Vulnerability Profiles with Respect to Present and Future Water-Related Hazards in the Vietnamese Mekong Delta –
Providing the Information-Base for Successful Coping and Adaptation within the Framework of Integrated Water Resources Management

Jörn Birkmann, Matthias Garschagen, Vo Van Tuan, Nguyen Thanh Binh

Why vulnerability assessment matters for IWRM in the Mekong Delta

Flood Risk Management is since long considered a key component within Integrated Water Resources Management (IWRM) (compare, for example, part 2-2 of the UNESCO IWRM guidelines; UNESCO 2009) particularly with respect to flood risk mapping consisting of mapping hazards and exposed or vulnerable elements. However, much of the prevalent IWRM discourse, including conceptual frameworks, implementation guidelines or legislative regulations, has to date been dominated by a strong emphasise on engineering-based technical solutions in response to challenges related to flooding. This thinking is heavily based on a rather technocratic paradigm drawing on the notion that natural hazards have to be controlled or fought against and that natural hazards are an external threat to human society resulting in the need for taming this hazard or nature at a whole (Birkmann 2006; Casimir 2008). Such a paradigm can in particular be observed in Vietnam and the Mekong Delta where the natural resource management of the last years was explicitly following the direction of taming nature and where living in harsh environmental conditions is often described as a constant fight with the (external) elements (Käkönen 2008; Garschagen 2009).

What has in this discussion often been overlooked until the recent past is the fact that the potential damage of natural hazards does not solely depend on the hazard as such or on the question how far this hazard can be controlled. Rather, internal vulnerabilities in a societal system play a key role in influencing the actual damage or the damage potential, in particular in countries with limited resources to implement and effectively maintain protective technical hazard mitigation solutions and to avoid failure thereof. Vulnerability can in this context be understood as the internal pre-conditions in a society or a social-ecological system that influence the potential to experience harm due to a given hazard (Thywissen 2006). Drawing on this notion, risk can be understood as the product of a given hazard and a vulnerable societal system that is exposed to this hazard. Risk management (also in the context of IWRM) has, hence, to focus not only on the hazard component of this equation, i.e. on the question of how to tame or mitigate this hazard – which in any case can be a hopeless undertaking due to the fact that a. there are no protection measures for certain hazards, b. hazard mitigation options can often not provide full coverage of a given area or system, and c. are prone to failure. Integrated risk management rather has at the same time to aim at reducing the internal vulnerabilities within a given societal system, meaning to improve the pre-conditions of agents within this system to cope with, recover from and adapt to certain hazard phenomena and to be flexible to react to new situations that may emerge, for example, in the context of climate change.

In order to achieve this goal, risk management within IWRM has to be informed on vulnerabilities in the respective societal system, meaning in detail that risk managers have to gain an understanding of how vulnerabilities emerge and progress, which causal relations exist between certain drivers of vulnerability, which options are possible to counter-act and reduce those vulnerabilities and, finally, which different profiles and trajectories of vulnerabilities exist for distinct population groups or sectors with the given system. The vulnerability assessment within the project of developing a Water-Related Information System for the Sustainable Development of the Mekong Delta in Vietnam (WISDOM) responds to this demand.

Conceptual Approaches for risk, vulnerability, resilience and adaptation science

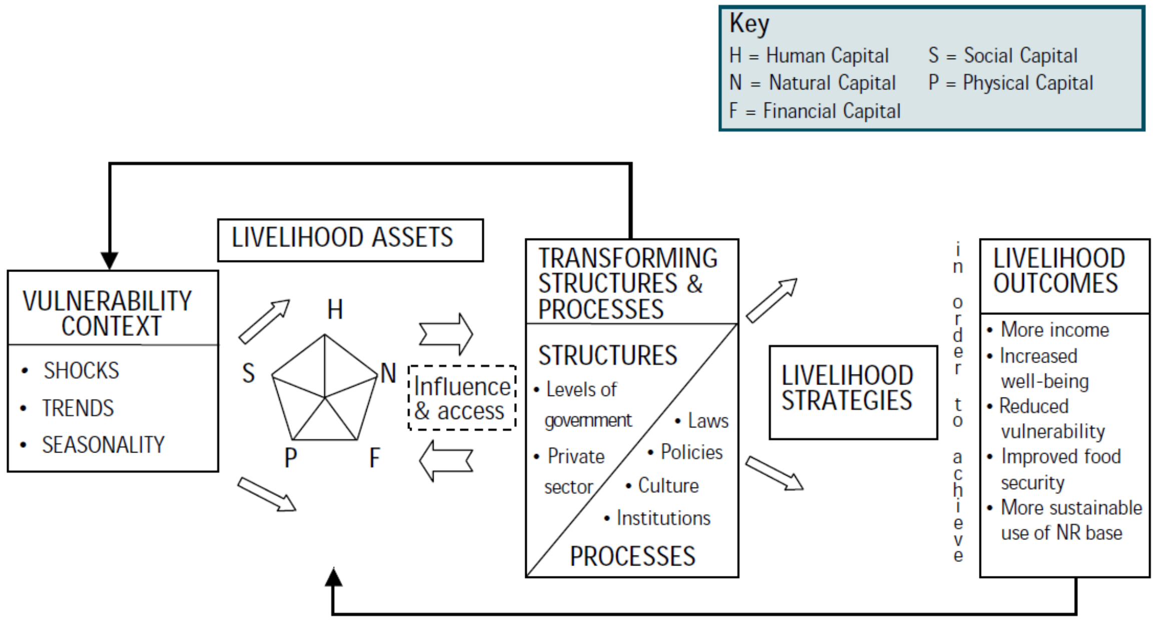
Changing focus in risk research: from hazard focus to vulnerability

Over the last decades, paradigms and conceptual approaches that influence how to understand and deal with risk related to natural hazards have changed quite substantially. Well into the 1970s, risk discourses revolving around natural hazards were mainly focused on the assessment of hazard probabilities including in particular magnitude and frequency analysis. Departing from this focus within the hazard research, a notion of vulnerability developed in which vulnerability was mainly understood as the physical vulnerability of exposed elements and the economic losses to be expected if certain exposed elements are hit by hazards (of an expected probability). Responding to the risk of being harmed by a hazard was, hence, largely thought of in terms of structural response, i.e. houses that can withstand am earthquake of a certain probability or dyke systems that are constructed to protect against floods with an expected magnitude (Birkmann 2006; Thywissen 2006).

During the 1980s, however, a growing body of literature acknowledged and emphasised that disasters in the context of natural hazards are not only determined by the physical side of the natural hazard but that the development, progress and impact of disasters is strongly shaped also by the human action and by the internal pre-conditions of social systems to be harmed by hazards (Hewitt 1983; Oliver-Smith 1999; Wisner et al. 2004; Müller-Mahn 2005). The notion of vulnerability was thereby taken up and broadened in the sense that a particular emphasis was given to the social dimension of vulnerability (Handmer 2003). One of the key messages that evolved in the context of this thinking is that vulnerabilities vary between different social groups leading to socially stratified susceptibility patterns and disaster pathways (Chambers 1989).

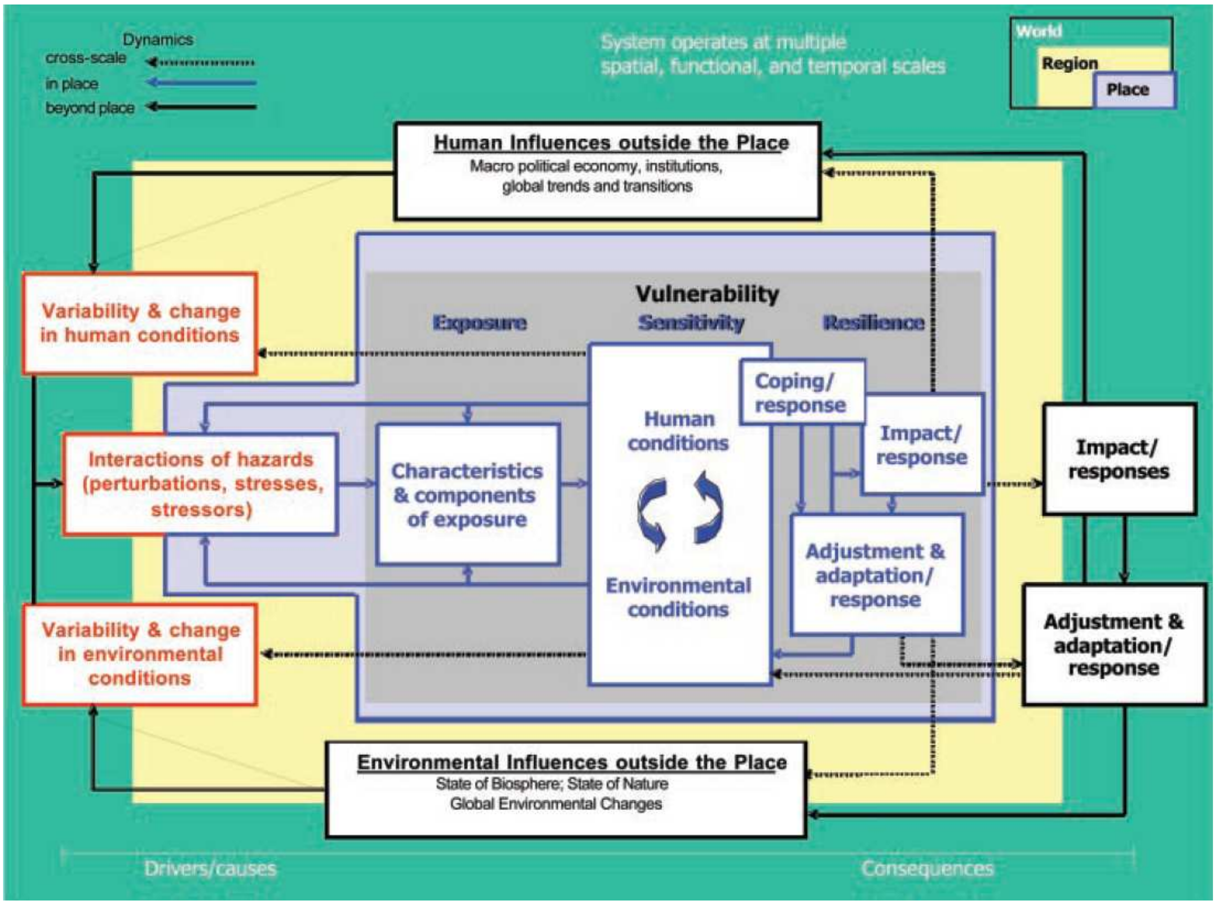
Risk was, thus, increasingly understood not through the primacy of the physical hazard event but rather as the combined result of potentially harmful hazards and the vulnerabilities within a given social or economic system. The formula formulating that risk equals the concurrence of hazard and vulnerability (R=HxV), therefore, gained prominence and wided-spread approval over the years. Departing from this shift in thinking, many models and frameworks developed since the 1980s set out to develop an ontology of the sub-components regulating vulnerability in order to frame vulnerability analysis and reduction. In this context, vulnerability approaches have been shaped in strong interaction with other approaches in the field of poverty and developing studies. One of the most prominent examples is the Sustainable Livelihood framework which puts emphasis on the acquisition, substitution and usage of different types of assets that an individual or household has for pursuing livelihood strategies. The availability of, access to and operational effectiveness of those asset portfolios are thereby regulated by transforming structures and processes that shape livelihood outcomes and vulnerabilities (Figure 1). Chambers (1989) as well as Bohle (2001), hence, differentiate between the external dimension of vulnerability made up by the exposure to hazards and the internal dimension which is composed of socially differentiated coping capacities. Turner et al. argue that vulnerabilities consist of exposure, sensitivity and resilience whereby the latter is an integrated and cross-temporal manner understood to comprise coping response, impact response and adaptation response (including adjustments to system components) (Figure 2) (Turner et al. 2003). Also focusing on the dynamic processes that drive vulnerability and eventually can lead to disaster, Wisner et al. differentiate within their Pressure and Release Model (PRA) three components which together shape the progress of vulnerability (**Figure 3**). Systemic and institutional root causes can comprise limited access to resources, exploitive structures and lack of power – with the focus on this domain heavily being influenced by Sen’s entitlement theory (Sen 1981) and by the works of political ecology (e.g. Blaikie & Brookfield 1987). Dynamic pressures comprise destabilising processes at various scales that are inadequately governed and regulated like, for example, rapid urbanisation, rapid urbanisation change, ecosystem degradation or the erosion of ethical standards or local governance institutions. In combination, root causes and dynamic pressures can lead to unsafe conditions and an increase in vulnerability. When hit by a disaster, the increased risk of the populations or systems in those unsafe conditions, hence, manifests itself in a disaster.

Figure 1 Sustainable livelihood framework



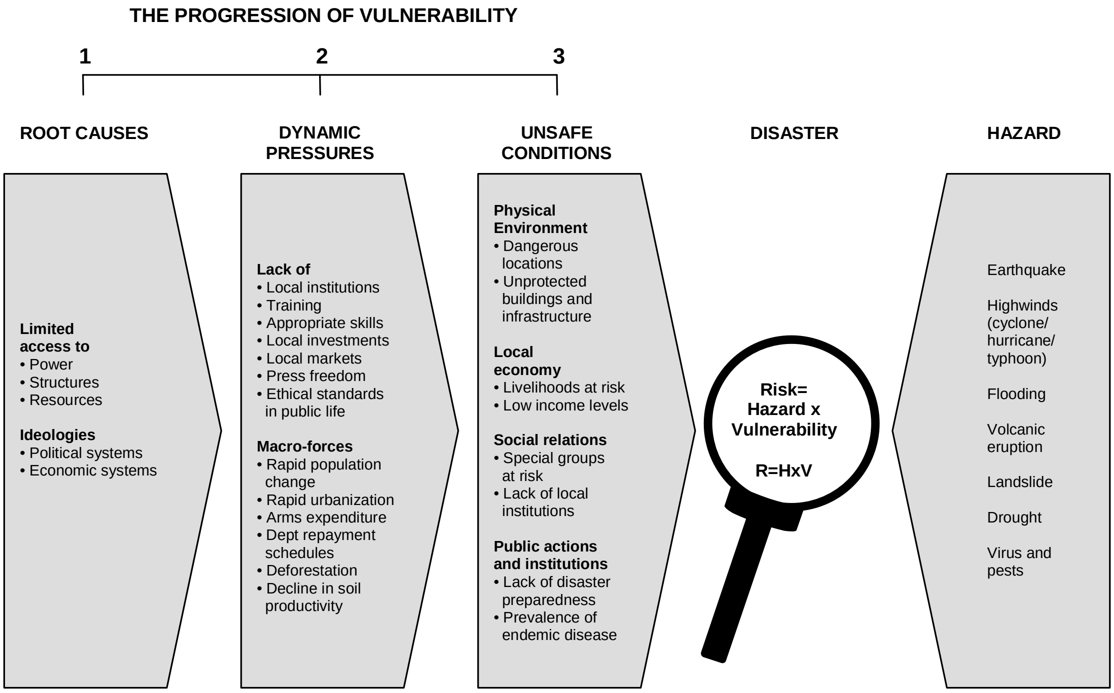
Source: DFID 1999

Figure 2: The Turner et al. Framework (the social-ecological perspective)



