KEEPING AHEAD OF FLOODS AND DROUGHTS

A CASE STUDY OF SDAU KAONG COMMUNE, CAMBODIA

by

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ABSTRACT

The Lower Mekong Basin covers four countries, Lao PDR, Thailand, Cambodia and Vietnam. These countries are often affected by floods and sometimes by droughts. These natural hazards silently and adversely affect people's livelihoods in the region. In the face of future environmental changes, especially climate change and dam construction along the Mekong River, patterns of floods and droughts are more likely to exacerbate the situation. For this case study of a vulnerable commune in this setting, I developed a hybrid model of the development and complexity paradigms to both organise my research data and extend my analysis. This holistic hybrid paradigm enabled me to explore the interrelationships between natural hazards, disasters, and vulnerability, and adopt a multidisciplinary approach in which I attempt to integrate disaster risk management and climate change adaptation models to highlight problems and to propose interventions. The results obtained indicate that in the future floods and droughts are likely to be more frequent and severe and just what impact additional dams currently being planned or built will have over the control of water levels remains an outstanding question. Plans need to be made to enable people to cope with floods and droughts because these can have a hugely detrimental impact on their livelihoods including crops and personal property, people, community infrastructure and environment. Although current coping strategies are in place, disasters still occur. Based on the vulnerability context of the Sustainable Livelihoods Framework and the Pressure and Release (PAR) model, I was able to show how vulnerability is exacerbated by dissonant social, economic, and political structures. This research also proposes an integrated framework, including adaptive management and participatory action research, as a way of monitoring interventions that could possibly resolve some of the challenges.

Keywords: natural hazards; disasters; coping strategies; vulnerability; social, economic, and political structures

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List of abbreviations, acronyms, and symbols

AAA	American Anthropological Association
AADMER	ASEAN Agreement on Disaster Management and Emergency Response
AAS	Australian Academy of Sciences
ACDM	ASEAN Committee on Disaster Management
ADB	Asian Development Bank
ADPC	Asian Disaster Preparedness Center
AIT	Asian Institute of Technology
APN	Asia-Pacific Network
AR4	IPCC Fourth Assessment Report
ASEAN	Association of Southeast Asian Nations
CBDP	Community-Based Disaster Preparedness Programme (Cambodia)
CBDRM	Community-Based Disaster Risk Management
CMDG	Cambodia's Millennium Development Goals
CRC	Cambodian Red Cross
DDR	Disaster Risk Reduction
DRM	Disaster Risk Management
DFID	Department for International Development
EIC	Economic Institute of Cambodia
FAO	Food and Agriculture Organization
FGDs	Focus Group Discussions
FWUC	Farmer Water User Community
GCM	Global Climate Model
GDP	Gross Domestic Product
GHG	Greenhouse Gas
HDI	Human Development Index
HFA	Hyogo Framework for Action
ICEM	International Center for Environmental Management
IDRC	International Development Research Centre
IDS	Institute of Development Studies
IIED	International Institute for Environment and Development
IGSM	(MIT) Integrated Global Systems Model
IMF	International Monetary Fund
IPCC	Intergovernmental Panel on Climate Change
IRN	International Rivers Network
ISDR	International Strategy for Disaster Reduction
Lao PDR	Lao People's Democratic Republic
LDCs	Less Developed Countries
MoE	Ministry of Environment (Cambodian)
MoP	Ministry of Planning (Cambodian)
MOWRAM	Ministry of Water Resources and Meteorology (Cambodian)
MRC	Mekong River Commission
NAPA	National Adaptation Programme of Action (Cambodian)
NCDD	National Committee for Sub-National Democratic Development
NCDM	National Committee on Disaster Management (Cambodian)
NGO	Non-governmental Organization
NPRS	Cambodia's National Poverty Reduction Strategy
NSDP	National Strategic Development Plan
NZAID	New Zealand Agency for International Development
ODI	Overseas Development Institute

PALDIN	Participatory Adult Learning, Documentation and Information Networking
PAR	Pressure and Release (Model)
PDOWRAM	Provincial Department of Water Resources and Meteorology (Cambodian)
PLA	Participatory Learning and Action
PRA	Participatory Rural Appraisal
RGC	Royal Government of Cambodia
RRA	Rapid Rural Appraisal
SLF	Sustainable Livelihoods Framework
SRES	(IPCC) Special Report on Emissions Scenarios
SSIs	Semi-Structured Interviews
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNISDR	United Nations International Strategy for Disaster Reduction
UNSD	United Nations Statistics Division
USAID	United States Agency for International Development
VUW	Victoria University of Wellington
WFP	United Nations World Food Programme
WHO	World Health Organization
UNFCCC	United Nations Framework Convention on Climate Change

Symbols

%	Percent
°C	Degrees Celsius
CO_2	Carbon dioxide
ha	Hectare
km	Kilometer
km^2	Square kilometer
m	Meter
MW	Megawatt
ppm	Parts per million
US$	US dollar

Chapter I: Introduction

1.1 Background, statement of the problem, and approach

Disasters are global concerns. Between 1974 and 2003, over 6350 natural hazards caused US$1.4 trillion in economic losses and altogether 5.1 billion people were affected, including 2 million dead (Guha-Sapir, Hargitt, and Hoyois (2004, p. 91). Floods and droughts were among the most disastrous natural hazards. A few Asian countries, characterised by both high vulnerability and a low capacity to cope with the challenge, suffered the most (Birkmann, 2006; K. Smith & Petley, 2009).

The Mekong River, located on the mainland of Southeast Asia, is the world's tenth-largest river which flows nearly 5000 km from China to Myanmar through Lao PDR, Thailand, Cambodia and Vietnam prior to discharging in the South China Sea (MRC, 2012b). Its watershed covers an area of 795,000 km^2 which stretches from its source on the Tibetan Plateau in China to the end point in the Mekong Delta of Viet Nam. Under the international agreements that set up the Mekong River Commission (MRC), the Mekong River is divided into Upper and Lower sections (MRC, 2012b). The Upper section falls within the borders of China and entirely under Chinese administrative authority. The Lower Mekong Basin plays a more complex role than the Upper Mekong in terms of political arrangements, socioeconomic development and environmental resources (UNDP, 2006). It covers four countries, Lao PDR, Thailand, Cambodia and Vietnam, who have agreed to work closely together (Scott W.D. & Pearse-Smith, 2012). These countries are often affected by floods and sometimes by droughts and because any riparian rights they may exercise will affect their neighbours, they have signed up to an international agreement in which they have undertaken to keep each other thoroughly informed (MRC, 2010).

The frequency of natural catastrophes has increased since the 1950s, especially climate-related disasters (K. Smith & Petley, 2009). According to the experts, this trend has been caused by several factors including population growth, land pressure, socioeconomic inequality, climate change, and dams. These factors have led to high vulnerability and exposure to natural hazards and need to be given more attention. About 61 million people, 35% of the total population in the four countries, live in the Lower Mekong River Basin, and the population grows at an annual rate of approximately 1.5% (MRC, 2011b). Most people living in the basin depend on agriculture. Farmers clear forests to establish cultivated areas and often show a

preference for flood-prone areas where moist soils provide good returns from agriculture. The average Human Development Index (HDI) of the four countries in this basin was about 0.7 in 2007 with Cambodia and Lao PDR scoring the lowest HDI (MRC, 2011a). In these countries, there is a big gap between rich and poor. The poor usually have limited access to resources as well as decision-making.

Conditions are not necessarily changing for the better. Climate change is likely to cause an increased number of water related stresses including floods and droughts (Bates, Kundzewicz, Wu, & Palutikof, 2008; IPCC, 2007b, 2012). A study by the Mekong River Commission indicates that climate change will lead to changes in temperature, precipitation, and evaporation, resulting in severe floods and droughts in the Mekong River (Eastham et al., 2008). Moreover, dam construction is likely to cause significant changes in water level and water discharge which are likely to have an adverse effect on the occurrence of both floods and droughts. There have been concerns that the impacts of dam building could also have an adverse impact, although at the moment there are too few studies to document how construction may affect future floods and droughts. Cambodia, one of the poorest nations and the most downstream in the region, is very nervous about the potential impact on people's livelihoods (Goh, 2007; Scott W.D. & Pearse-Smith, 2012).

Reducing disaster losses has been a primary concern of governments and organisations all over the world. The International Strategy for Disaster Reduction (ISDR) was adopted in 2000 by the United Nations in order to guide and coordinate global partners committed to the task of building resilient communities to achieve sustainable development (UNISDR, 2011b). The UNISDR aims "to lead the ISDR partnership toward increased political and financial commitment for measurable change" (UNISDR, 2011a, p. 1). Under UNISDR, the Hyogo Framework for Action (HFA), 2005-2015, aims to reduce disaster risk through integrated policy initiatives designed to improve the ability of developing countries to manage hazardous events, to develop institutional capacity, and to implement disaster risk reduction components. HFA is "enhancing climate change related disaster risk reduction strategies", and it also promotes systematic approaches to reduce both vulnerability and hazard impacts (Birkmann, 2006; UNISDR, 2011a, p. 16). Disaster risk reduction (DDR) and climate change adaptation have already been combined as a concept that should help deal with future challenges and so achieve sustainable development (IPCC, 2012; UNISDR, 2011a). Helen Clark, UNDP Administrator, on 15 August 2012 at the University of

Canterbury, made a speech in which she argued for the development of new directions that would “cut across development sectors” and “converge with the development and environment agendas” including “climate-related disaster risk” and adaptation (UNDP, 2012).

Poverty reduction and livelihood improvement have been the main priorities of the government of Cambodia. However, most of the poor are in rural areas and as floods and droughts[1] are the main types of disasters affecting their livelihoods, alleviating the impact of these could make a major contribution to poverty reduction. For example, a single flood in 2000 caused US$150 million in damage (NCDM, 2002). Also, a drought in 2002 affected around 2 million people and more than 100,000 ha of paddy fields were affected (MoE, 2005). The 2011 floods caused at least US$161 million in damage, including 423,400 hectares of irrigated rice fields, and killed 240 people (DAP News, 2011, 2012). Local communities have had to learn how to cope with climate related hazards such as floods and droughts through the use of limited resources at hand, their experience and indigenous knowledge (UNFCCC, 2007), but this is not enough. Disasters will continue to occur and local ways of mitigating such events has not improved. Past studies that focused on collecting information about coping strategies failed to identify root causes and processes that make people vulnerable to floods and droughts. Ways to enhance both the effectiveness and efficiency of existing coping strategies have been largely ignored and it is not clear what resources, alternative long-term coping strategies, and adequate experience-sharing mechanisms need to be put in place (UNFCCC, 2007; USAID, 2008). In a situation of high vulnerability and low capacity, the impact of disasters cannot be reduced and there is an urgent need for research to find out what needs to be done and inform countries along the lower reaches of the Mekong River Basin so their people can better prepare for future floods and droughts.

Disasters are broad and complicated and to come to a good understanding of them requires a multidisciplinary approach and a skilled number of researchers who can provide a wide, comprehensive picture of how disasters occur and what interventions work well. Firstly, disaster risk reduction makes it necessary to assemble not only past and present knowledge but also projections about the future (Wisner, Gaillard, &

[1] For the purpose of this study a drought is a long period of abnormally low rainfall caused by the late or non arrival, or uneven distribution of precipitation from the Southwest Monsoon that adversely affects the growth of crops, size of yields and living conditions in specific areas of rural Cambodia. Lower stream flow due to human activities is also considered.

Kelman, 2012). Also, both local knowledge and specialist knowledge from related disciplines and professions are required in order to bring a diverse range of knowledge together (IPCC, 2012; Wisner et al., 2012). Secondly, natural hazards in themselves are not the only causes of disasters (Blaikie, Cannon, Davis, & Wisner, 1994; Wisner et al., 2012). Social, economic, and political structures affect human vulnerability and their capacities; these can open the way to disaster when significant natural events such as floods and droughts occur.

This research attempts to develop a hybrid of both development and complexity paradigms by integrating two fields of knowledge, an approach which I believe is more relevant for less developed than developed countries, especially the countries of the Lower Mekong region. Development paradigms focus on the vulnerability of people in less developed countries as the main reason for unfavourable outcomes. The complexity paradigm finds ways to reduce disasters in a sustainable way by focusing on society-nature interactions within a long-term period. Therefore, this research focuses initially on vulnerability and then goes on to investigate some aspects of society-nature interactions that affect sustainable livelihoods.

1.2 Research aim and research questions

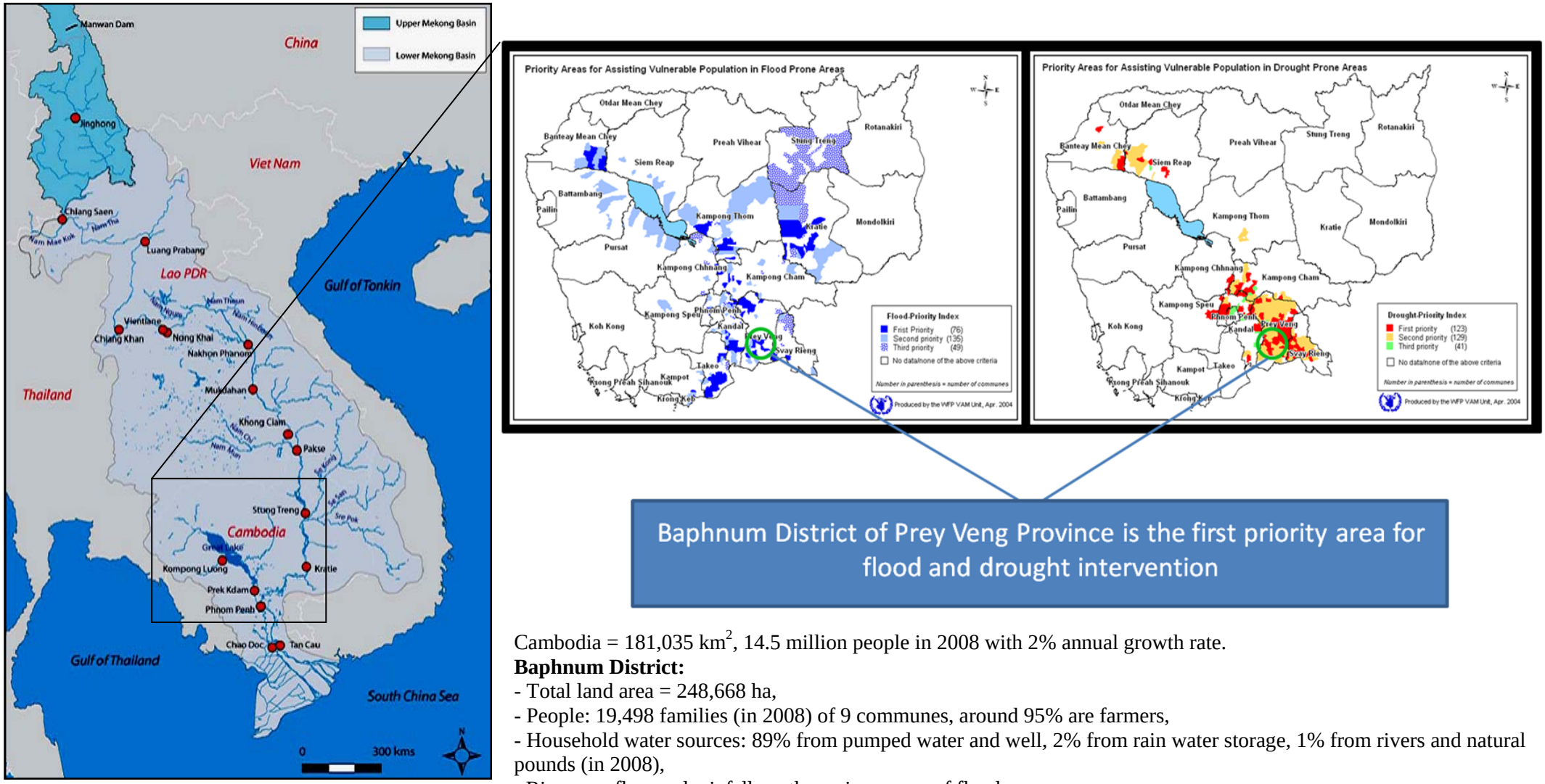
This research aims to first identify and critically examine the impacts of floods and droughts and coping strategies and then discusses ideas designed to enable people to better prepare for future events, disturbances of floods and droughts. I will address the following questions:

1. Why floods and droughts occur, and are these natural hazards likely to become increasingly severe?
2. What have the impacts of floods and droughts on local livelihoods been in the past and what strategies do locals use to cope with these impacts?
3. Why do disasters occur and how can they be reduced?

1.3 Research location

Baphnum District, Prey Veng Province of Cambodia (Map 1.1) was selected for the study because it is the first priority area for flood and drought intervention in Cambodia. As shown in the map, this district is located in the downstream area of the Lower Mekong Basin which makes it vulnerable to changes in water levels and discharge surges from upstream.

Map 1.1: Priority areas for flood and droughts intervention



Baphnum District of Prey Veng Province is the first priority area for flood and drought intervention

Cambodia = 181,035 km^2, 14.5 million people in 2008 with 2% annual growth rate.

Baphnum District:

- Total land area = 248,668 ha,
- People: 19,498 families (in 2008) of 9 communes, around 95% are farmers,
- Household water sources: 89% from pumped water and well, 2% from rain water storage, 1% from rivers and natural pounds (in 2008),
- River overflow and rainfall are the main sources of flood.

Source:Garcia (2002); MRC (2011a); NCDD (2009a); UNSD (2009); WFP (2004); World Atlas (2011)

Within Baphnum district I narrowed my research area to Sdau Kaong Commune through which flows the Kampong Trabaek River, a diversion of the Mekong River (see **Section 4.1** for more information about this river). This commune was selected for several reasons. The commune faces the most frequent and severe flood and drought problems. It is also an area in which local people have for many generations dealt with floods and droughts. It is also representative of the wider district, and study findings have the potential to provide a model representing the most developed ideas of why disasters occur, what good coping strategies might be applied, and what arrangements need to be made to secure a better future. Work of this nature has not previously been undertaken in Cambodia.

1.4 Plan of the thesis

This thesis is organized into seven chapters. Chapter I is an introduction to the background, problems, and approach of the research. This is followed by a statement regarding my research aim and objectives. Chapter II reviews impacts caused by floods and droughts and possible responses. Chapter III describes methodology and methods including the data collecting methods and analysis used in this study. Chapter IV discusses the big picture of the Lower Mekong River Basin and its relation to the study area including climate change and dam construction. Trends in the frequency and scale of hazards are also included. Chapter V illustrates impacts caused by floods and droughts, and current coping strategies. In Chapter VI, I discuss why disasters occur and what might be done to offset future uncertainties relating to floods and droughts. Finally, in Chapter VII, I summarize previous chapters and draw conclusions from the findings.

Chapter II: An overview of disasters: threats and responses

Disasters occur when damage is caused by hazards; and hazards can be categorized as natural hazards, technological hazards, and context hazards (K. Smith & Petley, 2009). This research focuses only on floods and droughts that are natural hazards. Therefore, this chapter aims to review the concepts of floods and droughts along with possible interventions. First, an account of the impacts, definitions, and causes of floods and droughts is given. Second, hazard paradigms are discussed. A hybrid of the development and complexity paradigms is presented along with the reasons why this paradigm is suitable for this research. For the complexity paradigm, both fields of disaster risk management and the climate change adaptation frameworks are used to better understand the bigger picture of problems and ways to achieve resilient communities. For the development paradigm, the sustainable livelihoods framework (SLF) and the pressure and release (PAR) model are introduced to explore vulnerability, coping capacity/adaptation, and livelihood outcomes.

2.1 Floods and droughts and their impacts

2.1.1 Floods

Floods in this work are defined as a "significant rise of water level in a stream, lake, reservoir or coastal region" (Guha-Sapir, Vos, Below, & Ponserre, 2012, p. 36). A flash flood is a sudden increase of flood water. Floods occurring in coastal areas are due to the rise of sea levels caused by winds associated with storm surges. However, floods in my research area are neither flash floods nor storm surges because flood water increases gradually.

Flood disasters have both physical and social causes. Physical floods occur when a river or waterway is unable to carry a high load of water within its banks which then break and water inundates the surrounding countryside. Coastal floods resulting from exceptionally high tides and wind driven tidal surges can also cause inundation (K. Smith & Petley, 2009) but these will not be discussed in this thesis. River floods are caused by atmospheric factors such as rainfall and snowmelt, tectonic factors such as landslides, and technologic factors such as dam failures (K. Smith & Petley, 2009; Wisner et al., 2012). These factors bring changes in water levels and the discharge which flows over banks or breaches them results in flooding. The social causes of floods can include such things as population growth resulting in high concentrations of

people living in vulnerable low lying areas suitable for intensive agriculture where few flood mitigation measures are in place (Wisner et al., 2012).

Flooding is the most common global natural hazard and accounted for approximately 30% of both total natural hazards and fatalities worldwide between 1900 and 2006 (K. Smith & Petley, 2009). This means that each year floods affect approximately 20 million people and cause 20,000 deaths. Asia is the continent that suffers the most. About 40% of floods occur in Asia; and this causes about 58% of the economic damage and more than 90% of deaths around the world. In Asia, the number of flood-prone areas, exposure to risk, and vulnerability are high, while flood protection by engineering structures is limited (K. Smith & Petley, 2009).

In Cambodia, floods and droughts are the two most significant natural disasters as shown in the following table. Although droughts affected lots of people, the number of people killed by droughts is lower than other natural disasters in Cambodia. This is because droughts in Cambodia are usually of short duration and are over within less than a year.

Table 2.1: Cambodian most significant natural disasters, 1900-2011

Disaster	Affected people (Top 10 disasters)			Economic costs (Top 10 disasters)		
	Ranking	Years	Total affected people	Ranking	Years	Damage (US$)
Floods	2	2000	3,448,053	1	2011	521,000,000
	3	2001	1,669,182	2	2000	160,000,000
	4	2011	1,640,023	3	1991	150,000,000
	5	2002	1,470,000	5	2010	70,000,000
	6	1996	1,300,000	7	2001	15,000,000
	7	1991	900,000	8	1996	1,500,000
	10	1999	535,904	9	2007	1,000,000
				10	1999	500,000
Droughts	1	1994	5,000,000	4	1994	100,000,000
	8	2002	650,000	6	2002	38,000,000
	9	2005	600,000			

Adapted from: EMDAT (2012)

2.1.2 Droughts

A drought is a long-lasting dry period, and it can be characterized by water deficiency due to lower precipitation (Guha-Sapir et al., 2012). It is a period of serious water deficiency that usually develops slowly and can affect a region or even several countries at the same time (K. Smith & Petley, 2009). Smith and Petly (2009) mention four types of droughts: meteorological, hydrological, agricultural, and famine droughts

that are caused respectively by a combination of shortfalls in rainfall, stream flow, soil moisture, and food production.

Droughts make up around 6% of global natural hazards and caused approximately 53% of all deaths from natural hazards between 1990 and 2006 (K. Smith & Petley, 2009). Droughts in more developed countries do not usually cause deaths but they can cause food shortages and the impact of such shortages in less developed countries can result in famine-induced deaths (Below, Grover-Kopec, & Dilley, 2007). Drought causes negative impacts on agriculture, food availability, water supply and sanitation, and hydropower (Guha-Sapir et al., 2012).

2.2 Possible interventions

2.2.1 Hazard paradigms

There are four major hazard paradigms (K. Smith & Petley, 2009). Smith and Petley (2009) provide a good description of these paradigms. First, the *engineering paradigm* dominated before the 1950s. This paradigm used weather forecasts and warnings about hazards and attempted to build large engineering structures to withstand events. Second, the *behavioural paradigm*, dominating in more developed countries between the 1950s and the 1970s, looked at the links between hazards and people. It emerged during the 1940s from the work of Gilbert White who believed society and hazards were interrelated. This paradigm included social scientists and focused more on disaster warning and aid as well as land planning to reduce the impact of events. Third, the *development paradigm* was concerned more with the conditions in less developed countries (LDCs) and dominated thinking between the 1970s and the 1990s. This paradigm took the position that although people in LDCs suffered the most, the magnitudes of hazard events were similar. The vulnerability of people in these countries was viewed as the main reason for unfavourable outcomes. Researchers working within this paradigm shifted their focus from hazards *per se* in LDCs to develop an understanding of *disasters-based viewpoints* by investigating how underdevelopment was linked (especially the human vulnerability of poor and disadvantaged people) to disasters (K. Smith & Petley, 2009). Fourth, the *complexity paradigm* emerged in the 1990s. Based on the view that the current world is changing rapidly, practitioners look for ways to reduce disasters in a sustainable way by focusing on society-nature interactions. This paradigm holds to the position that hazards can be managed in a

manner that will meet local needs on a long-term basis. Research conducted within this *complexity paradigm* was developed as a multidisciplinary approach (Wenger, 2006).

My research is a hybrid of the development and complexity paradigms. It focuses mainly on vulnerability, and it investigates some aspects of society-nature interactions that are such an important part of building a resilient community centred on the goal of establishing sustainable livelihoods. It is not a complete *complexity paradigm* because it deals mostly with vulnerability.

As explained above, the *complexity paradigm* uses multidisciplinary approaches. Current publications support multidisciplinary approaches in disaster management. Firstly, Wisner, Gaillard, and Kelman (2012) have produced a handbook called "the Routledge Handbook of Hazards and Disaster Risk Reduction". In this guide to reducing the impact of events they identify the keys to disaster risk reduction as multi-sectoral work, top down and bottom up approaches, current knowledge, future projection of likely events, and bringing both local and outside knowledge to the challenge in order to better understand the processes at work and ways to manage it. Secondly, the IPCC Working Group I on "the science of climate change" and Working Group II on "impacts, adaptation and vulnerability" have published a recent report involving the collaboration of authors from 62 countries; and these reports showcase the emergence of an integrated disaster risk management approach that includes the challenge that is likely to be posed by climate change (IPCC, 2012). The approach seems eminently sensible and timely because there can be little doubt that in the future, climate-induced floods and droughts are likely to increase. Hazards and disaster risks will become more severe. Therefore, my research combines both fields of disaster risk management and the climate change adaptation frameworks to explore problems and to propose solutions.

My research also uses the Sustainable Livelihoods framework (SLF) along with the pressure and release (PAR) model to frame vulnerability in a way designed to increase the coping capacity/adaptation of local people. Out of my concern to find a way for people to overcome future uncertainties in a rapidly changing world, I introduce the ideas of adaptive management and participatory action research as tools that could possibly be used to enable people to better manage change.

Disaster risk management, climate change adaptation, Sustainable Livelihoods framework (SLF), and pressure and release (PAR) model are elaborated below.

2.2.2 Disaster risk management and disaster risk reduction

Risk management is a process. Risk is identified and assessed so as to develop strategies to manage and mitigate it (K. Smith & Petley, 2009). Disaster risk management (DRM) can be defined as:

> Processes for designing, implementing, and evaluating strategies, policies, and measures to improve the understanding of disaster risk, foster disaster risk reduction and transfer, and promote continuous improvement in disaster preparedness, response, and recovery practices, with the explicit purpose of increasing human security, well-being, quality of life, and sustainable development. (IPCC, 2012, p. 558)

Hazard management works effectively in an iterative cycle; and at the end of each cycle the experience is reviewed and analysed to enhance learning as a means to development and to improve performance in the next cycle (K. Smith & Petley, 2009).

Disaster risk reduction (DRR) can be defined as "both a policy goal or objective, and the strategic and instrumental measures employed for anticipating future disaster risk; reducing existing exposure, hazard, or vulnerability; and improving resilience" (IPCC, 2012, p. 558). DRR is an approach supported by the Hyogo Framework for Action (see **Section 5.3.4**). Disaster can be reduced through loss sharing, event modification, and vulnerability modification (Crozier, 2002; K. Smith & Petley, 2009). Loss sharing involves disaster aid (relief and medical support) and insurance. Event modification aims to move the hazard away from people. Vulnerability modification is about adaptation by supporting community preparedness, forecasting and warning schemes, and land-use planning. Adaptation/coping capacity includes proactive mechanisms that can be built continuously to increase the capacity of a society to respond and recover from a disturbance.

Hazard, vulnerability, exposure, and coping capacity/resilience have direct impacts on risk and disaster. Hazard, vulnerability, and exposure increase disaster risks while the coping capacity/adaptation minimizes disaster risks. Therefore, in order to build a safer community, hazard, vulnerability, and exposure should be reduced while increasing coping capacity/ adaptation. These key terms are elaborated below.

Hazard

A hazard is the cause of a disaster. It is a potential threat to people (such as death or injury), the environment (such as loss of flora and fauna), and property in such a manner that rebounds on society as economic loss (K. Smith & Petley, 2009). The UNISDR defines hazard as "a dangerous phenomenon, substance, human activity or

condition that may cause loss of life, injury or other health impacts, property damage, loss of livelihoods and services, social and economic disruption, or environmental damage" (UNISDR, 2009a, p. 17). The UNISDR also describes natural hazard as losses and disruption caused by natural phenomenon such as floods and droughts.

Risk and Disaster

Risk, a likely consequence of an event, is the probability that a hazard may occur and create losses (K. Smith & Petley, 2009). In a conventional calculation, risk is the function of hazard, elements at risk (such as people, property, and others), and vulnerability (Crozier, 2002). Birkmann (2006) adds coping capacity/adaptation to the risk function. When people are killed, injured or adversely affected by a hazard, the term "disaster" is used. Disaster, the actual consequence, is the realization of hazard (K. Smith & Petley, 2009). Similar to risk, disaster is the function of hazard and vulnerability. If there is neither hazard nor vulnerability, disasters cannot occur. Therefore, to solve disasters, research should focus on hazard and vulnerability. In my research, vulnerability is given higher priority as it suits a local context in the study area.

Vulnerability

Vulnerability is one of the most important factors causing disasters. Vulnerability was defined by the UNISDR as a situation in which "the characteristics and circumstances of a community, system or asset make it susceptible to the damaging effects of a hazard" (UNISDR, 2009a, p. 30). Vulnerability can be caused by social, economic/financial, physical, and environmental factors which can vary over time (UNISDR, 2009a). Communities that have more positive qualities built into these factors have less vulnerability than others. Similarly, people who live in the same community may face different levels of vulnerability. The indirect results of vulnerability are damage or harm caused by different magnitudes of hazards (Birkmann, 2006). Therefore, less vulnerable households/communities are less likely to be damaged than more vulnerable households/ communities although they face the same magnitude of hazard. Moreover, as vulnerability changes over time, the communities affected by previous severe disasters could be weaker in their response to the next hazard while the communities facing a small disaster could develop and strengthen their coping capacities (Birkmann, 2006).

Coping capacity

Coping capacity is the important element in disaster management. It influences the extent of a hazard's harm. A system with higher coping capacity can suffer fewer disaster losses than one with a lower coping capacity. Consequently, coping capacity minimizes disaster risks. The IPCC defines coping as "the use of available skills, resources, and opportunities to address, manage, and overcome adverse conditions, with the aim of achieving basic functioning in the short to medium term", and capacity as "the combination of all the strengths, attributes, and resources available to an individual, community, society, or organization that can be used to achieve established goals" (IPCC, 2012, p. 33). Coping capacity is a measure of a society's strengths and resources to respond and recover from a disaster. The UNISDR defines coping capacity as "the ability of people, organizations and systems, using available skills and resources, to face and manage adverse conditions, emergencies or disasters" (UNISDR, 2009a, p. 8). The key elements to building coping capacity are awareness, resources, and management (UNISDR, 2009a). Moreover, coping capacity can be a part of resilience. Resilience works on most of what coping capacity does; and it ensures the system recovers and remains functioning following a hazard (Birkmann, 2006).

