability of different socio-economic groups in the rural floodplains of the VMD.

8. Transforming Structures in Flood Risk Governance and Their Impacts on Vulnerability Patterns

In the rural floodplains of the VMD coping and adaptation to floods have been implemented by different actors at different levels based on their specific roles and resources. It was stressed in Chapter 6 how different socio-economic groups react to flood impacts through their accessibility to livelihood resources. Taking this into account, this chapter tries to explore the transforming structures and processes that have influenced the coping and adaptation capacity and processes of different socio-economic groups. Specifically, the major transforming structures and processes, such as embankments, flood-related policy and large-scale relocation projects, are examined in order to evaluate positive and negative impacts on socio-economic groups' flood vulnerability. Flood response processes in terms of the transforming structures and processes are also classified into short- and-long term reactions - coping and adaptation. Coping deals with direct hazard impacts and losses while adaptation is associated with change as well as chances for development (Birkmann et al., 2009). However, the adoption of a new development path caused by adaptation processes can have both positive and negative effects on the livelihoods of different socio-economic groups.

8.1. Legal Frameworks and Institutions Relating to Flood Risk Governance

Disaster risks, particularly flood-related risks, are governed by different administrative levels and formal institutions. The Vietnamese government has issued a series of policies and regulations, and certain institutions were established in order to mitigate flood risks for different regions, elements or groups of people exposed to flooding. The legal frameworks and institutions which play important roles in flood-related risk and damage reduction have influenced actors in the rural floodplains differently. In the flood context of the VMD, annual slow-onset floods provide both disadvantages and advantages to the biophysical systems (see Chapter 5); consequently, the policy of "*living with floods*" is accepted as a core strategy advocated by the government and supported by local residents. Regarding these legal frameworks and institutions, both structured and unstructured measures to respond to floods have aimed to mitigate flood damages as well as to gain flood-related benefits. While structured measures are "hard devices", unstructured measures are considered "soft solutions" needed to ensure that the former work well (Be et al., 2004; Sanh et al., 2004).

8.1.1. Policies in Relation to Flood Risk Governance

As previously discussed, the government has issued and regularly adjusted a series of policies to govern disaster risk, particularly with regard to floods (Table 18). National and provincial policies and strategies related to flood prevention and mitigation have focused on minimising flood damage and improving people's living conditions. "*Living with floods*" is an important strategy to reduce negative flood impacts and gain flood-related benefits. It emphasises some important solutions as follows:

(1) Residential clusters and dykes and embankments are to be built in densely-populated areas in order to relocate poor households that are severely prone to hazards, particularly floods;

(2) Community-based childcare houses are to be organised during high floods to protect children from flood risks;

(3) Basic rural infrastructure (e.g., local roads, schools, clinics and administrative offices) is to be built or upgraded above the flood peak of 2000;

(4) People's awareness and knowledge regarding flood prevention and control are to be improved in order to live with floods effectively;

(5) Preservative funds and basic materials (e.g., food, medicine, clothes and other flood-based tools) at the commune level are to be mobilised through the "four pillars on site" principle, including command, manpower, means and materials at the grass-roots level;

(6) Facilities and flood-related forecast methods are to be improved; and

(7) Agriculture, particularly summer-autumn and autumn-winter rice crops, and income-earning activities for the poor are to be protected and developed during the flooding season.

Policies and regulations have been issued at different administrative levels in order to guide and manage flood response strategies. Generally, unstructured measures for flood adaptation were implemented; but the structured measures were prioritised by the local governments (Be et al., 2004; Sanh et al., 2004). Local residents in the rural floodplains are strongly exposed to flood risks, but simultaneously struggle to sustain their livelihoods (especially the poor). It is evident from the empirical findings (see Chapter 7) that poor households prone to floods worry about their livelihood disruption more than about flood risks. As a result, a gap exists between local residents' needs and the flood-related structural interventions. Therefore, a feasible long-term strategy for flood response needs to be based on an interdisciplinary as

well as sustainable livelihoods approach since these interventions may create conflicts among local natural resources users.

Table 18: The flood-related policies and interventions in the Vietnamese Mekong Delta

Timeline	Major natural events and flood-related interventions and policies	Major content and results
1978	High floods peaking at 4.94 metres measured at Tan Chau Gauging Station	Extensive crop damage, particularly to floating rice.
1977-1980	Brown Plant Hopper (BPH) outbreak	Many households suffered from hunger, stimulation of double HYV and Brown Plant Hopper tolerant rice varieties.
1990	Decree No. 168-HDBT of the Council of Ministers established and outlined CCSFC	Stipulation of the functions, responsibilities and organisation of the CFSC from central to local levels.
1993	Ordinance for Storm and Flood Control and Prevention of the National Assembly	Building of fundamental regulations for storm and flood control and mitigation: planning, early warning systems, evacuation, relief, resources, mitigation.
1994-1996	A series of high floods peaking at 4.3-4.9 metres measured at Tan Chau	Extensive damage to infrastructure, crops and over 750 people killed.
1996	Decision 256/QD-TTg on subsidised credit for the elevation of house foundations for the poor	Selected poor households prone to floods were granted subsidised long-term credit for house foundation elevation.
1996	Decision 99-TTg in 1996 of the Prime Minister on development of irrigation and transport construction in VMD 1996-2000	-Embankment construction to protect the SA rice crop and low and medium flooded areas. -Trial construction of residential clusters and dykes in the flood-prone provinces.
1997	Typhoon No.5 "Linda" hit the southern tip of Vietnam	Many boats, infrastructure and crops destroyed; over 2,900 people killed or missing.
2000-2002	The historical 2000 floods peaking at 5.06 metres measured at Tan Chau Gauging Station	Highest loss of life and damage to crops and infrastructures due to floods in the VMD. A series of high floods (2000-2002) killed over 1,050 people.
2001	Decision 173/2001/QD-TTg of the Prime Minister on socio-economic development in the Mekong Delta	Construction of residential clusters and dykes, stilt houses, high house foundation, electricity, water supplies, which must be relevant to transportation, irrigation and flood control planning.
2002	Decision 105/2002/QĐ-TTg of the Prime Minister on deferred payment for houses for the relocated	Relocated households that previously lived in flood-prone areas could purchase houses on deferred payment in residential clusters and dykes VMD.
2007	Decision 172/2007/QD-TTg on the strategy for natural disaster prevention, response and mitigation to 2020	Introduction of the "*living with floods*" policy; the government took initiatives to prevent storms, thunderstorms, whirlwinds, salinity intrusion and drought in the VMD.
2008	Decision 158/2008/QD-TTg on the national target program to response to climate change	Assess climate change intensity and scenarios, enhance research for climate change response and related institutions and plans, improve response capacity.
2011	Decision 2139/QD-TTg of the Prime Minister on the national climate change adaptation strategy	Adaptive capacity to climate changed is planned to be enhanced through integrative programs and inter-ministries.

(Source: Author, desk study and KIP, 2008 and 2009)

Policies and regulations were issued at different administrative levels to guide and manage flood response strategies. Figure 40 indicates that the Prime Minister has built decrees and decisions to specify the responsibilities of involved stakeholders. At the provincial level, the Provincial People's Committee has issued directions annually to create targets for flood control and damage reduction based on the aforementioned national policies and decrees. The

decrees and official correspondences were guidelines for the provincial CFSCs to guide CFSCs at grass-roots level to implement their responsibilities. At the district and commune levels, CFSCs mainly follow the plans and directions of the central and provincial CFSCs, but also issue some of their own regulations in order to implement their responsibilities in the current context of communities at the grass-roots level and mobilise existing local resources. In urgent cases (e.g., severe damage due to high floods), formal coping activities at the grass-roots level could support social networks associated with mobilising charitable contributions (e.g., boats, machines, wooden materials and money) for rescue, houses reconstruction, crop harvesting and dyke maintenance.

8.1.2. The Committee for Flood and Storm Control and Its Roles in Flood Risk Governance

8.1.2.1. Planning and Coordination

CFSCs, which consist of varying departments or units, are organised and coordinated at both horizontal and vertical levels (Figure 40). At each administrative level, the People's Committee (PC) organises a CFSC and promulgates regulations for its functions and responsibilities. The head of the CFSC is simultaneously a vice chairman of the respective PC. A vice head of the CFSC is a director or head of the Department of Agriculture and Rural Development (DARD) at provincial, district or commune levels. Dong Thap CFSC included 23 and 28 members from varying departments in 2004 and 2008, respectively. The Department of Water Resources Management of DARD provides the standing office of the CFSC. The organisation and coordination of CFSCs at the provincial, district and commune levels are similar. In order to mitigate flood impacts and increase coordination among CFSCs, sub-committees are established, including infrastructure and production protection, healthcare-education-environment protection, search and rescue, relief, communication and propaganda.

8.1.2.2. Planning and Participation in Decision-Making Processes

The planning process of the CFSCs is both vertical and horizontal. At the national level, the Prime Minister's Office directs the provincial PC (vertical direction), the CCFSC, the Southern CFSC and relevant Ministries/Bureaus (horizontal direction) to develop the plan for storm and flood control and mitigation. At the provincial level, the provincial PC specifies the instructions and general objectives of the Prime Minister's Office, the Central CFSC and the relevant Ministries/Bureaus. The provincial PC directs the CFSC, its Departments (horizontal) and district PCs (vertical) to take precautions against storms and floods and assigns tasks to

the CFSCs' members. Based on the general plan of the Central CFSC and the provincial PC, the provincial CFSC makes a general plan for provincial departments (horizontal) and district PCs (vertical). The provincial departments, in turn, specify the general plan of the PC and the CFSCs into a more specific plan based on their particular responsibilities in order to both implement the plan and direct their units and the district PCs to implement the plan. Planning and implementing at the district level were similar to those at the provincial level, both the horizontal and vertical directions. The PC and CFSC at commune level implement instructions and plans from the district level.

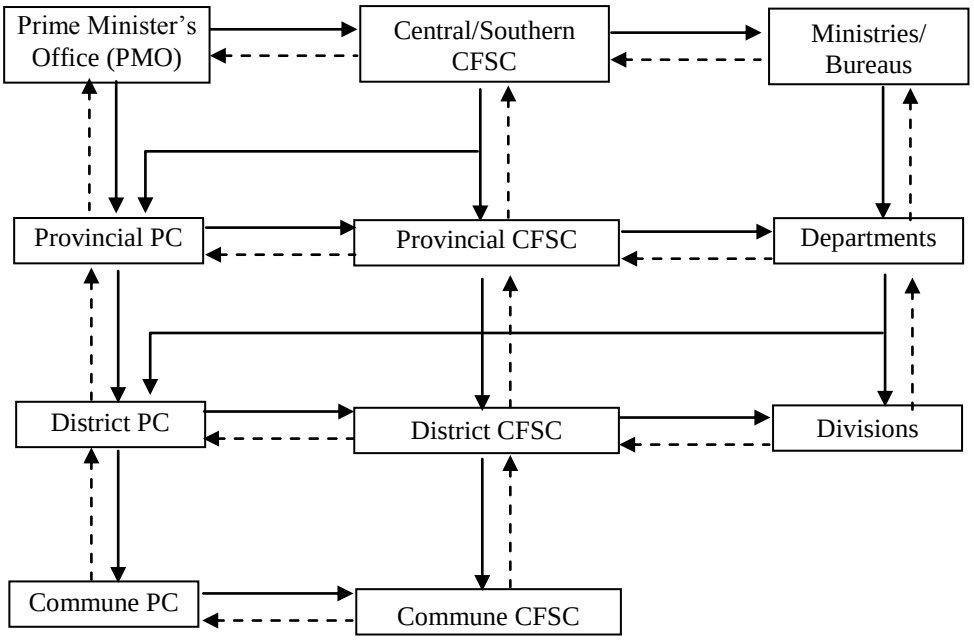


Figure 40: Organisational structure of the CFSCs at various levels
(Source: Be et al., 2004; Sanh et al., 2004)

Planning is annual and dependent on the severity of floods occurring in the previous or current year. The plan includes three phases: before, during and after floods. The first phase (before flooding and from 1 to 30 June) focuses on preparedness and the final reporting and evaluation of response and recovery from the last flooding. A general plan for flood prevention and control in the current year is made. During the second phase from 1 July to 31 October, preparedness for flood prevention and control as planned in the first phase is evaluated. Planning for coping with floods in the second phase is carried out based on the flood situation and future predictions from the Centre for Hydro-Meteorological Forecasting. The third phase occurs from 1 November to 31 December, and during this period, the relief and response undertaken in the second phase are evaluated, and a plan for recovery is developed. In general, the plan is usually adjusted according to the context of annual slow-onset floods.

8.1.2.3. Coordination Mechanism

The coordination mechanism is vertical from the central to the provincial, district and commune levels and horizontal from PC, CFSC to departments. The Provincial CFSC coordinates all activities and makes decisions for annual and periodically general plans. On behalf of the provincial CFSC's head, the executive deputy head of the provincial CFSC directs and monitors activities assigned to the provincial and district departments/units. The chief secretary of the CFSCs' standing office takes charge of administrative work and consultancy for the CFSCs. The members of the CFSCs or the CFSCs' standing office jointly discussed flood prevention and control, which proved as important as their assigned professional duties.

For plans and tasks of the CFSCs' subcommittees, heads of the subcommittees make decisions and coordinate their work with other involved departments. For the plans and tasks of each department, the respective head of the department makes decisions and coordinates their approved activities. The planning and implementation is adjusted to the context of high floods and emergency. In such cases, heads of departments can make urgent decisions based on the "four pillars on site" principle and then report later. The strategy of the "four pillars on site" principle is decentralisation of power to local authorities and communities that are involved in flood prevention and control. According to that principle, local authorities at the grass-roots levels and communities can make their own decisions and use their own resources, facilities and manpower to control flooding and to mitigate flood damages. In the 2000s, the normal annual budget was approximately 14,000 USD distributed for the provincial CFSC. This budget was increased in case of severe floods.

8.1.2.4. Reporting Hierarchies

Reporting hierarchies in planning, monitoring and evaluation are both vertical and horizontal. For horizontal reporting, departments report their specific plans, monitoring and evaluation to both the CFSCs and the PC at the same level. For the vertical direction, the departments, the CFSCs and the PC report those to their authorities at the direct higher level. The CFSCs and the PC, therefore, receive specific plans and reports from both the departments at the same level and the CFSCs and PC from the level below. Reporting frequency differs depending on the severity of flooding. In normal floods, reporting frequency is twice a month before flooding, four times a month during flooding and once a month after the flood.

Strengths of Committee for Flood and Storm Controls

In flood-prone areas, CFSCs build the bridge between the natural hazard response policies and the local community's needs. They reach down to the grass root level and are linked to varying departments/units, which are involved in mitigating flood damage as well as the recovery process. The focus group discussion with the Dong Thap CFSC members in 2008 revealed several predominant strengths of the CFSC. Firstly, annual planning was both a vertical and horizontal process, which was instructive and participatory. Specific plans made by provincial departments were flexible, relevant and active. Secondly, CFSCs exist at all administrative levels (e.g., central, provincial, district and commune) and coordinate the overall resources for flood prevention and mitigation. The "four pillars on site" principle is relevant to the timely response in cases of emergency and effective recovery. This principle has stimulated societal contributions in terms of finance and manpower for flood control and mitigation. Finally, several non-structural measures including the organisation of childcare centres, the adjustment of the schooling year during flooding, the organisation of swimming training, and awareness-raising with regard to flood risk and adaptation were implemented effectively at the grass-roots level in order to improve the protection of children. These measures also offer income-earning opportunities for poor people in the floodplains. Generally, regarding urgent or short-term coping with high floods, the operation of CFSCs is relatively effective; however, they have not yet achieved long-term livelihood adaptation for local residents, particularly poor households. It is evident that income from both off-farm activities and flood-related resource exploitation has been reduced, and access to other livelihood opportunities is limited because of low human capacity.