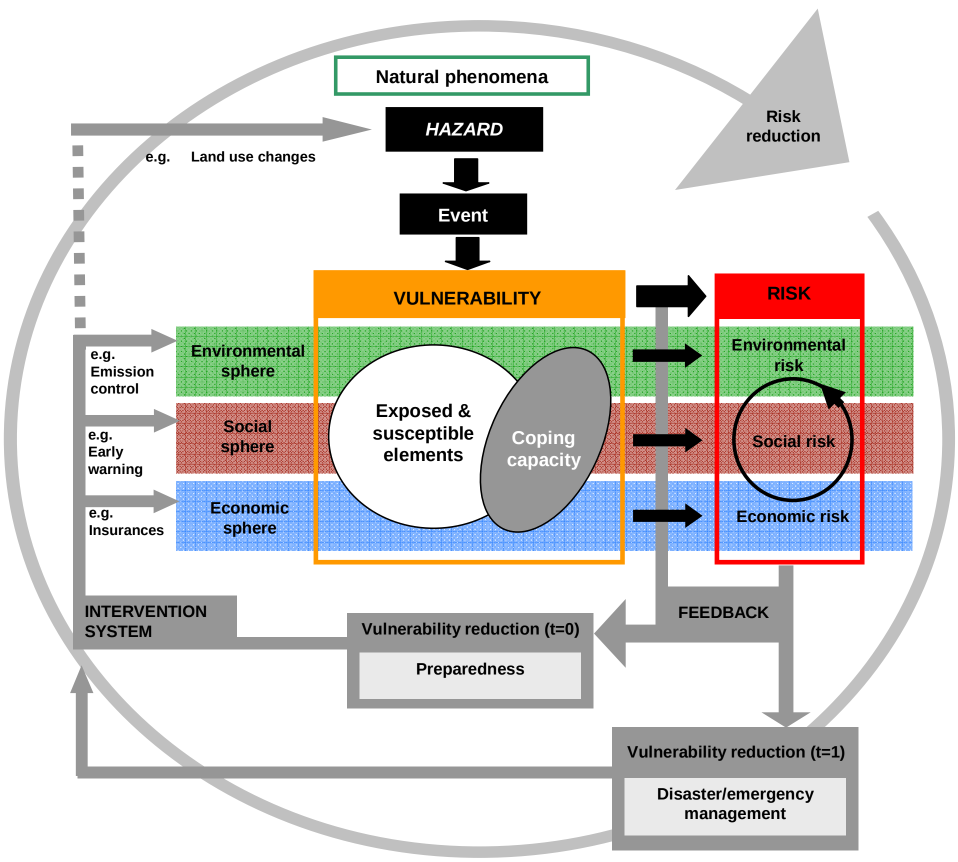
Source: Turner et al. 2003

Figure 3: The pressure and release model



Source: Wisner et al. 2004

Figure 4: The BBC conceptual framework



Source: Birkmann 2006

The BBC framework is linked to conceptual work done by Bogardi and Birkmann (2004) and Cardona (1999 and 2001). It grew from three discussions: how to link vulnerability, human security and sustainable development, the need for a holistic approach to disaster risk reduction and the broader debate about causal frameworks for measuring and assessing sustainable development. The BBC framework stresses the fact that vulnerability analysis goes beyond the estimation of exposure and deficiencies in the past. It underlines the need to view vulnerability within a process (dynamic), which means focusing simultaneously on exposure and susceptibility as well as coping capacities and potential intervention tools. Furthermore, the BBC framework underlines the need to focus on social, environmental and economic aspects of vulnerability, clearly linked to the concept of sustainable development (see Birkmann 2006, p. 35). Additionally, the BBC framework promotes a problem-solving perspective, by analyzing the probable losses and harm of the various elements at risk, as well as their robustness and coping capacities as well as potential ways on how to reduce exposure, susceptibility and increase coping capacity (interventions). Lastly, the differentiation of response processes is an important analytical difference. While within the disaster event the capacities of disaster agencies are key, the phases before and after disasters have occurred require specific strategies for preparedness (t=0).

Resilience in coupled social and ecological systems

Over the recent years, a growing body of literature has been giving strong emphasise on the coupling and interaction of social and ecological systems. The notion that social, cultural, economic and political actors and institutions have great influence on the management of ecosystems and that sustainability in those systems – often serving as livelihood basis for given communities – is regulated by often politically contested power structures is not entirely new and has, in particular, found strong expression in the works coming out of political- or human-ecology (Robbins 2004; Walker 2005, 2006, 2007). However, the latter having mainly been influenced by social scientists and strongly focusing on power struggles, a new school of thought has gained momentum more recently which is originating to big parts from an ecology perspective – but has soon found strong entrance into social sciences and humanities.

The perspective on integrated social-ecological systems emerges from the fact that social and ecological systems have in the past for too long been conceptualised as two separate systems being embedded in two different regulative regimes. Contrasting this notion, the focus on “navigating social-ecological systems” (Berkes et al. 2003) emphasises that social and ecological elements have to be thought of as integrally connected within one regulative regime tied together by human management and use of ecosystems on the one hand and fundamental reliance on goods and services provided by ecosystems at various scales on the other hand (Berkes et al. 2003; Gunderson and Holling 2002; Walker et al. 2004). Challenging the prevalent ontology of social and ecological spheres, proponents of the concept of coupled social ecological systems claim that those systems are “neither humans embedded in an ecological system nor ecosystems in an human systems, but rather a different thing altogether. Although the social and ecological components are not identifiable, they cannot easily be parsed for either analytic or practical purposes.” (Walker et al. 2006). However, how exactly those coupling processes work and can be expressed in conceptual and theoretical terms is still rather open and subject to ongoing research across different disciplines.

In the context of social-ecological systems, resilience has become a popular concept to describe and analyse dynamics and management approaches of and within those systems (Folke 2006; Walker et al. 2006). The concept of resilience has thereby over the years undergone a substantial shift and advancement with respect to its ontology, field of application and guidance for decision making (compare table 1). The original field of application was strongly linked to the collapse and (transformative) reorganisation of CSES (e.g. Abel et al. 2006; Walker et al. 2004; Gunderson 2000) often linked to cascading effects (Kinzig et al. 2006) and the question of the ability to govern those processes (Lebel et al. 2006) across scales (Cumming et al. 2006).

However, it has soon been recognised that lessons learned from those resilience discourses can be of great use for disaster preparedness and recovery (Masten & Obradovic 2008; Gunderson 2010) – not exclusively but also in the context of climate change. With respect to this field, the genealogy of the term can be described as follows: Having departed from a strong focus on the ability of a system to recover after a disaster to the state the system had before the disaster or to withstand the hazard altogether (resilience as recovery and robustness), resilience is today by most scholars understood in a wider and more dynamic sense, comprising elements of adaptive learning, openness, adjustment, transformation, innovation and and reorganisation in response to disturbances allowing to be better prepared for the next hazard (Handmer and Dovers 1996; Folke 2006; compare table 1). In this understanding, disturbances and hazards create opportunities for reorganisation of the systems and for transformation into new trajectories. This new understanding, however, also brings about new challenges for decision making and governance as actors need to facilitate this open process through institutional learning that is open to the critical re-consideration of existing planning and management paradigms, the incorporation of uncertainties into decision making and the support for innovative and open approaches.

Table 1: different resilience concepts

Resilience Concept	Characteristics	Focus on	Context
Engineering Resilience	Return time, efficiency	Recovery, constancy	Vicinity of stable equilibrium
Ecological/ecosystem resilience and social resilience	Buffer capacity, withstand shock, maintain function	Persistence, robustness	Multiple equilibria, stability landscape
Social-ecological resilience	Interplay disturbance and reorganization, sustaining and developing	Adaptive capacity, transformability, learning, innovation	Integrated system feedback, cross-scale dynamic interactions

Source: Folke (2006)

The implications of this resilience thinking for decision making and integrated water resources management in the context of changing natural hazards in view of climate change will be further explored in the discussion section, supported by the empirical findings from three case study assessments presented below.

Coping and Adaptation

The concepts of coping and adaptation have gained substantial prominence in scientific and political discourses revolving around natural hazards and climate change. The terms are thereby often lumped together without clearly differentiating their different notions and implications – doing so, however, is necessary and of great help for guiding decision making and analytical approaches.

We understand coping as a short-term, often re-active, response to deal with the impacts of a hazard shortly before, during or after the hazards strikes and, by doing so, to minimize the effects of a disaster. Coping can happen at various scales, can involve different actors and institutions and may happen in formal and/or informal ways, ranging from the individuals over households to official disaster response by, for example, military forces of a nation-state. Coping can comprise spontaneous, unplanned action (e.g. running away from a flash-flood) as well as planned activities following pre-defined contingency plans (e.g. mobilisation of military forces for dyke protection at certain flood levels).

Adaptation, in contrast, implies a longer time frame and a notion of planned, strategic, target-oriented and coordinated action. While coping measures are mainly undertaken within the existing frame of processes and structures within the system and are generally not aimed at altering the principles of operation within a given system as such, adaptation often implies an adjustment of system components, processes and structures in response to experienced or anticipated hazards or climate change impacts in order to moderate harm or even exploit beneficial opportunities (strongly altered on the basis of IPCC 2007: 869).

Even though conceptually appealing, a clear-cut differentiation between coping and adaptation is often hard to uphold against the background of real world activities and empirical data in the context of dealing with natural hazards and climate change. Many activities assessed within the framework of the following vulnerability assessment showed elements of both, coping and adaptation. We take this, however, not as an argument for discarding those two concepts. Rather we take these observed hybrid forms as motivation for analysing and discussing the interactions and blends of rather spontaneous short-term response that remains within the semantics of a given system or worldview (coping) with actions and measures that follow a more strategic approach that involves a longer time horizon and the possibility of changing the ontological and operational landscape of an existing systems altogether.

Questions that arise in this context include, for example, the interplay of generic and specific adaptive capacities (Handmer 2003), interlinkages between erosive coping capacities that degrade livelihood assets (e.g. selling of livestock on crisis situation), the coping capacity in future and the adaptive capacity or the question, how coping mechanisms have to be adapted in view of climate change.

Legal and institutional framework for disaster risk management and climate change adaptation in Vietnam [1]

Disaster Risk Management

Owing to the country's long experience with natural hazards and resulting disasters, Vietnam has a comprehensive system of formal disaster risk management. The coordination and implementation of disaster risk management falls within the remit of the Ministry of Agriculture and Rural Development (MARD). The mandate of the ministry defines that the section of water resources has to "unify the management of dike construction and protection, headwork for prevention of floods and typhoons and efforts to prevent and combat flush flooding, floods, typhoons, drought, and landslides along riversides and coastal areas" (SRV 2009). In order to supervise the implementation and maintenance of disaster prevention measures (such as dykes and shelters) and to organize disaster response (e.g. on-the-spot dyke repair units) MARD and its subsidiary departments are in charge of coordinating committees of flood and storm control of which one is in place at the national level and at every province, district and commune/ward respectively. These committees are headed by high ranking officials of the Ministry or by leading officers of the People's Committee of the respective level and include representatives from the different planning agencies and other relevant institutions such as the Red Cross or the Women's Union.

In November 2007, the Prime Minister approved the new long-term National Strategy for Natural Disaster Prevention, Response and Mitigation to 2020. This strategy confirms the role of MARD as focal agency for disaster risk management and sets out guiding principles and objectives for the next years. These comprise the improvement of early warning systems, the improvement of planning and building codes in view of natural hazards, the fostering of capacity building at all levels, the relocation of people in disaster-prone areas and the upgrade of structural protection measures such as sea dykes, flood resistant embankments or storm shelters (SRV 2007).

Climate Change Adaptation

Similar to developments in the international community and in most countries, the formulation of official climate change adaptation policies is a rather recent phenomenon in Vietnam. Earlier initiatives had been mainly focusing on climate change mitigation strategies[2] (e.g. the first drafts for the correspondence with the UNFCC in the 1990s). However, owing to the exceptional risk that climate change implies for Vietnam, the Government as well as other actors within the ministries and from the international cooperation community in Vietnam pushed for a speedy process of institutionalising climate change adaptation efforts.

In December 2008, the Prime Minister approved the National Target Program to Respond to Climate Change. This program officially acknowledges the importance of climate adaptation for the overall sustainable development of the country. It, therefore, calls for adaptation efforts of all levels and sectors and for the mainstreaming of climate change adaptation into general planning processes. In order to achieve this goal the plan appoints responsibilities and tasks to government sectors and institutions. The plan specifies that the Ministry for Natural Resources and the Environment (MoNRE) will act as the focal agency for all climate change response activities in Vietnam. The ministry and its subsidiary departments at the lower levels, therefore, have to coordinate response measures and facilitate the communication of other ministries, sectors and the localities with the national Government (which has the ultimate responsibility).

Table 2 summarizes the objectives of the National Target Program as well as the most important tasks including the envisaged timetable for completion.

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[1] The paragraphs of this chapter are originating from Garschagen (2009).

[2] The author follows the commonly agreed terminology in which climate change response comprises the two domains of climate change adaptation and climate change mitigation. Adaptation in this notion refers to the "adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities" (IPCC, 2007). Mitigation comprises all measures that reduce green house gas emissions, limit their growth or enhance sinks. Due to the focus of this paper, the author has to limit the discussion to adaptation measures here; however, fully acknowledging that measures from both domains are absolutely necessary and that "mitigation is the best adaptation" in the long run.

Table 2. Objectives and targets of the National Target Program to Respond to Climate Change

Objective[3]	Targets to be achieved by 2010 (selection)	Targets to be achieved by 2015 (selection)
Assessment of climate change impacts in Vietnam	– scenarios based on existing data – pilot projects for assessment	– update/completion
Identification of response measures	– implement pilot/test projects in different sectors and locations	– wide scale implementation based on lessons learned
Establishment of scientific and practical basis for response measures	– development of a national science and technology program on climate change	– completion and updating of climate change database – update research and implement results
Consolidation of organisational structure and capacity building amongst relevant institutions	– development of framework for legal documents and mechanisms – coordination amongst ministries, sectors and localities	– mechanisms to prioritize climate change activities
Raising public awareness and human resources development	– over 10% of population and over 65% of Government staff with basic knowledge on CC	– over 80% of population and 100% of Government staff with basic knowledge on CC
Promotion of international cooperation and support	– establish bilateral and multilateral cooperation mechanisms for implementing the national target plan	– completion and effective implementation
Mainstreaming into development planning (socio-economic, sectoral, local)	– guidance documents and classification of measures	– mainstreaming into future planning – assess implementation for period 2010-2015
Development and implementation of action plans and (pilot) projects	– ministries and local authorities complete action plans	– action plans being implemented

Source: own figure on the basis of SRV (2008).

Methodological Framework

Even though the detailed methodology for conducting the research in the three separate case study areas may vary to a certain extent (as they are also part of separate PhD thesis supervised by different professors), all of the three research campaigns follow a common approach in terms of epistemology and general methodology. This way, elements of the research design can be mutually integrated into the design of other case study areas, allowing for later comparisons and comprehensive theorizing. It is, hence, guaranteed that the character of a comprehensive research undertaking, bound together through three case study areas, can be achieved.

The research in all three case study areas employ a combined application of methods typically recalled to as rather qualitative and those being usually described as more quantitative in nature. Based on a sound literature review, first explorative phases of research included in all three case study areas the collection and analysis of official governmental reports and statistics on the subjects and areas in question. In addition, focus group discussion and interviews with local experts were conducted in the early phase in order to sharpen the general understanding of the matter at hand – prominent interviewees during this phase were, for example, the leaders of the district level Departments for Agriculture and Rural Development or the local representatives of the Committees for Flood and Storm Control. In parallel to tapping this “expert knowledge” the empirical research in the early phase of the project also included explorative interviews on household level, deploying more qualitative and semi-structured interview techniques. Those were further supplemented by the application of methods usually referred to as participatory rapid/rural appraisal-methods (PRA) which include, for example, the joint development of historical time-lines, wealth rankings, actor influence mappings, Venn-diagrams or transect walks.