2.2.3 Climate change adaptation

Why climate change

Climate change is likely to affect floods and droughts. On a global scale, the SRES indicates six scenarios for likely global surface warming between 2000 and around 2100 as figure below (IPCC, 2007b). Van and Riahi (2008), argue the IPCC assessment is over optimistic because a "computerized fairy tale" is not reliable. The uncertainty and climate sensitivity make the estimation unclear. However, similar to the IPCC, the MIT Integrated Global Systems Model (IGSM) estimates that by 2100, the CO_2-equivalent concentration would be between 470-1020 ppm while the temperature would increase by 1.8 - 7^{o}C compared to 2000 (Prinn et al., 2010). Business as usual would cause a tripling of CO_2 by about 2100. Consequently, the temperature would increase around 4^{o}C. With an additional 4^{o}C or higher, the world temperature would break the record of the last few million years (AAS, 2010). Moreover, the scenarios project in the IPCC (2007b) and other projections are currently being argued to be out of date. The current climate change scenarios are believed to be much more serious.

Figure 2.1: SRES scenarios projection on global surface warming

Case	Temperature change (°C at 2090-2099 relative to 1980-1999) [a, d]	
	Best estimate	*Likely* range
Constant year 2000 concentrations[b]	0.6	0.3 – 0.9
B1 scenario	1.8	1.1 – 2.9
A1T scenario	2.4	1.4 – 3.8
B2 scenario	2.4	1.4 – 3.8
A1B scenario	2.8	1.7 – 4.4
A2 scenario	3.4	2.0 – 5.4
A1FI scenario	4.0	2.4 – 6.4

Notes:
a) These estimates are assessed from a hierarchy of models that encompass a simple climate model, several Earth Models of Intermediate Complexity, and a large number of Atmosphere-Ocean General Circulation Models (AOGCMs) as well as observational constraints.
b) Year 2000 constant composition is derived from AOGCMs only.
c) All scenarios above are six SRES marker scenarios. Approximate CO_2-eq concentrations corresponding to the computed radiative forcing due to anthropogenic GHGs and aerosols in 2100 (see p. 823 of the WGI TAR) for the SRES B1, AIT, B2, A1B, A2 and A1FI illustrative marker scenarios are about 600, 700, 800, 850, 1250 and 1550ppm, respectively.
d) Temperature changes are expressed as the difference from the period 1980-1999. To express the change relative to the period 1850-1899 add 0.5°C.

SRES scenarios

SRES refers to the scenarios described in the IPCC Special Report on Emissions Scenarios (SRES, 2000). The SRES scenarios are grouped into four scenario families (A1, A2, B1 and B2) that explore alternative development pathways, covering a wide range of demographic, economic and technological driving forces and resulting GHG emissions. The SRES scenarios do not include additional climate policies above current ones. The emissions projections are widely used in the assessments of future climate change, and their underlying assumptions with respect to socio-economic, demographic and technological change serve as inputs to many recent climate change vulnerability and impact assessments. *{WGI 10.1; WGII 2.4; WGIII TS.1, SPM}*

The A1 storyline assumes a world of very rapid economic growth, a global population that peaks in mid-century and rapid introduction of new and more efficient technologies. A1 is divided into three groups that describe alternative directions of technological change: fossil intensive (A1FI), non-fossil energy resources (A1T) and a balance across all sources (A1B). B1 describes a convergent world, with the same global population as A1, but with more rapid changes in economic structures toward a service and information economy. B2 describes a world with intermediate population and economic growth, emphasising local solutions to economic, social, and environmental sustainability. A2 describes a very heterogeneous world with high population growth, slow economic development and slow technological change. No likelihood has been attached to any of the SRES scenarios. *{WGIII TS.1, SPM}*

Source: IPCC (2007b)

As shown in Figure 2.1, temperature is likely to increase in any of the SRES scenarios. B1 is the most optimistic scenario (1.8 ^{o}C increase, range from 1.1-2.9 ^{o}C) while A1FI is the most pessimistic scenario (4 ^{o}C increase, range from 2.4-6.4 ^{o}C). Any increased temperature means that floods and droughts are likely to become more frequent and severe (WHO, 2007). The IPCC (2007b) also indicates that more frequent heavy precipitation events are likely to occur in most areas of the world over the coming years. Precipitation changes are likely to result in increasing drought and flood risk (ODI, 2009; Richard, 2010). Global warming, therefore, will very likely cause increased evaporation as well as increased soil moisture loss in many regions (IPCC, 2007b; Kallis, 2008).

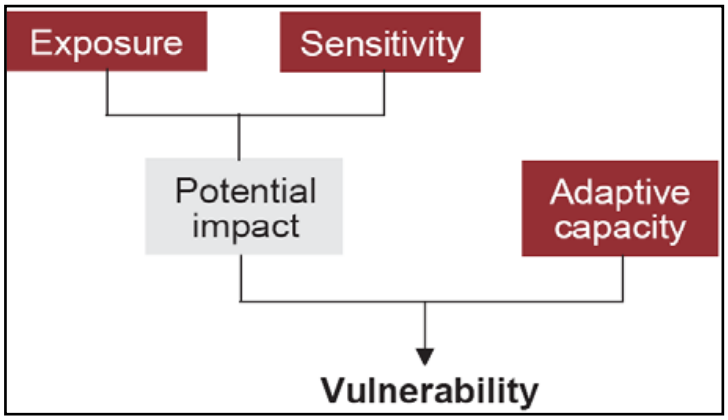
At the regional level, from 1900 to 2005, precipitation increased in central Asia and declined in parts of southern Asia (IPCC, 2007b). Climate change is likely to influence long-term changes in precipitation and temperature and could change local hydrological cycles. Monsoon precipitation in South Asia is also likely to follow an upward trend, which could lead, for example, to peak discharges in main rivers in Bangladesh, again resulting in floods (Mirza, 2002). In developing countries, climate-related variability (changes in temperature, rainfall, drought, and flooding) creates a risk

to rural livelihood (Adger, Huq, Brown, Conway, & Hulme, 2003). A study by the Mekong River Commission (2009) on the Lower Mekong Basin (Cambodia, Lao PDR, Thailand, and Vietnam) indicates that the climate hazards from flooding and drought have already affected crop production, food, income generation, and general uses of natural resources. To conclude, current and future floods and droughts in Cambodia are likely to be affected by climate change; therefore, a climate change adaptation framework would help document what is happening and contribute to a better understanding of the nature of the problem.

Climate change adaptation

The IPCC defines vulnerability as "the degree to which a system is susceptible to, and unable to cope with, adverse effects of climate change" (IPCC, 2007c, p. 883). It should be noted that although the definition of vulnerability in climate change adaptation differs from that of disaster risk management, both share several common points. In climate change adaptation, vulnerability is viewed as a function of exposure, sensitivity and adaptive capacity as shown in Figure 2.2 below. In a more recent concept of disaster risk management, vulnerability is caused by *susceptibility/fragility*, and low *resilience* is used similarly to *sensitivity* and low *adaptive capacity* of climate change adaptation (Cardona, 2006, 2011; McCarthy, Canziani, Leary, Dokken, & White, 2001).

Figure 2.2: Components of Vulnerability



Source: Allen Consulting Group (2005)

Exposure (influences)

Exposure can be defined as "the nature and degree to which a system is exposed to significant climatic variations" (IPCC, 2001, p. 987). It is about *influences* that affect a system (Allen Consulting Group, 2005) and these influences can be variability of extremes and other variables that cause external disturbances to affect a system

(Manning et al., 2011). In disaster risk management, exposure can also indicate elements (people, systems and others) at risk/losses because they are located in vulnerable areas (Birkmann, 2006; UNISDR, 2009a). Therefore, people and elements in the flood- and drought-prone areas would be affected the most.

Sensitivity (a system's responsiveness and changing degree)

The IPCC defined sensitivity as "the degree to which a system is affected, either adversely or beneficially, by climate variability or climate change" (IPCC, 2007a, p. 86). Allen Consulting Group (2005) makes a precise explanation of sensitivity that is the *responsiveness and changing degree* of a system when faced with certain influences. Both direct and indirect impacts can cause a system to be sensitive. For example, the changes in precipitation that affect the magnitude of floods and droughts can be a direct impact leading to vulnerability when a system is sensitive; while the indirect impacts are mainly manifest in socio-economic issues (IPCC, 2007a; Lawrence, Tegg, Reisinger, & Quade, 2011). A sensitive system is easily affected even by a small influence. Sensitivity can be minimised through adaptation (IPCC, 2007b).

Adaptation, adapting capacity, and coping capacity

Adaptation is "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, 2007c, p. 869). Adaptation can be autonomous (reactive) or anticipatory (proactive) (Manning et al., 2011). The autonomous (reactive) adaptation is mostly about a response to actual stress while the anticipatory (proactive) adaptation is about a response to anticipated stress (ADB, 2009; Manning et al., 2011).

Adaptive capacity is about the ability of a system to adapt to stress. The IPCC defines adaptive capacity as "the whole of capabilities, resources and institutions of a country or region to implement effective adaptation measures" (IPCC, 2007a, p. 76). Adaptive capacity includes coping capacity (coping) and the ability to adapt (adapting). Both of these change over time (Lawrence et al., 2011); and their concepts are sometimes difficult to separate but the IPCC (2012) has no problem in providing a distinction. Coping is an action taken to solve a problem. In the face of a problem, a coping position is taken to ensure survival and immediate recovery from unusual stress using whatever limited knowledge, experience, and resources are available (IPCC, 2012). Coping uses successful tactics used in past events and applies these to ameliorate current stress. Coping is achieved when a system can cope with a stress and return back

to its previous state (Manning et al., 2011). Adapting, on the other hand, is about modifying something to suit conditions. Although past strategies can be used, it gives priority to extending these to meet future conditions by developing new strategies through *learning and reinvention* in a proactive manner (IPCC, 2012). Adapting minimizes disturbance through a system's exposure or sensitivity (Manning et al., 2011).

There are various schools of thought on adaption such as the traditional view (technocratic view and actor-centred view) and the resilience view (systems view) (Chapman, 2011; Nelson, Adger, & Brown, 2007). The traditional technocratic view focuses on technological options to respond to disturbances while the traditional actor-centred view focuses on the vulnerability of people. These views focus on some aspects such as specific risks, actors, practices, and governance issues. In addition, a resilience view tries to strengthen the system to respond to changes. Resilience focuses on the interrelationships between socio-ecological systems.

Resilience

Resilience can be viewed through three different concepts including engineering resilience, focusing on recovery, ecological and social resilience, focusing on persistence, and integrated social-ecological resilience, focusing on capacity and transformability (Folke, 2006). All resilience concepts aim to build robustness of a system. This research uses more of the concepts from integrated social-ecological resilience than the other two. Resilience can be defined as "the ability of a social or ecological system to absorb disturbances while retaining the same basic structure and ways of functioning, the capacity for self-organization, and the capacity to adapt to stress and change" (IPCC, 2007a, p. 86). Therefore, adaptive capacity through autonomous and planned adaptation measures play a key role in reducing the vulnerability of a system (Manning et al., 2011). Resilience covers not only the ability to recover to the previous state, known as coping capacity, but is also a measure of how a system is able to withstand dynamic and ongoing pressure (Lawrence et al., 2011). Resilience is a concept accepted by a considerable number of scholars, namely Adger (2000); Aven (2011); Berkes, Colding, and Folke (2004); Folke (2006); Timmerman (1981).

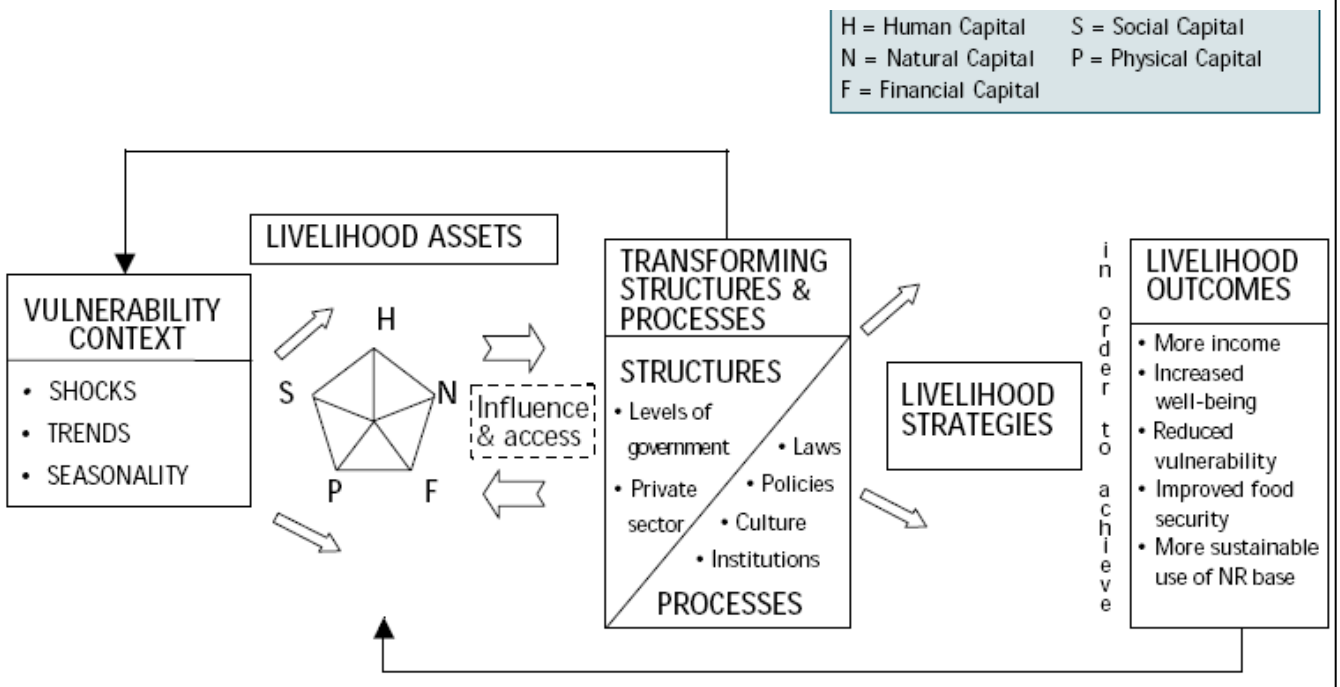
Resilience can be the end-goal of adaptation. Commitment to enhance resilience might be achieved by reducing vulnerability through reducing exposure and sensitivity as well as increasing adaptive capacity. It promotes experience and available resources

to better cope with hazards. Berkes (2007); Folke, Colding, and Berkes (2003); Gardner and Denkens (2007) recommend several elements that can build community resilience from natural hazards within environmental changes and these are adaptation (coping and adapting); reflection, knowledge development and learning; flexibility; and creating opportunities.

2.2.4 Sustainable Livelihoods framework

The Sustainable Livelihoods framework consists of five pillars: *vulnerability context, livelihood assets, transforming structures and process, livelihoods strategies* and *livelihood outcomes* as outlined in the figure below. This concept was developed originally from ideas put forward in the Brundland Report 1987 followed by Chambers and Conway in 1992 (Birkmann, 2006; DFID, 1999). They viewed livelihood capabilities and assets as a means to achieve livelihoods, and focused on coping and recovering from disturbances as a means to achieve sustainability (Chambers & Conway, 1991; DFID, 1999).

Figure 2.3: The Sustainable Livelihoods framework (SLF)



Source: DFID (1999)

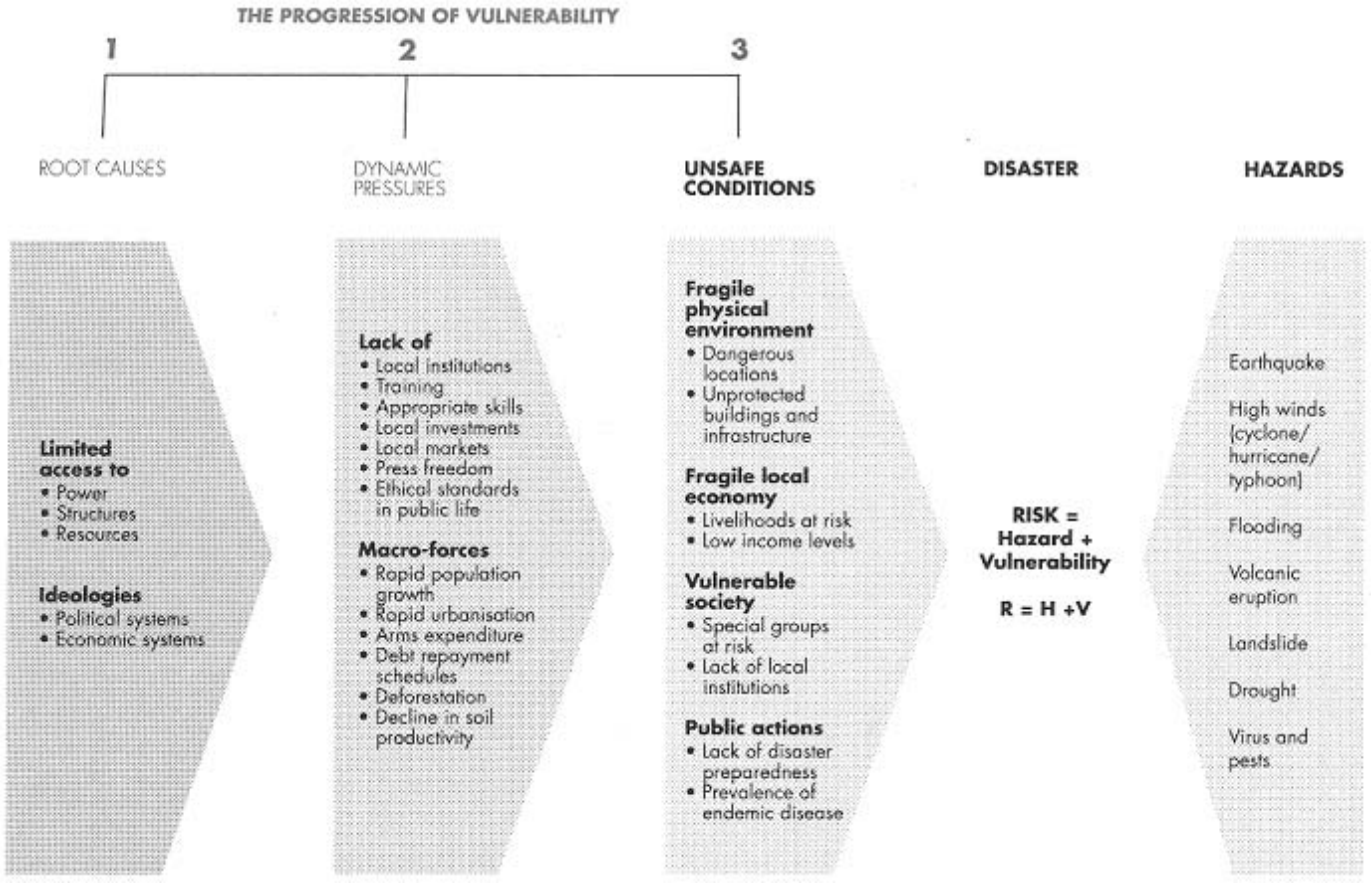
The framework first designed by Ian Scoones (IDS, 1998) provides a summary, starting with the vulnerability context, of the transforming structures and processes that influence livelihood assets and access to resources that are used by people to design strategies which in turn determine livelihood outcomes. Each of the pillars, access to livelihood assets combined with the vulnerability context (shocks, seasonality and

trends), and how both transforming structures and processes work, are key elements of sustainability. The framework highlights the importance of vulnerability that has to be minimised if positive livelihood outcomes are to be achieved. The framework reminds us that if a resilient community is to be set up on the foundation of positive livelihood outcomes, these outcomes must be negotiated through a complex social-environmental system (Adger, Hughes, Folke, Carpenter, & Rockstrom, 2005).

The SLF shares ideas similar to those found in other frameworks and disaster notions (Birkmann, 2006). The five livelihoods assets or capital could be elements of exposure and susceptibility as well as resources that contribute to coping capacity (Birkmann, 2006). Shocks occurring in the vulnerability context can be given substance as floods and droughts. The transforming structures and processes are similar to root causes that can result in dynamic pressures and driving forces that add negative strength to vulnerability as in the pressure and release (PAR) model (Birkmann, 2006), explained in the paragraph below. The livelihood strategies, where successful, can be seen as coping capacity/adaptation changes that contribute to a system's resilience in a sustainable way.

As vulnerability is the main concern in this research, I have chosen to discuss what must be done with reference to the pressure and release (PAR) model. This model follows the reasoning that disasters are the result of a vulnerability created by pressures that start from root causes, build into dynamic pressures and eventually develop into unsafe conditions (see figure below). Root causes could be economic and political processes that influence the distribution of, and access to, power and resources. Dynamic pressures are processes that find their origin in such things as lack of training and declining soil productivity that transform root causes into unsafe conditions. Unsafe conditions are expressed in terms of human vulnerability characterised by an increase in the number of people exposed to hazards leading to disasters. Therefore, this model aims to relieve these pressures, especially root causes (economic and political systems), in order to minimise vulnerability and disasters.

Figure 2.4: The Pressure and Release model



Source: Blaikie et al. (1994)

2.2.5 My research approach

I use a hybrid of the development and complexity paradigms described earlier in order to develop my research framework as in the figure below. The complexity paradigm in this research is that it focuses on long-term sustainable livelihoods and resilience. It also considers society-nature interactions through inclusion of climate change and dam construction. Therefore, an integrated approach to climate change adaptation framework and disaster risk management is used. The development paradigm in this research focuses on vulnerability that is a cause of disaster and ways to reduce vulnerability and to build coping capacity/adaptation.

In Figure 2.5, the orange box in the framework shows vulnerability. In the climate change adaptation framework, vulnerability is the function of adaptation and potential impacts consist of exposure and sensitivity. Moreover, in the field of disaster management, disaster is a function of vulnerability and natural hazards. Based on this concept, I add hazards to this box to illustrate how disasters occur. Disasters can be severe when both vulnerability and natural hazards are increased. Therefore, the keys to solve the problems can best be found by focusing on the nature of both vulnerability and

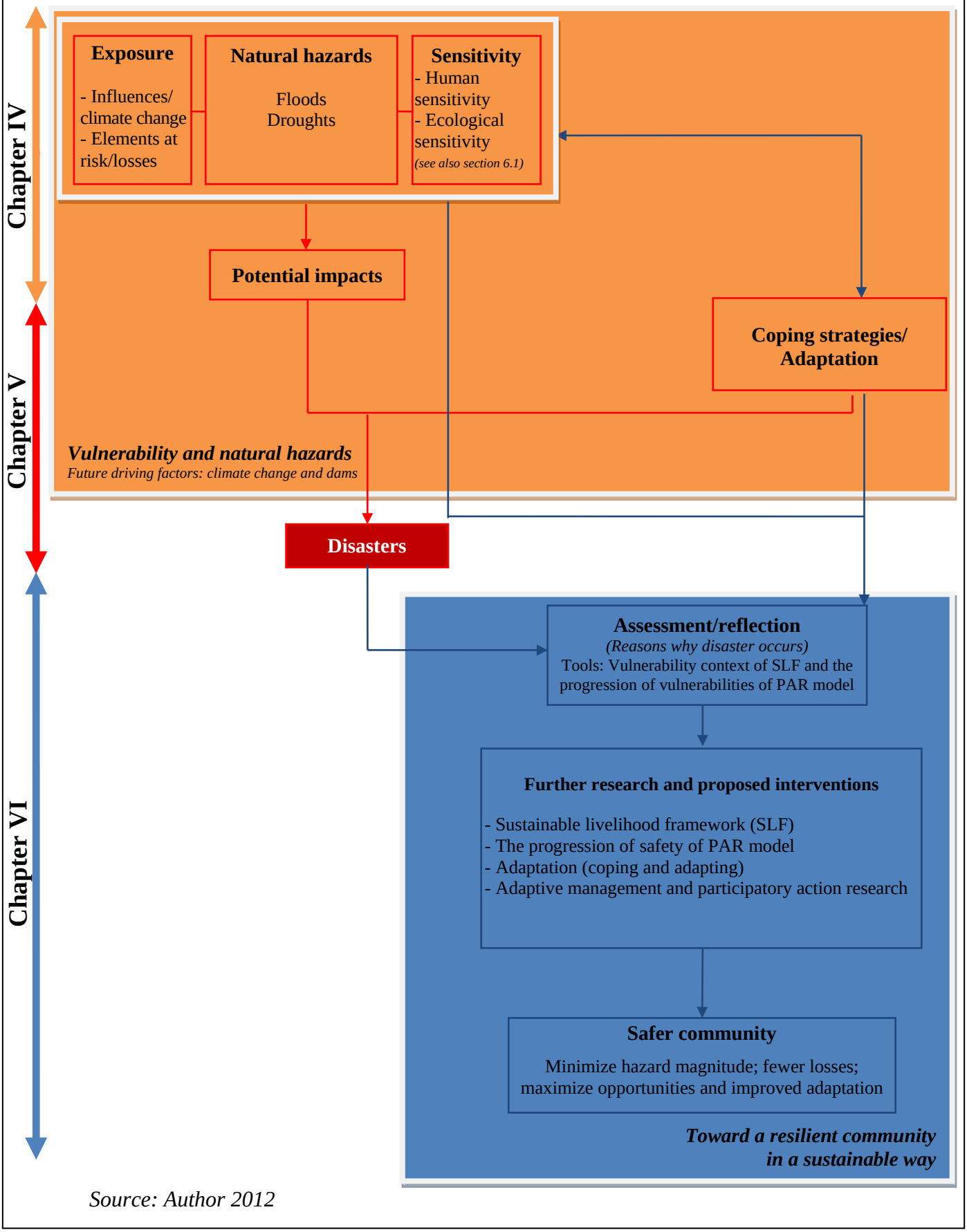
natural hazards. Furthermore, as the research area is located in the Mekong River Basin, the future climate change and dam construction in the Mekong River Basin are likely to influence floods and droughts.

In Figure 2.5, the blue box shows root causes of vulnerability and proposed solutions. Vulnerability is explored through the Sustainable Livelihood framework (SLF) and the pressure and release (PAR) model. Using these tools, the processes causing vulnerability and the processes minimising vulnerability can be seen clearly.

Also, the actual future influence is not completely known and the sensitivity of society to natural hazards is not easy to predict. Firstly, Smith and Petley (2009) proposed three patterns of socio-economic tolerance towards hazards. Over time, socio-economic tolerance may remain unchanged even while the trend of the hazard is threatening to become either less or more severe. The socio-economic tolerance may decrease over time although the trend of the hazard does not change. Secondly, adaptation and adjustment that work one time may not work at another time due to variability within a system (Campbell & Ericksen, 1990). The range of adaptation may either remain constant or change over time. Adjustments to a system can be used to amplify the range of adaptation. However, at some time, extreme events may occur in a specific time in a return period for example of 10 years or 100 years. As the frequency of events increases, the adaptation and adjustment process may simply not be able to cope. Therefore, other strategies such as emergency services or other rescue mechanisms need to be planned in advance. These lead to uncertainty. As a result, adaptive management and participatory action research are introduced in order to solve uncertainty, resulting in a safer community (see **Section 6.3.5**).

As shown in Figure 2.5, the framework illustrates three main components including natural hazards and potential impacts, disasters and coping strategies, as well as vulnerability and proposed interventions. These three components will be elaborated in detail in Chapter IV, Chapter V, and Chapter VI respectively.

Figure 2.5: My research framework



Source: Author 2012

Chapter III: Methodology

This research follows Crotty (1998) who suggests a consideration of epistemology, theoretical perspective, methodology, and methods in the research design. Epistemology is the theory of knowledge either subjective or objective while theoretical perspective is the philosophical stance (Creswell, 2003). The theoretical perspective used in this research is constructivism. Methodology is a strategy used to reach outcomes such as field research, while methods are research techniques such as Focus Group Discussions (FGDs), Semi-Structured Interviews (SSIs), observation, and secondary data collection. All of these considerations will be elaborated as below followed by ethical issues, research limitations, and data analysis.

3.1 Research focus and methodology

The research objectives and questions were stated in **Chapter 1**. This chapter outlines the methodology used to achieve those objectives. As a researcher who went into the exercise wanting to identify ways in which a more resilient community could be built my interest was more than academic. The methodology was designed to research hazards and disaster impacts as well as the factors influencing disasters singled out for study. It was also necessary to identify ways that enable people to cope with disasters and how these might be changed for the better.

To achieve the research objectives, a mixed assembly of qualitative and quantitative data collection was used. In my view this strategy promised to achieve the best overall understanding of the problems involved which would enable me to not only explore the nature of the problem/s themselves but also to lead to better solutions. As a result, both deductive and inductive reasoning was used. Deductive reasoning usually starts with theoretical framework working towards empirical evidence, while inductive goes the opposite way (Neuman, 2005). This research uses the deductive reasoning to explore factors leading to hazards and disasters. The inductive reasoning was the main focus and it was shown in the suggested framework in Figure 6.6. This framework can be used as a guide to creating a safer community that will be better able to cope with future uncertainty.

Qualitative field research brings many advantages. It allows researchers to observe the rural people's social lives that are the important inputs to assess people's livelihoods and their vulnerability. Qualitative research enables the researcher to be flexible to the situation in the field in order to maximise research outputs. The

researcher worked closely with research subjects so that some of the sensitive information could be discovered. The voice of participants, especially the poor, was given priorities in my research. The poor had equal opportunities to share information and express their ideas which were signs of empowerment. The research was informed more by subjectivity than objectivity. According to Robinson (1998), the researcher's interpretations are given privilege because they could understand the actual situations in the research area through the collaborative work and their own observation.

Although this research is both qualitative and quantitative, constructivist is the main proposed theoretical perspective. Qualitative data is the priority while quantitative data is only to complement some gaps in qualitative data such as socioeconomic, climatic, and disaster data. Social constructivism, can be combined with interpretivism, after Berger and Luckmann (1967) and Lincoln and Guba (1985) (Creswell, 2003). Social constructivism often uses subjectivity to understand the world, and it focuses on the complexity of views collected mostly through interactions or discussions of open-ended questions with people (Creswell, 2003). Crotty (1998) showed that constructivism is a qualitative research which interpretations are made based not only on historical and social perspective in the research area, but also the experiences and background of the researcher. Guba and Lincoln (1989, p. 180) mention fairness deals in constructivism as a "deliberate attempt to prevent marginalization, to act affirmatively with respect to inclusion, and to act with energy to ensure that all voices in the inquiry effort have a chance to be represented in any texts". Therefore, my research followed these.