Weaknesses of the Committees for Flood and Storm Control

CFSCs have gradually increased their responsibilities for disaster risk reduction; however, they still have various weaknesses that need to be improved in order to meet the communities' needs, particularly to achieve vulnerability reduction of different socio-economic groups. The weaknesses of the CFSC were discussed by Dong Thap CFSC members during the focus group discussion in 2008. Specific strategies that are developed and implemented by individual departments or units are usually difficult to integrate into overall measures. Consequently, the possibility for long-term livelihood adaptation in the rural floodplains is shaped by the level of coordination among CFSC members as well as their institutional strategies.

The first weak point is that a plan of the provincial CFSC is directive and general. Although the planning takes into consideration livelihoods and living conditions of the poor in flood-prone areas, the implementation of planning is lacking active participation from varying actors and the community in terms of flood-related livelihoods and also in terms of evaluation. For instance, poor households are more vulnerable to floods as well as influenced by flood-related interventions; but they have rarely participated in flood-related mitigation programs.

The second weak point is that human resources and the capacity of the CFSC standing office are inadequate. Regarding the duties from their positions in their respective institutions, it is difficult for the staff of the CFSC standing office to fulfil all their additional duties in the CFSCs. Furthermore, they have low capacities in terms of the appropriate methods and skills for this work while they are responsible for synthesising the reports quickly. Consequently, annual reports mainly just list major flood damages rather than analyse the setbacks caused by poor flood-related planning and coordination.

The third shortcoming is that the planning does not fully reflect a strategic and long-term solution for flood prevention and sustainable development. The combination of structured and unstructured measures was proposed by almost all staff of the provincial CFSC. The unstructured measures have helped to support structured measures (e.g. agreement for periodical flooding in embankments) or to deal with negative consequences caused by the structured measures. Structural measures, which are generally prioritised, include the upgrading of basic infrastructure (e.g., roads, healthcare centres and schools), the establishment of an effective network for coordination from village to provincial levels, and the upgrading of flood forecast facilities. Non-structural measures have contributed to improving people's awareness of flood prevention and control, strengthening capacities to improve their livelihoods, and to fostering participation in planning, monitoring and evaluation. The use of such non-structural measures would also increase CFSC staff capacity in planning, implementation, monitoring and evaluation, and would improve precision and the updating of flood information.

The final weak point is that financial resources from the government for flood control and mitigation are inadequate and inactive. The budget is determined based on annual flood forecasts; therefore, flood mitigation is usually considered to be a short-term activity. Coping activities such as the plantation of trees for erosion protection and dyke upgrading were therefore often funded and applied just before the onset of annual floods and were in consequence not strong enough to withstand the water waves.

Solutions for Improving Flood Management and Mitigation

As discussed, the provincial CFSC plays an important role in coping with floods and mitigating flood damages. To improve the performance of the CFSC further, the remaining weaknesses need to be resolved in a feasible manner, as proposed by Dong Thap CFSC members. According to the participants of the 2008 FGD, the weaknesses were already recognised by CFSCs; however, they have not yet been addressed due to limited human and financial resources and coordination among CFSC members. Thus, barriers in the interactions between structural and non-structural measures in the rural floodplains as well as short and long-term strategies need to be identified and overcome to ensure a viable flood adaptation strategy.

Table 19: Weaknesses and possible solutions of CFSC at the provincial level

Weakness	Solutions	Institutions commented[22]
1. Lack of coordination	Coordination among CSFC members should be improved and clearly defined.	DOIT, DPI, DOH, DOLISA,
2. Incomprehensive early warning systems	Both "soft" and "hardware" for early warning systems need to be improved in order to predict more precisely weather variability.	DARD, Public Security, CHMF
3. Lack of identification of major groups and places vulnerable to floods	GIS maps to define major places and elements exposed and vulnerable to annual slow-onset floods.	WU, DOLISA, DOH, DOC, RCA, EC, DOIT
4. Inadequate support for people relocated from floodplains	Relocation needs to consider livelihoods and basic social and infrastructure needs.	DARD, FA, DONRE, DOET
5. Underestimation of flood risks	Awareness of flood risks should be improved in order to mitigate flood losses and human fatalities	FA, Public Security, YU
6. Unsustainable livelihoods in the rural floodplains	Flood-related resources decline quickly; therefore, rural job creation and flood-based agricultural production should be implemented.	DARD, DOLISA

(Source: Focus group discussion with the Dong Thap CSFC members, 2008)

The first solution is that the coordination process in CFSC systems should be improved in order to increase the effectiveness of flood management and mitigation. According to the participants of the FGD in 2008, flood preparedness before and after floods should be more

[22] Dong Thap CSFC members joining the focus group discussion in 2008 included Department of Agriculture and Rural Development (DARD), Department of Construction (DOC), Department of Education and Training (DOET), Department of Health (DOH), Department of Labour, Invalids and Social Affairs (DOLISA),Department of Natural Resources and Environment (DONRE), Department of Industry and Trade (DOIT), Department of Planning and Investment (DPI), Electricity Company (EC), Farmer's Association (FA), Centre for Hydro-Meteological Forecasting (MHFC), Red Cross Association (RCA), Youth Union (YU), Women Union (WU).

focused by CFSC because the preparedness helps CFSC members and local residents to actively respond to flood impacts. These experiences would provide useful lessons for disaster risk reduction strategies. Clearly, the members of CFSC recognised that urgent coping strategies try to mitigate flood damage rather than adapt to flood impacts.

The second solution is that the early warning system regarding annual slow-onset floods and other natural hazards, particularly typhoons, needs to be improved since it is necessary to ensure preparedness. In the context of climate change, the combination of floods and other hazards, particularly between floods and typhoons, should be examined. Moreover, the relationship between flood levels in the upstream and downstream areas of the VMD has changed due to the changes in embankments, dyke systems, irrigation systems and land use. In brief, improving the early warning system may contribute to more effective decision-making relating to flood adaptation strategies.

The third solution is that vulnerability and needs for specific socio-economic groups and places should be assessed because such knowledge can support appropriate planning to cope with extreme events. According to CFSC actors concerned with social disparities, major groups vulnerable to floods include the poor, children, the elderly, the disabled and mothers with infants. Areas prone to floods and elements at risk of flooding should be identified via the use of GIS maps and flood damage databases, and vulnerability mapping should be established for improved short-term responses as well as long-term disaster risk reduction. This would better show that certain socio-economic groups, communes or regions are differentially exposed and vulnerable to annual slow-onset floods. Measuring the vulnerability of socio-economic groups helps in the development of relevant short and long-term strategies to respond to hazards, particularly floods. In short, individual CFSC members proposed that identifying major exposed elements and measuring the vulnerability of different socio-economic groups should be implemented in the context of annual slow-onset floods, but the vulnerability assessment methodology had not yet been constructed by either the CCSFC or by scientists.

The fourth solution is that the relocation practice, which has relocated poor and landless residents exposed to annual floods, should be associated with basic infrastructure and livelihood improvement. The participants stated that residential clusters and dykes should be equipped with adequate basic infrastructure. Information and knowledge about residential clusters and dykes should be disseminated to rural residents because of the changes in lifestyle from rural farms to small semi-urban dwellings with space for small-scale production. Moreover, after the floods in 2000, the built environment has changed due to the

construction of rural infrastructure and dyke systems which influence flood impacts. For instance, the number of people exposed to floods in Dong Thap gradually decreased from 80 per cent in 2004 to 20 per cent in 2008 because of informal and formal relocation and the construction of embankments and rural roads. Thus, relocation is related not only to living places, but also to access to livelihood opportunities.

The fifth solution is that local residents should be trained to gain flood-related knowledge and experience. Local residents understood well the annual flood impacts; however, their underestimation of flood risks may still cause them harm from flood impacts. As the participants noted, although community awareness in terms of flood risks has improved, disseminating flood-related information to residents in the flood-prone areas needs to be promoted because many households still live and work in the rural floodplains. Some of them expect to rely on external relief in case they are affected by floods. Besides formal financial resources (e.g., international aid, central government funding), financial mobilisation for a flood adaptation strategy is considered a sustainable contribution for flood adaptation.

The final solution concerns the quick decline in flood-related resources because of depletion and illegal exploitation (e.g., electric fishing tools, dense nets) and changes in land cover and dyke systems. The CFSC members indicate that policies that support flood-related agriculture for landowners and non-farm activities for landless residents should be introduced because of the decrease in rural income-earning activities.

In summary, flood-related policies and institutions, particularly the CFSC, have shaped not only formal coping and adaptation strategies, but also informal responses carried out by rural residents. Formal responses emphasise short-term coping strategies regarding extensive flood impacts rather than focus on long-term livelihood adaptation. Sustaining rural livelihoods plays a key role in any response strategy since it enables rural residents to enhance their capacity to reduce flood vulnerability through the improvement of physical conditions as well as the reduction of high-risk livelihood activities like fishing.

8.2. Formal Coping Processes in Flood Risk Governance

Although informal coping capacity at the household level is necessary to mitigate direct flood impacts, formal coping activities are implemented by local governments as well as CFSCs to mobilise wider human, material and financial resources in order to urgently mitigate extreme flood impacts, particularly flood-related disasters. The flood recovery funds are mobilised from governments at all levels and contributed charitably from various sponsors. During high floods, relief funds are mainly contributed by the public, and the Fatherland Front generally

manages and distributes these financial funds and materials to flood-affected households. While the informal flood coping activities are carried out by individuals or the community, formal flood coping activities are governed by local governments and institutions. Regarding high floods in the VMD, formal coping activities include both structured and unstructured measures which enable preparation, coping and recovery from flood impacts. Structured coping measures include physical delivery or construction projects, such as dyke upgrading, evacuation, material aids and crop protection. In contrast, unstructured coping measures include flood-related training courses and propaganda. Normally, coping is a short-term response to sudden or unforeseen events; however, for repeated hazards like annual slow-onset floods in the VMD, many formal coping activities are informed by past flood events and informal coping activities. Understanding short formal unstructured and structured coping activities and the interplay between formal and informal flood responses may indicate the roles of different actors within short-term flood response strategies.

8.2.1. Unstructured Formal Coping Measures

In the "*living with floods*" policy, structural measures are focused on more by local governments in order to respond to flood impacts; however, unstructured measures have gradually become an important part in the overall flood response strategy. The unstructured measures that have been regularly applied since the 2000 floods have helped to reduce the number of children drowning and to enhance human security and income earning activities in flooding seasons. These unstructured measures are conducted by social institutions, such as the CFSCs, and by the local branches of the Women Union, the Farmer's Association, the Youth Union and the Fatherland Front.

Each of these social institutions is responsible for specific tasks of the local CFSC relating to flood prevention and mitigation that enable local residents to cope with flood impacts. Of these, the local Fatherland Fronts mobilise financial and material resources which are used to support people who are socially marginalised and to provide relief to flood-affected households. The local Women Union usually organises discussions on flood-related issues, particularly the preparation of drinking water, food, and family healthcare, aiming to enhance the flood risk awareness and coping strategies of local women. In this way, housewives in the rural floodplains are provided with knowledge on caring for their families while at risk from floods. Women Unions usually provide training courses associated with income-earning activities (e.g., handicrafts) that may create income-earning activities to women during the flooding season. However, these income-generating tasks are often insecure since market problems (e.g., price fluctuation, market disconnection) usually constrain their stability and

achievements. Local branches of the Farmer's Association are another type of organisation responsible for housing improvements and crop calendar adjustments that help local residents to protect their physical household assets and major income from agriculture. The unstable housing structures of some selected poor residents were reinforced through CFSC's financial support before flooding. Youth Unions also help local residents to quickly cope with direct flood fatalities and damage such as sunken boats or destroyed houses. Generally, CFSC members have tried to meet their responsibilities in the rural floodplains; however, the coordination among the CFSC members bears several weaknesses which were previously discussed and highlighted by Dong Thap CFSC members.

In short, formal unstructured coping is a "soft" measure to increase people's coping capacities through training courses and supportive community activities (e.g. sharing of flood-related problems and advice). As mentioned above, some coping measures were carried out informally at first but were formalised later on. These include the reinforcement of houses, the installation of grass fences around houses, dyke upgrading and protection, swimming classes, and the prevention of water-borne diseases based on local knowledge of flood-exposed residents. These informal coping activities were selected and formally transferred to rural communities, but they have not yet met the needs of people in flood-prone areas regarding the improvement of income generation. According to Dong Thap CFSC members, formal unstructured activities are usually interrupted and unsystematic at the community level in the context of normal floods since many flood-related prevention and mitigation activities are only implemented during extreme flood events. These activities would be more effective if CFSC members better coordinated flood-related stakeholders at the grass-roots level and if long-term flood response strategies and livelihood sustainability were defined as a priority.

The importance of unstructured measures is emphasised by both the local governments and farmers since flood-related issues, such as a lack of volunteer activities for embankment maintenance, insufficient flood risk awareness, and a lack of knowledge relating to livelihood improvement need to be addressed for vulnerability reduction. The remaining limitations are reflected by the negative outcomes of flood responses. According to the in-depth interviews with Dong Thap CFSC in 2009, unstructured measures promoted by the government were internalised and adopted by society, especially in terms of the "living with floods" strategy. In other words, these unstructured measures have enhanced and disseminated their flood-related knowledge in rural communities in order to help local residents live with floods more effectively.

8.2.2. Structured Formal Coping Measures

8.2.2.1. Critical Infrastructure and Agriculture Protection

Protecting major infrastructure (e.g., embankments, main bridges and roads) and agriculture is prioritised by the local governments and the CFSCs. Depending on the levels of (potential) flood damage, local human resources or army forces were urgently commanded to protect critical infrastructure and agriculture. In the research sites, the army participated in protecting dyke systems and harvesting summer-autumn rice crops threatened by early and high flood impacts. In the case of small and medium levels of (potential) flood damage, formal coping through CFSCs was coordinated with informal collective coping through local resource mobilisation in order to mitigate flood damage. The army provides a powerful response, but reacts more slowly than informal collective coping activities managed by local residents. The informal collective coping activities are implemented quickly and in a timely way in order to reduce damage to crops, dyke systems, roads, bridges and houses.

8.2.2.2. Emergency Aid

Relief, a short-term measure, plays an important role in quickly mitigating flood disasters. In the VMD, relief provides for basic needs, including food, medicine, drinking water, filtered water containers, clothes, blankets, and fishing tools to local residents affected by floods. Relief is usually distributed during/after high floods when local residents fail in their coping strategies with regard to using their own resources. Relief is managed by the CFSCs. During high floods, provincial and district CFSC members are responsible for the mitigation of flood damage, particularly relief, at the local level. At the community level, the CFSC organises the mobilisation of local raw materials and transportation while simultaneously receiving external relief funds and materials to address urgent problems (e.g., damaged or collapsed houses, fatalities, water and food shortages, medicine needs). The financial contributions for the formal relief are rapidly mobilised from the public during and after extreme flooding events. Therefore, relief is reactively implemented due to a lack of long-term preparedness. In short, the interplay between CFSCs and informal coping strategies serves to quickly mobilise and implement response activities in the flood-prone areas in which extreme flood damage exceeds local residents' own resources and capacities.