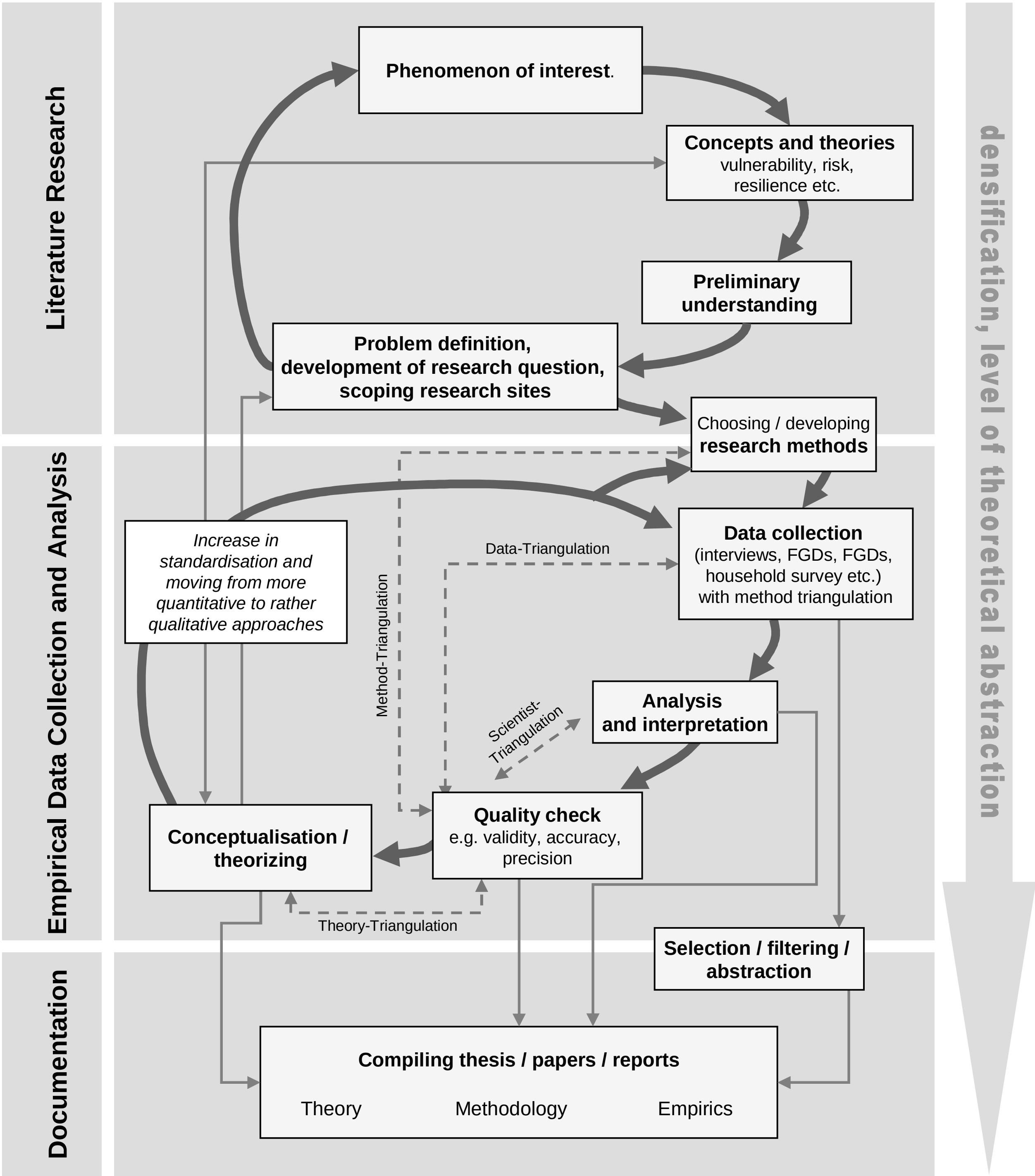
The findings of this explorative research phase were then fed into the development of a standardised household survey campaign in order to test some of the correlation-hypothesis explored during the qualitative research steps and to be able to compare elements and correlations of vulnerability along the lines of different case study areas, socio-economic groups as well as other variables identified during the first research phase. In a last step, the analysis of the household survey data was used to develop an aggregated vulnerability index.

[3] For the official wording of the objectives and tasks refer to SRV (2008).

The household survey campaigns were conducted in 2009 and early 2010 and covered a total sample size of around 1,600 households in the three case study areas. The campaigns in the single case study areas where conducted in compact blocks so that the time between the response to the first and the last questionnaire in each of the three case study areas was never greater than 5 weeks. Each of those campaigns was supported by a team of 10-15 staff members and master students of Can Tho University who received a two-day training prior to every campaign.

Figure 5 depicts the main methodological elements according to the underlyling epistemological principles of hermeneutic cycles and grounded theory (Glaser & Strauss 1998)

Figure 5 Research steps and methodological elements within hermeneutic cycles and grounded theory

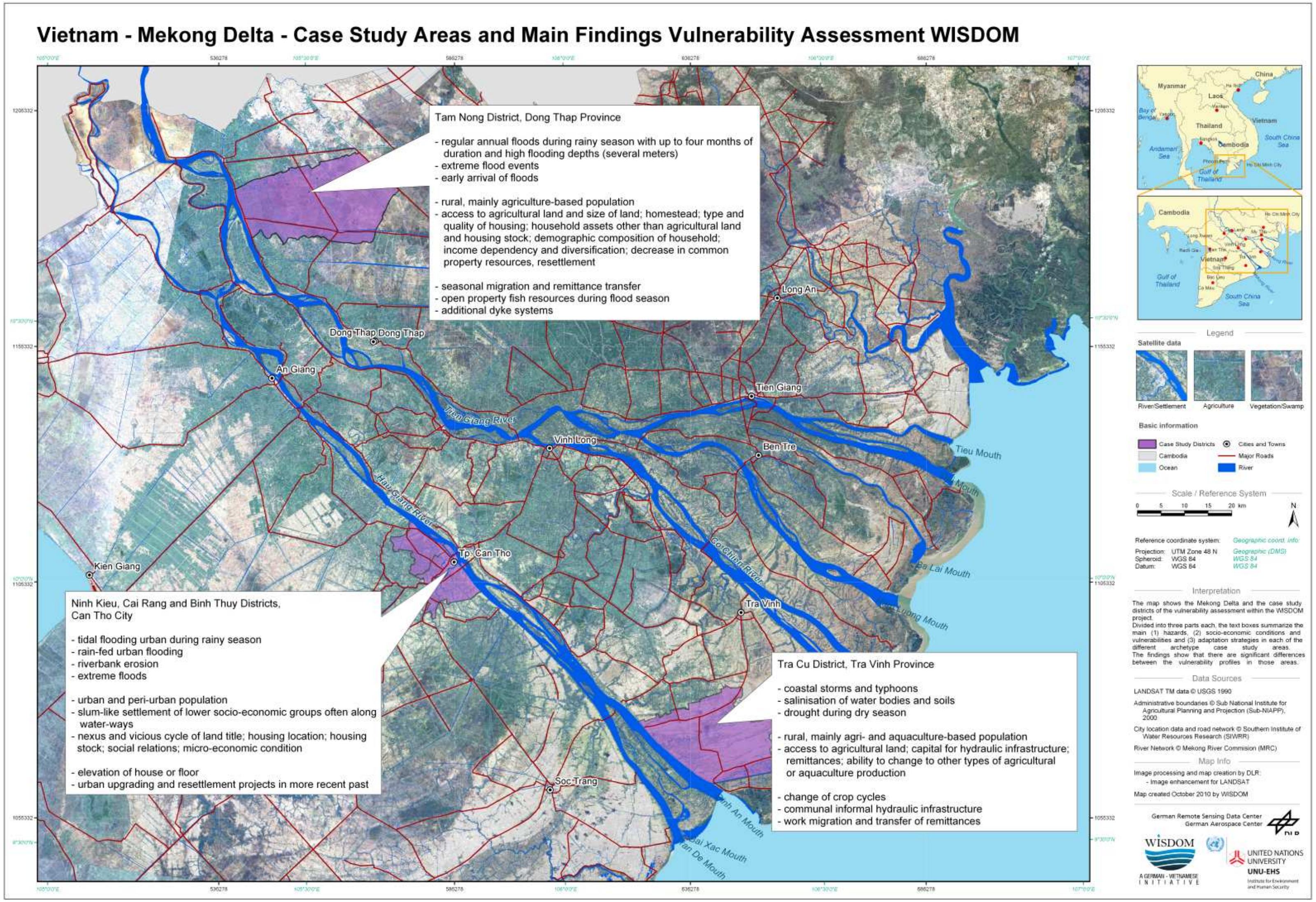


Source: Own draft based on Garschagen 2008, Mayring 2002; Lamnek 2005; Hamhaber 2004

Case Study Areas and Vulnerability Profiles

The vulnerability assessment within WISDOM comprises three different case study areas along the Hau River. This enables us to draw comparisons with respect to vulnerabilities at community and household level along the lines of different hazard patterns as well as different socio-economic conditions. Figure 6 shows the location of the different case study areas in the Delta. The detailed description and analysis of each of the locations is then given in the respective sections below.

Figure 6 the three study sites in Vietnam



Source: own draft Garschagen 2010

Dong Thap

by Tuan Vo Van

Role of the study area within the wider vulnerability assessment

The research sites are located in both inland and river bank areas in the flooding region in Dong Thap province. This province is severely affected by acid sulphate soils which have been leached by flood water (Le Quang Minh et al., 1997). Rice is the main crop, accounting for 94.3 % of planted area of the annual crops (Dong Thap Statistical Office, 2008). Double rice cropping is the most popular farming system, and triple rice cropping has become the norm in the fully-protected areas in the downstream districts of Dong Thap province.

In the Vietnamese Mekong Delta (VMD), annual floods have existed for thousands of years along the main stream of the Mekong River, which originates from the Tibetan Plateau in China and passes through Myanmar, Thailand, Laos, Cambodia and Vietnam to the East Sea. They occur slowly from late July through December, peaking in the late September or mid October due to the Great Lake in Cambodia which is a large natural retention area. The flooded area accounts for 53.3% of the natural area and over 50% of the delta's population. Flooding levels vary from 0.5 to 4 meters in the upper and middle parts of the delta. Flood depth increase or decrease per day is between 5 to 7 cm during normal floods and 10 to 20 cm during big floods (Tran Nhu Hoi, 2005). The flooding depths from 4.5 to over 5 m, measured by Tan Chau Gauging Station located in the Upper VMD, are classified as big floods, which cause serious economic problems and human fatalities (Figures 8-12).

The history of the VMD indicates that its society is heavily shaped by the use of natural resources and water (Miller, 2003). The Vietnamese pioneers in the 17th and 18th century mainly settled in places with high elevation along natural rivers. Later, poor landless households migrated formally and informally into the area and had to find new livelihood opportunities in the floodplains through fishing and obtaining agricultural land as most of the elevated land along the rivers was already taken. Consequently, they are confronted with flood risks while earning their livelihoods. The differences of the migration periods and settlement patterns have indicated the changes and differences in flood coping and adaptation capacity.

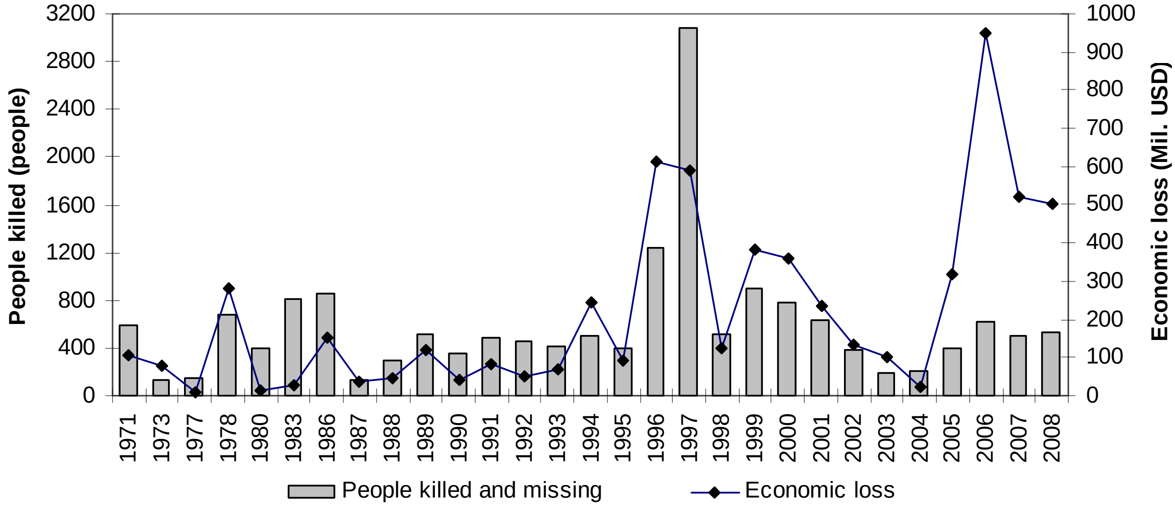
Given the above, a case study was selected in Dong Thap, one of three provinces most prone to floods, and thus serving as a representative site in the Upper VMD. It allows comparing flood vulnerability and response strategies to the other case studies across the delta in Can Tho and Tra Vinh. Access to land as well as ability to migrate are major response strategies in floodplains and are understood through the juxtaposition with the hazard and socio-economic context in the other case study areas. The case study of Dong Thap also indicates that formal interventions (relocation and construction of embankments) have influenced rural livelihoods of different socio-economic groups. In order to achieve these purposes, 370 households were investigated through standardized questionnaires, of which the surveyed households located in the floodplain (rice fields), along local roads, in the residential cluster, and in the residential dyke were 81, 169, 41 and 79, respectively.

Past hazards

Floods are natural phenomena, but extraordinary big floods cause serious problems for infrastructure, crops and human lives (Figures 8-12). The big floods are caused simultaneously by the combination of large upstream discharge affected by tropical typhoons or low atmospheric pressures, long and heavy rainfall in the delta itself and high tidal levels in the canals and rivers reducing their drainage capacity (Tran Thanh Be et al., 2007). The recorded big floods in the last four decades seem to be increasing in frequency, -- particularly for the years 1961, 1966, 1978, 1984, 1991, 1994, 1995, 1996, 2000, 2001 and 2002 are to be mention (Fig. 3). Since 2003, flooding depths have decreased; however, big floods may cause high damages after series of small floods because of decrease in flood preparedness due the decrease in "normal" flooding and related experience. In the Upper VMD, the flooding depths are not much different; however, damage levels are significantly different if flooding depths increase several decimetres given the flat form and low-laying of the delta (Figures 10-12). According to relations identified in statistical analysis of past flooding events, significant economic problems and human fatalities are associated with flooding depths exceeding 4.5 metres, which has become the threshold height of a flood hazard given the long history of annual floods in this area.