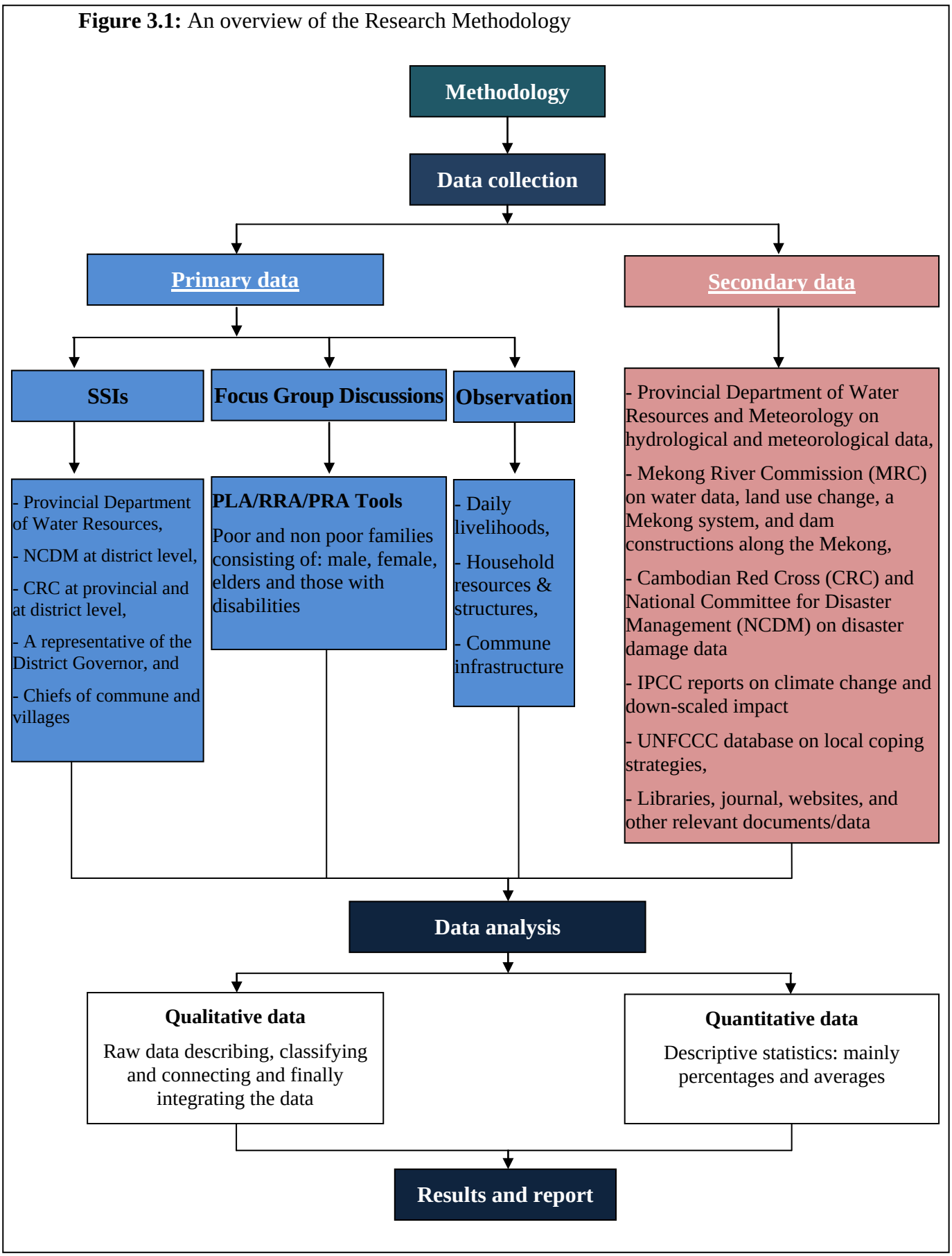
Qualitative and quantitative data was collected by accessing sources of both primary and secondary data. I found it rewarding to follow the example of Creswell (2003) who has shown that integrated information drawn from both qualitative and quantitative data sets enables the researcher to make a much more comprehensive analysis of problems.

3.2 The methods of data collection

Both primary and secondary data collection, as shown in the figure below, was used in order to collect required data for the research objectives. Primary data collection involved fieldwork, while secondary data was drawn from relevant documents. Qualitative data was mainly collected through primary data of field research where the researcher took notes and observed through Focus Group Discussions (FGDs), Semi-Structured Interviews (SSIs), and observation. Observations made in the field provided

an additional source of primary data. Quantitative data mainly involved existing statistics research which the researcher collected, for example relevant data, documents, reports, and publications both at a national and global scale.

Figure 3.1: An overview of the Research Methodology



3.2.1 Primary data

The research used a number of individual and group discussions in order to investigate the natural hazards of floods and droughts and their disastrous impacts on rural people's livelihoods. It also looked at coping options and the ways people think they will be affected by future floods and droughts. Moreover, information on their socioeconomic conditions along with other factors leading to vulnerability, the main cause of disasters, was also collected. To fully document this I conducted field-level stakeholder meetings and Focus Group Discussions (FGDs) with local authorities and communities. In the field-level stakeholder meetings I used Semi-Structured Interviews (SSIs) to get general and specific information. The nature of floods and droughts and the hydrological system in the study area was mainly obtained from the Semi-Structured Interviews (SSIs). Information relating to households, community resources, socioeconomic and the general situation of the commune was collected from local authorities during the SSIs. SSIs also examined the participants' organisations' roles and existing policy frameworks related to floods and droughts. To explore the trend of floods and droughts, a record of climatic data was collected during the SSIs from the Provincial Department of Water Resources and Meteorology. Information regarding floods and droughts, both of which had disastrous impacts on rural people's livelihoods and their coping options, were mainly collected through Focus Group Discussions.

The fieldwork was conducted in Sdau Kaong Commune, Baphnum district, Prey Veng Province of Cambodia between early May and late June and divided into three phases. In the first phase, I visited local authorities and related stakeholders to ask for their support and to get general information. The research commune was also visited and initial networking with local people was implemented. In the second phase, the Focus Group Discussions (FGDs) and observation were fully conducted. After that, a brief summary of the results was reported back to the participants and missing information was also collected.

Sample size and sampling technique

In the SSIs, the participants in these meetings included both local government and non governmental agencies working on these issues. The researcher conducted SSIs with eight representatives from the Provincial Department of Water Resources, NCDM at district level, CRC at provincial and district levels, a representative of the District Governor, and chiefs of a commune and two villages. In addition, I conducted FGDs with people in Sdau Kaong Commune, Ba Phnum District, Prey Veng Province (see

Section 6.1 for social-economic status and profile of the study area). These FGDs consisted of groups of both genders, of young and older members, including village chiefs, and commune councils who knew the nature of floods and droughts in their commune. As shown in the following table, 14 people from poor families and 16 people from the non-poor families joined the FGDs. It should be noted that the criteria for well-being analysis are shown in **Section 6.1**. These people came from four villages of the commune, and they were selected based on their well-being status, gender, and age as shown in the table below. Three of these villages experience floods and the other is susceptible to droughts. A field work checklist and question guidelines has been reproduced in **Appendix I**. These were prepared prior to fieldwork.

Table 3.1: Characteristics of group discussion participants

Characteristics	**Group discussion participants**	
	Number	**Percentages**
Wealth		
Poor	14	47%
Non-poor	16	53%
Total	30	100%
Gender		
Male	13	43%
Female	17	57%
Total	30	100%
Age Group		
18-35	3	10%
36-45	9	30%
46-60	12	40%
60^{+}	6	20%
Total	30	100%
Location (villages)		
Ta Kouk	6	20%
Krang Chen	11	37%
Siem	8	27%
Prey Kantrong	5	17%
Total	30	100%

Source: Fieldwork 2012

PLA/RRA/ PRA Tools used

This research focuses on rural people's livelihoods and the ways these livelihoods link to vulnerability and disasters. Within this context, participatory research works very well. Participatory research allows marginalized groups to take part in research processes and it is more likely to be subjective qualitative research where researchers act as facilitators (PALDIN, 2007). Participatory Learning and Action engages local people to participate in an activity in order to stimulate a mutual learning process where an outsider acts as a facilitator rather than an expert (IIED, 2009; McKinnon & McKinnon, 2010). PLA can be used to support the development of adaptation within a participatory context (IIED, 2009). It promotes local participation and a bottom up approach widely considered suitable for rural communities in developing countries, especially "putting the last first" as suggested by Robert Chambers (Chambers, 1983; IIED, 2009; McKinnon & McKinnon, 2010). Chambers (1983) advocates a notion that brings the poor and the marginalised people into the development processes especially in a participatory way. In addition, in the 1960s, urban bias and unfair distribution of resources and power were perceived by Michael Lipton as elements leading to some of the reasons why the poor stayed poor (Lipton, 1977). As shown in the following table, the PLA/RRA/PRA tools used in this research are participatory and bring the marginalised people into the focus of the research.

Table 3.2: Tools used for this research

Tools	**Participants/remarks**
Well being Analysis	Used available recent data from the commune
Hazard mapping	Chief of the commune and others
Historical Timeline	Poor and Non-poor families, 15 participants in 1 session
Seasonal Calendar	Poor and Non-poor families, 30 participants in 2 sessions
Networks and Mobility Mapping	Poor and Non-poor families, 30 participants in 2 sessions
Institutional Analysis	Poor and Non-poor families, 30 participants in 2 sessions
Problem and possibility Analysis: 1. Problem: damages 2. Propose solution: coping options	Poor and non-poor families consisting of male, female, and elder people; 30 participants in 4 sessions
Transect walk	One guide, the chief of the commune

Source: Fieldwork 2012

Well-Being Analysis: This exercise aims to classify the socio-economic conditions of villagers. The poor and non-poor families face different levels of vulnerability to floods and droughts. I used the well-being criteria developed by the Ministry of Planning (see **Section 6.1** for details). After measures of well-being were explored, the following PLA/RRA/PRA tools were used with both the poor and non-poor families.

Hazard mapping: With the guidance of the Commune Chief helped by several locals the researcher drew a hazard map of floods and droughts. A sketch map of the commune along with its significant infrastructure was outlined. Villages were categorized into different zones based on the severity of their level of exposure to flood and/or drought.

Historical Timeline: This was just a small exercise that I used to record the flood and drought events over the past decade; significant disasters were identified and discussed.

Seasonal Calendar: With the help of farmers I drew a diagram that recorded the local annual farming cycle and when other significant events including floods, droughts, and food shortage were likely to occur. It was used to establish the pattern of villager activities. This allowed me to not only find out when hazard and disasters are likely to occur but also which activities are affected. The most recent significant events were also recorded.

Institutional Analysis and Network and Mobility Mapping: This work explored the relationships between local inhabitants and other institutions both inside and outside the community. It was undertaken to establish the quality and significance of different relationships, and their purpose. In addition, Network and Mobility Mapping were used to understand various contacts within and outside the community. I also used these tools to show the flow of resources to and from the community.

Problem and Possibility Analysis: This exercise was the main focus of my fieldwork. It was designed to explore the problems and issues relating to floods and droughts. Disaster damage was discussed in detail with participants in group discussions. After these, existing and proposed coping options were identified by participants from the community.

Transect walk: In the course of a transect walk, notes were taken on the nature of the environment in the commune. This was undertaken with a local guide, the chief

of the commune. My primary focus was on the three principal resources including crops, livestock, and soil within the floodable paddy, drought-prone paddy, canal and water courses, as well as village land and houses. A range of significant features were also recorded.

Participant - Observation

Participant - Observation was used in this research to establish the nature of how local people go about securing their daily livelihoods and how villagers deal with everyday matters. I called at some households to find out what resources and structures they had at hand that could be used to cope with disasters. I also evaluated the commune infrastructure such as roads, canals and high ground to get an independent idea of vulnerability and the capacity of the commune to deal with disasters. These observations enabled me to build up an independent 'file' of information that was very useful when it came to cross checking the other information collected.

3.2.2 Secondary data

Relevant data, documents, reports, and publications from both the national and global level were collected and reviewed. The Cambodian Red Cross (CRC) and the National Committee for Disaster Management (NCDM) provided useful data on damage caused by floods and droughts. Moreover, the UNFCCC database on local coping strategies, community based adaptation strategies, knowledge, mechanisms, and experience from other developing countries was also found to be extremely useful (UNFCCC, 2007) because it outlined local coping strategies that have been used in other settings subject to specific hazards or climate conditions. Consequently, it was used as the main validation of my fieldwork

Several readily available sources of secondary data were used. Libraries and journal articles were consulted. These provided not only useful concepts but also some related comparative studies that enabled me to check how both my research methods and results measured up against other studies. A range of websites were accessed frequently in the search for information, including online newspapers (www.dap-news.com), data on disaster losses (www.emdat.be), information about the Mekong River (www.mrcmekong.org), information about disaster management in Cambodia (www.ncdm.gov.kh), information about global disaster risk reduction (www.unisdr.org), climatic data (www.wmo.int), and general search (www.google.com). The policy frameworks reviewed and used in this study were mainly collected from websites.

In addition, related hydrological and meteorological data was collected from the Provincial Department of Water Resources and Meteorology (PDOWRAM) and the Mekong River Commission (MRC). Their data documented water levels, rainfall, and temperature. MRC has also produced several reports on the likely future incidence of floods and droughts. I used these findings as well as hydrological and meteorological data from PDOWRAM to draw my own conclusions on the likelihood of future floods and droughts. I was interested in comparing scientific data and findings with local perceptions as a measure of preparedness, and addressed the question of what local people expect to face in the future. The IPCC (2007b) reports and more up-to-date documentation on relevant down-scaled impacts were used to support the projection of future climate change and its likely impacts on floods and droughts.

3.2.3 Ethical Issues

The research followed VUW ethical guidelines relating to academic integrity and human ethics. I also made sure it was consistent with the ethical code laid down in 1998 by the American Anthropological Association (AAA). The Ethics approval was obtained before fieldwork was undertaken.

The data collected was treated as confidential; and an undertaking was given that no names would be used in the report findings. Consent to participate was given verbally in a manner consistent with Khmer culture. An Information Sheet on the nature of the research was made available to participants in both English and Khmer and my supervisor provided a letter of recommendation which identified the academic nature of my research and attested to my institutional affiliation. These were translated into Khmer and given to SSIs participants and the Commune Chief. Access to the collected information is restricted. The information obtained will be destroyed within two years of the completion of the project.

3.2.4 Limitations

Some data of interest and relevance was not available. Although the 2000 flood was reported as the biggest flood in the last decade I could not find information on flood damage from the local authorities at district level. During the early days post-conflict, reconstruction data was not stored properly and the office was moved several times. I was not able to find this information while conducting fieldwork and given the time constraint had to let the matter drop. Information on more recent floods was available but data on droughts was very limited. Moreover, climatic and meteorological data is

limited to the last few decades only, especially after 1984, and this limits the researcher in building the trends of rainfall, temperature, and water level.

Several unexpected issues arose while I was in the field. The study was conducted during the start of the wet season when most families were busy cultivating their rice. People often started work in the early morning and came home at noon. This restricted the time I could work with them. I was also constrained by restrictions around the commune elections. Local officials made it clear they did not like to have strangers around asking questions either immediately before or during elections and I was obliged to wait three weeks until the election was over. As my time in the field did not coincide with either a flood or drought event I was unable to see directly how people cope with these events.

3.3 Data analysis

Data analysis is a very important element of the research. As this research is more subjective, information was crosschecked between primary and secondary sources in order to assess its validity and reliability for both the data itself and interpretations made by the researcher. Information assembled from related studies and journals also became part of the triangulation exercise. The quantitative and qualitative data were analyzed as follows, for:

- quantitative data, descriptive statistics (mainly percentages and averages) were processed using computer software, MS-Excel;
- qualitative data analysis was evaluated using an iterative process recommended by Dey (1993) that started from raw data such as field notes, summary records of meetings and interview texts from which salient points were extracted, the information was then classified and combined with similar material across the board and finally where possible integrated with quantitative data (Dey, 1993).

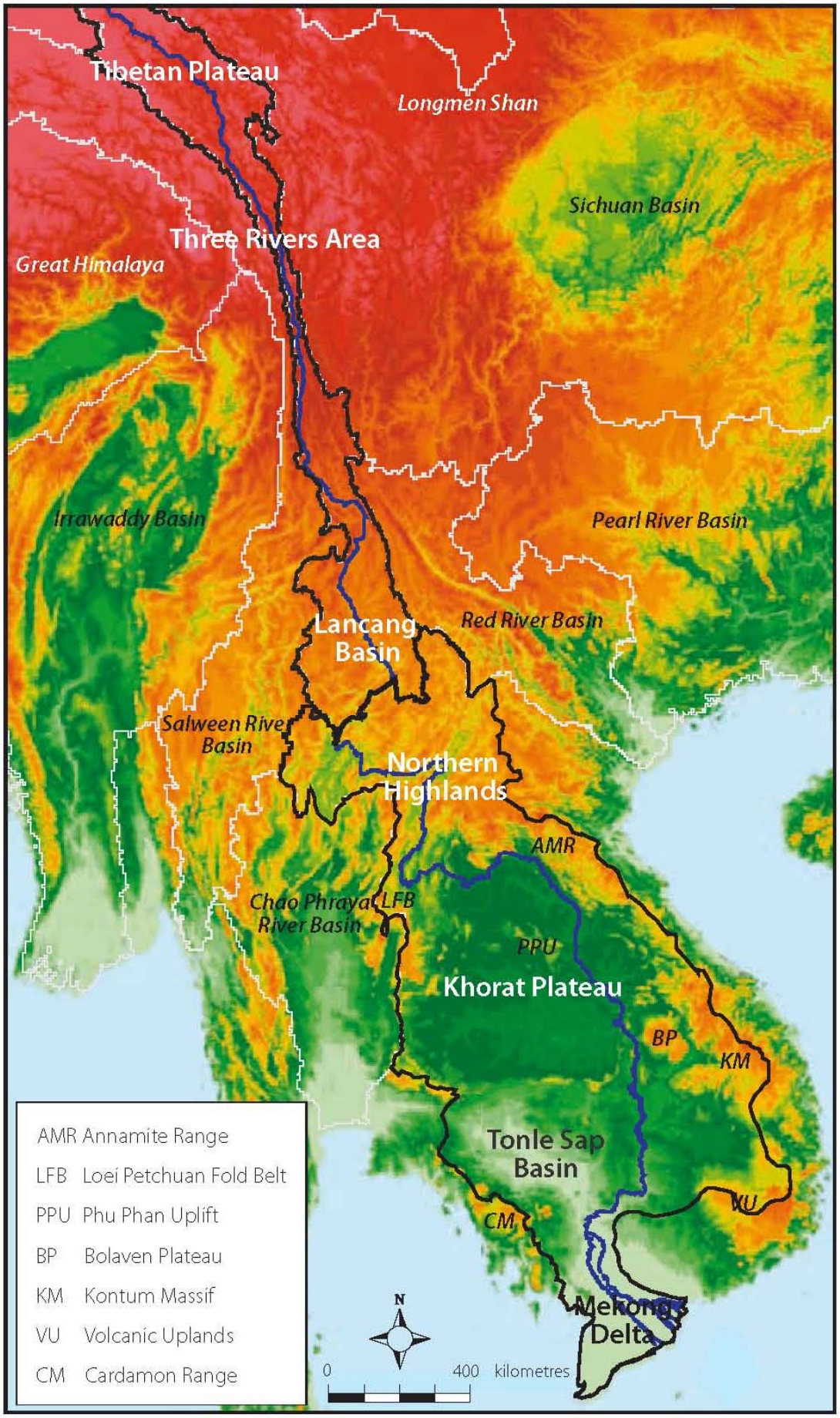
Chapter IV: The Mekong River and the context of floods and droughts

Disasters are the outcomes of natural hazards coinciding with vulnerability. This chapter focuses only on the natural hazards of floods and droughts. In order to explore these natural hazards, regional and global contexts that lead to floods and droughts need to be understood. As the Mekong River is the main cause of floods and droughts in the study area, its system and basins have to be reviewed. Moreover, future floods and droughts are likely to be affected by climate change and regional dam construction along the Mekong River. As a consequence, in order to prepare and plan for future disaster interventions, climate change and dam construction plans need to be included in this study. This study limits its scope to focus only on these factors, and the following sections show details.

4.1 Geography, locations and susceptibility

The study area is located in a flood plain of the Mekong River Basin. As mentioned in Chapter 1, its basin covers an area of 795,000 km^2 from the source in the Tibetan Plateau of China to the end point in the Mekong Delta of Vietnam. As shown in Map 4.1 below, the physiographic regions of the Mekong River Basin can be divided into seven broad areas within the Upper and Lower Mekong Basin. The Upper Mekong Basin, located in China and Myanmar, contains three physiographic regions including the Tibetan Plateau, Three Rivers Area and Lancang Basin; while the Lower Mekong Basin, located in Lao PDR, Thailand, Cambodia and Vietnam, consists of the Northern Highlands, Khorat Plateau, Tonle Sap Basin and Mekong Delta (Elhance, 1999; MRC, 2012b; Radosevich & Olson, 1999).

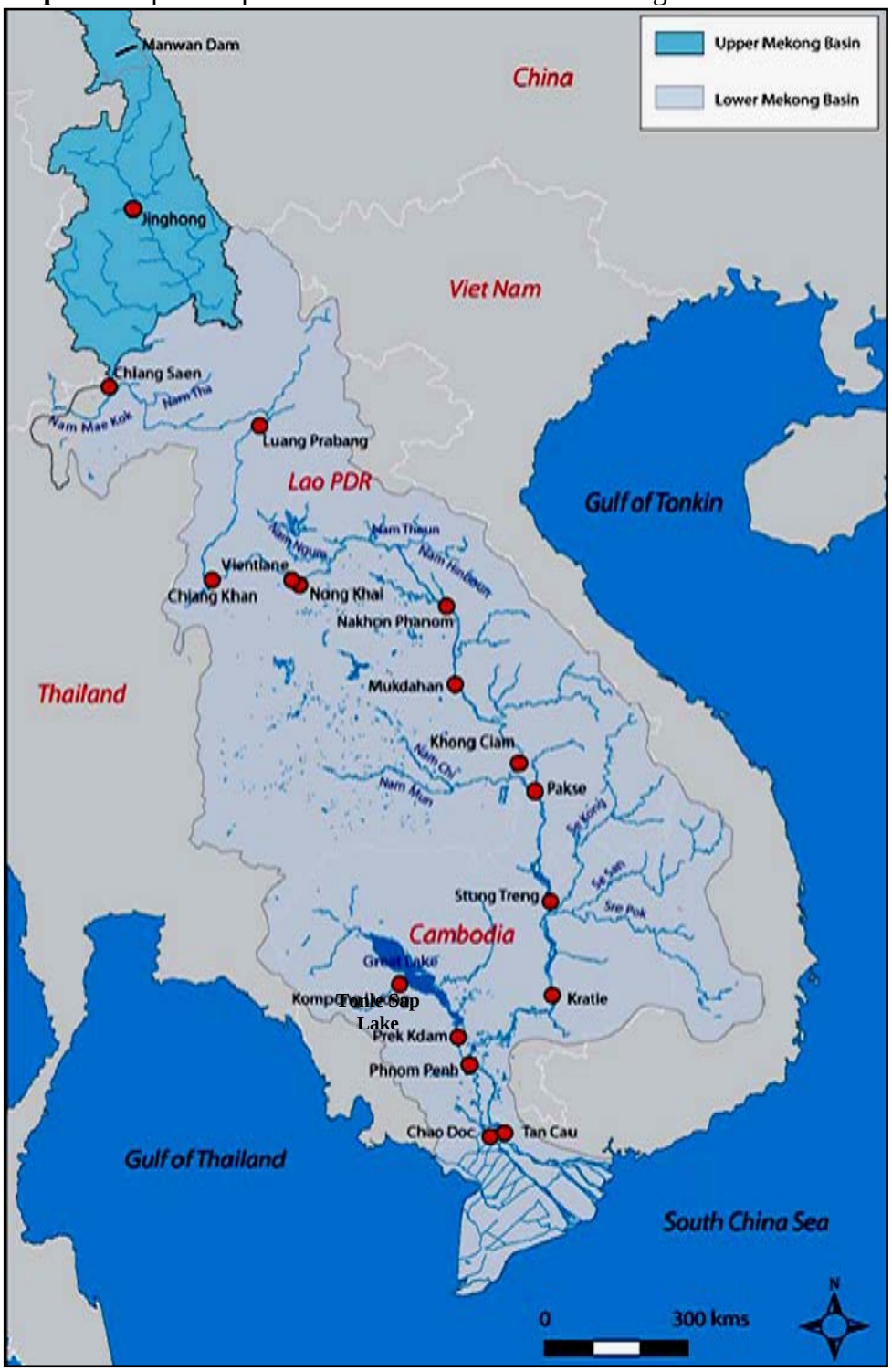
Map 4.1: The Mekong Basin and its seven physiographical regions



Source: MRC (2011a)

Only 16% of the total annual flow that runs into the South China Sea originates in China, most enters the rivers from tributaries, from the left and right bank (see Map 4.2 and Table 4.1 for details). However, in the dry season the flow from upstream, snow melt from China, makes up approximate 24% of the total flow.

Map 4.2: Important places and rivers within the Mekong Basin



Source: MRC (2011a)

Table 4.1: "Proportional contributions to total Mekong River - mean annual flow by river reach"

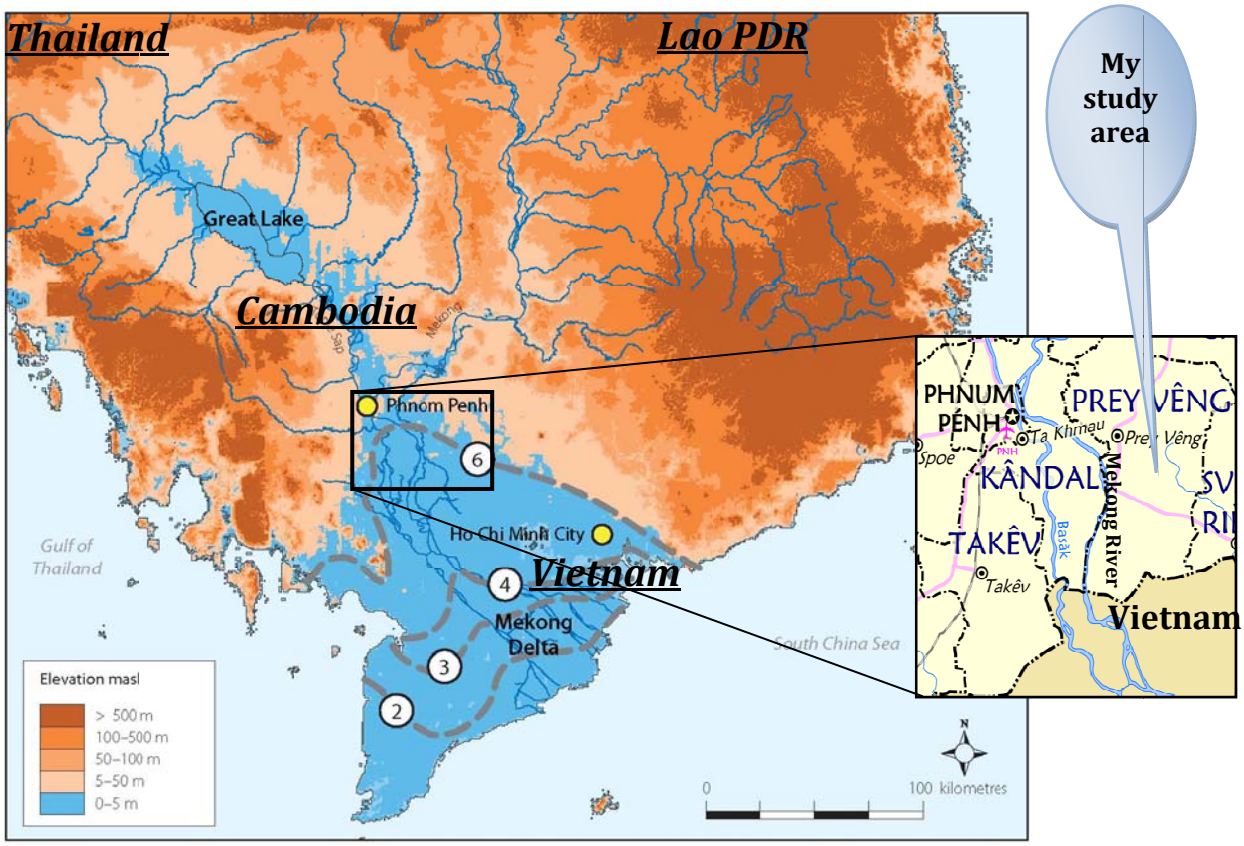
River Reach	Left Bank (%)	Right Bank (%)	Total (%)
China	16		16
China – Chiang Saen	1	3	4
Chiang Saen – Luang Prabang	6	2	8
Luang Prabang – Vientiane	1	2	3
Vientiane – Nakhon Phanom	18	4	22
Nakhon Phanom – Mukdahan	3	1	4
Mukdahan – Pakse	4	6	10
Pakse – Kratie	22	2	24
Tonle Sap	9		9
Total	**55**	**20**	**100**

Source: MRC (2012a)

The above table shows that most of the mean annual flow by river reach comes from the Lower Mekong Basin starting from Chaing Saen until Tonle Sap. This represents approximately 80% of the total mean annual flow by river reach within the Mekong River.

The study area, located within the lower section of the Lower Mekong Basin, through which flows the Kampong Trabaek River (which local people call Prey Kduoch River because it flows through Prey Kdouch Village prior to reaching this commune). This river, a diversion of the Mekong River, flows southward from the main stem to Sdau Kaong Commune. Located within the Lower Mekong Basin, the maximum height above sea level between zero and five metres (shown in Map 4.3**)**, the Kampong Trabaek River joins with various diversion rivers/streams of the Mekong River prior to reaching the Mekong Delta of Vietnam and the South China Sea. The flood plain gently slopes towards the south and as the description would suggest, is susceptible to floods. Water levels in the study area tie in closely with the global increase in water levels, but of course they are determined by regional water levels in the Mekong River Basin. Floods usually occur between mid August and mid October. The hydrological station at Neak Luong measures the water level and flood risk in the study area (see figure below). It should be noted that 80-90% of the annual volume of water collected in the Mekong River Basin flows out between June and November (MRC, 2012a).