8.2.2.3. Protecting Children from Flood Risks

The major coping measure implemented to protect children under six from floods was the gathering of children at childcare houses during flooding seasons. Local houses were arranged as child day-care centres which were operated during those seasonal floods. The number of

children's day-care houses was organised flexibly depending on the flood forecast (Figure 41). These houses assisted adults, particularly the poor, to focus on their income-earning activities in the floodplains while their children were safe in the day-care houses. However, children under three years of age still needed to be cared for by their adult family members, and children living in the remote areas lacked access to this service. In addition, according to the provincial CFSC's staff, almost all drowning incidents for children occurred at night and far from densely populated areas. Regarding the use of individuals' houses as child day-care centres, the basic equipment of these houses to meet children's needs is inadequate.

School schedule flexibility is a regular coping measure to protect young pupils from flood risks. In the rural floodplains, the school year, which begins in September during high flooding, is temporarily adjusted and the schools are closed during high floods. These measures help children living in flood-prone areas to reduce their exposure to flood risks, particularly since they go to school in small wooden boats. In addition, children are taught how to swim by both their families and teachers. However, according to the focus group discussions in Phu Hiep and An Hoa Communes in 2008, children living in highly elevated areas reduced their swimming capacity. This was because households that were relocated to residential clusters and dykes gradually reduced their flood coping capacity. It implies that coping is shaped by actors' perception (Troeger, 2002).

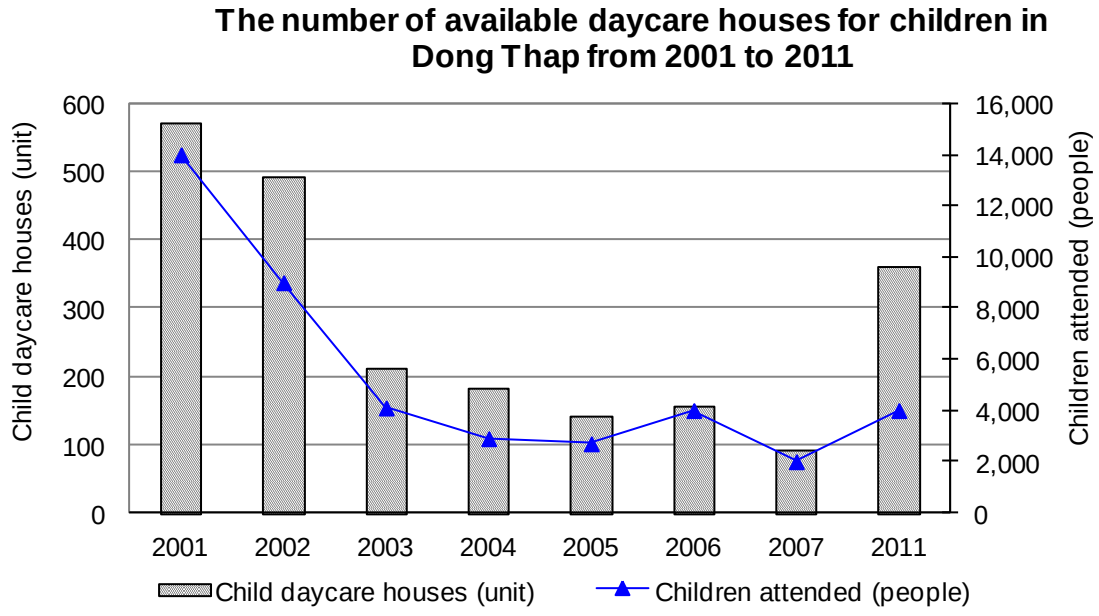


Figure 41: The number of available day-care houses for children in Dong Thap from 2001 to 2011
(Source: Author, data from Dong Thap CFSC, 1994-2011)

In short, serious flood-related damage can be partly mitigated if coping is improved and implemented appropriately in the rural floodplains. Flood coping is mainly carried out just before and during floods while adaptation is usually initiated well before floods come, and

gradually improves the livelihood situation. During long-term flooding, local residents had to cope with flood impacts while earning their livelihoods. In the research sites, the coping patterns applied depend on the levels of (potential) flood damage, in which informal individual coping, informal collective coping, semi-formal coping and formal coping activities are successively implemented. In cases of small-scale or low flood damage, each household could conduct its own coping activities; however, for larger scale or severe flood risk impacts, informal collective coping activities (e.g., neighbours or villagers) or semi-formal coping activities (e.g., villagers and local army forces) or formal coping reactions (e.g., regional army forces) would be mobilised in order to deal with flood impacts. Clearly, these coping patterns both supplement and play a specific role in preventing and mitigating flood damage. In many cases coping involves learning and is applied in the long term due to repetition. Several informal coping activities (e.g., preparation of houses, and life-vests) are supported or promoted by the CFSCs as formal coping responses, so that knowledge can in turn contribute to enhancing coping capacity at the household level. Coping is a critical response strategy to mitigate direct flood impacts; however, adaptation is a key strategy that enables rural residents to live successfully with slow-onset floods. Adaptation is usually based on flood experience and has been gradually enhanced through lessons learned and improved livelihood assets. Thus, understanding different adaptation patterns is important in order to know how local residents adjust and develop livelihood strategies that enable both flood damage reduction and sustainability.

Table 20: Main formal coping and adaptation patterns of local authorities in the rural upper VMD

Coping activities	Adaptation measures
1) Mitigating agricultural damage - command army to help farmers harvest crops - command army to protect dyke systems - subsidise agricultural materials after floods	1) Protecting agriculture - construct embankments - adjust crop seasonal calendars - support intensification of agriculture
2) Protecting people‘s life - organise evacuation for flood-affected households - organise child day-care centres - adjust schooling time	2) Implementing flood risk management - relocate flood-exposed households - provide swimming training for students
3) Coping with flood and livelihood disruption - provide basic needs (food, medicine, clothes) - provide fishing tools (boats, nets, hooks) - provide recovery funds or resources for residents affected by floods	3) Improving rural livelihoods - support flood-related agriculture projects (infrastructure, credits) - train occupations for rural labour

(Source: Author, KIP, focus group discussions, in-depth interviews, Dong Thap, 2008-2010)

8.3. Major Formal Adaptation Processes in Flood Risk Governance

Formal interventions should be viewed as a transforming process in which different actor interests and struggles are located. Flood-related interventions in the VMD have been used for

a long period of time although these formal interventions have received more money and attention since the historic 2000 floods. The interventions in the water-based environment of the VMD have shifted from adaptation to more control through large-scale hydraulic control structures and agricultural modernisation (Kakonen, 2008). Some central flood-related interventions, such as conversion to high-yielding rice varieties, embankments, residential clusters/dykes and non-structured measures, have differently affected local residents' livelihoods. These interventions have brought advantages for some groups and disadvantages for others.

Table 21: Embankment in Phu Hiep and An Hoa Communes

Items	Phu Hiep Commune	An Hoa Commune
Natural area (ha)	5,066	2,630
Of which agricultural land (ha)	3,296	2,118
Full flood-control area (ha)	2,000	558
Full flood-control area/Agricultural land (%)	61	26
Semi flood-control area/Agricultural land	39	74

(Source: KIP in Phu Hiep and An Hoa Communes in 2008 and 2011)

8.3.1. Embankment Measure

The construction of embankments that is popular in the VMD helps to protect SA crops from the early floods and to develop AW crops during the flooding season. In the 2010s, since AW rice is officially accepted as the major annual crop in the rural floodplains, the construction of embankments has been increasing. Dyke systems are usually built along canals by elevating canal dykes. The height of upgraded embankments has contributed to increasing the construction of formal and informal residential clusters or dykes as well as basic public infrastructure such as markets, clinics, schools and administrative buildings. The construction of these residential clusters and dykes has provided both advantages and disadvantages to flood-affected households in the rural floodplains in the upper VMD.

In the research sites, full flood-control embankments were constructed in the late 2000s, and the third rice, the AW rice crop, has been cultivated since 2011. The construction of the full flood-control dykes was funded by the government and landowners. Landowners contributed financial resources to the construction of embankments based on their agricultural land size. In Phu Hiep Commune, the large full flood-control embankments were financially supported by an ODA project of the Japan Bank for International Cooperation (JBIC). Sixty one per cent of agricultural land of the commune is fully protected from floods. The sluice gates of the embankments have enabled farmers to get in and out floodwater that helps to improve soil fertility. However, because of a lack of financial resources, the full flood-control

embankments in An Hoa Commune were constructed without sluice gates. Semi flood-control embankments were also built in order to protect the rest of agricultural land (Table 21).

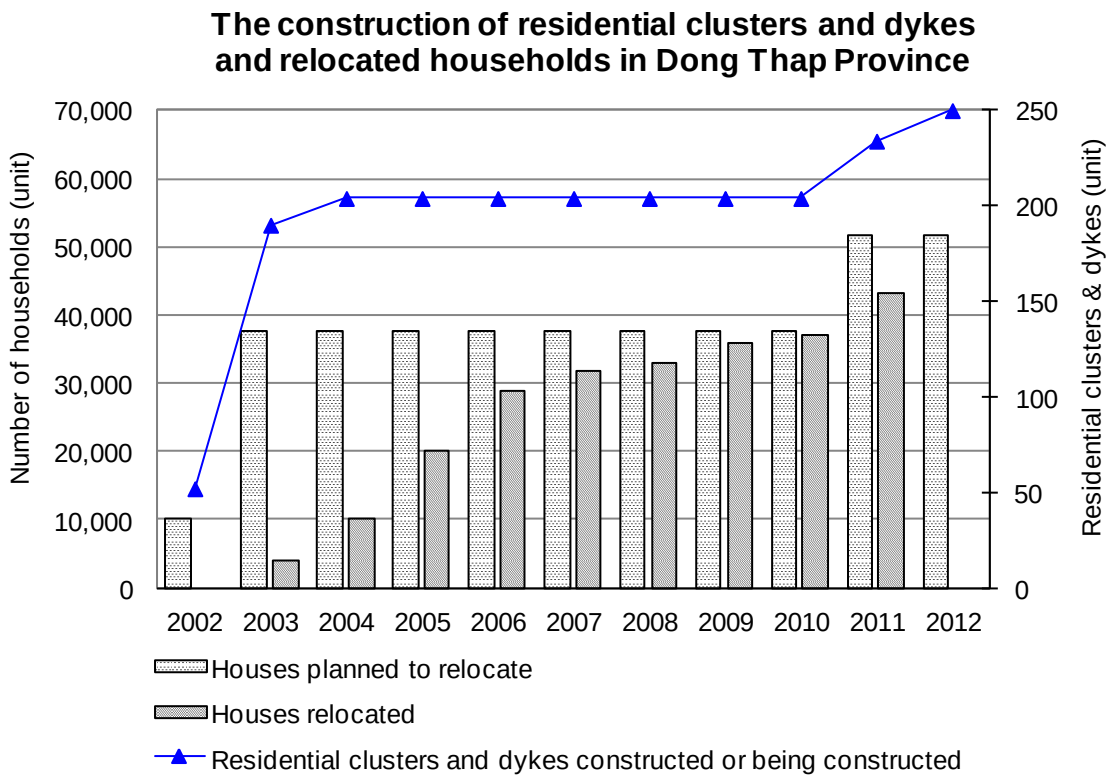


Figure 42: The construction of residential clusters and dykes and relocated households in Dong Thap
(Source: Author, data from Dong Thap CFSC, 2002-2012)

8.3.2. Relocation Measure

Human security is the first priority of the *"living with floods*" strategy. Relocation is hereby seen as an essential solution to mitigate mortality and flood damage. The objective of this policy is to relocate poor households prone to floods to residential clusters or dykes. After the high floods in 1996, the government started to construct several trial residential clusters and dykes in the VMD. The detrimental impacts of the high floods in 2000 increased the popularity of the relocation policy and led to the construction of a large number of residential clusters and dykes in the delta (Figure 42).

There are two categories of relocation sites: residential clusters and residential dykes. A residential cluster is built at a high elevation and has parallel rows of houses; a residential dyke is a tall dyke built along a canal with one row of houses. Residential clusters are usually constructed nearby densely populated areas while residential dykes are constructed along main canal systems. The government has built basic infrastructures in the residential clusters and dykes and provided subsidised housing for the relocated households. The public loans have to be repaid in regular instalments within 10 years. Once the houses are paid off, the

relocated households will obtain residential land certificates, one of the major prerequisites for obtaining new loans from banks.

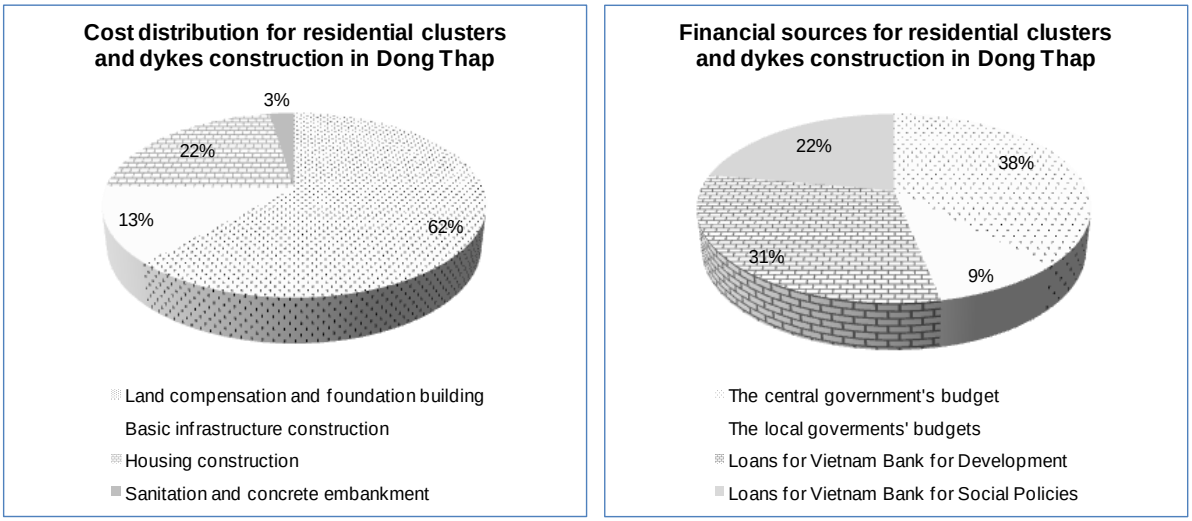


Figure 43: Financial sources and distribution for the second phase of the construction of residential places (2008-2012)

(Source: Author, used data from Decision 173/2001/QD-TTg of the Prime Minister, Decision 1171/QD-UBND.HC of Dong Thap People's Committee, Decision 1998/QD-TTg of the Prime Minister)

In Dong Thap, the residential clusters and dykes were constructed in most communes in the severely flood exposed districts in the north of the province. Table 3 indicates that around 250 residential clusters and dykes were built since 2002, i.e. 25 per cent of all residential clusters and dykes in the VMD. In total, approximately 200,000 people in the floodplains of Dong Thap were resettled, of whom around 80,000 were children. In the first phase of the relocation policy, the government planned to build 210 residential clusters and dykes, six of which were not completed until the end of 2011. Figure 42 also shows that the number of the relocated households was lower than planned. Among the 204 residential clusters and dykes which were constructed, 127 are residential clusters, accounting for 62 per cent of the total residential places. In the residential clusters, residential land size and the distance between the houses are smaller than in the traditional rural settlements. Moreover, the basic housing characteristics are different from the ones in traditional rural settlements, where stilt houses surrounded by trees prevail and where each household possesses small animal cages. This indicates that local residents had to adapt to the semi-urban living style. In the research area, the first residential clusters and dykes had been constructed in 2002 and the households moved to the newly built residential areas in 2003.