Past losses

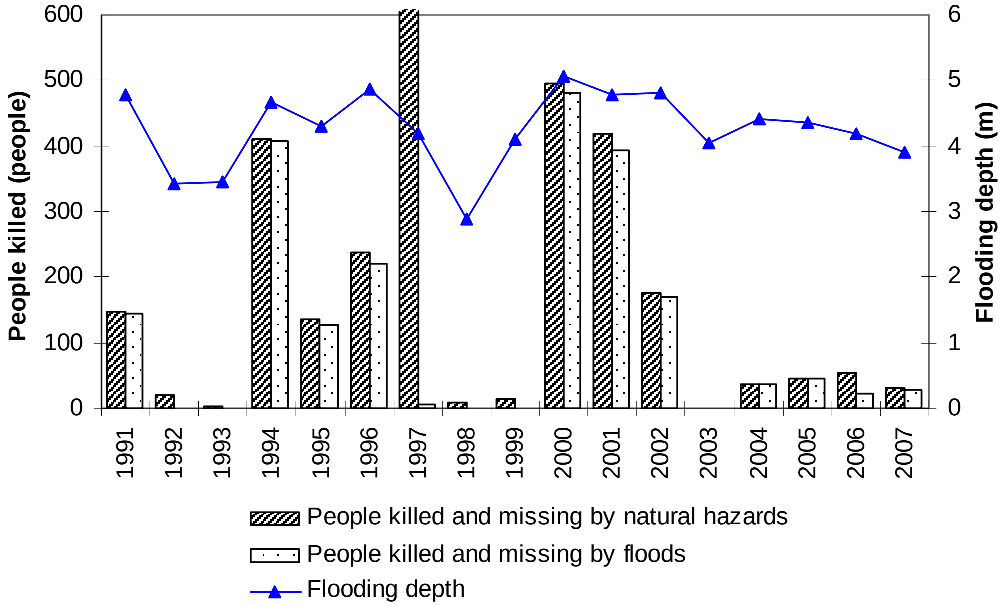
Figure 7 People killed and economic loss by natural hazards in Vietnam (1988-2008)



(Source: Author, data from CCSFC, 1989-2008)
(Economic loss was converted into the value of the Year 2000, USD/VND=14,177)

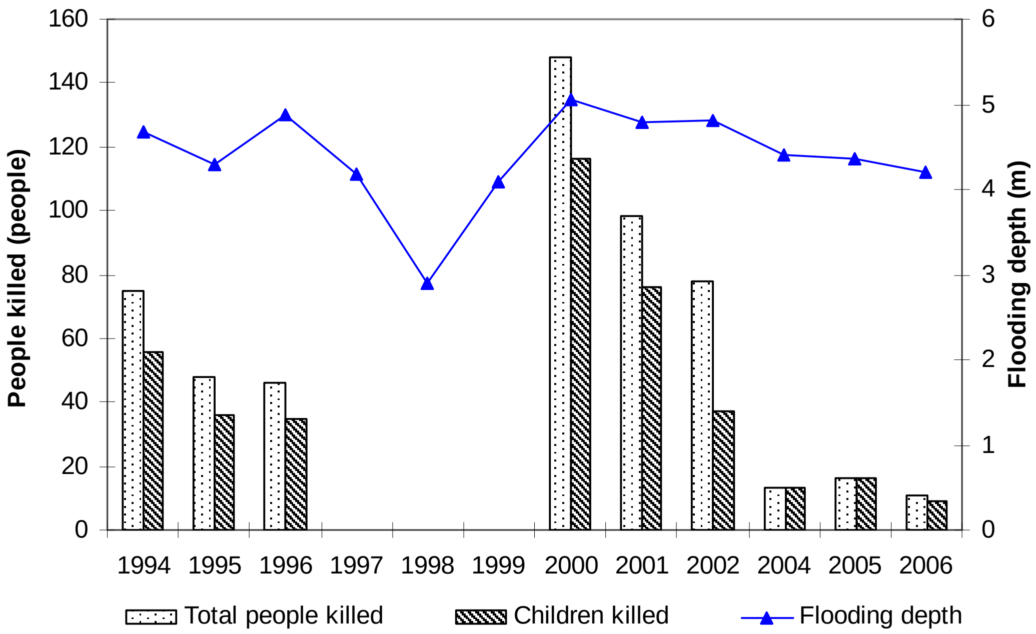
Vietnam has for a long time been exposed to high fatalities caused by natural hazards, in which flooding kill one third of exposed victims (Figure 7). Recently, while the number of people missing and killed by hazards is not changing much, economic loss has been significantly increasing (Figure 7). In the upper VMD, flooding is considered as a major natural hazard so that almost all hazard victims and damages were caused by annual slow-onset floods. Children under six suffered the highest fatalities, accounting for 74 % of total victims (Figure 9). According to Dong Thap CSFC staff, almost all children drowning occurred in poor households and at night time when the children crawled and fell into the water while their parents were sleeping. During flooding, poor children were not sufficiently protected by adults since their parents and adult members usually worked in floodplains.

Figure 8 People killed and missing by natural hazards and floods in the Mekong Delta



(Source: Author, data from CCSFC, Dong Thap CSFC 1990-2006)
(People killed and missing by natural hazards in 1997 was 2,244)

Figure 9 People killed by floods in Dong Thap

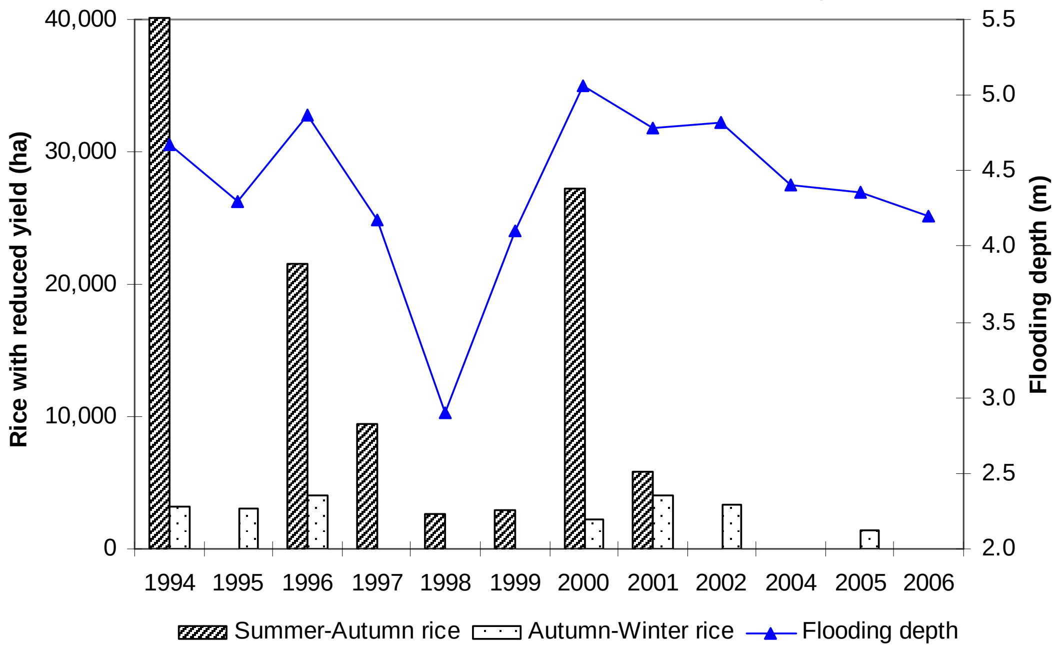


(Source: Author, data from Dong Thap CSFC 1994-2006)

Main economic losses due to floods in the upper VMD are related to crop loss, and destruction of houses and infrastructure. A double rice crop is the major farming system in the flood-prone areas. The second crop, Summer-Autumn rice, is harvested at the beginning of the flooding season, usually in May or June. Therefore, there have in the past been large areas of Summer-Autumn rice destroyed or reduced in yield due to early floods. In order to protect Summer-Autumn rice and develop Autumn-Winter rice, semi- and fully-protected dyke systems have been constructed by the government. Since the third rice crop, the Autumn-Winter rice crop, has been introduced in the fully-protected area, this season is characterized by high risk of being damaged (Figures 10-11).

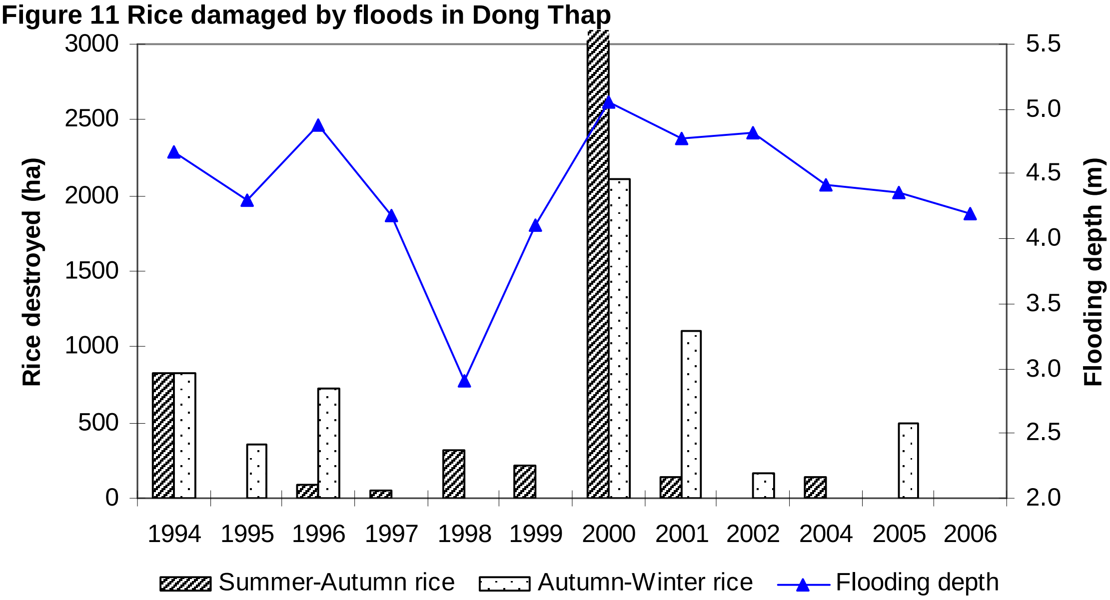
In the rural delta, temporary houses are still the norm, accounting for approximately 60% of poor households. These houses are easily being destroyed or damaged particularly with respect to long duration of floods and high flood peaks (Figure 12). In brief, flood damages have reduced due to low flooding; however, elements vulnerable to floods may increase because of increase in economic activities and physical interventions. For instance, the planted areas of Autumn-Winter rice grown during the flooding season in Dong Thap have annually increased approximately 39% within the last decade (Dong Thap Statistical Book, 1998-2008), and embankments have been continuously constructed in floodplains.

Figure 10 Rice with reduced yield by floods in Dong Thap



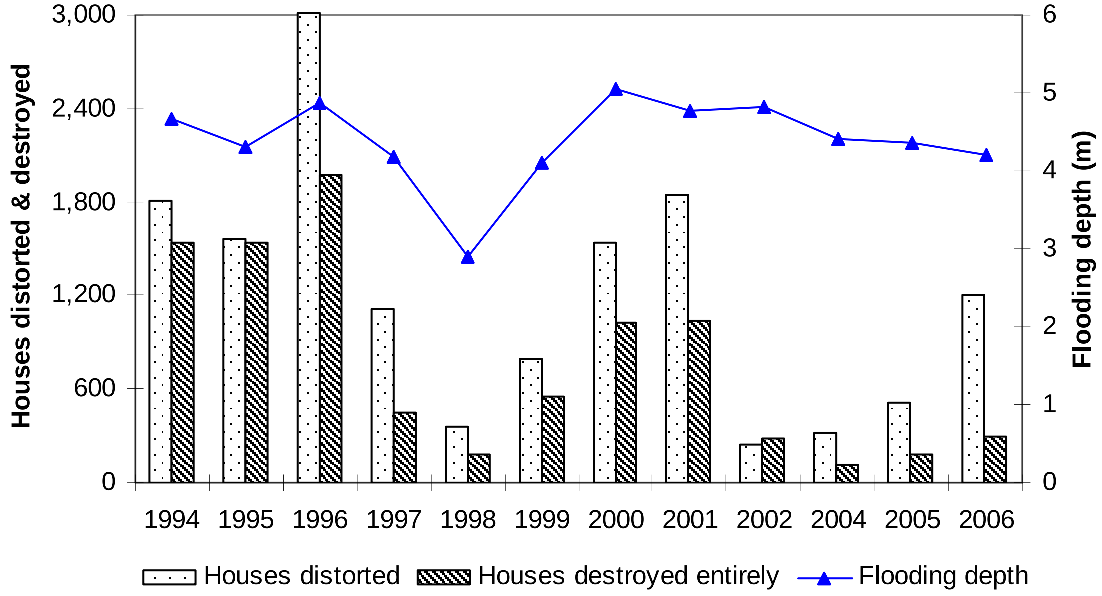
(Source: Author, data from Dong Thap CSFC 1994-2006)

Figure 11 Rice damaged by floods in Dong Thap



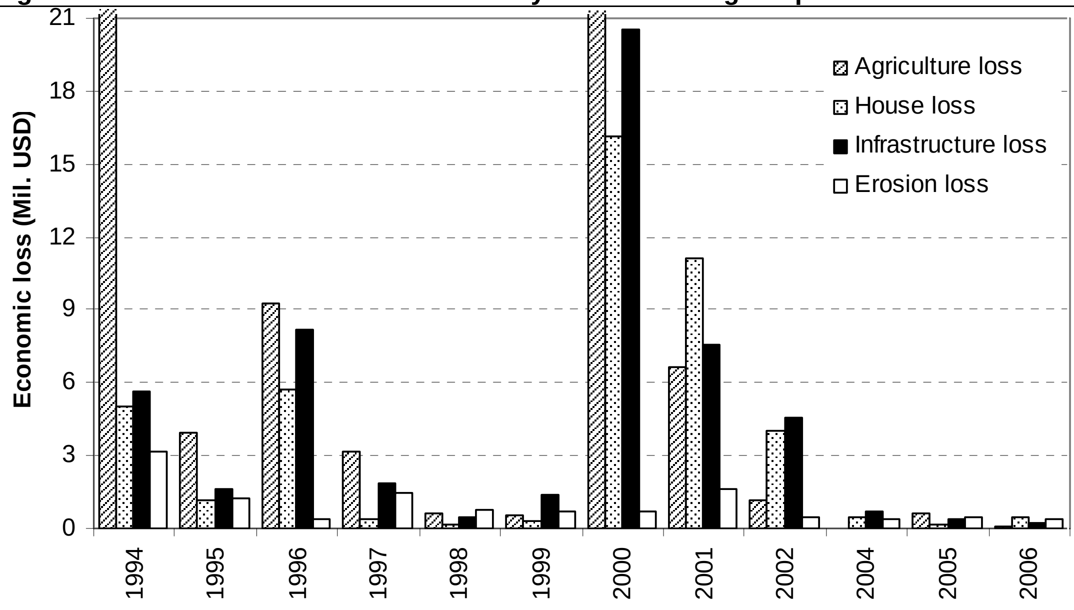
(Source: Author, data from Dong Thap CSFC 1994-2006)

Figure 12 Houses damaged and destroyed by floods in Dong Thap (1994-2006)



(Source: Author, data from Dong Thap CSFC, 1994-2006)

Figure 13 Total estimated economic loss by floods in Dong Thap



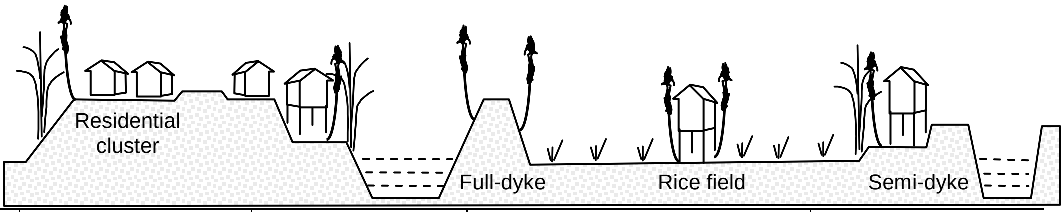
(Source: Author, data from Dong Thap CSFC 1994-2006)
(Economic loss was converted into the value in the year 2000, USD/VND=14,177)

Exposure to Floods

Exposure to different flooding levels

In the rural Plain of Reeds, people usually live in floodplains, either along low dykes, along high dykes or in elevated places as residential clusters or dykes (Figure 14). These patterns of settlements depend on their migration periods, wealth, land ownership or resettlement policy (Figure 14). Exposure levels to floods are changing regarding people's coping and adaptation. In the densely populated areas, other facilities such as electricity, tap water, elevated local roads, schools and markets are constructed by local governments. In Phu Hiep commune, the pioneers, who resettled in the 1960s, have located in the elevated places and been protected by trees surrounding their houses and high dykes (Figure 14).