Map 4.3: Elevation in the research area

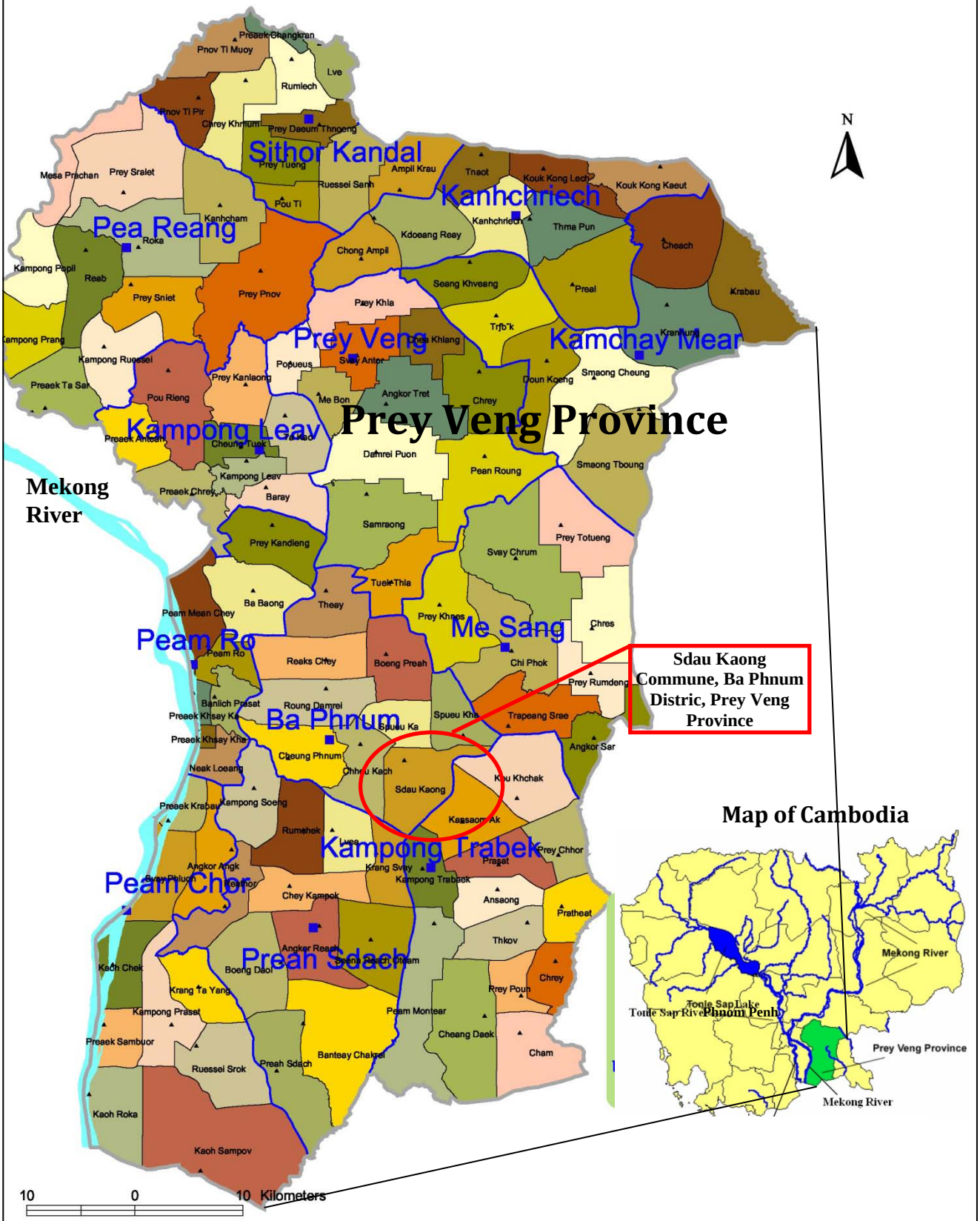


Adapted from MRC (2010) and NCDD (2009a)

The study area is in Sdau Kaong Commune, located in Ba Phnum Distric, Prey Veng Province as shown in Map 4.4. Prey Veng is one of the 24 provinces in Cambodia. It is located in the south of the country. This province, with an area of 4,883 km^2, has 12 districts, 116 communes, and 1139 villages. With a population growth of approximately 2% per year, this province has a population of 1.12 million, equal to 41,975 families in 2008 (NCDD, 2009b).

Sdau Kaong Commune consists of 15 villages, as shown in the table below. This commune is bordered by Spueu Ka and Spueu Kha Communes to the north, Chheu Kach Commune to the west, Kansaom Ak Communes of Kampong Trabek District to the east, and Krang Svay Commune of Preah Sdach District to the south. It lies east and approximately 85 km (2 hours drive) from Phnom Penh and approximately 40 km (1 hour drive) south of Prey Veng Town.

Map 4.4: Administrative map of Sdau Kaong Commune, Ba Phnum Distric, Prey Veng Province, Cambodia and main national rivers



Adapted from I. Ramage, Pann, S., Eng, S. (2003) and WFP (2000)

4.2 Hazard identification

4.2.1 Floods

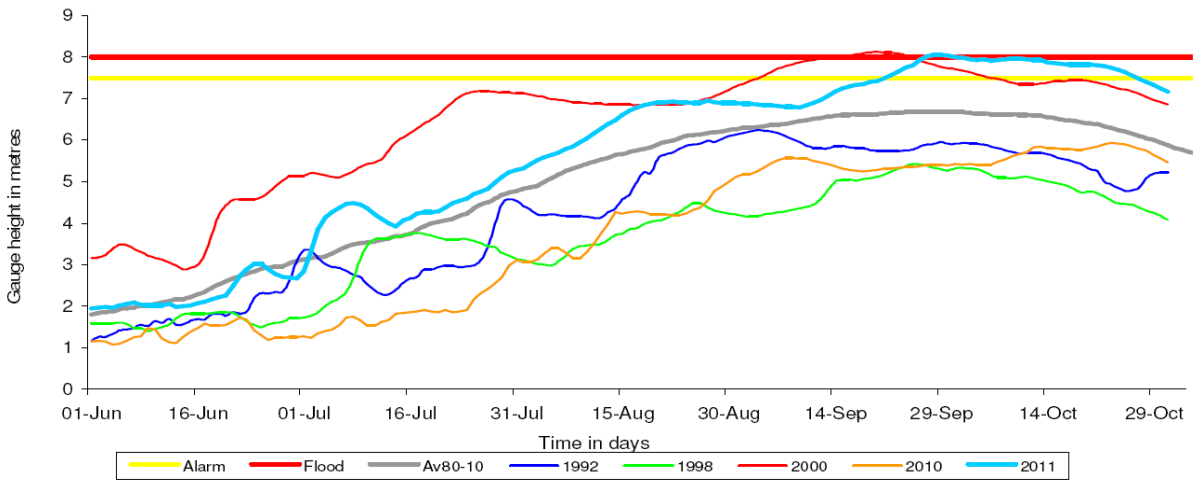
Origin

The main cause of floods in Prey Veng Province is the result of rising water levels in the Mekong River, followed by heavy rainfalls at local, national, and regional level in the catchment of Mekong tributaries. Floods in this area extend over the flood plain. Even though the scale of the floods is large, the speed at which the water rises is not dangerously fast. However, in some cases when flood control and related infrastructures collapse, the water level may increase faster than normal and create a considerable hazard. In general, the maximum water level can increase up to 40 cm per night (Kea, Heang, Prak, & Brun, 2005) without causing undue concern.

Frequency and historical record

As the area is located in the Mekong River flood plain, floods are normal events. Historical records indicate that major floods can be expected every 5 years or so although longer return periods may be seen. However, since 1996, it is believed that floods have become more frequent and severe. For example, in 2000 the number of floods broke the record for damage caused over the last 70 years (Kea et al., 2005). As shown in the figure below, a recent flood in 2011 was nearly the same size as the 2000 event.

Figure 4.1: Observed water level at 7am at Neak Luong hydrological station of the Mekong River



Source: MRC (2011a)

Duration

The duration of floods in this area vary between 0 and 90 days. In most cases, floods subside after a short period. However, it is estimated that the average flood lasts for about 17 days (Kea et al., 2005).

4.2.2 Droughts

Origin

The main causes of droughts in Prey Veng Province are water deficit in canal, ponds, and underground water, rainfall deficit, and soil moisture deficit. The water deficit in canal, ponds, and underground water usually occurs in the dry season and can be attributed on one hand, to the demand for water and on the other hand, to lower water levels and discharge of the Mekong River. This also affects the water levels of the Kampong Trabaek River where original canals and a new irrigation system get water to irrigate the commune. Moreover, about three-quarters of the annual rainfall in Cambodia usually comes from the southwest monsoon between May and October (Dyoulgerov, Bucher, Zermoglio, & Forner, 2011). If its arrival is delayed and/or the demand for agricultural water is excessive, this results in both soil moisture deficit and ‘wet season’ droughts.

Frequency

Heavy droughts were experienced in 1995, 1998, 2001, 2002 and 2004. More frequent and severe droughts have been observed in recent years (Kea et al., 2005).

Duration

Droughts, defined loosely as a serious shortfall in the availability of water to meet normal needs, occur nearly every year, especially between December to May when temperatures are high and rainfall rare. As explained above droughts occur not only during the dry season but also in the wet season. One of the longest droughts on record was experienced in 2004 when no rain fell for 7 months.

4.2.3 Hazard assessment

Hazard mapping and the seasonal calendar were used as tools to assess the nature of the hazard and to measure peoples’ vulnerability.

Hazard mapping

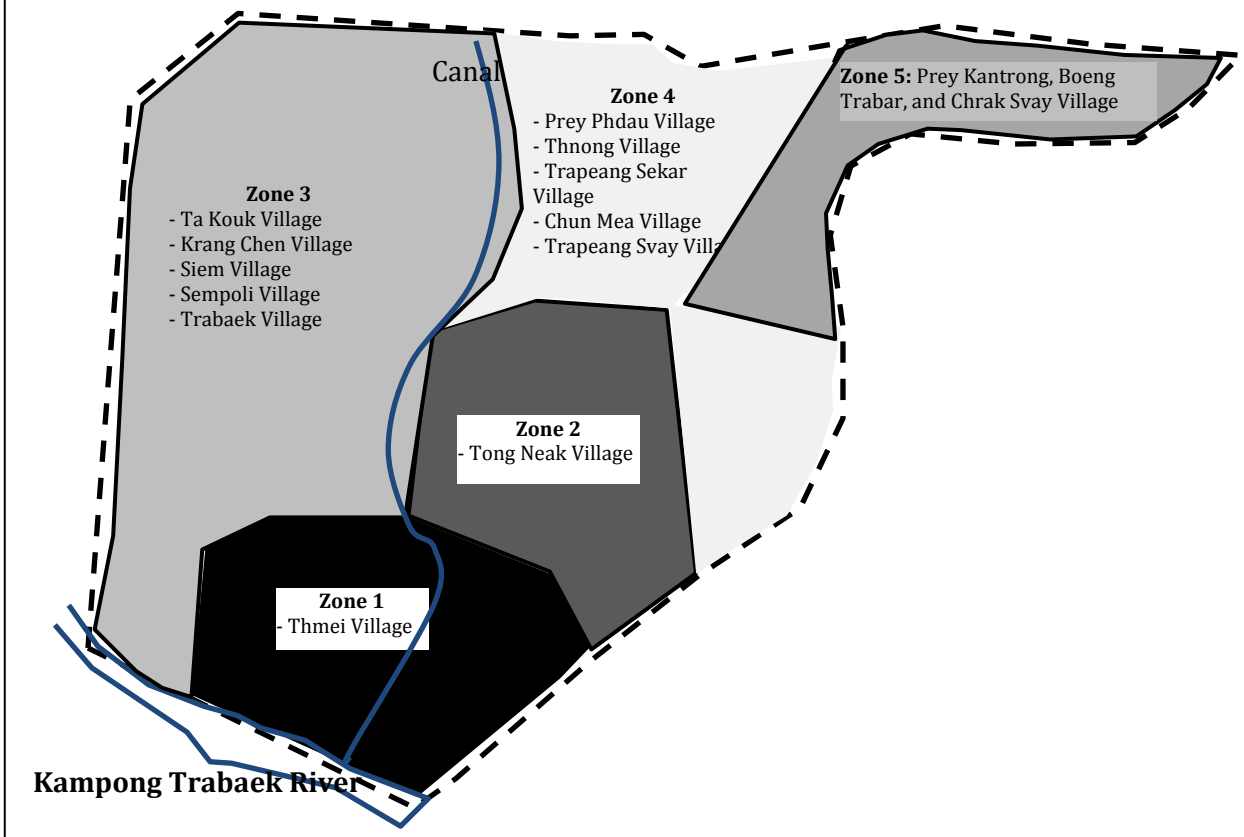
Floods and droughts are the focus of this study. Based on field observations and group discussions, Thmei village suffers the most from floods followed by Tong Neak village. Both

settlements suffer from annual floods which sometimes affect the other five villages in the commune including Ta Kouk, Krang Chen, Siem, Sempoli and Trabaek. Some settlements are better placed. The five villages of Prey Phdau, Thnong, Trapeang Sekar, Chun Mea and Trapeang Svay rarely suffer from floods. However, in the case of huge floods such as those of 2000, most villages, including those named, were flooded. Only the three remaining villages, Prey Kantrong, Boeng Trabar, and Chrak Svay villages were not flooded. Based on the results of these field observations and group discussions, the study area can be divided into five zones to create a flood map as in Map 4.5. Zone one is the most flood-prone area.

High ground is the best option for evacuation. Currently, there are approximately 15 elevated areas in the commune. Some of these areas are newly built. In general, there are about 1-3 elevated areas in each of the flood prone villages in zone 1, zone 2, and zone 3. The area of these elevated sites varies from about 15 x 20 m to 40 x 40 m. The height also varies from 0.5 m to 1.5 m. Because most of these elevated areas are built on land at higher elevation, the structures add to the advantage of standing on higher ground.

As might be expected, villages that suffer less from floods are the villages that suffer the most from droughts. Included in this category are Prey Knatrong, Boeng Trabar, and Chark Svay villages, the most drought prone areas. Drought sometimes affects the villages in zones 3 and 4. Villages in zones 1 and 2 suffer less from drought than other villages in the commune.

Map 4.5: Hazard mapping in Sdau Kaong Commune



Source: Fieldwork 2012

Seasonal calendar

The seasonal calendar records significant events and activities over the year. This allows researchers to know when the hazards and disasters may occur and which activities will be affected. This exercise of putting together a seasonal calendar was carried out during the group discussions of the field research, and the result is shown in the table below.

Table 4.2: Seasonal calendar of Sdau Kaong Commune

Event	Remarks	Months											
		J	F	M	A	M	J	J	A	S	O	N	D
Raining	*Rainfall between June and July secures rice growing*												
Flood	*Severe floods usually occur in September*												
Drought	*Severe droughts usually occur in February*												
Rice cultivation													
- Wet season													
- Recession rice													
- Dry Season													
Other crops													
Fishing													
Food shortage													
Water shortage													
Human Disease	*Most people sick between January and March*												
Animal Disease	*Most animals and poultry sick October to November*												
Migration													

Source: Fieldwork 2012
Note: Black highlight represents the significant months

4.3 Trends of floods and droughts

We know that disasters are a function of natural hazards, natural elements that place people and the environment at risk, and of vulnerability. It can be said that disasters are not in the full sense of the word ‘natural’ because whether a disaster occurs or not is as much a measure of how well an event is (or is not) adequately managed by the people who bear the brunt of its impact (Wisner et al., 2012).

In this section, rather than discussing the management side of things I want to discuss hazards in isolation. In **Section 4.1**, I discussed the Mekong River Basin and how it affects floods and droughts in the study area. Here I will focus on climate change and dam construction along the Mekong River Basin, and limit the scope of the discussion to these two categories as the associated factors are likely to have a major impact on future floods and droughts in Cambodia. Current hazard trends and what they indicate about possible future events are a subject of considerable interest. In this discussion, current hazard trends will be reviewed to see if any significant changes are evident so far. As previous development projects have failed largely because they have excluded consideration of indigenous

knowledge and voices (Agrawal, 2003), I have tried to avoid this omission. To ensure successful adaptation, UNFCCC (2003) recommends several elements such as stakeholder participation, integration of traditional and modern knowledge, local decision-making and consideration of local cultures. Therefore, I have attempted to evaluate the possible impact of future hazards as much as possible from a local perspective and placed local views alongside a computer model that uses data collected by scientists.

Understanding local perspectives towards climate trends and the likelihood of future disasters in terms of floods and droughts was an important part of my participatory research project. People always talk about the weather. They are aware of how temperature and rainfall are a characteristic of floods and droughts but their knowledge of climate change is not something that is necessarily well informed. The researcher used group discussions to find out what their response was to information that current and future trends of temperature and rainfall, floods and droughts are likely to soon adversely affect their livelihoods. The main causes of floods and droughts were discussed with villagers as part of an exercise to get their perspectives on trends. The results revealed that villagers are well aware that there are several factors that contribute to floods including upstream and local rainfall, and how low lying areas are more vulnerable. The main causes of droughts listed during group discussions included references to inadequate rainfall, insufficient ground water exacerbated by ponds drying up, increased demand for water, and high temperatures.

To communicate an understand that included ideas of uncertainty and complexity, the researcher used both local knowledge and scientific perspectives to build a big picture of factors contributing to future floods and droughts. Local and scientific knowledge supplemented and complemented each other and this participatory work added an interesting dimension to what would have otherwise been an exercise in established scientific research.

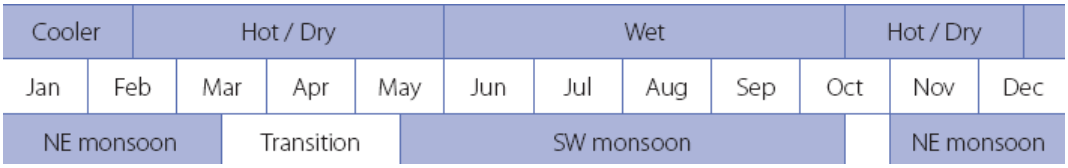
4.3.1 Climatic trend

a. Overview of the Lower Mekong Region's climate context

The Lower Mekong Basin's climate is tropical monsoon, hot and moist, where the monthly temperature is over 20 ^{o}C (MRC, 2010). A purely tropical climate is characteristic of the Earth's surface lying along the Equator. The monsoon zone is bounded in the north by the Tropic of Cancer and in the south by the Tropic of Capricorn; these demarcate the latitudes at which the sun is directly overhead at the height, respectively, of the northern and southern hemisphere summers (C. Ramage, 1971). The monsoon is the reversing wind combined with precipitation which accompanies the movement of the sun (C. Ramage, 1971). The study area

is influenced by the south-west monsoon, which commences in May/June and lasts through to September/October, when it turns to become the north-east monsoon; these cause two distinct wet and dry seasons respectively (MRC, 2010). The south-west monsoon has a direct relationship with the Indian Ocean that brings the moisture-laden winds up to the wall presented by the Himalayas resulting in high precipitation (Ramamurthi & Jambunathan, 1967; Ramanathan & Ramakrishnan, 1932). The north-east monsoon is triggered by high cool air pressure systems that move from Central Asia bringing high pressure, cool, dry stable cyclonic systems that gradually heat to bring hot dry conditions to mainland Southeast Asia (Blumer, 1998; Nagarajan, 2009; Robert & Anthony, 2007).

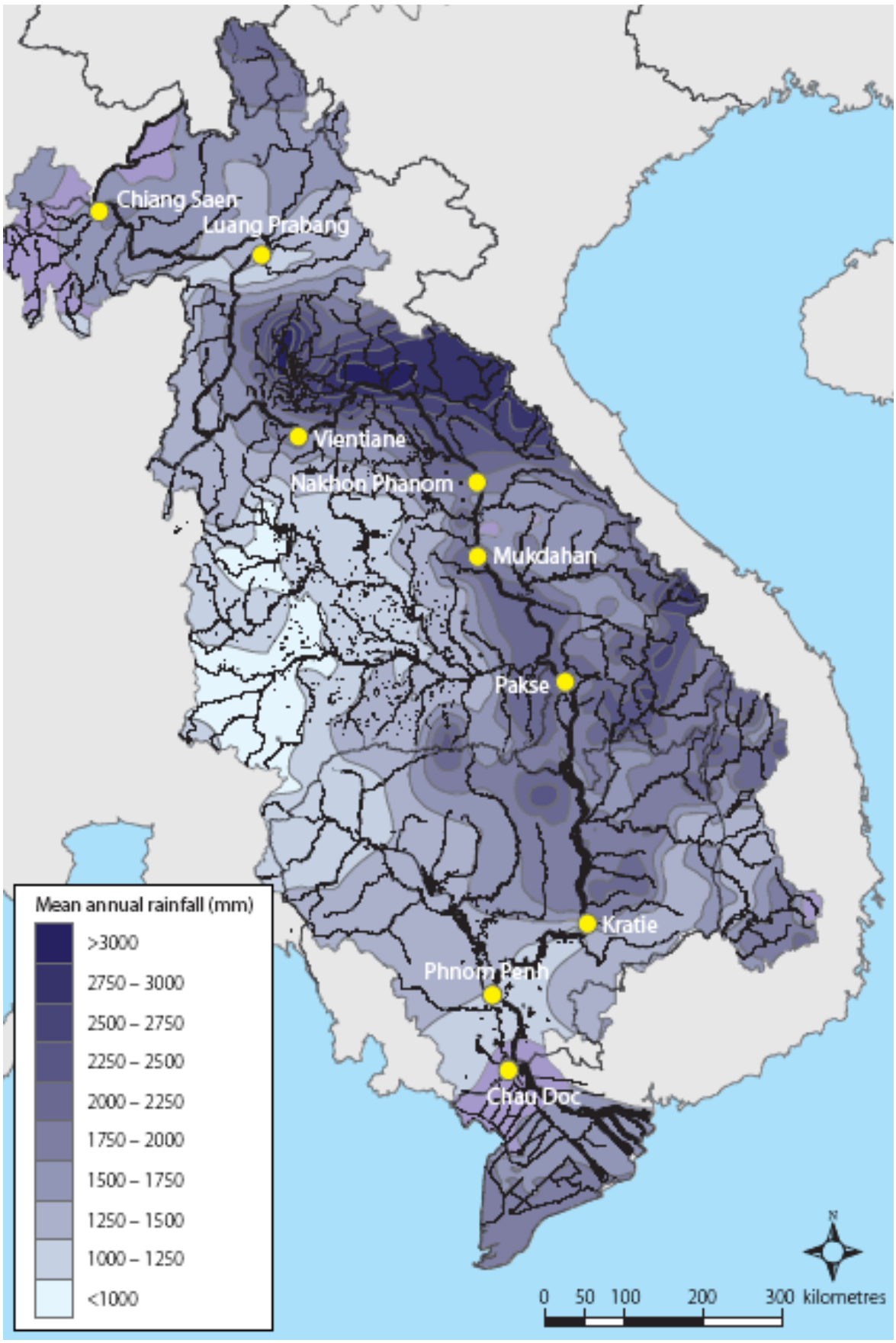
Figure 4.2: The Lower Mekong's seasonal climate



Source: MRC (2010)

The monsoon influences the rainfall in the Lower Mekong Basin. The highest rainfalls are in the west of Lao PDR while the lowest rainfalls are in central regions of Thailand as shown in Map 4.6. The annual rainfall varies every year by plus or minus 15 %. Fluctuations affect the water level and mainstream flows in the river.

Map 4.6: Rainfall in the Lower Mekong research area



Source:MRC (2010)

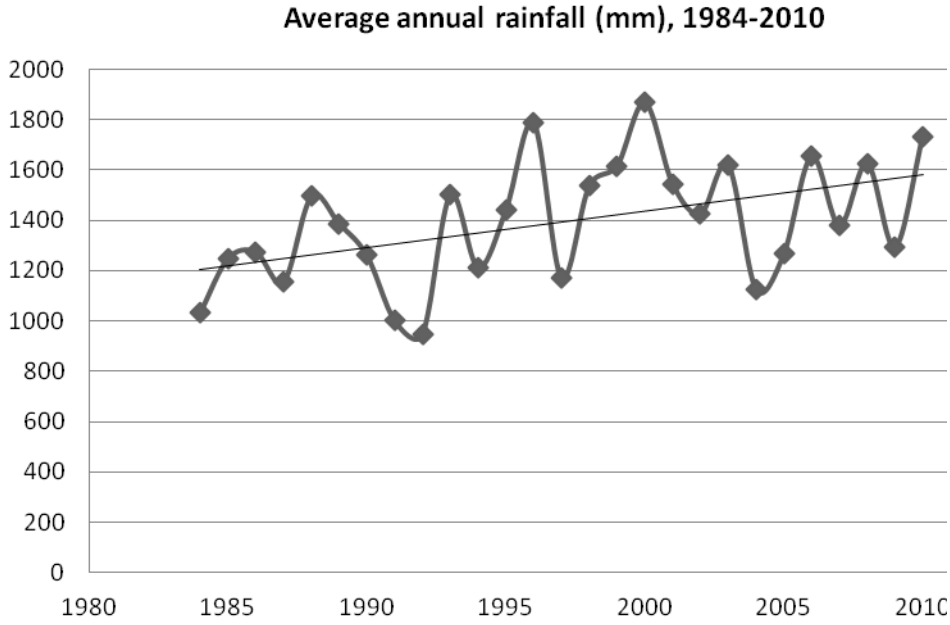
b. Climatic trend in the research area

The raw data of rainfall, temperature, and river flow presented in this chapter were provided by the Provincial Department of Water Resources and Meteorology in Prey Veng Province. There are several hydrological and meteorological stations in the province. However, the most reliable data was provided by Preck Ta Tam of Prey Veng Town which is located approximately 40 km from the study area. I applied correlation analysis to this data to document significant trends.

Rainfall

The average annual rainfall records between 1984 and 2010 presented immediately below indicate a positive correlation of increased rainfall over the period. The correlation was produced by using Microsoft Excel's Trendline function as shown in below figure. Rather than investigate this statistic approach deeply, I am using a simplified process to describe the results. Therefore, the trend below does not show a strong increase, so it is difficult to discern the change by reading the yearly data. It only becomes apparent when subjected to a mathematical correlation analysis. Therefore, the findings below can be used to inform villagers in my research area only that which their own common sense will tell them. As expected, in years with low rainfall, the possibility of drought is high. In contrast, the possibility of floods is high in any years with higher rainfall.

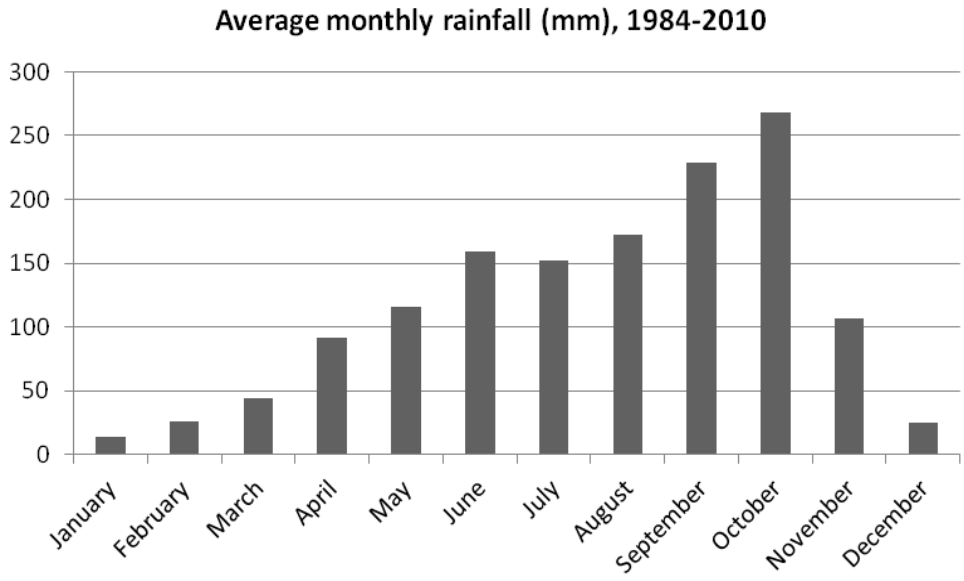
Figure 4.3: Average annual rainfall (mm), 1984 and 2010



Based on data from Provincial Department of Water Resources and Meteorology in Prey Veng Province

Rainfall varies across the months. Rain usually starts in April so that the farmers can start rice cultivation between late April and June. Most rainfall occurs between August and October as shown below. This data is consistent with local people's perspectives. They expect the rain to start falling in April and last through to October; however, the rainfall in June and July is very important to secure rice growing. They said that the period for heavy rainfall may change a little from year to year but not too much. They added that unexpected events such as storms may make for unseasonal changes of the temperature and rainfall but these events were isolated and infrequent.

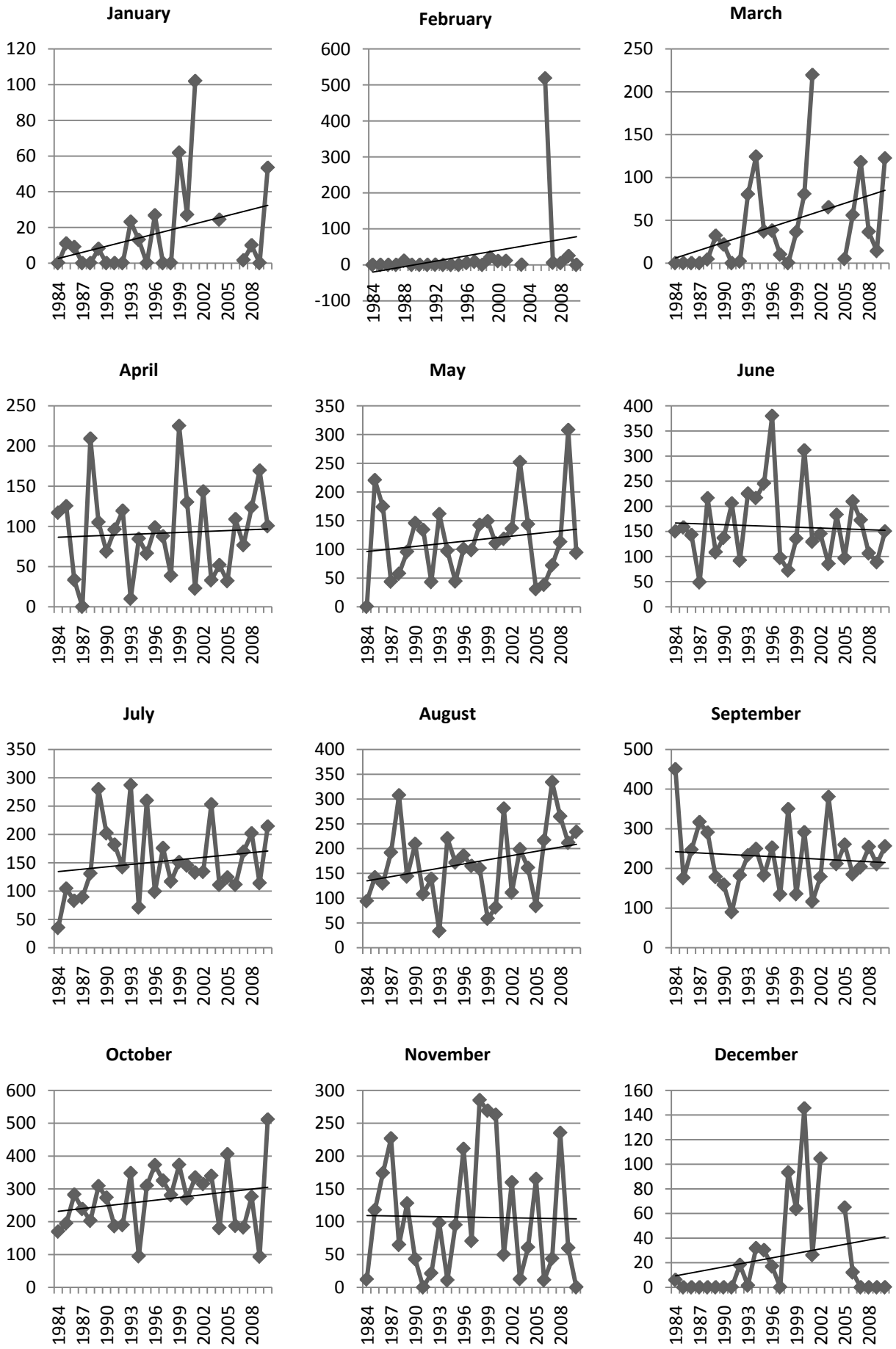
Figure 4.4: Average 1984 – 2010 monthly rainfall (mm)



Based on data from Provincial Department of Water Resources and Meteorology in Prey Veng Province

In addition to changes in annual average rainfall, the trend in average precipitation each month over 1984 - 2010 also shows a positive increase over the year except for June and September. This is shown in Figure 4.5 below. The scale of each month's rainfall (mm) varies from 0 to 120 during January, the period of lowest rainfall during the year, and from 0 to around 500 during the height of the rainy season. The graph below shows unexpected events such as storms in some months of the years. For example, the highest 518 mm rainfall in February 2006 and the 220 mm rainfall in March 2001 were caused by unexpected climate-related perturbations.