The budget for the construction of the residential clusters and dykes came from the central government, local governments, and from public bank loans. The total cost for constructing the residential clusters and dykes in the VMD was approximately 470 million USD. In Dong

Thap the costs were as high as 136 million USD, i.e. 29 per cent of the total cost for the delta. Figure 43 shows that in the rural floodplains, construction and land compensation accounted for 62 per cent of the total cost. Almost all residential clusters were built in the paddy fields; therefore, the land had to be filled by a large amount of river sand collected from the Mekong River sediments.

Table 22: Residential cluster and dyke construction relocation households in Phu Hiep and An Hoa

Items	The first phase (2002-2007)		The second phase (2008-2013)	
	Phu Hiep	An Hoa	Phu Hiep	An Hoa
Number of residential clusters built	1	0	0	0
Number of residential dykes built	0	1	1	0
Number of relocated households	164	366*	100	59*

(Source: KIP in Phu Hiep and An Hoa Communes in 2008 and 2011)
(Note: * there are 425 house foundations, but 59 of them eroded soon after construction. These houses were newly built in the second phase)

In Phu Hiep Commune, the first residential cluster was built in 2003 and 164 poor households severely exposed to floods were resettled as part of the first phase of the relocation policy (2002-2007). In An Hoa Commune, a residential dyke was constructed in 2002 so that 366 poor households who had no residential land and were exposed to both flood and riverbank erosion impacts could be resettled. In the second phase, in Phu Hiep Commune, a residential dyke was built in 2011 in order to resettle 100 households still exposed to flood risks. In An Hoa Commune, where a large number of households were already resettled in the first phase of the policy, no new residential clusters or dykes have been constructed since 2002. Instead, the eroded house foundations were reconstructed in order to relocate 59 households still exposed to flood impacts and riverbank erosion.

8.4. The Influences of Transforming Structures on Social Vulnerability Patterns

The transforming structures have influenced coping and adaptation processes and the capacity of different socio-economic groups in the rural floodplains. Coping and adaptation of socio-economic groups has contributed to the reduction of disaster risks; but social vulnerability has been shaped by local residents' capacity, external factors or transforming structures. It is noted that social units or socio-economic groups adapted not only to biophysical environmental change but also to the transformation of the wider social, economic, political and discursive landscapes. Therefore, understanding the governmental transforming structures affecting flood vulnerability of different socio-economic groups is a critical task.

8.4.1. Influences on Exposure

Governmental transforming structures have both reduced and increased the flood exposure of different socio-economic groups in the rural floodplains. The construction of embankments and the relocation policy are two of the most prominent examples for the dual nature of governmental transforming structures.

8.4.1.1. The Influence of Relocation Policy on Flood Exposure

As previously discussed, the relocation policy of the early 2000s reduced the number of poor households prone to floods through the construction of residential clusters and dykes. The relocated households included poor landless and small land-owning households living in flood-prone areas that were either flooded or significantly eroded. In these residential clusters or dykes, children are not at risk of drowning and physical household assets are widely protected. In brief, the relocation policy provides many positive impacts.

However, the relocation policy had exposed the relocated households to new hazards. The relocated residents lived far from their agricultural production areas. This resulted in a decrease in off-farm income and small-scale agriculture in their homesteads as well as an increase in daily expenses[23]. Moreover, according to the in-depth interviews with relocated households, relocated people were highly concerned because they had to take large loans to afford a new house[24]. Moreover, the relocated people's lifestyles changed from rural to semi-urban. Thus, the relocated people lost small-scale agriculture on their homesteads. This also explains why almost all poor people who had no residential land were willing to resettle to the residential clusters or dykes. The households who possessed only little residential land mostly continued to live with floods rather than move to the residential clusters and dykes. This relates mainly to the dependence on flood-related resources and small-scale agricultural benefits from their homesteads.

8.4.1.2. The Influence of Embankment on Flood Exposure

The major role of embankments is to protect agriculture in the rural floodplains. Embankments have become popular in the upper VMD since the early 2000s and have notably contributed to flood management. In the Long Xuyen Quadrangle, floods were partially controlled and the drainage capacity was improved. As a result, almost all of the agricultural land in flood-prone areas was protected by semi flood-control dykes. Some of the

[23] This has also been described by other studies. Hoi (2005) found that the daily expenditures increased by: 27% for breakfast, 30% for school fees, 37% for transportation, 24% for health care and 50% for social communication.

[24] Costs for buying houses and house foundation were paid through installments.

land was protected for the entire year due to full flood-control embankments. Semi flood-control embankments are used to protect the SA rice crops; however, these dyke systems are easily eroded by floods. Full flood-control dykes protect the SA rice crops as well as the AW rice and other crops during flooding season. Because of these agriculture-related benefits, over 80 per cent of the people living in flood-prone areas said that dyke systems were necessary and useful for protecting physical assets and their livelihoods.

On the other hand, embankments also contributed to exposing new elements to flood impacts. The large flood in 2011 showed that the increase in AW rice resulted in large crop failures due to numerous dyke breaches. In consequence, the economic loss increased. The exposed elements belonged to different actor groups so that formal flood-related measures had diverse effects on different actor groups.

Moreover, the embankments have increased flooding in the downstream areas. While the flood peaks in the upper districts of the VMD in 2011 (e.g. An Phu, Tan Chau, Tan Hong, Hong Ngu) were lower than in previous flood years, flood peaks in the downstream areas (e.g. Cho Moi, Long Xuyen, Can Tho) were higher than in any other flood year before.

8.4.2. The Influences on Susceptibility

8.4.2.1. The Influences of Relocation Policy on Flood Susceptibility

The relocation policy relocated local residents, particularly children, from susceptible housing conditions in the rural floodplains to flood-protected residential clusters and dykes. Local residents mainly lived in temporary houses before (see Chapter 6) which were easily damaged by floods. The relocated households received semi-permanent houses which were better adapted to strong winds and floods. Particularly, residential landless households have thereby reduced their flood susceptibility.

8.4.2.2. The Influences of Embankment on Flood Susceptibility

Embankments led to numerous negative impacts on rural residents, especially for poor households. Firstly, embankments constrained making use of flood-related resources inside the full flood-control areas. In Phu Hiep and An Hoa Communes, landless households relied on flood-related resource exploitation and off-farm wage activities. However, dyke systems shortened the duration of flooding and therefore also the time for making use of flood-related resources in the rural floodplains from five months to three months per year. Secondly, off-farm activities became more seasonal. This was caused by the synchronised sowing schedules in the full flood-control area. For example, the demand for off-farm activities became strictly

seasonal due to the synchronised sowing schedules which were set by agricultural staff at the district level. At the time, the duration of rice harvesting was shortened to only one week whereas in the past harvesting took place within one month. As a result, off-farm labourers had to reduce the number of off-farm work days. Thirdly, embankments forced an increase in the AW rice crop production, despite the fact that this crop is extremely susceptible to dyke breaches in the flooding period. Fourthly, protected areas were polluted and degraded due to agricultural intensification, a reduction of sediments and a lack of floodwater drainage systems. As previously discussed in Chapter 5, annual slow-onset floods fertilise soils, reduce the danger of pests, destroy weeds and provide flood-related resources. Flooding is necessary to leach and wash out acidity in acid sulphate soils which are common and severe in the Plain of Reeds. In the long-term embankments may therefore increase the susceptibility with regard to acid sulphate soils and soil infertility. Fifthly, the costs for dyke construction and maintenance were high since approximately one third of the new dykes in the Plain of Reeds were eroded by floods. Overall, it has therefore been shown that embankments protect physical household assets and agriculture from floods; however, they also create conflicts among natural resource users in the rural floodplains.

8.4.3. The Influences on Adaptive Capacity

8.4.3.1. The Influences of Relocation Policy on Adaptive Capacity to Flood Impacts

The relocation policy changed the adaptive capacity of the relocated people. Firstly, the relocated households bought the semi-permanent houses on credit and after repaying all instalments, the households received residential land rights. However, according to the relocated households in Phu Hiep Commune, these subsidised houses lacked basic standards such as toilets, walls and concrete floors. Relocated residents therefore had to use their savings or had to access informal financial sources for the required construction work. Secondly, the relocated people had more opportunities to access basic public infrastructure and services, such as to the national electricity lines, tap water supply, schools, healthcare stations, child day-care houses, markets, and transportation infrastructure, all of which are usually established in densely populated areas. However, household expenditure also significantly increased. Thirdly, the relocated households improved their competitiveness regarding access to off-farm activities due to the establishment of off-farm labour teams. The off-farm income of relocated labourers is significantly different from the income of non-relocated off-farm labourers (see Chapter 6).

Although the relocated households received subsidised houses and residential land on credit, chronically poor households could not substantially improve their financial capacity. They could not legally transfer their properties or use the land as collateral. In the early stage of the relocation policies, some poor people even refused to be relocated or they illegally transferred their relocation rights to others. In An Hoa Commune, poor households which were formerly in the relocation program rebuilt temporary houses along canals or returned to their former settlements. Access to additional money for housing and livelihoods was a main constraint for chronically poor households relocated in residential clusters or dykes. This indicates that several households preferred taking immediate benefits derived from transferring the relocation rights over flood-free housing.

Furthermore, since the relocated families were not allowed to carry out livestock farming and the conditions were unfavourable for fishing, they had to shift from small-scale farming and off-farm employment to predominantly non-farm activities (see Chapter 6). However, several relocated households continued to engage in small-scale farming (e.g., poultry, pig and snakehead fish cultivation) in their small homesteads, particularly in An Hoa residential dykes, since they had few other livelihood options.

8.4.3.2. The Influences of Embankments on Adaptive Capacity

Despite the negative impacts of embankments on some socio-economic groups, as discussed previously, they also contributed to improving the adaptive capacity of rural households to respond to flood impacts, most notably the capacity of rice producers. Firstly, rice producers were able to protect their SA rice crops through both semi- and full flood-control embankments. Secondly, embankments enabled rice producers to cultivate the AW rice crops during the flooding season. Although the AW crop is susceptible to dyke breaches, according to interviews with rice producers in Phu Hiep, it provides more economic profits than SA rice crops. Moreover, in 2011 the Ministry of Agriculture and Rural Development accepted the AW rice crop as major annual rice crop in the VMD. This created a strong pressure with regard to future construction of embankments. Thirdly, embankments enabled rice producers to modernise their agriculture, particularly by using combine harvesters, because of better water management as well as a lack of off-farm labour.

8.5. Governmental Transforming Structure Influences on Human Agency

Governmental transforming structures also influenced coping and adaptation to floods of local households in the rural floodplains. These structures have both positively and negatively influenced local people's strategies. In many cases, rural households had developed flood-

related knowledge which was adopted in governmental measures. For instance, training courses and awareness-raising programs promoted local knowledge with regard to flood-resistant housing, the use of trees as buffer fences, and embankment construction techniques. These human agencies changed the structures and mitigated flood impacts.

Communities prone to annual flood impacts focused on enhancing swimming capacity. Local residents trained their children how to swim as early as possible. Swimming capacity helps young children to protect themselves from drowning. It was evident that few children above six years of age were killed by floods (see Chapter 5) since they could swim when they fell into the water. Nowadays, swimming training was established in schools in the rural floodplains as an important response to flood risks.

In the rural floodplain, as previously discussed, flood-related mitigation funds were mainly mobilised among religious groups in order to support rural households that were severely affected by flood impacts (see Chapter 6). Gradually, these flood-related financial funds were both informally and formally allocated to flood-affected communities.

The construction and maintenance of stilt houses was another adaptive strategy to flood impacts. Before every flood season, local residents individually or collectively improved their stilt houses through tires and trees. Both commune People's Committees acknowledged the importance of this technique and supported it financially via annual CFSC flood response programs.

As previously discussed, the construction of embankments is a popular measure that is based on local individual demonstrations. Embankments to protect crops from flood impacts were first implemented by local communities in the 1960s when the HYV were initially cultivated in the VMD. In the 1960s and 1970s, wealthier households constructed small-scale semi flood-control embankments in order to protect their fruit trees and the SA rice crops in flood-prone areas. In Phu Hiep and An Hoa Communes, individual small-scale embankments were constructed by wealthier rice producers along the primary canal systems in order to protect their SA rice crop from the early floods.

Flood-based forms of agriculture and aquaculture, such as the intensive farming of snakehead fish, fresh water shrimp, and flood-related vegetables, were developed by households but have gained formal support and were extended across the rural floodplains. The local governments have issued or adjusted policies in order to support such flood-related agriculture. Moreover, flood-related infrastructure, such as local roads, electricity lines and irrigation systems, were constructed for the implementation of these selected models. For example, flood-related

agriculture, also called the Project 31, was successfully implemented in An Giang, another severe flood-prone province in the upper VMD. Regarding this project, supportive structures such as technology, basic infrastructures and loans at reasonable interest rates were provided and modified in order to support flood-related agriculture. In Tam Nong District, the use of rice fields for fresh water shrimp farming has increased during the flooding seasons, and supportive infrastructure has been constructed. By doing this, rural residents were able to earn benefits from flood-related production and flood-related resources.

In short, human agency has influenced several aspects of the governmental transforming structures regarding flood-related issues. Local residents have invented, learned and tested flood-related knowledge in the context of their individual circumstances and annual slow-onset floods. These selected flood-related experiences were formalised and (re)introduced to local communities through training courses or flood-related projects. The interactions between flood-related human agency and the governmental structures enable the reduction of flood risks as well as contributing to flood-related livelihoods.

9. Conclusion

Annual slow-onset floods have existed for thousands of years in the VMD; however, floods have increasingly changed due to both climate change and human interventions. In particular, the northern provinces of the VMD experienced severe losses of life and livelihoods in the past due to major floods, such as in the year 2000 and 2001. Strategies to reduce flood risk and the exposure of people to floods, such as the construction of embankments, have shortened the spatial extent and duration of inundation on paddy fields. At the same time, these embankments have increased the water velocity in major canals in the areas, which has had severe consequences for flood-based livelihoods (see Chapter 5). In recent years, flood damage patterns with regard to wet crops, temporary stilt houses and basic infrastructure (e.g., public buildings, roads, dykes and water and electricity supply systems) have changed. For example, SA rice losses decreased; however, the damage to the AW rice increased. The damage to temporary stilt houses was reduced; however, the damage to basic infrastructure was slightly increased. On the other hand, structural interventions, such as embankments, have significantly reduced the exposure of people to high flood impacts and hence have reduced the number of fatalities, especially children. Children were most vulnerable to the floods in 2000 and 2001. The damage to SA crops and individual houses decreased; however, the damage to the basic infrastructure (e.g., embankments and rural roads) mainly constructed by local governments has increased significantly (see Chapter 5). Consequently, the analysis of different flood patterns and the respective losses and damages due to high floods revealed that changes in cropping types and strategies as well as interventions to reduce flood risks, such as embankments, were the main drivers for the changes observed in exposure and loss patterns for different actors and groups to floods. Particularly, the changes in rice production as well as government interventions to reduce flood exposure of people and rural communities have changed the vulnerability of different households and farming systems to floods. These changes are not primarily a result of changing conditions in flood patterns (e.g., changes in the hazard), but rather are determined by socio-economic transformation processes at the national, provincial and local level such as changes due to Doi Moi (the national level) and provincial or local changes, like resettlement, rice intensification and infrastructure construction.