Figure 14 Transect map of the inland site, Phu Hiep Commune (west-east direction)



Settlement periods	Relocated in 2003 from the floodplain, shaped by the relocation policy	Resettled in the 1960s, forced by the former government	Informally resettled in the 1990s, attracted by obtaining agricultural land and flood-related resources	Informally resettled in the 1980s, attracted by obtaining agricultural land
Basic infrastructure	Electricity, tap-water, schools, market, transportation	Electricity, tap-water, schools, market, transportation	lacks of access to basic infrastructure	Electricity, schools

(Source: Author, Transect Walk in Phu Hiep commune, 2008)

People who live in floodplains are strongly exposed to floods. Their houses are directly exposed to flooding right from the early phase of the flooding season. They live far from elevated roads and densely populated areas so that they often lack access to basic infrastructure (electricity, tap-water, elevated roads, schools and markets). In the flooding season, they travel by boat which constrains them and their children in their access to basic services like schooling. In addition, approximately 61% of poor households still live in temporary houses which are easily damaged by strong floods. It is difficult for them to evacuate to high places or be supported by community since they live far from the densely populated areas and lack transportation means (e.g. motorized boat).

People who live along low dykes are affected at medium flooding. These households also lack access to several basic infrastructures, including electricity, tap-water and schools. Their houses are easily affected by floods and strong winds. These households have been constrained for evacuation since their houses are far from densely populated areas, and local roads are inundated. In contrast, people who live along elevated roads can escape directly from floods. Their houses are protected by high dykes and trees. They easily move to elevated roads if their houses are destroyed by strong winds. However, according to focus group discussions in Phu Hiep in 2009, these people have struggled with transportation problems as their house are linked with elevated roads and dense vehicle movements.

People who live in residential clusters or residential dykes are not affected directly by floods, but they have encountered other constraints regarding the changes in their living styles and livelihood activities. Before resettlement, most of them were poor people with no residential land and high exposure to flooding. These relocated households were accepted to access subsidized house foundations and house frames, which would be paid through the installments within 10 years.

Exposure to floods due to different land ownership

Land ownership is one of important factors enabling inhabitants to achieve rural livelihood outcomes. From the social and economic crises of 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). Households were considered as autonomous and independent economic units, and they were distributed agricultural land. When the collective system was dismantled in 1988, and the land law was reformed in 1993 (continuously modified in 1998 and 2003), farm households had the right to use their land in the long-term and could transfer, exchange, lease, inherit or mortgage.

Exposure to floods differs along the lines of land ownership. There is significant high correlation between wealth, classified by wealth ranking exercises by local people, and agricultural land ownership in the research site (Pearson correlation=0.688**). Land ownership shapes rural livelihood activities. Landless people earn main income from off-farm activities such as fishing and off-farm wage activities which normally only cover their daily costs of living. Therefore, they must find flood-related activities in the risky flooding condition. Moreover, during flooding events, children in landless households are inadequately supervised by others given that their parents and other adult family members are usually working in the floodplains. Recently, since flood-related resources decline quickly, and off-farm wage activities become more important seasonally, landless people have tried to shift into other income-earning activities, in which remittance as main household income increased 15% within the last decade (household survey, 2009).

Land owners usually earn their main income from crop production (household survey, 2009). Exposure to floods depends on their cropping patterns which have been changing due to both formal and informal measures. Major crops exposed to floods have been changing from the floating rice before the 1980s to Summer-Autumn rice in 1999 and Autumn-Winter rice after the 2000s due to the changes in rice-based farming systems and embankments. In reality, large planted areas of Summer-Autumn and Autumn-Winter rice crops were destroyed or reduced in yield by big floods in the past (Figure 11).

Susceptibility or Sensitivity

Susceptibility / sensitivity, as one component of vulnerability according to the framework of Turner et al. (2003), indicates that exposed coupled human-environmental systems, have also a different degree of sensitivity or susceptibility to the impacts of the respective hazard. In the slow-onset flood context in the upper VMD, sensitivity to floods at household level is 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 sensitivity or susceptibility. Landless households have been constrained in accessing formal loans and implementing livelihood diversification. They were dependent on the susceptible flood-related resources, open assets, which decline quickly through the increase in dyke systems, agrochemical use and illegal exploitation. Lack of access to residential land have impeded flood-affected people to deploy response strategies like housing improvement.

As a large percentage of the rural population relies on agriculture, particularly rice cultivation, the lack of access to agricultural land has essential influence on rural livelihoods. Landless households have been constrained in accessing formal loans and implementing livelihood diversification. They were depended on flood-related resources, in the form of open access resources, which now decline quickly through the increase in dyke systems, application of agrochemicals use and illegal exploitation. Lack of access to residential land have impeded flood-affected people to deploy response strategies like housing improvement.

Recently, inhabitants have gradually shifted into other livelihood activities like urban non-farm activities; however, it is difficult for the poor to access other livelihood activities. Rural people have human-related constraints (low educational grades, poor health and out of potential labor age), poor access to financial mechanism and no agricultural land. According to household survey in 2009, mainly young laborers (16-35), accounting 96% of urban migrants, can find low-skilled jobs in urban areas. However, the fact that remittances are small has constrained migrant laborers to reinvest or contribute to flood response capacity in the rural areas.

Coping and adaptation

Coping

As mentioned in the introduction, coping with hazards particularly floods is considered as a short-term activity in order to minimize the damage or impact within an acute disaster situation (Birkmann, 2009). First of all, people apply a series of coping strategies just before and during flooding in order to improve their general condition for living in order to cope with flood impacts. They increase the stability of the house through installing supportive wires just before floods. In addition, they build grass fences to break waves and remove several planks of the floor in order to prevent them from destruction by flood waves, and then gradually lift up their house floor regarding increase in flooding depth. Secondly, flood-related livelihood is considered as an important issue for flood-affected people particularly the poor. Floods provide both advantages and disadvantages; therefore, people conduct flood-related activities, especially fishing during flooding. Flood-related products provide food not only for the flooding season but also for the dry season due to processed products (dried fish, fish sauce and salted fish). Third, protecting dependants, especially children, is paid much attention to by flood-affected people. Fishermen assign adult members to take care of their children and the elderly, or children are with them in the floodplains. They improve wooden fence to protect children from floods and prepare home-made lifebuoys while fishing. The wives in poor households often try to access and prepare food and medicine during the flooding periods. Normally they borrow money from private money lenders at high interest rates.

Besides informal coping, a series of formal coping activities are implemented by the Committee for Floods and Storm Control. This institution is organized at all administrative levels and includes various departments. In big floods, children can be protected at daycare centers, which are organized at local people's houses in densely populated areas. It is sometimes marginalized children particularly poor children living in low populated places. During early floods or dyke breakage, the army is drafted in to help farmers to harvest crops or protect dyke systems. In addition, relief is quickly deployed in flood-prone areas. Relief funds are mobilized from informal and formal sources, in which local resources, mobilized through "four pillars in site" principal including command, manpower, means and materials at the grassroot level. When flood disasters occur, severe flood-affected houses are compulsorily evacuated.

Table 3 Coping patterns and adaptation strategies in the Upper Vietnamese Mekong Delta

Coping patterns	Adaptation Strategies
1. Informal coping patterns	**1. Informal adaptation strategies**
1) Adjusting housing condition - support house with wires just before floods - build grass fence at low floods - remove several planks of house at low floods - lift up house floor regarding flooding - evacuate when houses are strongly flooded	1) Improving housing condition - gradually elevate homestead - grow trees or bushes surrounding homestead - build wooden stilt houses - improve good wooden or concrete stilt houses
2) Coping with livelihood disruption - small-scale fishing - collect flood-related vegetables - sell or give up agriculture just before floods - seasonally migrate for remittance	2) Improving flood-related livelihoods - large-scale fishing - cultivate flood-related agriculture (snakehead fish, freshwater prawn and vegetables) - build high or solid cages - learn flood-related knowledge and experiences
3) Protecting dependents or people - prepare children protection facilities - take children along for fishing or travelling - prepare man-made life saving devices	3) Living with floods - improve housing condition and physical assets - assign adults to take care of children - informally relocate along elevated roads - train children to swim
2. Formal coping patterns	**2. Formal Adaptation strategies**
1) Mitigating agricultural damage - army to help famers harvest crops - army to protect dyke - subsidize agro-materials	1) Protecting agriculture - construct semi- and fully embankments
2) Protecting people's life - organize evacuation flood-affected households - organize child daycare centers - adjust schooling time	2) Implementing flood risk management - relocate flood-affected households - provide swimming training for pupils
3) Coping with livelihood disruption - provide basic needs (foods, medicine, clothes) - provide fishing tools (boats, nets, hooks)	3) improving rural livelihoods - provide credits for flood-related agriculture - train short-term occupations -

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

Adaptation

Adaptation to floods is considered as a long-term strategy and associated with learning either before or after an extreme event occur (Birkmann, 2009). Both informal and formal adaptation strategies are used to adapt to slow-onset floods. Informal adaptation strategies include improvement of housing condition, flood-related livelihood adaptation and flood-related knowledge accumulation. Better-off people, who have had relative livelihood resources and access to livelihoods assets, have usually applied adaptation strategies. In contrast, the poor often implement a series of coping activities. First of all, people have gradually improved their condition for living regarding homestead elevation, planting (Son Nam, 1992), concrete housing construction and physical household asset enhancement. Second, people have implemented their flood-based livelihoods (flood-related agriculture, crop calendar adjustment, migration) in order to adapt to livelihood disruptions. Third, people have learned and disseminated flood-related knowledge. They learned how to improve living conditions, how to adapt to floods and how to earn flood-related benefits.

Several formal adaptation strategies are applied in the flood-prone areas, in which the embankment and relocation are predominant. Dyke construction has been popularly implemented in the 1990s and 2000s. Those dyke systems aim at protecting Summer-Autumn crops and develop Autumn-Winter crops within the fully-protected dykes. Regarding dyke systems, farmers have adjusted their seasonal crop calendars which protect Summer-Autumn crops from floods. However, dyke systems have created the strong seasonality of crop cultivation and constrained flood-related resource development. It has contributed to decrease in both off-farm income and flood-related activities. In fact, there are different perceptions relating to dyke system construction regarding varying land ownership and flood-related income dependency. Landless people would like to take flood-related benefits without embankments while land owners want to rely on rice crop cultivation with dyke systems.

Relocating landless households prone to floods has been implemented in the VMD after the historic 2000 flood, based on the 1548/2001/QD-TTg Decision. In the rural Plain of Reeds, normally one or two residential clusters or dykes were constructed in each commune. The resettled households escaped from direct flood impacts; however, after resettlement, these households struggled with lacks of basic infrastructure, high daily costs of living, loss of social networks and business contacts and livelihood activity disruption. Gradually, these constraints have been resolved through formally improving basic infrastructure and informally establishing off-farm wage labor teams in order to compete with wage labor outsiders. Currently, both the demand for off-farm activities in the residential clusters or dykes and the decline in flood-related resources in floodplains have attracted poor households, who refused to be resettled in residential places in the 2000s, to be relocated (focus group discussions with poor groups in Phu Hiep in 2008). However, almost all middle and better-off people don’t like to live in the residential clusters since it is narrow, noisy and costly.

Can Tho City: Vulnerability to Current and Future Floods and Typhoons in Urban and Peri-Urban Areas

by Matthias Garschagen

Role of the study area within the wider vulnerability assessment

Climate change adaptation and responding to natural hazards within cities is not an entirely new field of research but should – for good reasons – receive increased attention (Birkmann et al. 2010). Living in a heavily urbanising world (in particular with heavily urbanising countries like Vietnam), cities increasingly become places of accumulated risk to natural hazards, while at the same time creating specifically urban vulnerabilities and development challenges (c.f. Pelling 2003; Birkmann et al. 2010). In Vietnam, the strong urbanisation of the past decade and the expected intensification in future urbanisation processes, coupled with challenges resulting from wider socio-economic and political transformation affecting the resilience particularly of poor urban dwellers, calls for in-depth case study research to explore the details of vulnerability pathways and adaptation potentials of an increasing share of the Vietnamese society.

Comprising the largest urban centre south of HCMC, Can Tho City constitutes the demographic and economic centre of the Mekong Delta. The recently upgraded class I city is undergoing rapid change and growth as it is earmarked to solidify its leading position as trade and production hub for the entire delta. Playing this role, the city hosts key functions for social and economic systems at the wider Delta scale, for example, with respect to health infrastructure, head-offices of companies, research institutions or as hub for seasonal or permanent migration and the generation of remittances.

Owing to the rapid urbanisation and transformation processes that can be observed in Can Tho over the last decades and that are expected to even intensify in future, the city is increasingly characterised by social stratification and fragmentation resulting, for instance, from forced resettlement, rocketing land prices, modifications to social security networks or labour migration. Disparities with respect to short-term coping as well as long-term adaptation capacities to water-related hazards and in particular to future hazards expected in the context of climate change are therefore on the rise between different population groups in the city and the wider social networks that members of those groups may support beyond the borders of Can Tho City.

In summary, the case study of Can Tho City contributes to the general goal of the vulnerability assessment within WISDOM to compare vulnerability, coping and adaptation patterns along the lines of different socio-economic groups as well as different hazard profiles represented in the Delta. The Can Tho City case study region adds the urban and peri-urban focus to this exercise as well as, in terms of the hazard pattern, an area that has not yet experienced drastic hazards in the past but will be affected heavily in future due to climate change impacts.

Past Hazards

One key characteristic of the case study area Can Tho City – in contrast to Tra Vinh and Dong Thap – is that the urban areas of Can Tho have in the past experienced comparatively few and mild natural hazards. While the northern, rural districts of Can Tho City are affected regularly by flooding during the rainy season, the urban districts in the south are just beyond the extent of common seasonal flooding. This means that the urban areas of Can Tho are (so far) not facing extended flooding with substantial flooding depths during the rainy season.

However, many parts of the city are subject to tidal flooding during those months, meaning that streets and houses can be flooded up to 80cm for several hours – particularly during the monthly tide peaks towards the end and middle of the lunar month. This tidal flooding, however, often implies substantial problems for the affected households, businesses or infrastructure elements (compare “coping and adaptation”).

Figure 15 Tidal Flooding in Can Tho City

Source: M. Garschagen 2009

Figure 16 Tidal Flooding in Street in Can Tho City

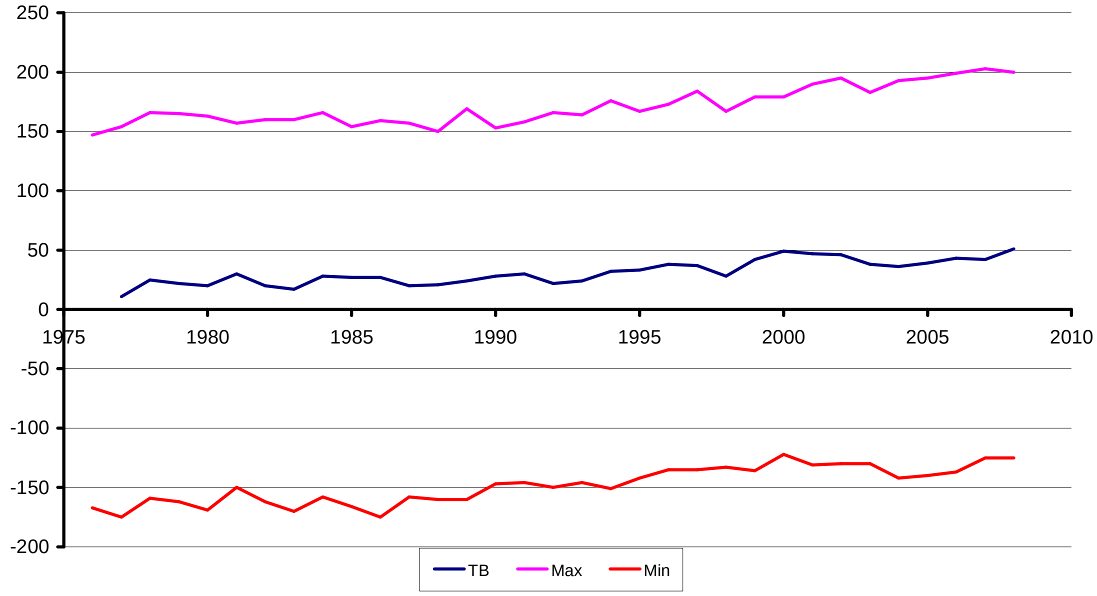
Source: M. Garschagen 2009

Hazard Exposure

Apart from the existing hazard of tidal flooding, Can Tho City is projected to be highly exposed to several climate change related hazards in future, making it an interesting case study for exploring how a dynamically growing city is dealing with the challenge of adapting to future (and new) hazards. Those climate change related hazards comprise slow-onset progressive hazards such as sea level rise, an expected increase in annual river-based flooding or changes in temperature patterns as well as rather irregular hazards such as most importantly typhoons and smaller storms, other events of heavy precipitation, rising variability in precipitation and storm surges. Very importantly, those hazards are likely to occur in combination under conditions of climate change, leading to multi-hazard situations in which impacts can overlay into complex hazard situations. Resulting from this combination of hazards and the risk of concurrent multi-hazard phenomena, is a complex mix of potential secondary hazards concurring with direct and indirect impacts of the hazard listed above. Given the complex mix of land uses and the particularities of an urban and peri-urban environment, the range of those secondary hazards is very wide, ranging from, for example, urban flooding, spread of water- or vector-borne diseases in slum areas with insufficient draining and sewerage, increased river bank erosion and the consecutive collapse of buildings and other infrastructure, but also soil and water salinisation, the lack of freshwater resources or heat-related health problems in quarters with bad ventilation.