Figure 4.5: Average each month rainfall (mm) over 1984 - 2010

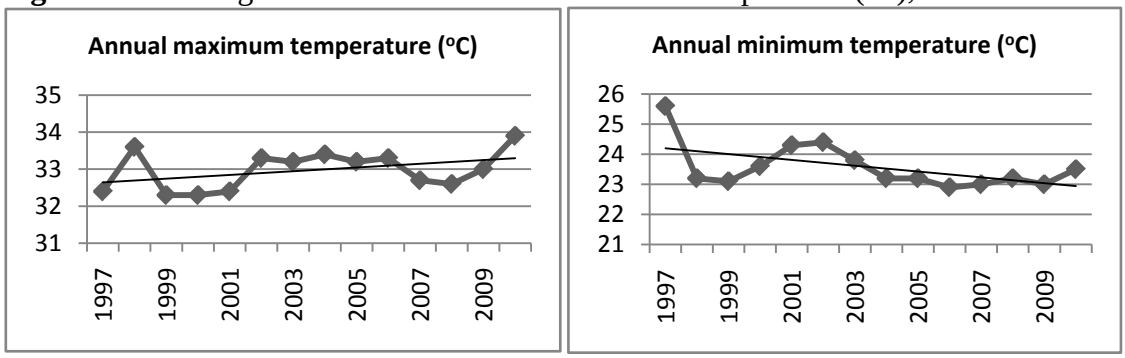


Based on data from Provincial Department of Water Resources and Meteorology in Prey Veng Province

Temperature

Other than slight increases in rainfall, extreme temperatures are only increasing slightly and tend to confirm local perceptions that nothing much is happening. The average annual temperatures between 1997 and 2010 are shown below. The annual maximum temperature trends go upwards while the annual minimum temperature declines. These are signs of extreme temperatures either higher or lower than the normal range. However, the mathematical correlation analysis below illustrates a weak relationship over a long period. It is hard for the local people to feel the changes. The authorities need to be far more proactive in teaching people about the consequences of current trends to prepare the community for what they are likely to face in the longer term.

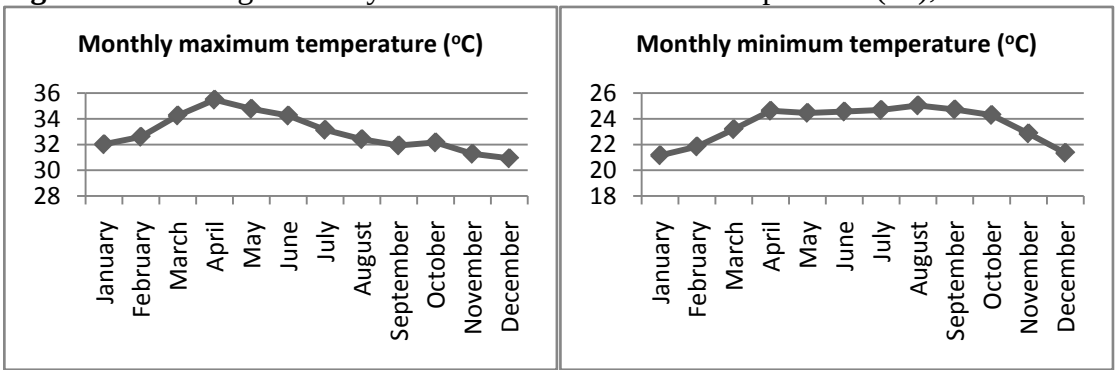
Figure 4.6: Average annual maximum and minimum temperature (^{o}C), 1997 - 2010



Based on data from Provincial Department of Water Resources and Meteorology in Prey Veng Province

The average monthly temperature for 1997-2010 shows monthly variation. The monthly maximum temperature is usually at its highest between March and June. The monthly temperature reaches its lowest point of around 21 ^{o}C in December, January, and February. Villagers expect temperature drops, especially at the start of the cool season in December and the gradual rise to the high temperatures that characterise the hot dry season, especially in late March.

Figure 4.7: Average monthly maximum and minimum temperature (^{o}C), 1997 - 2010

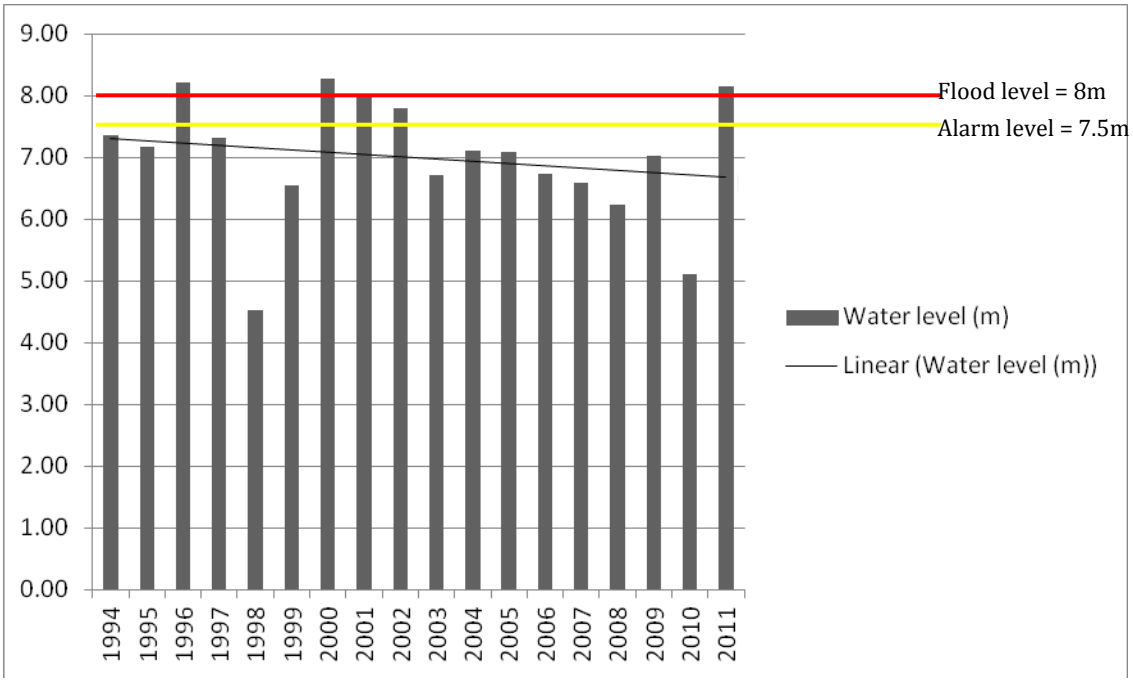


Based on data from Provincial Department of Water Resources and Meteorology in Prey Veng Province

Water level

It is worth reviewing the annual maximum water levels of the Mekong River between 1994 and 2011. The flood warning level is 7.5m, and the flood level is 8 m. Some places in my research area have a lower elevation and a rise in water level of more than 6.5 can result in the possibility of a flood, especially when combined with heavy rain. The following Figure 4.8 shows that significant floods occurred in 1996, 2000, 2001, and 2011. As shown in **Section 4.2.1**, floods have been more frequent and severe since 1996. One of the reasons for this may be climate change (see **Section 4.3.2** for details). However, this figure also illustrates a slightly falling trend over the past two decades, and one of the reasons for this may be the hydropower dams built on the upper reaches of the Mekong by China. Reservoir storage would not account for very much of the drop (see **Section 4.3.3** for details).

Figure 4.8: Maximum annual water levels (m), 1994 – 2011



Based on data from Provincial Department of Water Resources and Meteorology in Prey Veng Province

4.3.2 Floods and droughts in a context of climate change

As floods and droughts in the study area are linked to the region wide hydrological system of the Mekong Basin and global climate change, it is possible that changes are likely to result in more frequent floods and droughts in the study commune. A study of the Mekong Basin indicates that climate change will lead to changes in temperature, precipitation, and evaporation resulting in severe floods and droughts (Eastham et al., 2008). This study used the SRES A1B scenario (see Figure 2.1 for description) with the most suitable 11 GCM

simulations to forecast the changes in temperature, precipitation, and evaporation between the base line of 1951 - 2000 and 2030. The prediction is that by 2030 the annual temperature will have increased by 0.79 ^{o}C, with major increases occurring between July and November; annual precipitation will increase by 13.5%, with major increases between May to September; the annual potential evaporation will increase by 2%, with major increases between February to June. Therefore, these changes will result in significant increases in runoff, discharge, and river flow in the basin by 2030.

In Cambodia, frequent and severe floods and droughts can be expected. First increases in runoff, discharge, and river flow will occur. It may be possible that Cambodia will also face climate-induced changes similar to changes in up-stream sub-catchment areas. Moreover, it is likely that given its position on the lower Mekong the accumulative impacts from upper catchments are likely to be much greater. As a result, it is likely that extreme floods will become more frequent. Some villagers in the research area also believe that floods will be severe because of deforestation, climate change, and the shrinking of Tonle Sap[2]. There is a contradictory trend too. When the rains depart and the flow declines, there remains the challenge of increased water capture in China where four dams have been built (see **Section 4.3.3** for more details). This belief is strongly held by a majority of local people. Most villagers believe that floods will be less severe because of the current construction of irrigation systems, better water control, bigger canals and the building of flood protection embankments and elevated roads.

Secondly, both increasing temperatures and evaporation combined with decreasing mean monthly flow and lower discharge during the dry season could well become factors in increasing the intensity of droughts (see **Section 4.3.1 and 4.3.3** for details). This is consistent with local people's perceptions as most of them expressed the belief that droughts will be severe because of deforestation, general development, climate change, population growth, and the shrinking of Tonle Sap and other smaller water reservoirs in their commune. Droughts are likely to be severe, and although their reasoning may be quite different, the anticipated outcome of scientists and locals is remarkably consistent.

It should be noted that changes in climatic trends and future climate change are likely to affect livelihoods directly, especially agricultural production and environmental resources;

[2] Tonle Sap, the biggest freshwater lake in the region, has an area of between 2 700 and 15 000 km^2, meaning that the lake expands and shrinks according to the seasons of the year. It serves as an important reservoir to store the Mekong River Basin's floodwater. People are concerned about sedimentation that minimizes the lake's capacity.

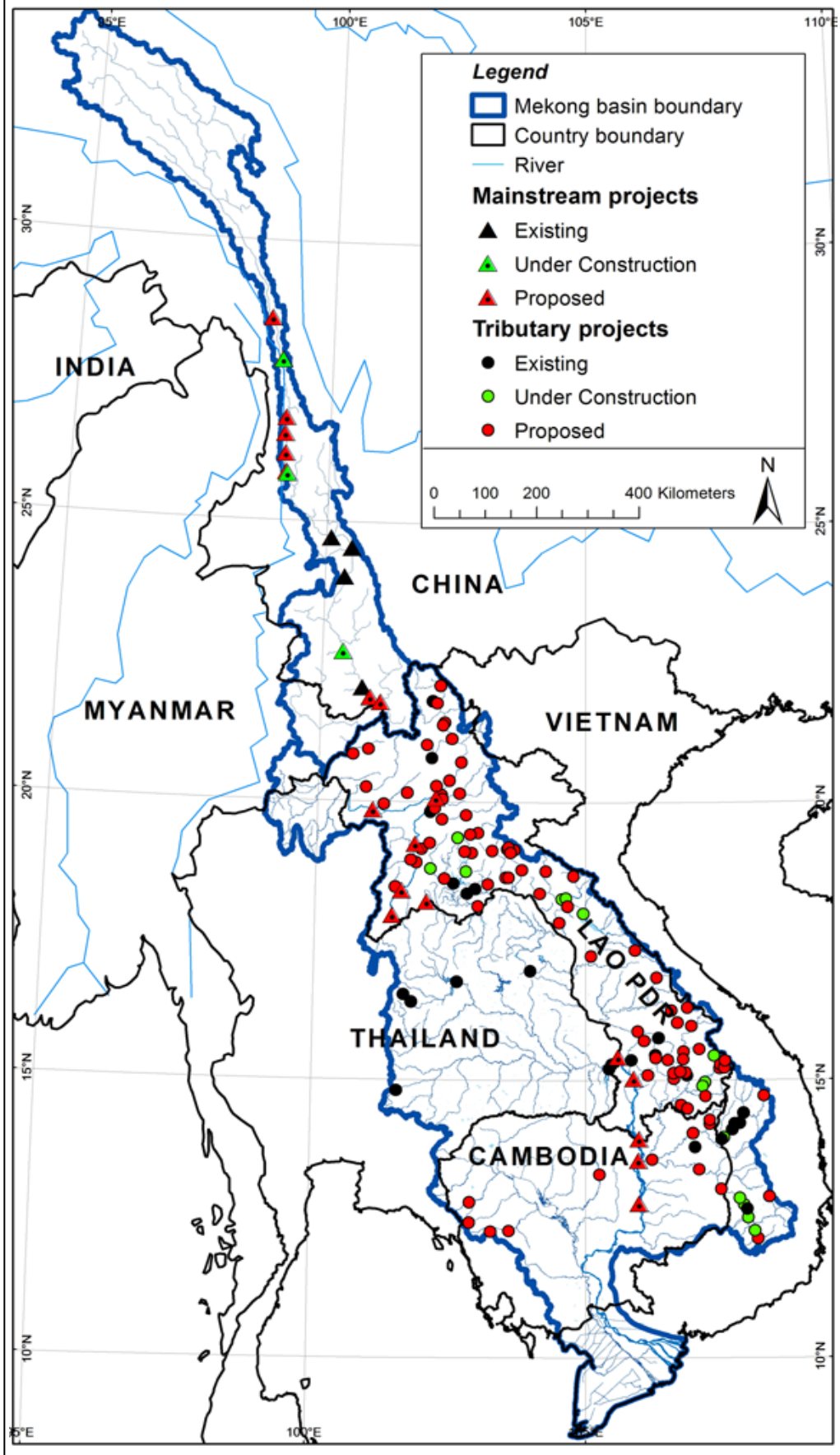
however this will not be covered in this study. Further research on climate change impacts on livelihoods should investigate these issues.

4.3.3 Dams and their relationship to floods and droughts

The Mekong River is ranked as the world's tenth-largest river and the world's second-most bio-diverse river after the Amazon (MRC, 2012b; T.F., 2012). Moreover, it is the heart of Southeast Asia, as the Mekong River Basin provides food, income and fisheries to millions of people in the region. It supplies water for both Cambodia's Tonle Sap, the largest freshwater lake in Southeast Asia, and the Mekong Delta, the best rice growing area in Vietnam (Grumbine, Dore, & Xu, 2012). Vietnam is the world second-largest rice exporter. The Lower Mekong River is described by Grumbine et. al. as "one of the world's last great stretches of undammed river" (Grumbine et al., 2012). The economic growth and demand for power are the main reasons for hydropower dams. By 2025, if the planned hydropower dams are built in the Lower Mekong, the annual income will go mostly to Laos and Cambodia, equivalent to about 18% and 4% of both countries' 2009 GDP respectively. The electricity demand is projected to increase at 6.9% annually in response to rapid economic and population growth in the region (Babel & Wahid. S. M., 2009).

Hydropower dams have been actively considered in Southeast Asia over the last decade. The Mekong Basin has a potential to produce 53,000 megawatts (MW) of electricity. 17 dams, 1600 MW, were built on the tributary rivers of the basin before the end of 2005 (MRC, 2005); however, dams in the mainstream of the Lower Mekong River do not yet exist (MRC, 2008). By 2030, 12 dams and 77 dams have been planned respectively for the mainstream and tributary rivers of the Mekong Basin (Grumbine et al., 2012; ICEM, 2010; Molle, Foran, & Kakonen, 2009; Ziv, Baran, Nam, Rodr´ıguez-Iturbe, & Levin, 2012). Most of the big projects, including the problematic Xayaburi Dam, will be built in DPR Lao; this country has huge generating potential. The figure below illustrates this. Moreover, the dams already built in China are already a matter of concern. Currently, four dams have been completed and an additional 4 to 6 dams will soon be added. As these dams are located in the Upper Mekong, issues of construction are not included in the scope of the work of the MRC, an intergovernmental organization of the Lower Mekong countries. Therefore, the concerns of downstream countries have not been fully addressed. The increasing presence of dams in China will have less impact in the wet season than the dry season because mainstream flows from China in the wet season is only 15% of the total, whereas in the dry season this rises to 30% (IRN, 2002; MRC, 2011a). If a high volume of water is siphoned off for irrigation this could result in severe droughts downstream.

Map 4.7: Existing and future dams in the Mekong River Basin



Source: Mekong Flows (2012)

Dams affect floods and droughts in several ways. Dams along the Mekong River will regulate the natural flow of water, resulting in changing patterns of floods and droughts. Floods in the rainy season may be reduced because either the water will be stored in reservoirs behind dams or the water level will be controlled and released in a consistent manner (ICEM, 2010; MRC, 2008; Richter et al., 2010). If the north-south flow of the Mekong did not rise high enough to reverse its flow, south-north into the Tonle Sap, this would have a disastrous impact not only on Cambodian fish production but also on floodplain rice production (Orr, Pittock, Chapagain, & Dumaresq, 2012). There is also a question, at least in my mind, that in the event of an unforeseen flood of unexpected magnitude, will those who manage these upstream dams release a wall of water if their dams are subject to duress? Would this ever become an option for dam operators as an extreme course of action to secure their dam operation? Besides, if irrigation is an option, will a critical amount of water be diverted, enough to endanger downstream needs? It is not so much a question of water being stored in reservoirs to keep hydroelectric generators going (ICEM, 2010) but fear of an absolute water deficit that could result in serious drops in ground water which would inevitably result in drought.

It should be noted that current and proposed dams are likely to affect socioeconomic development including livelihoods as well as environmental resources in the region. These include damaging the ecosystem and especially impacting disadvantageously the world's widest range of freshwater fish species, inundating agricultural land, and interrupting the annual deposition of natural nutrients on the floodplains (ICEM, 2010; Scott W.D. & Pearse-Smith, 2012; T.F., 2012; UNDP, 2006). These are important natural assets which contribute to the livelihoods of the approximately 60 million people who live on the flood plains of the Lower Mekong. However, owing to the limited scope of this research I regret that I have not been able to cover these aspects in any detail. If the issues are to be adequately documented further detailed research would be required.

4.4 Conclusion and additional thoughts

People living in the Mekong River Basin are subject to natural hazards such as floods and droughts and the management of these will continue to depend on cooperation between upstream and downstream governments of the countries through which the river flows. More frequent and severe floods and droughts have been observed in recent years. The maximum duration of floods and droughts could reach up to three and seven months respectively.

In the case study area, villages susceptible to floods and droughts have been identified through hazard mapping, and the principal activities that are likely to be affected by natural hazards including agricultural and other livelihoods matters, were explored in the course of a seasonal calendar exercise. Both indigenous and scientific knowledge on climatic trends, climate change, and dam construction were assembled. Increased annual rainfall, extreme temperatures, and changes in water levels have already been experienced, and these changes will continue into the future.

Climate change and dam construction along the Mekong River Basin are the two major factors that could lead to changes in the nature of floods and droughts. For now, owing to the complex nature of the social-ecological relationship, the extent and significance of these changes is not entirely clear. The combined impact of climate change and dam construction may or may not follow the proposed scenario. Because of this uncertainty, related stakeholders and researchers need to continuously monitor human activities and their impact on the complex natural and human ecology of the Mekong River Basin. **Section 6.3** of Chapter 6 will propose a way to address this uncertainty.

Chapter V: Disasters and coping strategies

5.1 Introduction

Disasters are a function of hazard and vulnerability. If there is neither hazard nor vulnerability, disasters cannot occur[3]. In Chapter IV, I documented some of the outstanding features of natural hazards, floods and droughts in my study area. This chapter focuses on disasters from these natural hazards (**Section 5.2**) along with current coping strategies (**Section 5.3**). Coping capacity and disasters have a direct relationship. If coping capacity is low the impact of disasters will be high, especially when floods and droughts are involved. In addition to the investigation of current official coping strategies (**Section 5.3.1**), local perspectives on disaster measures and coping ideas also need to be taken into account (**Section 5.3.2 and 5.3.3**). These indicate to researchers what kind of coping measures work. Through the experience of previous development work, the results of this participatory research work will increase the chances of success because local voices have been listened to and the needs of villagers identified so the results can be included in planning or intervention work as indicated in Chapter VI. Moreover, the related policy frameworks of regulatory structures and processes (**Section 5.3.4**) that are currently working in disaster management can be critically reviewed from a wider perspective as either opportunities or constraints for future disaster intervention. All of these matters will be elaborated below.

5.2 Disaster impacts

Based on the results from the field research, the impacts of floods and droughts, as measured by those most affected, are categorized as damage to crops and personal property, people, community infrastructure and the environment, and do not preclude the possibility of positive impacts. The impacts were identified through PLA/RRA/PRA tools especially problem and possibility analysis and historical timeline supplemented by the commune's disaster reports. The range of impacts also covers both direct and indirect impacts. Direct impacts are the initial, primary impacts from disasters while indirect impacts are the consequences which follow these and are principally evident by how they disrupt local livelihoods.

5.2.1 Flood impacts

a. Direct

3 For the purpose of this study, a hazard is a likely event that could lead to disasters if preparedness is low or non existent rather than an unlikely major event such as a meteor strike

Damage to crops and personal property

Floods cause negative impacts on crops and personal property. Rice fields, the main crop in this area where more than 90 percent of householders are farmers, are damaged nearly every year by floods. Other crops mostly grown to meet domestic needs such as mango, potato, cucumber, gourd and pumpkin are also adversely affected and can be lost completely. In addition, during an event, livestock such as chickens, ducks, cows, and buffalos can often be lost, drowned or subsequently become ill. Clothes and kitchen materials are sometimes lost. Finally, income generation is badly affected as people take time to evacuate family members and move property to higher ground. To prove the flood damage as explored through PLA/RRA/PRA tools, the actual damage caused by floods in the commune in the past, reported by commune's disaster reports, is shown in the following Table 5.1

Table 5.1: Major recent flood damage data of Sdau Kaong Commune

Year	Affected villages	Flooded households	Food shortage households	Deaths	Evacuated households	Houses flooded	Cultivated land (ha)	Damaged rice field	Animals lost	Damaged infrastructure
2001	12 out of 15	1608	1148	1	266	478	2043	310 ha	5 cows, 3 buffalos and other poultry	n/a
2005	n/a	n/a	435	0	n/a	n/a	2665	195 ha (395 ha flooded)	n/a	n/a
2011	7 out of 15	1100 out of 2550	n/a	1	141	427	n/a	722 ha (1090 ha flooded)	n/a	3.3 km out of 22 km road damaged, 65 out of 599 wells damaged, 64 out of 411 latrines damaged

Based on data from the District Committee for Disaster Management in Ba Phnum district

Affected people

Floods can cause deaths, disease, and injury. The common diseases that follow floods include diarrhoea for all ages, and dengue fever which is especially hard on children. Difficult access to health services and transport makes the situation worse. Sometimes people are

injured during evacuation, by snakes or while taking care of their property. Each year, about one person, usually a child, is drowned.

Damage to community infrastructure and environment

Usually some communal infrastructure and environmental resources are damaged. Sections of local inundated roads are damaged and occasionally whole sections are destroyed. As a result, transport becomes increasingly difficult not only during floods but afterwards when the water has drained away. Pagodas, schools, and health centres built on higher ground are not usually damaged but floods make it difficult for people to access these areas for traditional ceremonies, study, and getting to health services. Often the capacity of storage ponds and canals is reduced and reticulation systems are either broken or compromised. Fish stocks usually fall because fish in ponds and streams escape into deeper water. If the water remains for an extended period over several months, trees can also be lost.

b. Indirect impacts (consequences)

The consequences of the impacts described above often persist. Floods can badly affect rice yields and storage, animal and poultry health as well as other income generating activities, and food shortages can quickly become a major concern for a large number of people. People can also spend a lot of money and time taking care of their families. In the post-event environment diarrhoea and cholera epidemics are common, children cannot go to school, and schools are usually closed for extended periods. As mentioned above transport is another concern. Damage to local roads takes a long time to fix. In some areas which remain flooded, boats are used to meet travel needs but not all families have boats. Although there is no forest in this commune, scattered fruit and timber trees can be damaged if left in standing water for a long time.

c. Benefit

Floods not only have negative impacts but can also have a positive impact. Nutrients are deposited by flood waters which improve the quality of the soil and make for better crops. Moreover, some pests are usually removed and these factors alone can result in higher rice yields. In flood prone Zone 1 Thmei village, regular annual floods ensure rice yields of up to 5-7 tonnes per hectare, much higher than the other villages where 1-3 tonnes of rice per hectare are considered normal. Although floods can damage the rice crops standing in the field when floods occur, not all is lost. People can usually grow quick maturing rice varieties after the floods have receded. These rice varieties mature in just 3-4 months. If the water does

not drain away another opportunity becomes available: people can catch fish to eat as well as sell the surplus catch at the market to make money.

5.2.2 Drought impacts

Like floods, droughts cause many negative impacts. It should be noted that in my use of the term seasonal droughts or extended dry periods not only occur as part of the dry season but also in the wet season if the rains expected from the southwest or northeast monsoon do not come, are delayed, or bring inadequate precipitation. Droughts can seriously damage a rice crop, the main crop in this area, as well as mango, banana, and other trees. Pigs, chickens, and ducks can either get sick or die from inadequate water and/or hot temperatures. Water shortages not only limit the supply of drinking water they can also result in poor personal hygiene; as a consequence, some diseases such as diarrhoea and skin disease can occur. Information related to drought impacts was limited because local people did not pay much attention to droughts while the impacts were not adequately reported and recorded.

5.2.3 Impact ranking

The losses caused by floods and droughts are categorised into groups as mentioned in **Section 5.2**. This section aims to find out which losses are the most important for the community. During group discussions, participants were asked to state which losses they thought were most important, along with their reasons to justify their choice. The most important factors which influenced their choice were the number of families affected and the impact on their livelihoods. Therefore, it is clear that the impact ranking was discussed and agreed among villagers themselves. The most significant losses in order of importance were crops and personal property followed by people (deaths, diseases, and injury), community infrastructure and environmental damage. Crop losses are the first priority because these are the mainstay of their economy and livelihood. As more than 95% of families are farmers, crops are their main source of income generation. Personal property and livestock are also important potential sources of money which can be sold to help people through emergencies. Sometimes, they sell livestock to buy medicine and other basic needs, especially food. Although in disasters people may be affected by deaths, sickness, and injury, these matters were given lower priority in people's thinking because such events did not figure in most people's lives; the number of families affected by the loss of crops and personal property was much higher. One death a year did not count in the opinion of the hundreds of families that suffered from crop losses. Damage to community infrastructure was given lowest priority. Currently, little of the community infrastructure is disabled and only small components are

usually affected. The exceptions to this observation must include damage to roads and ponds as mentioned above. Environmental resources were also given lowest priority because there is no forest or environmentally protected area in this Commune.

5.3 Coping with disasters

5.3.1 Current coping strategies

A range of coping strategies used in this area have been either passed down through many generations or have a more recent origin and are designed to cope with the current situation. These coping strategies are similar to some developing countries in Asia (Brahmi & Poumphone, 2002; Lasco & Boer, 2006; Mishra & Mishra, 2010; Tibig, 2003; UNFCCC, 2007) and can be categorized into three groups: before, during, and after the events.

a. Floods

Before the floods

Early warning system

The local people have a traditional way of predicting floods. For what it is worth the first is tied to astrology, where the Year of the Dragon (2000, 2012, 2024, and so forth) and the Year of the Horse (2002, 2014, 2026, and so forth) are believed to bring big floods. It may be considered entirely coincidental. Another way is to observe mosquitoes. When there are many more mosquitoes than normal, people believe that big floods will occur. A more empirical and reliable approach favours observation. Floods in this area are not flash floods; the river rises steadily. When the rains have come, some people make it a habit to watch the river carefully to see if there is any change in the water level. If they see a rise they will discuss it with their neighbours to determine the significance of the change and whether to prepare for evacuation.

However, the government's early warning system is much more reliable. Weather forecasts are run collaboratively. The Provincial Department of Water Resource and Meteorology collects hydrological data from its stations located at regular intervals along the river. The Department of Meteorology and the Department of Hydrology and River Works in the Ministry of Water Resources and Meteorology receive and analyze the data in close collaboration with the Mekong River Commission (MRC). The Department of Meteorology produces weather forecasts which include predictions of rainfall. The Department of Hydrology and River Works is in charge of forecasting any changes in water levels. When data of significance is finalized, alerts are sent to TV and radio stations, relevant government

and non-government institutes, and the Cabinet. Local people can access this early warning system either on air through TV and radio stations or via the village chief. Village chiefs get early warning messages from both Commune and District level so they can alert people to get ready.

Preparedness

Preparedness is perceived as an important element of survival. As soon as there is a flood alert, people often store food for their families, enough for the expected duration of the event, as well as preparing feed for their livestock. People construct shelves above the expected water line to store food and erect fences to keep livestock close to their house in a safe place. They make sure to keep enough rice, basic food, and firewood at hand so they can feed themselves during the period of inundation. Poultry is usually restricted to higher ground either around or in the house. Cows and buffalos are either tethered on patches of elevated ground in close proximity to their houses or evacuated to areas considered to be safe if they are sure of their ground. Some families keep their cows and buffalos with them in their house. Better-off families also prepare some medicines for emergency situations.

House design

Most houses in flood-prone areas sit on piles 1 to 2 meters above the ground, above the normal flood level. Some houses have a special roof that they can open and sit on top of.

Flood control structure

Most public infrastructure is built to withstand floods. Most roads are 0.5 to 1 meter higher than the undisturbed ground around them and serve as low levies which prevent water from flowing into low-lying areas. Ponds, canals, and irrigation canals can store some flood water. This year there is a project to build a modest concrete barrage along the river bank in Thmei Village so that flood water will not run so easily into the commune. This barrage, which is approximate 1.5 m high, 0.4 m wide, with a 0.4 m foundation, is a rock and concrete wall to protect floods, as shown in the figure below. This externally funded project is currently under construction and its effectiveness has yet to be tested.

Figure 5.1: Barrage along the river bank in Thmei Village, by Author 2012

Sandbags and pumping machine

When floods are expected, empty sandbags and pumping machines are sometimes temporarily provided by the Provincial Department of Water Resources and Meteorology. People fill the sandbags and use them to build a low embankment. Petrol and diesel engine pumps are sometimes used to pump excess water from the field so that crops can survive.