In addition, the analysis of exposure and changes in rural livelihood strategies indicates that new rice-based farming systems are developed and rice growing periods are extended (two rice crops to three rice crops). This also implies a longer temporal exposure of these crops and assets to the flood risk. These new farming systems are shaped and supported by various

factors, such as technology (e.g., HYV), irrigation systems (e.g., for the SA rice in two rice crops system), embankment (e.g., for the AW rice in the three rice crops system) and population growth in the rural floodplains. The intensification of rice framing was based on the assumption that these changes might generate more income and prosperity for rural communities; however, the consequences of the introduction of new farming systems for different households and social groups were diverse. Overall, the study underscores the fact that a large proportion of the rural population living in rural floodplains in Dong Thap and other provinces still depend on rice-based farming livelihoods and on flood-related benefits. Hence, flood-based benefits have shaped flood exposure in the rural floodplains. Therefore, flood-affected residents do not only perceive floods as a natural hazard or threat but also as an important resource and choose to live with floods, due to the specific benefits floods brought to rice farming and fish catching during the flooding season. The research revealed that disadvantaged groups, such as landless households in rural Dong Thap heavily depend on flood-related benefits and therefore directly or indirectly accepted high levels of flood exposure and risk. However, due to a decline in flood-related resources (e.g., fish resources), due to such interventions as dyke construction and the use of agro-chemicals, flood-affected residents have changed their livelihood strategies. Particularly, out-migration and forced relocation were strategies that fundamentally changed livelihoods, social networks and flood exposure, particularly for poor rural households. In this regard, the research undertaken in the VMD underscores the fact that flood vulnerability is not static but dynamic; since floods, exposed elements and peoples, their susceptibility, and their coping capacity are changing over time. These dynamics of flood vulnerability are characterised, for example, by changes in exposure, but also changes in livelihoods and access to certain resources that help an individual or household to cope and adapt to floods.

The analysis of flood loss data, an examination of census data, the household survey data and the results of participatory surveys revealed a key issue, namely that in flood-exposed rural communities, several forms of livelihood capital, such as agricultural land and flood-related knowledge, are extremely important in terms of substituting and enforcing other assets such as good houses, boats, machines, that are needed to ensure survival in large floods without major harm and losses. The analysis of flood vulnerability, and particularly using the indicators selected to assess flood risk, show that access to agricultural land is critical to livelihood sustainability, since it enables landowners to diversify their income sources and livelihood strategies. In addition, land and land certificates also function as important securities when facing losses, especially due to floods. For example, an official land

certificate can be used to access loans from state-owned banks. Thus, it is an essential form of capital, which enables either an improvement in the coping process or the building of adaptive capacities in terms of livelihood diversification (see Chapter 8). In contrast, the landless do not have these resources. In addition, many of the landless farmers investigated are still heavily dependent on fishing as their main livelihood during the flooding season or on off-farm activities, which provide little space to diversify or change livelihood strategies and to build financial capital to better cope with losses due to floods (see Chapter 6).

Consequently, access to agricultural land is a major factor that determines flood vulnerability in rural areas in Dong Thap. In this regard, accessing, accumulating and protecting agricultural land can be viewed through the perspective of institutional economics which mean to further explore in-migrants to protect their land as well as to deal with the challenge of conflicts between different natural resource users. The study also showed that while the transaction costs that enabled in-migrants to access and protect their land changed over time, they were particularly high in the period of economic transformation. For example, for many in-migrant farmers the conversion from floating rice to high-yielding rice in the 1990s resulted in risks of crop and failures, which in many cases necessitated the selling of agricultural land. Agricultural land was more easily accessed by the later in-migrants who were wealthier. These wealthier households obtained the achievements of the initial in-migrants whose capacity was exhausted because of a lack of both human force and financial resource. Also due to the lack of clear property rights, the farmers who failed in the high-yielding rice conversion were marginalised in terms of their access to other resources.

Although agricultural land was originally given to farmers for a relatively low price, the transaction costs for accessing and maintaining agricultural production were high and in fact shaped the susceptibility of rural households to both flood risks and livelihood disruption. Thus, in-migrants lacked the financial capacity to protect their land and to successfully covert their production process from traditional rice to high-yielding rice farming.

In addition, governmental measures to increase protection against the flood risk, such as dyke systems and embankments, had quite different impacts than expected on farmers in the VMD. For example, while some farmers benefited from such measures, since such interventions enhanced agriculture, particularly in terms of producing additional AW rice, landless farmers and residents who have a higher dependency on flood-related resources (such as fish during the flooding season) faced additional difficulties and constraints in accessing flood-related resources due to these new structures. Consequently, the research findings underscore that although the government has successfully reduced flood exposure with such dyke systems, it

has introduced additional or intensified conflicts between landowners and flood-based resource users during the flood season. In this regard, poor rural households were not just more susceptible to floods due to their limited assets, but were even more vulnerable due to the decline in flood-related resources. In addition, the household interviews revealed that landless farmers were often engaged in low-skilled jobs and mainly lived in particularly unsafe housing conditions. Consequently, their adaptive capacity to change to other livelihood activities is limited.

The household survey in Chapter 6 also underscored the fact that these households often live in temporary stilt houses that are more susceptible to high flood impacts. Moreover, these households also reside in more susceptible living locations, such as in remote floodplains, along low canal dyke systems or in lowly populated areas while wealthier households reside in safer places and areas that are more accessible to higher places (e.g., roads, markets, public buildings) (see Chapter 6).

Some of the households classified as poor and landless have been able to reduce their flood vulnerability, since they were able to gradually improve their housing conditions, were able to successfully conduct out-migration or were better off after having been relocated by the government. However, most households classified as poor and landless showed an increase in vulnerability and a further erosion of adaptive capacity. This applies particularly to poor households that relied on off-farm income and hence mainly worked as cheap labour for larger agricultural enterprises. These activities often do not provide any opportunity for enhancing the capacity to shift into new livelihood strategies due to limited resources and the further decline of, for example, flood-related resources, which many people engaged in off-farm activities were still depending on during the flooding season.

Another important finding of the research is that local knowledge has contributed to successfully adapting to flood impacts. Rural people in Dong Thap have gained their flood-related knowledge through a trial and error process and through experience from other farmers. Experience and knowledge on how best to deal with floods have also been disseminated within communities (see Chapter 6). In the context of annual floods, adaptive capacity is enhanced through flood-related knowledge. For example, exposed households are familiar with floods and know how to better respond to flooding, such as selling livestock before the flood season or moving important items to higher places in the house. However, when abnormal floods occur, such as particularly high floods or the opposite, such as very low water levels, these strategies fail to provide security. Past flood losses even show that

there seems to be a certain tipping point when local knowledge is inappropriate and major damages and losses occur (see Chapter 5).

The flood vulnerability of different groups is shaped by flood-related policies and transformation. One of the core concepts, such as the concept of *"living with floods"* was developed and implemented by the government in order to underscore the fact that people have to improve their livelihood security even if floods cannot be avoided. The concept of *"living with floods"* is accepted by various stakeholders since residents' livelihoods are closely associated with floods; however, major loss and harm in times of high floods also question the concept. Interestingly, the transforming structures, including relocation, embankment and agricultural intensification, have caused positive and negative impacts on different socio-economic groups in terms of their ability to "live with floods".

Embankments which were mainly built around the year 2000 in order to reduce flood impacts in the rural floodplains have strongly modified vulnerability profiles and have provided an important basis for further changes in crop production and the exposure of crops to floods. Embankments have functioned on the one hand as measures to increase human security, and on the other hand as an intervention to support the further intensification of rice production, particularly the development of a third rice crop (the AW rice). The production of the AW rice during the flooding season provides more profit than the second rice crop grown in the dry season. In addition, conflicts over water scarcity are less during the AW rice production compared to this problem during the SA crop production. This might also be the reason why embankments are still constructed and the AW rice production is continuously increasing. The downside of this development is a significant decrease of flood-related resources, which, as discussed, will particularly increase the susceptibility, and the lack of coping capacity for those rural households that depend on these resources during the flooding season.

Livelihood disruption due to floods "pushes" many rural people to migrate to urban areas to search for new income opportunities while the "pull" factors seem to discriminate the quality of employees coming from these regions. Almost all rural labourers captured within the survey conducted low-skilled work and earned limited incomes; hence, they only generated small remittances for family members that still live in the rural area.

Agricultural intensification has influenced human vulnerability to floods. While agricultural intensification has, in general, contributed to increasing income for many households, at the same time it constrains adaptive capacity since it contributes to a more mono-structured

income generation and to a severe decline in environmental qualities and resources (see Chapter 6)

Another important transformation can be seen in the relocation policies conducted after the major floods in 2000. The resettlement of poor households prone to floods into residential clusters/dykes has helped to locate households into areas which allow them either to be saved from flood impacts or to evacuate rapidly when required. However, the resettlement process in itself can also pose additional stress to households at risk. For example, many households resettled from flood prone rural areas into the new residential clusters/dykes and had to cope with the new situation by undertaking second order adaptation to shocks induced by the resettlement process. Among those shocks were, for example, the increase in the daily cost of living, the change in rural life style (e.g., narrowness, noise, gambling), the loss of social networks and the disruption to income-earning activities due to the distance from former places of work or the limited availability of jobs in the new place. Also access to basic infrastructure was for some households in the new location a key problem in the early stage of resettlement. These problems have been improved over the years through formally upgrading the activities of the basic infrastructure and access to off-farm jobs in terms of informally established off-farm labour teams which collect people with the same interests to undertake off-farm activities. In this regard, the research conducted shows that institutional arrangements in relation to flood-based issues play an important role in both causing flood related problems and in dealing with flood-related problems. It means that these institutional arrangements have attempted to reduce flood-related losses and fatalities, but at the same time have generated flood-related problems for different social groups in the rural floodplains.

Migration and relocation have severely influenced the exposure and susceptibility of rural people in Dong Thap to floods. The study of changes in vulnerability due to resettlement revealed that, particularly in the so-called new residential clusters/dykes, people had to finance major parts of their house on their own and in many locations the actual incorporation phase (according to Scudder's model) has not been yet achieved (see Chapter 8).

In addition, for decades the rural floodplains in the VMD were a place where in- and out-migration played a major role in responding to livelihood disruption. Organised and voluntary migrations from densely populated areas to the rural floodplains aimed to improve in-migrants' livelihoods through flood-related resources, off-farm wages and reclamation. Forced migrations to the flood-prone areas in the 1960s and the 1980s were influenced by both political and economic goals. The resettlement policies were part of a guiding vision of rural economic development. Formal in-migrants were given agricultural land while informal

in-migrants hoped to get land from the formal in-migrants. However, approximately 40 per cent of in-migrants could not access any agricultural land (see Chapter 6). They had insufficient capability to reach or protect their land use rights. These in-migrants stayed in the floodplains, returned to their home villages or migrated to other places.

While seasonal migration is a coping strategy during flooding, a permanent resettlement process is an adaptation strategy to stresses or shocks. Historically, in the VMD, people migrated to the rural floodplains in order to respond to their livelihood insecurity caused by agricultural landlessness or poverty; however, within the floodplains they were exposed to a new hazard, particularly slow-onset flooding. These in-migrants already recognised flood impacts; however, livelihood opportunities strongly attracted them to make a trade-off between livelihood opportunities and flood risks. The economic opportunities through fishing and access to agricultural land were "stronger" than the potential flood losses. When flood-related resources decline, especially in the context of the intensification of rice production, local residents will face new challenges in terms of the changes of opportunities and risks in these floodplains. Economic opportunities for fishermen and poor households have significantly declined; hence these groups have to deal with the erosion of their livelihood options. Many of the breadwinners of these households have seasonally or permanently migrated to urban areas for non-farm jobs. As a result, children from poor households are insufficiently protected by adults and physical household conditions from flood impacts. A new trade-off and balancing exercise during the flooding season can be observed between strategies to generate remittance to deal with livelihood disruptions and activities to stay in the flood-prone area to protect human and physical assets. Young labourers have shifted to non-farm jobs in the urban areas; however, they often undertake manual low-skilled work due to their low educational levels and professional expertise. As a result, remittances, which could be partly used to enhance livelihood adaptation to floods, are quite limited. Overall, the in- and out-migration process has been essentially forced by economic opportunities and these migration processes have partly affected the flood vulnerability of landless households in the rural floodplains.

Another important response strategy to floods was the introduction of resettlement programs by the Vietnamese government. The forced resettlement has significantly reduced flood exposure but in many cases as the vulnerability assessment shows has increased the susceptibility of relocated families due to new livelihood disruptions and insecurities. Relocated residents have escaped flood risks; however, they are exposed to new shocks caused by the relocation, such as narrow places, noisy, gambling, and joblessness. Although

the infrastructure conditions are, in some cases, a clear improvement compared to the situation in the floodplains, at the same time the costs of living due to better infrastructure and services have significantly increased. That means that relocated households have to deal with a reduction in their flood-related and homestead-based income, but at the same time have to deal with a significant increase in their daily living expenses: electricity, tap water, food and service costs. Consequently, forced relocation has reduced physical exposure to flooding, but did not sufficiently address other factors of vulnerability, such as susceptibility or limited coping capacity. In this context many relocated households have developed new strategies (e.g., informal labour teams) that enable them to cope with new types of shock. These strategies seem to be effective in the short- and medium-term; however, whether these strategies are really an opportunity to move these households out of chronic poverty is still to be seen.

Coping and adaptation mechanisms in the rural floodplains are diverse and sometimes constrain each other since they are conducted by different actors and socio-economic groups without considering the negative effects for other households or regions. Coping strategies are conducted to mitigate direct flood impacts. In relation, adaptation strategies are associated with long-term and more strategic changes linked to reorganisation and adjustment processes which make it possible to sustain the livelihoods of communities and provide opportunities for positive change (see Chapters 6 and 8). Both coping and adaptation have contributed to reducing flood damage; however, informal or non-governmental versus formal/governmental strategies often encompass quite different actions and sometimes may even generate mismatches.

Formal coping strategies conducted by the government, such as rice harvesting threatened by early floods or dyke breakage, evacuation and relief, help flood-affected households to respond to large-scale flood impacts at the regional/provincial level. Informal coping is often linked to flood-related knowledge and experience over the years. Coping processes have contributed to enhancing flood adaptation. However, in some cases, governmental coping and adaptation strategies, such as dyke construction or resettlement can also disrupt or challenge local knowledge, since the flooding conditions might have fundamentally changed (e.g., dyke construction) and some resources for coping and adapting to floods (e.g. flood-related fish resources) are not available any more.

The study has also revealed that even when different socio-economic groups are exposed to the same flooding risks, they implement different coping processes and measures (see Chapter 6). For example, households classified as poor usually undertake coping activities because of

inadequate livelihood assets while wealthier households mainly develop adaptation options, since they have resources to do so. A common strategy that falls in between coping and adaptation processes is the temporal migration, conducted particularly by landless residents, in order to partly cope and partly adapt to livelihood disruption due to flood impacts. Coping activities normally result in positive outcomes, in which direct flood impacts are reduced; however, they sometimes have negative long-term consequences or are likely to be unsustainable in the long run. In addition, due to a decrease in food-related resources and the seasonality of off-farm activities, rural labourers tend to search more intensively for new jobs in urban areas. Although this might be a reasonable transformation process, various households interviewed either failed in their temporal migration strategy or were not able to access stable remittances because of getting solely low-skilled jobs. In this context, even temporal migration to urban centres is, in many cases, not a successful strategy to respond to floods.

Although "*living with floods*" is still a challenge for many rural households in the VMD, it is important to acknowledge that the study has also shown that many coping and adaptation processes already take place and are informed by local knowledge. This means that local knowledge contributes to both coping and adaptation strategies conducted by households independent of governmental programs. Local residents learn and disseminate such knowledge within informal daily communications or even through formal channels of communication, such as broadcasting or training sessions (see Chapter 6). In this context, flood-affected people know how to predict the weather status in traditional ways, build stilt houses, protect their houses and physical household assets, engage in flood-related agriculture and shift to flood-related income earning activities (e.g., fishing during the flood season). However, local knowledge on how to deal with floods is challenged by transformation processes, such as the construction of dykes, which have fundamentally changed flood patterns and the intensification of agricultural production which can severely affect traditional coping and adaptation options.