Interestingly, the frequency and intensity of tidal flooding in the city has been increasing over the last years which has to be seen in relation to a rising trend in maximum levels in Can Tho's Hau River (one of the main branches of the Mekong) (compare Figure 17).

Figure 17: Water levels in Hau River

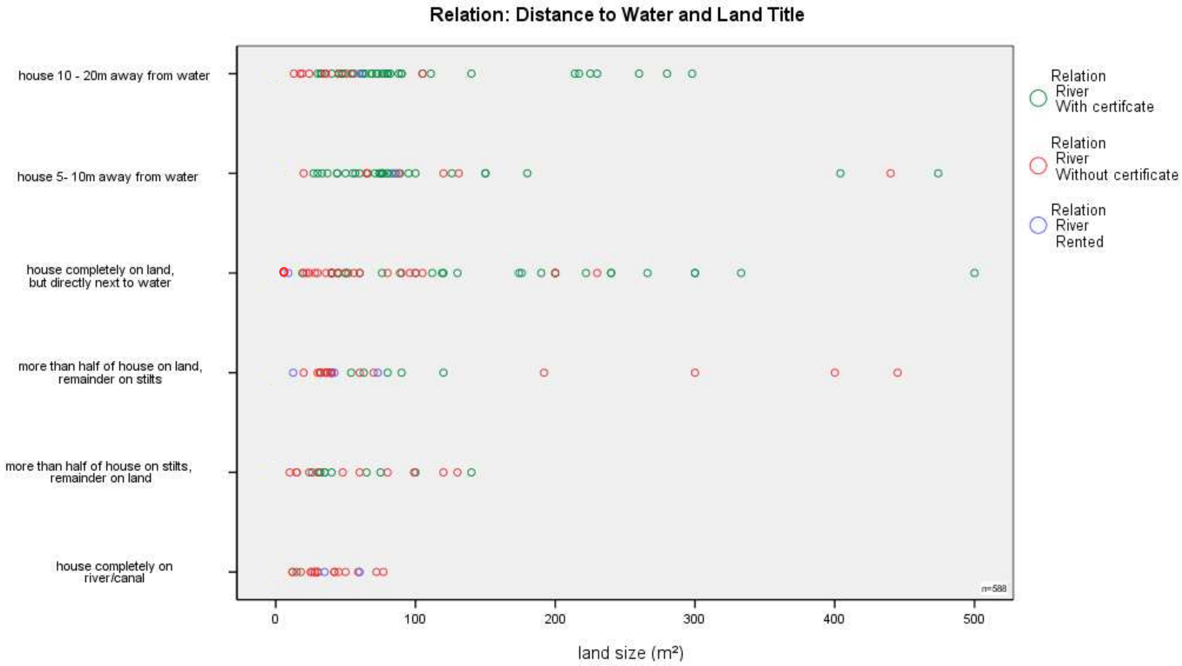


Source: DONRE CTC 2009

The reasons for this increase in the river's water levels are not yet entirely clear and are contested in the scientific as well as – particularly – political arena. Amongst the reasons most prominently stated are climate change, land subsidence in Can Tho City, but most importantly hydraulic infrastructure upstream in the Mekong Delta (in particular embankments and other dyke constructions in Dong Thap and An Giang that block off former retention areas and channel more water downstream) as well as dams in riparian countries upstream. As precise assessment exercises, e.g. on the basis of hydrological modelling, are lacking so far, the precise contribution of each of these factors is hard to assess. However, according to prevalent expert opinion in Vietnam, the two latter reasons are by far the most important to describe the trends of rising water levels of the last decades.
Regardless of the precise reason for this trend, it allows for an interesting analysis with respect to future climate change hazards and the related vulnerability and adaptation: Based on the assumption that adaptation to climate change related hazards will draw to big parts on strategies and mechanisms that have earlier been applied in other context settings, the situation of rising water levels in Hau River over the last decades and the analysis of adaptation patterns to this change, allows for generating lessons learned with respect to the adaptive capacities to certain climate change hazards such as sea level rise or the increase in urban flooding.

Within Can Tho, the nexus of physical exposure with the susceptibility elements of socio-economic status and land title could be identified as one of the major criteria for regulating socially stratified exposure to tidal flooding and river bank erosion. Figure 18 indicates that poorer socio-economic groups often have to live in slum-like housing (with limited space) which is close to or even on the water due to the fact that the households lack sufficient resources for acquiring land title and houses in less exposed areas further away from the water.

Figure 18: Correlation of physical exposure, land title and land size



Source: own draft Garschagen 2010

Coping

As indicated in the rationale for selecting the case study areas as well as in the introduction to the Can Tho case study and its hazard patterns, Can Tho has in the past been only exposed to a rather limited range of hazards with comparatively low intensity. Hence, the need for deploying coping mechanisms has been quite low in the past and experiences with coping are limited. However, certain coping responses can be observed with the respect to currently given hazards. These are detailed below.

Tidal Flooding particularly during rainy season

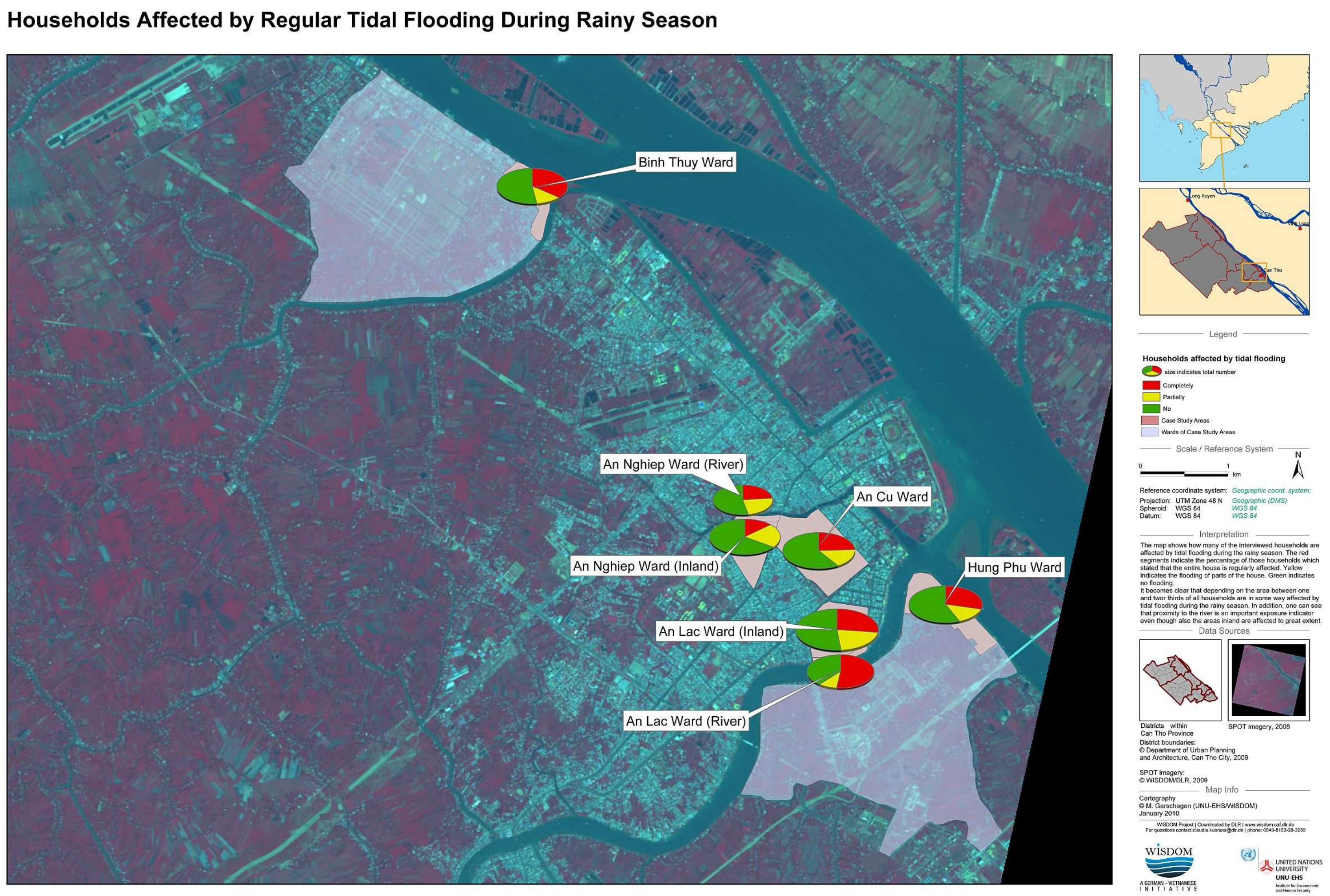
Households affected by tidal flooding (mainly during the rainy season) in Can Tho apply several coping measures in response to this hazard. In the absence of physical flood protection measures like dykes within the city, the most prominent strategy to prevent flood damage to furniture or appliances in the house is to elevate those assets for the time of expected or actual flooding, using bricks. In addition, many households have small-scale flood-prevention devices installed in their house, for example, in door-frames in order to protect at least some parts of the house from flooding.

In the peri-urban areas, small-scale dyke systems (i.e. earth dykes of up to 1m height) are quite common which protect a number of households that are located close together. The maintenance of those dyke systems is usually supervised by the local People's Committee at ward level in the sense that the local officer or group leader has to arrange the workforce required for the maintenance of the dyke or for necessary top-ups. This work is usually implemented before the advent of the rainy season and is conducted by household members (usually men) of the households located within the embanked area.

In some cases, household members reported that they evacuate children when they expect the highest flood peaks (in the middle and end of the lunar calendar). This in particular true if the flood peak is expected to be reached at night time, meaning that infants and small children who have to sleep on the floor are at particular risk of being affected. In those cases, children and infants have been reported to be sent to relatives in less exposed, i.e. less flood-prone, areas.

The above-mentioned case already hints towards the fact that the number of floors a household has available has great influence on the range of possible coping measures with respect to vertical evacuation of people and physical assets. In general, poorer and lower middle-class households – often living in slum-like housing conditions without land certificate – do in most cases not have sufficient resources to build houses with more than a ground floor and can, hence, not revert to vertical evacuation of temporary relocation of assets within their own house. But even for those households that do have several floors, vertical evacuation is only of limited feasibility as many assets cannot be easily moved to the first floor (kitchen appliances, gas cookers, motorbikes etc.). However, it has to be mentioned that these households usually have a much smaller physical exposure per se (see Figure 19) and, hence, experience way less flooding, even in the ground-floor.

Figure 19


Households Affected by Regular Tidal Flooding During Rainy Season
Binh Thuy Ward
An Nghiep Ward (River)
An Cu Ward
An Nghiep Ward (Inland)
Hung Phu Ward
An Lac Ward (Inland)
An Lac Ward (River)
Can Tho
Legend
Households affected by tidal flooding
size indicates total number
Completely
Partially
No
Case Study Areas
Wards of Case Study Areas
Scale / Reference System
0 1 km
N
Reference coordinate system: Geographic coord. system:
Projection: UTM Zone 48 N Geographic (DMS)
Spheroid: WGS 84 WGS 84
Datum: WGS 84 WGS 84
Interpretation
The map shows how many of the interviewed households are affected by tidal flooding during the rainy season. The red segments indicate the percentage of those households which stated that the entire house is regularly affected. Yellow indicates the flooding of parts of the house. Green indicates no flooding.
It becomes clear that depending on the area between one and twor thirds of all households are in some way affected by tidal flooding during the rainy season. In addition, one can see that proximity to the river is an important exposure indicator even though also the areas inland are affected to great extent.
Data Sources
Districts within Can Tho Province
SPOT imagery, 2008
District boundaries:
© Department of Urban Planning and Architecture, Can Tho City, 2009
SPOT imagery:
© WISDOM/DLR, 2009
Map Info
Cartography
© M. Garschagen (UNU-EHS/WISDOM)
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For questions contact:claudia.kuenzer@dlr.de | phone: 0049-8153-28-3280
WISDOM
A GERMAN - VIETNAMESE INITIATIVE
UNITED NATIONS UNIVERSITY
UNU-EHS
Institute for Environment and Human Security

Storms
Many households reported to evacuate their children when strong storms are expected. The most prominent places for evacuation in Can Tho are communal buildings like pagodas, temples, churches or schools. The evacuation does sometimes follow the warning issued by the local People's Committee officers; however, in most cases it rather seems to be triggered by storm warnings in the television. Evacuation durations are usually quite short and have not been observed to last longer than 24 hours.
In addition, many households – in particular those with a poor or provisional housing stock – do prepare their homes when storms are expected in order to prevent damage. In particular provisional roofs made of banana leaves or corrugated metal sheets are in those cases secured with additional wooden elements, tightened with ropes or supported with additional ballast through e.g. sand bags or old motorbike tires.

Committee for Flood and Storm Control
Like all other province and districts in Vietnam, also Can Tho and the case study districts of Ninh Kieu, Binh Thuy and Cai Rang have committees for flood and storm control in place (CFSC) which are in charge or organising the disaster preparation, response and recovery. However, given the low disaster profile in those districts to date, the action required by this committee and the implementing bodies of disaster management (mainly the local People's Committees, Fatherland's Front, military, police) was comparatively little. Nevertheless, in cases of smaller disasters, the committee organises the support for affected households. For the case study areas those are mainly households whose house has been affected or destroyed by river bank erosion.
In addition, the CSFC organises trainings for local officers of the People's Committees and other organs in order to prepare teach and practise response measures for the case of larger disasters.