Shift of farming

Quick maturing rice varieties have become popular as these varieties take only 3-4 months to finish their cycle. Therefore, farmers can harvest the yield before late season perturbations come in from across the South China Sea. However, sometimes floods can occur with the normal southwest monsoon, so early that even the short maturing rice varieties are drowned before they can be harvested. The last option is to grow recession rice after the monsoon and rely on residual water in the fields. An irrigation system is being constructed and it is hoped that by later this year (2013) farmers will be able to double crop in some areas.

Voluntary teams

The Cambodian Red Cross and NCDM, working on disaster mitigation, are the two active agencies supported by the government. These agencies have their own offices at provincial level and representatives at District and Commune level. At Commune level, the Chief of the Commune and community members have formed voluntary teams. These teams are responsible for disseminating ‘disaster information’ to local people so that they can prepare for upcoming floods: reporting damage and losses to district level authorities;

reporting on disasters to government and non-government institutes as well as private sector agencies and individuals to encourage people to make donations to relief work; and when the time comes, work on evacuation and rescue, and make food, medicine and shelter available.

During the floods

Evacuation and rescue

Evacuation is a good option to escape from floods. There are about 15 elevated areas in the Commune. The area of these elevated sites varies from about 15 x 20 m to 40 x 40 m. People in vulnerable houses, those with floors close to the ground, usually move to elevated areas or live temporarily with neighbours who live in houses better designed to cope with floods. If the water rises to dangerously high levels, nearby ferries and boats can be used to rescue people, under government supervision through NCDM.

Emergency relief

The Cambodian Red Cross usually plays an important role in providing food, medicine, clothes, sleeping materials, shelters, and water filters to affected families in collaboration with the NCDM. Provision is made to ensure that people can access basic survival needs, especially the poor.

Using water filters and boiling water

Unhealthy bacteria and other diseases are generally present in flood water. During flood events, people often find it difficult to secure a source of good drinking water and accept the hazard of using what is at hand. Not everybody is placed at risk. Water filters such as ceramic filters and bio-sand filters donated by government and non-government agencies are commonly used in this area. About 50 percent of the people have these filters at home. Ceramic filters are small and portable and can be carried away in emergencies. Bio-sand filters which are big and heavy have to be left behind. Some families who have no water filters usually boil the water. Another option is to use water purification tablets with chlorine to kill bacteria and viruses in water. These tablets are sometimes handed out by relief teams.

Emergency money

During events it is difficult for people to get the necessities of life. They cannot earn money, and flood waters not only destroy their rice fields but also make them sick. In such situations farmers try to raise loans by selling personal property to meet both immediate needs and to buy seeds and agricultural inputs for when they are able to resume rice cultivation after the floods. There are several banks and micro finance institutions from which people can

borrow money at an interest rate of around 2 to 4 percent per month. Loans can help with recovery but if people cannot pay the money back in good time loans can also make things worse. Default can result in the significant loss of property. When they need money some people prefer to sell their poultry, animals, and jewellery. In rare cases, land and houses may be sold.

Alternative temporary income generation

There are a few alternative ways of securing a livelihood that people turn to during disasters. Some people go fishing for their daily food and sell the surplus at the market. Another option for income generation is to seek work as a migrant in Phnom Penh as well as other places, both inside and outside Cambodia. Thailand is a favourite destination for those looking for temporary work. If a well paid job can be found it may be extended to become a long term occupation.

Coping by changing eating habits

Several coping strategies are applied in response to floods. Some people change their eating habits to fit the situation. They eat less than normal, and they look for any kind of food that they can gather from the land and water around them.

After the floods

Seed is often given to farmers to plant another crop of rice after their rice fields are damaged. The second crop is very important for farmers as they will rely on this to provide income, food security, and ease them back into normal life. A good harvest will enable them to pay off debts.

When damage occurs to commune infrastructure, the damage is reported to the government and related stakeholders. Rehabilitation and recovery is usually undertaken by the Cambodian Red Cross, the National Committee for Disaster Management (NCDM), and other government and non-government agencies. This work is usually conducted in a way that will ensure that similar damage does not reoccur in subsequent events of the same or higher magnitude. For example, roads are built higher and schools higher off the ground than previous structures. Sometime because of post event outmigration many people may permanently or temporarily leave the community in search of a more rewarding livelihood.

b. Droughts

Droughts set different challenges of similar significance to survival and people activate a range of coping strategies. Droughts unfold more slowly and the people are usually

facing difficulties before an event is announced through PDOWRAM, media, and the chief of the village. Therefore, people can prepare by 'rationing' or more carefully managing their use of available water. Water from wells and household ponds is monitored and sometimes underground water may be pumped into irrigation ditches and rice fields. Such machines however, are expensive to run and the practice is not common. Sometimes food and medicine are distributed to help affected families, especially the poor. In addition, people can either borrow money from lending agencies or sell property including livestock and stored rice to get money for emergency needs. People may eat less than normal over periods when the stress of food shortages are unavoidable, or borrow food from their neighbours. As mentioned earlier, migration is also an option. It should be noted that droughts usually develope slowly; therefore, local people give less attention to these events.

c. Emerging coping strategies

Some new coping activities have emerged in recent years. As already mentioned, water filters and even medicines have been made available post-event over the past few decades. In the past people left the immediate neighbourhood in search of higher ground but now, thanks to outside support there are many more elevated areas to which they can retreat. Livestock medicine has also become available in recent years. Short term rice varieties have also become popular with some farmers. These varieties were introduced by agricultural agencies and make it possible for farmers to not only grow a second crop of rice but also to harvest it sooner. The number of micro finance institutions and banks has grown very quickly over the past ten years and provide reliable and quickly negotiated credit for a greater number of farmers than ever before. The formal interest rates arranged with outside agencies are lower than those offered by local people who lend money in the traditional way. As already mentioned, in-country migration has been taken as an option for many decades; what has changed is that more people are willing to leave the country in search of work often placing them at some disadvantage on the Thai labour market.

5.3.2 A survey on risk reduction options

Risk reduction refers to activities that contribute something towards minimising losses from disasters. In my fieldwork, local people were asked whether they could reduce the impacts of floods and droughts. Risk reduction options are what they believed they could do with each negative impact. Their responses were organised into four groups which included prevention, reduction, transfer, and living with disasters; therefore, these slightly differ from **Section 5.3.1**. This exercise aimed to establish local perspectives on risk reduction options. It

may also serve as a guide for local community approaches to disaster reduction planning, and to that extent is relevant to on-going work on Community-Based Disaster Risk Management.

As mentioned earlier, the direct disaster impacts are categorized as damage to crops, personal property, people, community infrastructure and environment. The four options listed as approaches to disaster risk reduction have been placed by local people under these categories to indicate how they cope.

Table 5.2: Risk reduction options

Hazards	Damages/negative impacts			
	Crops	**Personal property**	**People**	**Community infrastructure and environment**
Floods	Living with disasters	Prevention, Reduction	Reduction	Reduction, Living with disasters
Droughts	Reduction	Reduction	Reduction	Living with disasters

Source: Fieldwork 2012

This table illustrates various risk reduction options agreed by those villagers who took part in the group discussions. The 'flood impact' and 'risk reduction' options were first explained, then discussed. People thought they could do nothing to minimise crop damage caused by floods. Floods cannot be forecasted with much precision and evade the reach of long-term forecasts. Therefore, farmers have no choice but to take the risk of growing their rice crop. If a huge flood occurs during the crop cycle, damage is unavoidable. If there is an engineering solution available, it lies beyond the resources, ability and capacity of the community to utilise it. In the absence of considerable external support and without huge donations from external agencies nothing can be done.

The loss of personal property such as livestock, clothes, household goods and the like, could either be prevented or reduced. Villagers proposed several activities to achieve this. People could move their property to higher ground and other safe places during the flood periods. They could also construct shelves in their house so that property could be placed safely above the water. If placed in an elevated storage position, the loss of medicines and food prepared for human and livestock could be minimised.

The risk of flood related illnesses, injury, and death could be reduced through many available actions. Awareness of the potential danger arising from floods could make a difference, as could knowledge of the possible impacts on water supply and sanitation. Temporarily moving people away from the affected area could also help. Frequent meetings

to review preparedness and disseminate relevant information to the community remained important. Moreover, the supply of useful equipment such as adequate latrines, water filters, and camping facilities were helpful. Accessing health service in a quick and reliable manner was pointed out as an important area in which improvement could be made.

Villagers thought the loss of community infrastructure and environmental damage could either be reduced or lived with. After flood events, damage reports are always prepared and sent to related stakeholders, especially the relevant government agencies. Requests for rehabilitation and aids for recovery are usually pointed out. If financial approval is given by the government or related stakeholders, including NGOs, for rehabilitation and reconstruction, this usually takes place relatively quickly. This work, with a view to 'adaptable development', as discussed, is approached in a manner that makes provision for subsequent events of a similar magnitude, meaning that roads, schools, and other infrastructure are built higher so that they will better weather the impact of future floods. However, this is not to say that all infrastructure built to the guidelines laid out in this policy are always successful; unusually big flood events still wipe out roads, sweep trees away and wash debris into storage ponds and water ways.

Various options to minimise losses from droughts were also discussed during fieldwork. Villagers argued that agricultural production losses of rice and other crops could be reduced through better use of local water sources. In close proximity to the Kampong Trabaek River the water table is usually quite high and villagers insisted that ground water was a resource that was under utilised. When surface storage in ponds failed, additional water could be made available by digging deeper wells to pump water onto the fields and minimise losses. Second, livestock losses could be reduced through adequate hygiene, early treatment of diseases when they occurred, and better storage of food and fodder. Confining chickens to cages could minimise the spread of infectious diseases. Training services either to strengthen or introduce new animal management and livestock techniques were proposed. Third, the affects of drought-related influences on people could be reduced in a similar way to flood-related factors. Awareness rising from drought impacts as well as water supply and sanitation programs, along with proposed mitigation measures, could contribute to minimising the above impacts. Again making sure essential equipment and services are available can make a huge difference. These include adequate latrines and water filters, quick and reliable health services, sufficient ground water, and careful attention given to personal hygiene. As droughts do not damage community infrastructure and the environment to any great extent, those participating in the discussion did not think anything needed to be done to guard against

losses. People were used to hot dry periods when little or no rain falls and were not worried by short term, predictable, and seasonal fluctuations.

5.3.3 Local perspectives on disaster measures

Local ideas concerning good ways to minimise disaster impacts were discussed. In fact, some information in this section is similar to the previous section. However, it is separated because this section is about what local people need and request; and they are unlikely to do it without outsiders and their support. To get the information, people were asked to brainstorm ideas that are categorised into three main groups and discussed below.

Infrastructure and engineering solutions

People believed water related structures could minimize floods and droughts. Flood control facilities including dams and sand bags might be able to control flood waters. Natural disaster impacts could also be reduced through increasing canal size to enable more water to either flow through diversions when floods were running, drain fields when floods had passed or store water during drought periods. Moreover, local people thought that using engine driven pumps to get rid of excess flood water following inundation was a good way to save fields of rice especially after small floods. Such pumps could also be used for irrigation during dry periods. Villagers raised the idea of building more bridges and diversion canals to reduce damage to roads as well as get rid of excess water quicker.

Agricultural support

Agriculture is the main source of income for this commune. Therefore, any support in this area will improve people's livelihoods. Agricultural techniques and support for flood resistant crop varieties, and flood-recession rice would be considered helpful. Besides, the community wants to have clear proposed measures laid down to protect their livestock. These measures, including improved availability of medicine, fodder, high ground refuges, were mentioned along with other important points such as making good information available well in advance of disasters. Farmers were particularly insistent that livestock medicines and fodder should be made available and accessible so they could avoid losses owing to diseases or seasonal sicknesses.

Water supply and sanitation program

Safe water and diseases are the main concerns for public health in the study area. They would welcome a safe water supply and sanitation development programme supported by relevant stakeholders and would like to see more done in terms of awareness raising, technical

support that would enable them to build more wells, finding more sources of quality water, making more latrines, providing more water filters, strengthening health services to reduce water related diseases and addressing the problem of an inadequate water supply.

5.3.4 Policy framework

Legal and policy frameworks

At a global level, the Hyogo Framework of Action (HFA) 2005-2015, for which Cambodia is one of the signatory members, is the result of a World Conference on Disaster Reduction, a meeting held by UN-ISDR in 2005 (ADPC, 2005; UNISDR, 2012; Varma, 2005). UN-ISDR, created in 2000, is "the successor to the secretariat of the International Decade for Natural Disaster Reduction (IDNDR)" (UNISDR, 2012). IDNDR was designated in the 1990s by Resolution 44/236 of the United Nations General Assembly to take international action to reduce the incidence and magnitude of natural disasters, especially in developing countries (NCDD & MoP, 2008).

The Hyogo Framework for Action 2005-2015: Building the Resilience of Nations and Communities to Disasters aims to promote disaster risk reduction (DRR) actions through integrated policy initiatives to improve the ability of developing countries to manage events, develop the institutional capacity, and implement DRR components (ISDR, 2007; UNISDR, 2012). To achieve its objectives, based on ISDR (2007), HFA identified five priority actions:

1. *Ensure that disaster risk reduction (DRR) is a national and a local priority with a strong institutional basis for implementation;*
2. *Identify, assess and monitor disaster risks and enhance early warning systems;*
3. *Use knowledge, innovation and education to build a culture of safety and resilience at all levels;*
4. *Reduce the underlying risk factors;*
5. *Strengthen disaster preparedness for effective response at all levels* (ISDR, 2007, p. 6).

At a regional level, the ASEAN Agreement on Disaster Management and Emergency Response (AADMER) was adopted in 2010 (ASEAN, 2012). AADMER 2010-2015 applies to the membership region as a whole and is monitored to ensure that HFA guidelines are followed by all member states (ACDM, 2010). The agreement focuses on disaster risk reduction in the region through cooperation, coordination, and mutual support among governmental and non-governmental institutes, as well as local communities. Building resilient and safer communities by protecting them from disasters, and minimising the loss of lives and damage to the socio-economic, as well as physical and environmental assets of the member states by 2015, is the main vision of this agreement (ACDM, 2010). It works to four

strategic components, including risk assessment and an early warning system, prevention and mitigation, preparedness and response, and recovery (ACDM, 2010).

At the national level, natural hazard management has been written into several policy frameworks. The Strategic National Action Plan for Disaster Risk Reduction (SNAP-DRR) for 2008 to 2013 was launched in Cambodia in March 2009 in response to the government's declared commitment to global disaster reduction, especially the HFA. SNAP-DRR, established by the National Committee for Disaster Management and the Ministry of Planning (NCDD & MoP, 2008), is the main DRR policy framework in Cambodia which deals with DRR through strengthening, namely management and information systems, disaster response capacities, and integration of DRR into the government's policies, strategies, and plans (NCDM & MoP, 2008). It follows the HFA priorities for action. Moreover, Cambodia's National Poverty Reduction Strategy (NPRS) works on the impacts of natural disasters, such as floods and droughts, on socio-economic vulnerability, especially in rural areas (IMF, 2004). Furthermore, the National Strategic Development Plan (NSDP) as the main advocate of Cambodia's Millennium Development Goals (CMDG) includes references to the policy in all of its principal papers. NSDP does not handle disaster management directly but incorporates it into key thematic areas in which plans are prepared to protect natural hazards as well as to reduce risk and vulnerability to hazards (Rinbo, 2009).

Actors

Over the past few years, in response to floods and droughts, several major government and non-government institutes have been established.

NCDM

The National Committee for Disaster Management (NCDM), created in 1995 through a sub-decree, is a government institute of which the Prime Minister is the president (Rinbo, 2009). The main responsibilities of NCDM are preparedness, response to, and mitigation of disasters all over the country. This institute has the biggest national responsibility for disaster management and has members from among the ministers of all related government institutions, representatives from the Cambodian Red Cross, the Royal Cambodian Armed Forces, and the Civil Aviation Authority (Rinbo, 2009; Saohorn, 2009). At the provincial level, the same hierarchical structure is followed. There are Provincial Committees for Disaster Management (PCDMs) in each province. These are chaired by the Provincial Governor. PCDMs have representatives from provincial offices of all related ministries and other governmental institutes. In order to strengthen disaster management efficiency, similar

structures at the district level called the District Committee for Disaster Management (DCDM) and at commune level called the Commune Committee for Disaster Management (CCDM) are in place.

In the study area, based on field research, DCDM is chaired by the District Governor and four Vice-District Governors with 22 members from all related government agencies at district level including a Commune Chief. The DCDM is responsible for working with all disaster management events in the area, communication and information dissemination to the NCDM, disaster preparedness and protection, emergency relief and rehabilitation, planning and making proposals to the NCDM, communication and liaison with related non-government agencies, holding regular meetings, and participating in fund raising. At the commune level, CCDM is chaired by the Commune Chief who is assisted by three members who are the current commune officials. The CCDM works under the direct supervision of the DCDM.

CRC

The Cambodian Red Cross (CRC), Cambodia's largest humanitarian organisation engaged in disaster relief and which should be considered an auxiliary to the government (CRC, 2012). It works closely with governmental ministries and institutes, non-governmental institutes, and other Red Cross partners (CRC, 2003). CRC operates in all the provinces through its provincial offices as well as its branches at district and commune levels. This institute established its own Disaster Management Department in 1994 and Community-based Disaster Preparedness Programme (CBDP) in 1998 in order to help vulnerable people to be better prepared, to respond to and mitigate disasters in Cambodia (CRC, 2003, 2012). In Prey Veng Province, based on field research, CRC started work in 1983 and has since made major contributions to disaster preparedness and mitigation, and provided health training to community and related stakeholders. It set up an Early Warning System in 2004, has provided emergency relief through food, first aid, and help with evacuation, has set up disaster data collection and dissemination, provided financial support for building elevated areas, gifted seeds and boats, undertaken structural work and so forth.

Governmental ministries

Many governmental ministries undertake work related to disaster management, such as the Ministry of Environment, Ministry of Agriculture, Forestry and Fisheries, Ministry of Water Resources and Meteorology (MOWRAM) and so on. However, the Ministry of Water Resources and Meteorology carries a particular responsibility because of the important role it is expected to play. At the national level, there are two important departments in the Ministry.

First, the Department of Hydrology and Rivers which is responsible for observing and collecting hydrological data to monitor and analyse flows. The results are made available to government and non-government institutes, stakeholders and media, and communities in order to encourage people to remain alert, to prepare for and respond to hazards when they occur (PDRSEA, 2008). Second, the Department of Meteorology is responsible for collecting climatic data such as rainfall, temperature, wind speed, and temperature, and for providing weather forecasts (Kea et al., 2005). Here again their data is disseminated to related agencies.

As mentioned earlier, NAPA is a programme under the Ministry of Environment which makes up the main climate change adaptation's policy framework. It is designed to look at trends and changes relating to climatic hazards such as flood, drought, windstorm, high tide, salt water intrusion events and malaria (MRC, 2009). It has identified 39 priority adaptation projects that will need to be implemented if Cambodia is to adapt to the impacts of climate change. Some of these involve capacity building, awareness raising, and infrastructure development. NAPA priority projects also address challenges likely to arise in a range of sectors including agriculture, water resources, human health and coastal zone management. Among these 39 projects, 20 projects relate to water resources and agriculture including 9 projects dealing with droughts and 5 projects dealing with floods (MoE, 2006).

Other NGOs: WFP

In Prey Veng Province, there are several NGOs working in disaster related areas, such as the World Food Programme (WFP), CARE, CEDAC, and so forth. However, based on fieldwork carried out in the study area, it was surprising how often people mentioned the usefulness of the World Food Program. The WFP is a United Nations organisation operating in Cambodia. It works closely with the government and NGO partners in order to provide food assistance to affected families. WFP plays an important role in emergency relief by providing food assistance, principally through food for work programs. Its role in the post disaster recovery phase through repair and rehabilitation of damaged infrastructure is often critical in getting things up and running again.

5.4 Conclusion

Flood and drought disasters include both direct and indirect damage to crops and personal property, community infrastructure and environment which have an impact on people, although floods can also bring some benefits, especially for agricultural activities. To deal with these disasters, people use a variety of coping strategies before, during, and after the natural hazards and some coping strategies have emerged in recent decades. Local people

believed that the impact of floods and droughts on people and personal property could be either reduced more easily or given willingnesses to reduce than the impact on crops and community infrastructure and environment. They proposed some good solutions to minimise disaster impacts and these were infrastructure and engineering solutions, agricultural support, and water supply and sanitation programs. Furthermore, much progress of the policy frameworks include many legal and policy status on disaster reduction at global, regional, and national levels as well as governmental and non-governmental actors has been made.

Chapter VI: Vulnerability and proposed interventions

Disasters, as mentioned earlier, are the outcomes of natural hazards coinciding with vulnerability. In Chapters IV and V, I discussed natural hazards and disasters; however, we do not know all the reasons why disasters occur. In this chapter, I will identify and discuss the known factors using the *vulnerability context* of the Sustainable Livelihoods Framework (SLF) and Pressure and Release Model (PAR) to explain these. Vulnerability needs to be assessed because it is the most critical factor in disaster risk reduction and building a resilient community (Kasperson, Kasperson, Turner, & Schiller A., 2005). Finally, an integrated framework is offered as a way of monitoring interventions that could possibly resolve some of the challenges.

6.1 Overview of social-economic status and profile of the study area

Before discussing the factors that cause disasters, the social-economic status of a community needs to be reviewed so that this information can be used in the *vulnerability context* of the Sustainable Livelihoods Framework (SLF) and Pressure and Release Model (PAR).

Population

This commune has 2560 families, a total of 10875 people including 5746 men. Around 65 percent of the people are over 18 years old. The number of families in each of the 15 villages is shown below:

Table 6.1: Families in Sdau Kaong Commune

	Villages															**Total**
Name	Ta Kouk	Trapeang Sekar	Siem	Thmei	Krang Chen	Sempoli	Trabaek	Thnong	Prey Phdau	Chun Mea	Chrak Svay	Prey Kantrong	Boeng Trabar	Tong Neak	Trapeang Svay	
Families	139	98	165	67	305	206	130	178	169	275	197	132	169	187	143	**2560**
%	5.4	3.8	6.4	2.6	11.9	8	5.1	7	6.6	10.8	7.7	5.2	6.6	7.3	5.6	**100**

Source: Fieldwork 2012

Poverty

Poor and very poor households were identified through criteria from the Ministry of Planning. The indicators used to evaluate the wealth of each household are housing condition, land size, income, animal raising and other assets, food shortage, unemployed members,

means of transportation, situation of household head, remittance, and other unexpected problems or crises. The result is shown as follows.

Table 6.2: Poverty level of Sdau Kaong Commune

Villages	Total families	# Poor families	% Poor families	# Very poor families	% Very poor families	# Total poor and very poor families	% Total poor and very poor families
Ta Kouk	139	41	29%	16	12%	57	41%
Trapeang Sekar	98	48	49%	5	5%	53	54%
Siem	165	26	16%	24	15%	50	30%
Thmei	67	23	34%	23	34%	46	69%
Krang Chen	305	64	21%	45	15%	109	36%
Sempoli	206	34	17%	32	16%	66	32%
Trabaek	130	18	14%	29	22%	47	36%
Thnong	178	36	20%	36	20%	72	40%
Prey Phdau	169	24	14%	49	29%	73	43%
Chun Mea	275	41	15%	61	22%	102	37%
Chrak Svay	197	41	21%	27	14%	68	35%
Prey Kantrong	132	20	15%	37	28%	57	43%
Boeng Trabar	169	33	20%	33	20%	66	39%
Tong Neak	187	23	12%	28	15%	51	27%
Trapeang Svay	143	42	29%	23	16%	65	45%
Total	**2560**	**514**	**20%**	**468**	**18%**	**982**	**38%**

Based on poverty identification by Sdau Kaong Commune

This table indicates a poverty rate of 38% which is similar to a previous poverty study in this area. A study by the National Committee for Sub-National Democratic Development (NCDD) in 2009 showed that households living in poverty in this commune made up 40% of the total number of households in 2004 and 35% in 2009.

Education

Kindergartens, primary schools[4] and a secondary school[5] are accessible at the commune centre while high schools[6] are located at district centres. There are 2 official kindergartens, 5 primary schools and 1 secondary school which consist respectively of 48 rooms, 54 rooms and 11 rooms. There are not enough rooms to meet demand. There are around 30 students per primary school room and 100 students per secondary school room. Most of the students drop out after secondary school. About 60 teachers work in this sector.

[4] Primary school consists of grade 1-6.
[5] Secondary school consists of grade 7-9.
[6] High school consists of grade 10-12.

Socio-economic situation

The house conditions in the commune vary from small to large. Roofs are equally likely to be covered with thatch, corrugated zinc/fibro sheets, or roof tiles. There is no reticulated electricity supply so batteries are used to light houses and run TV sets and radios. More than 50 percent of households have access to TVs and radios.

As already mentioned the primary income generating activity is rice cultivation. More than 90 percent of families are small holder farmers. Around 35 percent of farmer households own less than 1 hectare of rice land and approximately 3 percent are landless. The total area of cultivated land consists of 2872 hectares of (mostly rain fed) wet season and 220 hectares of (mostly irrigated) dry season land. Nearly all of the wet season land is rain fed rice. However, an irrigation system is being constructed in the commune. It is believed that both rice yields and livelihoods will be improved after the system is finished. The average rice yield of both wet and dry season rice is around 2.70 tonne per hectare. Therefore, every year over 8000 tonnes of rice can be produced in the study area. If we divide the total rice yield by the number of households, we can say that each household produces an average of 3 tonnes of rice. Farmers can sell their rice for between US$ 250 and 500 per tonne depending on the season and the quality of the rice.

Livestock are also a good source of income and food. Cattle, pigs, chickens, and ducks are fed. Around 85 percent of households have either cattle, pigs, or chickens. On average, people have 2 to 3 cattle per family, and around 20 percent of families have more than 3 pigs. Ducks are less popular; only about half of all households raise ducks. Fishing is also an important source of food and/or income for some families.

Migration is a new trend in the current decade. People usually send their daughters and sons to work in Phnom Penh and other places both inside and outside Cambodia. The most common jobs for female migrants are factory work and domestic help while males are more likely to find employment in construction or other labouring work. Remittances make an important contribution to family income.

Health facilities

There is a Health Centre operating in the commune. However, villagers raised questions about the reliability and skill of staff, the availability of medicine, and the quality of service. Severe diseases and sickness are referred to district or provincial hospitals, and sometimes patients are sent to public hospitals in Phnom Penh. In addition, there are several private doctors and

pharmacies available. These are much better than the Commune's Health Centre, but the costs are much higher.

Water supply and sanitation are not sufficient. Wells are the main source of drinking water and cooking. There are 289 wells including 271 hand water pumps and 18 hand-dug wells. The ratio of families to wells is 1:9. Nearly 50 percent of families have their own water filters at home while about a quarter of all families boil water. Latrines are not widely available. People go into fields or behind trees or buildings to relieve themselves. Consequently, diseases can be spread easily, especially during floods.

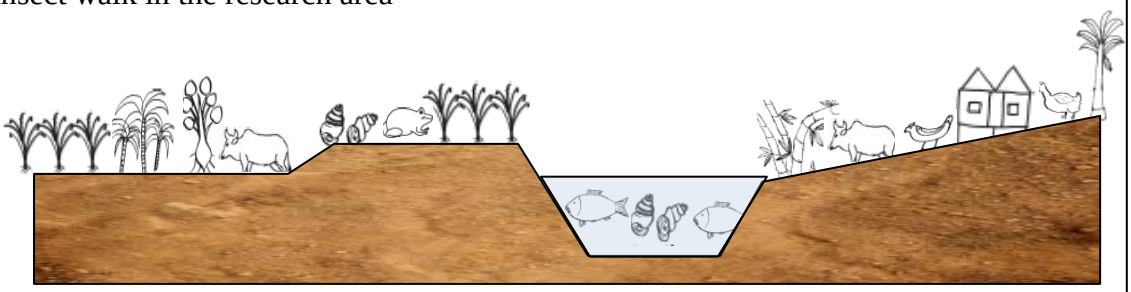
Environment, infrastructure and other resources

The environment in this area could be described as following. There is neither forest nor protected areas and trees are few and far between. There are many shallow, seasonal lakes and canals that dry out over the hot season. Chemical fertilizers are used by most farmers and chemical pesticides by a minority but both pollute the environment. These substances remain in the soil and contaminate flood water. This becomes unhealthy when people use flood water for drinking and cooking.

The cultural landscape includes 3 pagodas managed by 21 monks. Buddhist and other Khmer traditional ceremonies are held there. The main laterite road and secondary roads provide approximately 5 km of good access to all the villages in the commune. There are also many water channels to control both drainage for flood water and irrigation for agriculture.

A transect walk was conducted during fieldwork. The primary focus was on 3 resource systems including crops, livestock, and soils within the floodable paddy, drought-prone paddy, canal and water sources, as well as village land and houses. Any potential opportunities and problems were also recorded. The result is shown below.