In order to examine the vulnerability of different groups to flood events, concepts of different schools of thought were combined and triangulated. Particularly, the sustainable livelihoods framework that originates in development geography and poverty research was combined with frameworks based on a general system theory by authors in disaster risk reduction research. The frameworks and empirical findings underscore the fact that flood vulnerability is not solely linked to or determined by the severity or intensity of the flood, but also the dynamic exposure, susceptibility and different capacities of people to cope with and adapt to

floods (see Chapters 5 and 6). The livelihood approach was particularly useful to explore how exposed households access, substitute and combine their resources in order to respond to floods. The frameworks of the disaster risk reduction community draw attention to potential feedback processes between risk reduction measures and vulnerability. The empirical findings highlight that access to and the availability of agricultural land is particularly key in terms of a household's ability to cope with and adapt to floods, since this capital can be transformed into or used to access other livelihood assets. Access to agricultural land makes it possible to generate income, to diversify agriculture, to access formal loans and to strengthen social relations.

Moreover, although one might expect that in the socialist country like Vietnam access to land, particularly agricultural land, is easily facilitated by the government, the interviews and the vulnerability assessment revealed that many farmers who failed to shift from cropping traditional rice to high-yielding variety rice also were likely to lose their land. In contrast, many of the households that are classified as wealthy have successfully accessed and protected their allocated or transferred land. In the study, natural assets (e.g., floods, flood-based resources), physical assets (e.g., embankments, irrigation systems, land), human assets (e.g., technology for rice production, flood-related knowledge), financial assets (e.g., relative's financial supports, savings) and social assets (e.g., relatives' and neighbours' support in terms of finance and spirits) influenced the ability of farmers to access and protect their agricultural land.

The vulnerability assessment conducted within this study combines both quantitative and qualitative information. While qualitative methods enable the exploration of why people might have suffered more than others (see Chapter 5), the quantitative vulnerability assessment that was conducted allowed for a comparison between the different social groups and to examine the role of selected factors in the more quantitative statistical way. Information gathered in a qualitative way also informed the quantitative methods, for example, the weighting factors used were also reflecting the perception of stakeholders and the importance of different indicators as judged by local residents.

The identification of major reasons that shape the flood vulnerability of different households is thus explored through different methods and their triangulation. The findings show that each indicator contributes differently to flood vulnerability, depending on the region or specific social group. Interestingly, local residents named access to agricultural land as the most important factor shaping vulnerability while official representatives of the flood risk management organisation (Tam Nong Committee for Flood and Storm Control) argued that

the lack of a strategy to protect children during the flooding season was the major factor that made these households highly vulnerable. It meant that the research findings showed different perspectives and understandings in terms of the flood-related problems, while the official representatives of the flood risk management organisation aimed to improve human security through the use of specific measures to protect children during floods. Local residents argued that the major problem was livelihood insecurity, for example, due to limited access to agricultural land. Consequently, different notions and understandings of security can be observed through the conduct of such quantitative and qualitative vulnerability assessments.

Policy relevance of the findings

Due to climate change and socio-economic transformations in the VMD, floods are changing abnormally. Local residents cope with and adapt to both floods and other socio-economic changes. Therefore, flood vulnerability reduction should focus on both actual and potential changes in climatic and weather conditions as well as the potential impacts of socio-economic changes and the respective uncertainty linked to it. Rather than conducting very specific strategies that only help to cope with specific floods, robust and no-regret strategies are needed that sufficiently allow for the building of adaptive capacity against potential unexpected changes. Hence, adaptive capacity improvement regarding climate variability and potential structural interventions should be undertaken in order to both mitigate hazardous impacts and sustain flood-related livelihoods.

The findings also show that floods both cause flood damage and provide flood-related benefits. Therefore, the concept of *"living with floods"* needs to be defined more precisely; in other words, as well as a reduction in the negative impacts of floods, flood-related benefits should be secured or re-established. Flood risk mitigation is a key subject for local governments; however, little attention has been paid to the dependency of particular vulnerable households to flood-related resources. Hence, sustaining flood-related resources is not a major objective for local or provincial governments. In addition, the relocation policy focuses on reducing people's exposure to floods, while not enough emphasis is given to the negative consequences and challenges that people face in such new residential clusters. Traditional governmental risk management approaches have failed to reduce the vulnerability of people to floods and socio-economic changes.

Outlook

Compared to conventional risk management strategies in the rural floodplains, such as the construction of dyke systems and residential clusters and dykes, the vulnerability assessment

shows that people may not primarily be victims of high floods due to their exposure but their lack of adaptive capacity (e.g., a lack of important assets, particularly agricultural land). Hence, the vulnerability assessment developed in this research can inform policymaking processes in order, for example, to move from the paradigm of reducing risk by reducing exposure to reducing risk by reducing susceptibility or enhancing the adaptive capacity (e.g., access to important assets) of exposed communities.

Furthermore, the indicators themselves have been proven to be a relevant tool kit to identify, analyse and assess different social groups and their vulnerability to floods. Although flood vulnerability might in other rural areas encompass additional features, the general approach and methodology used in this study can be transferred to other provinces, since statistical data will also be available in these provinces and additional information can also be gathered through household interviews and qualitative research methods. It might be that in some provinces in the VMD, access to agricultural land is not a key factor of vulnerability; nevertheless, the overall methodology and research procedure can be applied in a similar way.

Moreover, in the VMD, a large number of farmers have relied on rice-based livelihoods that are extremely susceptible to floods and other natural hazards in the context of climate change and socio-economic transformation. Based on the results of this study and the constraints in the quantitative household survey, the adaptive capacity of different socio-economic groups can be assessed in different ecological zones using the qualitative assessment approach. To ensure an adaptive capacity assessment, priorities of actions and flood-related policies for adaptive strategies as well as climate change adaptation should be implemented and enhanced.

The study also hints at new research needs. While the focus of the research was centred on rice-based livelihoods in the rural floodplains of the northern VMD, it clear that economic transformation processes in urban areas have an influence on the capacities of people to cope with and adapt to floods (e.g., sending remittances for temporary migrations). Also the process of temporary migration was discussed as one measure to deal with livelihood insecurities and flood risks. Migration is likely to be highly relevant in the future, since it is very likely that due to the rapid economic development that is occurring in cities in Vietnam income and wealth gaps between urban and rural areas will increase. This may also influence the vulnerability of rural communities, for example, if this leads to an intensification of socially selective migration (e.g. male population in working age). Whether an intensification of temporary and long-term migration to cities would significantly reduce the capacities of communities in rural areas to prepare for floods or whether due to higher remittances people might have increased capacities to deal with floods needs to be examined in the future.

Finally, another important new research topic is linked to the question, to what extent do the past coping and adaptation practices of local residents in the rural floodplains help to cope with new hazards that are likely to affect the VMD (e.g., typhoons)? In particular, stilt houses that help with survival in normal floods might pose additional risks to people when they are exposed to strong winds or storms. In addition, the construction of dams and hydropower plants in the upstream Mekong Basin that are planned and implemented is likely to create longer periods of water scarcity in the dry season or changes to water flow. These changes in water-related conditions can severely influence agriculture, which is intended to expand the cultivation area of the three rice cropping seasons. How these structured measures in the upstream Mekong Basin might affect the rural livelihoods in the VMD is nearly unknown and therefore systematic vulnerability scenarios for these new hazard types (e.g., low water tables) are needed and worth studying in the future.

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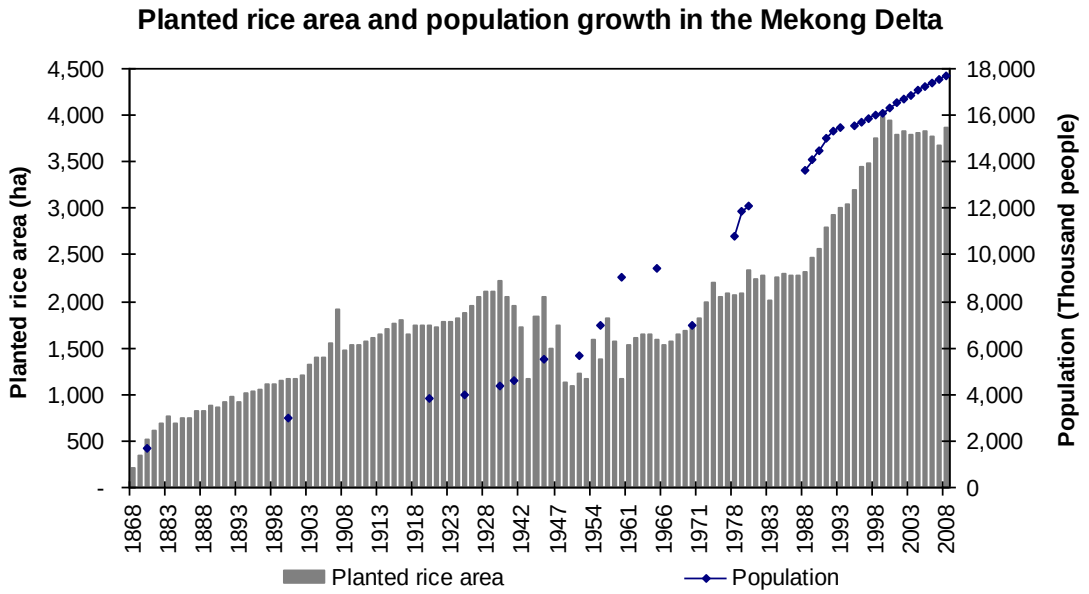
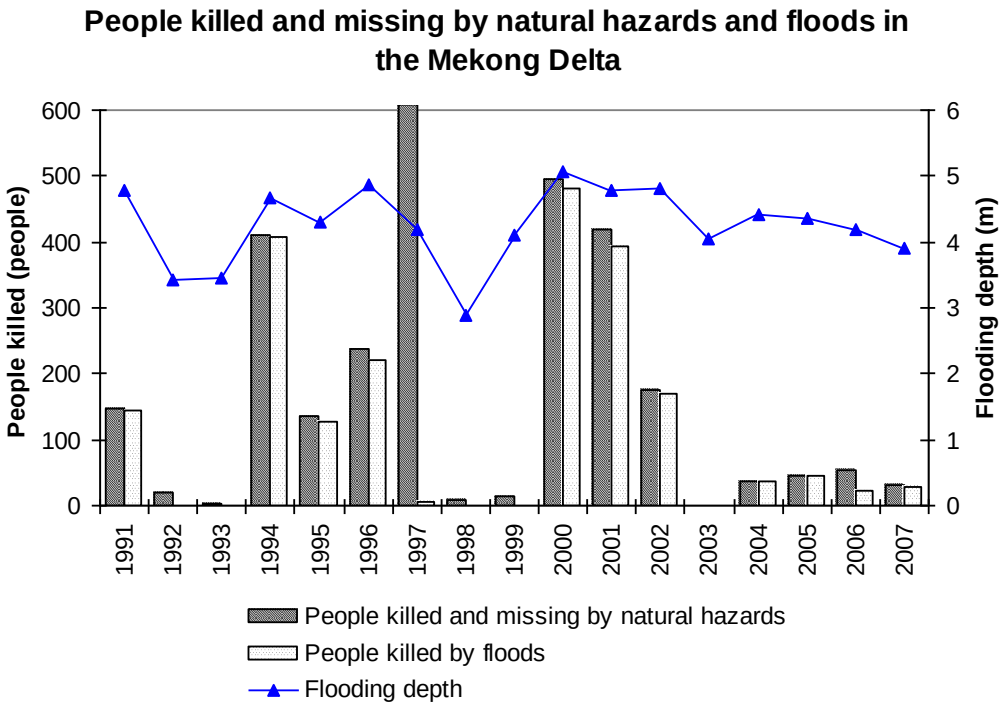
Appendixes

Appendix 1: Population and rice-planted area in agricultural land the Mekong Delta

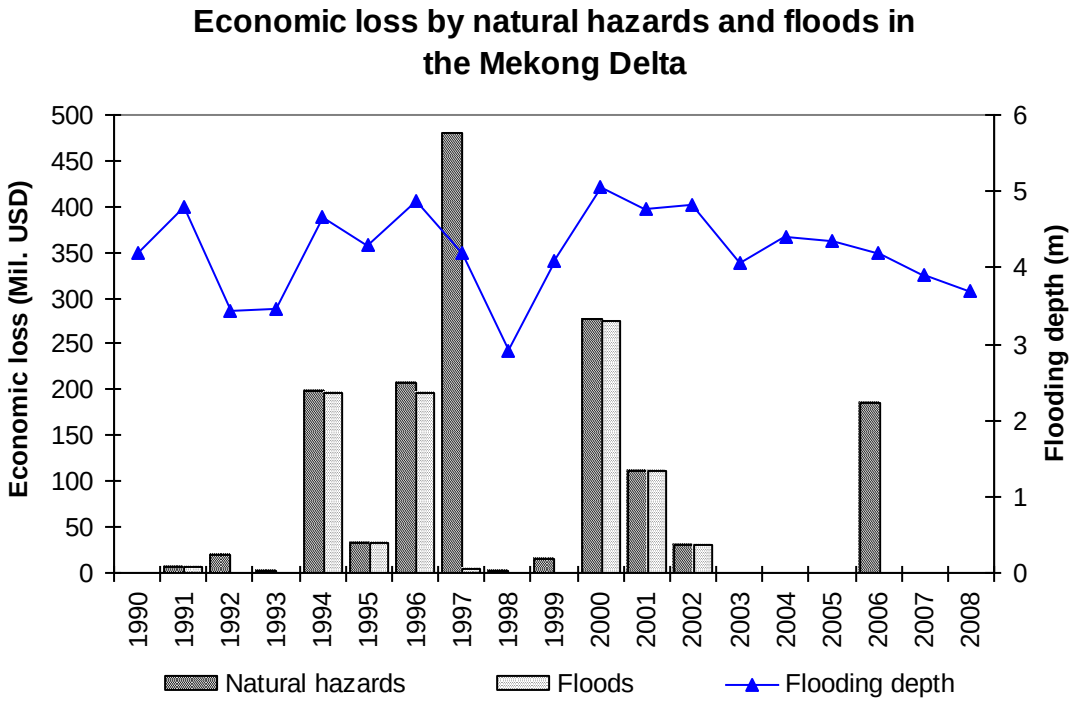


Appendix 2: People killed due to natural hazards and floods in the Mekong Delta



(Flooding depth was in Tan Chau Gauging Station)
(People killed and missing due to natural hazards in 1997 was 2,244)

Appendix 3: Estimated economic losses due to natural hazards and floods in the Mekong Delta



(Amount of economic losses from 1990-2008 were converted into the value of the year 2000 for comparison, USD/VND =14,177)
(Economic losses by other natural hazards in 2003, 2004 and 2005 were not available)

Appendix 4: Independent sample test of means of charitable funds between believers and non believers

	Levene's Test for Equality of Variances		t-test for Equality of Means			
	F	Sig.	t	df	Sig. (2-tailed)	Mean Difference
Equal variances assumed	4.874	.028	-1.972	243	.050	-138,963.134
Equal variances not assumed			-4.299	133.562	.000	-138,963.134

(Source: Household survey, 2009)

Appendix 5: Vulnerability of different land ownership groups (Duncan Test)

Land ownership group	N	Subset for alpha = .05		
		1	2	3
Large land ownership group	86	.6358		
Small land ownership group	82		1.1456	
Landless group	82			1.6776
Sig.		1.000	1.000	1.000

(Source: Household survey, 2009)

Appendix 6: Vulnerability of different wealth groups (Duncan Test)