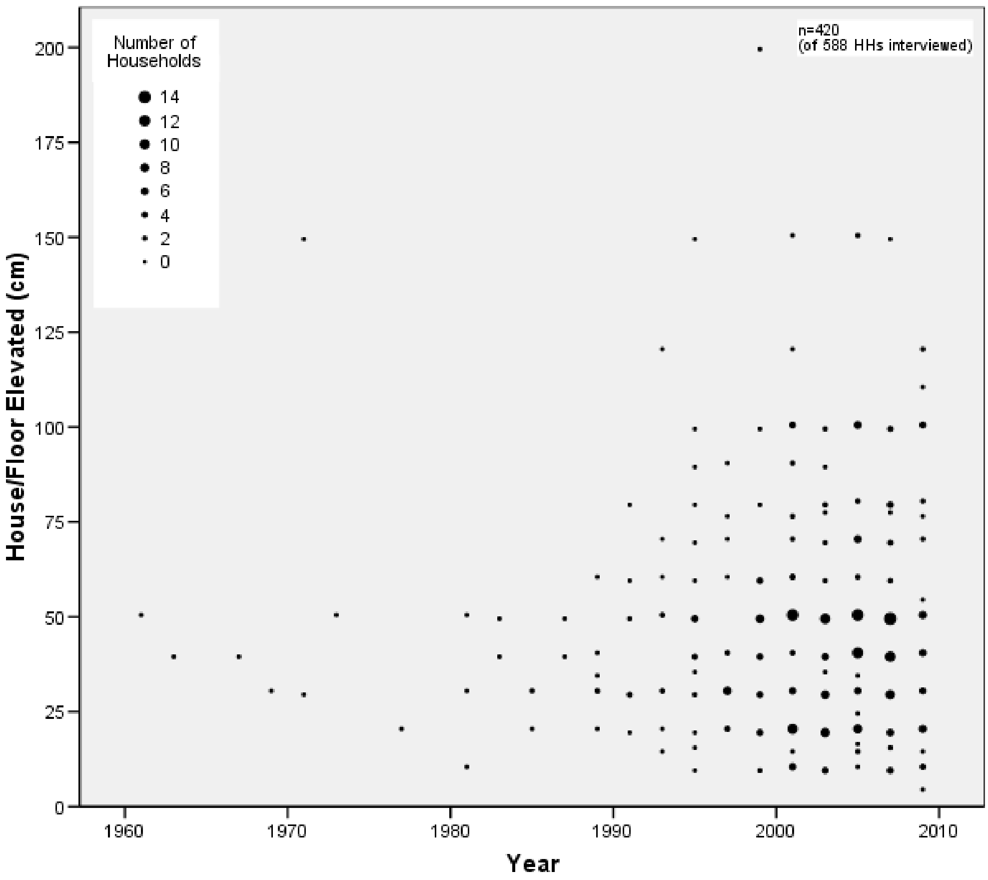
Adaptation

Tidal Flooding
With respect to longer-term structural adaptation measures, adjustments to the housing stock is the most important adaptation that can be observed. Due to the overall rise in water levels and intensity as well as frequency in flooding events, many households have been observed to elevate their house or parts of their house in order to mitigate flooding exposure. Of 588 households, interviewed in flood-exposed areas within Ninh Kieu, Cai Rang and Binh Thuy in 2009, 71% reported that they have elevated their floor or parts of their floor at least once over the last 50 years. In general, two trends could be identified in this context: First, the number of households elevating their floor or house has been increasing over the last years. Second, the amplitude of elevation is increasing (compare figure 20). Besides the trend of increasing flood levels and frequencies, this development is surely also influenced by the fact that the absolute number of residents in Can Tho is increasing and that the general socio-economic development over the last years, enables more households to accumulate the necessary resources to implement such adaptation measures.
With respect to financing and implementing those measures, figures 21 and 22 show that the single households are by far the most important actors for initiating such adaptation measures and that support by the local governments or the government-related organisations such as the Fatherland's Front does only play a very limited role in supporting households in need of such adaptation. Preliminary analysis reveals that this is also and in particular true for poor households which have major difficulties in financing those physical adaptation options.

River Bank Erosion
Households located directly along rivers or canals in Can Tho are often affected by river bank erosion, eroding also the foundations of the house of the sediments at the shores that stilts are build into. As a result, the affected households have been observed to be under constant pressure to maintain or rebuild parts of their house, meaning in particular erosion protection walls and/or stilts. Figure 25 illustrates some rebuilding efforts triggered by river bank erosion (here in combination with a vertical elevation due to rising water levels). Depending on the available resources of the households, the

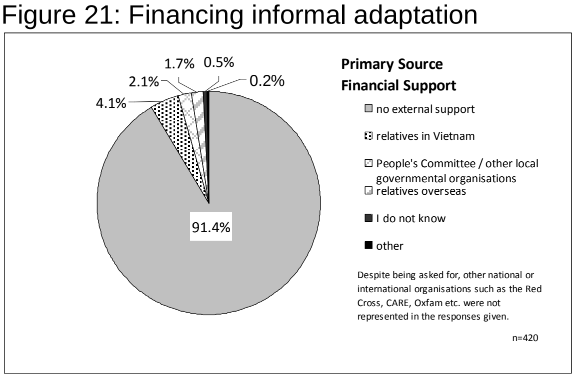
rebuilding is either done by hired workforce or mainly by household members with the support of relatives, neighbours and friends who share this type of labour force support in a reciprocal manner. The building material used, was reported to be mainly of low quality such as second-choice bamboo poles or sand and gravel which is collected from construction sites.

Figure 20: House and/or floor elevation as adaptation option



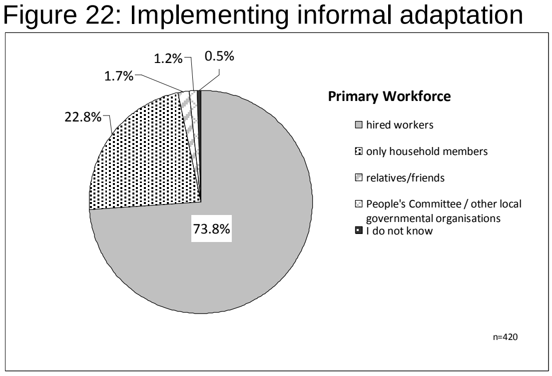
Source: Garschagen 2009

Figure 21: Financing informal adaptation



Source: Garschagen 2009

Figure 22: Implementing informal adaptation



Source: Garschagen 2009

Figure 23 Floor elevation	Figure 24 Floor elevation	Figure 25 River bank erosion protection and floor elevation
		

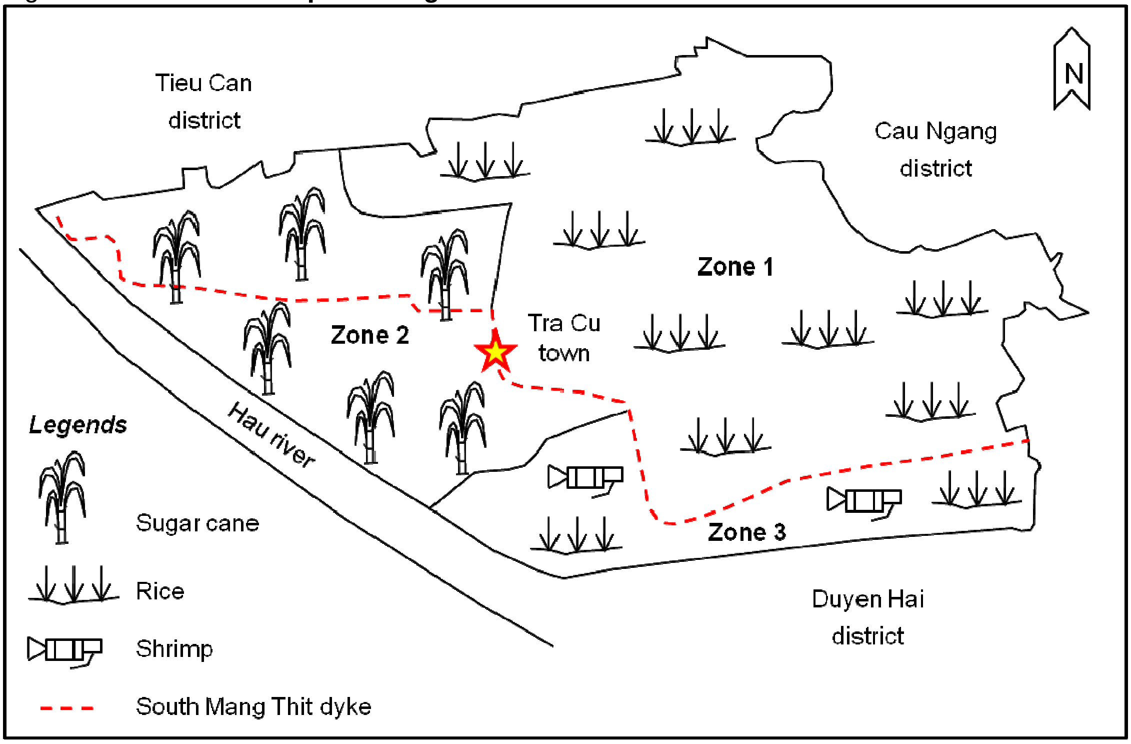
Tra Vinh: Vulnerability to Salinisation, Floods and Typhoons in Rural Areas

by Nguyen Thanh Binh

Role of the study area within the wider vulnerability assessment

Due to its given geographic position and topographic condition, salinity intrusion is a normal phenomenon in the Mekong Delta of Vietnam. In the dry season, seawater can penetrate into the Delta about 40 – 60 km inland and about 2.1 million ha (about 55% of total Delta areas) are affected by salinity (Miller, 2003; Sam, 2006). It causes many problems for agricultural development and people's livelihoods (Hashimoto, 2001; Hossain et al., 2006; Hanh and Furukawa, 2007). An analysis on rice productivity in the coastal area of the Mekong Delta has shown that rice cropping intensities decreased with increasing salinity level in canal water (Kotera et al., 2008). Potentially, within the context of global climate change – especially sea level rise – the Mekong coastal region would be among the regions most suffering globally in terms of affected population, biodiversity degradation, land loss and water-related hazards including flooding and storms (Dasgupta et al., 2007; Hanh and Furukawa, 2007; Carew-Reid, 2008). With around 65 km of coast line, Tra Vinh province would be affected the most by the sea level rise. Carew-Reid (2008) projected that around 45.7% of province area would be inundated (the third highest percentage per province in Vietnam) by 1 m sea level rise.
Under the framework of "vulnerability asessement" of the WISDOM project, Tra Cu district which covers an area of 370 km^2 in Tra Vinh province was selected for carrying out the research (Figure 26). The main reasons for the selection of Tra Cu district as the study area were: (1) The district has been affected by salinity problems and drought; (2) The district encompasses various socio-economic groups and different ethnicities (i.e. Vietnamese and Khmer ethnic, high poverty rate); (3) Economic activities are diversified due to different ecological zones (i.e. freshwater zone for intensified rice farming; brackish water zone for aquaculture and brackish water zone for sugar-cane farming). Therefore, data and information will be collected and compared among such 3 zones as well as between different socio-economic groups. The results from Tra Cu will be not only useful for the district itself but also for other coastal regions.

Figure 26 **The Tra Cu map showing three different zones**



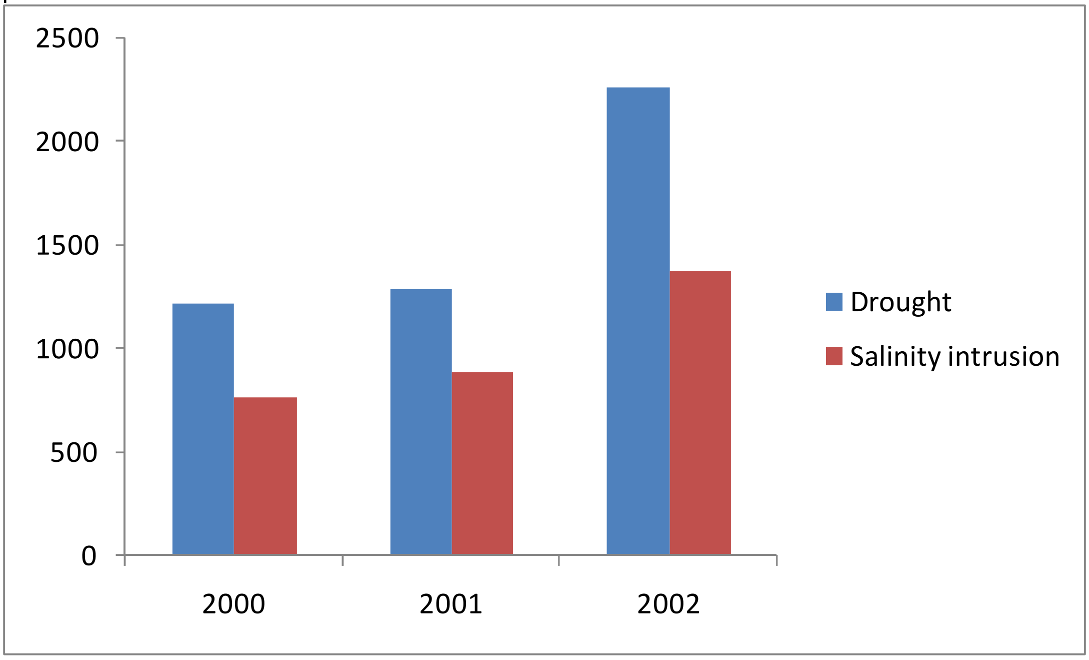
(Sources: Mapping exercise with DARD staff in Tra Cu district in 2009)

As mentioned, Tra Vinh case study is situated down-stream at the Mekong River with much differences in term of socio-economics from the other two case study areas in Dong Thap and Can Tho. Thus, combining the results from three study sites will provide a full picture of vulnerability in the whole Mekong delta including up stream annual slow-onset floods in rural areas of Dong Thap province, tidal and urban flooding in Can Tho city and salinity intrusion in Tra Vinh province.

Past hazards

The economic losses caused by the effects of salt water intrusion in 2005 was estimated at USD 45 million or 1.5% of annual rice production in the Mekong Delta (MARD, 2005). Apart from the economic loss, the salinity intrusion also caused ecological and health problems. It degraded water quality, damaged aquatic ecosystems and threatened bio-diversity in coastal areas (White, 2002; Hanh and Furukawa, 2007). As a result, livelihoods of downstream communities are extremely influenced, particularly for poor people who rely mainly on natural resources (Hossain et al., 2006; Nhan et al., 2007). Salinity intrusion and drought in the dry season are - according to the data available - increasing in the coastal region of the Mekong Delta. An example from Tra Cu district, Tra Vinh province shows that upland crop areas affected by saline water raised from 763 to 1375 ha between 2000 and 2002 and by drought from 1221 to 2266 ha in the same period (Figure 27). Given data restrictions with respect to salinity measurements, this analysis is based on a very short time frame; however, those numbers may function as an alarm signal for the likelihood of a larger trend.

Figure 27 Affected upland crop areas by salinity intrusion and drought in Tra Cu district, Tra Vinh province



Source: (DARD-TC, 2003)

Typhoons have rarely happened in the past but are expected to increase in intensity and frequency in future. Since 1997, there have been two harmful typhoons in the Mekong Delta namely Linda in 1997 and Durian in 2006. In Tra Vinh province, the loss was estimated around 82.76 billion VND by the Durian typhoon. In term of housing, the typhoon caused 830 fully and 2352 partly collapsed houses and in agricultural sector, it destroyed 3033 ha of rice, 524 ha of fruit trees, 135 ha of sugar cane and 128 ha of upland crops in the province in 2006 (KI interview, 2009).

Exposure to natural hazards

Before 1995, the district was strongly affected by salinity intrusion which caused freshwater scarcity in the dry season (November to May) due to low flow from Hau River (one of the Mekong River branches) and tidal influence from East Sea. Since 1995, a series of embankments and sluice gates (Figure 28) have been built in the district to prevent sea water intrusion under the framework of the South Mang Thit Sub-project (SMS) from the World Bank fund.