Figure 6.1: Transect walk in the research area



Resources systems	Floodable paddy	Drought-prone paddy	Canal and other water sources	Village land and houses
Crops	- Short term rice - Medium term rice - Long term rice - Water spinach - Sugar palm	- Short term rice		- Short term rice - Banana - Mango - Cucumber - Water spinach - Taro - Papaya - Bamboo
Livestock wildlife	- Cattle - Crab - Frog - Snail	- Crab - Frog - Snail	- Fish - Crab - Small shrimp - Frog - Snail	- Cattle - Pig - Chicken - Duck - Fish - Cricket
Soil	Loamy	Sandy	Sandy and clay	Sandy
Problems	Flooding, water pollution	Drought, insufficient water and water sources for paddy	No water in dry season, accidents during floods	Flooding
Opportunities	Grow rice two seasons per year	Wells, pumping water	Irrigated water, fishing,	Raising livestock and fish, plant fruit trees and vegetable

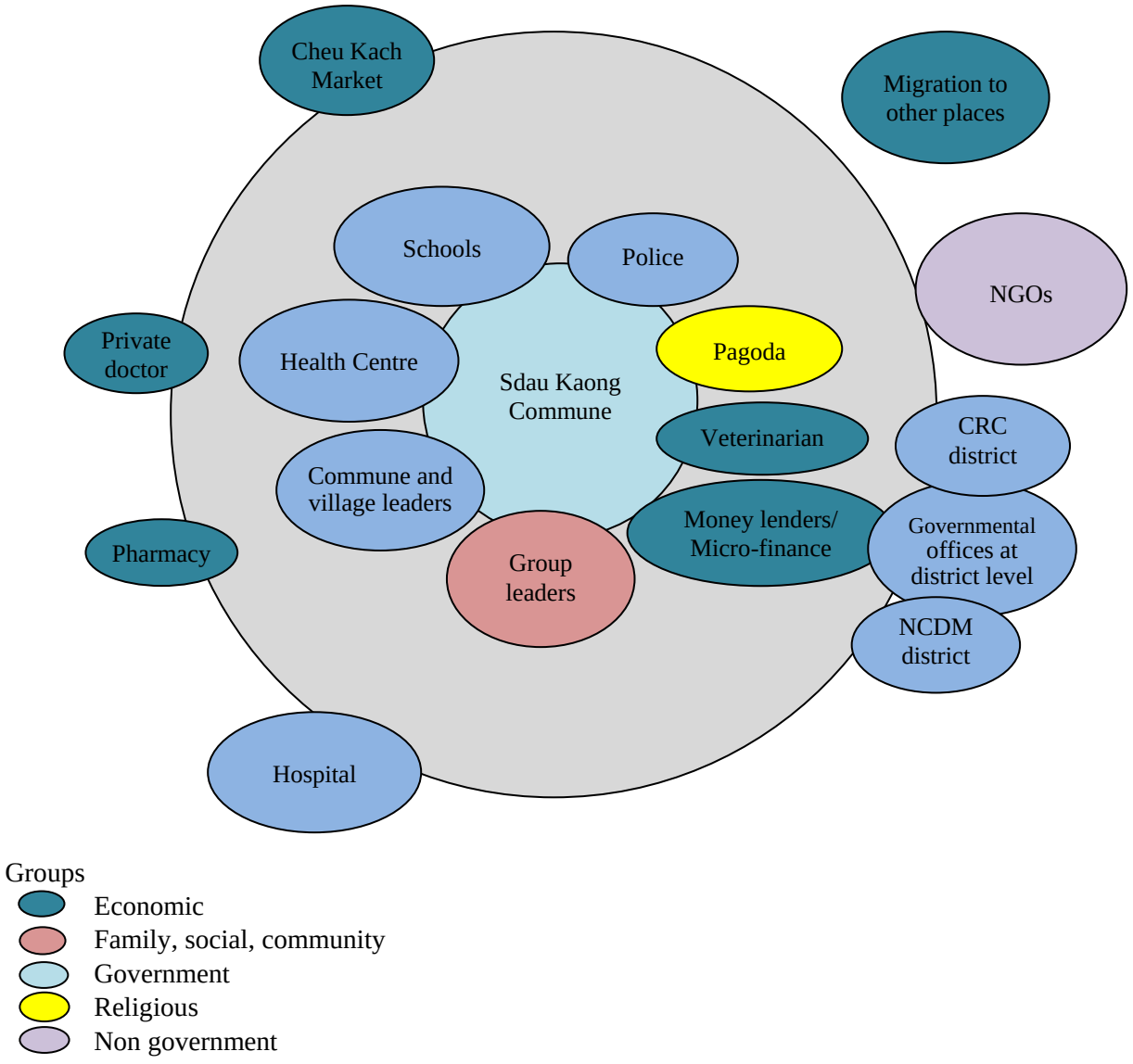
Source: Fieldwork 2012

Networking

Institutional Analysis was carried out during the fieldwork. This exercise allowed the researcher to investigate the relationship between the local inhabitants and other agencies both inside and outside the community. Those which included a relationship within the commune were placed in the inner circle that encompassed all agencies within Sdau Kaong Commune while those outside this circle had a more distant relationship. The bigger the circle the more

important it is for the commune. For example, people give most priority to schools, health centres, micro-finance institutes, and outside agencies such as NGOs, Cheu Kach Market, migration to other places, and local governmental agencies. Although strictly speaking 'migration to other places' is not an agency or institution I have included it as an important area of concern, because overall priority was given to areas considered to be important to meeting their basic needs and providing livelihood alternatives. NCDM, CRC, and WFP, who are the main actors in disaster risk reduction, are included in the local governmental agencies and NGO categories. The relationship is categorized into 5 groups, namely: economic; family, social, and community; government; religious; and non government groups.

Figure 6.2: Institutional Analysis in the research area



Source: Fieldwork 2012

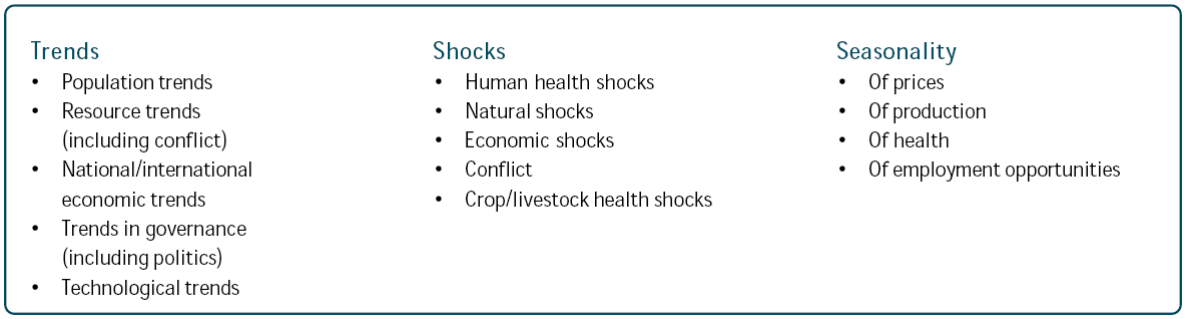
6.2 Factors causing disasters

In the Sustainable Livelihoods framework described in **Chapter 2**, the *vulnerability context* is defined as the external factors that influence (create or destroy) *livelihood assets*. Limited assets/capital affect local people's capacity to cope with and to recover from stresses, and the status of assets constitutes vulnerability. Major components of assets and vulnerability interact and influence each other. Vulnerability and assets affect livelihood choices. When people are seriously disadvantaged by unfavourable access to these assets and subject to environmental stress, this can quickly result in disastrous outcomes. Because of their critical role, vulnerability and asset constraints will be identified in the *vulnerability context* and discussed in the following paragraphs. The PAR model will then be applied to the configuration and the causative factors analysed. Information collected in the course of fieldwork and secondary data will then be used to show how the *vulnerability context* and PAR models can be brought together.

6.2.1 Vulnerability context

The *vulnerability context* of SLF consists of *trends*, *shocks*, and *seasonality* as shown in the following Figure 6.3 (DFID, 1999). *Trends*, *shocks*, and *seasonality* provide a big picture of how vulnerability comes about. *Trends* influence the availability of assets and livelihood strategies while *shocks* are the main causes of damage to local assets; *seasonality* forces additional pressure (DFID, 1999). See following paragraphs for details.

Figure 6.3: Vulnerability context



Source: DFID (1999)

Firstly, various *trends* have influenced people's livelihood. In the research area, the population grows at a rate of about 2% per year. This means that assets such as land are increasingly divided between new family members. As a consequence family farms get smaller and smaller and along with this their productive capacity per farm and household unit

gets smaller and smaller[7]. The likely exposure to natural hazards increases because more people with fewer assets per head/family unit live in the flood- and drought-prone areas. Reserves of assets such as water in ponds underground tend to decline owing to increased consumption and inadequate conservation. Income generation may increase if surpluses can be produced, especially if the price of rice rises on the global market; however, any increase in production per hectare is more likely to go to local domestic consumption. If farmers borrow at unfavourable rates to make up for shortfalls and get into debt, if production trends and prices go against them, they soon run into trouble. Programmes run by the National Committee for Sub-National Democratic Development (NCDD) and NGOs that support the participation of the poor in the development processes are not always effective enough to overcome these downward trends. The limited knowledge and capacity of the poor and the constraints on duration and scope of the programmes can place the poor in a situation in which they are unable to sustain favourable livelihood outcomes. As the poor have limited resources, they cannot always access secure location/housing and modern agricultural inputs to boost production.

Secondly, *shocks* such as floods and droughts have destroyed local assets. As discussed in **Chapter V**, these natural hazards can diminish social, financial, natural, physical, and human assets. Crops, personal property and housing, rural infrastructure, and the environment are usually seriously damaged. People are often injured, can become sick or even die. Consequently, survivors are then even more vulnerable to further natural hazards because they have lost their assets to cope with and recover from these disturbances.

Thirdly, *seasonality* indicates changes in prices, production/food, health, and employment opportunities, changes which mostly affect the poor. An annual inflation rate of 3-6% (Deng, 2011; EIC, 2012) significantly increases the price of processed food as a commodity and of agricultural inputs. Unfortunately the price of agricultural products on local markets usually increases slower than commodity products and services, which adversely impacts on the poor the most. This affects the seasonal prices in the upcoming years when the price of agricultural products are reduced by the middlemen during the harvest periods; leading to a big gap between processed food and agricultural products. Moreover, agricultural production is not stable, and natural hazards often destroy crops and make people and their livestock sick. The poor, having limited skills and assets, cannot diversify their income sources. Being dependent on farming alone makes them the most vulnerable to floods and droughts.

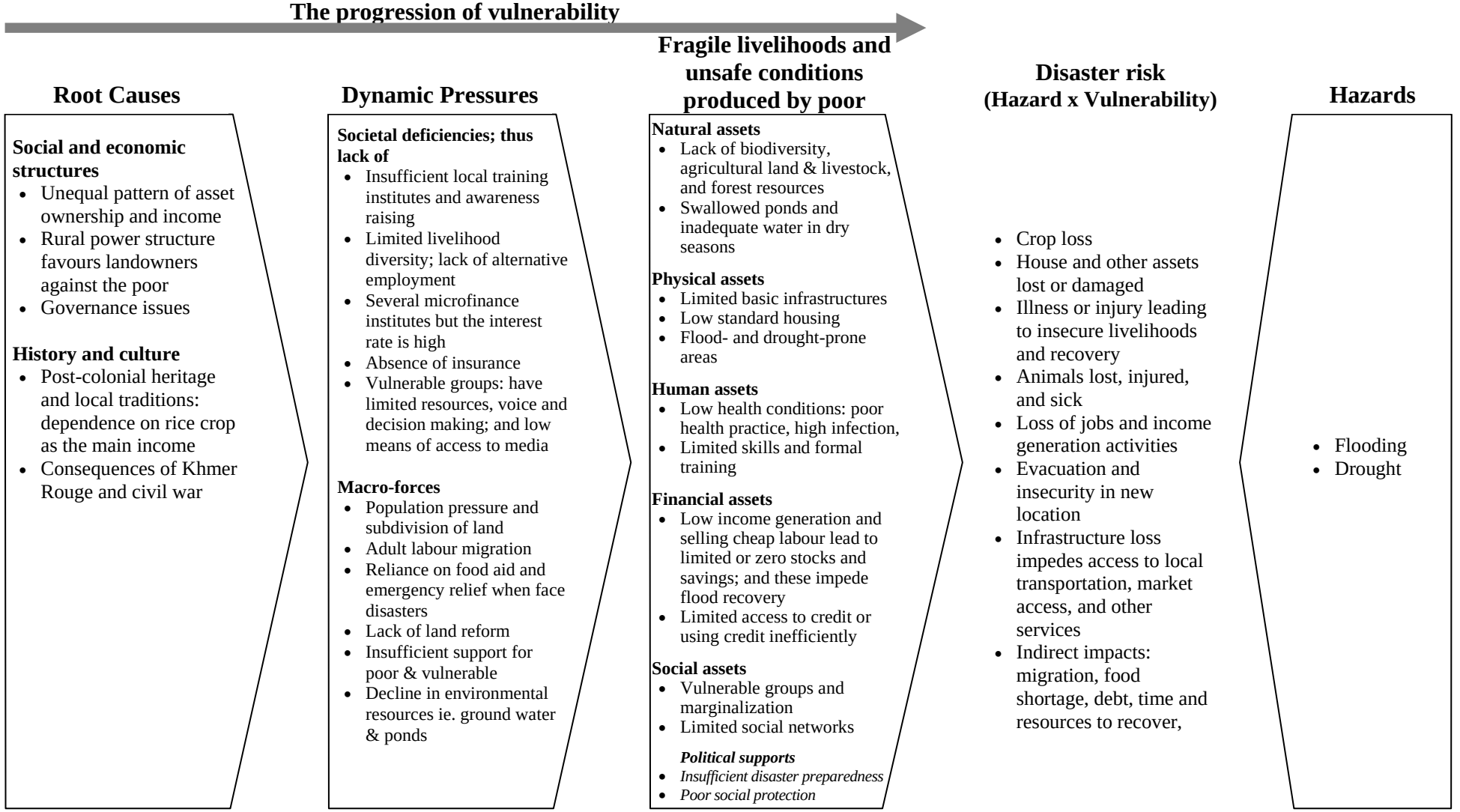
[7] Overall gross production per ha may increase with intensification but production per worker eventually declines

6.2.2 Vulnerability processes

The Sustainable Livelihoods framework provides a clear picture of livelihoods and key influences. However, it mainly focuses on general agrarian policies and livelihoods rather than specifying natural hazards and disasters. A disaster affecting the sustainability of livelihoods is a part of the framework. The PAR model is very similar to the Sustainable Livelihoods (SL) approach but it specifically focuses on disasters, vulnerability and hazards. I use this latter model to supplement the SL approach in order to fully account for why disasters occur.

The Pressure and Release (PAR) model classifies nature, or what is 'natural' as consisting of assets/resources and hazards. This model was originally developed by Blaikie et al. (1994) and includes three major progressive steps in the development of a vulnerable situation or what the authors refer to as vulnerability (*root causes, dynamic pressure,* and *unsafe conditions*), disaster risk, and hazards. Wisner et al. (2012) further developed this model and added to these three major elements. My research uses the PAR model developed by Blaikie et al. and Wisner et.al. in association with the PAR model developed in Bangladesh by Ahmed (2003), and modified to fit my fieldwork results and observations as well as other relevant secondary data on the socio-economic status of farmers drawn from the NCDD website. This is presented below (Figure 6.4).

Figure 6.4: Pressures leading to disasters from floods and droughts in my research area



Adapted from Ahmed (2003); Blaikie et al. (1994); Chambers and Conway (1991); Wisner et al. (2012)

The above figure indicates steps towards vulnerability. It begins from *root causes to dynamic pressures,* and then develops to *unsafe conditions*. *Root causes* are unequal access to assets, infrastructure, and power through political and economical systems, meaning that the poor and other vulnerable groups such as women, children, and elderly have limited access to such assets. Cambodia was under the colonial rule of the French from 1863 to 1953. Also, development was badly affected by the 1970s civil war and by Khmer Rouge under the Pol Pot regime which ran the nation into the ground. Pol Pot implemented a dictatorial system of agrarian socialism under which he forced urban dwellers into the countryside to become farm labourers. It has been estimated that approximately two million people, around 25% of total population, including many educated people, were either killed or died under the primitive conditions imposed (The History Place, 1999). Cambodia is still recovering from this assault.[8].

Secondly, *dynamic pressures* consist of societal deficiencies and macro-forces. In my study area, primary schools are easily accessed by students while secondary and high schools are located further away from residential village areas. The current generation, both male and female have more opportunities to attend schools than previous generations. However, many of them do not continue to secondary and high school level. This limits the development of people's intellectual capacity and knowledge. Over 90% of people in the research area are farmers with a low level of education. Even if they wanted to, the majority of people are less qualified and less likely to find alternative jobs outside the agricultural sector. Many things are against them. If they need to access credit as an emergency option to enable them to acquire urgent needs, the interest rates charged by traditional providers/money lenders are very high. Current local microfinance agencies provide a lower interest rate of around 2-4 % per month; however, this is still high. These agencies require evidence of property titles and ownership of assets to secure loans. The poor who have limited assets consequently find it difficult to negotiate low interest rate loans. Furthermore, insurance is overwhelmingly limited in cities and urban areas, is expensive, and available at rates that most rural families cannot afford. There is no incentive or government subsidy available to make insurance more affordable, and minimizing the impact of disasters is by far the best development strategy. Vulnerable groups of people who have limited capacities, assets, and knowledge, have less influence on decision makers who, if better disposed, might be willing to support their needs. In addition, macro forces such as population pressure, adult migration, reliance on external

[8] In fact further research is required to check the numbers that are currently accepted

support, insufficient protection for the poor, and environmental resource degradation are also dynamic pressures that contribute towards unsafe conditions.

Thirdly, *fragile livelihoods and unsafe conditions* are caused by social, economic, and political structures. These structures are the *root causes* and *dynamic pressures* that diminish the number and quality of assets available to people. These assets include natural, physical, human, financial, and social assets/capital that lead to unsafe livelihoods. Chambers and Conway (1991, p.1) define Sustainable Livelihoods as comprising of "people, their capacities and their means of living, including food, income and assets". Therefore, the five assets are central to Sustainable Livelihoods. If these assets are threatened, the livelihoods are not safe, and people are less likely to cope and recover from shocks which lead to vulnerability as shown in the Disaster Risk column above in Figure 6.4.

There is less than full agreement between the way Wisner et.al. and the Sustainable Livelihoods experts such as Chambers and Conway (1991) configure resources or assets and capital. Wisner et.al. prefer the broader term 'resources', Chambers and Conway 'assets/capital'; the former use six categories including 'political resources', the latter five categories and subsume political aspects under 'social assets'. Rather than explain or resolve the differences between the former, concerned primarily with disaster management, and the latter with rural development work, I will retain use of the political category because I wish to emphasise the importance of positive adaptive initiatives rather than passive coping investments. To promote a more exact focus I have exchanged the Wisner et.al. use of the broad term 'economic resources' for 'financial assets' and given preference to the use of the terms 'assets' and 'capital' over 'resources'. Information about these assests, discussed below, come from my field research including field observations and secondary data. My aim is to indicate what constitutes "fragile livelihoods and unsafe conditions".

Natural assets are the stock of attributes found in a specific environment and include the climate, lay of the land, quality of the soil, rivers and streams, and flora and fauna, all of which are under constant modification by human occupation. In my research area, rich sedimentary soils, trees, ponds, underground water, land cleared for agriculture, arable farming and animal/livestock raising are currently among the most important natural resources. Population pressure has been brought into the relationship between human occupation and natural resources. Farmland has been divided and allocated to new members of families as they mature, marry and settle down. Land has become a commodity. A few plots of land have been sold to pay off debts or generate cash to use in times of emergency, for example to pay for medical treatment when diseases and illnesses strike. Rich families

sometimes take advantage of opportunities to buy agricultural land from families in financial difficulty, especially the poor, at a price below the market value. Families with large areas of land either hire labour from poor households to do the necessary agricultural work for them or rent out their land to the poor under share crop arrangements. The impact of livestock is not heavy, nor do livestock provide much income. A few households own cattle, buffalo and pigs. Nearly all keep chickens that mostly look after themselves but are sometimes fed on household waste. This is a traditional way of keeping animals. Fields are levelled and enclosed by a perimeter of low bunds behind which water, either from irrigation or run off, is captured to grow rice. Rice is the main source of both subsistence-domestic income and cash. Some households generate a small income from the sale of sugar palm or sugar palm drinks and some ferment sugar palm to produce alcoholic beverages. Given prevailing market constraints the price of these products is much lower in the village than on urban markets. By transporting goods to urban areas middle men can make a good living. The total available water in ponds and under the ground tends to drop more quickly as the population increases. Natural resource management and governance could be improved.

The situation regarding access to water and sanitation is not yet acceptable, especially in the dry season. As already mentioned, on average, one out of nine families has their own well. Some wells do not provide water during the dry season. Finding other water sources such as ponds and rivers takes time and the water quality is not always good. Some people have received either ceramic filters or bio-sand filters from the Cambodian Red Cross (CRC) and other NGOs to purify their water. However, when filters break or malfunction, getting replacements can be difficult and depends mainly on external backup support.

Physical assets include the infrastructure and other material changes made to the natural environment including canals, raised refuge platforms to which people can retreat during a flood, roads, houses ranging from small wooden dwellings made out of local materials to big concrete houses with tile roofs, a health centre, schools, pagodas, battery-based energy, television sets, radios, and mobile phones. Firstly, the current irrigation system is not sufficient; however, a new system is currently being built in the area and this project should have an impact on agriculture within the next few years. Secondly, the current primary laterite road may be in good condition but the secondary roads branching off from this primary road are not so well maintained. It should be noted that transport is very important for delivering products and agricultural inputs as well as enabling farmers to access outside markets. Laterite roads usually remain in good condition for a few years after construction but in the absence of a well run highway department, maintenance is a problem. At the moment

maintenance relies on external financial support. During election campaigns, politicians usually promise to build additional infrastructure if their political party wins the election. Thirdly, house conditions vary. As indicated above, the poor have smaller and lower quality houses which can be quite fragile and are easily destroyed by floods. Only a few rich families have latrines in their houses. Consequently, infectious diseases can be transmitted all too easily. Furthermore, the health centre and schools are government run, and therefore public property. The reliability and quality of service, equipment, and staff is limited. The richest families have more options because they can afford private services which are faster and more reliable. Lastly, most poor families cannot access mass media and information because they do not have television sets, radios, and mobile phones. Although some of them can afford to buy these items, the cost of running them on a battery based energy supply is discouraging. They know that to keep the equipment working they will have to spend their fragile income on recharging batteries. Therefore, these people often decide to rely on word of mouth, talking to their neighbours and relying on the chief of the village to provide natural hazard warnings and forecasts.

Why people live in a hazard zone is not always easy to understand. Often it is simply because their ancestors lived there and low level floods are viewed positively because soil quality for agricultural purposes is maintained by silt deposits. Themi village is a good example. Although most exposed to flooding it also produces the highest rice yields owing to the frequent deposit of organic nutrients in silt.

Human assets are the knowledge, skills, and capacities of members of the community. There has been a government policy issued to promote rural education; however, this policy focuses on primary school education. Overall the current human assets in the study area need to be improved. Most boys of school age go to primary school but fewer girls are given the opportunity of an education. Because the older generation and women have been denied the opportunity to receive a basic education, this has in turn limited their modernising influence on their children and the wider community. Children are still sometimes taken out of school to do agricultural work for their families or may spend hours taking care of animal/livestock which prevents them from fully concentrating on their studies. As an observer in the field, I could also see how past actions continue to influence current outcomes. More than 90% of households in my study area are involved primarily in farming activities. Most families are unable to diversify and increase their incomes owing to limited knowledge, skills, and capacities. The flow of money in the commune is low and the incidence of ill health caused by diseases and so forth adversely affects their ability to work and earn more

income. Many cannot afford good quality medical services and there are few available to support them if an emergency situation should arise. Most qualified doctors tend to work in urban areas and in the private sector where they can earn more money.

Financial assets call attention to the availability of cash and savings that support self-reliance. In the study area, financial capital is not readily available. Monetary income from agricultural activities, savings and loans, remittances, and savings held in the form of jewellery and other property or belongings is poor. The income from agriculture is not stable; it depends on unpredictable natural conditions including rainfall, pests, and natural hazards. The price of agricultural products is often influenced by middlemen and excess supply during the harvest periods, which coincides with the time farmers have urgent debts to pay. This keeps price of agricultural products down. As a result, the income from agricultural activities remains low while the cost of agricultural inputs increases annually. For some families, the agricultural production cannot supply enough food and income over the year, especially when they face floods and droughts. Consequently, these families have no choice but to either borrow money from microfinance agencies or borrow food from relatives, neighbours, friends or those lending for profit in kind. The interest rates from these services are usually high and make it difficult for farmers to pay back debts. If the next farming cycle is not successful, these people have to sell jewellery or other property, or wait for remittances to come in. In some cases, this can lead to landlessness.

Social assets consist of networks, membership, relationships, familial support and trust. Social resources contribute to income generation and saving, as well as innovation and knowledge sharing (DFID, 1999). In my opinion, current social assets in the commune are in a fragile state. Some households send family members to work outside the commune so that they can send money back to support their families. Such migration is sometimes unsafe because people have limited access to information about the conditions at their destination and what they will have to cope with. People have to depend on middlemen and neighbours to make decisions for them. A few families sent members of their family to work outside the commune a few years ago and have not heard from them since. Another concern is that migration will result in all the mature young and middle aged adults leaving the community to find jobs, leaving children and the elderly to look after themselves. The fear is that if the trend continues the commune may lack enough adult labourers in the future to work in the fields.

People are willing to volunteer support for community work. There is a group called the Farmer Water User Community (FWUC) that has been set up recently to operate and maintain the new irrigation system, though the effectiveness of this FWUC is not yet known.

FWUC members are elected and the group is an official community-based organisation recognised by the Ministry of Water Resources and Meteorology.

Political support influences disaster preparedness and insurance. Existing national policies mainly focus on post-disaster emergency relief which do not take climate change into full account; coping and disaster response is given priority (MRC, 2009). Some disaster preparedness training has been provided to local authorities, and the poor, who have limited knowledge and capacity, do not benefit much from these. Discussions, on how effective training is, and what sorts of follow up measures are most appropriate, is more often debated than resolved. However, as mentioned above, there is a policy in place to promote insurance in the study area. The National Committee for Disaster Management (NCDM) and the Cambodian Red Cross (CRC) are strongly supported by the government and expected to provide emergency relief, recovery and rehabilitation support. In a society based on top down patron client relationships, small holder farmers come at the bottom of the hierarchy and their political voice is muted. Better participatory planning could change this and instead of waiting passively for empty promises from politicians, people could convey their own wishes and take a more active role in promoting adaptive plans to better manage events that might otherwise become disasters.

6.2.3 Thesis limitation

Under Victoria University of Wellington regulations, a Master's thesis must be completed within one year. Because of this, both observations in the field and the scope of documentation had to be kept to what I could do within this period. I was only able to review some of the main publications from an immense body of literature on disaster studies. I focused particularly on identifying current potential impacts and shortfalls in coping capacity that lead to current disasters. The factors that cause disasters were also examined and reviewed in **Section 6.2**. However, because of the time and resource constraints, and given the nature of this research, I could not extend my reading in a way that would strengthen my knowledge of comparative studies to a wider range of possible interventions. Future changes within the Mekong catchment including climate change, dam construction, and other at present unknown factors are sure to bring about social-ecological changes. This lacuna is given a place in the PAR model as a part of the need to account for uncertainty and complexity. It is included as a *complexity paradigm* in which multidisciplinary approaches are designed to see the holistic big picture and ensure long-term sustainability within uncertainty, making it necessary to keep the research process open and results constantly under review.

Following the mode and ethos of this principle, in the following section I will explore ideas that could be picked up and made the subject of further research as possible interventions. These ideas are based on information collected in the course of fieldwork and on current concepts and theories being discussed widely over the last few decades by academics and practitioners all over the world. I believe these ideas are relevant to, and adequately account for, environmental changes that are likely to impact on developing countries like Cambodia. This can be used by policy makers and national programme planners to set up coping strategies that will enable governments to better manage floods and droughts. Researchers may also find them of interest to their own work.

6.3 Further research and some possible interventions

6.3.1 Introduction and Sustainable Livelihoods (SL) approach

It is clear that disasters occur when vulnerability is adversely tested by hazards. In order to minimise disasters, both vulnerability and hazards have to be reduced. The five assets discussed above, if found to be healthy and strong, can be used to reduce both vulnerability and hazards. These assets build the human capacity to cope with and adapt to hazards. People need these assets to prepare, respond, recover, as well as remain functioning after disturbances have passed. Assets are the most important components needed to build a resilient community. These assets can be built by using a Sustainable Livelihoods approach as a guide to development work and/or as a research framework.

The aim of the Sustainable Livelihoods[9] approach is to build a long-term resilient community that can both respond positively to and recover from hazard events. A healthy community with sustainable livelihoods should be able to cope with hazards and remain functioning after such disturbances. The livelihoods approach outlines six core principles including *people-centred, holistic, dynamic, building on strengths, macro-micro links,* and *sustainability* (DFID, 1999). Based on DFID (1999), these principles can be described as follows. *People-centred* is a principle that focuses on those at the community level and their changing livelihoods, the impacts and influences of policy frameworks on livelihoods, as well as respect for local perspectives. A *holistic* principle seeks opportunities and constraints through a system approach that involves various influences, actors, and livelihoods strategies/outcomes so as to understand factors that affect sustainable livelihoods. The *dynamic* principle promotes investigation, understanding, and continuous learning from on-

[9] "A livelihood comprises the capabilities, assets (including both material and social resources) and activities required for a means of living" (DFID, 1999, p. 1)

going changes in order to solve complex and uncertain problems. *Building on strengths* is another principle which searches for people's strengths and uses these as inherent potential to achieve their objectives, while constraints are either minimised or removed. *Macro-micro links* aim to enhance the participatory work/connection between the external national/regional level and local communities in terms of linkages between policy/institutions and local people's livelihoods/lesson learnt. Finally, the *sustainability* principle promotes resilience and minimises livelihoods' compromise. Consequently, I apply these principles as part of my proposed intervention. The PAR model discussed in **Section 6.3.3** deals with most of these principles (*people-centred*: improving the community's livelihoods; *holistic*: understanding that the natural environmental consists of both constraints and opportunities; *building on strengths*: searching possible intevensions to build required assets; *macro-micro links*: understanding that local community alone cannot overcomes the pressures from political, economic, and social structures; and *sustainability*: promoting sustainable livelihoods). Adaptation (coping and adapting), adaptive management, and participatory action research shown in **Section 6.3.4,** deal mostly with the dynamic principle, and the principles of building on strengths and sustainability. Finally, the ideas from these sections will be brought to the suggested framework in **Section 6.3.5**.

The SLF provides a big picture format into which reliable information can be drafted and subsequently used to plan livelihood activities. This framework also makes it possible to identify potential transforming structures and processes that could have a direct influence on both the status of assets and the vulnerability context. The PAR model is similar to the SLF but focuses more specifically on disasters and hazards, and lends itself to explaining how transforming structures and processes work.

As explained, we can see that SL and especially the SLF and PAR/adaptation (the coping and adapting model) can refine the process of minimising vulnerability and hazards. I would argue that in order to reduce disaster risk, the five assets have to be improved through an SL approach and preliminary analytical work using the SLF and PAR model. These assets can be used as capacities to cope and adapt to disturbances. Enhanced capacities can minimise vulnerability and hazard impacts within a situation of environmental change. To meet the challenges of environmental change management itself, adaptive and participatory action research should be used. In the following sections I will discuss the usefulness of the SLF, followed by a discussion of how the PAR model provides a guideline for adaptation and can be used as a tool in the challenge to cope with environmental changes.

6.3.2 The Sustainable Livelihoods Framework (SLF)

The Sustainable Livelihoods Framework (SLF) is a heuristic device that enables researchers to assemble the many different aspects of a livelihood system and present the system in a manner that focuses on people as the centre, showing how local people and stakeholders share in a situation where if they work together in a development process, they may be able to reduce poverty. This framework provides an overall picture of issues affecting livelihoods, the key influences and processes, and the interaction of the different elements that affect livelihoods. Thus, this framework can be used to prepare development plans designed to improve people's livelihoods.

The SLF is a flexible tool consisting of several major components such as *vulnerability context, livelihood assets, transforming structure and processes, livelihoods strategies,* and *livelihood outcomes* (DFID, 1999). The *vulnerability context* includes those external factors that influence (creating or diminishing) *livelihood assets*. In a living situation with limited assets, people are less able to cope and recover from disturbances that heighten their vulnerability. *Livelihood assets* can be both opportunities and strengths on which to build people's capacities and make them less vulnerable to disturbances. These assets are used to secure livelihoods and access to them may differ from household to household. The assets are interrelated and access to one or more asset may influence access to other assets (DFID, 1999). If people have land, they can use this land to access micro credit. The *transforming structure and processes* account for the agencies, institutes, and policies that influence access to livelihood assets. They can create assets, and determine who gets access to assets through political intervention. *Livelihoods strategies* are what people do, the activities they resort to claim available assets as opportunities and choices. This helps people to secure their livelihoods and to maintain resilience in the face of disturbances. The policies made by *transforming structure and processes* also cause direct impacts on livelihoods options. *Livelihood outcomes* are the final achievements made by people who mobilise relevant *livelihoods strategies*. The favoured outcomes from *livelihood outcomes* may remain as goals and could be such things as generating more income, increasing well-being and food security while decreasing vulnerability to disturbances.