Wealthy groups	N	Subset for alpha = .05		
		1	2	3
Wealthier group	73	.6132		
Medium group	106		1.1670	
Poor group	71			1.6579
Sig.		1.000	1.000	1.000

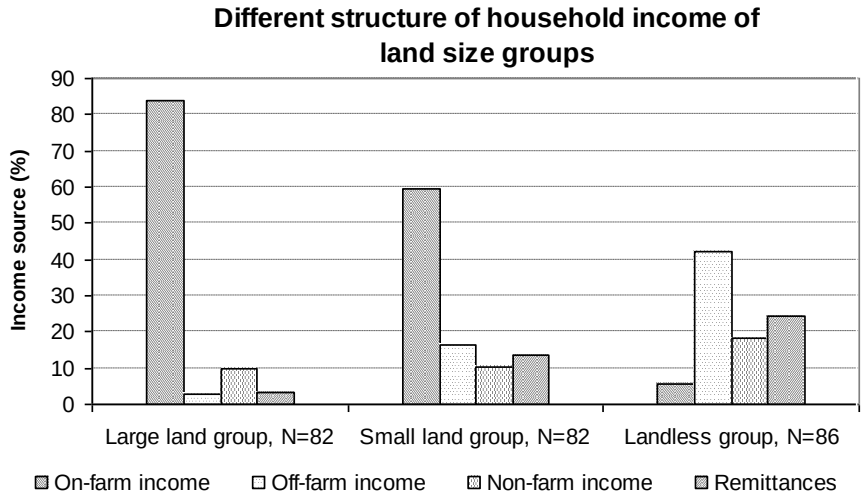
(Source: Household survey, 2009)

Appendix 7: Vulnerability of groups with different in-migration periods (Duncan Test)

In-migration periods	N	Subset for alpha = .05		
		1	2	3
Long in-migration (Before 1970)	40	.8316		
Medium in-migration (1970-1979)	71	.9679		
Short in-migration (1980-1999)	117		1.2832	
New in-migration (2000-2009)	19			1.5762
Sig.		.281	1.000	1.000

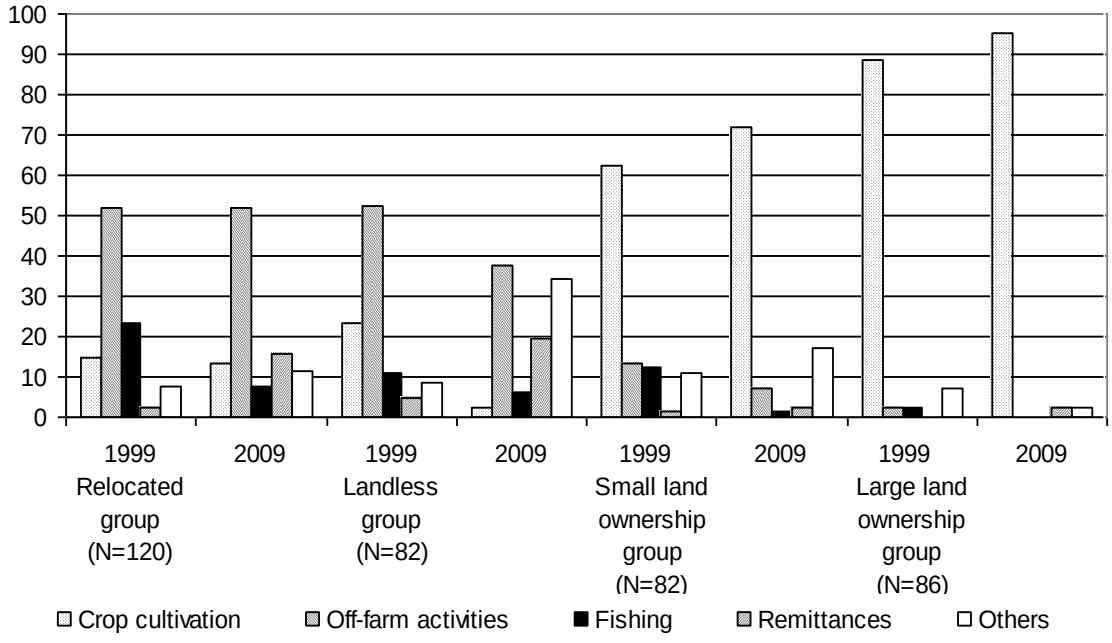
(Source: Household survey, 2009)

Appendix 8: Different structure of household income of land size groups



(Sources: Author, household survey, 2008)

Appendix 9: Changes in main income sources regarding different socio-economic groups



(Sources: Author, household survey, 2008)

Household Survey Questionnaire

VULNERABILITY ASSESSMENT TO FLOODS IN DONG THAP, THE MEKONG, VIETNAM

Date of investigation:_____
Name of interviewer:_____
Name of interviewee:_____ Code:_____
Religion:_____ Group: _____
Commune name:_____ Hamlet name:_____

FAMILY PROFILE

1. Family members

No	Members' names	Relationship	Age	Sex	Education	Skills linked to occupation	Membership
1							
2							
3							
4							
5							
6							
7							
8							

Relationship: 1 = head; 2 = wife/husband; 3 = son; 4 = son-in-law; 5 = daughter; 6 = daughter-in-law; 7 = father; 8 = mother; 9 = grandson; 10 = granddaughter; 11= others (specify)

Sex: 1 = male; 2 = female

Skills: 1 = fishing; 2 = off-farm wage labour; 3 = farmer; 4 = worker; 5 = trader/service; 6 = office job; 7 = public servant; 8 = carpenter; 9 = old people; 10= young people; 11= pupil; 12= assistant; 13 = housewife

Membership: 1 = Farmers' Association; 2 = Women' Union; 3 = Youth Union; 4 = Veteran Association; 5 = credit group; 6 = extension club; 7 = hamlet/commune officers; 8 = others (specify)

2. Household assets

No	Names of assets	Year	Kinds	Main financial sources
1	House			
2	Pig cage			
3	Boat			
4	Fuel machine			
5	Electric pumps			
6	Motor cycles			
7	Bicycle			
8	TV			
9	Radio			
10	Telephone			
11	Cell phone			
12	Deep-well			
13	Tap water			
14	Big water container			
15	Fishing tools			
16	Others			

Kinds of houses:

1 = High foundation and tentative house
2 = High foundation and semi-permanent house
3 = High foundation and permanent house
4 = Tentative stilt house
5 = Semi-permanent stilt house
6 = Permanent stilt house

Financial sources:

1 = savings
2 = public loans
3 = private loans
4 = relatives
5 = informal relief
6 = formal relief
7 = instalment

3. Where is your house located? And why is it located there?

No	Located place	Reasons for the house location
1	In residential clusters or dykes	
2	Close to high roads (m)	
3	Close to canal (m)	
4	In the flooded area	
5	Others	

Reason for the location

1 = inherited from relatives
2 = temporarily living on relatives' land
3 = no homestead, living on agricultural land
4 = enjoy natural resources
5 = landless poor household
6 = buy homestead to escape from floods
7 = buy homestead to access transportation
8 = others (specify)

4. How long have your family (or parents) been settled in the commune? (years)

---

5. From where did your family (or parents) come? ( )

WATER USE

6. Which type of water do you use for different purposes?

Type/Season	Drinking	Cooking	Washing dishes	Washing yourself	Livestock	Rice and vegetables	Aqua-culture
Dry Season							
Rainy season							
Reason for changes of water use							

Water sources:

1 = tap
2 = river/canal
3 = pond/dug well
4 = hand pump (deep-well)
4 = bottled
5 = rain water
6 = other (specify)

Reasons for changes:

1 = canal water polluted
2 = easily get sick by using canal water
3 = high cost of tab water
4 = tab water unavailability
5 = lack of rain water reservation
5 = others (specify)

LOCAL PEOPLE'S RISK PERCEPTIONS

7. What type of hazards do you define as most relevant for your commune, what type of hazards have you personally experienced?

No	Type of Hazard Threat	Level of Importance	Personal experience	
			Year	Level of intensity
1	Flood (a) big and _____ (b) small floods)_____			
2	Typhoon/Storms			
3	Salinisation of water			
4	Heat wave (long period of very hot days)			
5	Decrease of fish stock			
6	Contamination of water due to agro-chemicals			
7	Car/Road Accident			
8	Human disease			
	a) diarrhoea			
	b) fever			
	c) itchy symptoms			
	d) cancer			
	e) others			
9	Sea level rises (SLR)			
10	Losing job			
11	Environmental pollution			
12	Rising food prices			
13	Decrease in agricultural product prices			
14	River bank erosion			
15	High-yielding rice transition			
16	Being affected by war			
17	Others			

Level of importance: 1 = most importance 2 = very importance
3 = importance 4 = little importance 5 = not importance

Level of intensity: 1 = major intensity 2 = medium intensity 3 = minor intensity

8. Have you ever heard about climate change?

1 = Yes 0 = No

9. If yes, do you think that your livelihood is or will be affected by climate change?

1 = Yes, it is already affected because of
_____

2 = Yes, it will be affected in future because of
_____

3 = No
4 = I do not know

10. Landownership

Kinds of land	Land owned	Area (m^2)	Year
- Paddy			
- Vegetables			
- Homestead			
- Others			

Owned land:

1 = reclaimed
2 = allocated from Gov.
3 = bought
4 = inherited
5 = exchanged
6 = others (specify)

11. How many hectares did your family have in your old hometown? (ha)

12. Land sold and given to your relatives

Kinds of land	Land distributed	Area (m^2)	Year
- Paddy			
- Vegetables			
- Homestead			
- Others			

Land distributed:

1 = sold
2 = gave to relatives
3 = exchanged
3 = re-contributed to the Gov.
4 = others (specify)

13. Land sold due to income problems (only for landless people or people living in a new residential cluster and were landless before)

Kinds of land	Land area sold (m2)	Year	Reasons for selling
- Paddy			
- Vegetables			
- Homestead			
- Others			

Reasons:

1 = sickness of family members
2 = failure in agriculture (specifically)
3 = failure in trading or services,
4 = losses due to floods
5 = house building
6 = family ceremonies
7 = high cost of private loans
8 = lack of loans from banks
9 = lack of irrigation cost payment
10 = land policy reforms
11 = invest in new income activities
12 = lack of main labour

14. Why did you re-distribute to the Gov.?

1 = excess land size regulation
2 = severity of acidity
3 = have doubts about high-yielding rice
4 = lack of money for irrigation cost
5 = lack capital for high-yielding rice
6 = forest state farm
7 = land re-contribution policy

HOUSEHOLD INCOME

15. Income from on-farm activities a year

Activities	Area or heads	Times a year	Production (kg)	Price (VND)	Income (VND)	Estimated Cost (VND)
1) Crop cultivation						
- WS paddy						
- SA paddy						
- AW paddy						
- Vegetable						
- Fruits						
- Others						
2) Animal husbandry						
- Cows						
- Pigs						
- Others						
3) Poultry						
- Chicken						
- Ducks						
- Others						
4) Aquaculture						
- Snakehead fish						
- Fresh water prawn						
- Catfish						

16. Occupation of household members

No	Household member	Job	Place	Income (VND)	Estimated cost (VND)	Share of income for household (%)

Jobs: 1 = fishing; 2 = off-farm wage labour; 3 = farmer; 4 = worker; 5 = trader/service; 6 = office job; 7 = public servant; 8 = carpenter; 9 = other (specify)

Place: 1 = home commune; 2 = home province; 3 = other provinces

17. How are household income changed within 10 years ago? (MG)

No	Household member	Job	Place	Share of income for household (%)

Job: 1 = farmer; 2 = trader/service; 3 = shop keeper; 4 = workers; 5 = motor cycle driver; 6 = public servant; 7 = office job; 8 = off-farm activities; 9 = other (specify)

Place: 1 = home commune; 2 = home province; 3 = other provinces

18. Other income sources

No	Other income sources	Total
1	Pension	
2	Relief	
3	Relatives	
4	Others	

19. Do you give financial support to relatives who are not living in your household?

0 = No 1 = Yes

Relation of person	Place of living of person (district, province)	Amount spent in highest month	Amount spent per year (average)

Relationship: 1 = head 2 = wife/husband 3 = son 4 = son-in-law
5 = daughter 6 = daughter-in-law 7 = father 8 = mother
9 = grandson 10 = granddaughter 11= children 12 = parents
13 = relatives

20. Do you receive financial support from relatives who are not living in your household?

0 = No 1 = Yes

Relation of person	Place of living of person (district, province)	Amount received in highest month	Amount received per year (average)

21. Structure of income sources

No	Income sources	Ranking of Importance (before flood 2000)	Ranking of Importance (now)	Reasons
1	Crop production			
2	Animal raising			
3	Aquaculture			
4	Wage labour			
5	Fishing			
6	Non-farm activities at home			
7	Non-farm activities far home			
8	Others			

Reasons for changes of income sources:

1 = decrease of off-farm jobs 2 = decline of natural resources
3 = decrease of agricultural land 4 = decrease of main labour
5 = increase aquaculture 6 = increase main labour
7 = introduced non-farm activities by friends or relatives
8 = failure in agriculture

CHANGES OF INCOME AND ADAPTATION TO FLOODS

22. Main changes of the government and the district after major natural hazard events

No	Main hazard events	Major changes of the government and the district
1	Flood 1978	
2	Flood 1991	
3	Flood 1996	
4	Flood 2000	
5	Typhoon 5 (1997)	
6	Other hazards	

23. Major changes of infrastructure in your house

No	Main changes	Year	Reasons
1	Relocation		
2	Build solid stilt house		
3	Build solid house foundation		
4	Build high concrete pig pen		
5	Big concrete water containers		
6	Tab water instalment		
7	Deep well construction		

Reasons for changes of infrastructure:

1 = landless poor households
2 = protect human lives, especially children
3 = prevent strong water waves
4 = limit damages from storm
5 = protect house due to high floods
6 = house foundation elevation policy
7 = stilt house construction policy
8 = save enough money
9 = water supply station availability
10 = water polluted
11 = take flood-related resources
12 = trading
13 = use of under floor
14 = close to high road
15 = homestead owner didn't agree for us to live here

24. Changes of on-farm activities

No	Main changes	Year	Reasons
1	Traditional rice to high yielding rice,		
2	Sow WS rice early		
3	Grow vegetables		
4	Raise fish in flooding seasons		
5	Grow shrimp in flooding season		
6	Raise pig in the flooding season		
7	Cow raising		
8	Duck raising		

Reasons for changes of on-farm activities:

1 = irrigation system improvement
2 = new variety availability
3 = learnt new techniques
4 = local authority policy
5 = take flood-related resources,
6 = applied in the hamlet
7 = own money available
8 = access public loans
9 = take family labour
10 = get higher income
11 = live in residential cluster

25. Changes of off-farm activities

No	Main changes	Year	Reasons
1	Seasonal migrate to other places for off-farm activities		
2	Change to other activities at home places		
3	Decrease of fishing		
4	Others		

Reasons for changes of off-farm activities:

1 = decrease in off-farm jobs
2 = decrease in natural resources
3 = introduced non-farm activities by friends or relatives
4 = mechanisation
5 = agro chemical use
6 = severe seasonality of off-farm activities
7 = decrease of main labour
8 = dangerous in flooding condition
9 = don't like off-farm activities
10 = far flood field and inconvenience for fish equips (especially boats)
11 = fail in agriculture

26. Changes of non-farm activities

No	Main changes	Year	Reasons
1	Migrate to cities for non-farm activities		
2	Seasonal migrate to cities for non-farm activities		
3	Conduct non-farm activities in the commune		
4	Change to other non-farm activities at home places		
5	Others		

Reasons for changes of non-farm activities:

1 = decrease in off-farm jobs
2 = decrease in natural resources
3 = introduced non-farm jobs by friends/relatives
4 = failure in fish production
5 = decrease in rice production
6 = savings for family needs
7 = don't like on-farm work
8 = dangerous in flooding condition
9 = low net income
10 = earn higher income
11 = take family labour

27. Why don't you migrate to big cities for income?

1 = have young children
2 = have old parents
3 = find enough income here (fishing, off-farm)
4 = don't know jobs in other places
5 = don't adapt to new situation in the cities
6 = low net income (high cost, low income)
7 = outside potentially requested ages (16-35 years old)
8 = gain income for on-farm work
9 = unstable jobs
10 = live and work in peace and contentment,
11 = low education and skills

28. How are your plans about income earning activities in the future?

 Maintain current situation

No	Increase income earning activities	Reasons for the increases
1	increase on-farm activities	
	a) intensive rice production (three rice crops)	
	b) increase vegetable production,	
	c) consume natural feed (snakehead fish in net, duck)	
	d) increase intensive aquaculture (shrimp, *Pangasius*, snakehead fish)	
2	increase non-farm activities	
	a) agro-services (agro-chemical shop, harvester, thresher, pump)	
	b) groceries, handicraft,	
	c) petty traders	
	d) migrate to big cities for non-farm earning activities,	
3	increase off-farm activities	
	a) wage labour	
	b) fishing	
	c) others (specify)	

Reasons for the increase of income earning activities,

1 = full-protect dyke construction
2 = natural feed availability
3 = increase of aquaculture product prices
4 = relocation in the residential cluster/dyke
5 = contact with migrated people
6 = increase main labour
7 = lacks of choices for income
8 = don't like these activities
9 = job creation policy
10 = decrease of off-farm activities
11 = get higher income
12 = hire in agricultural land
13 = applied in the hamlet
14 = own money available
15 = daily consumption,

No	Decrease income earning activities	Reasons for the decreases
1	decrease on-farm activities	
	a) rice production,	
	b) vegetable production	
	c) agricultural production based on natural feed (snakehead fish in net, duck)	
	d) intensive aquaculture (shrimp, *Pangasius*, snakehead fish)	
2	decrease non-farm activities	
	a) agro-services (agro-chemical shop, harvester, thresher, pump)	
	b) groceries, handicraft,	
	c) petty traders	
	d) migrate to big cities for non-farm earning activities,	
3	decrease off-farm activities	
	a) wage labour	
	b) fishing	
	c) natural resource collection	

Reasons for the decrease of income earning activities

1 = decrease in family main labour
2 = difficult to hire labour
3 = decline of natural resources
4 = lack of capital
5 = low net income
6 = seasonality of off-farm labour need
7 = mechanisation
8 = unstable jobs
9 = decrease in off-farm activity demand
10 = concentrate on-farm work
11 = shift into non-farm work

CHANGES AND THE ROLE OF INSTITUTIONS & ORGANISATIONS

29. Who and what type of institution was most helpful to adapt and implement changes?

No	Main changes linked to experienced flood impacts	Support through informal institutions	Support through formal institutions
1	Diversification of crops		
2	Improved housing situation – particularly if that is the case due to		
	a) Relocation		
	b) Build solid stilt house		
	c) Build solid house foundation		
3	Improved access to city or customers due to dyke system and local roads		
4	Migrate to cities for non-farm activities		
5	Change to other activities at home places		
6	Others (specify)		

Informal institutions:

1 = family
2 = relatives
3 = neighbour
4 = membership of informal associations
5 = kind people inside the commune
6 = kind people outside the commune
7 = others (specify)

Formal institutions:

1 = National Gov.
2 = Local people's committee
3 = Youth Union
4 = Women Union
5 = Farmers' Association
6 = local Fatherland Front
7 = Veteran
8 = Red Cross Association
9 = International agencies
10 = others (specify)

ACCESS ASSETS AND FLOOD-RELATED INSTITUTIONS

30. How and which weather forecast information do you access?

No	Information sources	Frequency	Relevance
1	Television		
2	Radio		
3	Broadcasting systems		
4	Newspaper		
5	Internet		
6	Local authorities		
7	Neighbours		
8	Phone relatives in the delta		
9	Others		

Frequency: 1 = every day, 2 = every week, 3 = 1 or 2 a month, 4 = events only

Relevance: 1 = most relevance, 2 = very relevance, 3 = relevance, 4 = little relevance, 5 = not relevance

31. Do you access the forecasting information about normal or high floods?

0 = No, 1 = If yes,

No	Information sources and decision	□ Normal floods	□ Big floods
1	Whom do you get information?		
2	How do you decide on normal or big floods?		

Information sources:

1 = TV 2 = radio 3 = broadcasting systems
4 = newspaper 5 = internet 6 = local authorities
7 = neighbour 8 = phone relatives 9 = others

Decision:

1 = Adjust seasonal calendar 2 = Migrate for income activities
3 = Prepare to evacuate 4 = Prepare house
5 = Prepare cages for livestock production 6 = Have no decision
7 = Prepare food 8 = Prepare fishing tools
9 = Borrow loans from moneylenders

32. Which financial sources do you access in the flooding season?

1 = Relatives 2 = Neighbour 3 = Banks
4 = Moneylenders 5 = Local financial funds 6 = Unable to borrow money
7 = No need

33. Do you access relief information or information regarding the potential support after a major hazard event (flood and water contamination) has impacted the commune?

0 = No
1 = If yes, where do you get the information?
1 = Hamlet leaders 2 = Local mass unions 3 = Neighbours
4 = Relatives 5 = Local broadcasting system 6 = Others

34. Did you ever receive external support after a flood or storm or typhoon?

0 = No => because 1 = This was never necessary
2 = I would feel strange about this
3 = Nobody would help me anyway
4 = Selected by local leaders
1 = Yes

Type of event	Year	Institution/people asked for support (1-9)	Support received	Amount/goods received	Had to pay back (yes, no, share)

Institutions and organisations:

1 = neighbour 2 = hamlet authorities
3 = commune authorities 4 = Youth Union
5 = Women Union 6 = Red Cross/Crescent
7 = relatives inside commune 8 = relative outside commune
9 = benefactors inside commune 10 = benefactors outside commune
11 = urgent reaction team 12 = religious bodies
13 = others

Kinds of supports:

1 = boat 4 = rice 7 = seed subsidy
2 = hooks and nets 5 = instant noodle 8 = money
3 = filtered water container 6 = medicine 9 = house
10 = clothes, blanket

PREPAREDNESS, COPING AND ADAPTATION

35. Which COPING activities do you do when your household is potentially or heavily affected by floods (shortly before the flood or during the flood season)?

No	Activities	Rating	Cost	Financial source	Responsibility
1	Prepare house				
	a) keep their house by metal wires				
	b) lift the group floor of the house during floods (20-30 cm)				
	c) take out several wood pieces of house floors in strong waves				
2	Make grass buffer fence				
3	Elevate important assets				
4	Take care children				
5	Send children to day-care centres				
6	Sell animals or agricultural products				
7	Evacuate to higher places				
8	Migrate to other relatives in a non-flood prone region				
9	Stay at home				
10	Follow local leaders' guide				
11	Others (specify)				

Rating: 1 = high priority 2 = medium priority 3 = low priority

Financial sources: 1 = savings 2 = public loans 3 = private loans
4 = relatives 5 = relief 6 = others (specify)

Responsibility: 1 = husband 2 = wife 3 = children 4 = others

36. Which institutions/organisations do you access for immediate help when your household is affected by floods?

No	Institutions	Ranking of importance to cope with floods (1-12)	Ranking of influence to make decision (1-12)
1	Neighbours		
2	Hamlet authorities		
3	Commune authorities		
4	Youth Union		
5	Women Union		
6	Red Cross Association		
7	Relatives inside the commune		
8	Relative outside the commune		
9	Benefactors inside the commune		
10	Benefactors outside the commune		
11	Urgent reaction team		
12	Religious bodies		

37. **What are the measures/actions you undertake to adapt to floods after or before major floods/salinisation processes** (these actions prevent harm and ensure the continuation of the normal life or income earning activities – they are normally different from coping)

No	Names of activities	When	Financial resource	Sources learnt
1	build or prepare house			
	a) keep their house by metal wires			
	b) build solid stilt house			
	c) build solid house foundation			
	d) prepare fence to protect children from drowning			
2	prepare facilities to protect agricultural products and production			
	a) build agricultural product storage			
	b) build high cages			
	c) grow trees as buffer fence			
3	adjust crop seasonal calendar			
	a) early rice sowing			
	b) arrange livestock raising			
	c) arrange snakehead fish raising			
	d) arrange duck herd raising			
4	access to basic needs			
	a) build deep-well			
	b) access to tap water			
	c) build concrete water containers			
	d) buy good boats and machines			
5	raise flood risk awareness			
	a) swimming training for children			
	b) prepare life-secured equip			
	c) be ready to live with floods			
6	Others (specify)			

When: 1 = before floods 2 = after floods

Financial sources:

1 = savings 2 = public loans
3 = private loans 4 = relatives
5 = relief 6 = others (specify)

Sources learnt:

1 = informal stories in the hamlet 2 = direct observations
3 = advance farmers 4 = family members
5 = radio 6 = TV
7 = newspaper 8 = commune CFSC
9 = others

LOCAL PEOPLE'S PERCEPTIONS

38. How are floods changing in the future? And what do you think are the reasons for it

No	Main changes of floods	Reasons for flood changes
1	Higher	
2	Lower	
3	Shorter	
4	Longer	
5	Flood water more polluted	
6	Others (specify)	

Reasons for flood changes

1 = dam construction in the upstream
2 = dyke construction in the MD
3 = irrigation system construction
4 = local road construction
5 = God' will
6 = climate change
7 = flood cycle
8 = I don't know

39. What are positive and negative impacts of flood-related interventions?

No	Food-related interventions	Relevance	Positive impacts	Negative impacts
1	Residential dykes			
2	Residential clusters			
3	Full-protected dykes			
4	Semi-protected dykes			
5	Local roads			
6	Funding for stilt house			
7	Funding for house foundation			
8	Flood-related agri-production			
9	Tap water supply			
10	Others			

Relevance: 1 = most relevance 2 = very relevance 3 = relevance
4 = little relevance 5 = not relevance

Positive impacts:

1 = protect house 2 = protect physical assets 3 = protect human life
4 = protect agri production 5 = transportation, 6 = increase crops
7 = crop diversification 8 = strong anchor 9 = money
10 = increase off-farm activities
11 = enrich natural resources and soils
12 = access electricity, tap-water and transportation
13 = homestead and house

Negative impacts

1 = decrease off-farm income 2 = high daily cost
3 = change living style 4 = lack of main infrastructure
5 = decrease small scale production 6 = lost old neighbour relationship
7 = indebtedness 8 = decrease alluvial matters
9 = decrease natural resources 10 = remain insects/diseases
11 = decline flood experience 12 = hinder water flow
13 = environment pollution 14 = high cost of reservation
15 = high cost for construction 16 = narrow
17 = worry about dyke broken 18 = social evils
19 = motorcycle accident 20 = difficult transportation
21 = inconvenience for fishing equips

40. What are interactions between upstream and downstream changes?

1 = Higher flooding depth downstream
2 = Low flooding depth downstream
3 = No change
4 = I don't know

41. Do you think that a storm like Typhoon No. 5 in 1997 was the most severe storm that can possibly reach Dong Thap?

1 = Yes, I think Dong Thap is not much affected by storms and will also in future not be affected by bigger storms than Typhoon No. 5 in 1997

2 = I think that there will be more severe storms in the future

3 = I do not know about these things

42. What would you do if a storm or a strong whirlwind occurred at the same time as flooding?

1 = stay at home
2 = move to permanent houses in the hamlets
3 = move to public infrastructure in the hamlets
4 = move to the high dykes in the hamlet
5 = move to relatives' houses in other communes
6 = follow local authority guides
7 = pray to God
8 = others (specify)
9 = I don't know

43. Positive impacts of floods

No	Positive impacts	Levels of positive impacts in a normal flood	Levels of positive impacts in a high flood
1	get alluvial matters		
2	release pets/diseases		
3	enrich natural resources		
4	feed for aquaculture and poultry production		
5	fishing		
6	break-up grass and waste of agricultural production		
7	get informal relief		
8	get public subsidy		
9	get public help for house preparation		
10	get new house or relocation		
11	other		

Levels of positive impacts

1 = high positive impacts
2 = medium positive impacts
3 = low positive impacts
4 = no positive impacts
5 = I don't know

44. Negative impacts of floods

No	Negative impacts	Levels of impacts in a normal flood	Levels of impacts in a high flood
1	affect physical assets		
	a) house damaged		
	b) house foundation damaged		
	c) dykes damaged		
	d) cages damaged		
	e) boat damaged		
	f) machine lost		
	g) deep-well harmed		
	h) others		
2	crop production damaged		
	a) interrupt crop production		
	b) loss of SA paddy		
	c) loss of vegetables		
	d) plants fallen		
	e) others		
3	animal raising affected		
	a) interrupt animal raising		
	b) pig damaged		
	c) chicken damaged		
	d) duck damaged		
	e) others		
4	aquaculture damaged		
5	interrupt off-farm wage labour		
6	Non-farm activities affected		
	a) agro-services affected		
	b) trade/services affected		
7	schooling interrupted		
8	high cost of flood prevention		
	a) dyke system construction fee		
	b) annual dyke conservation cost		
	c) cost for animal cages		
	d) cost for water use for living		
	e) cost for human security equips		
	f) others		
9	Psychological impacts		
	a) worry about house and assets damaged		
	b) worry about income activity interrupted		
	c) worry about human security		
	d) take time to take care children		
	e) others		
10	other (specify)		

Levels of negative impacts

1 = high negative impacts 2 = medium negative impacts

3 = low negative impacts 4 = no negative impacts 5 = I don't know

45. How important do you consider the following risks to be for your life? Please rate and rank regarding your perceived importance today and ten years ago

No	Risks	Importance today	Importance 10 years ago
		Rating (1-10)	Rating (1-10)
1	Floods a) normal floods b) big floods		
2	Typhoon/storm		
3	Salinisation of water		
4	Heat wave		
5	Decline of fish stock		
6	Contamination of water due to agro-chemicals		
7	Car/motor cycle accident		
8	Human diseases		
	a) diarrhoea		
	b) dengue fever		
	c) cancer		
	d) others		
9	Sea level rise		
10	Losing jobs		
11	Environmental pollution		
12	Rising food prices		
13	Decrease agricultural product prices		
14	River bank erosion		
15	High-yielding rice transition		
16	Being affected by war		
17	Others		

Rating: 1 = most importance 10 = little importance

RELIGION

46. **Do you go to the Pagoda?** 1 = Yes 0 = No

1 = every day 2 = every week 3 = every month
4 = every year 5 = for the main festivities

47. Who goes to the Pagoda of your family members? (figured out based on question 1)

48. Why do they go to the Pagoda?

1 = pray for health of family members 2 = pray for family to escape from bad things
3 = pray for good fortune 4 = pray for wealth
5 = learn good things

49. You estimated amount of money given to the Pagoda or volunteer funds:

Amount of money	Every day	Every week	Every month	Every year	For main festivities	Never
Money given to Pagoda (VND)						
Money given to volunteer funds (VND)						

50. Why do you give money to the pagodas?

1 = for my ancestors 2 = for better life after death 3 = to renovate the Pagoda
4 = to repent 5 = for charity 6 = festival organisation
7 = luckiness

51. Why do you give money to the charitable funds?

1 = for my Ancestors 2 = for better life after death 3 = to renovate the Pagoda
4 = to repent 5 = for charity 6 = festival organisation
7 = luckiness