Based on hydrologic regimes, topological conditions, and irrigation systems, Tra Cu is divided into 3 different zones (reference to the map above). Each zone has particular activities and faces with varying issues which have summarized in Table 4 below:

Figure 28 Sluice gate and dyke system under the framework of South Mang Thit sub-project

Source: N.T. Binh 2010

Table 4 Characteristics of 3 different zones in the study site

	Zone 1 (rice zone)	**Zone 2 (sugar-cane zone)**	**Zone 3 (aquaculture zone)**
Irrigation system	Freshwater whole year Good irrigation system thank to SMS (100% inside SMS)	1/3 freshwater whole year (inside SMS) and 2/3 affected by brackish water in the dry season (outside SMS)	Brackish water in the dry season (100% outside SMS)
Main economic activities	2 to 3 rice crops per year Upland crops (maize, peanut, …) Cattle, pigs, poultry	Sugar-cane 1 to 2 rice crops per year Upland crops (maize, peanut, …) Less animal husbandry	Shrimp culture 1 rice crop in the wet season and 1 shrimp crop in the dry season Less animal husbandry
Major hazards and problems	Freshwater scarcity in the dry season (especially from February to April) Drought, especially along sand ridges Brackish water leakage Whirlwind	Brackish water intrusion can destroy or reduce crop production Affected by tidal influence (flooding) Whirlwind Storm (seldom)	Shrimp diseases Brackish water can destroy or reduce crop production Freshwater scarcity Affected by tidal influence (flooding) Whirlwind Storm (seldom)

(Sources: FGD and KI interviews, 2009)

In zone 1, brackish water intrusion has been controlled owing to the SMS which allowed the agricultural development as farmers can grow 2 or even 3 rice crops per year. However, from February to April, low discharge from Hau River and less local rainfall cause freshwater scarcity for crop irrigation and animal husbandry. Especially, along the sand ridges where land elevation is higher, the problems become more and more serious. Besides, brackish water leakage during closed-gate period is also recorded. In affected areas, the crop yields could decline by 20 – 30% (KI interviews, 2009).

In zone 2, sugar-cane farming is popular. This zone is strongly affected by brackish water intrusion and tidal influence, especially the low land elevation and outside SMS areas (compare figure 26). The salinity duration is between December and May while tidal influence (causing flooding) becomes very important from November to January every year. During the last 15 years, the salinity level was highest in 1998 and lowest in 2000 (KI interviews, 2009). The maximum salinity concentration was recorded at Vam Buon station (around 30 km from the sea) as 13.9 ppt in April 1998 while it was 4.4 ppt in March 2000 (Sam, 2007). Both brackish water intrusion and tidal influence are considered as constraints for agricultural development in this zone. Such problems affect more than 500 ha sugar-cane and 300 ha upland crops annually (KI interviews, 2009).

In zone 3 due to its location, the salinity intrusion and tidal influence are bigger than zone 2. The maximum salinity concentration was recorded at 25 ppt at La Bang station (around 15 km from the sea) in April, 1998. The rice-shrimp integrated farming system is popular in this zone. Farmers grow rice in the wet season based on rainfall and cultivate tiger shrimp in the dry season. If the rain stops early and salinity levels become higher the rice production is at risk of being lost.

Currently, salinity intrusion, tidal influence and freshwater scarcity in the dry season are severe problems for agricultural development in the study site. Zone 1 is exposed to these hazards less than zone 2 and 3 due to the dyke and sluice gate systems under the SMS. As mentioned, the SMS have been supporting rice intensity in zone 1; however, it is also causing some problems such as chemical pollution in water bodies, reduction of natural fish resources and increase water level (flooding) in zone 2 and 3 during the periods of closed sluice gates (FGD and KI interview, 2009). In the view of sea level rise the whole areas will be strongly affected even inside the SMS area because of low topology. It was identified that if the sea level increases 20-30 cm the SMS dyke systems will be out of use (KI interview, 2009). Besides, under climate change the storms and whirlwinds which are seldom occurrence now will be increased in the future. Moreover, upstream interventions (i.e. deforestation, irrigation and hydropower development) will change river flows and cause more vulnerability to downstream regions.

Coping and Adaptation

To cope with and adapt to salinity intrusion and related problems, the government and local people have many strategies and actions such as dyke buildings, crop calendar adjustments, crop or species changes, water storage and groundwater exploitation, and migration to find new jobs.

Dyke buildings: Besides “big projects” as the SMS which was planned and built by the central government, many “smaller projects” have been implemented to prevent brackish water intrusion and tidal influence in Tra Cu. These smaller projects are funded by the province and/or district. At high risk areas, farmers have also protected themselves by building small earth walls around their fields (Figure 29). These investments are very costly and suitable for the better-off groups while the poor groups cannot afford to implement such measures. Generally, the dyke systems have shown many advantages; however, they have also caused negative impacts such as reducing natural fish resource and increasing water level outside the dyke areas. During the focus group discussions and KI interviews in 2009, local people reported that before the construction of sluice gates and dyke systems natural fish resource was abundant and contributed a significant part to total household income, especially landless and poor people. An estimation from Long Truong hamlet leader in zone 1 showed that in 1990, natural fish contributed around 15% of total household income; is the contribution is now only only 1% (KI interview, 2009). In closed sluice gate time, the crops inside the dykes are protected from salinity intrusion but it causes serious inundation in the other side of the dykes. Particularly in 2005, the outside areas could not bear the high water level, the sluice gates had to be opened to avoid catastrophic failure.

Crop calendar adjustments: Based on experiences and seasonal calendars from the Department of Agriculture and Rural Development, farmers have adjusted their crop calendar. For example, if the rain comes later they will seed later and vice versa. But this sometimes can put people at risk due to abnormal weather (i.e. shorter rainy period, sooner salinity intrusion). Thus, it is necessary to improve the weather forecast system by using both modern technologies and indigenous knowledge.

Crop or species changes: These options are also popular. Instead of rice farming, farmers chose other crops which need less water than rice such as maize, water-melon, etc. In aquaculture areas (zone 3), before the 1990s, farmers grew only one traditional rice crop in the wet season but later on they have introduced shrimp in the dry season (Figure 30). In recent years, shrimp farming has faced with diseases and environmental pollution. To cope with the situation, some farmers culture crabs or other fish species instead of shrimp. The integrated rice-shrimp farming is a suitable system in coastal area (Binh et al., 2009). Therefore, it is important to do more research on this farming in order to diversify agricultural activities and utilize land and water resources in saline affected areas.

Figure 29 Individual earth walls to cope with tide

Source: N.T. Binh 2010

Figure 30 Integrated rice-shrimp farming

Source: N.T. Binh 2010

Water storage and groundwater exploitation: In the wet season, farmers harvest and store rain water in jars or small tanks in order to use in the dry season, mostly for drinking and cooking. For other types of household consumption, people use groundwater from individual drill wells or rural tap water supply systems (these systems are newly developed). Along the sand ridge areas, groundwater is also exploited for watering upland crops. In the 1990s, many handle wells were drilled under a UNICEF

program. According to Department of Natural Resource and Environment, there are more than 14,000 drill wells in Tra Cu today. Currently, the use of groundwater is free of charge which can cause overdraft in the near future. Thus, research on groundwater market is necessary for better management of this resource in the region.
Migration to find new jobs: Before the SMS was built, the natural fish resources were considered as a source of income for local people, especially the poor. However, after the construction of the SMS, natural fish stocks have been reduced which affects mainly the poor people who have previously relied on open access, common pool, natural fish resources. Besides, crop failures due to water related hazards have caused many difficulties in people's livelihoods. On the other hand, local industrial activities have not much developed but rural labour activities are increasing. Therefore, a number of young people have moved to cities (e.g. Ho Chi Minh City, industrial zones in South East of Vietnam) to find new jobs since 1995. It is estimated that around 10% of total population have migrated out the district (KI interview, 2009). Most of them are poor and unskilled labourers; therefore, the wage is low but it still is a main income source for their families.

Adaptation of vulnerable social group: The poverty rate is high and greater in Khmer population (TCSO, 2009). Household livelihood activities differ from wealth groups. The poor rely much on unskilled off-farm and/or non-farm wage labour due to their low education. Therefore, the adaptive capacities are low in the poor and Khmer population. The government has many policies to reduce poverty among such population (i.e. The 135 Program for improving infrastructure and living conditions in difficult villages, The 134 Program for supporting land, houses and tap-water in minority ethnic population, etc); however, they do not seem to be very effective and stable due to single disciplinary approach. It means that the projects were planned and implemented with top-down manner and lack of participation from the communities. The people who escape from being "below the poverty line" are easy to return to poverty if they are faced with some shocks such as diseases or crop failures. It is necessary to build up more effective measures and investments for rural poor areas (i.e. extension, education, micro-credit, job creation, health care programs). The way to set up such programs should change from current "top-down" approaches towards an inclusion of participatory and multi-disciplinary components in order to make them more useful and stable.

Comparison and Synthesis

The discussion of the vulnerability analysis in the three case study areas has yielded lessons in the below-listed domains which are of great relevance to advancing the integration of vulnerability thinking within the framework of IWRM:

Vulnerability much more than exposure:
Do date, much of the prevailing discourse on natural hazards and disaster mitigation within the IWRM context views vulnerabilities (which allow a manifested hazard to cause disaster, compare conceptual section) as more or less equal to physical exposure. This becomes evident in mapping approaches of, for example, housing agglomerations, critical infrastructure or population densities. The research has shown, however, that particularly in the context of the Mekong Delta, exposure is only one of the three main dimensions constituting vulnerability besides resilience and sensitivity (compare section on concepts and figure Turner). In particular the examples of resettlement and the risk of long-term vulnerabilities resulting from this have demonstrated that exposure reduction may in fact lead to an increase in sensitivity and an decrease in resilience, both propelling the vulnerability of the respective group and increasing the risk of being harmed by future hazards – in particular in the context of changing hazard patterns due to climate change that may lead to new exposures also in the resettlement sites, e.g. with respect to typhoon-induced flooding.
A second example are the dyke systems in Dong Thap which are constructed by water resources planners in order to reduce exposure but have been proven to deteriorate the livelihood base of certain population groups, in turn increasing their vulnerability towards future hazard events.
Hence, adaptation measures proposed and implemented through IWRM channels need to stronger focus on the temporal and spatial secondary effects (Adger et al 2005; Birkmann forthcoming) and on integrating the notion of generic vulnerability reduction (Handmer 2003) and adaptation besides the focus on specific solutions geared only to the first order impact on exposure.

Vulnerability not mono-causal and monolithic as often thought:
Directly linked to the previous point is the lesson that vulnerability is much more dynamic and socially differentiated even within micro-scale geographical entities than often thought. The analysis and comparison of two rural case study with each very different internally fragmented hazard and vulnerability patterns with the urban case study area with equally differentiated internal pattern have shown that vulnerability configuration are highly complex and can show great disparities even within a formidably homogeneous region. The still too often used notion – in particular within the context of IWRM – of, for example, *the* coastal rural community as such showing *this* particular exposure and vulnerability pattern or *the* urban regions as such being affected in one specific way for fixed reasons can, hence, no longer be supported and has to be critically challenged.

Yet, bringing the first two points together, the analysis has also shown that on a micro-scale, strong correlations can be found between exposure (i.e. location of the households) and its vulnerability pattern (compare figure 18). Hence, adaptation measures proposed under IWRM have to acknowledge the need for small-scale assessment and for developing water management and adaptation options that are able to deal with this need for differentiated solutions at small-scale. This is surely not an easy task as it requires a serious re-consideration of the set of adaptation and disaster mitigation measures that are predominantly discussed in the moment and that usually apply a much broader focus (like, for example, large-scale dyke systems for protecting certain districts or city quarters; compare for a review on Ho Chi Minh City and other cities Birkmann et al. 2010).

Vulnerability highly dynamic and multifaceted
The analysis has also revealed the multifaceted and dynamic nature of vulnerability which challenges some of the predominant paradigms within IWRM which – in particular Vietnam – is deeply rooted in the notion of being able to centrally plan and manage water-related systems and their components based. In this thinking such control is based on identification of clear causal relations and the assessment of cause-effect studies in hydrological systems, eventually guiding the implementation of control measures (mostly within the physical domain). Also the current discourse in Vietnam around hydrological climate change adaptation is strongly based on the assumption that once clear climate change scenario is developed and cause-effect relations of physical response measures evaluated, the task of adaptation is completed with the successful implementation of this (engineering) measure. The vulnerability study, however, virtually imposes a more dynamic and complex understanding of vulnerability reduction and adaptation, in which adaptation is more understood as a ongoing process that is highly dynamic and differentiated for different socio-economic group. Hence, adaptation has to be less understood in terms of the result or endpoint but rather in terms of an ongoing process.

Cascades, thresholds, tipping points in vulnerability and limits of adaptation:
The assessment within the three case study areas has illuminated aspects of cascades, thresholds and tipping points in the development and progress of vulnerability as well as regarding (potential) limits of adaptation. As introduced in the pressure and release model in the theoretical chapter, the idea of progressing vulnerabilities that are rooted in structurally and institutionally unfavourable conditions which are through dynamic pressures transformed into vulnerable conditions is not new. However, inspired the ecology-based research on resilience, the vulnerability assessment within WISDOM is grounded in the hypothesis that this progress of vulnerability might not be as constant or linear as the PRA model might implicitly suggest but is rather shaped by cyclic developments causing cascading effects potentially leading through threshold-passing to tipping points in which formidably small additional stress or perturbation may cause exponential increases in susceptibility and resilience-loss which can, in turn, eventually bring about the collapse of the entire system in question. In years of increased salinity levels in Tra Vinh, for example, that cause income losses and force the household to send members to urban areas for seasonal off-farm occupation, a relatively small drop in price levels for the produces rice or sugar in Tra Vinh or a formidably short drop-out from work by the person sending remittances can potentially cause the respective household in Tra Vinh to tip into a larger and long-lasting crises situation.
This notion of thresholds and tipping points can – based on the analysis – also be transferred to adaptation processes in Vietnam. The gradual up-lift of houses or housing-floors observed in Can Tho may be working for a certain time – i.e. every time the rising water levels necessitate a new up-lift and/or the household has acquired sufficient resources for implementation. However, after a while the costs for the next uplift will raise exponentially as also the roof, door, windows, pipe-works etc. would have to be adjusted, potentially pushing the costs beyond the feasible limits for the respective

household (compare figure 31 for illustration which shows a house that has already undergone two rounds of elevation with the next one necessitating costly adjustments to the roof, windows and door.
Integrated Water Resources Management, therefore, also has to more strongly integrate this notion of cascades, threshold-passing and tipping into the analysis tool-box and concept development. This will require additional research, testing and learning in the future.

Figure 31: Tipping points in physical adjustment of housing structures

Source: M. Garschagen 2010

Critical elements of vulnerability outside the conventional scope of IWRM focus
Apart from the recommendation to more strongly integrate the underlying notions resulting from the afore-mentioned paragraphs (i.e. acknowledging that vulnerability comprises dimensions of multi-causality, complex dynamics, non-linearities, cascades, thresholds and tipping), the vulnerability assessment within WISDOM also calls for a stronger consideration of more concrete drivers of vulnerability to water-related hazards that could be identified but have so far largely been considered to be outside the conventional scope of IWRM. Informed by the case studies, this means, for example, that IWRM has to be more closely integrated with the planning and implementation of resettlement initiatives, urban upgrading projects or broader social security programmes if aims at fully capturing the field of long-term disaster risk reduction with respect water-related hazards.
In Summary, this means to focus more strongly also on soft and institutional aspects in the sense of entitlement and access (for livelihood formation) rather than only looking at the physical dimensions of structural measures for flood control and exposure regulation.

Teleconnectivity in vulnerabilities across different scales and actors:
Last but not least, the case studies have contributed to a highly important emerging topic in the context of IWRM, disaster risk management and climate change adaptation. This is the consideration of potential or actual linkages and causal relations of vulnerability reduction measures across geographical and temporal scales as well as across different actor groups. The raising flood levels in Can Tho, for example, are quite likely to a certain degree caused by the food control measures (dykes and embankments) in provinces upstream – staying within our case study areas, Dong Thap would be one of them. Even though the request for reviewing physical hydraulic infrastructure measures against their impact in other locations is not new, the actual implementation of this postulation seems to be rather week in the Mekong Delta. Teleconnectivities of vulnerability across time, space and actors are not intensively discussed yet within the IWRM players in the Delta and a discussion on the social dimension and trade-offs of those teleconnectivities is not taking place. Keeping in mind, however, that those teleconnectivities are likely to raise steeply in intensity and distance if intensifying climate change hazards are being responded to with ever-larger physical infrastructure measures, this discourse if of great relevance and needs to be seriously taken up by the IWRM community.

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