The *vulnerability context* is an external factor which local people may have little say in altering. *Transforming structures and process* that can correct the *vulnerability context* lie mainly in the political structure embedded in *root causes* and *dynamic pressures* of the PAR model. The PAR model lends itself more explicitly as a tool to understand what actions should be taken in order to covert vulnerability into capacities.

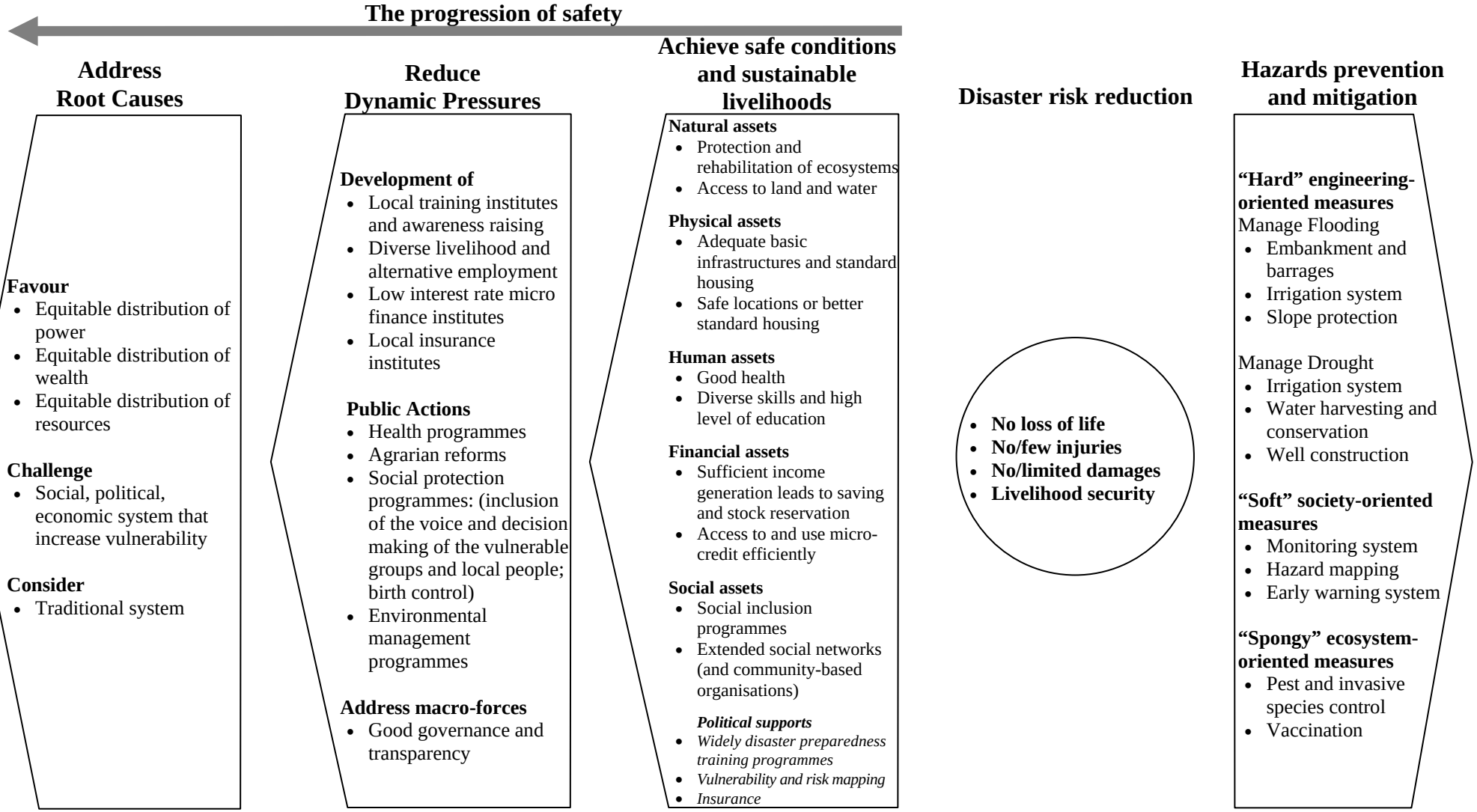
6.3.3 Safety processes of PAR

The *natural environment* can cover both the constraints of vulnerability and possible hazards, and the opportunities of assets/resources (Wisner et al., 2012). Human activities such as policy and economic decisions influence the *natural environment*. Political and economic systems affect people's access to livelihoods, their means of protection, and the exposure to hazards which can lead to increased vulnerability. High vulnerability to hazards results in disasters. On the other hand, if the *natural environment* is well managed, it can also provide opportunities and assets/resources that strengthen the capacity of people to use the assets most likely to minimize vulnerability and mitigate hazards. However, these critical assets are not equally available to different groups and individual households. Currently, the poor, women, and other vulnerable groups have less favourable access. As access is usually determined by privileges embedded in political, economic, and social structures, they are not so easy to change. And as I have already observed, these make up the *root causes* and *dynamic pressures* that tend to keep things as they are, with the poor locked into high vulnerability and the rich more able to cope. Limited access results in marginalization that exacerbates the position of the poor, leaving them more vulnerable to harm from floods and droughts. The solution is to find a way to release this lock by modifying the *root causes* and *dynamic pressures.*

We can see that the five assets of the PAR model are the key here. These assets/resources can be used as capacities to cope and recover from shocks (Kuban & MacKenzie-Carey, 2001; Wisner, Blaikie, Cannon, & Davis, 2004). Wisner et.al. (2012) provide a good description of these assets/resources as opportunities. Natural assets, including crops and biodiversity, include water and food stocks. Physical assets, in terms of safe housing and infrastructure, make people safer when faced with hazards. Human assets are knowledge and skills that provide alternative income generating activities and the ability to cope with hazards. Financial assets provide a source of money that people can use to cope with shocks. Social assets such as social networks and kinship are the forms of solidarity that can be drawn on in emergencies.

As explained earlier, political, economic, and social structures can process these assets so that they become opportunities. Addressing the *root causes* and reducing the *dynamic pressures* can turn these structures around, as shown in the following figure.

Figure 6.5: The progress to release the "pressures" leading to disaster risk reduction from floods and droughts in my research area



Adapted from Ahmed (2003); Blaikie et al. (1994); Chambers and Conway (1991); Wisner et al. (2012)

The figure above illustrates clearly the progression toward a safer community. Firstly, we need to both minimize vulnerability and increase capacities. This can be achieved through *achieving safe conditions and sustainable livelihoods.* Addressing *roots causes* and reducing *dynamic pressures* are the ways to use the critical five assets as a positive force to improve people's capacity and livelihoods strategies and outcomes. To promote access to these assets, DFID (1999) indicates in its discussion of SL assets/capital areas in which possible intervention can be made.

Table 6.3: Possible assets interventions and their impacts

Assets	**Interventions**		**Impacts**
	Direct support ***(provision of)***	**Indirect support** (***transforming structure and processes***)	
Natural	• Natural resources conservation • Efficient resources allocation for agricultural purposes	• Environmental policies • Reform the structure of local natural resources institutes • Market development (price of natural and agricultural products)	Sustainable natural resources can be used as income generation and natural stock.
Physical	• Development in physical resources	• Reform sector programmes • Effective participatory processes • Promote private sector involvement • Promote own construction and management	Income and other resources can be used to build physical resources resulting well-being improvement
Human	• Health and educational infrastructure and personnel • Knowledge and skills development	• Health and educational policies and organisations • Reform local institutions to ensure equal access	Improved human resources lead to enhanced income and food security that can be used to reinvest in education and health services. Therefore, vulnerability and birth rate will be decreased.
Financial	None	• Policies and reform toward rural microfinance institutes and organisations with low interest rates • Support equal access to credit	Increased income and saving can be used to invest in other resources.
Social	• Support for the internal group's leadership and management • Support for network linkage with others	• Policies on network formation and structure • Good governance • Equal participation and decision making	Enhanced networking and participation can be used to strengthen resources management effectively and efficiently.

Adapted from DFID (1999)

Secondly, we need to deal with hazards, because disaster risks are a function of vulnerability and hazards. According Wisner et al. (2012), hazards can either be prevented or mitigated through "hard" and "soft" engineering and "spongy" ecosystem-oriented measures. "Hard" engineering can be construction works such as embankments, while "soft" engineering can be an early warning system and hazard mapping. "Spongy" ecosystem-oriented measures following an event, focus on pest management and the possible outbreak of diseases. This can be controlled by pest control and vaccination. If we follow the *complexity paradigm*, all aspects that can possibly cause disasters should be looked at. Table 6.3 above provides an overview of the matters that need to be taken into account if disaster risks are to be reduced. As is discussed in **Section 6.3.4** below, the five assets can be targeted to minimise vulnerability and to increase the human capacity for coping and adapting to floods and droughts. Therefore, when these assets are built up, people will become more capable of finding a way to prevent or mitigate hazard with reference to the assets immediately available to them, or at least they would know how to get outside support. However, in Cambodia, where most rural people live in remote areas below the poverty line and have limited access to assets/resources, vulnerability and "soft" engineering measures and an early warning system should be the first priority, followed by "spongy" ecosystem-oriented measures and, where relevant, "hard" engineering.

Many possible solutions to minimise disasters were discussed with local people during the field research as is shown in **Section 5.3.3**, and these mainly include agricultural support as well as water supply and sanitation programmes. These show outsiders what kind of activities would be helpful; however, I will not specify detailed activities that need to be carried out for several reasons. The situation is dynamic; future hazards will be affected by climate change, new dams will be built along the Mekong River, and there are other unexpected factors that I have been unable to take into account in this limited study. And these would all have to be factored into subsequent profiles and appropriate interventions drawn up to fit the changing circumstances. However, we do know what assets can be used to protect and mitigate natural hazards. The status of some of those listed in Table 6.3 could be changed by informed development work. This could clear the way for a situation in which an improved configuration of assets could then be used for "hard" and "soft" engineering-oriented and "spongy" ecosystem-oriented measures.

6.3.4 Towards a better community

If we use the five assets configuration of PAR, it lists the political category as a separate characteristic which directs our attention, not so much to preparedness in terms of

passive coping with events as they occur (as used in the 1990s and are described in Chapter 2), to developing a more proactive capacity to adapt as has been promoted in recent decades (Lavell, 2003). Coping requires that assets/resources and knowledge be made ready in advance of events to enhance the response to hazards and can be achieved through planning and disaster preparedness, early warning, and awareness raising (IPCC, 2012). However, coping alone is not enough to reduce disaster risks and if future natural hazards exceed expectations then preparedness itself will be found wanting. Coping strategies need to be supplemented by proactive adapting strategies that reduce vulnerability through modifying exposure and/or sensitivity; and this contributes to risk reduction by anticipating changes in the magnitude of risks and through political action that find a way to minimise these (Blaikie et al., 1994). The capacity of each of the fields identified in the asset configuration need to be enhanced to reduce and/or prevent disasters from occurring but above all of these it is collective action, and committed follow up to planning that can have the most profound effect (Cardona, 2010; Lavell, 2003; Maskrey, 1994). This implies a political willingness to prioritise adaptation. When the risk is minimised, people need fewer assets to cope with potential hazards. Such a state indicates that a good level of sustainable livelihoods has been achieved.

Future capacity is likely to be affected by climate change and dam construction along the Mekong River. Based on IPCC (2012), it is expected that future climate change will cause extreme floods and droughts. This will severely test capacity and resilience because people's assets/resources may be seriously compromised by these hazards (UNISDR, 2009b; Wisner & Adams, 2002). This makes it all the more urgent for attention to be given, not only to alleviating poverty but to building the capacity of the poor so they can survive coming hazards. The current political and diplomatic set up of the Mekong Commission cannot influence, let alone control, the number and type of dams built or already under construction in China. The national demand for power in Thailand is likely to result in several hydro-dams being built in the DPR Lao; these will change water levels and unanticipated discharge may result in surge flows along the Mekong that may place downstream communities at risk. At present many dams have been proposed along the Mekong River, and future impacts from these projects remain unknown.

An enhanced capacity for handling change is needed, especially within the current state of uncertainty, in order to prepare for future disturbances. This may have to wait for a recovery phase when people reflect and learn from past actions (Birkmann et al., 2010; Vogel & O'Brien, 2004). This implies that nothing will be done until after a disaster has occurred.

During such phases, people have to rethink ways to develop and strengthen their future within an unforgiving regime of environmental changes. For example, damaged physical infrastructure can be rebuilt and placed in a way that minimises future risk, the rice cultivation schedule can be moved to better fit in with shifts in weather patterns, new disease resistant rice varieties can be introduced and grown in the damaged rice fields. During the recovery phase, local people and outsiders can identify previous conditions leading to vulnerability in order to solve the root causes of disasters. They can learn from the past and improve their decision making for the future through participatory discussion, reflection, and planning (Christoplos, 2006; IDB, 2007). But why must a community wait for disaster to strike before building the necessary resilience through transformational change? It is clear that both coping and adapting have to take place; transformational change sums up the challenge of dealing with the complexity of uncertainty.

Transformation requires that qualitative changes be made in both the system and structure; a new paradigm needs to be put in place that shifts policy from doing the minimum which only enables people to passively cope with a challenging situation, to one under which positive adaptation becomes possible (Folke et al., 2010; IPCC, 2012; A. Smith & Stirling, 2010). These changes, through proactive policies and intervention toward better adaptation, are elements of safety processes mentioned in **Section 6.3.3.** These safety processes build up the required assets/resources that can be used in adaptation. In order to adapt to future extreme disturbances within uncertainty, adaptation is shifting toward an approach that ensures resilience through learning and its associated iterative processes (Hallegatte, Lecocq, & De Perthuis, 2011; IPCC, 2012). Given the political will, learning and iterative processes can be achieved through participatory action research and adaptive management.

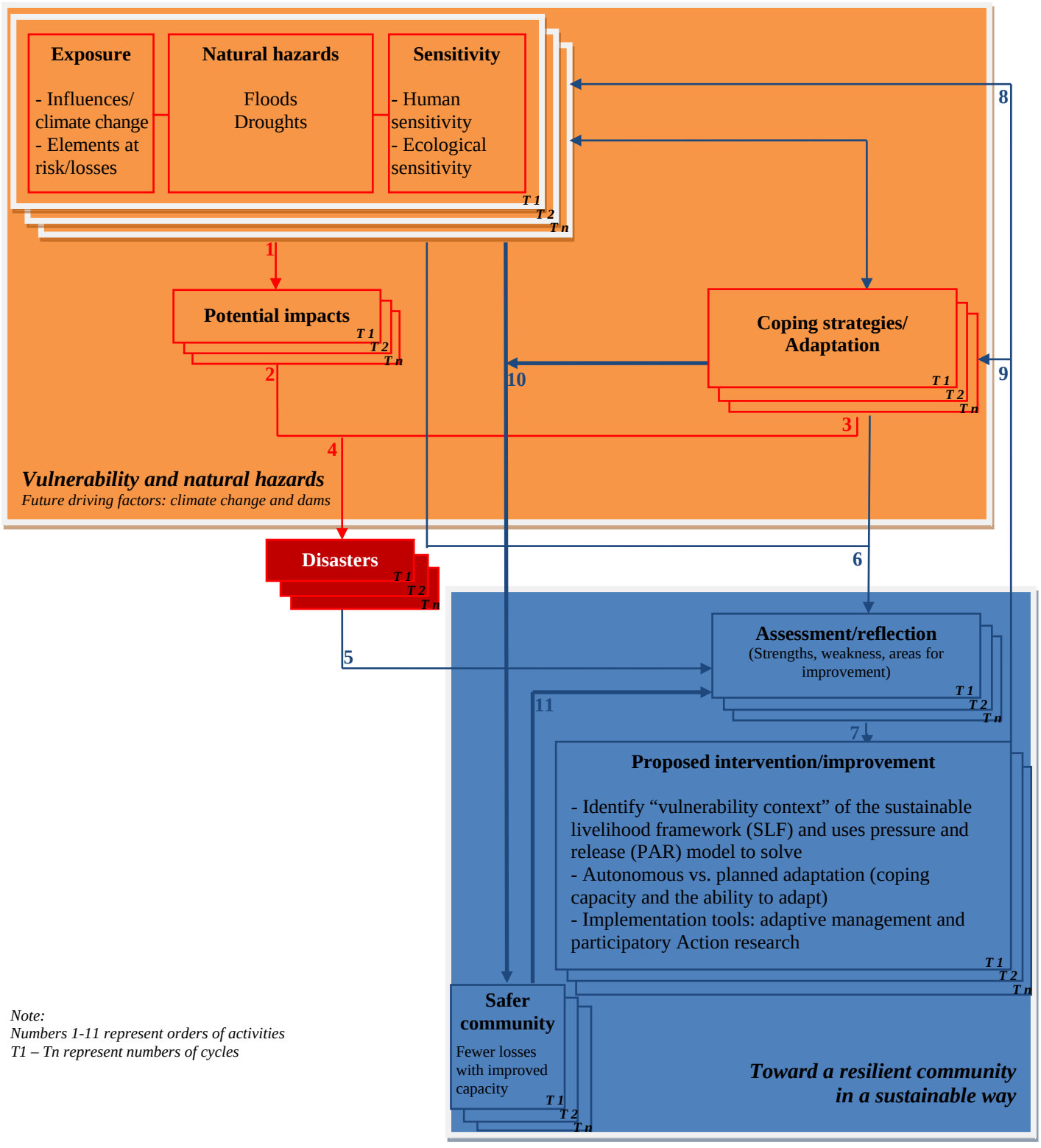
Participatory action research is a development tool, and it achieves more than traditional research. It aims to identify problems and solve these in a cyclical process rather than taking no action, as is expected of conventional research. Action research usually involves a cycle of planning, taking action, analysing evidence, and reflecting for the next cycle (Riel, 2007). Participatory action research ensures that both outside specialists and local people can work and share knowledge so that they can learn collaboratively (Whyte, 1991). The voices of all people, especially the poor, are included in this kind of research. Local people, again especially the poor, can raise their needs and concerns as well as propose solutions and make decisions. This type of research may be very political, but it is a very effective tool, if conducted correctly, to empower local people and to promote sustainability.

Adaptive management, an iterative process of learning from participatory problem identification, interventional actions and reflection (Berkes, 2009), can improve decision making through a learning-by-doing approach. Therefore, it is useful for people who need to adapt to and live with uncertain environmental changes. In the face of limited information with few response strategies available, the approach recommends that experimentation be set up in such a way as to facilitates innovation (Armitage, Marschke, & Plummer, 2008) and to optimise learning of new knowledge and information used to inform policies, making both better decisions and better solutions. Through a continuous iterative process, innovations themselves can become a generative source of positive changes with a wide range of social and technological implications, including special knowledge and resources that feed into radical transformations of adaptation practices (IPCC, 2012).

6.3.5 Suggested framework

Based on the discussion in **Section 6.3.1, 6.3.2, 6.3.3, and 6.3.4,** and combined with concepts drawn from disaster risk reduction and climate change adaptation, I believe the following figure (Figure 6.6) provides a guide to, and summary of, the ideas discussed above. Firstly, this framework builds on my previous framework in Figure 2.5 in **Section 2.2.5,** illustrating three main components, including natural hazards and potential impacts, disasters and coping strategies, as well as vulnerability and proposed interventions that were described and discussed in Chapters IV, V, and VI respectively. Secondly, I add an idea for long-term sustainable livelihoods despite environmental changes, that could be used to monitor interventions and continue to build required assets for adapting to natural hazards. I use the interrelationships between these ideas to propose a sequence of activities through 11 steps. Work is set up to follow a continuous iterative loop back at each step in the overall process rather than waiting for a complete cycle to be completed. This means that activities are progressively informed by information gathered, learnt, reviewed, and reflected on at each step. The aim is to achieve continual improvements at each loop. Following this principle, the 11th activity is not the final step but is itself assessed and subjected to critical reflection in order to improve the system and engage in the examination of subsequent hazards more effectively.

Figure 6.6: Action research framework to achieve long-term sustainable livelihoods and resilience



Note:
Numbers 1-11 represent orders of activities
T1 – Tn represent numbers of cycles

Source: Author 2012

Chapter VII: Conclusions

A hybrid of the development and complexity paradigms provides a bigger picture of the interrelationships between disasters, vulnerability, and natural hazards. The hybrid paradigm focuses on a multidisciplinary approach to integrate disaster risk management and climate change adaptation models to highlight problems and to propose interventions. In the attempt to implement this idea, the research used the Sustainable Livelihood Framework (SLF) and the Pressure and Release (PAR) model through the use of PLA/PRA and RRA tools, observations, and secondary data. In this hybrid paradigm, disasters are viewed as outputs of natural hazards which coincide with levels of vulnerability. Natural hazards such as floods and droughts have already had significant impacts on people's livelihoods, and these natural hazards are expected to become more frequent and severe in the future. Vulnerability reduces the capacity of people to cope with disturbances, and disturbances themselves can in turn make people more vulnerable to future events. The following paragraphs summarise the information that has been presented on the causes of floods and droughts, the impacts of disasters and the ways people cope with them, the causes of vulnerability and its relation to disasters, and proposed interventions.

Firstly, floods and droughts in the study area link to the region wide hydrological system of the Mekong Basin, to climate change, and to dams. Floods come from rising water levels in the Mekong River and heavy rainfall at local, national, and regional levels in Mekong tributaries; fortunately, the water does not rise dangerously fast. Floods usually occur between July and October, and severe floods often occur during September. Since 1999, floods have become more frequent and severe, especially in 2000 and 2011. Quite the opposite to floods, droughts are characterised by serious water deficits in canals, ponds, and underground, by poor rainfall and by low soil moisture, especially between January and March when temperatures are high and rainfall is rare. Since 1994, droughts have become more frequent and severe; for example, one of the longest droughts on record was experienced in 2004 when no rain fell for 7 months.

Future floods and droughts are likely to change their patterns. Significant changes in climatic data have been recorded between 1984 and 2010 in Prey Veng Province. The data seems to show that the average annual rainfall has slowly increased. However, the distribution of rainfall has actually changed. Rainfall has increased in many months of the years while the rainfall in June and September has decreased. Moreover, between 1997 and 2010, the annual

maximum temperature trended upwards while the annual minimum temperature declined. These extreme temperatures are either higher or lower than the normal range. Changes in rainfall and temperature indicate that future floods and droughts will follow a different pattern.

It may be possible that current changes are likely to result in more frequent floods and droughts in the study commune. These findings are consistent with research carried out by Eastham et. al. (2008) which indicates that marked changes in temperature, precipitation, and evaporation occurred in the Mekong Basin between 1951 and 2000. He estimates that these changes will result in significant increases in runoff, discharge, and river flow in the basin by 2030. As the study area is located in the Lower Mekong River, the accumulative impacts of changes in the upper catchments are likely to be much greater. As a result, it is likely that extreme floods will become more frequent and severe. Furthermore, the increase in both temperature and evaporation, combined with a decreasing mean monthly flow and lower discharge during the dry season, could well become a factor in increasing the intensity of droughts.

Dams affect floods and droughts in several ways. Floods in the wet season may be reduced because either the water will be stored in dam reservoirs, or the water level will be controlled and released in a consistent manner. But when there is a huge flood will the dam operator release this water in the form of a flash flood in order to preserve dam operation? Besides, due to the fact that dams need big reservoirs to store water, some areas will be permanently inundated. However, in the dry season, droughts may be severe for two reasons. In the upper catchment water may be withheld, stored in reservoirs to supply water for dams or diverted for irrigation. The lower water discharge and flow may also result in a ground water deficit.

Secondly, both floods and droughts have direct impacts on crops and personal property, people, community infrastructure and environment, as well as indirect impacts. For direct impacts, the most significant losses in order of importance are likely to be crops and personal property, followed by human diseases, community infrastructure and environment damage. Rice and other crops such as mango, potato, cucumber, gourd, and pumpkin are often destroyed by these natural hazards. Moreover, livestock such as chickens, ducks, cows, and buffalos are often lost or fall ill, while clothes and kitchen materials are sometimes lost, especially during floods. Floods and droughts also affect local people’s income generation and spending. Food shortages come into play, and diseases, like amoebic dysentery that spread quickly, are common. Common disturbances to community infrastructure and

environment include inundated roads and limited access to pagodas, schools, and health centres, damaged storage ponds and canals, and declines in fish stock can be expected. However, it should also be noted that floods can bring a few benefits such as nutrients being spread on the soil, pests being removed, and opportunities created for recession rice cultivation. The major indirect impacts of floods and droughts are the loss of both resources and time during these events which are slow to recover after the event has passed.

To cope with these natural hazards, local people and other stakeholders use a range of available resources and knowledge. Coping with floods can be categorized into three sequential periods: before, during, and after events.

- Before the floods, people usually give priority to an early warning system. They store enough food and medicine, prepare a place to which they can evacuate people and livestock, design flood proof houses, having sandbags and pumps available, delay rice cultivation if informed that a flood is on the way, and assemble teams of volunteers to help people.
- During the floods, useful activities are usually quickly put in place. These involve evacuation and rescue, the provision of emergency relief, boiling or filtering water, accessing emergency money and loans, selling personal property, and engaging in temporary alternative income generation such as fishing or going in search of paid employment. Getting food can be a challenge and survivors often have to change their eating habits.
- After the floods, seeds are often given to farmers. Rehabilitation and recovery are usually undertaken if there are enough resources and outside support is available.

For droughts, the coping strategy is similar to floods. The coping methods include taking note of early warnings, using ground water, ponds and pumps, distributing food and medicines, people accessing loans, selling personal property, changing eating habits, and moving in search of work. Some material aids used to cope in times of floods and droughts have only become available in recent years and include water filters, pharmaceutical medicines, elevated evacuation areas, short term rice varieties, micro finance and emigration. However, these more recent coping strategies still contribute little to sustainable mitigation of disasters in an effective and efficient manner.

Thirdly, vulnerability is the main cause of disasters. By integrating the vulnerability context of the Sustainable Livelihoods Framework with the Pressure and Release (PAR) model I was able to show how vulnerability is exacerbated by dissonant social, economic, and political structures. These structures are the *root causes* and generate the dysfunctional *dynamic pressures* that diminish the availability of Sustainable Livelihood assets including natural, physical, human, social/political and financial capital to people resulting in

increasingly *fragile livelihoods and unsafe conditions*. The origin of these *root causes, that were not be examined in detail in the course of this research will hopefully be the subject of further research.* These can be traced back to:

- French colonial rule from 1863 to 1953;
- the serious civil war of the 1970s and subsequent Khmer Rouge rule under the Pol Pot regime; and
- unequal access to resources, structure, and power throughout the political and economic systems that have occupied central stage over recent times.

These conditions have denied access to people, especially the poor and other vulnerable groups such as women, children, and the elderly, to a reasonable share of national assets. *Dynamic pressures* consist of societal shortfalls or deficiencies, and macro-forces. Societal deficiencies include inaccessible and insufficient local educational institutions, especially at secondary and high school level, lack of alternative job opportunities outside the agricultural sector, inaccessible low interest microfinance loans especially for the poor, and the unavailability of insurance. Vulnerable groups, who have limited capacities, resources, and knowledge, have less influence on decision making to support their needs. Macro forces include population pressure, adult migration, reliance on external support, insufficient protection for the poor, and the degradation of environmental resources.

Furthermore, this research has explored the nature of current disasters, contemporary vulnerability, and how floods and droughts have impacted or are likely to impact on the study area. Owing to the limited nature of the research in terms of both the time and resources made available for fieldwork, it has not been possible to thoroughly test the implications and likely usefulness of the suggested hybrid intervention model. In its place I offer it as an idea that could be adopted for further research into interventions and innovation in hazard mitigation. To start with, the integrated Sustainable Livelihoods Framework (SLF) and the Pressure and Release (PAR) model could be used as a guide to build assets/resources and human capacities required to reduce disaster risk by minimising vulnerability. To adequately overcome future environmental changes and uncertainty, iterative adaptation along with flexible, adaptive management supported by Participatory Action Research should be used. Adaptation promotes coping and diminishes the negative impacts of disturbances. Adaptive management and Participatory Action Research enhance continuous learning and transformational change in iterative processes.

Environmental changes are certain to occur, especially in the Mekong River catchment. These changes will come from climate change, dam construction along the Mekong River, and other unexpected issues. The future impacts will be severe and if there is no significant planning and action taken now, the consequences could be disastrous. Although vulnerability should be given to less developed countries, the key to minimising future disaster risks is to reduce both natural hazards and vulnerability by enhancing peoples livelihoods and assets/resources as the means to improving local capacity to cope with likely disturbances. The proposed framework presented in Figure 6.6 is designed to help people, especially people in Cambodia and other countries along the Mekong River, to see the big picture, in which disasters occur and how their impacts may be reduced. It lends itself to use by policy makers and national programme planners to remind them of the big picture made up of vulnerability, natural hazards, and disasters. It is hoped that the framework proposed and the ideas discussed in this dissertation will encourage subsequent researchers to refine their own research objectives. Researchers have an important role to play, not only conducting research that will immediately inform policy, but by making positive contributions to a flow of information that will sustain a creative iterative process.

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Appendix I: Checklist for field research

1.1 Semi-structured interview with related local government and non-government agencies

- Current situation of floods and droughts (magnitude, duration, speed of onset)
- Why some villages have problems with floods while others are concerned about droughts
- Trend of floods and droughts (frequency, historical performance, probability)
- Hydrological situation
- Statistics/data related the damages (people, goods, and environment)
- Socio-economic situation, environmental resources, and political structure
- Adaptation options that people have done so far to deal with the disasters; suggestions and recommendations for improvement
- What is the safe place during floods?
- Organization's roles and responsibilities before, during, and after the disasters
- Relevant policies, regulation frameworks, agreements

1.2 PLA/RRA/PRA tools with villagers based on "PLA Manual" by McKinnon & McKinnon (2010)

Social Economic classification

- Well Being Analysis: to classify the socio economic conditions of villagers.
    - List of households and put them in four wealth groups
    - Reasons/characteristics of each wealth group

Note: This exercise was not carried out because it had already been conducted by the commune authority based on criteria developed by the Ministry of Planning. The criteria and activities used are similar to what I intended to do; therefore, I decided to use this result for my research.

Impacts/damages identifications

- Seasonal Calendar
    - Annual farming cycle and other significant events in each season as well as finding out the main patterns of villagers' activities, and
    - Note on significant periods of each activities/events.
- Problem and Possibility Analysis: to explore the problems and issues related with floods and droughts.

Resilience/Coping strategies

- Institutional Analysis and Network and Mobility Mapping
    - Networks with insiders and outsiders and for what purposes
    - Importance of the networks/linkages
    - Flow of products/services due to the networks/linkages
- Problem and Possibility Analysis
    - Disasters and issues caused by floods and droughts and their root causes
    - Discussion on proposed coping strategies

Other tools

- Hazard mapping
    - Sketch map of the commune
    - Villages - exposure to floods and droughts
- Historical timeline
    - Floods and droughts' occurrences in the last decade, and
    - Significant disasters
- Transect Walk
    - Paddy field, canal and water sources, as well as village land and houses
    - Soil types
    - Agricultural activities: crops and livestock wildlife
    - Problems and opportunities